Hazel Avenue/U.S. 50 Interchange Project

SACRAMENTO COUNTY AND CITY OF RANCHO CORDOVA, CALIFORNIA
DISTRICT 3–SAC–50, (15.0/17.2)
03-3E380/0300020439
County Control Number 2011-70062

Public Final Environmental Impact Report/ Environmental Assessment

Volume 3: Technical Studies



Prepared by the
State of California Department of Transportation
and County of Sacramento

The environmental review, consultation, and any other actions required by applicable Federal environmental laws for this project are being, or have been, carried out by Caltrans pursuant to 23 U.S.C. 327 and the Memorandum of Understanding dated December 23, 2016 and executed by FHWA and Caltrans.

July 2020

Volume 3: Technical Studies

Copies of the following technical studies are included in this volume and are also available at the Sacramento County Office of Planning and Environmental Review, 827 7th Street, Sacramento, CA 95814. The documents can also be downloaded from the project website at http://www.sacdot.com/Pages/Project-Hazel-StateRoute50.aspx.

Community Impact Assessment

Traffic Operations Report

Visual Impact Assessment

Historic Property Survey Report including Archaeological Survey Report

Location Hydraulic Study

Water Quality Assessment Report

Paleontological Evaluation Report and Preliminary Paleontological Mitigation Plan

Hazardous Waste Initial Site Assessment

Air Quality Study Report

Noise Study Report

Noise Abatement Decisions Report

Natural Environment Study

Aquatic Resources Delineation

Tree Survey Memorandum

Biological Assessment

Biological Opinion

Mitigation Monitoring and Reporting Program (MMRP)

Hazel Avenue/U.S. Route 50 Interchange Project



Community Impact Assessment

Hazel Avenue/U.S. Route 50 Interchange Project
City of Rancho Cordova, Sacramento County
03-SAC-50/PM 15.1-17.5
Federal Project No.: EA 03-3E380/E-FIS 0300020439
County Control Number: 2011-70062

The environmental review, consultation, and any other action required in accordance with applicable federal laws for this project is being, or has been, carried out by the Department under its assumption of responsibility pursuant to 23 U.S. Code 327.

January 2017

Caltrans
CALIFORNIA DEPARTMENT OF TRANSPORTATION

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Community Impact Assessment

Hazel Avenue/U.S. Route 50 Interchange Project

City of Rancho Cordova, Sacramento County

03-SAC-50/PM 15.1-17.5

Federal Project No.: EA 03-3E380/E-FIS 0300020439

County Control Number: 2011-70062

January 2017

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Acronyms and Abbreviations

Caltrans	California Department of Transportation
CEQ	Council on Environmental Quality
CEQA	California Environmental Quality Act
CHP	California Highway Patrol
CIA	Communicate Impact Assessment
EMS	California Emergency Services
EO	Executive Order
FHWA	Federal Highway Administration
HOV	high occupancy vehicle
LOS	Level of Service
MSE	Mechanically Stabilized Earth
MTIP	Metropolitan Transportation Improvement Program
MTP/SCS	Metropolitan Transportation Plan/Sustainable Communities Strategy
NEPA	National Environmental Policy Act
RCDP	Rancho Cordova Police Department
ROW	right-of-way
SACOG	Sacramento Area Council of Governments
SPTC-JPA	Sacramento Placerville Transportation Corridor Joint Powers Authority
TMP	transportation management plan
UPRR	Union Pacific Railroad
USC	U.S. Code

Chapter 1 Introduction

This Community Impact Assessment (CIA) is prepared for the Hazel Avenue/U.S. 50 (US 50) Interchange Project (proposed project) by California Department of Transportation (Caltrans) standards as defined in the Standard Environmental Reference. The information in this document has been prepared as a "blended" assessment to comply with both the California Environmental Quality Act (CEQA) and the National Environmental Policy Act (NEPA), and other substantive environmental laws applicable to the subjects addressed in this document.

1.1 What is a Community Impact Assessment

The purpose of this report is to provide information regarding social, economic, and land use effects of the project so that final transportation decisions will be made in the public interest. The report is intended to clearly describe the relevant existing conditions and the potential socioeconomic impacts of the project.

Both NEPA and CEQA require consideration of social and economic impacts of projects in the preparation of environmental documents.

1.2 Laws and Regulations

This document has been prepared to comply with the following laws and regulations.

1.2.1 California Environmental Quality Act

CEQA is a California statute passed in 1970, shortly after the United States federal government passed NEPA, to institute a statewide policy of environmental protection. Caltrans is the "lead agency" under CEQA.

1.2.2 National Environmental Policy Act

NEPA is a United States environmental law that established a U.S. national policy promoting the enhancement of the environment and also established the President's Council on Environmental Quality (CEQ). Caltrans is the lead agency under NEPA for the majority of transportation projects on the State Highway System that have federal funding, as explained in Section 1.2.3, NEPA Assignment.

1.2.3 NEPA Assignment

Oversight of the NEPA environmental process for transportation projects has historically been the responsibility of the Federal Highway Administration (FHWA). California participated in the "Surface Transportation Project Delivery Pilot Program" (Pilot Program) pursuant to 23 USC 327, for more than 5 years, beginning July 1, 2007 and ending September 30, 2012. The Moving Ahead for Progress in the 21st Century Act, known as MAP-21 (P.L. 112-141), signed by President Obama on July 6th, 2012, amended 23 USC 327 to establish a revised and permanent Surface Transportation Project Delivery Program. As a result, Caltrans entered into a memorandum of understanding (MOU) pursuant to 23 USC 327 (NEPA Assignment MOU) with FHWA. The NEPA Assignment MOU became effective October 1, 2012 and terminates 18 months from the effective date of FHWA regulations developed to clarify amendments to 23 USC 327 or on January 1, 2017. The NEPA Assignment MOU incorporates by reference the terms and conditions of the NEPA Delegation Pilot Program MOU. Caltrans continues to assume FHWA responsibilities under NEPA and other federal environmental laws in the same manner as was assigned under the Pilot Program, with minor changes.

1.2.4 Title VI of the Civil Rights Act

Title VI of the Civil Rights Act of 1964 and related statutes require there be no discrimination in federally-assisted programs on the basis of race, color, national origin, age, sex, or disability; religion is a protected category under the Fair Housing Act of 1968.

1.2.5 Executive Order 12898

Signed by President Clinton in 1994, Executive Order (EO) 12898 established a directive addressing environmental justice impacts of federal actions. Environmental Justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies, and addresses environmental justice in low-income and minority communities. This EO directs federal agencies to take the appropriate and necessary steps to identify and address disproportionately high and adverse effects of federal projects on the health or environment of minority and low-income populations to the greatest extent practicable and permitted by law.

1.2.6 Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, and as amended in 1987

"The Uniform Act" intends (1) to provide uniform, fair, and equitable treatment of persons whose real property is acquired or who are displaced in connection with federally funded projects; (2) to ensure relocation assistance is provided to displaced persons to lessen the emotional and financial impact of displacement; (3) to ensure that no individual or family is displaced unless decent, safe, and sanitary housing is available within the displaced person's financial means; (4) to help improve the housing conditions of displaced persons living in substandard housing; and (5) to encourage and expedite acquisition by agreement and without coercion.

1.2.7 Americans with Disabilities Act

The Americans with Disabilities Act of 1990 extends the protection of the 1964 Civil Rights Act to the disabled, prohibiting discrimination in public accommodations and transportation and other services.

1.3 Assessment Process and Methodology Used

A profile of the community was constructed using demographic data from the U.S. Census Bureau and supplemented with information obtained from Sacramento County and the City of Rancho Cordova. Project impacts were determined by comparing the existing conditions to the construction-period and operational conditions, as provided by project designers.

1.4 Project Description

1.4.1 Introduction

The County of Sacramento, in cooperation with Caltrans and the City of Rancho Cordova, proposes to modify the existing Hazel Avenue/US 50 interchange, and extend and grade-separate Hazel Avenue over Folsom Boulevard and the Sacramento Placerville Transportation Corridor Joint Powers Authority (SPTC-JPA) rail corridor. The proposed project would extend Hazel Avenue south to a proposed intersection with the future Atlanta Street (a new roadway that will be constructed as part of the Easton Place development). The proposed project also includes:

- Construction of a portion of an eastbound transition auxiliary lane on US 50 from Hazel Avenue through the Folsom Boulevard Overcrossing, also known as the Natoma Overhead.
- Modification of the existing Aerojet Road off-ramp from US 50.
- Reconstruction of the westbound loop on-ramp.
- Reconstruction of the eastbound diagonal off-ramp, and both eastbound on-ramps.
- Eastbound on- and off-ramp auxiliary lanes, from west of the Hazel Avenue to the eastbound off-ramp, and from the loop on-ramp extending to the Folsom Boulevard interchange.
- Roadway improvements constructed along approximately 2,300 feet of Folsom Boulevard. Improvements include sidewalks, street lighting, and landscaping along the north side of Folsom Boulevard, and landscaping and lighting along the south.

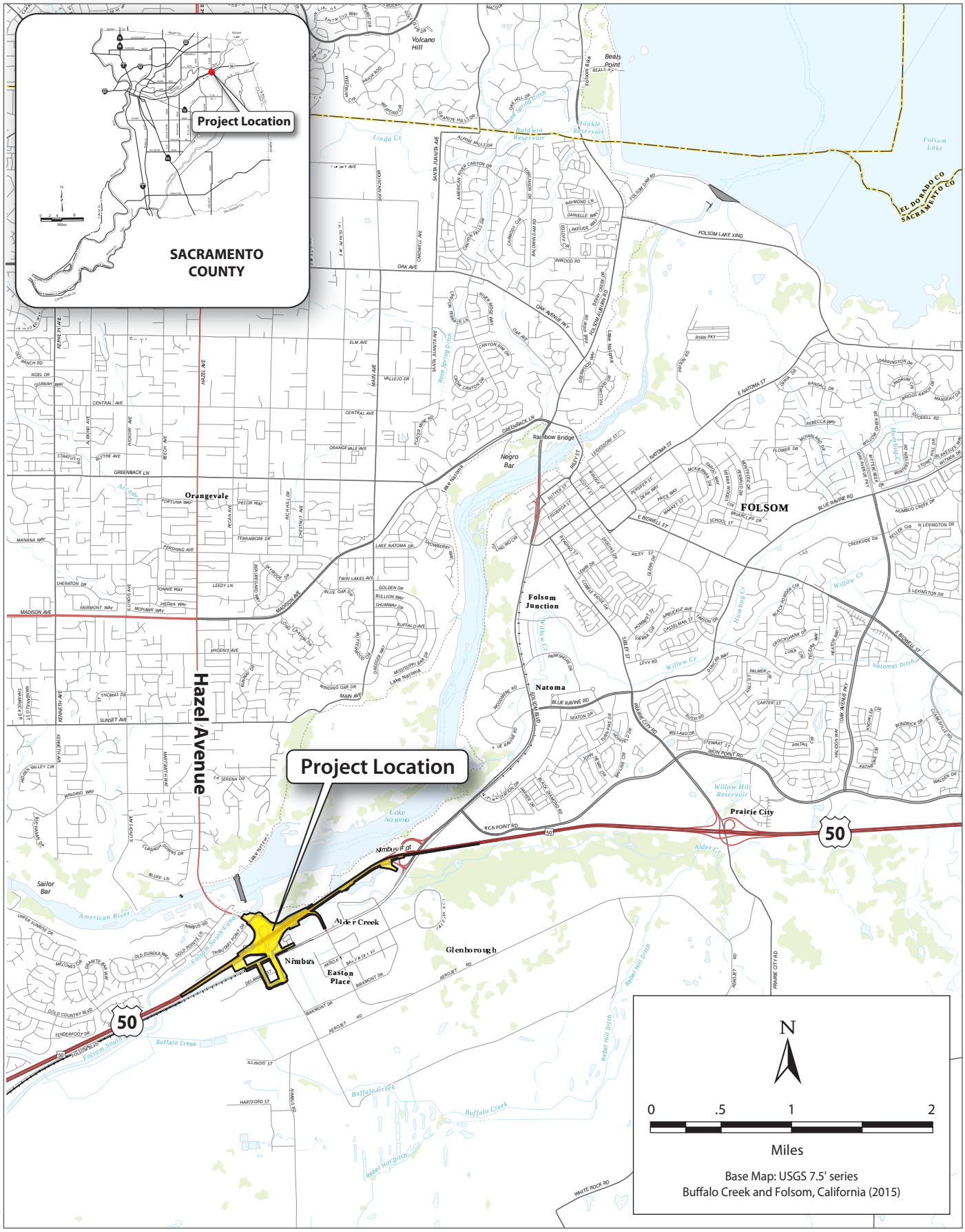
The proposed project is at the interchange of Hazel Avenue and US 50 in Sacramento County (Figure 1). The project area is bounded along Hazel Avenue by the Tributary Point/westbound off-ramp intersection to the north, and extends approximately 1,000 feet south of Folsom Boulevard to a future intersection within the proposed Easton Place development. The project limits along US 50 begin approximately 3,200 feet west of the existing Hazel Avenue Overcrossing, and extend 2,500 feet east of the Natoma Overhead. Improvements along Folsom Boulevard would extend from approximately 1,200 feet west of the Hazel Avenue intersection to a terminus 900 feet to the east (Figure 2).

1.4.2 Purpose and Need

1.4.2.1 Need

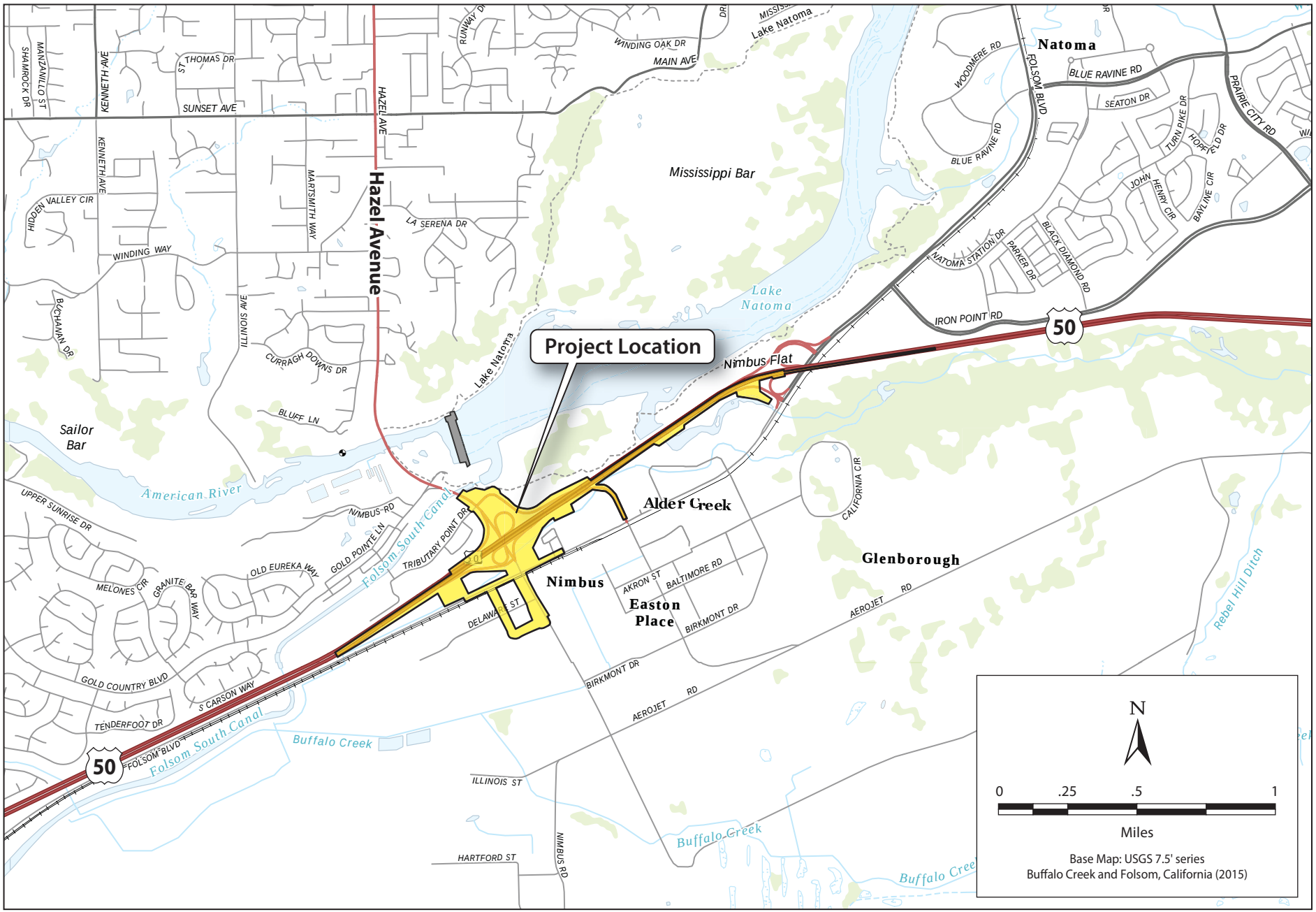
The proposed project is needed to relieve congestion at the existing interchange and to accommodate planned and approved developments identified by the adopted Sacramento County General Plan and the Sacramento Area Council of Governments' (SACOG's) Regional Transportation Plan.

The approved developments within and near the project area will increase traffic demand beyond what the existing interchange can accommodate. The close spacing between the Folsom Boulevard intersection and the eastbound off-ramp intersection does not provide sufficient queuing for increased traffic volumes. Additionally, the County of Sacramento is currently widening Hazel Avenue from four to six traffic lanes between the existing interchange and Madison Avenue. This increase in roadway capacity is expected to deliver more traffic to the Hazel Avenue/US 50 interchange during peak traffic periods.



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Figure 1
Project Vicinity



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Figure 2
Project Location

Traffic demand forecasts for the proposed project were conducted using SACOG's *Metropolitan Transportation Plan/Sustainable Communities Strategy* (SACOG MTP/SCS) projected to 2038 (20 years after anticipated opening day) and supplemented by anticipated levels of additional development currently in application or advanced planning stages. Based on these projections, it is anticipated the existing interchange will degrade to Level of Service (LOS) "F".

1.4.2.2 Purpose

The purpose of the proposed project is to modify the existing interchange to reduce congestion, improve traffic operations, accommodate travel demand due to planned and approved developments, and improve safety of all modes of travel, including bicycles and pedestrians.

The build alternatives for the proposed project would meet the following objectives.

- Improve operations by removing the close intersection spacing between the eastbound ramps and Folsom Boulevard, and minimizing conflict with heavy and light rail.
  - Proposed alternatives accomplish this by grade-separating Hazel Avenue over Folsom Boulevard.
- Provide sufficient capacity in the ramps and roadways for future traffic volumes.
  - Proposed alternatives accomplish this by widening and/or lengthening the on/off-ramps and Hazel Avenue as required by their respective traffic analysis.
- Maintain the Aerojet Road off-ramp connection to the approved development while improving the mainline operations.
  - Proposed alternatives accomplish this by removing the Aerojet Road exit from U.S. 50 but still providing direct access to Aerojet Road through the eastbound Hazel Avenue off-ramp.

1.4.3 Proposed Project

The proposed project would construct modifications to the existing interchange, and grade-separate and extend Hazel Avenue to the south to a future intersection with Atlanta Street, which will be built with the approved Easton Place development. Two alternatives, with one sub-alternative, have been developed for the project.

1.4.3.1 Features Common to All Build Alternatives

The following is a description of elements and design components that are common to all alternatives:

Roadway Modifications

- Construction of a portion of an eastbound transition auxiliary lane on US 50 from Hazel Avenue through the Folsom Boulevard Overcrossing, also known as the Natoma Overhead.
- Modification of the existing Aerojet Road off-ramp from US 50.
- Reconstruction of the westbound loop on-ramp, with the ramp intersection shifted north towards the westbound off-ramp terminus, increasing storage lengths. The ramp would be metered with two lanes (one mixed use, and one high occupancy vehicle [HOV] bypass), and a squared-up, pedestrian-friendly entrance.
- Reconstruction of the eastbound diagonal off-ramp to conform with the new Hazel Avenue profile and accommodate the Aerojet Road ramp divergence.
- Reconstruction of the eastbound diagonal on-ramp to conform with the new Hazel Avenue profile. The ramp would be metered with two lanes; one mixed flow, and one HOV bypass.
- Reconstruction of the eastbound loop on-ramp to conform with the new Hazel Avenue profile. The ramp would be metered with two lanes; one mixed flow, and one HOV bypass. A tie-back wall at the abutment of the overcrossing is proposed to maximize the opening through the structure. The loop ramp would develop an additional lane on US 50 that will continue on to the Folsom Boulevard interchange.
- Construction of eastbound on- and off-ramp auxiliary lanes on US 50, from west of the Hazel Avenue interchange to the eastbound off-ramp, and from the loop on-ramp extending to the Folsom Boulevard interchange.
- Modification of traffic signals and installation of safety lighting at the ramp intersections. A new signalized intersection and at-grade railroad crossing would be constructed for the jughandle.
- Maintenance of pedestrian access on the east side of Hazel Avenue with 6-feet sidewalks; however, the existing sidewalk on the overcrossing will remain 5 feet wide. Bicyclists may utilize the County standard 7-feet shoulders. It is expected that pedestrians and bicyclists would continue to use the nearby Bikeway and Pedestrian Overcrossing as the primary means for crossing US 50.
- Construction of roadway improvements along approximately 2,300 feet of Folsom Boulevard. Improvements include the removal of the existing signalized intersection with Hazel Avenue, and installation of sidewalks, street lighting, and landscaping along the north side of Folsom Boulevard, and landscaping and lighting along the south.

1.4.3.2 Transition Lane to U.S. 50/Folsom Boulevard Interchange

As indicated in Caltrans' 2009 Corridor System Management Plan, eastbound US 50 is shown to have one HOV lane and three mixed flow lanes to Hazel Avenue as the Concept

Facility. Additionally, eastbound US 50 is shown to have one HOV lane and three mixed flow lanes across Folsom Boulevard as the Ultimate Facility. The proposed project would accommodate these future facility improvements; conform to the approved Caltrans improvements at the Folsom Boulevard/US 50 interchange, some of which will occur in 2016; and would restripe the third mixed flow lane through the Folsom Boulevard/US 50 interchange.

The proposed project is required to add the mixed flow lane because it has been determined in the traffic analysis for this project, and in studies for adjacent projects, that the additional eastbound lane on US 50 extending through the Folsom Boulevard interchange is needed for operations.

Under all proposed project alternatives, accommodating this mixed flow lane will require the eastbound loop on-ramp to extend its auxiliary lane to the Folsom Boulevard/US 50 eastbound off-ramp. This would require widening and a new structure over Alder Creek.

Alder Creek currently flows under US 50 through a box culvert (Br. No. 24-0033). A Mechanically Stabilized Earth (MSE) wall (Br. No. 24-0372) is above the culvert. A new bridge would be required to widen US 50 over Alder Creek. The new bridge is necessary because there is insufficient lateral space to construct an adjacent MSE wall on top of the culvert and because the creek maintains a high operating water level.

Railroad Overhead

Hazel Avenue would extend and be grade-separated over Folsom Boulevard and the SPTC-JPA rail corridor. There is currently one light rail track on the north side of the Union Pacific Railroad (UPRR) tracks. Sacramento Regional Transit plans to add another track at this location; when the addition occurs, the existing UPRR track will be relocated south to accommodate the second light rail track. The proposed project design meets the requirements for all three tracks, with the clearances shown in Figure 3 below.

Temporary vertical clearances of 21 feet, 6 inches and permanent vertical clearances of 24 feet have been accounted for in the layout of all three alternatives for the Hazel Avenue Railroad Overhead. The vertical clearance provided would accommodate the Overhead Catenary System for the light rail.

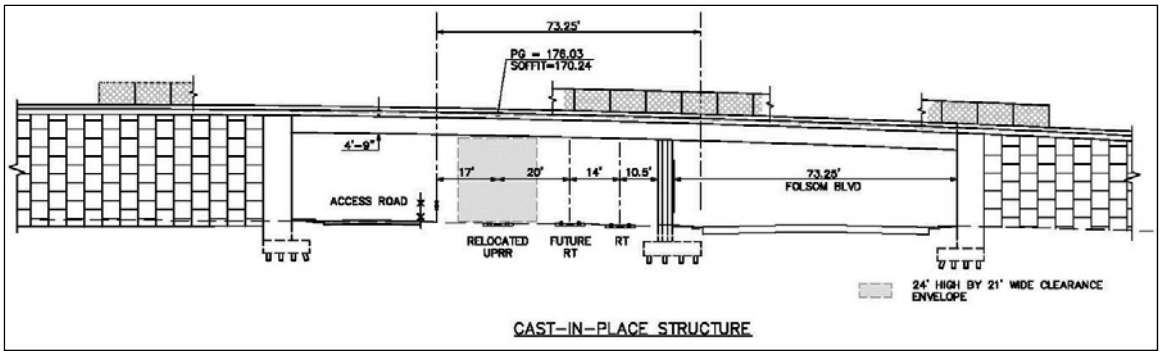


Figure 3. Cast-in-Place Stucture

Right of Way and Utilities

For Alternative 1, ROW acquisition is anticipated from parcels in the southwest quadrant of the interchange. It is anticipated that 12 parcels would be affected by the improvements, including full acquisition and demolition of structures at the Chevron gas station (APN 069-0160-012) and Cattleman's restaurant (APN 069-0060-085). The viaduct structure is proposed to cross over the northern portion of the Nimbus Winery parking lot (APN 069-0050-013) on an aerial easement, to allow parking below the structure and minimize project effects on the business.

The ROW take at the Nimbus Winery property would be larger in Alternative 1A because acquisition would be required instead of using an aerial easement.

For Alternative 2, ROW acquisition is anticipated from parcels in the southwest quadrant of the interchange. It is anticipated that 13 parcels would be affected by the improvements, including full acquisition and demolition of structures at the Chevron gas station, Cattleman's restaurant, and the Nimbus Winery property.

These acquisition needs described above are preliminary and would be finalized during the ROW acquisition process and final design phase of the project.

The proposed project would require the relocation of utilities for all build alternatives, and it is anticipated that this would include: gas lines, overhead electric lines, underground electric lines, fiber optic cables, water lines, sewer lines, and storm drain lines. There is also potential for project effects on other unknown utilities.

1.4.3.3 Alternative 1: L-9 Interchange with Viaduct Connector

Alternative 1 consists of a modified type L-9 interchange configuration. A Caltrans Type L-9 interchange indicates a ramp configuration that includes a diagonal off-ramp, a diagonal on-ramp and a loop on-ramp. This alternative would provide a viaduct connection to Aerojet Road (Figure 4).

As with all alternatives, Hazel Avenue would grade-separate over Folsom Boulevard and the SPTC-JPA rail corridor and would extend south to a proposed intersection with the future Atlanta Street. The existing at-grade intersection of Hazel Avenue and Folsom Boulevard would be removed, sidewalks would be extended across the former intersection, and the lanes would be restriped to remove left-turn lanes.

The location of the departure point of the existing Aerojet Road off-ramp from US 50 would be moved to join with the eastbound Hazel Avenue off-ramp. The eastbound Hazel Avenue off-ramp would split and introduce a direct viaduct ramp over Hazel Avenue to carry eastbound off-ramp traffic to Aerojet Road and Folsom Boulevard. The off-ramp diverge from US 50 would be shifted approximately 830 feet to the east in order to provide decision sight distance before the Aerojet Road split. The two-lane off-ramp would widen to five lanes at the ramp terminal intersection, with three left-turn lanes and two right-turn lanes. Retaining walls and barriers placed at the proposed right-of-way (ROW) would minimize acquisition. The eastbound off-ramp would also have an auxiliary lane prior to the exit.

The Aerojet Road viaduct would land adjacent to the eastbound diagonal on-ramp and then turn southerly to conform to Folsom Boulevard along its existing alignment. Retaining walls are proposed between the viaduct and the diagonal on-ramp to accommodate the grade difference, and to the outside of the ramp after the viaduct lands, to minimize ROW acquisitions. Retaining walls are also proposed along Aerojet Road as it approaches the horizontal curve towards Folsom Boulevard to accommodate the grade difference between the ramp and mainline and to minimize ROW acquisition.

The existing Hazel Avenue Overcrossing of US 50 would be widened on the west side to accommodate eight lanes (three through lanes and one freeway-only lane in both directions). The existing raised concrete median across the structure would be removed, and the roadway would be restriped with a 6-feet striped median. The existing sidewalk and barrier on the east side of the structure would remain.

1.4.3.4 Alternative 1A: L-9 Interchange with Undercrossing Connector

Alternative 1A is the same as Alternative 1, with the following exceptions:



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Figure 4
Alternative 1: L-9 Interchange with Viaduct Connector
Hazel Avenue/U.S. 50 Interchange Project

The eastbound US 50 off-ramp will split and introduce a direct tunnel ramp under Hazel Avenue to carry eastbound off-ramp traffic to Aerojet Road and Folsom Boulevard (Figure 5).

1.4.3.5 Alternative 2: Direct Flyover to Hazel Avenue with Connector

Alternative 2 consists of a modified type L-9 interchange configuration, with a flyover ramp carrying vehicles travelling from eastbound US 50 to northbound Hazel Avenue over the freeway to join with the westbound US 50 off-ramp (Figure 6).

The existing Aerojet Road off-ramp from US 50 would be removed.

The eastbound off-ramp divergence point from US 50 would be shifted approximately 680 feet to the east to provide decision sight distance. An auxiliary lane would precede the off-ramp. A retaining wall is proposed adjacent to the off-ramp to minimize ROW acquisition.

The eastbound off-ramp would split and introduce northbound and southbound Hazel Avenue ramps. The northbound ramp would also carry traffic headed for Aerojet Road/Folsom Boulevard. An overhead sign would direct vehicles heading to southbound Hazel Avenue into the right lane and direct vehicles destined for northbound Hazel Avenue or Aerojet Road or Folsom Boulevard to use either lane. Retaining walls are proposed for the ramp as it approaches the horizontal curve towards Folsom Boulevard to accommodate the grade difference between the ramp and mainline and to minimize ROW acquisition at an apartment complex.

The northbound Hazel Avenue movement would cross under Hazel Avenue at the interchange, cross over US 50 on a two-lane flyover structure, and then merge with the westbound off-ramp and terminate at the Hazel Avenue/Tributary Point intersection. The westbound off-ramp would split so that the southbound and through movements align to the left of the ramp, and the northbound movements are to the right.

The southbound ramp would connect directly to Hazel Avenue; however, for Alternative 2 an intersection is not required at Hazel Avenue and the eastbound ramp. By eliminating an intersection at the eastbound ramp, and by removing the heavy eastbound-to-northbound movements from the Hazel Avenue overcrossing, the existing structure could remain without widening.

The two-lane westbound off-ramp would be reconstructed to provide decision sight distance between the divergence point from US 50 and a new ramp split that accommodates the flyover. The westbound off-ramp would split on either side of the flyover ramp, with one



Figure 5
Alternative 1a: L-9 Interchange with Undercrossing Connector
Hazel Avenue/U.S. 50 Interchange Project



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Figure 6
Alternative 2: Direct Flyover to Hazel Avenue with Connector
Hazel Avenue/U.S. 50 Interchange Project

lane to the right carrying northbound Hazel Avenue traffic and the other crossing underneath the flyover ramp to join up on the left side of the flyover for the southbound Hazel Avenue movements. The profiles of the three ramps have been coordinated to match grade quickly in order to minimize retaining wall limits and enhance driver visibility. Overhead signage would direct drivers into the appropriate lanes for northbound and southbound Hazel Avenue traffic.

1.4.3.6 Alternative 3: No Build Alternative

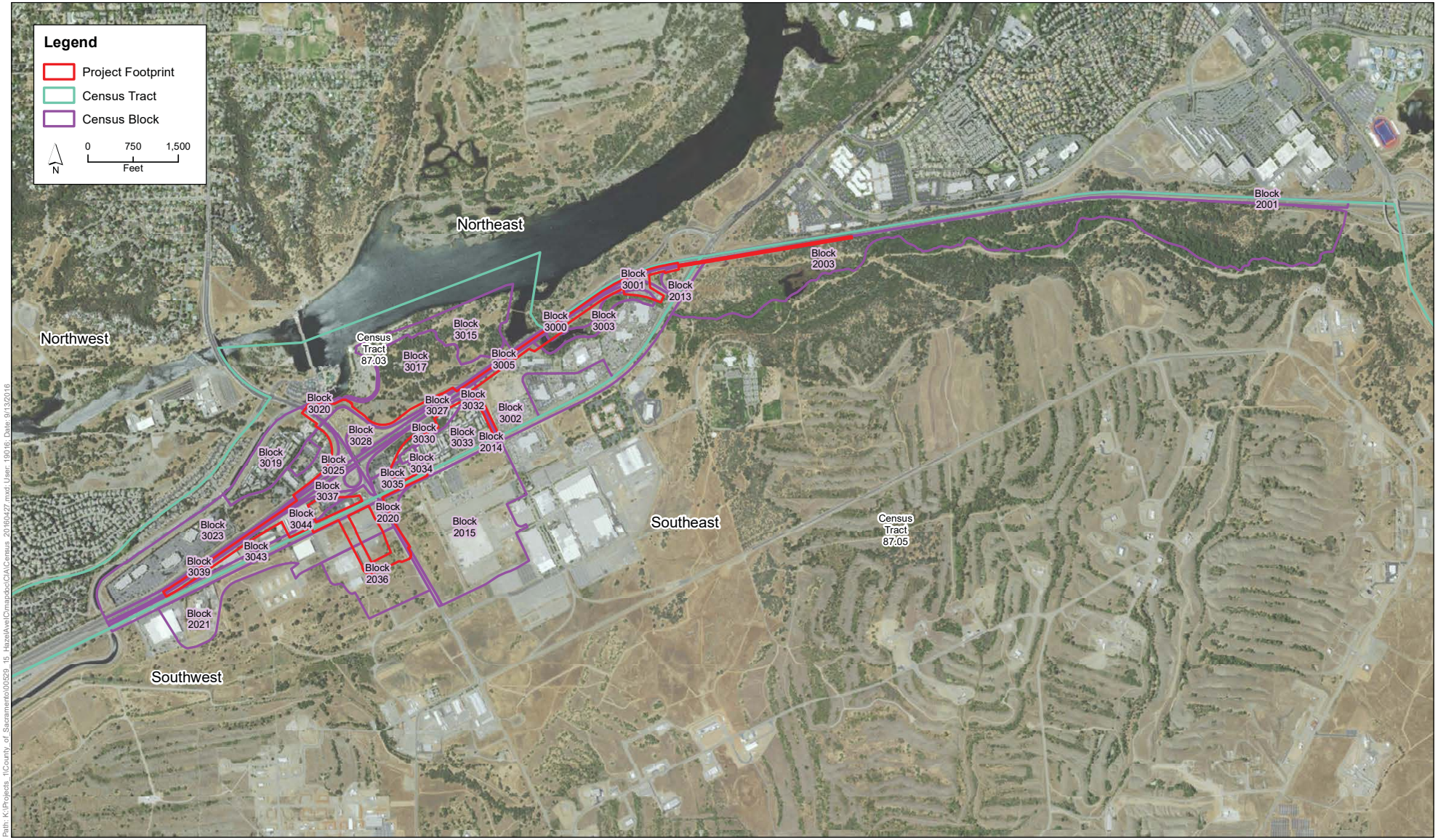
Alternative 3, the No Build Alternative, would not modify the existing interchange and would retain the same existing configuration, ramps, and lanes. The No Build Alternative does not meet the purpose and need of the proposed project.

1.5 Other Information

A separate pedestrian path/bicycle trail is proposed at the northeast quadrant. The pedestrian path/bicycle trail would directly or indirectly connect with the American River Bike Trail.

1.6 Study Area

Census tracts are typically used to determine the CIA study area for projects in rural areas, and block groups or individual blocks are used for projects in urban areas. Because the area surrounding the proposed project is primarily developed, the census blocks were used to determine the CIA study area for this project. For the purposes of this CIA, the study area comprises census tracts 87.03 and 87.05, which intersect the proposed project. There are 30 individual blocks within these census tracts that intersect the project alignment and have the potential to be affected by the proposed project (Figure 7).



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Figure 7
Community Impact Assessment Study Area

Chapter 2 Land Use

This chapter describes the land use in the study area, including existing and future land use; consistency with state, regional, and local plans; and parks and recreation.

2.1 Existing and Future Land Use

This section discusses the affected environment, environmental consequences, and avoidance, minimization, and mitigation measures for existing and future land use in the study area. There is no farmland in the study area, and farmland is not discussed further in this report.

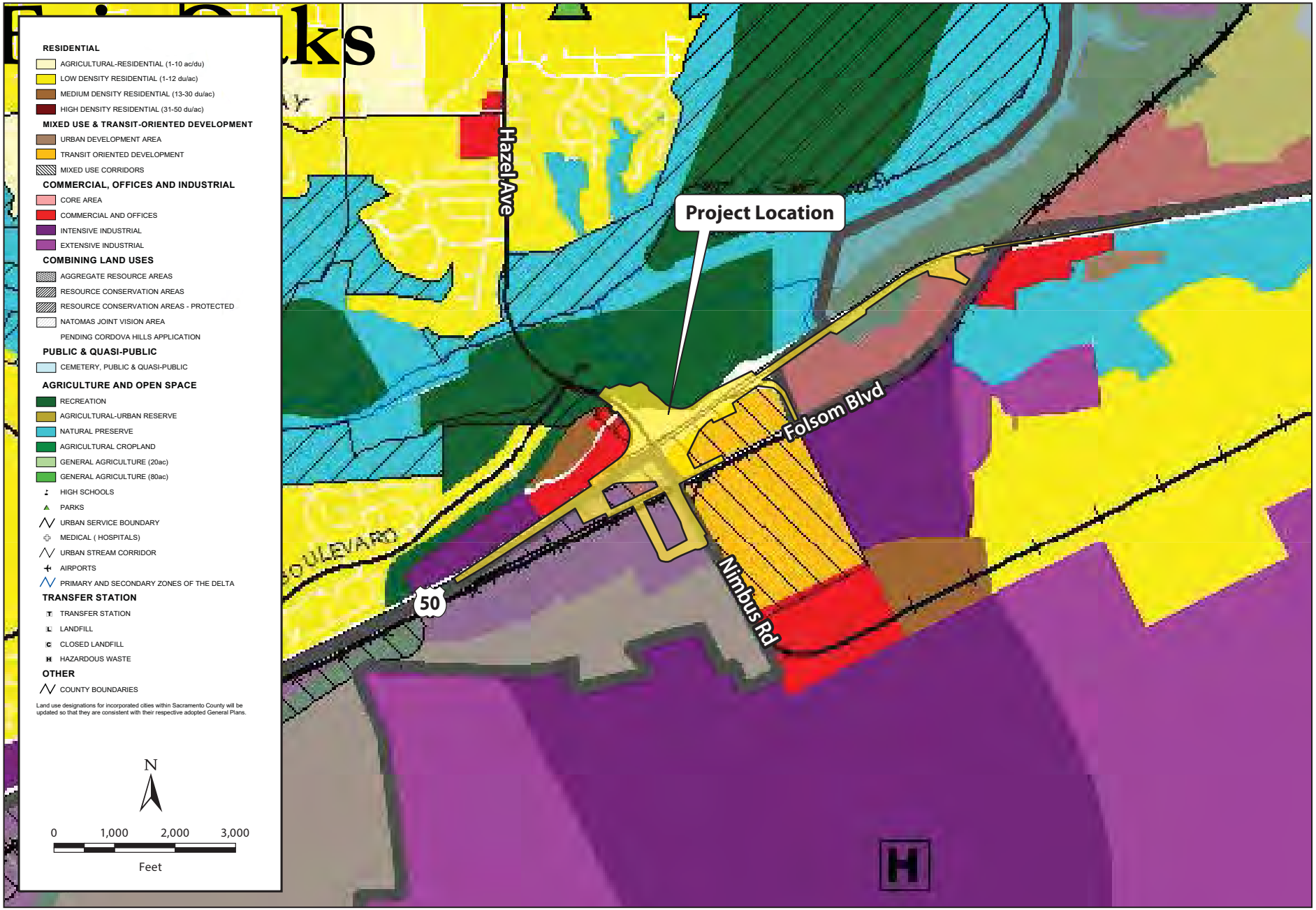
2.1.1 Affected Environment

According to the Sacramento County General Plan Land Use Designation map, the area surrounding the proposed project is designated as transit-oriented development, core area, recreation, commercial and offices, natural preserve, and extensive and intensive industrial (Figure 8) (Sacramento County 2013). The zoning primarily consists of Parkway Corridor Zoned Area (PC). North of Highway 50 and west of Hazel Avenue contains parcels zoned for Industrial-Office Park (MP), Light Commercial (LC), Multiple Family Residential 25 (RD25), and Residential 10 (RD10). South of Highway 50 and east of Hazel Avenue contains parcels zoned for General Commercial (GC), Mobile Home Subdivision (RM), and Limited Commercial (LC) (Figure 9) (Sacramento County 2015). The land uses in the portion of the project in the City of Rancho Cordova are parks and open space, estate residential, commercial mixed-use, and office mixed-use (Figure 10) (City of Rancho Cordova 2006). The zoning consists of general commercial, light industrial, and heavy industrial areas (Figure 11) (City of Rancho Cordova 2014).

For the purposes of describing the affected environment, the study area was divided into four quadrants on the basis of their location relative to US 50 (i.e., north or south) and Hazel Avenue (i.e., east or west). The land uses in each quadrant are described below.

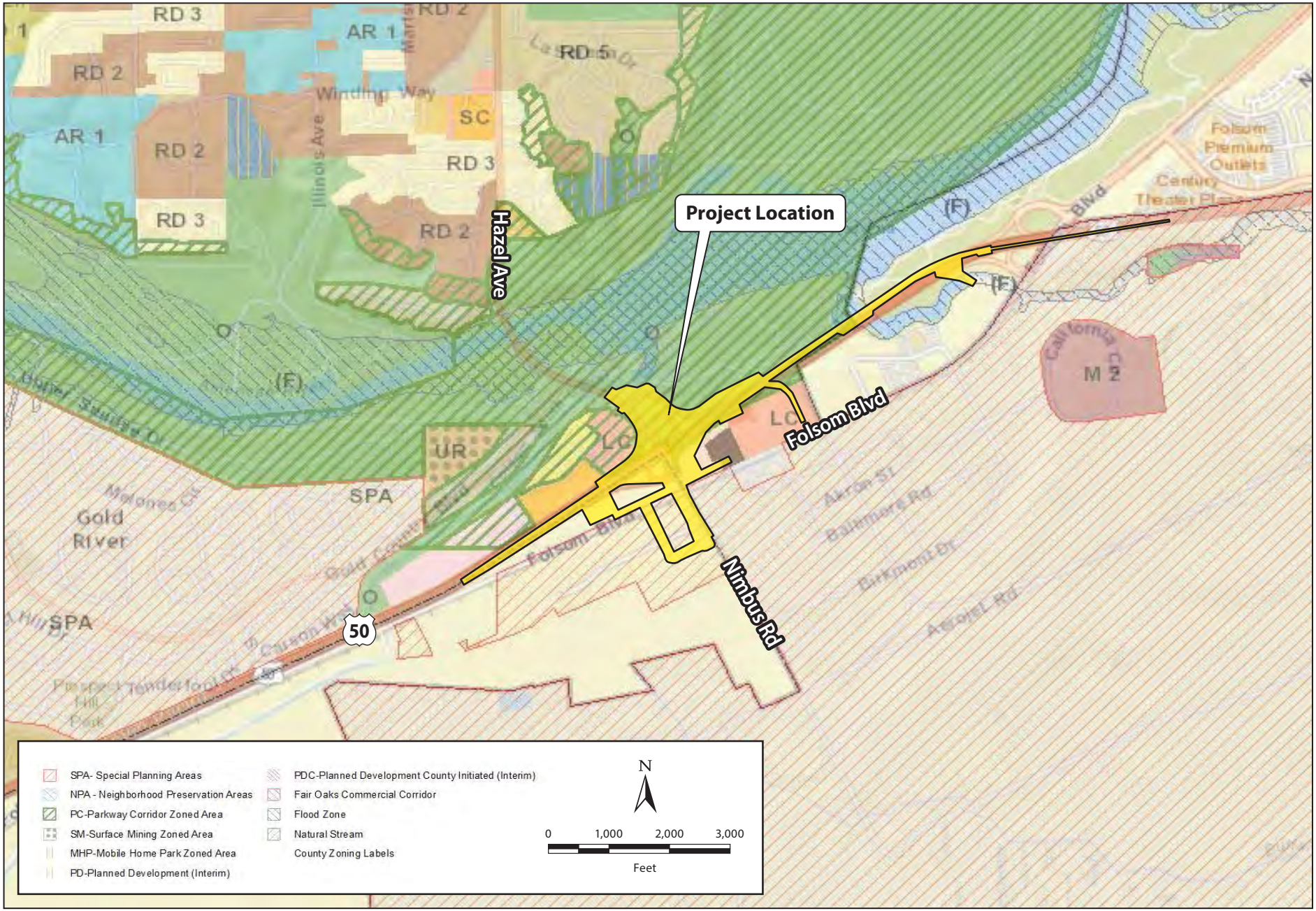
2.1.1.1 Northeast

The northeast quadrant of the study area (i.e., north of US 50 and east of Hazel Avenue) is land primarily designated for recreation and natural preserve uses, including the Nimbus Dam Recreation Area (Lake Natoma), the American River, and the American River Parkway



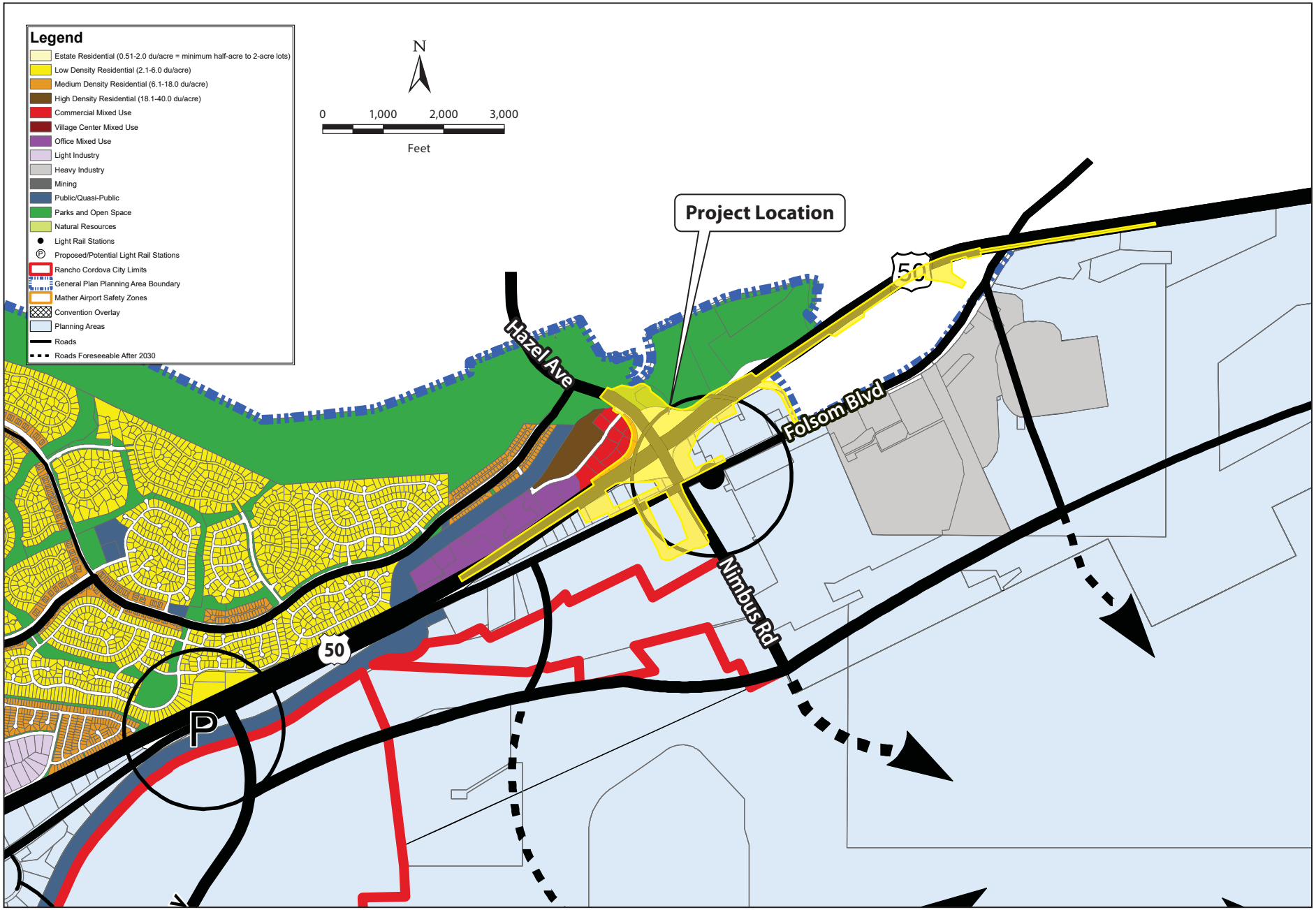
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Figure 8
County of Sacramento General Plan Land Use



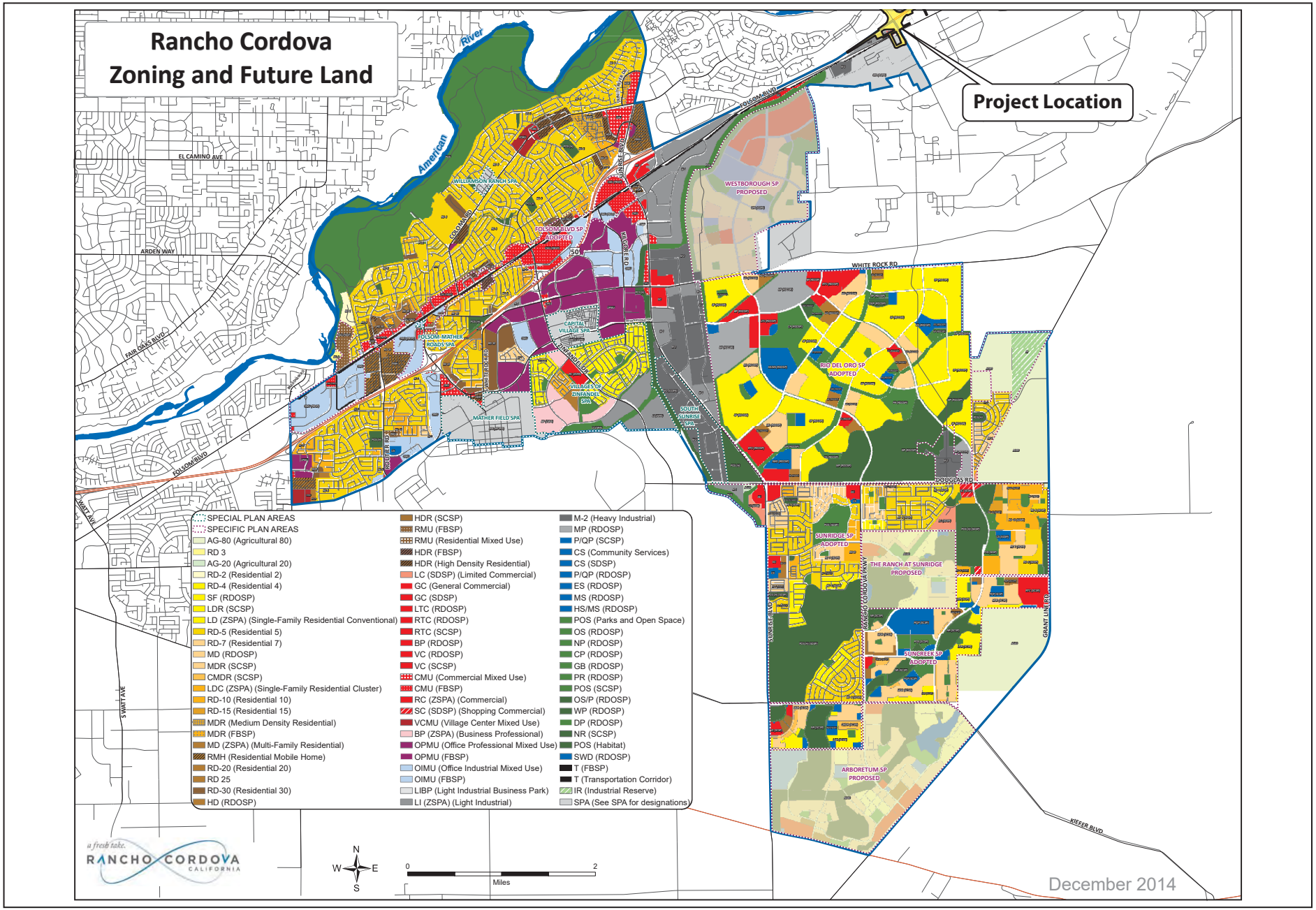
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Figure 9
County of Sacramento Zoning



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Figure 10
City of Rancho Cordova General Plan Land Use



Graphics... 0052915 (9/14/16) AB

Figure 11
City of Rancho Cordova Zoning

and Bike Trail. The American River flows west through this portion of the study area and contains bike trails on both the right and left banks of the river.

2.1.1.2 Northwest

The northwest quadrant of the study area contains commercial and office development, medium- and low-density residential development, and intensive industrial uses. Commercial uses along US 50 and Hazel Avenue include gas stations, furniture stores, hotels, and fast food restaurants. This portion of the study area additionally contains recreation and natural preserve uses, including the Folsom South Canal and the continuation of the American River and the American River Bike Trail. The American River flows west through this portion and bike trails are located on the left bank of the river.

2.1.1.3 Southeast

The southeast quadrant of the study area contains transit-oriented development with mixed use corridors, commercial and office development, medium- and low-density residential development, and both intensive and extensive industrial uses. The mixed use corridors along US 50 are composed of an RV and mobile home park and apartment complexes, with restaurants located throughout. The southernmost portion of this quadrant is dominated by intensive industrial use and contains a hazardous waste transfer station.

2.1.1.4 Southwest

The southwest quadrant is dominated by intensive industrial use. A small portion of the southwest quadrant in proximity to the Hazel Avenue/US 50 interchange contains commercial and office development (e.g., storage facility, hotel, and fire station) intermixed with restaurants (City of Rancho Cordova 2015). The approved Boroughs of Easton development is planned for the area south of US 50 between Hazel Avenue and Prairie City Road.

2.1.2 Environmental Consequences

The project would entail building a flyover structure over area that is currently zoned as LC. Once the new infrastructure is place, the zoning would no longer apply. Land acquisitions would be required for the proposed project; however, they would not change the land use designations or zoning in the study area. The land acquisitions and their impacts are discussed in Chapter 4, *Property Acquisitions and Relocations*. The Boroughs of Easton is a planned land use development in the project area. It is a 6,400-acre planned development along the south side of US 50 between Hazel Avenue and Prairie City Road on former buffer

lands for Aerojet, a major regional employer. The Boroughs of Easton consists of residential and commercial land uses with two planning areas, Glenborough and Easton Place. The Easton Place development is in the study area. The Easton Place Land Use Master Plan was approved by Sacramento County in 2009, and is also included in the County's General Plan. Easton Place is planned as an urban community to provide regional employment, shopping, entertainment, and residential uses in a walkable and transit-oriented environment (Easton Development Company 2009:2). The proposed project accommodates the additional traffic volumes that are projected to increase in the future due to planned growth and development such as the Boroughs of Easton.

As stated above, some commercial land uses would be acquired in the study area. However, overall land use patterns in the study area would remain the same, and the project would increase the traffic flow and safety throughout the project area.

2.1.3 Avoidance, Minimization, and Mitigation Measures

No potential conflicts with current or planned land uses in the study area are anticipated. Therefore, no measures are proposed to reduce impacts related to land use.

2.2 Consistency with State, Regional, and Local Plans

This section discusses the affected environment, environmental consequences, and avoidance, minimization, and mitigation measures for consistency with state, regional, and local plans that are applicable to the proposed project.

2.2.1 Affected Environment

Land use planning in the study area is governed by the Sacramento County General Plan of 2005-2030 (Sacramento County 2013:20–23, 26) , the Rancho Cordova General Plan (City of Rancho Cordova 2015:11, 21) and the SACOG MTP/SCS (Sacramento Area Council of Governments 2016:138, 140).

2.2.1.1 Sacramento County General Plan

In November of 2011, the County's General Plan was amended to make up the 2030 General Plan. The goals and policies in the 2030 General Plan will guide growth and development in the unincorporated County over the next 20 years. The General Plan Update focuses on economic growth, environmental sustainability, addressing needs of existing communities

and accommodating future smart growth. Goals and policies that are directly relevant to the proposed project are described in section 2.2.2.1 below.

2.2.1.2 Rancho Cordova General Plan

The City of Rancho Cordova adopted its General Plan in 2006. The Rancho Cordova General Plan covers land use and planning in the City as well as the developed areas of Rosemont, Larchment, Gold River, and the undeveloped areas south of Jackson Highway and east of Grant Line Road. The vision of the General Plan is "Building a City" which includes becoming a vibrant destination in the region and making the City a desirable place to live, work, and play. The goals, policies, and actions from the Rancho Cordova General Plan that are directly relevant to the proposed project are discussed below in Section 2.2.2.2.

2.2.1.3 Sacramento Area Council of Governments Metropolitan Transportation Plan/Sustainable Communities Strategy

The SACOG 2016 Metropolitan Transportation Plan/Sustainable Communities Strategy (MTP/SCS) links is a comprehensive vision that links air quality, transportation, and land use in the Sacramento region over the next 20 years. It covers Sacramento, Yolo, Yuba, Sutter, El Dorado and Placer counties and the 22 cities within those counties (excluding the Tahoe Basin).

2.2.2 Environmental Consequences

The following sections assess the project's consistency with plans and policies adopted by Sacramento County, and the City of Rancho Cordova. Only policies with direct relevance to the project were included in the consistency analysis.

2.2.2.1 Sacramento County General Plan

The goals and policies in the County of Sacramento General Plan that are directly relevant to the proposed project are listed below. The project's consistency with relevant policies is discussed below.

> **Mobility Goal: Provide mobility for current and future residents of Sacramento County through complete streets and through a balanced and interconnected transportation system which includes all modes of travel - automobile, transit, pedestrian and bicycling.**
>
> > **Policy CI-3.** Travel modes shall be interconnected to form an integrated, coordinated and balanced multi-modal transportation system, planned and developed consistent with the land uses to be served.

The proposed project entails major improvements to the existing Hazel Avenue/US 50 interchange. The purpose and need of the project is to reduce congestion, improve traffic operations, accommodate travel demand due to planned and approved developments, and improve safety of all modes of travel including bicycles and pedestrians.

> **Roadways Goal: Provide a balanced and integrated roadway system that maximizes the mobility of people and goods in a safe and efficient manner.**
>
> > **Policy CI-8.** Maintain and rehabilitate the roadway system to maximize safety, mobility, and cost efficiency.
> >
> > **Policy CI-9.** Plan and design the roadway system in a manner that meets Level of Service (LOS) D on rural roadways and LOS E on urban roadways, unless it is infeasible to implement project alternatives or mitigation measures that would achieve LOS D on rural roadways or LOS E on urban roadways. The urban areas are those areas within the Urban Service Boundary as shown in the Land Use Element of the Sacramento County General Plan. The areas outside the Urban Service Boundary are considered rural.
> >
> > **Policy CI-17.** Ensure that transportation infrastructure improvement projects initiated by the County include a comprehensive public outreach process and involves affected local stakeholders and communities in the beginning and throughout the planning and development process for the project.
> >
> > **Policy CI-18.** The County shall plan and prioritize the implementation of intersection improvements, where feasible, in corridors identified as congested.

As stated above, the proposed project would reduce congestion and improve traffic operations. Safety in the study area would be improved for motorists, bicyclists, and pedestrians, which would contribute to the Roadways Goal and associated policies regarding maximizing mobility and improving congestion.

Regarding public outreach, the Notice of Preparation (NOP) was released in February of 2016. A public scoping meeting was held on Thursday, March 3, 2016. The meeting was attended by a total of twenty-six people, including members of the project development team, local agencies, and other interested parties. A public meeting will also be held during the public circulation portion of the environmental document. The project is consistent with Policy CI-17.

> **Bike and Pedestrian Facilities Goal: Provide safe, continuous, efficient, integrated, and accessible bicycle and pedestrian systems that encourages the use of the bicycle and walking as a viable transportation mode and as a form of recreation and exercise.**
>
> > **Policy CI-38.** Design and construct pedestrian facilities to ensure that such facilities are accessible to all users.

The proposed project seeks to improve bicycle and pedestrian facilities, including the installation of sidewalks, street lighting, and landscaping. The project is consistent with the Bike and Pedestrian Facilities goal and Policy CI-38, because it contributes to the overall goal of improving safety and accessibility for all users.

2.2.2.2 Rancho Cordova General Plan

The goals, policies, and actions from the Rancho Cordova General Plan that are directly relevant to the proposed project are listed below.

> **Goal C.1: Develop a roadway system that accommodates future land uses at the City's desired level of service, provides multiple options for travel routes, protects residential areas from excessive traffic, coexists with other travel modes, and contributes to the quality of the City's residential, commercial, office, and industrial areas.**
>
> > **Policy C.1.2.** Seek to maintain operations on all roadways and intersections at Level of Service D or better at all times, including peak travel times, unless maintaining this Level of Service would, in the City's judgment, be infeasible and/or conflict with the achievement of other goals. Congestion in excess of Level of Service D may be accepted in these cases, provided that provisions are made to improve traffic flow and/or promote non-vehicular transportation as part of a development project or a City-initiated project.
> >
> > **Policy C.1.11.** As part of major individual roadway enhancement projects (e.g., intersection redesign, signalization of a previously un-signalized intersection), enhance and upgrade pedestrian and bicycle facilities within one-quarter mile of the project
>
> **Goal ISF.2: Ensure the development of quality infrastructure to meet community needs at the time they are needed.**
>
> > **Policy ISF.2.1.** Ensure the development of public infrastructure that meets the long-term needs of residents and ensure infrastructure is available at the time such facilities are needed.
> >
> > > **Action ISF.2.1.1.** Except when prohibited by state law, require sufficient capacity in all public facilities to maintain desired service levels and avoid capacity shortages, traffic congestion, or other negative effects on safety and quality of life.

As stated in the project description, the approved developments in and near the project area are projected to increase traffic demand beyond what the existing Hazel Avenue/US 50 interchange can accommodate, and would degrade the interchange to LOS "F". The purpose of and need for the proposed project is to reduce forecasted congestion by increasing capacity at the interchange. The proposed project also includes improvement of bicycle and pedestrian facilities, including the installation of sidewalks, street lighting, and landscaping, in the study area. The project is consistent with the goals and policies listed above.

2.2.2.3 Sacramento Area Council of Governments Metropolitan Transportation Plan/Sustainable Communities Strategy

The policies and strategies from SACOG MTP/SCS that are directly relevant to the proposed project are listed below.

> **Policy 27:** Support road, transit, and bridge expansion investments that are supportive of MTP/SCS land use patterns.

Strategy 27.1. Focus on ensuring transit and the arterial system perform well for the increased number of local trips, to support infill and compact development from smarter land uses without pushing growth outward because of overly congested conditions, and on providing a strong grid network (which offers alternative routes) wherever land uses allow.

Policy 30: SACOG also gives primary priority to selective road expansion, to support infill development and forestall midday congestion, when adequate funding for lifecycle maintenance costs are available.

Strategy 30.1. Pursue strategic road expansion that reduces congestion and supports effective transit services, walking and bicycling.

The proposed project is listed in SACOG's 2015/18 Metropolitan Transportation Improvement Program (MTIP), Amendment #20, as SAC24255 (Sacramento Area Council of Governments 2016:15 in Appendix B). The MTIP is federally required listing of regionally significant transportation projects and is updated by SACOG every two years. All projects in the MTIP must be consistent with the long range regional transportation plan, which for SACOG is the MTP/SCS. As stated above, the proposed project is intended to reduce congestion, improve overall traffic operations, and improve safety and increase accessibly for all modes of transportation including bicyclists and pedestrians. The project is consistent with the goals and policies listed above.

2.2.3 Avoidance, Minimization, and Mitigation Measures

No avoidance, minimization, or mitigation measures are required.

2.3 Parks and Recreation

2.3.1 Affected Environment

The northeast quadrant of the study area includes the Nimbus Dam Recreation Area (Lake Natoma) which is run by the California Department of Fish and Wildlife. This area contains open space, jogging and bicycle trails, and lake access. The Jedediah Smith Memorial Bicycle Trail, also known as the American River Bike Trail, is located in the American River Parkway. It starts in Discovery Park near the confluence of the Sacramento and American Rivers in downtown Sacramento and continues upstream for 23 miles to Beal's Point on Folsom Lake. In 1974, the Jedediah Smith Memorial Bicycle Trail was designated a National Recreational Trail by the U.S. Department of the Interior (National Recreation Trails 2011). In the study area, the bike trail passes through the Nimbus Dam Recreation Area, parallel to US 50. The bike trail crosses under the Hazel Avenue bridge on the left bank of the American River.

The Sacramento State Aquatic Center is in the Nimbus Dam Recreation area, just east of Hazel Avenue. The recreational activities such as swimming and boating, as well as paddle-board and canoe rentals, are provided year-round. The Nimbus Fish Hatchery is just west of Hazel Avenue, where year-round fishing and educational opportunities are provided. Parks and recreational areas are shown in Figure 12. The Fish Hatchery is under the jurisdiction of the Bureau of Reclamation.

2.3.2 Environmental Consequences

Alternatives 1 and 1a would entail construction within 50 feet of the Jedediah Smith Memorial Bicycle Trail. Alternative 2 would entail construction slightly further from the trail, approximately 150 feet. None of the project alternatives require temporary detours or other changes to the trail; access to the trail would be maintained during the construction period. The portion of the trail in the study area is currently alongside US 50 and Hazel Avenue, which are both busy transportation corridors. A small parking lot near Lake Natoma at the corner of Tributary Point Drive and Hazel Avenue, would be reconfigured under all of the project alternatives; however, this lot is a Caltrans park-and-ride and is not typically used for recreational use parking. It is anticipated that adequate parking would remain at Sacramento State Aquatic Center and along the segment of the bike trail that is just east of the aquatic center during the construction period and temporary construction is not anticipated to affect recreational opportunities at the American River Parkway, Lake Natoma, or the Jedediah Smith Memorial Trail. A Section 4(f) Report, *Resources Evaluated Relative to the Requirements of Section 4(f)*(ICF International 2016) was prepared for the project and concluded that the provisions of Section 4(f) would not be triggered for any recreational resources in the study area. Access to the recreation facilities within Lake Natoma would not change. During the construction period, recreationists traveling to the Lake Natoma on U.S. 50 or on Hazel Avenue could experience short-term, intermittent delays or traffic detours over a period of 24 months, depending on the sequence of construction activities. Lane closures would be required and are proposed during non-peak traffic hours. Weekends and night work will be required for the bridge widening (for Alternatives 1 and 1A), ramp realignment construction, and during conditions where traffic is detoured. Folsom Boulevard and the U.S. 50/Folsom Boulevard interchange would provide opportunities for detours when ramp closures are required. However, these temporary construction-related delays would not affect recreation use or enjoyment of the recreation area or facilities.



Figure 12
Parks and Recreation **A**reas in the Project Vicinity

2.3.3 Avoidance, Minimization, and Mitigation Measures

As stated above, access to the surrounding parks and recreational areas would be maintained during construction and no avoidance, minimization, or mitigation measures are required.

Chapter 3 Growth

Factors that influence land use and development in an area may include population and economic growth, desirability of locations, the costs and availability of developable land, physical and regulatory constraints, transportation, and the costs of sewer, water, and other utility services.

Transportation agencies play a role in land use changes by providing infrastructure that can improve mobility and/or open up access to new locations. New development generates travel to and from that location, and this additional travel creates demand for new transportation facilities. The relationship between transportation and land use and the degree to which one influences the other is a topic of ongoing debate. The following chapter addresses the growth in the study area and larger region and the extent to which the proposed project contributes to that growth.

Different transportation projects will influence growth to different degrees and in different ways, and a two-phase approach to the evaluation of growth-related impacts is used below. The first phase, called a "first cut screening," is designed to help figure out the likely growth potential effect and whether further analysis of the issue is necessary. The second phase involves the additional analysis of growth that is conducted in the event that the first-cut screening analysis suggests that growth impacts would occur.

3.1 Affected Environment

Both the County of Sacramento and the City of Rancho Cordova have experienced substantial amounts of growth in the past decade and are projected to have continued growth. Table 1 below shows the population projections for the region in the next ten years.

Table 1. Regional Population Growth

Area	2015	2025	% Change
Sacramento County	1,481,803	1,639,613	10.7%
City of Rancho Cordova	70,968	169,081	138.3%

Source: California Department of Finance 2016, City of Rancho Cordova 2015.

3.2 Environmental Consequences

The analysis of growth-related indirect impacts follows the first-cut screening guidelines provided in Caltrans' *Guidelines for Preparers of Growth-Related Indirect Impact Analysis*

(California Department of Transportation 2006:5-1–5-10). The first-cut screening analysis focused on addressing the three following questions.

- To what extent would travel times, travel cost, or accessibility to employment, shopping, or other destinations be changed? Would this change affect travel behavior, trip patterns, or the attractiveness of some areas to development over others?

Implementing the proposed project entails modification of the existing Hazel Avenue/US 50 interchange. Currently, the interchange experiences high levels of congestion. In addition, future approved projects such as the Easton Place development will continue to increase traffic projections beyond capacity. The close spacing between the Folsom Boulevard and eastbound ramp intersections do not provide sufficient queuing for increased traffic volumes.

The Hazel Avenue/US 50 interchange would improve access throughout the project area, and would benefit the existing and future residents of the surrounding areas, including Folsom, Orangevale, and Rancho Cordova.

- To what extent would change in accessibility affect growth or land use change—its location, rate, type, or amount?

The Hazel Avenue/US 50 interchange is an existing interchange in a largely built-out portion of Sacramento County. Other areas of planned development are identified in the Sacramento County General Plan and the SACOG MTP/SCS. The proposed project would accommodate this planned growth.

The extent to which the project would induce growth in the project area depends largely on the strength of local planning and growth management mechanisms, including adhering to adopted growth boundaries, maintaining existing zoning restrictions and land use designations, and implementing farmland and floodplain protection policies. In this case, there appears to be a strong, integrated structure that discourages premature and unplanned growth in the project area. The County of Sacramento has provided land use designations to guide future growth in the study area; and new development must adhere to these land use designations, per the rules and regulations of the relevant cities. Adherence to these restrictions reduces pressure for unplanned development by making adequate quantities of land available for development in locations that best serve the policy goals of the relevant cities. Given the coordinated growth control mechanisms in place, the project is unlikely to substantially encourage unplanned development in the project area, or to shift or hasten planned growth along the US 50 corridor.

- To what extent would resources of concern be affected by this growth or land use change?

Project-related growth is not reasonably foreseeable. While the proposed project would increase the efficiency of the Hazel Avenue/US 50 interchange, it would serve existing and planned future growth. The project is located in a suburban area of Sacramento County. As detailed in Caltrans' *Guidelines for Preparers of Growth-Related Indirect Impact Analysis*, transportation projects in suburban areas could cause growth-related impacts because of a greater presence of open space/vacant land (California Department of Transportation 2006:5-6). Presently, the land in the study area consists of a mix of uses, including residential, commercial, industrial, and open space. The study area is largely built out. As stated previously, growth is expected and planned for in the surrounding region. The population of Sacramento County is growing and is expected to continue to grow rapidly. This growth would not be attributable to, or otherwise influenced by, the proposed project. Based on the above first-cut screening analysis, no additional analysis related to growth is required.

3.3 Avoidance, Minimization, and Mitigation Measures

No avoidance, minimization, or mitigation measures are required.

Chapter 4 Community Character

4.1 Population and Housing

The study area comprises census tracts 87.03 and 87.05, which intersect the proposed project. There are 30 individual blocks within these census tracts that intersect the project alignment (Figure 7). However, only six of these blocks contain residential land uses and therefore only the following blocks are analyzed below:

- Block 3019, Block Group 3, Census Tract 87.03
- Block 3030, Block Group 3, Census Tract 87.03
- Block 3033, Block Group 3, Census Tract 87.03
- Block 3034, Block Group 3, Census Tract 87.03
- Block 3035, Block Group 3, Census Tract 87.03
- Block 3044, Block Group 3, Census Tract 87.03

4.1.1 Affected Environment

4.1.1.1 Regional Population Characteristics

The proposed project is located in Sacramento County and the City of Rancho Cordova. Table 2 shows the population of the County, the census tracts that intersect the project footprint, and the populated block groups that intersect the project footprint. According to the 2010–2014 American Community Survey, non-Hispanic Whites are the largest racial/ethnic group in the study area, and represent about 72% of the population. The Asian population makes up the next largest group, accounting for 12.7% of the population, and Hispanic/Latinos of any race make up the third largest group, accounting for approximately 11.7% of the population.

Table 2. Race and Ethnicity Data (2010-2014)

Area	Total	Hispanic or Latino (of any race)	%	Not Hispanic or Latino													
				White	%	Black or African American	%	Native American	%	Asian	%	Native Hawaiian/ Pacific Islander	%	Other Race	%	Two or More Races	%
Sacramento County	1,450,277	319,934	22.06	865,905	59.71	46,236	3.19	12,376	0.85	21,4861	14.82	14,533	1.00	101,936	7.03	94,430	6.51
Census Tract 87.03	4,947	278	5.62	3,266	66.02	191	3.86	0	0.00	1,270	25.67	0	0.00	0	0.00	220	4.45
Census Tract 87.05	5,826	998	17.13	3,055	52.44	299	5.13	0	0.00	1,508	25.88	150	2.57	243	4.17	571	9.80
*Study Area**	426	50	11.7	307	72.07	23	5.40	6	1.41	54	12.68	3	0.70	12	2.82	21	4.93
Block 3019	359	42	11.7	254	70.75	22	6.13	4	1.11	53	14.76	3	0.84	7	1.95	16	4.46
Block 3030	24	2	8.3	20	83.33	1	4.17	0	0.00	0	0.00	0	0.00	0	0.00	3	12.50
Block 3033	15	6	40.0	10	66.67	0	0.00	0	0.00	0	0.00	0	0.00	5	33.33	0	0.00
Block 3034	12	0	0	8	66.67	0	0.00	2	16.67	0	0.00	0	0.00	0	0.00	2	16.67
Block 3035	15	0	0	15	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Block 3044	1	0	0	0	0.00	0	0.00	0	0.00	1	100.00	0	0.00	0	0.00	0	0.00

* The study area for this CIA comprises the populated blocks through which the proposed project passes (Figure 7).

Source: U.S. Census Bureau, 2010–2014 American Community Survey, 5-Year Estimates Table DP5

4.1.1.2 Neighborhoods/Communities

According to Caltrans' guidelines for conducting Community Impact Assessments (California Department of Transportation 2011), community cohesion is the degree to which residents have a "sense of belonging" to their neighborhood; a level of commitment of the residents to the community; or a strong attachment to neighbors, groups, or institutions—usually because of continued association over time. Communities often are delineated by physical barriers such as major roadways or large open space areas.

Cohesive communities are indicated by specific social characteristics such as long average lengths of residency, home ownership, frequent personal contact, ethnic homogeneity, high levels of community activity, and shared goals. Transportation projects may divide cohesive neighborhoods when the projects act as physical barriers or are perceived by residents as psychological barriers. A transportation project perceived as a physical or psychological barrier may isolate one portion of a homogeneous neighborhood.

US 50 and Hazel Avenue divide the study area into four quadrants (described above), and traveling across US 50 and Hazel Avenue between these areas is not easily achieved. There is also a division of commercial uses, industrial uses, and residential uses in each of the four quadrants in the study area. The open space areas of the Nimbus Dam Recreation Area and American River Parkway are regional recreational destinations. The commercial developments are designed primarily to serve a regional, not local, clientele, thereby dividing each subarea within the study area into retail outlets populated with mostly non-local shoppers and local residents within their neighborhoods.

The affected roadways in the study area, including Hazel Avenue, serve as a primary transportation route for commuters and patrons of the local businesses and shopping areas. During the construction period, roadways would remain open with unrestricted travel during hours of non-construction activities. Travelers may experience delays during periods of active construction that would require temporary lane closures. These delays could discourage some travelers from using these access routes, but lane closures would be temporary, and implementation of the project's Transportation Management Plan (TMP) would ensure that access to adjacent properties would be provided during construction and that delays would be minimized as much as possible.

Overall, the project would improve existing roadways under all alternatives. None of the alternatives would significantly alter the divisions already existing in the community or that could further divide existing communities.

4.1.2 Environmental Consequences

4.1.2.1 Regional Population Characteristics

The proposed project would involve the improvement of the Hazel Avenue/US 50 interchange. As discussed in Chapter 3, the proposed project would not induce unplanned growth. In addition, the proposed project would not remove housing, so no displacement would occur. Therefore, the proposed project would not contribute to changes in the demographic characteristics of the region and study area.

4.1.2.2 Neighborhoods/Communities/Community Character

The proposed project entails modifying an existing interchange and would not change the community character of the area or further divide an existing community. Although transportation improvements are generally capable of having urbanizing effects in an area, the extent of the project improvements would serve to improve the existing interchange and serve planned future growth. Land use and zoning designations in the immediate and surrounding areas would not change as a result of the project.

In addition to providing sufficient traffic capacity, the proposed project is intended to enhance safety of all modes of travel. Features of the project include safety lighting and a new signalized intersection. Existing bike and pedestrian access will be maintained, and an additional new dedicated bike path will be constructed off Hazel Avenue. This new path will loop off Hazel Avenue and travel under Tributary Point Drive. Motorists currently make right turns from the US 50 southbound off-ramp onto Hazel Avenue. A dedicated bike path that avoids the freeway off-ramp will greatly enhance bicyclist safety.

The proposed project improves an existing interchange, and provides benefits to the community such as improved traffic operations, enhanced safety, and new bicycle and pedestrian facilities, which would be experienced by both local residents and the region. While the project does include access and travel benefits to the community, it also includes demolition of several structures that could change community character for some users. All of the alternatives include demolition of the Chevron gas station and Cattlemen's restaurant. Alternative 2 would also include demolition of the entire Nimbus Winery parcel. Cattlemen's restaurant, and the Nimbus Winery and some businesses within, have been in the community for many years. Demolishing these structures, particularly the Nimbus Winery, would change the community character for some users. There would be a larger impact on community character under Alternative 2 than Alternatives 1 and 1a.

4.1.3 Avoidance, Minimization, and Mitigation Measures

No avoidance, minimization, or mitigation measures are required.

4.2 Economic Conditions

4.2.1 Affected Environment

4.2.1.1 Regional Economy

The labor force of Sacramento County was 689,000 in 2015 (California Employment Development Department 2016). One of the largest major employers in both Sacramento County and in the City of Rancho Cordova is Aerojet Industries, which is located in the southeast quadrant of the study area. Other major employers include but are not limited to the Air Resources Board, AMPAC Fine Chemicals, various state government departments, Intel, Mercy General Hospital, Sacramento Bee, and California State University, Sacramento (CSUS).

4.2.1.2 Business Activity in the Study Area

Business activity within the study area includes large industrial operations (including Aerojet and other industrial uses along US 50 and Folsom Boulevard), and commercial uses including restaurants and hotels. There are several restaurants in the project footprint, including Cattleman's and Nimbus Winery. The Nimbus Winery building contains the Old Spaghetti Factory, Tommy T's Comedy Club and Dinner Theatre, Michaelangelo's home décor gift shop, Brainy Zoo toy store, Shelter Hope Pet Shop, and Monster Mini Golf. A brewery is also likely to open at the Nimbus Winery building in 2017. A Chevron gas station is in the project area at the corner of Folsom Boulevard and Nimbus Road.

4.2.2 Environmental Consequences

4.2.2.1 Regional Economy

The proposed project would involve the improvement of the existing Hazel Avenue/US 50 interchange. Impacts on the regional economy are not anticipated.

4.2.2.2 Employment and Income

All alternatives would require direct impacts through business displacement. Alternatives 1 and 1A would require the full acquisition and demolition of structures at the Chevron gas

station and Cattleman's restaurant. This would result in a loss of an estimated 30 full and part-time jobs.

Under Alternative 1A, the right-of-way acquisition at the Nimbus Winery property would be larger in Alternative 1, as acquisition is required as opposed to an aerial easement.

For Alternative 2, there would be full acquisition and demolition of structures at the Chevron gas station, Cattleman's restaurant and the Nimbus Winery property. This would result in a loss of an estimated 60 full and part-time jobs.

Income levels in the study area are described in section 4.5.1. Both census tracts in the project area have significantly higher median household incomes and lower percentages of people below the poverty level compared to the rest of Sacramento County. The businesses that would be affected are primarily in the food service industry and retail, where job opportunities are not specialized and therefore scarce. It is currently undetermined if the businesses would relocate or close. However, the affected businesses could potentially relocate within the community. Both the City of Rancho Cordova and Sacramento County have available land uses suitable for restaurants, retail, and entertainment, and it is anticipated that these businesses could relocate to areas that are equally economically viable.

4.2.2.3 Business Activity and Fiscal Conditions

Under all alternatives, businesses within the study area or the surrounding area would be displaced or relocated as a result of project implementation. Table 3 shows the property tax and estimated sales tax of each of the businesses that would be acquired under the proposed project.

Table 3. Affected Businesses in the Study Area

Jurisdiction	APN	Business Name	Tax Rate	Property Tax	Estimated Sales Tax*
City of Rancho Cordova	069-0160-012	Chevron	8.5%	$18,875.48	$184,061
Sacramento County	069-0060-085	Cattleman's Restaurant	8.0%	$16,960.64	$55,186
Sacramento County	069-0050-013	Nimbus Winery	8.0%	$47,009.48	$173,234

Sources: Property tax source: Sacramento County 2016.

Sales tax for these properties was calculated by applying the applicable tax rate to the sales tax from the most recent industry data was available on the economic census (2012).

Removal of these businesses would result in an initial loss of property and sales tax revenue for Sacramento County and the City of Rancho Cordova. However, the amount of tax revenue lost would be a small percentage of total revenue of these jurisdictions. In addition,

the businesses lost (restaurants, retail, and a gas station) are the types of businesses that could be relocated within these jurisdictions. It is likely that these businesses could relocate and resume generation of sales tax and payment of property tax.

For the businesses on Folsom Boulevard that are not displaced, access would remain from Folsom Boulevard. For travelers driving eastbound on U.S. 50 and exiting at Hazel Avenue to get to businesses on Folsom Boulevard, the proposed project configurations would result in added stop lights and the need to travel on the jughandle to reach Folsom Boulevard. Although the proposed project may result in some additional local travel for these drivers, access to the commercial businesses in the area would remain via existing driveways off of Folsom Boulevard; the commercial businesses' visibility from Folsom Boulevard and U.S. 50 would remain; and the overall operation of the interchange would be improved for people traveling to these destinations.

4.2.3 Avoidance, Minimization, and Mitigation Measures

Several businesses would be displaced as a result of the project. Acquisitions and compensation to property owners would occur consistent with the Federal Uniform Relocation Assistance and Real Properties Acquisition Policies Act, as amended. Appendix A contains a summary of relocation assistance and benefits.

4.3 Community Facilities and Services

4.3.1 Affected Environment

4.3.1.1 Schools

The Folsom Cordova Unified School District includes the cities of Folsom and Rancho Cordova, both of which adjoin US 50. The District Office–Education Services Center is located at 1965 Birkmont Drive.

4.3.1.2 Emergency Services

Police Protection

The Rancho Cordova Police Department (RCDP) and Sacramento County Sheriff's Department are headquartered at 2897 Kilgore Road (west of the study area). The police department provides primary law and traffic enforcement for the area and is organized into four bureaus: office of the chief of police, administrative services, investigations and

community services, and patrol operations. RCDP is responsible for responding to the scene of both emergency and non-emergency crimes; traffic collisions, enforcement and safety; and other requests for police service. Patrol is comprised of three separate shifts covering 24 hours (City of Rancho Cordova 2016). There are no Rancho Cordova police stations in the study area.

In close proximity, the California Highway Patrol (CHP) has their Sacramento Communications Center located at 3165 Gold Valley Drive and their East Sacramento division offices located at 11336 Trade Center Drive. CHP is responsible for enforcing the California Vehicle Code, particularly in areas of speed, safety belt/child restraints, driving under the influence, and distracted driving. In addition to enforcement, officers provide security for state properties, focus on congestion relief, assist allied agencies, and educate the motoring public on traffic safety. The East Sacramento division patrols the unincorporated areas of Sacramento County east of Watt Avenue, west of the El Dorado County Line, south of the American River, and north of Jackson Road (State Route 16) as well as Sunrise Boulevard and all unincorporated county area east of Sunrise Boulevard and north of the American River. It patrols approximately 22 miles of US 50 (California Highway Patrol 2016).

Fire Protection

The Sacramento Metropolitan Fire District, commonly referred to as Metro Fire, is responsible for fire protection services in the study area. Metro Fire is a combination of 16 smaller fire departments that serve a population of over 727,000 in a 417 square mile service area. On any given day, there are 155 on-duty personnel to serve the District's communities. The nearest Metro Fire station, Station 63, is in the immediate vicinity of the study area at 12395 Folsom Boulevard. The station is equipped with an engine company, paramedic ambulance (12 hours per day) and a Type III engine, or "grass rig" (Sacramento Metropolitan Fire District 2015).

Emergency Medical Services

There are no emergency medical services in the study area. The California Emergency Services (EMS) Authority medical center is located at 10901 Gold Center Drive. The EMS administers coordinated emergency medical care, injury preventions and disaster medical response. The Mercy San Juan Medical Centers, located at 6501 Coyle Avenue in Carmichael and 3400 Data Drive in Rancho Cordova, are part of a non-profit hospital that serves the areas of north Sacramento County and south Placer County.

4.3.1.3 Utilities

Utilities in the study area include gas lines, overhead electric lines, underground electric lines, fiber optic cables, water lines, sewer lines, and storm drain lines.

4.3.2 Environmental Consequences

4.3.2.1 Community Facilities

No schools or other community facilities are in the immediate project vicinity. Implementation of a TMP would reduce any temporary delays at the Hazel Avenue/US 50 interchange.

4.3.2.2 Emergency Services

During construction, lane closures will be required and are proposed to be performed during non-peak traffic hours. Weekends and night work will be required for the bridge widening (for Alternative 1 and 1A), ramp realignment construction, and during conditions where traffic is detoured. The proximity of Folsom Boulevard parallel to US 50 and the nearby Folsom Boulevard/US 50 interchange will provide opportunities for detours when ramp closures are required. Any required closures would be coordinated with emergency service providers so as not to hinder emergency responses.

4.3.2.3 Utilities

Any required utility coordination and service disruptions would be minimized to the extent feasible and would be communicated with customers in advance of any disruption to allow for alternative service arrangements.

4.3.3 Avoidance, Minimization, and Mitigation Measures

As part of construction, the project proponents will prepare and implement a TMP to avoid and minimize potential impacts. The TMP would ensure emergency vehicles and school bus routes are not impeded. The TMP would reduce impacts of the proposed project on temporary access and circulation caused by potential traffic delays during construction.

4.4 Relocations and Real Property Acquisition

4.4.1 Affected Environment

ROW acquisitions would occur under all of the project alternatives. Under Alternative 1, ROW is anticipated from parcels in the southwest quadrant of the interchange. It is anticipated that 12 parcels will be affected by the improvements, including full acquisition and demolition of structures at the Chevron gas station and Cattleman's restaurant. The viaduct structure is proposed to cross over the northern portion of the Nimbus Winery parking lot on an aerial easement to allow parking below the structure and minimize impacts on the business.

Under Alternative 2, ROW would be acquired from parcels in the southwest quadrant of the interchange. An estimated 13 parcels would be affected by the improvements, including full acquisition and demolition of structures at the Chevron gas station, Cattleman's restaurant and the Nimbus Winery property. Table 4 compares the ROW acquisitions by alternative.

Table 4. ROW Acquisitions in the Study Area (Square Feet)

Parcel	Alternative 1		Alternative 1a		Alternative 2	
	ROW	TCE	ROW	TCE	ROW	TCE
069-0160-005	0	1,806	0	1,806	0	1,806
069-0160-006	666	1,678	666	1,678	0	1,888
069-0160-007	2,599	1,510	2,599	1,510	703	1,512
069-0160-008	3,875	1,389	3,875	1,389	2,349	1,385
069-0160-015	1,2404	5,148	1,2404	5,148	5,718	4,782
069-0160-019	2,011	2,448	2,011	2,448	348	1,886
069-0160-020	0	270	0	270	1,182	1,240
069-0160-014	4,854	3,186	4,854	3,186	12,929	3,774
069-0160-011	5,973	1,407	5,973	1,407	8,624	1,409
069-0160-012	22,117 (full)	0	22,117 (full)	0	22,117 (full)	0
069-0050-013	5,768	20,315	32,669	7,569	123,119	0
069-0050-014	16,807	13,530	34,282	6,053	66,142	6,433
069-0050-085	17,959	4,214	17,959	4,214	18,037	0
069-0050-107	572	1,405	572	1,405	2,227	2,312
072-0231-125	270,447	38,167	27,0447	38,167	270,412	37,761
072-0231-079	24,922	6,722	24,922	6,722	27,891	6,615

4.4.2 Environmental Consequences

Under all alternatives, the Chevron gas station and Cattleman's restaurant parcels would be fully acquired. The ROW take at the Nimbus Winery property would be larger in Alternative 1A because acquisition would be required as opposed to an aerial easement.

All acquisitions would be conducted in accordance with the Federal Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended, and the California Relocation Act.

4.4.3 Avoidance, Minimization, and Mitigation Measures

Acquisitions and compensation to property owners would occur consistent with the Federal Uniform Relocation Assistance and Real Properties Acquisition Policies Act, as amended. Appendix A contains a summary of relocation assistance and benefits.

4.5 Environmental Justice

4.5.1 Affected Environment

Income data is not available at the block-level, so the two census tracts within the study area were used to determine the percentage of low-income households in the project vicinity. Table 5 shows the income rates for Sacramento County and census tracts 87.03 and 87.05.

Table 5. Income and Poverty Rates in the Study Area

Area	Median Household Income	% Families Below Poverty Level	% All People Below Poverty Level
Sacramento County	$55,615	13.7%	18.1%
Census Tract 87.03	$87,357	4%	5.2%
Census Tract 87.05	$108,765	3.2%	6.9%

Source: U.S. Census Bureau. American Fact Finder

Both study area census tracts have median household incomes that are more than double the U.S. Census-defined poverty level for a household of four. In addition, data from both census tracts in the study area indicate that the percentage of individuals living below the poverty threshold is significantly lower than it is for the county as a whole. Table 2 above shows the minority populations in the study area, which is predominantly white (more than 72%). The Hispanic population is approximately 11%, which is less than Sacramento County as a whole. Block group 3033 has a higher percentage of Hispanics than the rest of the study area. Block 3033 contains the Cobble Oaks Apartments, which is not considered low income housing. Blocks 3034 and 3035 contain a mobile home park. While income data is not available at this level, the race/ethnicity demographics described above in Table 2 show that the residents of these two blocks are predominantly white. In general, the study area is less diverse and has a much higher income than the rest of Sacramento County. Based on tract-level race/ethnicity and poverty data, there do not appear to be environmental justice populations residing in the study area.

4.5.2 Environmental Consequences

The temporary construction impacts, as well as the benefits, of the proposed project would accrue to all roadway users, including local residents. Implementation of the proposed project would improve the roadway for all users of the transportation system, regardless of race, ethnicity, or income. Although substantial adverse impacts were not identified, minor impacts associated with construction-period delays, noise, and air quality would not be borne disproportionately by low-income and/or minority populations.

No minority or low-income populations have been identified that would be adversely affected by the proposed project as determined above. Therefore, this project is not subject to the provisions of EO 12898.

Potential effects of a project are typically experienced in the area adjacent to and immediately surrounding the project location. Due to the distance of the proposed project from established neighborhoods, the potential for the proposed project to impact the community is considered to be minimal.

4.5.3 Avoidance, Minimization, and Mitigation Measures

No avoidance, minimization, or mitigation measures are required.

Chapter 5 Access, Circulation, and Parking

5.1 Affected Environment

5.1.1 Access

The primary roads in the study area include US 50, Hazel Avenue, and Folsom Boulevard. Sacramento Regional Transit provides public transportation services in the study area.

5.1.2 Circulation

In addition to roadways, the multimodal transportation system in the study area includes public transit, bikeways, pedestrian pathways/sidewalks and rail service.

5.1.2.1 Transit and Rail Services

The Sacramento Regional Transit Light Rail (Gold Line) runs from historic Folsom to downtown Sacramento, and has a station just south of the project alignment on Folsom Boulevard with pick up times every 30 minutes between 5:00 a.m. and 7:00 p.m. Monday through Friday. Trains run every 30 minutes between 7:30 a.m. and 7:00 p.m. on the weekends. In addition, Hazel Express (bus route 109) runs two round trips per day from Hazel Avenue/Greenback Lane to downtown Sacramento, utilizing Hazel Avenue and Folsom Boulevard in the study area.

5.1.2.2 Pedestrian and Bicycle Facilities

Bicycle and pedestrian travel is a common mode of transportation in the study area. Sidewalks are provided on Hazel Ave and Folsom Blvd, but not on Nimbus Road. Signalized crosswalks are provided in the study area at major intersections.

The American River Bike Trail is a highly popular bicycle route and crosses under the Hazel Avenue Bridge in the study area. There are bike lanes on all of the primary roads in the study area, including Hazel Avenue, Folsom Boulevard, and Nimbus Road.

5.1.3 Parking

Parking in the study area is at designated lots associated with businesses and retailers. On-street parking is not available in the study area.

5.2 Environmental Consequences

5.2.1 Access and Circulation

The proposed project would reconfigure the Hazel Avenue/US 50 interchange. Currently, the project area experiences congestion during peak hours, and the approved developments near the project area would increase traffic. The surrounding land uses are developed or planned for future development. The proposed project would reduce congestion, improve traffic flow, and accommodate future traffic demand. All alternatives would widen and lengthen off ramps to increase capacity for future traffic volumes, which are anticipated to increase beyond existing capacity. The project would also improve intersection operations and spacing, to minimize conflict with public transit. In addition, all of the project alternatives include a connection to the future Atlanta Street, which is part of the Easton Place component of the approved Boroughs of Easton development.

For travelers driving eastbound on U.S. 50 and exiting at Hazel Avenue to get to businesses on Folsom Boulevard, the proposed project configurations would result in added stop lights and the need to travel on the jughandle to reach Folsom Boulevard. Although the proposed project may result in some additional local travel for these drivers, access to the commercial businesses in the area would remain via existing driveways off of Folsom Boulevard; the commercial businesses' visibility from Folsom Boulevard and U.S. 50 would not be changed; and the overall operation of the interchange would be improved for people traveling to these destinations.

During the construction period, short-term lane closures may be required during off-peak hours. The Light Rail route in the study area runs alongside Folsom Boulevard. Several project features, including removal of the existing at-grade intersection at Hazel Avenue and Folsom Boulevard, construction of the new railroad overhead, and construction of a new signalized intersection and at-grade railroad crossing, would require coordination with Sacramento Regional Transit to avoid impacting the light rail operations. Overall, the project supports light rail and public transit service. The railroad overhead and new at-grade railroad crossing are designed around existing public transit services, so these services would be maintained in the future. Pedestrian access would be maintained on the east side of Hazel Avenue with 6-foot sidewalks and bicyclists would utilize the County standard 7-foot shoulders. It is expected that pedestrians and bicyclists would continue to use the nearby Bikeway and Pedestrian Overcrossing as the primary means for crossing US 50. In addition, a new dedicated bike trail would be constructed along Hazel Avenue, improving safety for bicyclists in the study area.

5.2.2 Parking

Parking spaces would be lost at some of the businesses that would be affected by the project alternatives. Under Alternative 1, Nimbus Winery would lose parking spaces where the property borders U.S. 50. Additional spaces would be lost under Alternative 1A, and under Alternative 2 the entire property would be acquired. The project proponents are in the process of meeting with affected property owners to discuss options for minimizing and/or mitigating for the loss of parking at the Nimbus Winery.

5.2.3 Avoidance, Minimization, and Mitigation Measures

A TMP is a program of activities for alleviating or minimizing work-related traffic delays by applying traditional traffic handling practices and innovative strategies including public awareness campaigns, motorist information, demand management, incident management, system management, construction methods and staging, and alternate route planning. TMP strategies also strive to reduce overall duration of work activities where appropriate. Typical components of a TMP can include measures such as the implementation of staging, traffic handling, and detour plans; restricting construction work to certain days and/or hours to minimize impacts to traffic and pedestrians; coordination with other construction projects to avoid conflicts; and the use of portable changeable message signs to inform the public of construction activities.

Implementation of the measures in the TMP would reduce the temporary access and circulation impacts of the project caused by potentially lengthy construction delays. In addition to the measures described above, the TMP will include the following measures:

- Any emergency service agency whose ability to respond to incidents will be affected by any lane closure must be notified prior to that closure.
- Work will be coordinated with the local busing system (including school buses and public systems) to minimize impacts on their bus schedules.
- The lead agency will provide information to residents and businesses before and during project work that may represent a negative impact on commerce and travel surrounding the zone of construction.

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Appendix A Summary of Relocation Benefits

Appendix A Summary of Relocation Benefits

California Department of Transportation Relocation Assistance Program

Relocation Assistance Advisory Services

The California Department of Transportation (Caltrans) would provide relocation advisory assistance to any person, business, farm, or non-profit organization displaced as a result of Caltrans' acquisition of real property for public use. Caltrans would assist residential displacees in obtaining comparable decent, safe, and sanitary replacement housing by providing current and continuing information on sales prices and rental rates of available housing. Non-residential displacees would receive information on comparable properties for lease or purchase.

Residential replacement dwellings would be in equal or better neighborhoods, at prices within the financial means of the individuals and families displaced, and reasonably accessible to their places of employment. Before any displacement occurs, displacees would be offered comparable replacement dwellings that are open to all persons regardless of race, color, religion, sex, or national origin, and are consistent with the requirements of Title VI of the Civil Rights Act of 1964, as amended. This assistance would also include supplying information concerning federal- and state-assisted housing programs, and any other known services being offered by public and private agencies in the area.

Residential Relocation Payments Program

A brochure on the residential relocation program is available in English at http://www.dot.ca.gov/hq/row/pubs/residential_english.pdf and in Spanish at http://www.dot.ca.gov/hq/row/pubs/residential_spanish.pdf.

If you own or rent a mobile home that may be moved or acquired by Caltrans, a relocation brochure is available in English at http://www.dot.ca.gov/hq/row/pubs/mobile_eng.pdf and in Spanish at http://www.dot.ca.gov/hq/row/pubs/mobile_sp.pdf.

The Business and Farm Relocation Assistance Program

A brochure on the business relocation program is also available in English at http://www.dot.ca.gov/hq/row/pubs/business_farm.pdf and in Spanish at http://www.dot.ca.gov/hq/row/pubs/business_sp.pdf.

Additional Information

No relocation payment received would be considered as income for the purpose of the Internal Revenue Code of 1954 or for the purposes of determining eligibility or the extent of eligibility of any person for assistance under the Social Security Act or any other federal law (except for any federal law providing low-income housing assistance).

Persons who are eligible for relocation payments and who are legally occupying the property required for the project would not be asked to move without being given at least 90 days advance notice, in writing. Occupants of any type of dwelling eligible for relocation payments would not be required to move unless at least one comparable "decent, safe, and sanitary" replacement

residence, open to all persons regardless of race, color, religion, sex, or national origin, is available or has been made available to them by the state.

Any person, business, farm, or non-profit organization, which has been refused a relocation payment by Caltrans, or believes that the payments are inadequate, may appeal for a hearing before a hearing officer or the Caltrans' Relocation Assistance Appeals Board. No legal assistance is required; however, the displacee may choose to obtain legal council at his/her expense. Information about the appeal procedure is available from Caltrans' Relocation Advisors.

The information above is not intended to be a complete statement of all of Caltrans' laws and regulations. At the time of the first written offer to purchase, owner-occupants are given a more detailed explanation of the state's relocation services. Tenant occupants of properties to be acquired are contacted immediately after the first written offer to purchase, and also given a more detailed explanation of Caltrans' relocation programs.

Important Notice

To avoid loss of possible benefits, no individual, family, business, farm, or non-profit organization should commit to purchase or rent a replacement property without first contacting a Department of Transportation relocation advisor.

Traffic Operations Report for Hazel Avenue/Route 50

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March 2016

This traffic operations report has been reviewed and approved by the following parties:

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EXECUTIVE SUMMARY

The County of Sacramento has contracted with Mark Thomas & Company (MTCo) to prepare Project Approval and Environmental Documentation (PA&ED) for improvements to Hazel Avenue near the Route 50 interchange. This traffic operations report documents the traffic operations analysis for the PA&ED phase. It builds upon the previous traffic operations analysis conducted by DKS Associates for the Project Study Report (PSR), including updated existing conditions, revised forecasts, and more focused traffic analysis.

Development of Traffic Forecasts

The assumptions, methodology and results of the traffic forecasting process, were originally documented in a January 17, 2011 report approved by Caltrans District 3. For the PA&ED phase, updated forecasting memoranda were prepared in October 2015 and November 2015. DKS updated existing conditions to reflect Year 2015 and revised forecasts to reflect a new 2022 opening year and 2042 horizon year.

Preliminary Traffic Analysis and Screening of Alternatives

During the PSR phase, a wide range of alternatives for improvements to Hazel Avenue near the Route 50 interchange were defined, evaluated and screened. During that phase, representatives from Caltrans Headquarters, Caltrans District 3 and Sacramento County DOT worked with MTCo and DKS to define several design alternatives for a detailed traffic operations analysis using a VISSIM traffic simulation model. Based on the results of that analysis, three alternatives were carried forward into the PA&ED phase.

Traffic Operations Analysis for PA&ED Phase

This report evaluates the "Viaduct" (Alternative 1), "Tunnel" (Alternative 1A), and "Direct Flyover" (Alternative 2) options under existing (2015) conditions, opening year (2022) and horizon year (2042). The results indicate that the no build scenario would result in extreme and unacceptable levels of congestion during the horizon year. The "Viaduct", "Tunnel", and "Direct Flyover" alternatives all perform acceptably during the opening and horizon year. All three build alternatives meet applicable level of service policies (relating to freeway and intersection operations) and provide adequate storage for estimated queues at ramp terminals.

1. BACKGROUND

The County of Sacramento has contracted with Mark Thomas & Company (MTCo) to prepare Project Approval and Environmental Documentation (PA&ED) for improvements to Hazel Avenue near the Route 50 interchange. The proposed project will extend Hazel Avenue as a six-lane facility south of Folsom Boulevard, including grade separating Hazel Avenue over the light rail tracks, heavy rail track, Folsom Boulevard, and a future public street adjacent to the south railroad right-of-way. The Hazel Avenue extension south of the light rail grade separation will continue to a future intersection with Easton Valley Parkway, which is part of the Easton Specific Plan approved by the County of Sacramento. Ultimately, Easton Valley Parkway will provide connections to White Rock Road (via the planned Rancho Cordova Parkway, located in the planned Westborough Specific Plan in the City of Rancho Cordova) and Prairie City Road and the City of Folsom's planned development south of US 50.

This report documents the traffic operations analysis conducted for the PA&ED phase, which has been conducted in the following steps:

Development of Revised Traffic Forecasts – Caltrans guidelines call for designing a project based on a horizon year 20 years after opening year of that project. The County has determined 2022 as the likely opening year for the Hazel Avenue/Route 50 project. By that time, the Easton/Glenborough project is expected to reach 3,000 dwelling unit equivalents (DUEs) and trigger the need for the project. Thus the horizon year for the project design should be 2042.

As requested by Caltrans, the 2042 traffic demand volumes are consistent with the "cumulative conditions" traffic volumes reported in the DEIR on the Folsom SOI. However, VISSIM simulation models using Folsom SOI EIR "demand" volumes indicate that the capacity constraints on Route 50 and its interchanges will limit the "volume served" along Route 50 near Hazel Avenue during the 2042 AM and PM peak periods. The analysis of potential design options for the PA&ED phase is based on the "constrained volumes" that result from the simulation models.

Preliminary Traffic Analysis and Screening of Alternatives – A Peer Review Meeting was held in 2011 to identify a range of alternatives for improvements to Hazel Avenue near the Route 50 interchange, discuss their pros and cons and narrow them to six alternatives for evaluation in a preliminary traffic operations analysis phase. That analysis indicated that three alternative designs (flyover, braided partial cloverleaf and diverging diamond) would each result in LOS F conditions at one of the major intersections along Hazel Avenue. It was recommended that these alternatives not be carried further in the PSR process.

A detailed traffic operations analysis using a VISSIM simulation model was then conducted on the remaining three alternatives. However, Caltrans Headquarters staff subsequently found that all of these alternatives would require unacceptable design exceptions. Therefore, representatives from Caltrans Headquarters, Caltrans District 3 and Sacramento County DOT worked with MTCo and DKS to define three new design alternatives for evaluation in a traffic operations analysis.

In the PSR traffic operations report (January 2013), three design alternatives were evaluated in a detailed traffic operations analysis using a VISSIM traffic simulation model for the project area. The analysis indicated that the "Loop Under" Alternative would result in unacceptable operations during the PM peak period in the horizon year, while the "Viaduct" and "Direct Flyover" alternatives would provide acceptable operations. It was recommended that these two alternatives be carried forward into the PA&ED phase.

Traffic Operations Analysis of PSR Alternatives – This report documents a detailed traffic operations analysis for the "Viaduct", "Tunnel", and "Direct Flyover" alternatives, using updated existing conditions and revised forecasts. This analysis is based on the same VISSIM simulation models that were previously approved by Caltrans. The conclusion of this analysis indicates that all build alternatives continue to perform acceptably with the revised volumes.

2. TRAVEL DEMAND FORECASTING

Caltrans guidelines call for designing a project based on a horizon year 20 years after opening year of that project. The County has determined 2022 as the likely opening year for the Hazel Avenue / Route 50 project. By that time, the Easton/Glenborough project is expected to reach 3,000 dwelling unit equivalents (DUEs) and trigger the need for the project. Thus the horizon year for the project design should be 2042.

Traffic forecasts were developed for a study area that would affected by the proposed improvements to Hazel Avenue near Route 50, which covers the following:

- US 50 between the planned Rancho Cordova Parkway interchange and the Prairie City interchange
- Folsom Boulevard from its interchange with Route 50 to west of the proposed "Jughandle" connection to Hazel Avenue
- Hazel Avenue from Gold Country Boulevard to the planned Easton Valley Parkway

This section describes the traffic forecasting process.

Roadway Network Assumptions

A number of new roadways and interchanges are planned near the Hazel interchange and future traffic volumes on Route 50 and through the Hazel interchange will be affected by implementation of those new facilities. This analysis assumes that roadway improvements will be implemented in the years identified in SACOG's MTP/SCS. **Table 2-1** shows the assumed improvements on key nearby roadways.

The future volume of traffic flowing on Route 50 and through the Hazel interchange will be affected by implementation of several new roadways, especially the following:

- The phased implementation of auxiliary lanes along Route 50 between Sunrise Boulevard and East Bidwell Street
- The widening of Hazel Avenue from Curragh Downs Drive to Madison Avenue
- Construction of the Rancho Cordova Parkway interchange and the extension of Rancho Cordova Parkway from Route 50 to White Rock Road
- The phased construction of Easton Valley Parkway through the Easton/Glenborough development, the westward extension through the Westborough Specific Plan, and the eastward extension through the Folsom South of US 50 development

Table 2-1
Roadway Network Assumptions

Roadway	Limits	Travel Lanes		
		2015	2022	2042
Hazel Ave	Greenback Lane to Madison Ave	4	4	4
	Madison Ave to Curragh Downs Dr	4	6	6
	Curragh Downs Dr to Route 50	6	6	6
	Route 50 to Jug Handle	0	4	6
	Jug Handle to Easton Valley Pkwy	0	4	6
Folsom Blvd	Sunrise Blvd to Hazel Ave	4	4	4
	Hazel Ave to Route 50	4	4	4
Easton Valley Pkwy	Rancho Cordova Pkwy to Hazel Ave	0	Partial[1]	6
	Hazel Ave to Prairie City Rd	0	Partial[1]	4
	Prairie City Rd to Oak Ave Pkwy	0	0	4
Rancho Cordova Pkwy	Interchange with Route 50	No	Yes	Yes
	Route 50 to Easton Valley Pkwy	0	4	6
	Easton Valley Pkwy to White Rock Rd	0	4	6
White Rock Rd	Prairie City to Grant Line Rd	4	4	4
	Grant Line Rd to Sunrise Blvd	2	4	4
Route 50 EB Aux Lanes	Sunrise Ave to Rancho Cordova Pkwy	No	Yes	Yes
	Rancho Cordova Pkwy to Hazel Ave	No	Yes	Yes
	Hazel Ave to Folsom Blvd	No	Yes[2]	Yes[2]
	Folsom Blvd to Prairie City Rd	No	Partial[3]	Yes
Route 50 WB Aux Lanes	Prairie City Rd to Folsom Blvd	No	No	Yes
	Folsom Blvd to Hazel Ave	No	No	Yes
	Hazel Ave to Rancho Cordova Pkwy	No	No	Yes
	Rancho Cordova Pkwy to Sunrise Blvd	No	No	Yes

[1] Assumes partial construction of Easton Valley Pkwy to provide local access, but no complete connection from Rancho Cordova Pkwy to Hazel Ave, or from Hazel Ave to Prairie City Rd.
[2] An auxiliary lane along eastbound Route 50 from Hazel Avenue to the Folsom Boulevard overcrossing is part of this project.
[3] Assumes auxiliary lane extends east of Folsom Blvd, consistent with Route 50 Auxiliary Lane PSR.

Opening Year 2022

The County has determined 2022 as the likely opening year for the Hazel Avenue / US 50 project. Based on phasing information previously provided by Aerojet, 2,732 single family residences and a growth of approximately 1,309 jobs were assumed in the 2022 forecasts. This amount of development is equivalent to about 3,000 dwelling unit equivalents (DUE's), which the County has established as the trigger point for the need to construct the Hazel Avenue / Route 50 Interchange Project.

The location of initial development (through 2022) was also based on the provided phasing information. The majority of the development is placed in Easton Place and the western portion of the Glenborough at Easton project, taking access to Hazel Avenue south of Folsom Boulevard, and Folsom Boulevard at the Aerojet Road and Birkmont Drive intersections. A small portion of the development would have easy access via Prairie City Road.

As shown in Table 2-1, by Year 2022 the Rancho Cordova Parkway interchange is assumed to be in place. Easton Valley Parkway is not assumed to be connected between Rancho Cordova Parkway and Hazel Avenue, or between Hazel Avenue and Prairie City Road. Portions of Easton Valley Parkway would likely be constructed to facilitate access Easton/Glenborough development.

The 2022 forecasts assume implementation of the proposed improvements to Hazel Avenue near the Route 50 interchange, which involve the following:

- Grade separation of the Hazel Avenue/Folsom Boulevard intersection and construction of the Jug Handle
- Extending Hazel Avenue south of Folsom Boulevard to future Easton Valley Parkway
- Providing a transition lane on eastbound Route 50 from Hazel Avenue to Folsom Boulevard

SACOG's SACSIM travel demand model was used to develop the traffic forecasts. SACOG has regionwide development assumptions for 2014 and 2020. SACOG's SACSIM model was run for these two years, with some adjustments made to 2020 land use scenario to better reflect Easton/Glenborough development phasing. The difference between the traffic volumes generated by those model runs provides a 6-year growth that would be added to 2015 traffic count data. In order to bring the 2015 traffic counts up to a Year 2022 forecast, that 6-year growth forecast was "straight-line" increased by 16.7 percent to represent a 7-year growth. This 7-year growth was then added to the 2015 counts.

Caltrans has requested that DKS compare future ramp volumes to existing counts. In some cases, ramp volumes decreased (e.g. due to the SACSIM model's projected diversion to new roadways). Caltrans requested that we not assume any volume decreases on ramps, stating the following[1]:

[1] October 26, 2015 email from Cynthia Smith, Caltrans District 3.

There is extensive new development proposed throughout the area as noted on page 6 'Forecasting Assumptions' [in the Traffic Forecasting Memorandum.] This new traffic growth historically has resulted in traffic utilizing and maximizing both new roads and state freeways. Traffic diversion away from freeway facilities in the past has been minimal and on a short term basis. The SACOG travel demand model does not account for signals, control delay, queueing, and driveways on local roadways which could result in local roads being more attractive as compared to the typical freeway facility. As a result this may cause an unrealistic drop in volumes on the freeway facility and ramps. Decreasing freeway or ramp demand traffic volumes 27 years into the future, compared to existing volumes, is not a reasonable assumption to Caltrans.

In the interest of added conservatism, Caltrans' request was accommodated for both the 2022 and 2042 forecasts.

Horizon Year 2042

In the 2011 Traffic Forecasting Report for the PSR, Caltrans had requested that the horizon year traffic forecasts be based on forecasts from cumulative conditions of the Folsom SOI EIR. The development forecasts in that EIR were based on the following:

- The EIR assumed buildout of City of Folsom (both the current boundaries and the proposed SOI) which are higher than SACOG 2035
- Buildout of the Easton/Glenborough project, which have higher employment levels than SACOG 2035
- For the City of Rancho Cordova, the City's buildout estimates were used, which are higher (especially for employment levels) than SACOG 2035 development levels
- The EIR assumed the El Dorado County General Plan EIR estimates for the El Dorado Hills area, which have higher employment levels than SACOG 2035
- For other areas, the development levels in the EIR were based on SACOG development levels

The growth assumptions for the Folsom SOI EIR have 41,000 more jobs and 15,000 more housing units than SACOG's 2035 MTP/SCS that was adopted in 2008. Due to the recession, SACOG's lowered its 2035 development forecasts in the current MTP that was adopted in 2012. Thus DKS views the cumulative development levels in the Folsom SOI EIR to represent a horizon year well beyond 2042. These development assumptions will provide conservatively high 2042 traffic demand estimates for this PA&ED phase.

In fact, the 2042 forecasts are so high that the demand will be constrained by the available capacity upstream on US 50. A VISSIM model was previously developed for the study corridor. Only the volume "served" (what is able to reach the Hazel Avenue and Folsom Boulevard interchanges) based on the VISSIM model is reported for Year 2042 and used for

operations analysis. This approach is consistent with the 2012 Traffic Operations Report for the PSR.

2042 Constrained Traffic Volumes

The 2042 Baseline traffic demand volumes are consistent with the traffic volumes reported in the DEIR on the Folsom SOI. However, a detailed analysis indicates that on some key elements of the planned roadway system, the 2042 traffic demand volumes would exceed capacities.

DKS prepared AM and PM peak period VISSIM simulation models using Folsom SOI EIR "demand" volumes. The results of those simulation models indicate that the capacity constraints on Route 50 and its interchanges will limit the "volume served" along Route 50 near Hazel Avenue as follows:

- Eastbound Route 50 volume served would be lower than demand because congestion on Route 50 west of Sunrise would meter traffic on Route 50 eastbound.
- Eastbound Route 50 volume served would also be lower than demand because congestion on Sunrise Blvd, Rancho Cordova Parkway and Hazel Avenue limits traffic getting onto freeway
- Westbound Route 50 volume served would be lower than demand because only two mixed flow lanes under the Prairie City interchange bridge limits capacity
- Westbound Route 50 volume served would also be lower than demand because congestion on Folsom Boulevard, Hazel Avenue and Rancho Cordova Parkway limits traffic getting onto Route 50.

The "volume served" during the highest traffic hour can be measured in the traffic simulation model for segments of the freeway, freeway ramps and intersection turning movements. Those volumes will vary somewhat from one simulation run to the next due to the "random arrival" of vehicles that enter the roadway system throughout the peak period. To provide adequate estimates, DKS typically runs its simulation ten times and uses the average volumes served from those runs.

The traffic simulation model shows that some of the biggest constraints are at the "gateways" to the VISSIM simulation model. This includes the capacity of Route 50 eastbound near Sunrise Boulevard and westbound near Prairie City Road, as well as on or near some on-ramps at the Sunrise Boulevard, Rancho Cordova Parkway, Hazel Avenue and Folsom Boulevard interchanges. The analysis of design alternatives is based on the "constrained" 2042 peak period volumes that result from VISSIM simulation models that use the traffic demand from cumulative conditions in the Folsom SOI EIR as inputs.

HOV Lane Forecasting

PeMS data was used to estimate flows in the HOV lanes of US 50 for existing (2015) conditions. The same parameters (e.g. date range, peak hour, average flow) used to calculate mixed lane flows were applied to calculate HOV lane flows.

The opening year and horizon year traffic forecasts were made using SACOG travel demand models, which include a mode choice model that predicts the number of HOVs on each roadway segment and accounts for the travel time savings from HOV lanes on both the mainline and at ramp metering locations. During their review of the initial 2042 forecasts, Caltrans expressed concern over the model's estimate of HOV's, as measured by the percentage of total vehicles on segments of Route 50 that would use the HOV lanes. Based on several discussions on this subject, DKS was asked to assume that 21% of the total 2042 peak hour "demand" on Route 50 would be HOV traffic. Caltrans recognized that use of this level of HOV demand in the traffic simulation model results in a lower percentage of HOVs actually using the HOV lanes due to 1) HOV's weaving to get in and out of the HOV lanes and 2) HOV's that would not use the HOV lanes because they are traveling short distances on Route 50.

3. OPERATIONS ANALYSIS METHODOLOGY

Field reconnaissance was undertaken to ascertain the traffic control and capacity characteristics of each of the study area intersections, roadway segments, and freeway elements. Combined with known or projected traffic volumes (discussed in **Section 2** of this report), these characteristics enable the calculation of performance measures. Levels of service are a quantitative stratification of performance measures that represent quality of service. There are six levels of service, ranging from A to F. LOS A represents the best operating conditions from the traveler's perspective and LOS F the worst. The specific performance measures that define LOS vary by type of transportation facility, and are discussed in the following subsections.

Intersection Operations Analysis

For signalized and unsignalized intersections, operational analyses were conducted using a methodology outlined in the Transportation Research Board's Highway Capacity Manual, 2000 (HCM 2000) and Highway Capacity Manual, 2010 (HCM 2010). The HCM 2010 methodology was used in all locations except where signalized intersection characteristics deemed the methodology inappropriate. These locations include intersections with unconventional signal phasing, and locations adjacent to light rail tracks where additional delay occurs due to light rail operations. In the selected locations, the HCM 2000 methodology was employed. The HCM procedure calculates an average control delay per vehicle for each movement at an intersection, and assigns a level of service designation based upon the average delay per vehicle. **Table 3-1** presents the HCM level of service criteria for signalized and unsignalized intersections.

Table 3-1
Level of Service Criteria (Intersections)

Level of Service (LOS)	Total Delay Per Vehicle (seconds)	
	Signalized Intersections	Unsignalized Intersections
A	$\leq$ 10	$\leq$ 10
B	> 10 and $\leq$ 20	> 10 and $\leq$ 15
C	> 20 and $\leq$ 35	> 15 and $\leq$ 25
D	> 35 and $\leq$ 55	> 25 and $\leq$ 35
E	> 55 and $\leq$ 80	> 35 and $\leq$ 50
F	> 80	> 50

Source: *HCM 2010 Highway Capacity Manual, Transportation Research Board, Washington, D.C., 2010.*

The HCM methodology also estimates queuing at intersection approaches. Queues at the ramp terminals are checked to ensure that the 95th percentile queues do not back up onto the freeway mainline.

Freeway Operations Analysis

For freeway segments, operational analyses were conducted using a methodology outlined in the Transportation Research Board's Highway Capacity Manual, 2010 (HCM 2010). The HCM 2010 methodology divides freeway segments into three categories: basic segments, merge and diverge segments, and weaving segments. *Merge segments* are defined as the ramp influence area extending from the merge point to 1,500 feet downstream of the merge point. *Diverge segments* are defined as the ramp influence area extending from the diverge point to 1,500 feet upstream of the diverge point. *Weaving segments* occur between a merge point and a nearby downstream diverge point. The maximum distance that would be considered a "weave" (as opposed to isolated merge and diverge segments) is determined by freeway volume, ramp volumes, and the number of weaving lanes. *Basic segments* encompass all other freeway segments that are not within the ramp influence area (e.g. classified as a merge, diverge, or weave).

The HCM procedure estimates an average density on the freeway segment (in units of passenger cars per mile per lane). **Table 3-2** presents the HCM level of service criteria for the freeway basic, merge/diverge, and weaving segments.

Table 3-2
Level of Service Criteria (Freeways)

Level of Service (LOS)	Maximum Density (Passenger Cars Per Mile Per Lane)		
	Basic Segments	**Merge/Diverge Segments**	**Weaving Segments**
A	≤ 11	≤ 10	≤ 10
B	> 11 and ≤ 18	> 10 and ≤ 20	> 10 and ≤ 20
C	> 18 and ≤ 26	> 20 and ≤ 28	> 20 and ≤ 28
D	> 26 and ≤ 35	> 28 and ≤ 35	> 28 and ≤ 35
E	> 35 and ≤ 45	> 35	> 35
F	> 45	Demand Exceeds Capacity	Demand Exceeds Capacity

Source: *HCM 2010 Highway Capacity Manual, Transportation Research Board, Washington, D.C., 2010.*

4. DESCRIPTION OF ALTERNATIVES

Alternatives 1, 1A, and 2 involve Hazel Avenue being grade-separated over Folsom Boulevard and the adjacent heavy rail and light rail tracks. Right turn overlap phasing would be provided for both the eastbound right and westbound right movements at intersection #10, Hazel Avenue & Jug Handle. All build alternatives also include construction of a transition lane along eastbound Route 50 from Hazel Avenue to Folsom Boulevard as part of the proposed project. These alternatives differ in the modifications to Route 50 on-ramps and off-ramps as follows:

- **No Build** – this alternative would maintain the existing roadway geometry, including existing traffic signals, lane configurations, the at-grade intersection at Hazel Avenue and Folsom Boulevard, and the lack of a transition lane along eastbound Route 50 from Hazel Avenue to Folsom Boulevard.
- **Alternative 1: L-9 Interchange with Viaduct Connector** (see **Figure 4-1**) – traffic on eastbound Route 50 headed for Aerojet Road would use the eastbound Hazel Avenue off-ramp and then diverge on a separate ramp that bridges over Hazel Avenue and its eastbound on-ramps to reach Aerojet Road.
- **Alternative 1A: L-9 Interchange with Undercrossing Connector** (see **Figure 4-2**) – same as Alternative 1 except traffic on Route 50 headed for Aerojet Road would use a separate ramp that goes under (rather than over) Hazel Avenue and its eastbound on-ramps to reach Aerojet Road.
- **Alternative 2: Direct Flyover to Hazel Avenue with Connector** (see **Figure 4-3**) – constructs a flyover ramp for eastbound Route 50 to northbound Hazel Avenue traffic. This ramp diverges from the eastbound Route 50 off-ramp, travels under Hazel Avenue, crosses over Route 50 and connects to the westbound Route 50 off-ramp to Hazel Avenue. Westbound off-ramp traffic headed southbound versus northbound on Hazel are "braided" on either side of the eastbound fly-over ramp before the intersection with Hazel Avenue. This alternative would remove about 1,700 vehicles making the left-turning movement at the eastbound off-ramp intersection and eliminate the need for a signalized intersection on Hazel Avenue at the eastbound off-ramp. Traffic headed to Aerojet Road would diverge from the eastbound ramp after it crosses under Hazel Avenue.

Alternatives 1 and 1A perform identically from a traffic operations standpoint, so results are reported for Alternative 1 and 1A collectively in this report. Alternative 2, as described above, is referred to consistently throughout this report.



Figure 4-1: Alternative 1: L-9 Interchange with Viaduct Connector

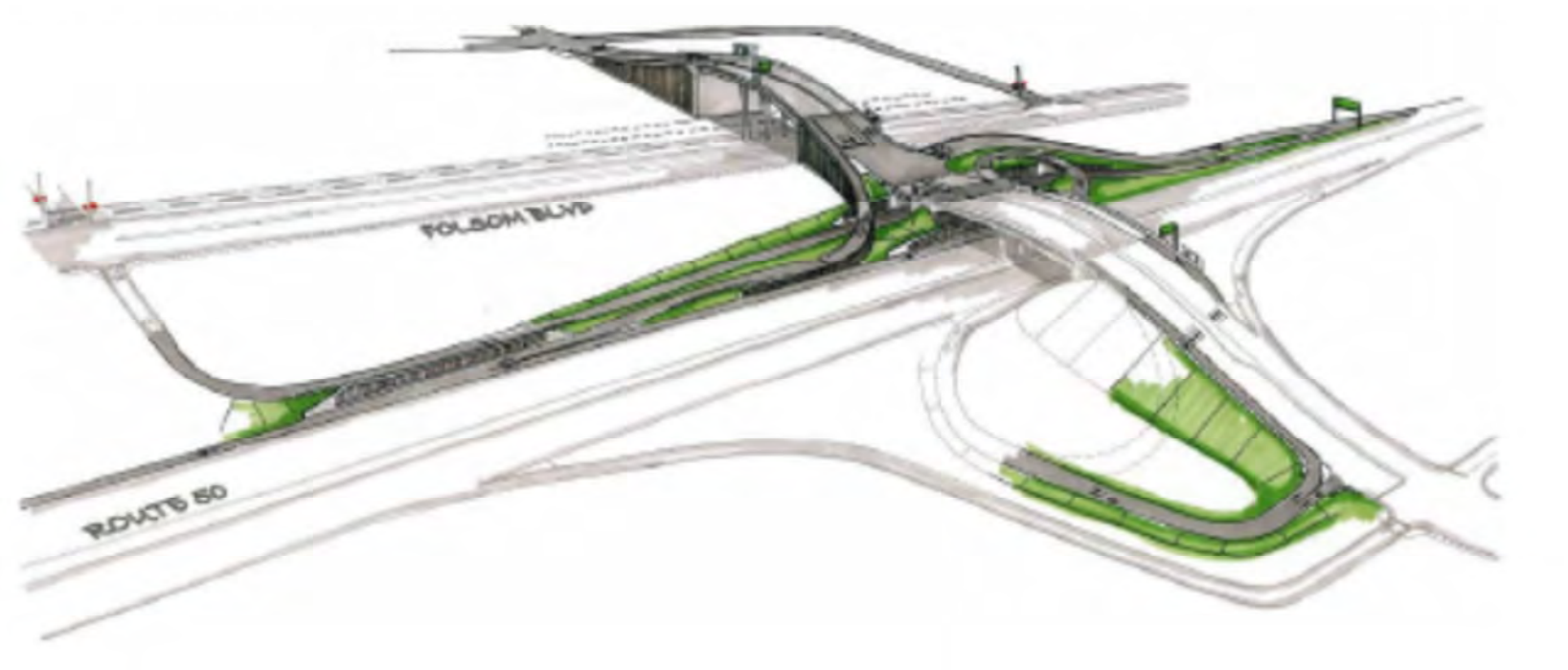


Figure 4-2: Alternative 1A: L-9 Interchange with Undercrossing Connector



Figure 4-3: Alternative 2: Direct Flyover to Hazel Avenue with Connector

5. EXISTING CONDITIONS

Existing Volumes

The development of existing volumes was discussed in **Section 2** of this report. The resulting intersection, freeway, and ramp volumes for the No Build Alternative, Alternative 1/1A, and Alternative 2 are shown in **Figure 5-1**, **Figure 5-2**, and **Figure 5-3**, respectively.

Intersection Operations

Table 5-1 summarizes the results of the operations analysis for the study area intersections.

In the Existing No Build Scenario, the following study intersections do not operate at an acceptable level of service during the AM or PM peak hours:

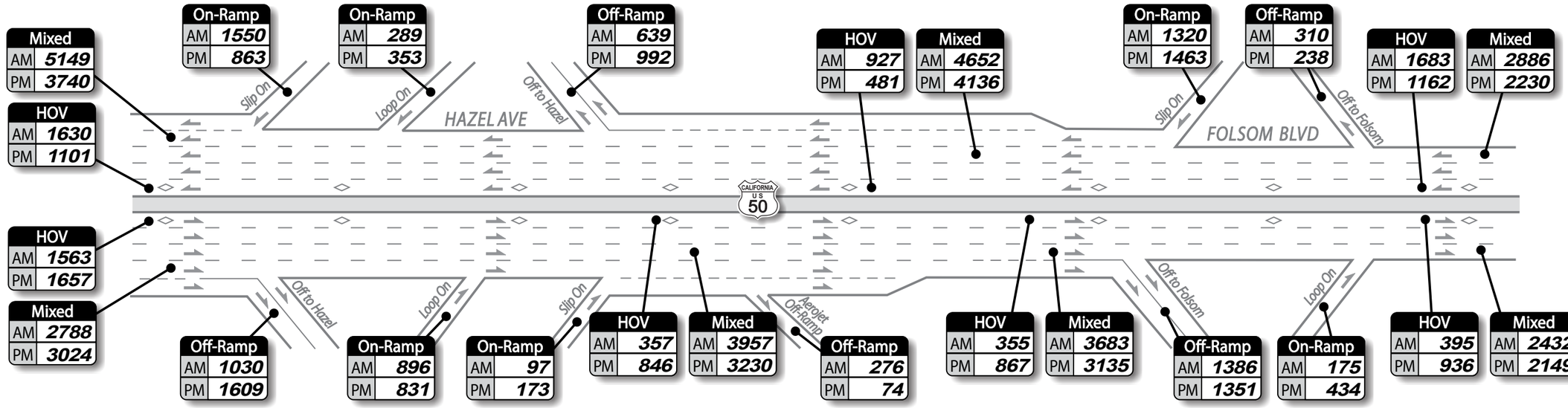
- Intersection #6: Folsom Blvd & Auto Mall Circle West (**LOS E** in the AM peak hour and **LOS D** in the PM peak hour)
- Intersection #9: Folsom Blvd & US 50 Westbound Ramps (**LOS D** in the PM peak hour)

In the Existing With Build Scenario, the following study intersections do not operate at an acceptable level of service during the AM or PM peak hours:

- Intersection #6: Folsom Blvd & Auto Mall Circle West (**LOS E** in the AM peak hour and **LOS D** in the PM peak hour)
- Intersection #9: Folsom Blvd & US 50 Westbound Ramps (**LOS D** in the PM peak hour)

Both intersection #6 and intersection #9 are shared by Sacramento County and the City of Folsom. Sacramento County has a level of service "E" policy, but the City of Folsom has a more restrictive level of service "C" policy. The implementation of the project does not cause delay to increase by more than 5.0 seconds at deficient intersections. Therefore, there are **no significant impacts** to study area intersections.

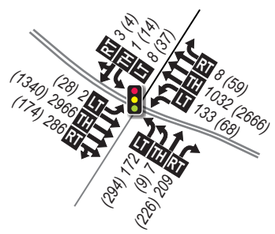
After implementation of either Alternative 1/1A or Alternative 2, the US 50 ramp terminal intersections operate at an acceptable level of service in both the AM and PM peak hour, under Existing Conditions.



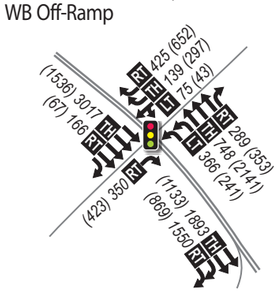
NORTH
Not to Scale

Freeway Schematic

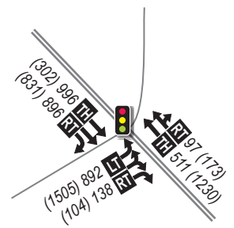
1 Hazel Ave. @ Gold Country Blvd.



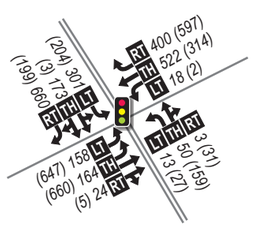
2 Hazel Ave. @ Tributary Pt. Dr./ WB Off-Ramp



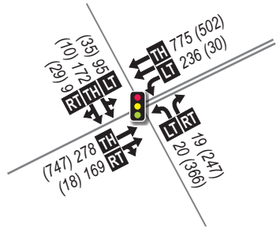
3 Hazel Ave. @ EB Ramps



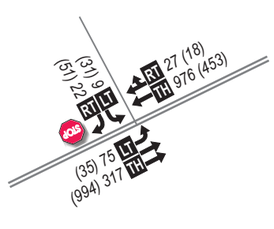
4 Hazel Ave. @ Folsom Blvd.



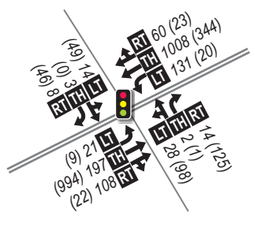
5 Aerojet Rd. @ Folsom Blvd.



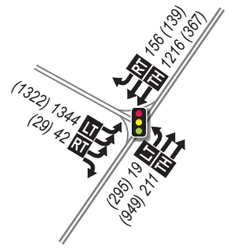
6 Folsom Blvd. @ Auto Mall Cir. (West)



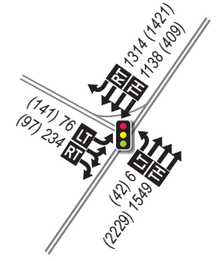
7 Folsom Blvd. @ Auto Mall Cir. (East)/ Birkmont Dr.



8 Folsom Blvd. @ EB Ramps

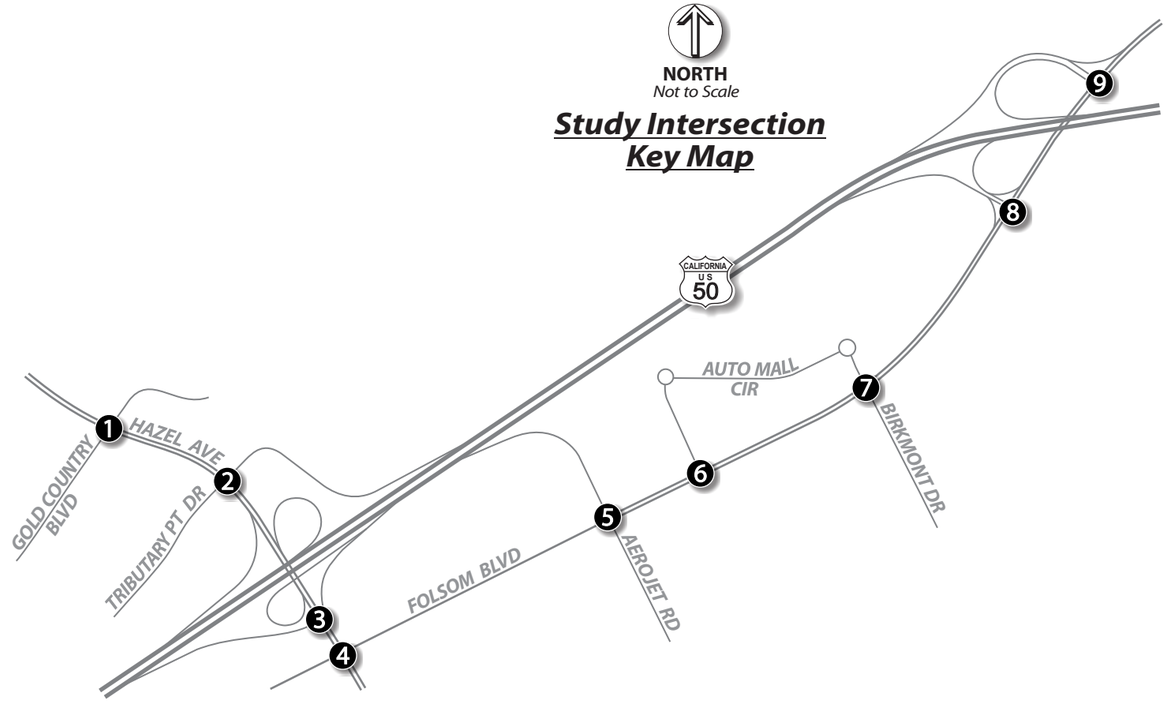


9 Folsom Blvd. @ WB Ramps



NORTH
Not to Scale

Study Intersection Key Map



LEGEND

Key Map

(#) - Study Intersection

Intersection Diagrams

STOP - Stop Sign

- Traffic Signal

- Lane Configuration

AM (PM) - Peak Hour Traffic Volumes

LT TH RT - Volume Turn Movement
Left•Thru•Right

Freeway Schematic

◇ - HOV (High Occupancy Vehicle) Lane

Data Location	
AM	0000
PM	0000

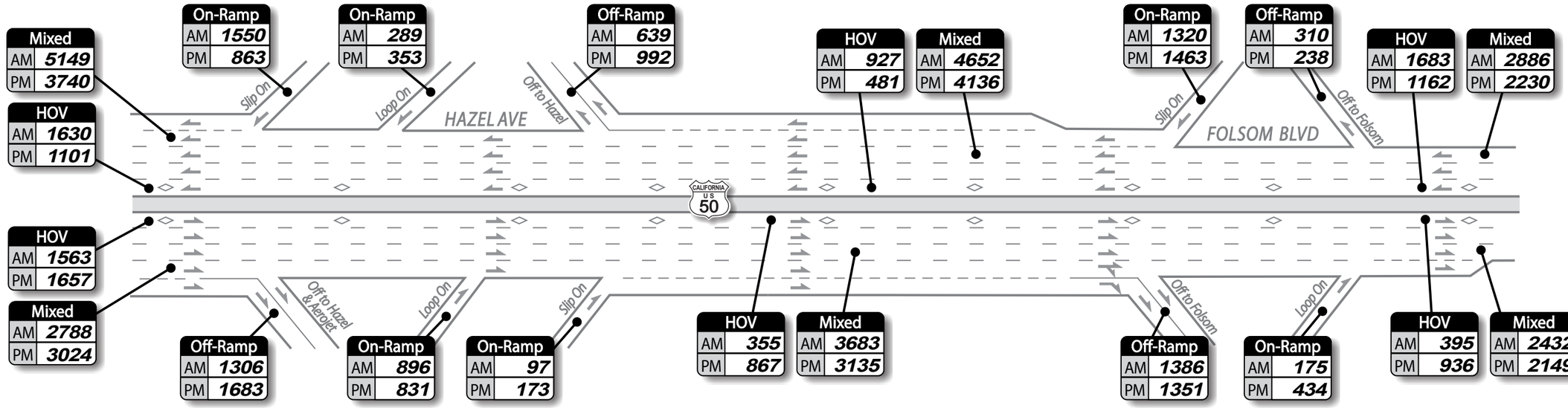
- Freeway Peak Hour Traffic Volumes

DKS

Figure **5-1**

2015 EXISTING CONDITIONS

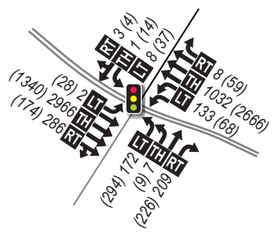
AM/PM Peak Hour Traffic Volumes and Lane Geometry



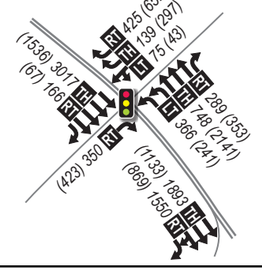
NORTH
Not to Scale

Freeway Schematic

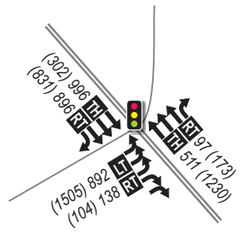
1 Hazel Ave. @ Gold Country Blvd.



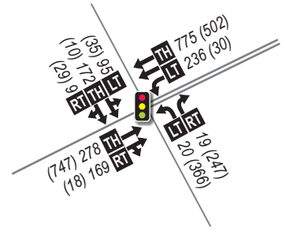
2 Hazel Ave. @ Tributary Pt. Dr./ WB Off-Ramp



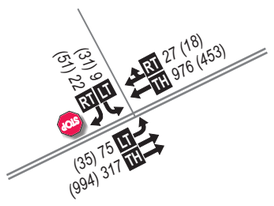
3 Hazel Ave. @ EB Ramps



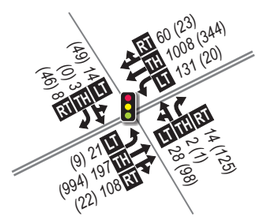
5 Aerojet Rd. @ Folsom Blvd.



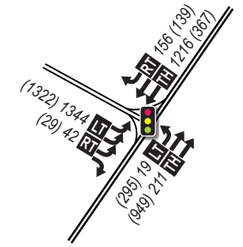
6 Folsom Blvd. @ Auto Mall Cir. (West)



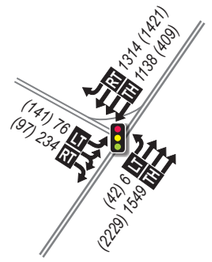
7 Folsom Blvd. @ Auto Mall Cir. (East)/ Birkmont Dr.



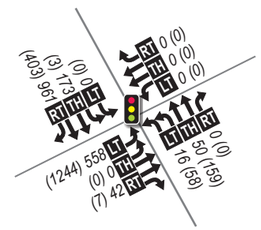
8 Folsom Blvd. @ EB Ramps



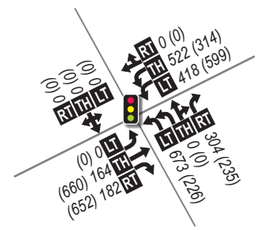
9 Folsom Blvd. @ WB Ramps



10 Hazel Ave. @ Jug Handle

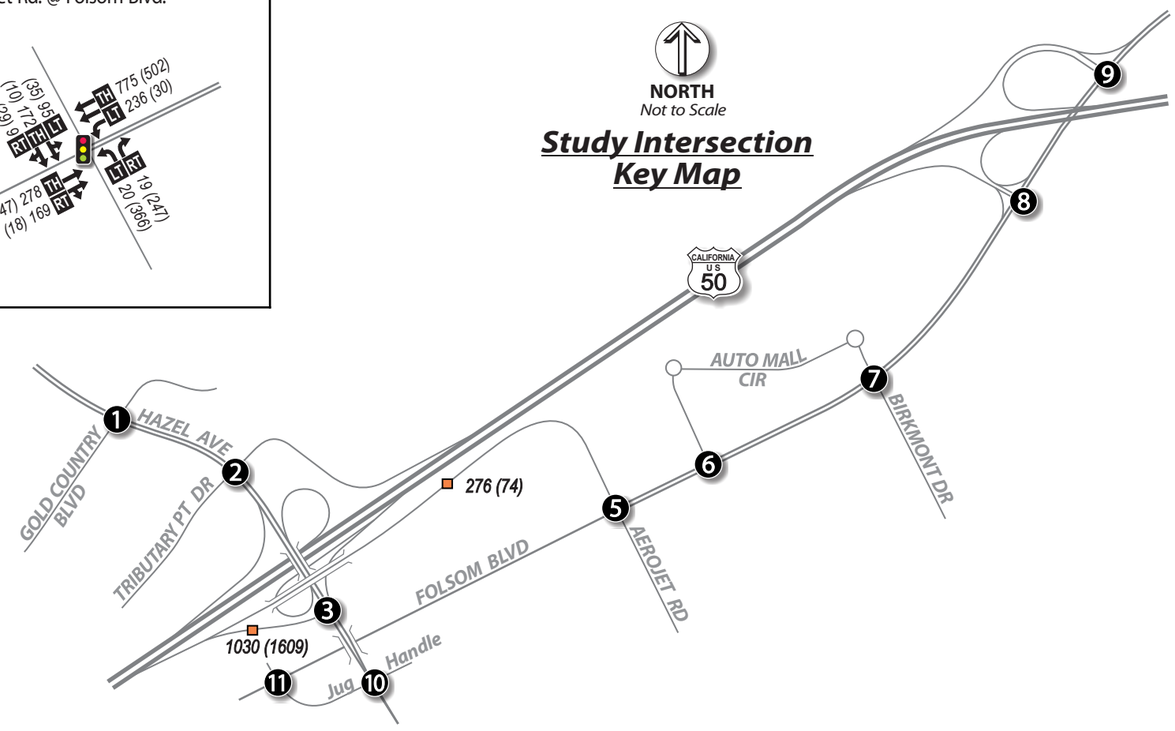


11 Folsom Blvd. @ Jug Handle



NORTH
Not to Scale

Study Intersection Key Map



LEGEND

Key Map
- # - Study Intersection
- AM (PM) - Peak Hour Fwy. Ramp Volumes

Intersection Diagrams
- STOP - Stop Sign
- Traffic Signal
- Lane Configuration
- AM (PM) - Peak Hour Traffic Volumes
- LT TH RT (Left•Thru•Right) - Volume Turn Movement

Freeway Schematic
- HOV (High Occupancy Vehicle) Lane

Data Location	
AM	0000
PM	0000

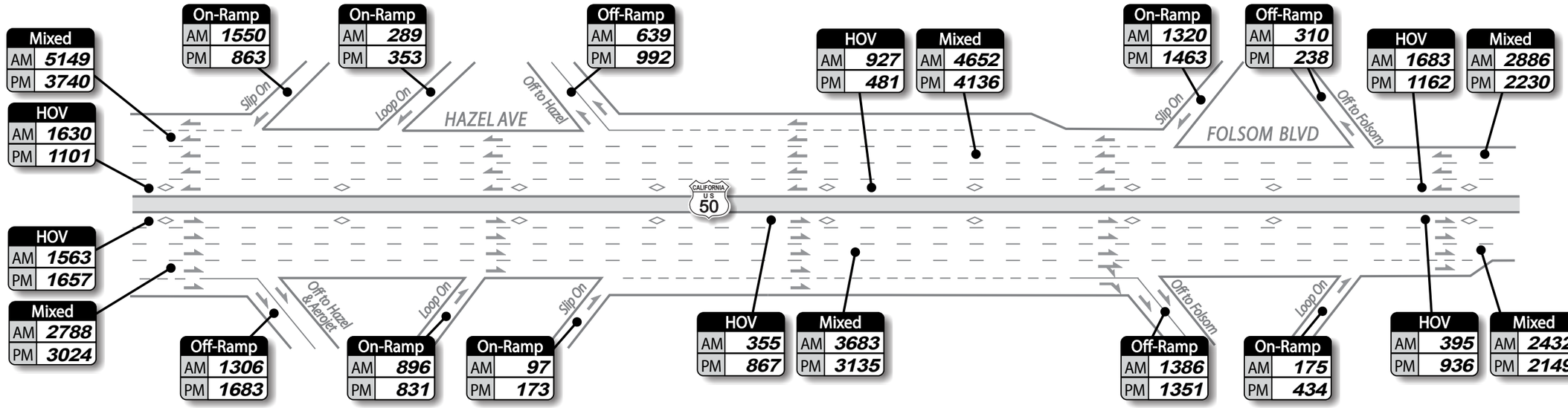
- Freeway Peak Hour Traffic Volumes

DKS

Figure **5-2**

2015 EXISTING WITH ALTERNATIVE 1

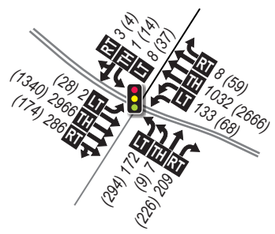
AM/PM Peak Hour Traffic Volumes and Lane Geometry



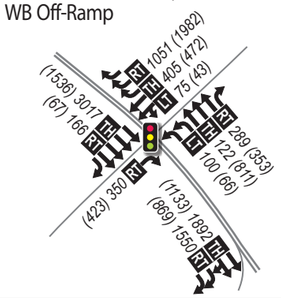
NORTH
Not to Scale

Freeway Schematic

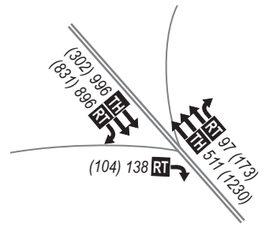
1 Hazel Ave. @ Gold Country Blvd.



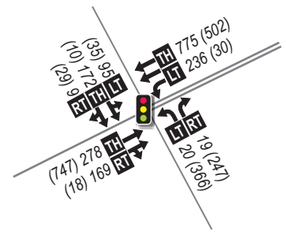
2 Hazel Ave. @ Tributary Pt. Dr./ WB Off-Ramp



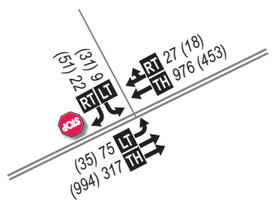
3 Hazel Ave. @ EB Ramps



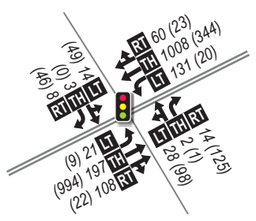
5 Aerojet Rd. @ Folsom Blvd.



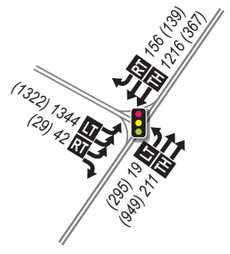
6 Folsom Blvd. @ Auto Mall Cir. (West)



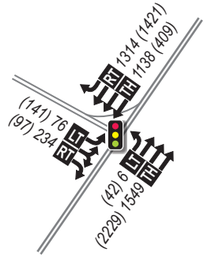
7 Folsom Blvd. @ Auto Mall Cir. (East)/ Birkmont Dr.



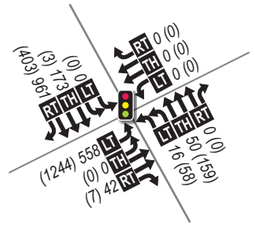
8 Folsom Blvd. @ EB Ramps



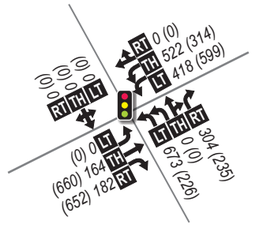
9 Folsom Blvd. @ WB Ramps



10 Hazel Ave. @ Jug Handle

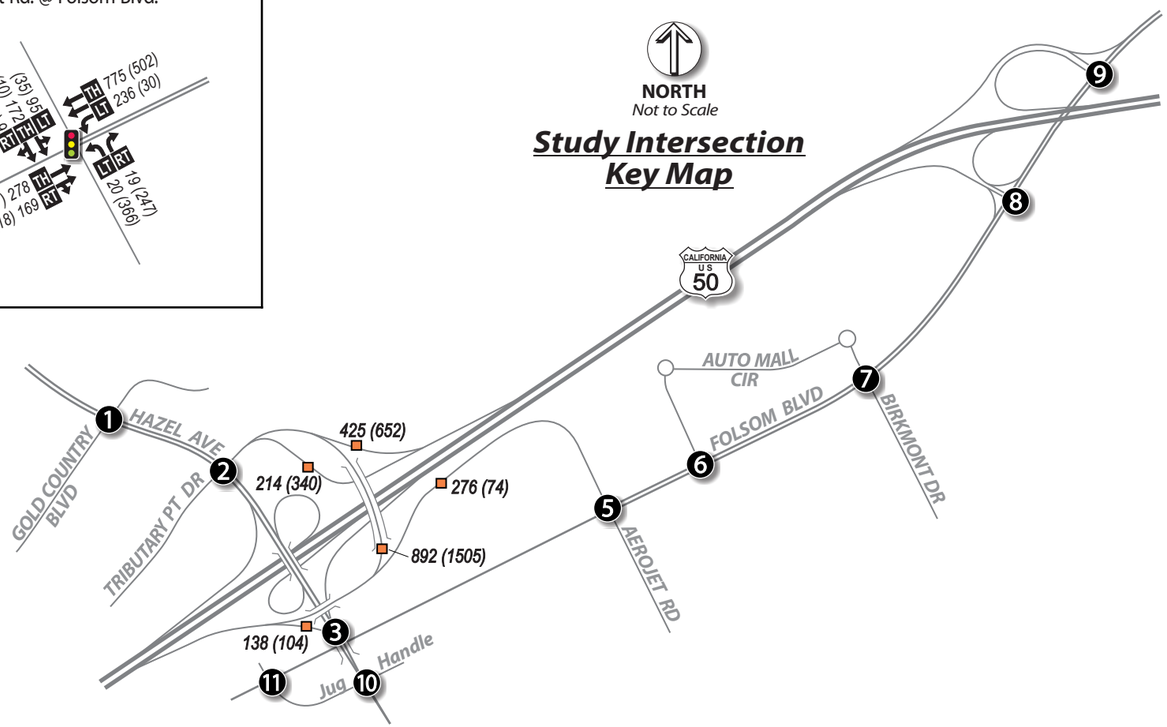


11 Folsom Blvd. @ Jug Handle



NORTH
Not to Scale

Study Intersection Key Map



LEGEND

Key Map
- # - Study Intersection
- AM (PM) ■ - Peak Hour Fwy. Ramp Volumes

Intersection Diagrams
- STOP - Stop Sign
- Traffic Signal
- ← - Lane Configuration
- AM (PM) - Peak Hour Traffic Volumes
- LT TH RT (Left•Thru•Right) - Volume Turn Movement

Freeway Schematic
- ◇ - HOV (High Occupancy Vehicle) Lane

Data Location	
AM	0000
PM	0000

- Freeway Peak Hour Traffic Volumes

DKS

Figure **5-3**

2015 EXISTING WITH ALTERNATIVE 2

AM/PM Peak Hour Traffic Volumes and Lane Geometry

Table 5-1
Existing (2015) Intersection Operations Analysis

No.	Intersection	Existing (2015) No Build				Existing (2015) with Alt. 1/1A				Existing (2015) with Alt. 2			
		AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour	
		LOS	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS	Delay (s)
1	Hazel Ave & Gold Country Blvd	C	23.2	D	39.7	C	23.2	B	19.8	C	23.2	C	23.8
2	Hazel Ave & US 50 WB Ramps/ Tributary Point Dr	C	32.4	E	62.8	C	24.6	C	28.4	C	27.0	C	33.0
3	Hazel Ave & US 50 EB Ramps	D	50.1	D	47.4	B	13.4	B	19.9	Free movement			
4	Hazel Ave & Folsom Blvd	C	34.7	D	39.8	Does not exist				Does not exist			
5	Folsom Blvd & Aerojet Rd	C	20.7	C	33.3	C	20.7	C	33.3	C	20.7	C	33.3
6	Folsom Blvd & Auto Mall Cir (West)	**(E)**	**(35.6)**	**(D)**	**(26.4)**	**(E)**	**(35.6)**	**(D)**	**(26.4)**	**(E)**	**(35.6)**	**(D)**	**(26.4)**
7	Folsom Blvd & Birkmont Dr/Auto Mall Cir (East)	B	11.8	B	17.3	B	11.8	B	17.3	B	11.8	B	17.3
8	Folsom Blvd & US 50 EB Ramps	C	26.6	B	16.9	C	26.6	B	16.9	C	26.6	B	16.9
9	Folsom Blvd & US 50 WB Ramps	C	21.9	**D**	**50.5**	C	21.9	**D**	**50.5**	C	21.9	**D**	**50.5**
10	Hazel Ave & Jug Handle	Does not exist				B	18.7	C	25.6	B	18.7	C	25.6
11	Folsom Blvd & Jug Handle	Does not exist				B	18.9	D	38.8	B	18.9	D	38.8

Note: **Bold** values indicate unacceptable level of service.
For intersections shared between Sacramento County (LOS "E" policy) and the City of Folsom (LOS "C" policy), Folsom's policy was used.
(X) (Y) indicates level of service shown for the highest delay stop-controlled approach.

Freeway Operations

Table 5-2A and **Table 5-2B** summarize the results of the operations analysis for freeway facilities. All basic, merge/diverge, and weave segments operate at an acceptable level of service during the AM and PM peak hours. Therefore, there are **no significant impacts** to freeway facilities.

After implementation of either Alternative 1/1A or Alternative 2, US 50 Eastbound and US 50 Westbound operate acceptably at the Hazel Avenue merge/diverge and weaving segments in both the AM and PM peak hour, under Existing Conditions.

Ramp Queuing

Table 5-3 summarizes the results of the ramp queuing analysis. No 95th percentile queues exceed the storage capacity of the ramps. Therefore, there are **no significant impacts** to ramp queuing.

Intersection Queuing

Table 5-4 summarizes the estimated 95th percentile queues and storage capacity at each intersection.

Under Existing No Build conditions, queues along southbound Hazel Avenue at the westbound off-ramp extend past the upstream intersection with Gold Country Boulevard. This is due to the heavy commute traffic using Hazel Avenue to access US 50. While signal timing changes along Hazel Avenue are assumed with the proposed improvements, southbound queuing on Hazel Avenue would still be expected to extend past Gold Country Boulevard. While the analysis indicates that this queuing occurs in both the AM and PM peak hour, field observations indicate that the issue is more pronounced in the AM peak hour.

Conversely, queuing occurs along northbound Hazel Avenue in the PM peak hour due to the bottleneck near the American River crossing. Field observations and this analysis indicate that this northbound queue typically extends along the bridge and past the Gold Country Blvd intersection, but not all the way to the freeway ramp terminal intersections. We recognize that northbound Hazel queues can occasionally extend back to the freeway. However, this level of queuing does not occur every day and is a sporadic condition that would not occur for an entire peak hour.

Queuing is currently an issue at the Folsom Boulevard/ Hazel Avenue intersection under the No Build condition, due to the short distance between the off-ramp and Folsom Boulevard. The grade separation of Hazel Avenue over Folsom Boulevard, together with the construction of the Jug Handle, eliminates the excessive queues at this location. After implementation of the proposed improvements, the left turn queue on the eastbound approach of the Jug Handle at Hazel Avenue is also estimated to exceed the length of the turn pocket. However, this is not anticipated to cause operational issues because the entire length of the Jug Handle (approximately 1,300 feet) effectively provides additional storage. So while the queue is likely to spill from the turn pocket into the leftmost though lane, queuing is not expected to spill back to the upstream intersection with Folsom Boulevard.

Table 5-2A
Existing (2015) Freeway Operations Analysis (US 50 Eastbound)

Existing (2015) No Build						Existing (2015) with Alternative 1/1A or Alternative 2					
Analysis Segment	Type	AM Peak Hour		PM Peak Hour		Analysis Segment	Type	AM Peak Hour		PM Peak Hour	
		LOS	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)			LOS	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)
Sunrise Blvd to Hazel Ave	Basic	B	14.9	B	16.3	Sunrise Blvd to Hazel Ave	Basic	B	14.9	B	16.3
Hazel Ave Exit	Two-Lane Diverge	A	9.0	B	13.3	Hazel Ave Exit	Two-Lane Diverge	B	10.5	B	13.7
SB Hazel Ave Loop Entrance	One-Lane Merge	B	19.7	B	17.5	SB Hazel Ave Loop Entrance	One-Lane Merge	B	18.2	B	17.1
NB Hazel Ave Slip Entrance	Weave	B	17.6	B	13.9	NB Hazel Ave Slip Entrance	Weave	B	16.0	B	13.7
Aerojet Exit						Folsom Blvd Exit					
Aerojet Rd to Folsom Blvd (Mixed)	Basic	C	19.7	B	16.9						
Folsom Blvd Exit	Two-Lane Diverge	C	26.2	C	21.3						
Folsom Blvd Entrance	One-Lane Merge	C	24.5	C	22.3	Folsom Blvd Entrance	One-Lane Merge	B	16.2	B	15.8
Folsom Blvd to Prairie City Rd	Basic	C	19.5	B	17.4	Folsom Blvd to Prairie City Rd	Basic	C	19.5	B	17.4

Note: **Bold** values indicate unacceptable level of service.

Table 5-2B
Existing (2015) Freeway Operations Analysis (US 50 Westbound)

Existing (2015) No Build						Existing (2015) with Alternative 1/1A or Alternative 2					
Analysis Segment	Type	AM Peak Hour		PM Peak Hour		Analysis Segment	Type	AM Peak Hour		PM Peak Hour	
		LOS	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)			LOS	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)
Prairie City Rd to Folsom Blvd (Mixed)	Basic	C	24.1	B	17.3	Prairie City Rd to Folsom Blvd (Mixed)	Basic	C	24.1	B	17.3
Folsom Blvd Exit	One-Lane Diverge	D	32.3	C	25.0	Folsom Blvd Exit	One-Lane Diverge	D	32.3	C	25.0
Folsom Blvd Entrance	One-Lane Merge	D	29.8	C	24.6	Folsom Blvd Entrance	One-Lane Merge	D	29.8	C	24.6
Folsom Blvd to Hazel Ave	Basic	D	26.4	C	21.7	Folsom Blvd to Hazel Ave	Basic	D	26.4	C	21.7
Hazel Ave Exit	Two-Lane Diverge	A	9.8	A	8.5	Hazel Ave Exit	Two-Lane Diverge	A	9.8	A	8.5
NB Hazel Ave Loop Entrance	One-Lane Merge	C	25.2	C	20.3	NB Hazel Ave Loop Entrance	One-Lane Merge	C	25.2	C	20.3
SB Hazel Ave Slip Entrance	One-Lane Merge	D	32.5	C	21.3	SB Hazel Ave Slip Entrance	One-Lane Merge	D	32.5	C	21.3
Hazel Ave to Sunrise Blvd (Mixed)	Basic	D	30.6	C	19.4	Hazel Ave to Sunrise Blvd (Mixed)	Basic	D	30.6	C	19.4

Note: **Bold** values indicate unacceptable level of service.

Table 5-3
Existing (2015) Ramp Queuing Analysis

Direction	Ramp Queue	Existing (2015) No Build			Existing (2015) with Alternative 1/1A			Existing (2015) with Alternative 2		
		Storage Length (ft)	AM Queue (ft)	PM Queue (ft)	Storage Length (ft)	AM Queue (ft)	PM Queue (ft)	Storage Length (ft)	AM Queue (ft)	PM Queue (ft)
US 50 Eastbound	Off-Ramp to Hazel Ave	1,350	257	683	2,400	179	290	2,250	-	-
	Off-Ramp to Aerojet Rd	1,425	121	50	2,400	121	50	2,250	121	50
	Off-Ramp to Folsom Blvd	1,300	312	268	1,300	312	268	1,300	312	268
US 50 Westbound	Off-Ramp to Folsom Blvd	1,550	47	37	1,550	47	37	1,550	47	37
	Off-Ramp to Hazel Ave	2,030	299	389	2,030	299	404	2,030	368	637

Note: **Bold** values indicate queuing exceeding storage capacity.
Gray shaded cells highlight changes to storage capacity due to the project.
Queues shown represent the 95th percentile.

Table 5-4
Existing (2015) Intersection Queuing Analysis

Intersection	Approach	Move-ment	Existing (2015) No Build			Existing (2015) with Alternative 1/1A			Existing (2015) with Alternative 2		
			Storage Length (ft)	AM Queue (ft)	PM Queue (ft)	Storage Length (ft)	AM Queue (ft)	PM Queue (ft)	Storage Length (ft)	AM Queue (ft)	PM Queue (ft)
Hazel Avenue & US 50 WB Ramps/ Tributary Point Dr	EB	RT	275	**287**	**368**	275	**287**	36	275	**344**	274
	WB	LT	2,030	299	389	2,030	299	404	2,030	368	328
		TH									
		RT	2,030	51	377	2,030	51	398	2,030	8	637
	NB	LT	320	246	140	320	186	151	320	68	49
		TH	1,440	146	266	1,440	30	501	1,440	65	339
		RT	Free Movement			Free Movement			Free Movement		
	SB	TH	860	**1,045**	**1,121**	860	**997**	467	860	745	136
		RT	225	56	211	225	32	4	225	41	1
Hazel Avenue & US 50 EB Ramps	EB	LT	1,350	257	683	2,400	179	290	Intersection Does Not Exist		
		RT				2,400	22	15			
	NB	TH	Free Movement			1,200	45	182			
		RT				Free Movement					
	SB	TH	1,140	412	126	1,140	102	91			
		RT	Free Movement			Free Movement					
Hazel Avenue & Folsom Boulevard	EB	LT	350	107	**492**	Intersection Does Not Exist			Intersection Does Not Exist		
		TH	>2,500	78	302						
		RT									
	WB	LT	200	43	12						
		TH	2,140	619	425						
		RT	2,140	230	350						
	NB	LT	700	30	58						
		TH	700	80	289						
		RT									
	SB	LT	200	**298**	**269**						
		TH									
		RT									

Table 5-4
Existing (2015) Intersection Queuing Analysis

Intersection	Approach	Move-ment	Existing (2015) No Build			Existing (2015) with Alternative 1/1A			Existing (2015) with Alternative 2		
			Storage Length (ft)	AM Queue (ft)	PM Queue (ft)	Storage Length (ft)	AM Queue (ft)	PM Queue (ft)	Storage Length (ft)	AM Queue (ft)	PM Queue (ft)
Hazel Avenue & Jug Handle	EB	LT	Intersection Does Not Exist			200	171	**454**	200	171	**454**
		TH				1,350	0	0	1,350	0	0
		RT				200	0	0	200	0	0
	WB	LT				200	0	48	200	0	0
		TH				500	0	64	500	0	0
		RT				200	0	0	200	0	0
	NB	LT				300	12	0	300	12	48
		TH				>2,500	10	4	>2,500	10	64
		RT				300	0	75	300	0	0
	SB	LT				300	0	0	300	0	0
		TH				1,200	37	0	1,200	37	4
		RT				1,200	59	0	1,200	59	75
Folsom Boulevard & Jug Handle	EB	LT	Intersection Does Not Exist			200	0	0	200	0	0
		TH				>2,500	124	718	>2,500	124	718
		RT				>2,500	49	370	>2,500	49	370
	WB	LT				500	135	352	500	135	352
		TH				>2,500	264	129	>2,500	264	129
		RT									
	NB	LT				1,350	177	115	1,350	177	115
		TH				1,350	0	0	1,350	0	0
		RT									
	SB	LT				200	0	0	200	0	0
		TH									
		RT									

Table 5-4
Existing (2015) Intersection Queuing Analysis

Intersection	Approach	Move-ment	Existing (2015) No Build			Existing (2015) with Alternative 1/1A			Existing (2015) with Alternative 2		
			Storage Length (ft)	AM Queue (ft)	PM Queue (ft)	Storage Length (ft)	AM Queue (ft)	PM Queue (ft)	Storage Length (ft)	AM Queue (ft)	PM Queue (ft)
Folsom Boulevard & Aerojet Road	EB	TH	2,140	161	437	2,140	161	437	2,140	161	437
		RT									
	WB	LT	370	205	65	370	205	65	370	205	65
		TH	665	204	230	665	204	230	665	204	230
	NB	LT	415	22	325	415	22	325	415	22	325
		RT	415	0	179	415	0	179	415	0	179
	SB	LT	1,425	121	50	2,400	121	50	2,250	121	50
		TH									
		RT									

Note: **Bold** values indicate queuing exceeding storage capacity.
Gray shaded cells highlight changes to storage capacity due to the project.
Queues shown represent the 95th percentile.

Crash Analysis

The PSR traffic operations report provided accident data from the Traffic Accident Surveillance Analysis System (TASAS) for the three year period from April 1, 2008 to March 31, 2011. MTCo previously conducted accident analysis based on this dataset. **Table 5-5** provides updated accident and accident rate data on the US 50 mainline between Sunrise Boulevard and Folsom Boulevard, and the ramps at the Hazel Avenue and Folsom Boulevard interchanges, based on a three year period from January 1, 2011 to December 31, 2013. For each location, these accident rates are compared to average rates from similar Caltrans facilities (rate groups). The rate data shows that the following locations have higher total accident rates than average total accident rates for similar State facilities:

- EB Mainline from Hazel Avenue to Folsom Boulevard
- EB On-ramp from SB Hazel Avenue
- EB On-ramp from Folsom Boulevard
- WB Off-ramp to Folsom Boulevard
- WB On-ramp from Folsom Boulevard
- WB Off-ramp to Hazel Avenue
- WB Slip On-ramp from SB Hazel Avenue

Eastbound US 50 Mainline from Hazel Avenue to Folsom Boulevard

The total crash rate that occurred at this location is **0.90** accidents per million vehicles, which is higher than the average total crash rate of **0.57** accidents per million vehicles. The type of collision and primary collision factors for the 67 accidents that occurred in the three year period are as follows:

Type of Collision

- Head On: 1
- Sideswipe: 8
- Rear End: 50
- Hit Object: 7
- Other: 1

Primary Collision Factor

- Follow Too Close: 3
- Improper Turn: 9
- Speeding: 44
- Other Violations: 10
- Unknown: 1

Eastbound Loop On-Ramp from Southbound Hazel Avenue

The total crash rate that occurred at this location is **0.78** accidents per million vehicles, which is higher than the average total crash rate of **0.73** accidents per million vehicles. The type of collision and primary collision factors for the 7 accidents that occurred in the three year period are as follows:

Type of Collision

- Sideswipe: 1
- Rear End: 6

Primary Collision Factor

- Follow Too Close: 1
- Speeding: 5
- Other Violations: 1

Eastbound On-Ramp from Folsom Boulevard

The total crash rate that occurred at this location is **1.30** accidents per million vehicles, which is higher than the average total crash rate of **0.72** accidents per million vehicles. The type of collision and primary collision factors for the 4 accidents that occurred in the three year period are as follows:

Type of Collision

- Rear End: 1
- Hit Object: 2
- Auto-Pedestrian: 1

Primary Collision Factor

- Alcohol: 1
- Speeding: 2
- Other Violations: 1

Westbound Off-Ramp to Folsom Boulevard

The total crash rate that occurred at this location is **1.64** accidents per million vehicles, which is higher than the average total crash rate of **1.00** accidents per million vehicles. The type of collision and primary collision factors for the 5 accidents that occurred in the three year period are as follows:

Type of Collision

- Broadside: 3
- Hit Object: 1
- Not Stated: 1

Primary Collision Factor

- Failure to Yield: 1
- Improper Turn: 1
- Other Violations: 3

Westbound On-Ramp from Folsom Boulevard

The total crash rate that occurred at this location is **1.75** accidents per million vehicles, which is higher than the average total crash rate of **0.63** accidents per million vehicles. The type of collision and primary collision factors for the 28 accidents that occurred in the three year period are as follows:

Type of Collision

- Sideswipe: 2
- Rear End: 3
- Broadside: 2
- Hit Object: 14
- Overturn: 7

Primary Collision Factor

- Alcohol: 2
- Improper Turn: 10
- Speeding: 10
- Other Violations: 4
- Other than Driver: 2

Westbound Off-Ramp to Hazel Avenue

The total crash rate that occurred at this location is **1.57** accidents per million vehicles, which is higher than the average total crash rate of **1.01** accidents per million vehicles. The type of collision and primary collision factors for the 17 accidents that occurred in the three year period are as follows:

Type of Collision

- Sideswipe: 3
- Rear End: 2
- Broadside: 1
- Hit Object: 8
- Overturn: 3

Primary Collision Factor

- Alcohol: 4
- Failure to Yield: 1
- Improper Turn: 6
- Speeding: 3
- Other Violations: 3

Westbound Slip On-Ramp from Southbound Hazel Avenue

The total crash rate that occurred at this location is **1.00** accidents per million vehicles, which is higher than the average total crash rate of **0.57** accidents per million vehicles. The type of collision and primary collision factors for the 12 accidents that occurred in the three year period are as follows:

Type of Collision

- Sideswipe: 5
- Rear End: 4
- Hit Object: 2
- Overturn: 1

Primary Collision Factor

- Alcohol: 1
- Improper Turn: 2
- Speeding: 3
- Other Violations: 4
- Other than Driver: 1
- Unknown: 1

Table 5-5
Accident Rates for Ramps at US 50 / Hazel Avenue Interchange

Location	Number of Accidents			Actual Accident Rate			Average Accident Rate		
	Total	Fatal	Injury	Fatal	Fatal + Injury	Total	Fatal	Fatal + Injury	Total
Mainline									
EB US 50 – Sunrise Blvd to Hazel Ave	79	1	32	0.005	0.16	0.38	0.003	0.17	0.54
EB US 50 – Hazel Ave to Folsom Blvd	67	0	23	0.000	0.31	0.90	0.003	0.18	0.57
WB US 50 – Folsom Blvd to Hazel Ave	34	1	16	0.013	0.23	0.46	0.003	0.18	0.57
WB US 50 – Hazel Ave to Sunrise Blvd	68	0	17	0.000	0.08	0.33	0.003	0.17	0.54
Ramps									
EB off-ramp to Hazel Ave	11	0	3	0.000	0.27	1.00	0.003	0.35	1.01
EB loop on-ramp from SB Hazel Ave	7	0	2	0.000	0.22	0.78	0.002	0.21	0.73
EB slip on-ramp from NB Hazel Ave	0	0	0	0.000	0.00	0.00	0.003	0.18	0.57
EB off-ramp to Aerojet Rd	1	0	1	0.000	0.73	0.73	0.003	0.24	0.84
EB off-ramp to Folsom Blvd	8	0	1	0.000	0.07	0.56	0.003	0.35	1.01
EB on-ramp from Folsom Blvd	4	0	3	0.000	0.98	1.30	0.003	0.24	0.72
WB off-ramp to Folsom Blvd	5	0	3	0.000	0.98	1.64	0.004	0.33	1.00
WB on-ramp from Folsom Blvd	28	0	10	0.000	0.63	1.75	0.002	0.22	0.63
WB off-ramp to Hazel Ave	17	0	6	0.000	0.55	1.57	0.003	0.35	1.01
WB loop on-ramp from NB Hazel Ave	0	0	0	0.000	0.00	0.00	0.002	0.21	0.73
WB slip on-ramp from SB Hazel Ave	12	0	2	0.000	0.17	1.00	0.003	0.18	0.57

Notes: For the ramps, the rate is accidents per million vehicles
Rates highlighted in gray exceed average rates for similar State facilities.

Source: TASAS data from Caltrans District 3 (Three year period from January 1, 2011 to December 31, 2013)

6. OPENING YEAR (2022) TRAFFIC OPERATIONS

Traffic Forecasting

Traffic forecasting assumptions for Opening Year (2022) are discussed in **Section 2** of this report. The resulting intersection, freeway, and ramp volumes for the No Build Alternative, Alternative 1/1A and Alternative 2 are shown in **Figure 6-1**, **Figure 6-2**, and **Figure 6-3**, respectively.

Intersection Operations

Table 6-1 summarizes the results of the operations analysis for the study area intersections.

In the Opening Year No Build Scenario, the following study intersections do not operate at an acceptable level of service during the AM or PM peak hours:

- Intersection #3: Hazel Ave & US 50 Eastbound Ramps (**LOS F** in the PM peak hour)
- Intersection #4: Hazel Ave & Folsom Blvd (**LOS F** in the PM peak hour)
- Intersection #5: Folsom Blvd & Aerojet Road (**LOS D** in the AM peak hour and **LOS E** in the PM peak hour)
- Intersection #6: Folsom Blvd & Auto Mall Circle West (**LOS F** in the AM peak hour and **LOS E** in the PM peak hour)
- Intersection #7: Folsom Blvd & Birkmont Dr/Auto Mall Cir (East) (**LOS F** in the PM peak hour)
- Intersection #9: Folsom Blvd & US 50 Westbound Ramps (**LOS D** in the AM peak hour and **LOS E** in the PM peak hour)

In the Opening Year With Build Scenario, the following study intersections do not operate at an acceptable level of service during the AM or PM peak hours:

- Intersection #5: Folsom Blvd & Aerojet Road (**LOS D** in the AM peak hour and **LOS E** in the PM peak hour)
- Intersection #6: Folsom Blvd & Auto Mall Circle West (**LOS F** in the AM peak hour and **LOS E** in the PM peak hour)
- Intersection #7: Folsom Blvd & Birkmont Dr/Auto Mall Cir (East) (**LOS F** in the PM peak hour)
- Intersection #9: Folsom Blvd & US 50 Westbound Ramps (**LOS D** in the AM peak hour and **LOS E** in the PM peak hour)

It should be noted that no changes in off-site intersection geometry (intersections #1, 5, 6, 7, 8, 9) were assumed for either the "No Build" or "With Build" scenarios, due to uncertainty about timing and phasing of improvements that will be implemented by the Easton/Glenborough project. The Easton/Glenborough project is not expected to be fully built by Year 2022. The level of service calculations are therefore predicated on the conservative assumption of maintaining existing geometry. The Easton/Glenborough project will be required to implement mitigations at intersection #5 (Folsom Boulevard and Aerojet Road) at full buildout.

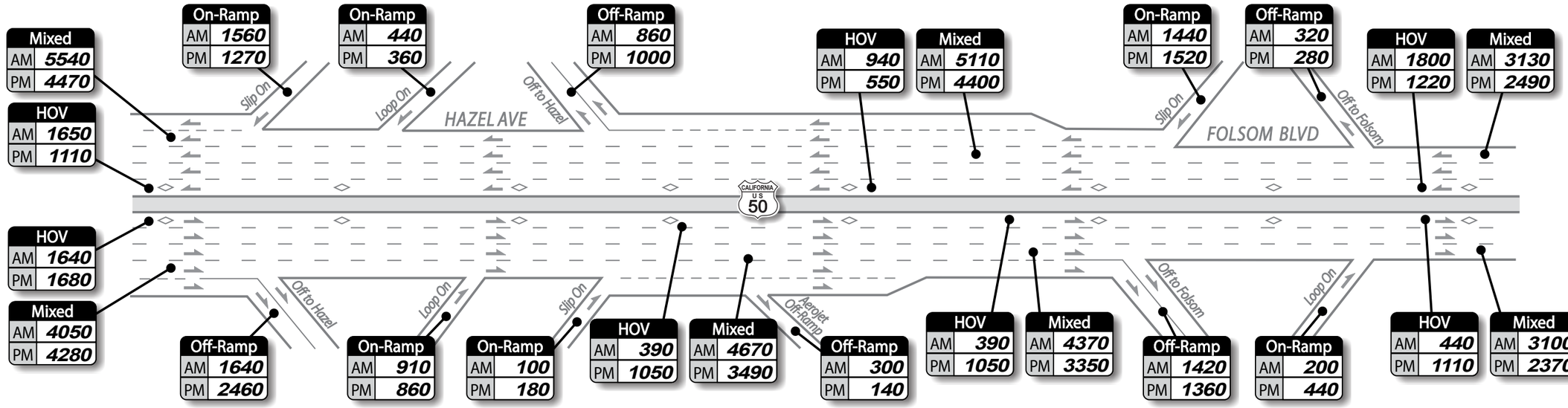
The Final Traffic Impact Study for the Easton Development Project[2] identifies the following mitigation measures at this location for Existing Plus Proposed Project conditions:

- Widen the northbound approach to provide dual left and dual right turn lanes
- Implement a northbound right turn overlap (protected) phase

Implementation of Easton/Glenborough's mitigation measure is expected to improve the level of service to an acceptable condition at intersection #5. Although not assumed by Year 2022, the Easton/Glenborough project will also be required to connect Glenborough Drive to the Folsom Boulevard/ US 50 Eastbound Ramps intersection by buildout. This would provide another access point to the development, reducing the amount of traffic using intersection #7 (Folsom Boulevard and Birkmont Drive/Auto Mall Circle) and improving operations.

After implementation of either Alternative 1/1A or Alternative 2, the US 50 ramp terminal intersections at Hazel Avenue operate at an acceptable level of service in both the AM and PM peak hour in Year 2022.

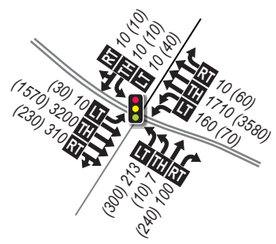
[2] Fehr & Peers Transportation Consultants, 2008.



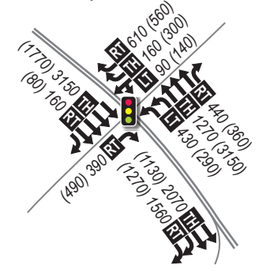
NORTH
Not to Scale

Freeway Schematic

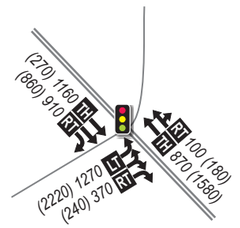
1 Hazel Ave. @ Gold Country Blvd.



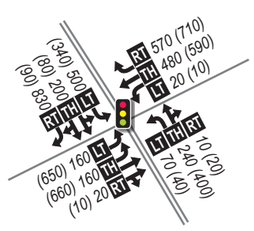
2 Hazel Ave. @ Tributary Pt. Dr./ WB Off-Ramp



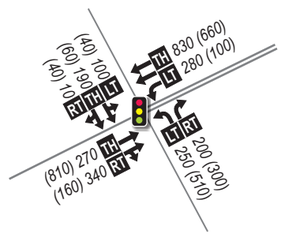
3 Hazel Ave. @ EB Ramps



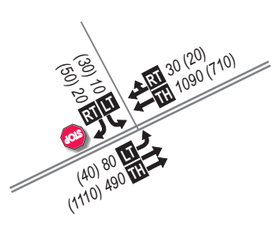
4 Hazel Ave. @ Folsom Blvd.



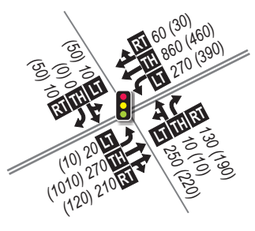
5 Aerojet Rd. @ Folsom Blvd.



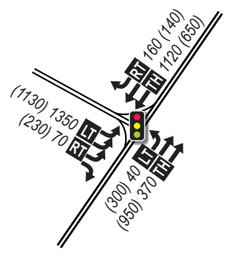
6 Folsom Blvd. @ Auto Mall Cir. (West)



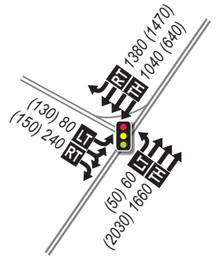
7 Folsom Blvd. @ Auto Mall Cir. (East)/ Birkmont Dr.



8 Folsom Blvd. @ EB Ramps

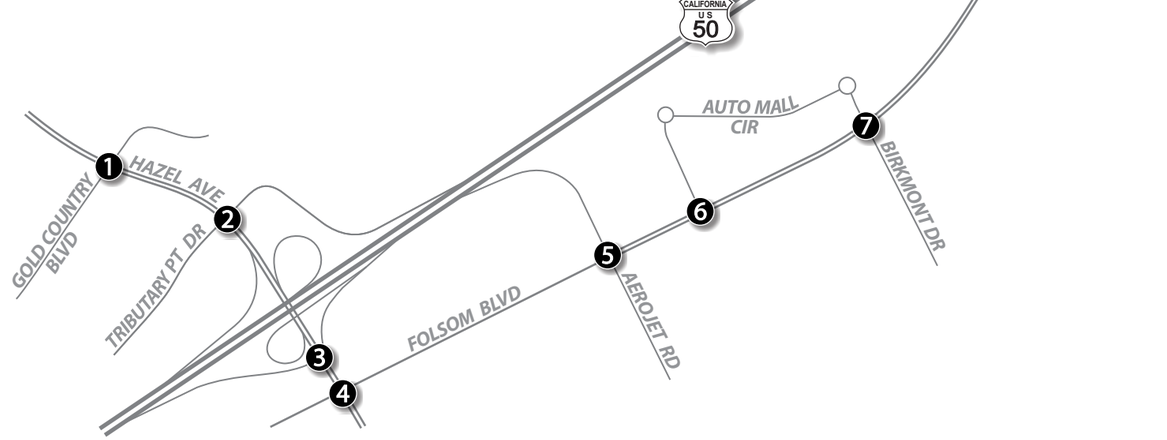


9 Folsom Blvd. @ WB Ramps



NORTH
Not to Scale

Study Intersection Key Map



LEGEND

Key Map

(#) - Study Intersection

Intersection Diagrams

STOP - Stop Sign

- Traffic Signal

- Lane Configuration

AM (PM) - Peak Hour Traffic Volumes

LT TH RT - Volume Turn Movement
Left • Thru • Right

Freeway Schematic

◇ - HOV (High Occupancy Vehicle) Lane

Data Location	
AM	0000
PM	0000

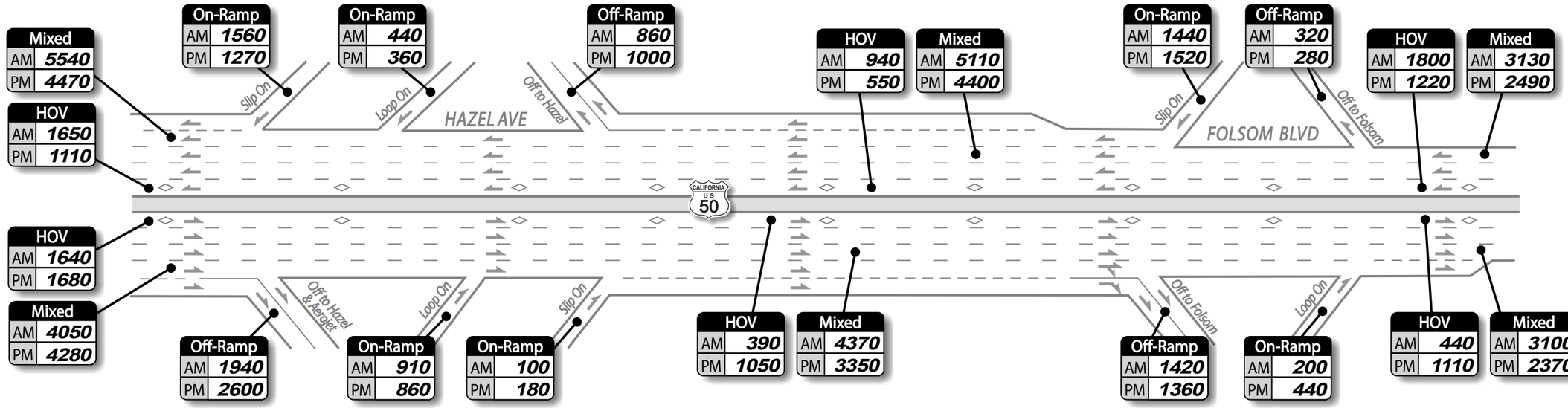
- Freeway Peak Hour Traffic Volumes

DKS

Figure **6-1**

YEAR 2022 NO BUILD

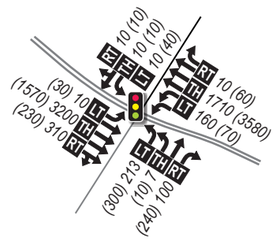
AM/PM Peak Hour Traffic Volumes and Lane Geometry



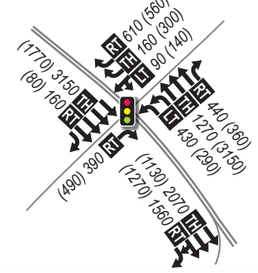
NORTH
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Freeway Schematic

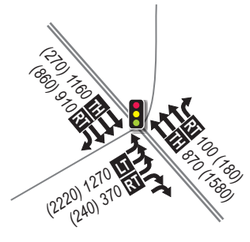
1 Hazel Ave. @ Gold Country Blvd.



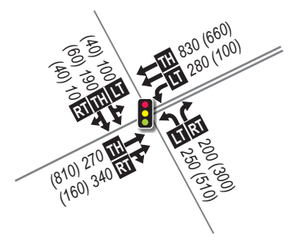
2 Hazel Ave. @ Tributary Pt. Dr./ WB Off-Ramp



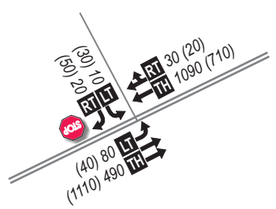
3 Hazel Ave. @ EB Ramps



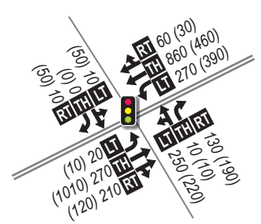
5 Aerojet Rd. @ Folsom Blvd.



6 Folsom Blvd. @ Auto Mall Cir. (West)



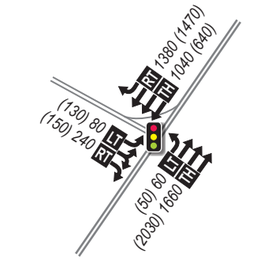
7 Folsom Blvd. @ Auto Mall Cir. (East)/ Birkmont Dr.



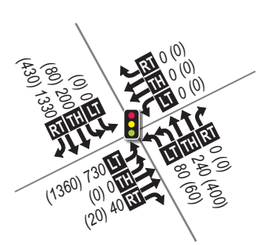
8 Folsom Blvd. @ EB Ramps



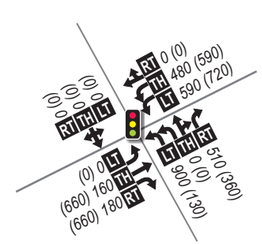
9 Folsom Blvd. @ WB Ramps



10 Hazel Ave. @ Jug Handle

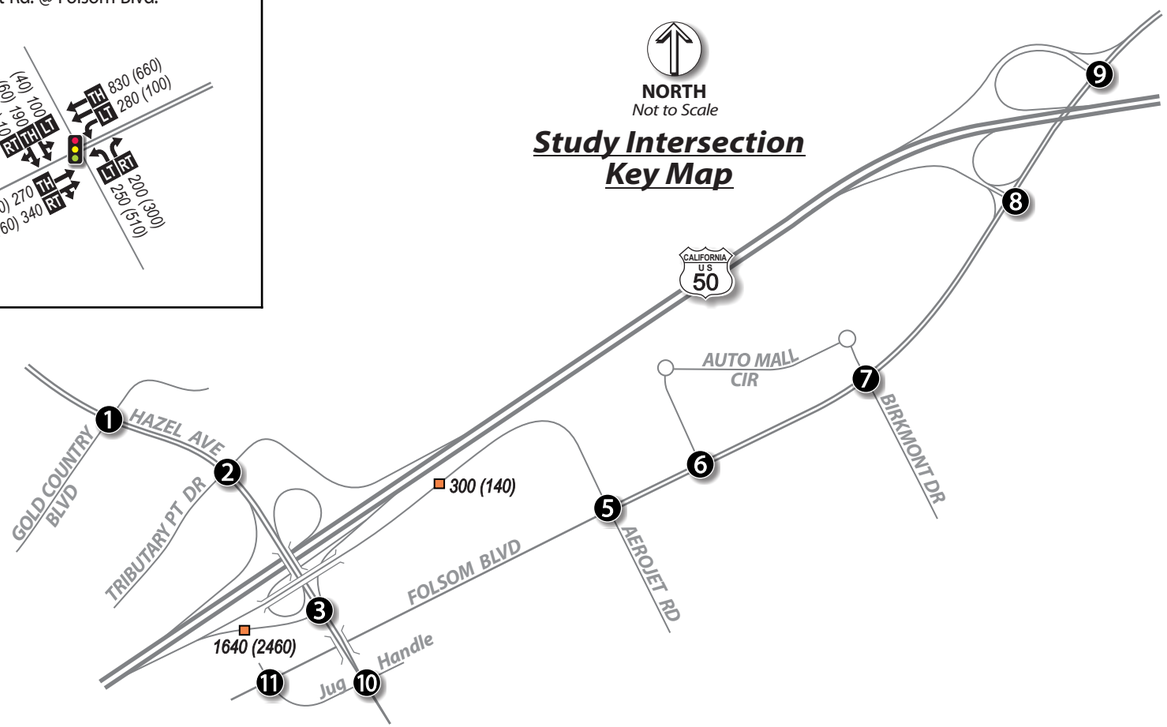


11 Folsom Blvd. @ Jug Handle



NORTH
Not to Scale

Study Intersection Key Map



LEGEND

Key Map

(#) - Study Intersection

AM (PM) ■ - Peak Hour Fwy. Ramp Volumes

Intersection Diagrams

STOP - Stop Sign

- Traffic Signal

← - Lane Configuration

AM (PM) - Peak Hour Traffic Volumes

LT TH RT - Volume Turn Movement
Left•Thru•Right

Freeway Schematic

◇ - HOV (High Occupancy Vehicle) Lane

Data Location	
AM	0000
PM	0000

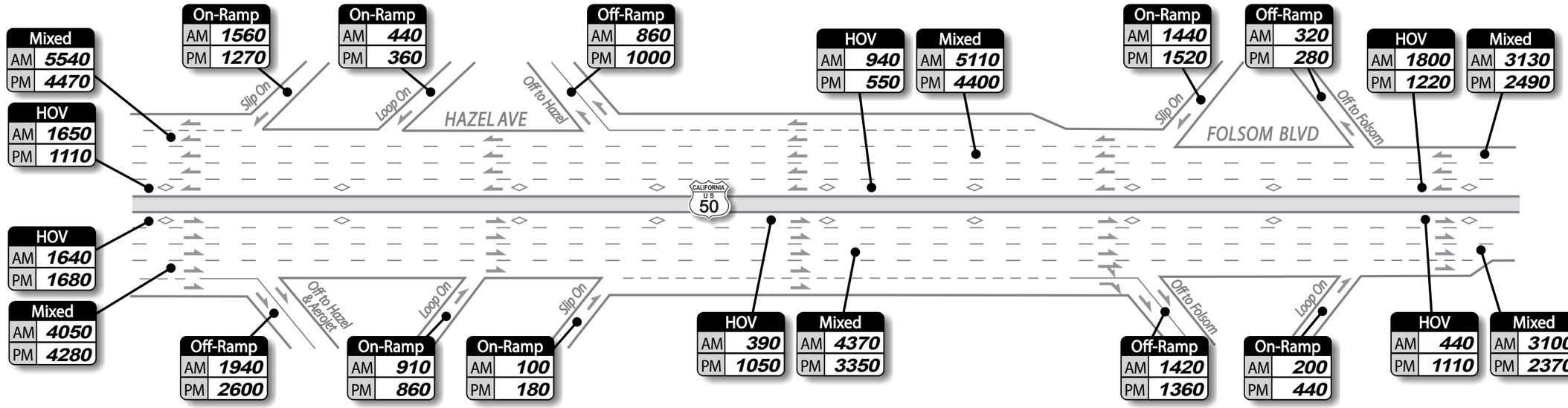
- Freeway Peak Hour Traffic Volumes

DKS

Figure **6-2**

YEAR 2022 WITH ALTERNATIVE 1

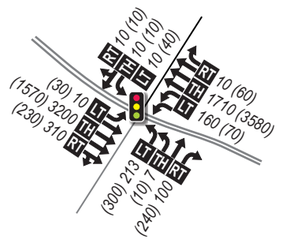
AM/PM Peak Hour Traffic Volumes and Lane Geometry



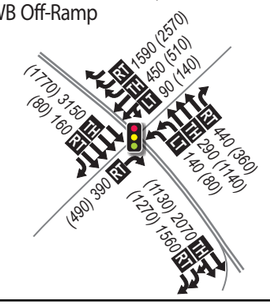
NORTH
Not to Scale

Freeway Schematic

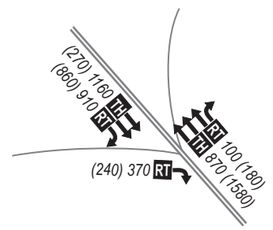
1 Hazel Ave. @ Gold Country Blvd.



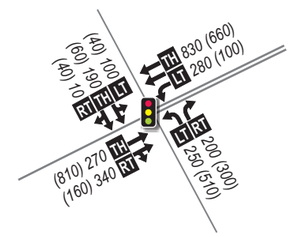
2 Hazel Ave. @ Tributary Pt. Dr./ WB Off-Ramp



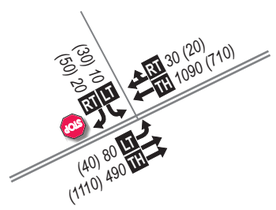
3 Hazel Ave. @ EB Ramps



5 Aerojet Rd. @ Folsom Blvd.



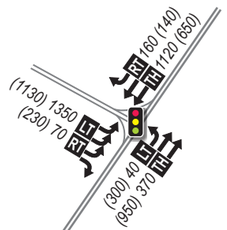
6 Folsom Blvd. @ Auto Mall Cir. (West)



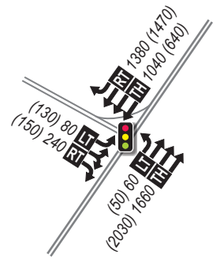
7 Folsom Blvd. @ Auto Mall Cir. (East)/ Birkmont Dr.



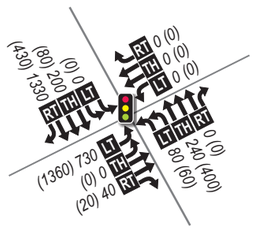
8 Folsom Blvd. @ EB Ramps



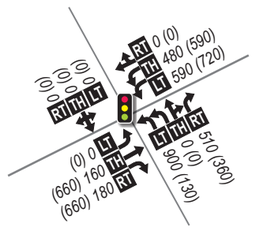
9 Folsom Blvd. @ WB Ramps



10 Hazel Ave. @ Jug Handle

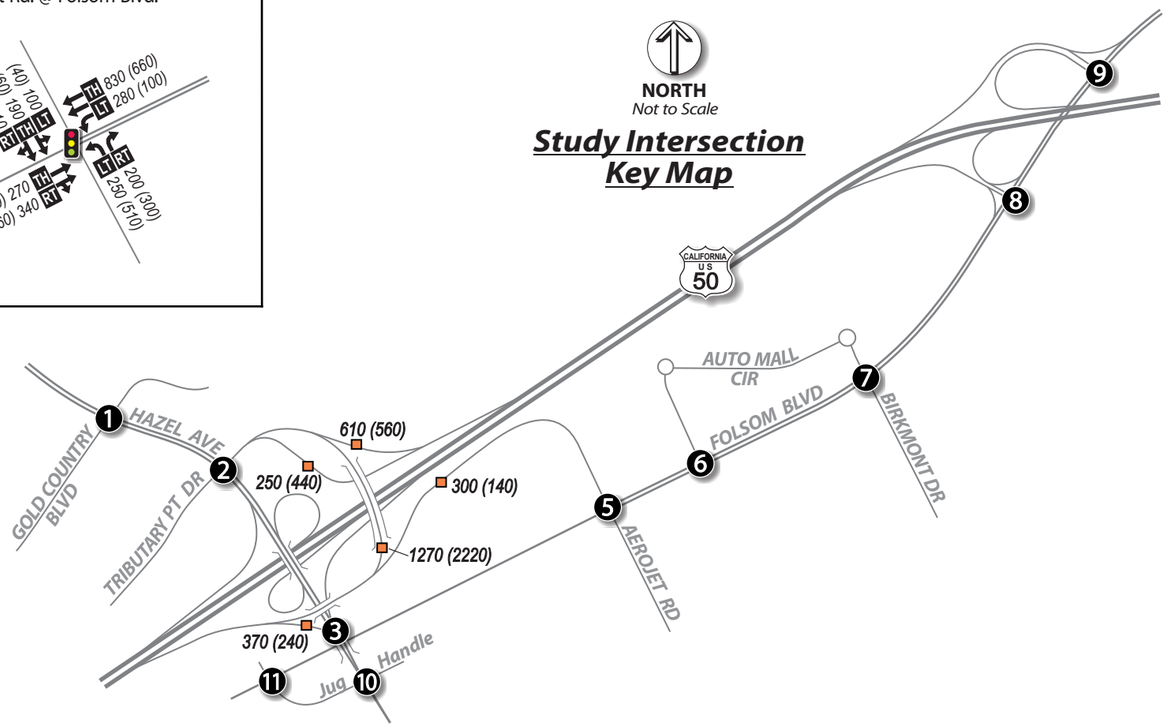


11 Folsom Blvd. @ Jug Handle



NORTH
Not to Scale

Study Intersection Key Map



LEGEND

Key Map
- (#) - Study Intersection
- AM (PM) ■ - Peak Hour Fwy. Ramp Volumes

Intersection Diagrams
- STOP - Stop Sign
- Traffic Signal
- ← - Lane Configuration
- *AM (PM)* - Peak Hour Traffic Volumes
- LT TH RT - Volume Turn Movement (Left•Thru•Right)

Freeway Schematic
- ◇ - HOV (High Occupancy Vehicle) Lane

Data Location	
AM	0000
PM	0000

- Freeway Peak Hour Traffic Volumes

DKS

Figure **6-3**

YEAR 2022 WITH ALTERNATIVE 2

AM/PM Peak Hour Traffic Volumes and Lane Geometry

Table 6-1
Opening Year (2022) Intersection Operations Analysis

No.	Intersection	Opening Year (2022) No Build				Opening Year (2022) with Alt. 1/1A				Opening Year (2022) with Alt. 2			
		AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour	
		LOS	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS	Delay (s)
1	Hazel Ave & Gold Country Blvd	C	23.7	E	66.1	C	26.5	E	69.3	C	23.7	E	78.5
2	Hazel Ave & US 50 WB Ramps/ Tributary Point Dr	D	40.3	D	42.6	D	36.4	D	40.5	C	30.0	E	63.7
3	Hazel Ave & US 50 EB Ramps	D	43.1	**F**	**82.7**	B	14.4	C	23.4	Free movement			
4	Hazel Ave & Folsom Blvd	D	50.9	**F**	**120.8**	Does not exist				Does not exist			
5	Folsom Blvd & Aerojet Rd	**D**	**37.5**	**E**	**61.0**	**D**	**37.5**	**E**	**61.0**	**D**	**37.5**	**E**	**61.0**
6	Folsom Blvd & Auto Mall Cir (West)	**(F)**	**50.7**	**(E)**	**(46.9)**	**(F)**	**50.7**	**(E)**	**(46.9)**	**(F)**	**50.7**	**(E)**	**(46.9)**
7	Folsom Blvd & Birkmont Dr/Auto Mall Cir (East)	C	25.7	**F**	**80.6**	C	25.7	**F**	**80.6**	C	25.7	**F**	**80.6**
8	Folsom Blvd & US 50 EB Ramps	C	24.1	B	18.0	C	24.1	B	18.0	C	24.1	B	18.0
9	Folsom Blvd & US 50 WB Ramps	**D**	**42.4**	**E**	**62.0**	**D**	**42.4**	**E**	**62.0**	**D**	**42.4**	**E**	**62.0**
10	Hazel Ave & Jug Handle	Does not exist				E	64.1	C	26.8	E	64.1	C	26.7
11	Folsom Blvd & Jug Handle	Does not exist				C	26.1	D	44.3	C	26.1	D	44.3

Note: **Bold** values indicate unacceptable level of service.
For intersections shared between Sacramento County (LOS "E" policy) and the City of Folsom (LOS "C" policy), Folsom's policy was used.
(X) (Y) indicates level of service shown for the highest delay stop-controlled approach.

Freeway Operations

Table 6-2A and **Table 6-2B** summarize the results of the operations analysis for freeway facilities.

In the Horizon Year No Build Scenario, the following basic, merge/diverge, and weave segments do not operate at an acceptable level of service during the AM or PM peak hours:

- US 50 Eastbound – Diverge Segment at the Folsom Boulevard Off-Ramp (**LOS F** in the AM peak hour)
- US 50 Westbound – Merge Segment at the Folsom Boulevard On-Ramp (**LOS F** in the AM peak hour)

In the Horizon Year With Build Scenario, the following basic, merge/diverge, and weave segments do not operate at an acceptable level of service during the AM or PM peak hours:

- US 50 Westbound – Merge Segment at the Folsom Boulevard On-Ramp (**LOS F** in the AM peak hour)

After implementation of either Alternative 1/1A or Alternative 2, the transition lane would alleviate the Year 2022 operational deficiency at the US 50 Eastbound diverge to Folsom Boulevard.

Ramp Queuing

Table 6-3 summarizes the results of the ramp queuing analysis.

In the Opening Year No Build Scenario, the following 95th percentile queues exceed the storage capacity of the ramps:

- US 50 Eastbound Off-Ramp to Hazel Avenue (PM peak hour)

In the Opening Year With Build Scenario, no 95th percentile queues exceed the storage capacity of the ramps.

Intersection Queuing

Table 6-4 summarizes the estimated 95th percentile queues and storage capacity at each intersection.

Under 2022 No Build conditions, queues along southbound Hazel Avenue at the westbound off-ramp extend past the upstream intersection with Gold Country Boulevard. This is due to the heavy commute traffic using Hazel Avenue to access US 50. While signal timing changes along Hazel Avenue are assumed with the proposed improvements, southbound queuing on Hazel Avenue would still be expected to extend past Gold Country Boulevard.

Queuing would be expected to be a major problem at the Folsom Boulevard/ Hazel Avenue intersection under the No Build condition, due to the short distance between the off-ramp and Folsom Boulevard. The grade separation of Hazel Avenue over Folsom Boulevard, together with the construction of the Jug Handle, eliminates the excessive queues at this location. After implementation of the proposed improvements, the left turn queue on the eastbound approach of the Jug Handle at Hazel Avenue is estimated to exceed the length of the turn pocket.

However, this is not anticipated to cause operational issues because the entire length of the Jug Handle (approximately 1,300 feet) effectively provides additional storage. So while the queue is likely to spill from the turn pocket into the leftmost though lane, queuing is not expected to spill back to the upstream intersection with Folsom Boulevard.

The northbound left and westbound left queues at the Folsom Boulevard/Aerojet Road intersection exceed storage capacity. The northbound dual left turn lane mitigation measure for the Easton/Glenborough development would be expected to alleviate the northbound queuing issue, provided the dual left turn lane is at least 300 feet long. It would not likely be feasible to implement westbound dual left turn lanes, due to the right of way constraints imposed by adjacent development and the light rail tracks. It would also likely be infeasible to lengthen the westbound left turn pocket, as this would run into the eastbound left turn pocket at Auto Mall Circle (West).

Table 6-2A
Opening Year (2022) Freeway Operations Analysis (US 50 Eastbound)

Opening Year (2022) No Build						Opening Year (2022) with Alternative 1 or Alternative 2					
Analysis Segment	Type	AM Peak Hour		PM Peak Hour		Analysis Segment	Type	AM Peak Hour		PM Peak Hour	
		LOS	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)			LOS	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)
Sunrise Blvd to Hazel Ave	Basic	C	21.9	C	23.7	Sunrise Blvd to Hazel Ave	Basic	C	21.9	C	23.7
Hazel Ave Exit	Two-Lane Diverge	B	17.7	C	23.4	Hazel Ave Exit	Two-Lane Diverge	B	19.3	C	24.1
SB Hazel Ave Loop Entrance	One-Lane Merge	C	23.1	B	19.9	SB Hazel Ave Loop Entrance	One-Lane Merge	C	21.6	B	19.1
NB Hazel Ave Slip Entrance	Weave	C	21.2	B	15.3	NB Hazel Ave Slip Entrance	Weave	B	19.2	B	14.7
Aerojet Exit						Folsom Blvd Exit					
Aerojet Rd to Folsom Blvd	Basic	C	24.0	C	18.1						
Folsom Blvd Exit	Two-Lane Diverge	**F**	**32.8**	C	23.4						
Folsom Blvd Entrance	One-Lane Merge	D	30.4	C	24.2	Folsom Blvd Entrance	One-Lane Merge	B	19.8	B	17.0
Folsom Blvd to Prairie City Rd	Basic	D	26.0	C	19.2	Folsom Blvd to Prairie City Rd	Basic	D	26.0	C	19.2

Note: **Bold** values indicate unacceptable level of service.

Table 6-2B
Opening Year (2022) Freeway Operations Analysis (US 50 Westbound)

Opening Year (2022) No Build						Opening Year (2022) with Alternative 1 or Alternative 2					
Analysis Segment	Type	AM Peak Hour		PM Peak Hour		Analysis Segment	Type	AM Peak Hour		PM Peak Hour	
		LOS	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)			LOS	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)
Prairie City Rd to Folsom Blvd	Basic	D	26.7	C	19.4	Prairie City Rd to Folsom Blvd	Basic	D	26.7	C	19.4
Folsom Blvd Exit	One-Lane Diverge	D	34.7	C	27.5	Folsom Blvd Exit	One-Lane Diverge	D	34.7	C	27.5
Folsom Blvd Entrance	One-Lane Merge	**F**	**32.8**	C	26.9	Folsom Blvd Entrance	One-Lane Merge	**F**	**32.8**	C	26.9
Folsom Blvd to Hazel Ave	Basic	D	30.2	C	23.3	Folsom Blvd to Hazel Ave	Basic	D	30.2	C	23.3
Hazel Ave Exit	Two-Lane Diverge	B	11.5	A	9.2	Hazel Ave Exit	Two-Lane Diverge	B	11.5	A	9.2
NB Hazel Ave Loop Entrance	One-Lane Merge	C	27.7	C	21.7	NB Hazel Ave Loop Entrance	One-Lane Merge	C	27.7	C	21.7
SB Hazel Ave Slip Entrance	One-Lane Merge	D	34.7	C	25.9	SB Hazel Ave Slip Entrance	One-Lane Merge	D	34.7	C	25.9
Hazel Ave to Sunrise Blvd	Basic	D	34.4	C	23.7	Hazel Ave to Sunrise Blvd	Basic	D	34.4	C	23.7

Note: **Bold** values indicate unacceptable level of service.

Table 6-3
Opening Year (2022) Ramp Queuing Analysis

Direction	Ramp Queue	Opening Year (2022) No Build			Opening Year (2022) with Alternative 1/1A			Opening Year (2022) with Alternative 2		
		Storage Length (ft)	AM Queue (ft)	PM Queue (ft)	Storage Length (ft)	AM Queue (ft)	PM Queue (ft)	Storage Length (ft)	AM Queue (ft)	PM Queue (ft)
US 50 Eastbound	Off-Ramp to Hazel Ave	1,350	493	**1,641**	2,400	246	479	2,250	-	-
	Off-Ramp to Aerojet Rd	1,425	185	120	2,400	185	120	2,250	185	120
	Off-Ramp to Folsom Blvd	1,300	326	270	1,300	326	270	1,300	326	270
US 50 Westbound	Off-Ramp to Folsom Blvd	1,550	49	37	1,550	49	118	1,550	49	118
	Off-Ramp to Hazel Ave	2,030	398	719	2,030	411	630	2,030	440	1,377

Note: **Bold** values indicate queuing exceeding storage capacity.
Gray shaded cells highlight changes to storage capacity due to the project.
Queues shown represent the 95th percentile.

Table 6-4
Opening Year (2022) Intersection Queuing Analysis

Intersection	Approach	Move-ment	Opening Year (2022) No Build			Opening Year (2022) with Alternative 1/1A			Opening Year (2022) with Alternative 2		
			Storage Length (ft)	AM Queue (ft)	PM Queue (ft)	Storage Length (ft)	AM Queue (ft)	PM Queue (ft)	Storage Length (ft)	AM Queue (ft)	PM Queue (ft)
Hazel Avenue & US 50 WB Ramps/ Tributary Point Dr	EB	RT	275	**361**	**572**	275	**431**	**464**	275	**467**	**583**
	WB	LT	2,030	364	719	2,030	393	630	2,030	440	452
		TH									
		RT	2,030	398	396	2,030	411	350	2,030	32	1,377
	NB	LT	320	280	115	320	232	139	320	91	54
		TH	1,440	242	1,117	1,440	169	1,316	1,440	139	535
		RT	Free Movement			Free Movement			Free Movement		
	SB	TH	860	**1,157**	415	860	**1,050**	475	860	**1,003**	463
		RT	225	38	30	225	31	23	225	16	11
Hazel Avenue & US 50 EB Ramps	EB	LT	1,350	493	**1,641**	2,400	246	479	Intersection Does Not Exist		
		RT				2,400	90	17			
	NB	TH	Free Movement			1,200	96	337			
		RT				Free Movement					
	SB	TH	1,140	452	136	1,140	176	35			
		RT	Free Movement			Free Movement					
Hazel Avenue & Folsom Boulevard	EB	LT	350	119	**565**	Intersection Does Not Exist			Intersection Does Not Exist		
		TH	>2,500	90	364						
		RT									
	WB	LT	200	49	36						
		TH	2,140	648	1,177						
		RT	2,140	383	939						
	NB	LT	700	105	80						
		TH	700	329	**869**						
		RT									
	SB	LT	200	**667**	**513**						
		TH									
		RT									

Table 6-4
Opening Year (2022) Intersection Queuing Analysis

Intersection	Approach	Move-ment	Opening Year (2022) No Build			Opening Year (2022) with Alternative 1/1A			Opening Year (2022) with Alternative 2		
			Storage Length (ft)	AM Queue (ft)	PM Queue (ft)	Storage Length (ft)	AM Queue (ft)	PM Queue (ft)	Storage Length (ft)	AM Queue (ft)	PM Queue (ft)
Hazel Avenue & Jug Handle	EB	LT	Intersection Does Not Exist			200	**382**	**524**	200	**382**	**524**
		TH				1,350	0	0	1,350	0	0
		RT				200	0	0	200	0	0
	WB	LT				200	0	0	200	0	0
		TH				500	0	0	500	0	0
		RT				200	0	0	200	0	0
	NB	LT				300	75	55	300	75	53
		TH				>2,500	48	159	>2,500	48	159
		RT				300	0	0	300	0	0
	SB	LT				300	0	0	300	0	0
		TH				1,200	52	44	1,200	52	44
		RT				1,200	1,046	80	1,200	1,046	80
Folsom Boulevard & Jug Handle	EB	LT	Intersection Does Not Exist			200	0	0	200	0	0
		TH				>2,500	176	743	>2,500	176	743
		RT				>2,500	61	399	>2,500	61	399
	WB	LT				500	258	439	500	258	439
		TH				>2,500	338	288	>2,500	338	288
		RT									
	NB	LT				1,350	341	71	1,350	341	71
		TH				1,350	0	0	1,350	0	0
		RT									
	SB	LT				200	0	0	200	0	0
		TH									
		RT									

Table 6-4
Opening Year (2022) Intersection Queuing Analysis

Intersection	Approach	Move-ment	Opening Year (2022) No Build			Opening Year (2022) with Alternative 1/1A			Opening Year (2022) with Alternative 2		
			Storage Length (ft)	AM Queue (ft)	PM Queue (ft)	Storage Length (ft)	AM Queue (ft)	PM Queue (ft)	Storage Length (ft)	AM Queue (ft)	PM Queue (ft)
Folsom Boulevard & Aerojet Road	EB	TH	2,140	274	708	2,140	274	708	2,140	274	708
		RT									
	WB	LT	370	**454**	197	370	**454**	197	370	**454**	197
		TH	665	370	337	665	370	337	665	370	337
	NB	LT	415	191	**735**	415	191	**735**	415	191	**735**
		RT	415	88	356	415	88	356	415	88	356
	SB	LT	1,425	185	120	2,400	185	120	2,250	185	120
		TH									
		RT									

Note: **Bold** values indicate queuing exceeding storage capacity.
Gray shaded cells highlight changes to storage capacity due to the project.
Queues shown represent the 95th percentile.

7. HORIZON YEAR (2042) TRAFFIC OPERATIONS

Traffic Forecasting

Traffic forecasting assumptions for Horizon Year (2022) are discussed in **Section 2** of this report. The resulting ("constrained") intersection, freeway, and ramp volumes for the No Build Alternative, Alternative 1/1A, and Alternative 2 are shown in **Figure 7-1**, **Figure 7-2**, and **Figure 7-3**, respectively.

Intersection Operations

Table 7-1 summarizes the results of the operations analysis for the study area intersections.

In the Horizon Year No Build Scenario, the following study intersections do not operate at an acceptable level of service during the AM or PM peak hours:

- Intersection #2: Hazel Ave & US 50 WB Ramps (**LOS F** in the PM peak hour)
- Intersection #3: Hazel Ave & US 50 EB Ramps (**LOS F** in the PM peak hour)
- Intersection #4: Hazel Ave & Folsom Blvd (**LOS F** in the AM and PM peak hours)
- Intersection #6: Folsom Blvd & Auto Mall Circle West (**LOS F** in the PM peak hour)
- Intersection #8: Folsom Blvd & US 50 Westbound Ramps (**LOS D** in the AM and PM peak hours)

In the Horizon Year With Build Scenario, the following study intersections do not operate at an acceptable level of service during the AM or PM peak hours:

- Intersection #6: Folsom Blvd & Auto Mall Circle West (**LOS F** in the PM peak hour)
- Intersection #8: Folsom Blvd & US 50 Westbound Ramps (**LOS D** in the PM peak hour)

Intersections #5, #6, and #8 are shared by Sacramento County and the City of Folsom. Sacramento County has a level of service "E" policy, but the City of Folsom has a more restrictive level of service "C" policy. The implementation of the project does not cause delay to increase by more than 5.0 seconds at deficient intersections. Therefore, there are **no significant impacts** to study area intersections.

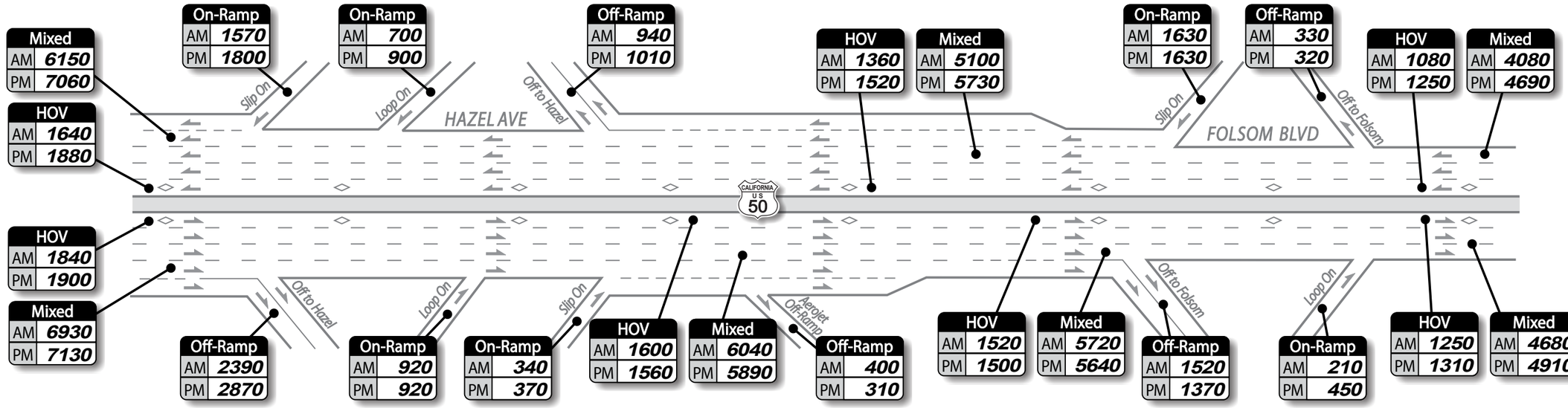
It should be noted that changes in off-site intersection geometry (intersections #1, 5, 6, 7, 8, 9) for both the "No Build" or "With Build" scenarios are consistent with the assumptions in the Final Traffic Impact Study for the Easton Development Project[3] for Cumulative Plus Proposed Project conditions. Specifically, the Easton/Glenborough project will be required to extend Glenborough Drive to the Folsom Boulevard/US 50 Eastbound Ramps intersection, which benefits operations at other signalized Folsom Boulevard intersections.

[3] Fehr & Peers Transportation Consultants, 2008.

The Easton/Glenborough project would also be required to implement the following mitigations at intersection #5 (Folsom Boulevard and Aerojet Road):

- Widen the northbound approach to provide dual left and dual right turn lanes
- Implement a northbound right turn overlap (protected) phase

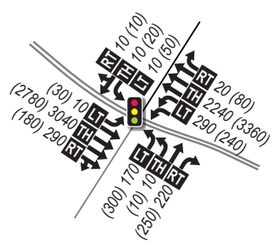
After implementation of either Alternative 1/1A or Alternative 2, the US 50 ramp terminal intersections at Hazel Avenue operate at an acceptable level of service in both the AM and PM peak hour in Year 2042.



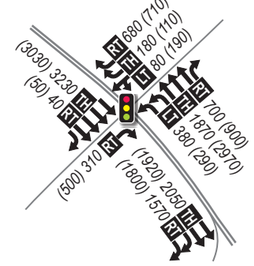
NORTH
Not to Scale

Freeway Schematic

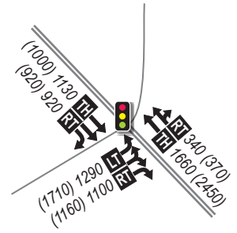
1 Hazel Ave. @ Gold Country Blvd.



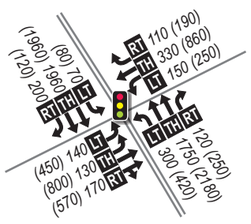
2 Hazel Ave. @ Tributary Pt. Dr./ WB Off-Ramp



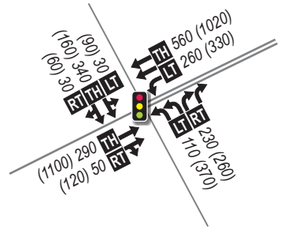
3 Hazel Ave. @ EB Ramps



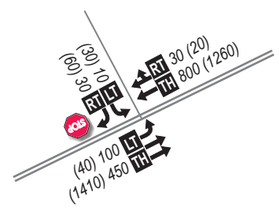
4 Hazel Ave. @ Folsom Blvd.



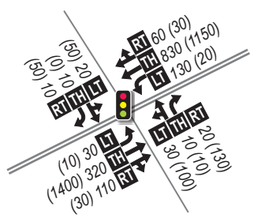
5 Aerojet Rd. @ Folsom Blvd.



6 Folsom Blvd. @ Auto Mall Cir. (West)



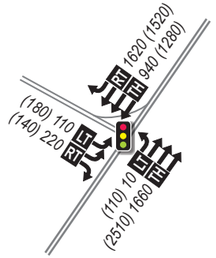
7 Folsom Blvd. @ Auto Mall Cir. (East)/ Birkmont Dr.



8 Folsom Blvd. @ EB Ramps

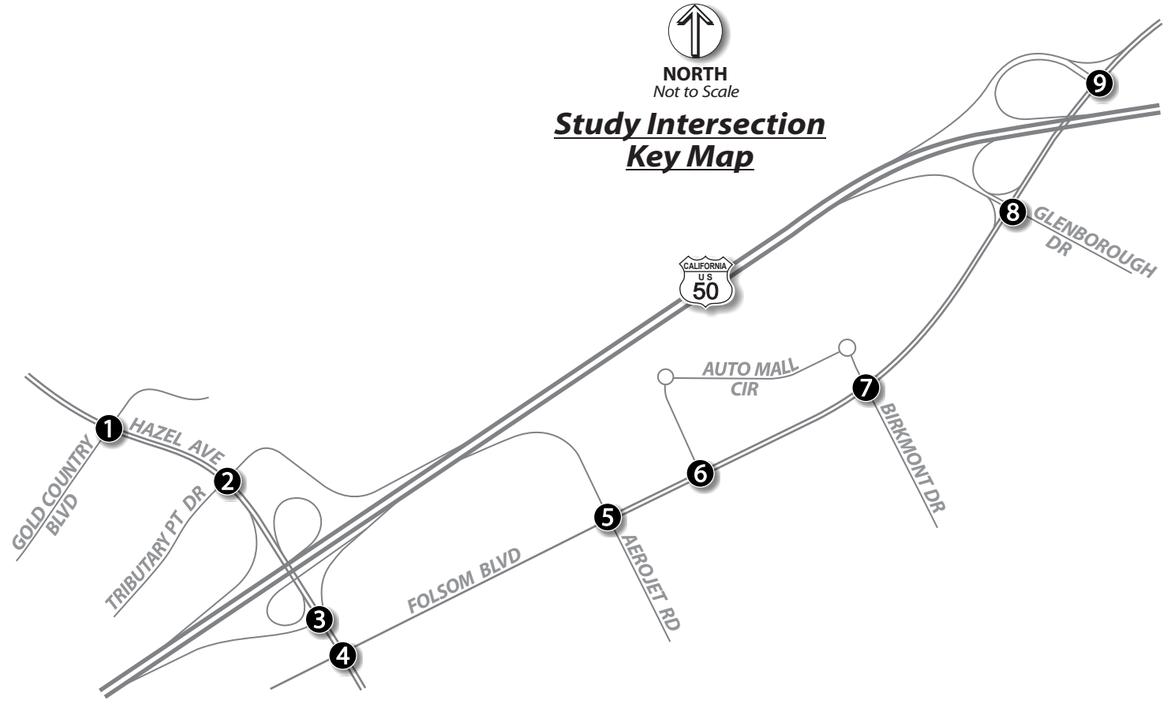


9 Folsom Blvd. @ WB Ramps



NORTH
Not to Scale

Study Intersection Key Map



LEGEND

Key Map
(#) - Study Intersection

Intersection Diagrams
STOP - Stop Sign
- Traffic Signal
← - Lane Configuration
AM (PM) - Peak Hour Traffic Volumes
LT TH RT - Volume Turn Movement
Left•Thru•Right

Freeway Schematic
◇ - HOV (High Occupancy Vehicle) Lane

Data Location	
AM	0000
PM	0000

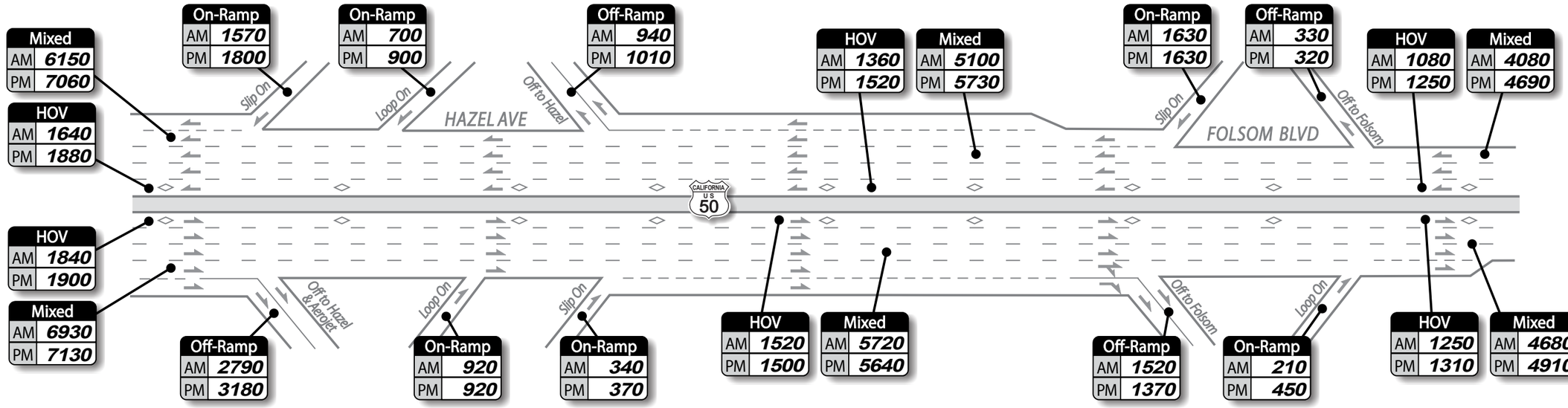
- Freeway Peak Hour Traffic Volumes

DKS

Figure **7-1**

YEAR 2042 NO BUILD

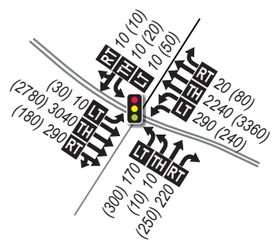
AM/PM Peak Hour Traffic Volumes and Lane Geometry



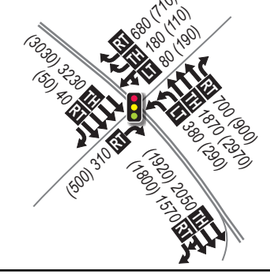
NORTH
Not to Scale

Freeway Schematic

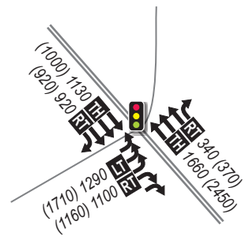
1 Hazel Ave. @ Gold Country Blvd.



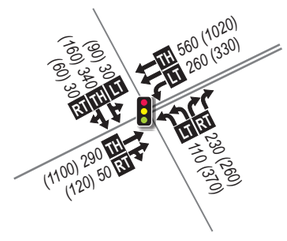
2 Hazel Ave. @ Tributary Pt. Dr./ WB Off-Ramp



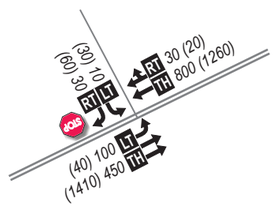
3 Hazel Ave. @ EB Ramps



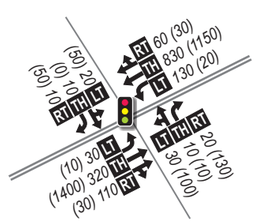
5 Aerojet Rd. @ Folsom Blvd.



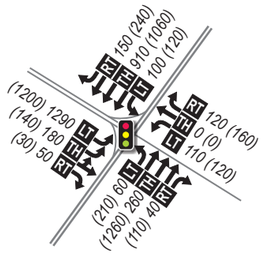
6 Folsom Blvd. @ Auto Mall Cir. (West)



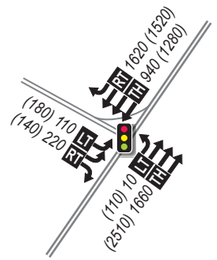
7 Folsom Blvd. @ Auto Mall Cir. (East)/ Birkmont Dr.



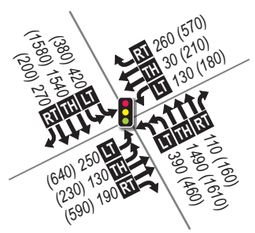
8 Folsom Blvd. @ EB Ramps



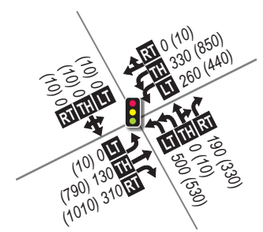
9 Folsom Blvd. @ WB Ramps



10 Hazel Ave. @ Jug Handle

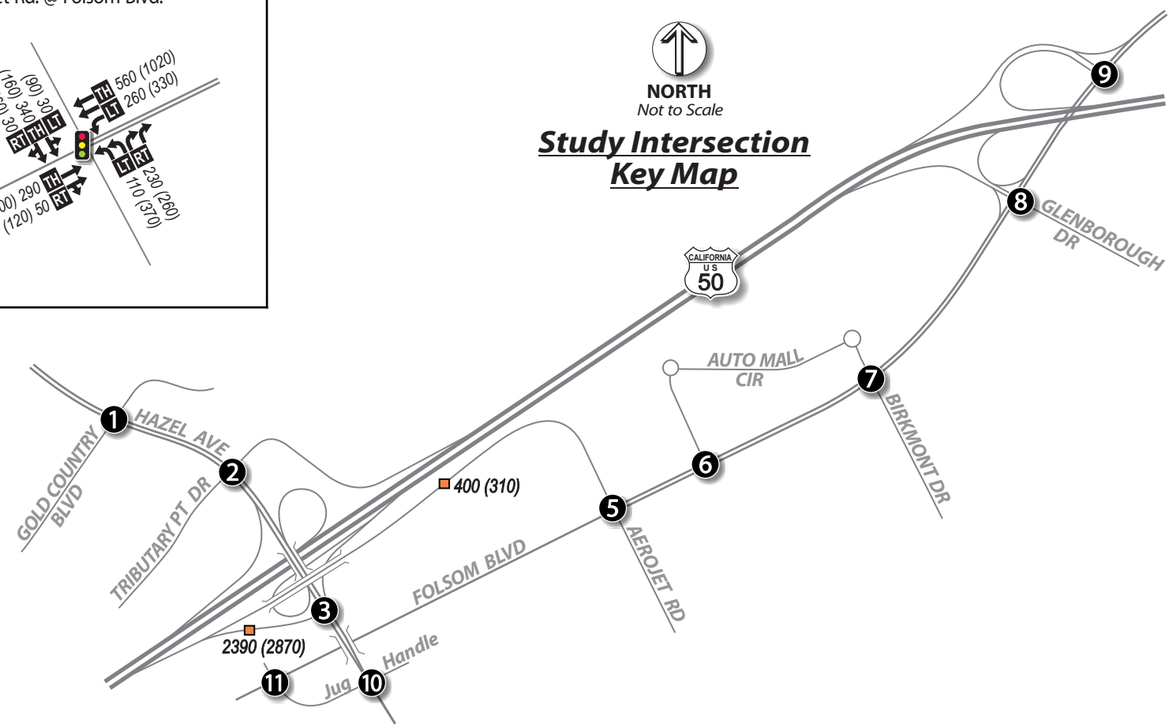


11 Folsom Blvd. @ Jug Handle



NORTH
Not to Scale

Study Intersection Key Map



LEGEND

Key Map

(#) - Study Intersection

AM (PM) - Peak Hour Fwy. Ramp Volumes

Intersection Diagrams

STOP - Stop Sign

- Traffic Signal

- Lane Configuration

AM (PM) - Peak Hour Traffic Volumes

LT TH RT - Volume Turn Movement
Left•Thru•Right

Freeway Schematic

◇ - HOV (High Occupancy Vehicle) Lane

Data Location	
AM	0000
PM	0000

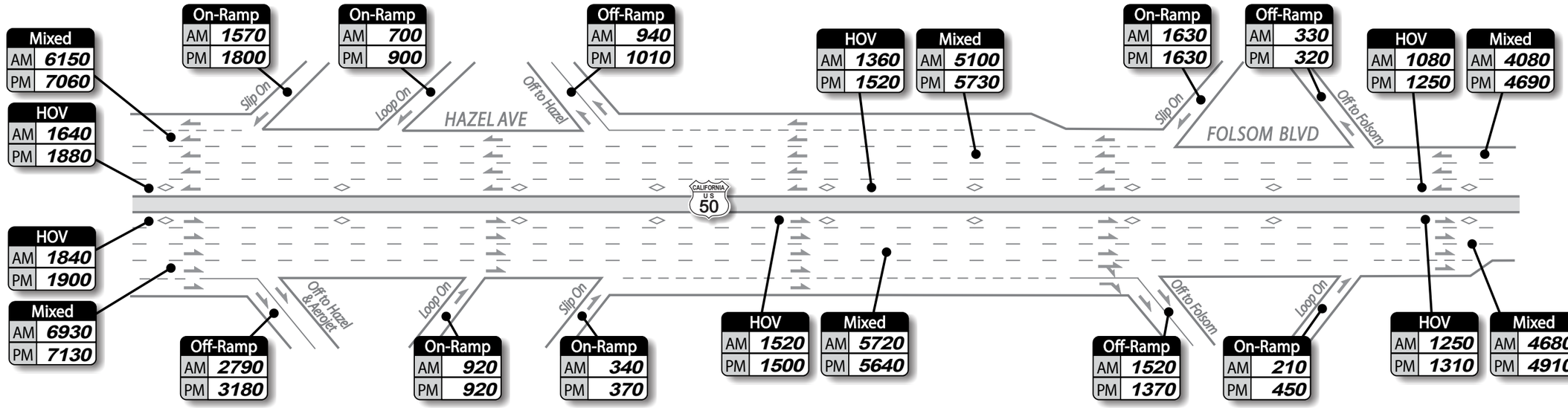
- Freeway Peak Hour Traffic Volumes

DKS

Figure **7-2**

YEAR 2042 WITH ALTERNATIVE 1

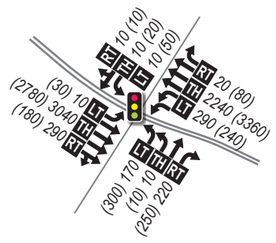
AM/PM Peak Hour Traffic Volumes and Lane Geometry



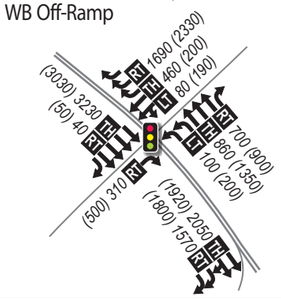
NORTH
Not to Scale

Freeway Schematic

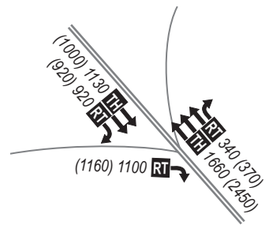
1 Hazel Ave. @ Gold Country Blvd.



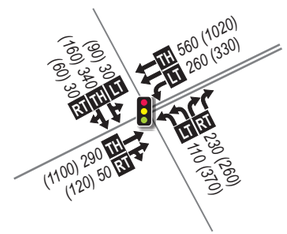
2 Hazel Ave. @ Tributary Pt. Dr./ WB Off-Ramp



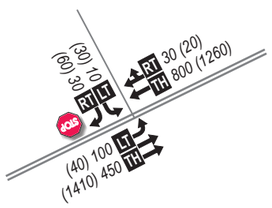
3 Hazel Ave. @ EB Ramps



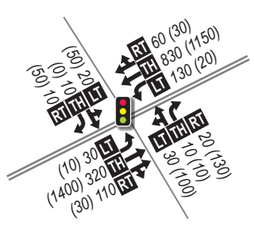
5 Aerojet Rd. @ Folsom Blvd.



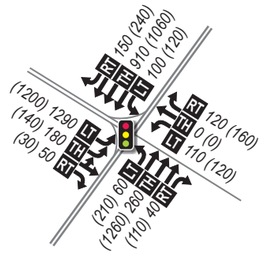
6 Folsom Blvd. @ Auto Mall Cir. (West)



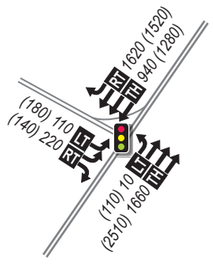
7 Folsom Blvd. @ Auto Mall Cir. (East)/ Birkmont Dr.



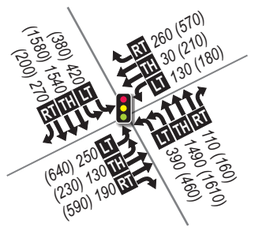
8 Folsom Blvd. @ EB Ramps



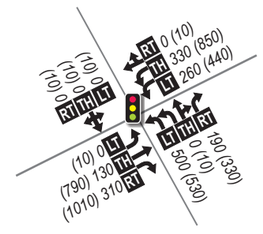
9 Folsom Blvd. @ WB Ramps



10 Hazel Ave. @ Jug Handle

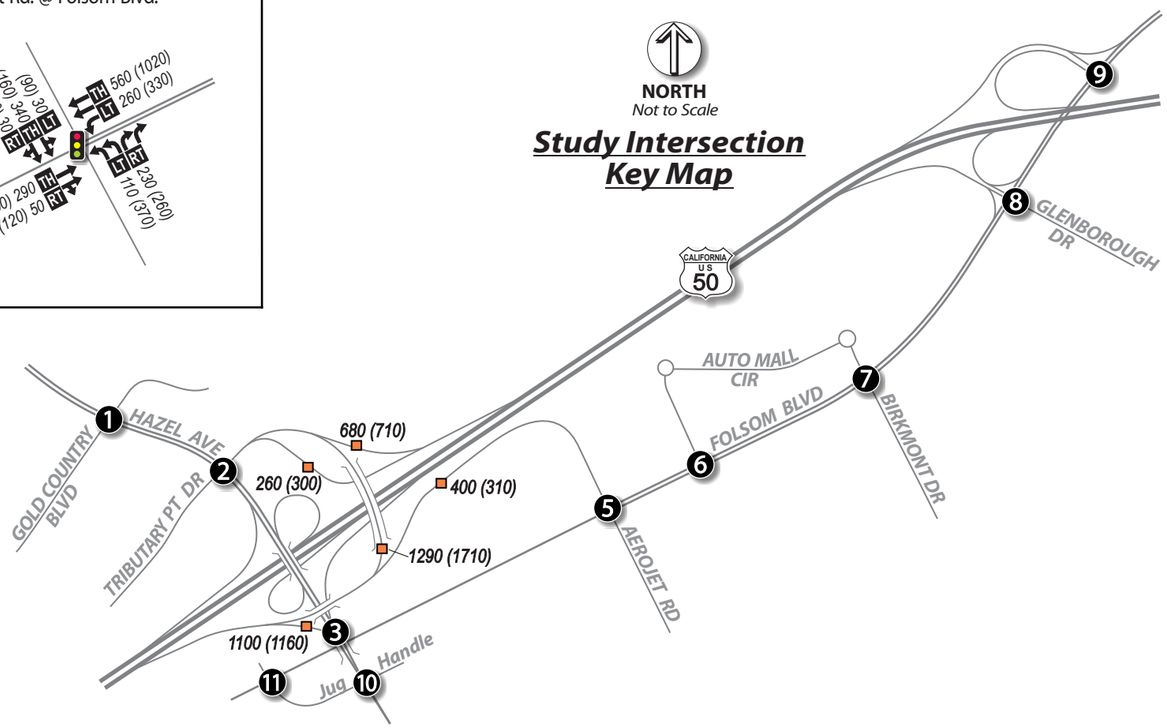


11 Folsom Blvd. @ Jug Handle



NORTH
Not to Scale

Study Intersection Key Map



LEGEND

Key Map

(#) - Study Intersection

AM (PM) - Peak Hour Fwy. Ramp Volumes

Intersection Diagrams

STOP - Stop Sign

- Traffic Signal

- Lane Configuration

AM (PM) - Peak Hour Traffic Volumes

LT TH RT - Volume Turn Movement
Left•Thru•Right

Freeway Schematic

◇ - HOV (High Occupancy Vehicle) Lane

Data Location	
AM	0000
PM	0000

- Freeway Peak Hour Traffic Volumes

DKS

Figure **7-3**

YEAR 2042 WITH ALTERNATIVE 2

AM/PM Peak Hour Traffic Volumes and Lane Geometry

Table 7-1
Horizon Year (2042) Intersection Operations Analysis

No.	Intersection	Horizon Year (2042) No Build				Horizon Year (2042) with Alt. 1/1A				Horizon Year (2042) with Alt. 2			
		AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour	
		LOS	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS	Delay (s)
1	Hazel Ave & Gold Country Blvd	C	30.8	D	54.5	C	29.6	E	55.5	C	30.3	E	61.5
2	Hazel Ave & US 50 WB Ramps/ Tributary Point Dr	D	42.2	**F**	**86.6**	D	42.1	E	72.4	C	32.1	E	65.7
3	Hazel Ave & US 50 EB Ramps	E	78.2	**F**	**90.9**	C	27.1	D	36.6	Free movement			
4	Hazel Ave & Folsom Blvd	**F**	**84.3**	**F**	**316.8**	Does not exist				Does not exist			
5	Folsom Blvd & Aerojet Rd	B	10.5	B	15.8	B	10.5	B	15.8	B	10.5	B	15.8
6	Folsom Blvd & Auto Mall Cir (West)	**(D)**	**(33.4)**	**(F)**	**(280.8)**	**(D)**	**(33.4)**	**(F)**	**(280.8)**	**(D)**	**(33.4)**	**(F)**	**(280.8)**
7	Folsom Blvd & Birkmont Dr/Auto Mall Cir (East)	B	14.1	B	17.5	B	14.0	B	17.4	B	14.0	B	17.4
8	Folsom Blvd & US 50 EB Ramps	**D**	**43.1**	**D**	**40.2**	C	32.8	**D**	**39.4**	C	32.8	**D**	**39.4**
9	Folsom Blvd & US 50 WB Ramps	B	15.9	B	12.3	B	16.3	B	16.5	B	16.6	B	16.5
10	Hazel Ave & Jug Handle	Does not exist				D	37.2	E	71.9	C	32.8	E	68.0
11	Folsom Blvd & Jug Handle	Does not exist				B	12.5	E	61.6	B	12.5	E	61.6

Note: **Bold** values indicate unacceptable level of service.
For intersections shared between Sacramento County (LOS "E" policy) and the City of Folsom (LOS "C" policy), Folsom's policy was used.
(X) (Y) indicates level of service shown for the highest delay stop-controlled approach.

Freeway Operations

Table 7-2A and **Table 7-2B** summarize the results of the operations analysis for freeway facilities.

In the Horizon Year No Build Scenario, the following basic, merge/diverge, and weave segments do not operate at an acceptable level of service during the AM or PM peak hours:

- US 50 Eastbound – Basic Segment from Rancho Cordova Parkway to Hazel Avenue (**LOS F** in the AM and PM peak hours)
- US 50 Eastbound – Diverge Segment at the Hazel Avenue Off-Ramp (**LOS F** in the AM and PM peak hours)
- US 50 Eastbound – Diverge Segment at the Folsom Boulevard Off-Ramp (**LOS F** in the AM and PM peak hours)
- US 50 Eastbound – Merge Segment at the Folsom Boulevard On-Ramp (**LOS F** in the AM and PM peak hour)
- US 50 Eastbound – Basic Segment from Folsom Boulevard to Prairie City Road (**LOS F** in the AM and PM peak hours)
- US 50 Westbound – Basic Segment from Prairie City Road to Folsom Boulevard (**LOS F** in the PM peak hour)
- US 50 Westbound – Diverge Segment at the Folsom Boulevard Off-Ramp (**LOS F** in the PM peak hour)
- US 50 Westbound – Merge Segment at the Folsom Boulevard On-Ramp (**LOS F** in the AM and PM peak hour)
- US 50 Westbound – Merge Segment at the SB Hazel Avenue Slip On-Ramp (**LOS F** in the AM and PM peak hour)
- US 50 Westbound – Basic Segment from Hazel Avenue to Rancho Cordova Parkway (**LOS F** in the PM peak hour)

In the Horizon Year With Build Scenario, the following basic, merge/diverge, and weave segments do not operate at an acceptable level of service during the AM or PM peak hours:

- US 50 Eastbound – Basic Segment from Rancho Cordova Parkway to Hazel Avenue (**LOS F** in the AM and PM peak hours)
- US 50 Eastbound – Diverge Segment at the Hazel Avenue Off-Ramp (**LOS F** in the AM and PM peak hours)
- US 50 Eastbound – Basic Segment from Folsom Boulevard to Prairie City Road (**LOS F** in the AM and PM peak hours)
- US 50 Westbound – Basic Segment from Prairie City Road to Folsom Boulevard (**LOS F** in the PM peak hour)
- US 50 Westbound – Diverge Segment at the Folsom Boulevard Off-Ramp (**LOS F** in the PM peak hour)
- US 50 Westbound – Merge Segment at the Folsom Boulevard On-Ramp (**LOS F** in the AM and PM peak hour)
- US 50 Westbound – Merge Segment at the SB Hazel Avenue Slip On-Ramp (**LOS F** in the AM and PM peak hour)
- US 50 Westbound – Basic Segment from Hazel Avenue to Rancho Cordova Parkway (**LOS F** in the PM peak hour)

The project does not add any traffic to a deficient ramp or cause freeway density to increase. Therefore, there are **no significant impacts** to freeway facilities. In fact, the project improves eastbound freeway operations in the vicinity of Hazel Avenue and adds a transition lane through the Folsom Boulevard interchange. This transition lane eliminates two LOS "F" segments at the Folsom Boulevard diverge and merge areas.

Ramp Queuing

Table 7-3 summarizes the results of the ramp queuing analysis.

In the Horizon Year No Build Scenario, the following 95th percentile queues exceed the storage capacity of the ramps:

- US 50 Eastbound Off-Ramp to Hazel Avenue (PM peak hour)

In the Horizon Year With Build Scenario, no 95th percentile queues exceed the storage capacity of the ramps. Therefore, there are **no significant impacts** to ramp queuing. The project is necessary to prevent estimated 95th percentile queues from backing up onto the mainline.

Intersection Queuing

Table 7-4 summarizes the estimated 95th percentile queues and storage capacity at each intersection.

Under 2042 No Build conditions, queues along southbound Hazel Avenue at the westbound off-ramp extend past the upstream intersection with Gold Country Boulevard. This is due to the heavy commute traffic using Hazel Avenue to access US 50. While signal timing changes along Hazel Avenue are assumed with the proposed improvements, southbound queuing on Hazel Avenue would still be expected to extend past Gold Country Boulevard.

Queuing would be expected to be a major problem at the Folsom Boulevard/ Hazel Avenue intersection under the No Build condition, due to the short distance between the off-ramp and Folsom Boulevard. The grade separation of Hazel Avenue over Folsom Boulevard, together with the construction of the Jug Handle, eliminates the excessive queues at this location. After implementation of the proposed improvements, the left and right turn queues on the Jug Handle approaches at Hazel Avenue are estimated to exceed the length of the turn pockets. However, this is not anticipated to cause operational issues because the entire length of the Jug Handle (approximately 1,300 feet) effectively provides additional storage. So while the queue is likely to spill from the turn pocket into the though lanes, queuing is not expected to spill back to the upstream intersection with Folsom Boulevard. It is recommended that the length of the northbound left turn pocket on Hazel Avenue at the Jug Handle intersection be increased to at least 350 feet. The east leg of this intersection is assumed to provide access to development. The ultimate geometrics of this westbound approach are not yet well defined, but should be designed to accommodate the estimated queues.

The westbound left queue at the Folsom Boulevard/Aerojet Road intersection exceeds storage capacity. It would not likely be feasible to implement westbound dual left turn lanes or lengthen the turn pocket, due to the right of way and existing development constraints.

Table 7-2A
Horizon Year (2042) Freeway Operations Analysis (US 50 Eastbound)

Horizon Year (2042) No Build						Horizon Year (2042) with Alternative 1/1A or Alternative 2					
Analysis Segment	Type	AM Peak Hour		PM Peak Hour		Analysis Segment	Type	AM Peak Hour		PM Peak Hour	
		LOS	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)			LOS	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)
Rancho Cordova Pkwy to Hazel Ave	Basic	**F**	**54.2**	**F**	**60.8**	Rancho Cordova Pkwy to Hazel Ave	Basic	**F**	**54.2**	**F**	**60.8**
Hazel Ave Exit	Two-Lane Diverge	**F**	**35.0**	**F**	**38.1**	Hazel Ave Exit	Two-Lane Diverge	**F**	**23.5**	**F**	**26.9**
SB Hazel Ave Loop Entrance	One-Lane Merge	D	34.1	D	33.0	SB Hazel Ave Loop Entrance	One-Lane Merge	D	32.1	D	31.4
NB Hazel Ave Slip Entrance	Weave	D	28.7	C	27.9	NB Hazel Ave Slip Entrance	Weave	C	26.2	C	26.2
Aerojet Exit						Folsom Blvd Exit					
Aerojet Rd to Folsom Blvd	Basic	E	35.7	E	35.5						
Folsom Blvd Exit	Two-Lane Diverge	**F**	**45.8**	**F**	**45.7**						
Folsom Blvd Entrance	One-Lane Merge	**F**	**41.4**	**F**	**44.4**	Folsom Blvd Entrance	One-Lane Merge	C	26.3	D	28.9
Folsom Blvd to Prairie City Rd	Basic	**F**	**56.2**	**F**	**67.7**	Folsom Blvd to Prairie City Rd	Basic	**F**	**56.2**	**F**	**67.7**

Note: **Bold** values indicate unacceptable level of service.

Table 7-2B
Horizon Year (2042) Freeway Operations Analysis (US 50 Westbound)

Horizon Year (2042) No Build						Horizon Year (2042) with Alternative 1/1A or Alternative 2					
Analysis Segment	Type	AM Peak Hour		PM Peak Hour		Analysis Segment	Type	AM Peak Hour		PM Peak Hour	
		LOS	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)			LOS	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)
Prairie City Rd to Folsom Blvd	Basic	E	41.4	**F**	**51.8**	Prairie City Rd to Folsom Blvd	Basic	E	41.4	**F**	**51.8**
Folsom Blvd Exit	One-Lane Diverge	E	44.0	**F**	**48.0**	Folsom Blvd Exit	One-Lane Diverge	E	44.0	**F**	**48.0**
Folsom Blvd Entrance	One-Lane Merge	**F**	**42.7**	**F**	**46.0**	Folsom Blvd Entrance	One-Lane Merge	**F**	**42.7**	**F**	**46.0**
Folsom Blvd to Hazel Ave	Basic	D	30.1	D	33.8	Folsom Blvd to Hazel Ave	Basic	D	30.1	D	33.8
Hazel Ave Exit	Two-Lane Diverge	B	11.5	B	13.0	Hazel Ave Exit	Two-Lane Diverge	B	11.5	B	13.0
NB Hazel Ave Loop Entrance	One-Lane Merge	D	29.4	D	32.6	NB Hazel Ave Loop Entrance	One-Lane Merge	D	29.4	D	32.6
SB Hazel Ave Slip Entrance	One-Lane Merge	**F**	**35.7**	**F**	**39.8**	SB Hazel Ave Slip Entrance	One-Lane Merge	**F**	**35.7**	**F**	**39.8**
Hazel Ave to Rancho Cordova Pkwy	Basic	E	41.8	**F**	**52.3**	Hazel Ave to Rancho Cordova Pkwy	Basic	E	41.8	**F**	**52.3**

Note: **Bold** values indicate unacceptable level of service.

Table 7-3
Horizon Year (2042) Ramp Queuing Analysis

Direction	Ramp Queue	Horizon Year (2042) No Build			Horizon Year (2042) with Alternative 1/1A			Horizon Year (2042) with Alternative 2		
		Storage Length (ft)	AM Queue (ft)	PM Queue (ft)	Storage Length (ft)	AM Queue (ft)	PM Queue (ft)	Storage Length (ft)	AM Queue (ft)	PM Queue (ft)
US 50 Eastbound	Off-Ramp to Hazel Ave	1,350	1,037	**1,753**	2,400	644	835	2,250	-	-
	Off-Ramp to Aerojet Rd	1,425	131	262	2,400	131	262	2,250	131	262
	Off-Ramp to Folsom Blvd	1,300	546	473	1,300	512	464	1,300	512	464
US 50 Westbound	Off-Ramp to Folsom Blvd	1,550	116	132	1,550	120	178	1,550	120	178
	Off-Ramp to Hazel Ave	2,030	606	577	2,030	610	694	2,030	450	1,195

Note: **Bold** values indicate queuing exceeding storage capacity.
Gray shaded cells highlight changes to storage capacity due to the project.
Queues shown represent the 95th percentile.

Table 7-4
Horizon Year (2042) Intersection Queuing Analysis

Intersection	Approach	Move-ment	Horizon Year (2042) No Build			Horizon Year (2042) Alternative 1/1A			Horizon Year (2042) Alternative 2		
			Storage Length (ft)	AM Queue (ft)	PM Queue (ft)	Storage Length (ft)	AM Queue (ft)	PM Queue (ft)	Storage Length (ft)	AM Queue (ft)	PM Queue (ft)
Hazel Avenue & US 50 WB Ramps/ Tributary Point Dr	EB	RT	275	235	**656**	275	244	**780**	275	**289**	**667**
	WB	LT	2,030	387	422	2,030	393	535	2,030	438	313
		TH									
		RT	2,030	606	577	2,030	610	694	2,030	450	1,195
	NB	LT	320	242	128	320	238	138	320	68	112
		TH	1,440	353	1,031	1,440	413	701	1,440	349	516
		RT	Free Movement			Free Movement			Free Movement		
	SB	TH	860	**1,126**	**1,070**	860	**1,119**	**1,038**	860	**1,055**	**935**
		RT	225	1	9	225	1	5	225	1	19
Hazel Avenue & US 50 EB Ramps	EB	LT	1,350	1,037	**1,753**	2,400	384	652	Intersection Does Not Exist		
		RT				2,400	644	835			
	NB	TH	Free Movement			1,200	264	816			
		RT				Free Movement					
	SB	TH	1,140	447	586	1,140	212	73			
		RT	Free Movement			Free Movement					
Hazel Avenue & Folsom Boulevard	EB	LT	350	163	**509**	Intersection Does Not Exist			Intersection Does Not Exist		
		TH	>2,500	117	1,109						
		RT									
	WB	LT	200	**257**	**604**						
		TH	2,140	535	1,587						
		RT	2,140	45	131						
	NB	LT	200	**572**	**939**						
		TH	700	**916**	**1,824**						
		RT	200	29	183						
	SB	LT	200	150	**246**						
		TH	200	**1,379**	**1,748**						
		RT	200	94	73						

Table 7-4
Horizon Year (2042) Intersection Queuing Analysis

Intersection	Approach	Move-ment	Horizon Year (2042) No Build			Horizon Year (2042) Alternative 1/1A			Horizon Year (2042) Alternative 2		
			Storage Length (ft)	AM Queue (ft)	PM Queue (ft)	Storage Length (ft)	AM Queue (ft)	PM Queue (ft)	Storage Length (ft)	AM Queue (ft)	PM Queue (ft)
Hazel Avenue & Jug Handle	EB	LT	Intersection Does Not Exist			200	**208**	**562**	200	146	**436**
		TH				1,350	108	159	1,350	87	134
		RT				200	198	**667**	200	155	**744**
	WB	LT				200	**298**	**393**	200	**217**	**315**
		TH				500	35	160	500	29	137
		RT				200	**294**	**745**	200	**232**	**790**
	NB	LT				300	262	276	300	208	**326**
		TH				>2,500	460	768	>2,500	418	542
		RT				300	44	82	300	44	65
	SB	LT				300	268	211	300	222	280
		TH				1,200	332	712	1,200	430	551
		RT				200	45	50	200	81	90
Folsom Boulevard & Jug Handle	EB	LT	Intersection Does Not Exist			200	0	30	200	0	30
		TH				>2,500	71	1,022	>2,500	71	1,022
		RT				>2,500	50	996	>2,500	50	996
	WB	LT				500	95	337	500	95	337
		TH				>2,500	119	1,003	>2,500	119	1,003
		RT									
	NB	LT				1,350	90	310	1,350	90	310
		TH				1,350	0	74	1,350	0	74
		RT									
	SB	LT				200	0	53	200	0	53
		TH									
		RT									

Table 7-4
Horizon Year (2042) Intersection Queuing Analysis

Intersection	Approach	Move-ment	Horizon Year (2042) No Build			Horizon Year (2042) Alternative 1/1A			Horizon Year (2042) Alternative 2		
			Storage Length (ft)	AM Queue (ft)	PM Queue (ft)	Storage Length (ft)	AM Queue (ft)	PM Queue (ft)	Storage Length (ft)	AM Queue (ft)	PM Queue (ft)
Folsom Boulevard & Aerojet Road	EB	TH	2,140	105	778	2,140	105	778	2,140	105	778
		RT									
	WB	LT	370	199	**530**	370	199	**530**	370	199	**530**
		TH	665	112	331	665	112	331	665	112	331
	NB	LT	415	45	239	415	45	239	415	45	239
		RT	415	19	85	415	19	85	415	19	85
	SB	LT	1,425	131	262	2,400	131	262	2,250	131	262
		TH									
		RT									

Note: **Bold** values indicate queuing exceeding storage capacity.
Gray shaded cells highlight changes to storage capacity due to the project.
Queues shown represent the 95th percentile.

Appendix A: Synchro Calculations

This appendix contains Synchro calculation sheets used to conduct intersection capacity analysis:

Appendix A-1: Existing (2015) No Build Scenario

Appendix A-2: Existing (2015) with Alternative 1/1A Scenario

Appendix A-3: Existing (2015) with Alternative 2 Scenario

Appendix A-4: Opening Year (2022) No Build Scenario

Appendix A-5: Opening Year (2022) with Alternative 1/1A Scenario

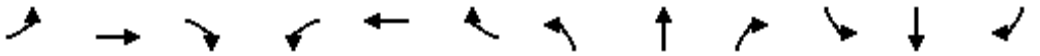
Appendix A-6: Opening Year (2022) with Alternative 2 Scenario

Appendix A-7: Horizon Year (2042) No Build Scenario

Appendix A-8: Horizon Year (2042) with Alternative 1/1A Scenario

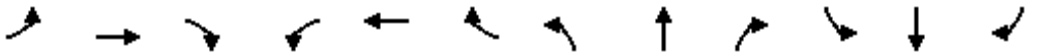
Appendix A-9: Horizon Year (2042) with Alternative 2 Scenario

Appendix A1
Existing (2015) No Build
Synchro Calculations



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	350	75	139	425	366	748	0	0	3017	166
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)			4.6		6.2	6.2	4.6	5.0			5.3	5.3
Lane Util. Factor			1.00		1.00	0.88	0.97	0.91			0.86	1.00
Frpb, ped/bikes			1.00		1.00	1.00	1.00	1.00			1.00	0.98
Flpb, ped/bikes			1.00		1.00	1.00	1.00	1.00			1.00	1.00
Frt			0.86		1.00	0.85	1.00	1.00			1.00	0.85
Flt Protected			1.00		0.98	1.00	0.95	1.00			1.00	1.00
Satd. Flow (prot)			1611		1831	2787	3433	5085			6408	1559
Flt Permitted			1.00		0.98	1.00	0.95	1.00			1.00	1.00
Satd. Flow (perm)			1611		1831	2787	3433	5085			6408	1559
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	0	0	365	78	145	443	381	779	0	0	3143	173
RTOR Reduction (vph)	0	0	159	0	0	380	0	0	0	0	0	34
Lane Group Flow (vph)	0	0	206	0	223	63	381	779	0	0	3143	139
Confl. Peds. (#/hr)												1
Confl. Bikes (#/hr)												2
Turn Type			Over	Split	NA	Perm	Prot	NA			NA	Perm
Protected Phases			1	4	4		1	6			2	
Permitted Phases						4						2
Actuated Green, G (s)			23.5		21.5	21.5	23.5	117.3			88.9	88.9
Effective Green, g (s)			23.5		21.5	21.5	23.5	117.3			88.9	88.9
Actuated g/C Ratio			0.16		0.14	0.14	0.16	0.78			0.59	0.59
Clearance Time (s)			4.6		6.2	6.2	4.6	5.0			5.3	5.3
Vehicle Extension (s)			1.0		1.0	1.0	1.0	1.0			1.0	1.0
Lane Grp Cap (vph)			252		262	399	537	3976			3797	923
v/s Ratio Prot			c0.13		c0.12		0.11	0.15			c0.49	
v/s Ratio Perm						0.02						0.09
v/c Ratio			0.82		0.85	0.16	0.71	0.20			0.83	0.15
Uniform Delay, d1			61.2		62.7	56.3	60.0	4.2			24.4	13.7
Progression Factor			1.00		1.00	1.00	1.15	1.65			0.87	0.58
Incremental Delay, d2			17.5		21.7	0.1	3.2	0.1			1.5	0.2
Delay (s)			78.7		84.4	56.4	72.2	7.1			22.8	8.2
Level of Service			E		F	E	E	A			C	A
Approach Delay (s)		78.7			65.8			28.5			22.0	
Approach LOS		E			E			C			C	

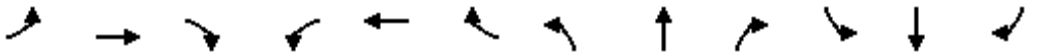
Intersection Summary			
HCM 2000 Control Delay	32.4	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.83		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	16.1
Intersection Capacity Utilization	90.3%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	892	0	138	0	0	0	0	511	97	0	996	896
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.5	3.5	3.5					4.7			4.7	4.7
Lane Util. Factor	0.95	0.91	0.95					0.95			0.95	1.00
Frpb, ped/bikes	1.00	1.00	1.00					1.00			1.00	0.98
Flpb, ped/bikes	1.00	1.00	1.00					1.00			1.00	1.00
Frt	1.00	1.00	0.85					0.98			1.00	0.85
Flt Protected	0.95	0.95	1.00					1.00			1.00	1.00
Satd. Flow (prot)	1681	1610	1504					3455			3539	1551
Flt Permitted	0.95	0.95	1.00					1.00			1.00	1.00
Satd. Flow (perm)	1681	1610	1504					3455			3539	1551
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	920	0	142	0	0	0	0	527	100	0	1027	924
RTOR Reduction (vph)	0	0	21	0	0	0	0	0	0	0	0	445
Lane Group Flow (vph)	460	460	121	0	0	0	0	627	0	0	1027	479
Confl. Bikes (#/hr)												1
Turn Type	Split	NA	Perm					NA			NA	Perm
Protected Phases	8!	8!						6 8!			2	
Permitted Phases			8									2
Actuated Green, G (s)	27.9	27.9	27.9					75.0			38.9	38.9
Effective Green, g (s)	27.9	27.9	27.9					71.5			38.9	38.9
Actuated g/C Ratio	0.37	0.37	0.37					0.95			0.52	0.52
Clearance Time (s)	3.5	3.5	3.5								4.7	4.7
Vehicle Extension (s)	1.5	1.5	1.5								1.0	1.0
Lane Grp Cap (vph)	625	598	559					3293			1835	804
v/s Ratio Prot	0.27	c0.29						0.18			0.29	
v/s Ratio Perm			0.08									c0.31
v/c Ratio	0.74	0.77	0.22					0.19			0.56	0.60
Uniform Delay, d1	20.4	20.7	16.1					0.1			12.2	12.6
Progression Factor	1.00	1.00	1.00					1.00			1.24	11.94
Incremental Delay, d2	3.9	5.3	0.1					0.0			0.7	1.8
Delay (s)	24.3	26.1	16.2					0.1			15.8	152.0
Level of Service	C	C	B					A			B	F
Approach Delay (s)		24.0			0.0			0.1			80.3	
Approach LOS		C			A			A			F	

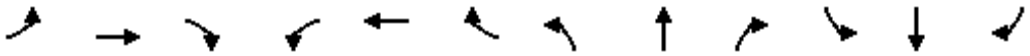
Intersection Summary			
HCM 2000 Control Delay	50.1	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.67		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	8.2
Intersection Capacity Utilization	60.9%	ICU Level of Service	B
Analysis Period (min)	15		

! Phase conflict between lane groups.
c Critical Lane Group



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	158	164	24	18	522	400	13	50	3	301	173	660
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.5	5.0		4.1	5.0	5.0	5.5	5.5		5.5	5.5	5.5
Lane Util. Factor	0.97	0.95		1.00	1.00	1.00	1.00	1.00		0.91	0.86	0.91
Frpb, ped/bikes	1.00	1.00		1.00	1.00	0.99	1.00	1.00		1.00	0.99	0.99
Flpb, ped/bikes	1.00	1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Frt	1.00	0.98		1.00	1.00	0.85	1.00	0.99		1.00	0.92	0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00		0.95	0.99	1.00
Satd. Flow (prot)	3433	3472		1770	1863	1563	1770	1846		1610	2913	1420
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.95	1.00		0.95	0.99	1.00
Satd. Flow (perm)	3433	3472		1770	1863	1563	1770	1846		1610	2913	1420
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	165	171	25	19	544	417	14	52	3	314	180	688
RTOR Reduction (vph)	0	6	0	0	0	130	0	2	0	0	117	339
Lane Group Flow (vph)	165	191	0	19	544	287	14	53	0	235	417	74
Confl. Peds. (#/hr)						1			1			1
Confl. Bikes (#/hr)												1
Turn Type	Prot	NA		Prot	NA	Perm	Split	NA		Split	NA	Perm
Protected Phases	1	6		5	2		3	3		4	4	
Permitted Phases						2						4
Actuated Green, G (s)	8.8	57.2		2.1	49.1	49.1	7.3	7.3		18.9	18.9	18.9
Effective Green, g (s)	8.8	57.2		2.1	49.1	49.1	7.3	7.3		18.9	18.9	18.9
Actuated g/C Ratio	0.08	0.54		0.02	0.46	0.46	0.07	0.07		0.18	0.18	0.18
Clearance Time (s)	5.5	5.0		4.1	5.0	5.0	5.5	5.5		5.5	5.5	5.5
Vehicle Extension (s)	1.0	1.0		1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0
Lane Grp Cap (vph)	286	1880		35	866	726	122	127		288	521	254
v/s Ratio Prot	c0.05	0.05		0.01	c0.29		0.01	c0.03		c0.15	0.14	
v/s Ratio Perm						0.18						0.05
v/c Ratio	0.58	0.10		0.54	0.63	0.40	0.11	0.42		0.82	0.80	0.29
Uniform Delay, d1	46.6	11.7		51.3	21.4	18.5	46.1	47.1		41.7	41.5	37.5
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	1.8	0.0		8.9	1.0	0.1	0.2	0.8		15.4	7.9	0.2
Delay (s)	48.4	11.7		60.2	22.4	18.6	46.3	47.9		57.1	49.4	37.8
Level of Service	D	B		E	C	B	D	D		E	D	D
Approach Delay (s)		28.5			21.5			47.6			46.9	
Approach LOS		C			C			D			D	

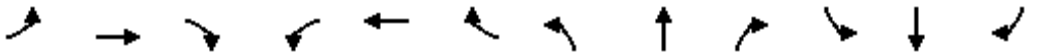
Intersection Summary			
HCM 2000 Control Delay	34.7	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	105.6	Sum of lost time (s)	21.5
Intersection Capacity Utilization	72.0%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	278	169	236	775	0	20	0	19	95	172	9
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.8		3.8	5.4		5.5		5.5		5.5	
Lane Util. Factor		0.95		1.00	0.95		1.00		1.00		0.95	
Frpb, ped/bikes		1.00		1.00	1.00		1.00		1.00		1.00	
Flpb, ped/bikes		1.00		1.00	1.00		1.00		1.00		1.00	
Frt		0.94		1.00	1.00		1.00		0.85		0.99	
Flt Protected		1.00		0.95	1.00		0.95		1.00		0.98	
Satd. Flow (prot)		3322		1770	3539		1770		1583		3462	
Flt Permitted		1.00		0.95	1.00		0.95		1.00		0.98	
Satd. Flow (perm)		3322		1770	3539		1770		1583		3462	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	296	180	251	824	0	21	0	20	101	183	10
RTOR Reduction (vph)	0	55	0	0	0	0	0	0	19	0	2	0
Lane Group Flow (vph)	0	421	0	251	824	0	21	0	1	0	292	0
Confl. Bikes (#/hr)			1						2			
Turn Type		NA		Prot	NA		Prot		Prot	Split	NA	
Protected Phases		6		5	2		3 8		3	4	4	
Permitted Phases												
Actuated Green, G (s)		14.0		22.3	39.5		4.2		2.3		10.7	
Effective Green, g (s)		14.0		22.3	39.5		4.2		2.3		10.7	
Actuated g/C Ratio		0.19		0.30	0.53		0.06		0.03		0.14	
Clearance Time (s)		4.8		3.8	5.4				5.5		5.5	
Vehicle Extension (s)		1.0		1.0	1.0				1.0		1.0	
Lane Grp Cap (vph)		625		531	1881		100		49		498	
v/s Ratio Prot		c0.13		c0.14	0.23		c0.01		0.00		c0.08	
v/s Ratio Perm												
v/c Ratio		0.67		0.47	0.44		0.21		0.01		0.59	
Uniform Delay, d1		28.0		21.2	10.6		33.5		34.9		29.7	
Progression Factor		1.00		1.00	1.00		1.00		1.00		1.00	
Incremental Delay, d2		2.3		0.2	0.1		0.4		0.0		1.1	
Delay (s)		30.3		21.4	10.7		33.8		34.9		30.9	
Level of Service		C		C	B		C		C		C	
Approach Delay (s)		30.3			13.2			34.4			30.9	
Approach LOS		C			B			C			C	

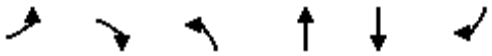
Intersection Summary			
HCM 2000 Control Delay	20.7	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.53		
Actuated Cycle Length (s)	74.3	Sum of lost time (s)	23.1
Intersection Capacity Utilization	52.6%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	21	197	108	131	1008	60	28	2	14	14	3	8
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.9		4.9	5.0			4.9	4.9		4.8	4.8
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00	1.00		1.00	1.00
Frt	1.00	0.95		1.00	0.99			1.00	0.85		1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00			0.96	1.00		0.96	1.00
Satd. Flow (prot)	1770	3351		1770	3509			1779	1583		1788	1583
Flt Permitted	0.95	1.00		0.95	1.00			0.96	1.00		0.96	1.00
Satd. Flow (perm)	1770	3351		1770	3509			1779	1583		1788	1583
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	23	216	119	144	1108	66	31	2	15	15	3	9
RTOR Reduction (vph)	0	36	0	0	2	0	0	0	14	0	0	9
Lane Group Flow (vph)	23	299	0	144	1172	0	0	33	1	0	18	0
Turn Type	Prot	NA		Prot	NA		Split	NA	Perm	Split	NA	Perm
Protected Phases	1	6		5	2		4	4		3	3	
Permitted Phases									4			3
Actuated Green, G (s)	1.7	32.2		11.8	42.6			3.4	3.4		2.5	2.5
Effective Green, g (s)	1.7	32.2		11.8	42.6			3.4	3.4		2.5	2.5
Actuated g/C Ratio	0.02	0.46		0.17	0.61			0.05	0.05		0.04	0.04
Clearance Time (s)	4.5	4.9		4.9	5.0			4.9	4.9		4.8	4.8
Vehicle Extension (s)	1.0	5.8		1.0	4.9			2.0	2.0		1.0	1.0
Lane Grp Cap (vph)	43	1554		300	2153			87	77		64	57
v/s Ratio Prot	0.01	0.09		c0.08	c0.33			c0.02			c0.01	
v/s Ratio Perm									0.00			0.00
v/c Ratio	0.53	0.19		0.48	0.54			0.38	0.01		0.28	0.01
Uniform Delay, d1	33.5	10.9		26.0	7.8			32.0	31.4		32.6	32.3
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00		1.00	1.00
Incremental Delay, d2	6.3	0.2		0.4	0.5			1.0	0.0		0.9	0.0
Delay (s)	39.7	11.1		26.5	8.3			33.0	31.4		33.5	32.3
Level of Service	D	B		C	A			C	C		C	C
Approach Delay (s)		12.9			10.2			32.5			33.1	
Approach LOS		B			B			C			C	

Intersection Summary			
HCM 2000 Control Delay	11.8	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.54		
Actuated Cycle Length (s)	69.4	Sum of lost time (s)	19.5
Intersection Capacity Utilization	53.4%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	76	234	6	1549	1138	1314
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.6	4.6	3.5	5.3	5.3	5.3
Lane Util. Factor	0.97	0.91	1.00	0.91	0.91	1.00
Frt	0.91	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.98	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	3221	1441	1770	5085	5085	1583
Flt Permitted	0.98	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	3221	1441	1770	5085	5085	1583
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	85	263	7	1740	1279	1476
RTOR Reduction (vph)	118	117	0	0	0	365
Lane Group Flow (vph)	99	14	7	1740	1279	1111
Turn Type	Prot	Perm	Prot	NA	NA	Perm
Protected Phases	4		5	2	6	
Permitted Phases		4				6
Actuated Green, G (s)	6.7	6.7	1.0	45.2	40.7	40.7
Effective Green, g (s)	6.7	6.7	1.0	45.2	40.7	40.7
Actuated g/C Ratio	0.11	0.11	0.02	0.73	0.66	0.66
Clearance Time (s)	4.6	4.6	3.5	5.3	5.3	5.3
Vehicle Extension (s)	2.0	2.0	1.5	2.2	2.2	2.2
Lane Grp Cap (vph)	349	156	28	3719	3348	1042
v/s Ratio Prot	c0.03		0.00	c0.34	0.25	
v/s Ratio Perm		0.01				c0.70
v/c Ratio	0.28	0.09	0.25	0.47	0.38	1.07
Uniform Delay, d1	25.3	24.8	30.0	3.4	4.8	10.5
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.2	0.1	1.7	0.0	0.0	47.2
Delay (s)	25.5	24.9	31.7	3.4	4.9	57.8
Level of Service	C	C	C	A	A	E
Approach Delay (s)	25.3			3.6	33.2	
Approach LOS	C			A	C	

Intersection Summary			
HCM 2000 Control Delay	21.9	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.95		
Actuated Cycle Length (s)	61.8	Sum of lost time (s)	13.4
Intersection Capacity Utilization	94.1%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	172	7	209	8	1	3	133	1032	8	2	2966	286
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		0.98	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1900	1863	1863	1863	1863	1863	1900
Adj Flow Rate, veh/h	177	7	215	8	1	3	137	1064	8	2	3058	295
Adj No. of Lanes	2	1	1	1	1	0	2	3	1	1	4	0
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	224	284	240	10	37	111	180	3521	1096	3	3852	363
Arrive On Green	0.07	0.15	0.15	0.01	0.09	0.09	0.10	1.00	1.00	0.00	0.64	0.64
Sat Flow, veh/h	3442	1863	1577	1774	406	1218	3442	5085	1583	1774	6003	566
Grp Volume(v), veh/h	177	7	215	8	0	4	137	1064	8	2	2434	919
Grp Sat Flow(s),veh/h/ln	1721	1863	1577	1774	0	1623	1721	1695	1583	1774	1602	1763
Q Serve(g_s), s	7.6	0.5	20.1	0.7	0.0	0.3	5.8	0.0	0.0	0.2	55.2	58.5
Cycle Q Clear(g_c), s	7.6	0.5	20.1	0.7	0.0	0.3	5.8	0.0	0.0	0.2	55.2	58.5
Prop In Lane	1.00		1.00	1.00		0.75	1.00		1.00	1.00		0.32
Lane Grp Cap(c), veh/h	224	284	240	10	0	149	180	3521	1096	3	3084	1131
V/C Ratio(X)	0.79	0.02	0.90	0.80	0.00	0.03	0.76	0.30	0.01	0.70	0.79	0.81
Avail Cap(c_a), veh/h	493	524	444	221	0	423	287	3521	1096	148	3084	1131
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	0.00	1.00	0.95	0.95	0.95	1.00	1.00	1.00
Uniform Delay (d), s/veh	69.1	54.1	62.4	74.5	0.0	62.1	66.2	0.0	0.0	74.8	19.5	20.1
Incr Delay (d2), s/veh	2.4	0.0	4.7	39.1	0.0	0.0	2.4	0.2	0.0	76.8	2.1	6.4
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	3.7	0.2	9.0	0.4	0.0	0.2	2.8	0.1	0.0	0.1	24.7	30.3
LnGrp Delay(d),s/veh	71.5	54.1	67.1	113.6	0.0	62.1	68.6	0.2	0.0	151.7	21.6	26.5
LnGrp LOS	E	D	E	F		E	E	A	A	F	C	C
Approach Vol, veh/h		399			12			1209			3355	
Approach Delay, s/veh		68.8			96.4			8.0			23.1	
Approach LOS		E			F			A			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	13.3	101.8	15.3	19.6	5.7	109.4	6.2	28.7
Change Period (Y+Rc), s	5.5	* 5.5	5.5	5.9	5.5	* 5.5	* 5.3	* 5.9
Max Green Setting (Gmax), s	12.5	* 55	21.5	39.1	12.5	* 55	* 19	* 42
Max Q Clear Time (g_c+I1), s	7.8	60.5	9.6	2.3	2.2	2.0	2.7	22.1
Green Ext Time (p_c), s	0.1	0.0	0.2	0.3	0.0	11.1	0.0	0.2

Intersection Summary	
HCM 2010 Ctrl Delay	23.2
HCM 2010 LOS	C

Notes

* HCM 2010 computational engine requires equal clearance times for the phases crossing the barrier.



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	1344	42	19	211	1216	156
Number	7	14	5	2	6	16
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	1600	0	23	251	1448	0
Adj No. of Lanes	3	1	1	2	2	1
Peak Hour Factor	0.84	0.84	0.84	0.84	0.84	0.84
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	1836	581	36	1784	1551	694
Arrive On Green	0.37	0.00	0.02	0.50	0.44	0.00
Sat Flow, veh/h	5003	1583	1774	3632	3632	1583
Grp Volume(v), veh/h	1600	0	23	251	1448	0
Grp Sat Flow(s),veh/h/ln	1668	1583	1774	1770	1770	1583
Q Serve(g_s), s	22.8	0.0	1.0	2.9	29.8	0.0
Cycle Q Clear(g_c), s	22.8	0.0	1.0	2.9	29.8	0.0
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	1836	581	36	1784	1551	694
V/C Ratio(X)	0.87	0.00	0.64	0.14	0.93	0.00
Avail Cap(c_a), veh/h	2308	730	497	1784	1601	716
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	22.6	0.0	37.3	10.2	20.5	0.0
Incr Delay (d2), s/veh	2.8	0.0	6.9	0.0	10.1	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	10.8	0.0	0.5	1.4	16.7	0.0
LnGrp Delay(d),s/veh	25.4	0.0	44.2	10.2	30.6	0.0
LnGrp LOS	C		D	B	C	
Approach Vol, veh/h	1600			274	1448	
Approach Delay, s/veh	25.4			13.0	30.6	
Approach LOS	C			B	C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		
Phs Duration (G+Y+Rc), s		44.0		32.8	5.1	38.9		
Change Period (Y+Rc), s		5.3		4.6	3.5	5.3		
Max Green Setting (Gmax), s		34.7		35.4	21.5	34.7		
Max Q Clear Time (g_c+I1), s		4.9		24.8	3.0	31.8		
Green Ext Time (p_c), s		9.9		3.3	0.0	1.8		

Intersection Summary	
HCM 2010 Ctrl Delay	26.6
HCM 2010 LOS	C

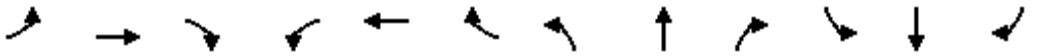
Intersection	
Int Delay, s/veh	1

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	75	317	976	27	9	22
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	175	-	-	-	0	0
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	97	97	97	97	97	97
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	77	327	1006	28	9	23

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	1034	0	-	0	1338	517
Stage 1	-	-	-	-	1020	-
Stage 2	-	-	-	-	318	-
Critical Hdwy	4.14	-	-	-	6.84	6.94
Critical Hdwy Stg 1	-	-	-	-	5.84	-
Critical Hdwy Stg 2	-	-	-	-	5.84	-
Follow-up Hdwy	2.22	-	-	-	3.52	3.32
Pot Cap-1 Maneuver	668	-	-	-	144	503
Stage 1	-	-	-	-	309	-
Stage 2	-	-	-	-	710	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	668	-	-	-	127	503
Mov Cap-2 Maneuver	-	-	-	-	127	-
Stage 1	-	-	-	-	309	-
Stage 2	-	-	-	-	628	-

Approach	EB	WB	SB
HCM Control Delay, s	2.1	0	19.2
HCM LOS			C

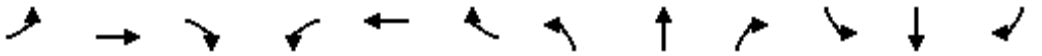
Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	668	-	-	-	127	503
HCM Lane V/C Ratio	0.116	-	-	-	0.073	0.045
HCM Control Delay (s)	11.1	-	-	-	35.6	12.5
HCM Lane LOS	B	-	-	-	E	B
HCM 95th %tile Q(veh)	0.4	-	-	-	0.2	0.1



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	423	43	297	652	241	2141	0	0	1536	67
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)			4.6		6.2	6.2	4.6	5.0			5.3	5.3
Lane Util. Factor			1.00		1.00	0.88	0.97	0.91			0.86	1.00
Frpb, ped/bikes			1.00		1.00	1.00	1.00	1.00			1.00	0.99
Flpb, ped/bikes			1.00		1.00	1.00	1.00	1.00			1.00	1.00
Frt			0.86		1.00	0.85	1.00	1.00			1.00	0.85
Flt Protected			1.00		0.99	1.00	0.95	1.00			1.00	1.00
Satd. Flow (prot)			1611		1851	2787	3433	5085			6408	1564
Flt Permitted			1.00		0.99	1.00	0.95	1.00			1.00	1.00
Satd. Flow (perm)			1611		1851	2787	3433	5085			6408	1564
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	445	45	313	686	254	2254	0	0	1617	71
RTOR Reduction (vph)	0	0	251	0	0	42	0	0	0	0	0	31
Lane Group Flow (vph)	0	0	194	0	358	644	254	2254	0	0	1617	40
Confl. Bikes (#/hr)												1
Turn Type			Over	Split	NA	Perm	Prot	NA			NA	Perm
Protected Phases			1	4	4		1	6			2	
Permitted Phases						4						2
Actuated Green, G (s)			20.9		30.2	30.2	20.9	98.6			72.8	72.8
Effective Green, g (s)			20.9		30.2	30.2	20.9	98.6			72.8	72.8
Actuated g/C Ratio			0.15		0.22	0.22	0.15	0.70			0.52	0.52
Clearance Time (s)			4.6		6.2	6.2	4.6	5.0			5.3	5.3
Vehicle Extension (s)			1.0		1.0	1.0	1.0	1.0			1.0	1.0
Lane Grp Cap (vph)			240		399	601	512	3581			3332	813
v/s Ratio Prot			c0.12		0.19		0.07	c0.44			0.25	
v/s Ratio Perm						c0.23						0.03
v/c Ratio			0.81		0.90	1.07	0.50	0.63			0.49	0.05
Uniform Delay, d1			57.6		53.4	54.9	54.7	11.0			21.6	16.5
Progression Factor			1.00		1.00	1.00	1.00	0.79			0.90	1.20
Incremental Delay, d2			16.9		21.5	57.2	0.2	0.7			0.5	0.1
Delay (s)			74.6		74.9	112.1	55.0	9.4			19.8	19.9
Level of Service			E		E	F	D	A			B	B
Approach Delay (s)		74.6			99.3			14.0			19.8	
Approach LOS		E			F			B			B	

Intersection Summary			
HCM 2000 Control Delay	36.1	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	16.1
Intersection Capacity Utilization	79.9%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	1505	0	104	0	0	0	0	1230	173	0	302	831
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.5	3.5	3.5					4.7			4.7	4.7
Lane Util. Factor	0.95	0.91	0.95					0.95			0.95	1.00
Frpb, ped/bikes	1.00	1.00	1.00					1.00			1.00	0.98
Flpb, ped/bikes	1.00	1.00	1.00					1.00			1.00	1.00
Frt	1.00	1.00	0.85					0.98			1.00	0.85
Flt Protected	0.95	0.95	1.00					1.00			1.00	1.00
Satd. Flow (prot)	1681	1610	1504					3474			3539	1550
Flt Permitted	0.95	0.95	1.00					1.00			1.00	1.00
Satd. Flow (perm)	1681	1610	1504					3474			3539	1550
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	1618	0	112	0	0	0	0	1323	186	0	325	894
RTOR Reduction (vph)	0	0	41	0	0	0	0	0	0	0	0	622
Lane Group Flow (vph)	809	809	71	0	0	0	0	1509	0	0	325	272
Confl. Bikes (#/hr)												1
Turn Type	Split	NA	Perm					NA			NA	Perm
Protected Phases	8!	8!						6 8!			2	
Permitted Phases			8									2
Actuated Green, G (s)	89.2	89.2	89.2					140.0			42.6	42.6
Effective Green, g (s)	89.2	89.2	89.2					136.5			42.6	42.6
Actuated g/C Ratio	0.64	0.64	0.64					0.98			0.30	0.30
Clearance Time (s)	3.5	3.5	3.5								4.7	4.7
Vehicle Extension (s)	1.5	1.5	1.5								1.0	1.0
Lane Grp Cap (vph)	1071	1025	958					3387			1076	471
v/s Ratio Prot	0.48	c0.50						0.43			0.09	
v/s Ratio Perm			0.05									c0.18
v/c Ratio	0.76	0.79	0.07					0.45			0.30	0.58
Uniform Delay, d1	17.8	18.5	9.7					0.1			37.3	41.1
Progression Factor	1.00	1.00	1.00					1.00			0.71	4.43
Incremental Delay, d2	2.7	3.8	0.0					0.0			0.6	4.4
Delay (s)	20.5	22.3	9.7					0.1			27.0	186.4
Level of Service	C	C	A					A			C	F
Approach Delay (s)		20.7			0.0			0.1			143.9	
Approach LOS		C			A			A			F	

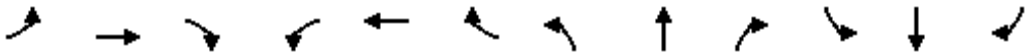
Intersection Summary			
HCM 2000 Control Delay	47.4	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.2
Intersection Capacity Utilization	89.5%	ICU Level of Service	E
Analysis Period (min)	15		

! Phase conflict between lane groups.

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	647	660	5	2	314	597	27	159	31	204	3	199
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.5	5.0		4.1	5.0	5.0	5.5	5.5		5.5	5.5	5.5
Lane Util. Factor	0.97	0.95		1.00	1.00	1.00	1.00	1.00		0.91	0.86	0.91
Frpb, ped/bikes	1.00	1.00		1.00	1.00	0.98	1.00	1.00		1.00	0.99	0.99
Flpb, ped/bikes	1.00	1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Frt	1.00	1.00		1.00	1.00	0.85	1.00	0.98		1.00	0.91	0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00		0.95	0.98	1.00
Satd. Flow (prot)	3433	3535		1770	1863	1547	1770	1817		1610	2838	1421
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.95	1.00		0.95	0.98	1.00
Satd. Flow (perm)	3433	3535		1770	1863	1547	1770	1817		1610	2838	1421
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	711	725	5	2	345	656	30	175	34	224	3	219
RTOR Reduction (vph)	0	0	0	0	0	376	0	4	0	0	76	113
Lane Group Flow (vph)	711	730	0	2	345	280	30	205	0	168	71	18
Confl. Peds. (#/hr)						9						
Confl. Bikes (#/hr)			3									1
Turn Type	Prot	NA		Prot	NA	Perm	Split	NA		Split	NA	Perm
Protected Phases	1	6		5	2		3	3		4	4	
Permitted Phases						2						4
Actuated Green, G (s)	33.9	65.5		0.6	30.8	30.8	17.7	17.7		16.7	16.7	16.7
Effective Green, g (s)	33.9	65.5		0.6	30.8	30.8	17.7	17.7		16.7	16.7	16.7
Actuated g/C Ratio	0.28	0.54		0.00	0.26	0.26	0.15	0.15		0.14	0.14	0.14
Clearance Time (s)	5.5	5.0		4.1	5.0	5.0	5.5	5.5		5.5	5.5	5.5
Vehicle Extension (s)	1.0	1.0		1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0
Lane Grp Cap (vph)	964	1919		8	475	395	259	266		222	392	196
v/s Ratio Prot	c0.21	0.21		0.00	c0.19		0.02	c0.11		c0.10	0.03	
v/s Ratio Perm						0.18						0.01
v/c Ratio	0.74	0.38		0.25	0.73	0.71	0.12	0.77		0.76	0.18	0.09
Uniform Delay, d1	39.3	15.9		59.8	41.0	40.8	44.7	49.5		50.0	45.9	45.3
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	2.6	0.0		5.9	4.7	4.7	0.1	11.4		12.3	0.1	0.1
Delay (s)	41.9	15.9		65.7	45.7	45.5	44.7	60.9		62.2	46.0	45.4
Level of Service	D	B		E	D	D	D	E		E	D	D
Approach Delay (s)		28.7			45.6			58.9			51.9	
Approach LOS		C			D			E			D	

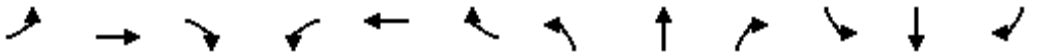
Intersection Summary			
HCM 2000 Control Delay	39.8	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	120.6	Sum of lost time (s)	21.5
Intersection Capacity Utilization	79.5%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	747	18	30	502	0	366	0	247	35	10	29
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.8		3.8	5.4		5.5		5.5		5.5	
Lane Util. Factor		0.95		1.00	0.95		1.00		1.00		0.95	
Frpb, ped/bikes		1.00		1.00	1.00		1.00		1.00		1.00	
Flpb, ped/bikes		1.00		1.00	1.00		1.00		1.00		1.00	
Frt		1.00		1.00	1.00		1.00		0.85		0.94	
Flt Protected		1.00		0.95	1.00		0.95		1.00		0.98	
Satd. Flow (prot)		3526		1770	3539		1770		1583		3255	
Flt Permitted		1.00		0.95	1.00		0.95		1.00		0.98	
Satd. Flow (perm)		3526		1770	3539		1770		1583		3255	
Peak-hour factor, PHF	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Adj. Flow (vph)	0	879	21	35	591	0	431	0	291	41	12	34
RTOR Reduction (vph)	0	1	0	0	0	0	0	0	126	0	32	0
Lane Group Flow (vph)	0	899	0	35	591	0	431	0	165	0	55	0
Confl. Bikes (#/hr)			1						4			
Turn Type		NA		Prot	NA		Prot		Prot	Split	NA	
Protected Phases		6		5	2		3 8		3	4	4	
Permitted Phases												
Actuated Green, G (s)		34.7		5.1	43.0		39.6		24.0		5.8	
Effective Green, g (s)		34.7		5.1	43.0		39.6		24.0		5.8	
Actuated g/C Ratio		0.32		0.05	0.40		0.37		0.22		0.05	
Clearance Time (s)		4.8		3.8	5.4				5.5		5.5	
Vehicle Extension (s)		1.0		1.0	1.0				1.0		1.0	
Lane Grp Cap (vph)		1129		83	1405		647		350		174	
v/s Ratio Prot		c0.26		0.02	c0.17		c0.24		0.10		c0.02	
v/s Ratio Perm												
v/c Ratio		0.80		0.42	0.42		0.67		0.47		0.32	
Uniform Delay, d1		33.6		50.2	23.6		28.8		36.6		49.3	
Progression Factor		1.00		1.00	1.00		1.00		1.00		1.00	
Incremental Delay, d2		3.7		1.3	0.1		2.0		0.4		0.4	
Delay (s)		37.3		51.4	23.7		30.8		37.0		49.7	
Level of Service		D		D	C		C		D		D	
Approach Delay (s)		37.3			25.3			33.3			49.7	
Approach LOS		D			C			C			D	

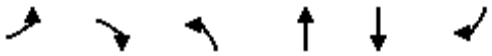
Intersection Summary			
HCM 2000 Control Delay	33.3	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	108.3	Sum of lost time (s)	23.1
Intersection Capacity Utilization	59.7%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	9	994	22	20	344	23	98	1	125	49	0	46
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.9		4.9	5.0			4.9	4.9		4.8	4.8
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00	1.00		1.00	1.00
Frt	1.00	1.00		1.00	0.99			1.00	0.85		1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00			0.95	1.00		0.95	1.00
Satd. Flow (prot)	1770	3528		1770	3506			1775	1583		1770	1583
Flt Permitted	0.95	1.00		0.95	1.00			0.95	1.00		0.95	1.00
Satd. Flow (perm)	1770	3528		1770	3506			1775	1583		1770	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	10	1080	24	22	374	25	107	1	136	53	0	50
RTOR Reduction (vph)	0	0	0	0	2	0	0	0	118	0	0	47
Lane Group Flow (vph)	10	1104	0	22	397	0	0	108	18	0	53	3
Turn Type	Prot	NA		Prot	NA		Split	NA	Perm	Split	NA	Perm
Protected Phases	1	6		5	2		4	4		3	3	
Permitted Phases									4			3
Actuated Green, G (s)	0.7	45.1		1.9	46.6			11.0	11.0		5.5	5.5
Effective Green, g (s)	0.7	45.1		1.9	46.6			11.0	11.0		5.5	5.5
Actuated g/C Ratio	0.01	0.54		0.02	0.56			0.13	0.13		0.07	0.07
Clearance Time (s)	4.5	4.9		4.9	5.0			4.9	4.9		4.8	4.8
Vehicle Extension (s)	1.0	5.8		1.0	4.9			2.0	2.0		1.0	1.0
Lane Grp Cap (vph)	14	1917		40	1968			235	209		117	104
v/s Ratio Prot	0.01	c0.31		c0.01	0.11			c0.06			c0.03	
v/s Ratio Perm									0.01			0.00
v/c Ratio	0.71	0.58		0.55	0.20			0.46	0.09		0.45	0.03
Uniform Delay, d1	41.1	12.6		40.1	9.0			33.3	31.6		37.3	36.3
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00		1.00	1.00
Incremental Delay, d2	87.8	0.8		9.0	0.1			0.5	0.1		1.0	0.0
Delay (s)	128.9	13.4		49.1	9.1			33.8	31.7		38.3	36.3
Level of Service	F	B		D	A			C	C		D	D
Approach Delay (s)		14.4			11.2			32.6			37.3	
Approach LOS		B			B			C			D	

Intersection Summary			
HCM 2000 Control Delay	17.3	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.54		
Actuated Cycle Length (s)	83.0	Sum of lost time (s)	19.5
Intersection Capacity Utilization	51.4%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	141	97	42	2229	409	1421
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.6	4.6	3.5	5.3	5.3	5.3
Lane Util. Factor	0.97	0.91	1.00	0.91	0.91	1.00
Frt	0.98	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.96	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	3394	1441	1770	5085	5085	1583
Flt Permitted	0.96	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	3394	1441	1770	5085	5085	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	148	102	44	2346	431	1496
RTOR Reduction (vph)	20	69	0	0	0	486
Lane Group Flow (vph)	151	10	44	2346	431	1010
Turn Type	Prot	Perm	Prot	NA	NA	Perm
Protected Phases	4		5	2	6	
Permitted Phases		4				6
Actuated Green, G (s)	5.4	5.4	2.2	27.1	21.4	21.4
Effective Green, g (s)	5.4	5.4	2.2	27.1	21.4	21.4
Actuated g/C Ratio	0.13	0.13	0.05	0.64	0.50	0.50
Clearance Time (s)	4.6	4.6	3.5	5.3	5.3	5.3
Vehicle Extension (s)	2.0	2.0	1.5	2.2	2.2	2.2
Lane Grp Cap (vph)	432	183	91	3250	2566	798
v/s Ratio Prot	c0.04		0.02	c0.46	0.08	
v/s Ratio Perm		0.01				c0.64
v/c Ratio	0.35	0.05	0.48	0.72	0.17	1.27
Uniform Delay, d1	16.9	16.3	19.5	5.1	5.7	10.5
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.2	0.0	1.5	0.7	0.0	129.5
Delay (s)	17.1	16.3	21.0	5.8	5.7	140.0
Level of Service	B	B	C	A	A	F
Approach Delay (s)	16.8			6.1	110.0	
Approach LOS	B			A	F	

Intersection Summary			
HCM 2000 Control Delay	50.5	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	1.08		
Actuated Cycle Length (s)	42.4	Sum of lost time (s)	13.4
Intersection Capacity Utilization	100.7%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	294	9	226	37	14	4	68	2666	59	28	1340	174
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		0.97	1.00		1.00	1.00		0.99
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1900	1863	1863	1863	1863	1863	1900
Adj Flow Rate, veh/h	306	9	235	39	15	4	71	2777	61	29	1396	181
Adj No. of Lanes	2	1	1	1	1	0	2	3	1	1	4	0
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	347	313	266	50	132	35	112	3176	989	37	3540	458
Arrive On Green	0.10	0.17	0.17	0.03	0.09	0.09	0.06	1.00	1.00	0.02	0.61	0.61
Sat Flow, veh/h	3442	1863	1583	1774	1408	375	3442	5085	1583	1774	5777	747
Grp Volume(v), veh/h	306	9	235	39	0	19	71	2777	61	29	1161	416
Grp Sat Flow(s),veh/h/ln	1721	1863	1583	1774	0	1783	1721	1695	1583	1774	1602	1718
Q Serve(g_s), s	12.3	0.6	20.3	3.1	0.0	1.4	2.8	0.0	0.0	2.3	17.3	17.3
Cycle Q Clear(g_c), s	12.3	0.6	20.3	3.1	0.0	1.4	2.8	0.0	0.0	2.3	17.3	17.3
Prop In Lane	1.00		1.00	1.00		0.21	1.00		1.00	1.00		0.43
Lane Grp Cap(c), veh/h	347	313	266	50	0	168	112	3176	989	37	2945	1053
V/C Ratio(X)	0.88	0.03	0.88	0.78	0.00	0.11	0.64	0.87	0.06	0.79	0.39	0.40
Avail Cap(c_a), veh/h	347	482	409	234	0	513	312	3176	989	161	2945	1053
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	0.00	1.00	0.61	0.61	0.61	1.00	1.00	1.00
Uniform Delay (d), s/veh	62.1	48.7	56.9	67.6	0.0	58.1	64.6	0.0	0.0	68.2	13.8	13.9
Incr Delay (d2), s/veh	21.7	0.0	9.4	9.2	0.0	0.1	1.4	2.3	0.1	13.0	0.4	1.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	6.9	0.3	9.6	1.6	0.0	0.7	1.4	0.7	0.0	1.3	7.7	8.5
LnGrp Delay(d),s/veh	83.9	48.7	66.3	76.8	0.0	58.2	66.0	2.3	0.1	81.2	14.2	15.0
LnGrp LOS	F	D	E	E		E	E	A	A	F	B	B
Approach Vol, veh/h		550			58			2909			1606	
Approach Delay, s/veh		75.8			70.7			3.8			15.6	
Approach LOS		E			E			A			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	10.0	91.3	19.6	19.1	8.4	92.9	9.3	29.4
Change Period (Y+Rc), s	5.5	* 5.5	5.5	5.9	5.5	* 5.5	* 5.3	* 5.9
Max Green Setting (Gmax), s	12.7	* 51	14.1	40.3	12.7	* 51	* 19	* 36
Max Q Clear Time (g_c+I1), s	4.8	19.3	14.3	3.4	4.3	2.0	5.1	22.3
Green Ext Time (p_c), s	0.0	11.2	0.0	0.3	0.0	12.1	0.0	0.3

Intersection Summary	
HCM 2010 Ctrl Delay	16.0
HCM 2010 LOS	B

Notes

* HCM 2010 computational engine requires equal clearance times for the phases crossing the barrier.

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	1322	29	295	949	367	139
Number	7	14	5	2	6	16
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	1377	0	307	989	382	0
Adj No. of Lanes	3	1	1	2	2	1
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	1690	535	361	1765	840	376
Arrive On Green	0.34	0.00	0.20	0.50	0.24	0.00
Sat Flow, veh/h	5003	1583	1774	3632	3632	1583
Grp Volume(v), veh/h	1377	0	307	989	382	0
Grp Sat Flow(s),veh/h/ln	1668	1583	1774	1770	1770	1583
Q Serve(g_s), s	15.2	0.0	10.1	11.8	5.6	0.0
Cycle Q Clear(g_c), s	15.2	0.0	10.1	11.8	5.6	0.0
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	1690	535	361	1765	840	376
V/C Ratio(X)	0.81	0.00	0.85	0.56	0.45	0.00
Avail Cap(c_a), veh/h	2926	926	630	2029	2029	908
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	18.3	0.0	23.2	10.6	19.7	0.0
Incr Delay (d2), s/veh	0.4	0.0	2.2	0.2	0.2	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	6.9	0.0	5.2	5.7	2.7	0.0
LnGrp Delay(d),s/veh	18.7	0.0	25.4	10.7	19.9	0.0
LnGrp LOS	B		C	B	B	
Approach Vol, veh/h	1377			1296	382	
Approach Delay, s/veh	18.7			14.2	19.9	
Approach LOS	B			B	B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		
Phs Duration (G+Y+Rc), s		35.5		25.0	15.8	19.7		
Change Period (Y+Rc), s		5.3		4.6	3.5	5.3		
Max Green Setting (Gmax), s		34.7		35.4	21.5	34.7		
Max Q Clear Time (g_c+I1), s		13.8		17.2	12.1	7.6		
Green Ext Time (p_c), s		6.3		3.2	0.3	6.8		

Intersection Summary	
HCM 2010 Ctrl Delay	16.9
HCM 2010 LOS	B

Intersection	
Int Delay, s/veh	1

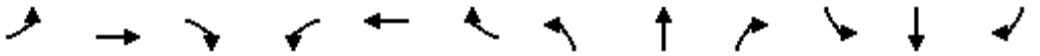
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	35	994	453	18	31	51
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	175	-	-	-	0	0
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	94	94	94	94	94	94
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	37	1057	482	19	33	54

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	501	0	-	0	1094	251
Stage 1	-	-	-	-	491	-
Stage 2	-	-	-	-	603	-
Critical Hdwy	4.14	-	-	-	6.84	6.94
Critical Hdwy Stg 1	-	-	-	-	5.84	-
Critical Hdwy Stg 2	-	-	-	-	5.84	-
Follow-up Hdwy	2.22	-	-	-	3.52	3.32
Pot Cap-1 Maneuver	1059	-	-	-	208	749
Stage 1	-	-	-	-	581	-
Stage 2	-	-	-	-	509	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1059	-	-	-	201	749
Mov Cap-2 Maneuver	-	-	-	-	201	-
Stage 1	-	-	-	-	581	-
Stage 2	-	-	-	-	491	-

Approach	EB	WB	SB
HCM Control Delay, s	0.3	0	16.3
HCM LOS			C

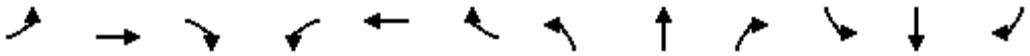
Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	1059	-	-	-	201	749
HCM Lane V/C Ratio	0.035	-	-	-	0.164	0.072
HCM Control Delay (s)	8.5	-	-	-	26.4	10.2
HCM Lane LOS	A	-	-	-	D	B
HCM 95th %tile Q(veh)	0.1	-	-	-	0.6	0.2

Appendix A2
Existing (2015) with Alternative 1/1A
Synchro Calculations



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	350	75	139	425	366	748	0	0	3017	166
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)			4.6		6.2	6.2	4.6	5.0			5.3	5.3
Lane Util. Factor			1.00		1.00	0.88	0.97	0.91			0.86	1.00
Frpb, ped/bikes			1.00		1.00	1.00	1.00	1.00			1.00	0.98
Flpb, ped/bikes			1.00		1.00	1.00	1.00	1.00			1.00	1.00
Frt			0.86		1.00	0.85	1.00	1.00			1.00	0.85
Flt Protected			1.00		0.98	1.00	0.95	1.00			1.00	1.00
Satd. Flow (prot)			1611		1831	2787	3433	5085			6408	1559
Flt Permitted			1.00		0.98	1.00	0.95	1.00			1.00	1.00
Satd. Flow (perm)			1611		1831	2787	3433	5085			6408	1559
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	0	0	365	78	145	443	381	779	0	0	3143	173
RTOR Reduction (vph)	0	0	159	0	0	380	0	0	0	0	0	34
Lane Group Flow (vph)	0	0	206	0	223	63	381	779	0	0	3143	139
Confl. Peds. (#/hr)												1
Confl. Bikes (#/hr)												2
Turn Type			Over	Split	NA	Perm	Prot	NA			NA	Perm
Protected Phases			1	4	4		1	6			2	
Permitted Phases						4						2
Actuated Green, G (s)			23.5		21.5	21.5	23.5	117.3			88.9	88.9
Effective Green, g (s)			23.5		21.5	21.5	23.5	117.3			88.9	88.9
Actuated g/C Ratio			0.16		0.14	0.14	0.16	0.78			0.59	0.59
Clearance Time (s)			4.6		6.2	6.2	4.6	5.0			5.3	5.3
Vehicle Extension (s)			1.0		1.0	1.0	1.0	1.0			1.0	1.0
Lane Grp Cap (vph)			252		262	399	537	3976			3797	923
v/s Ratio Prot			c0.13		c0.12		0.11	0.15			c0.49	
v/s Ratio Perm						0.02						0.09
v/c Ratio			0.82		0.85	0.16	0.71	0.20			0.83	0.15
Uniform Delay, d1			61.2		62.7	56.3	60.0	4.2			24.4	13.7
Progression Factor			1.00		1.00	1.00	0.79	0.40			0.48	0.22
Incremental Delay, d2			17.5		21.7	0.1	3.1	0.1			1.5	0.2
Delay (s)			78.7		84.4	56.4	50.8	1.8			13.3	3.2
Level of Service			E		F	E	D	A			B	A
Approach Delay (s)		78.7			65.8			17.9			12.8	
Approach LOS		E			E			B			B	

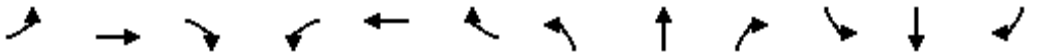
Intersection Summary			
HCM 2000 Control Delay	24.6	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.83		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	16.1
Intersection Capacity Utilization	90.3%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	278	169	236	775	0	20	0	19	95	172	9
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.8		3.8	5.4		5.5		5.5		5.5	
Lane Util. Factor		0.95		1.00	0.95		1.00		1.00		0.95	
Frpb, ped/bikes		1.00		1.00	1.00		1.00		1.00		1.00	
Flpb, ped/bikes		1.00		1.00	1.00		1.00		1.00		1.00	
Frt		0.94		1.00	1.00		1.00		0.85		0.99	
Flt Protected		1.00		0.95	1.00		0.95		1.00		0.98	
Satd. Flow (prot)		3322		1770	3539		1770		1583		3462	
Flt Permitted		1.00		0.95	1.00		0.95		1.00		0.98	
Satd. Flow (perm)		3322		1770	3539		1770		1583		3462	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	296	180	251	824	0	21	0	20	101	183	10
RTOR Reduction (vph)	0	55	0	0	0	0	0	0	19	0	2	0
Lane Group Flow (vph)	0	421	0	251	824	0	21	0	1	0	292	0
Confl. Bikes (#/hr)			1						2			
Turn Type		NA		Prot	NA		Prot		Prot	Split	NA	
Protected Phases		6		5	2		3 8		3	4	4	
Permitted Phases												
Actuated Green, G (s)		14.0		22.3	39.5		4.2		2.3		10.7	
Effective Green, g (s)		14.0		22.3	39.5		4.2		2.3		10.7	
Actuated g/C Ratio		0.19		0.30	0.53		0.06		0.03		0.14	
Clearance Time (s)		4.8		3.8	5.4				5.5		5.5	
Vehicle Extension (s)		1.0		1.0	1.0				1.0		1.0	
Lane Grp Cap (vph)		625		531	1881		100		49		498	
v/s Ratio Prot		c0.13		c0.14	0.23		c0.01		0.00		c0.08	
v/s Ratio Perm												
v/c Ratio		0.67		0.47	0.44		0.21		0.01		0.59	
Uniform Delay, d1		28.0		21.2	10.6		33.5		34.9		29.7	
Progression Factor		1.00		1.00	1.00		1.00		1.00		1.00	
Incremental Delay, d2		2.3		0.2	0.1		0.4		0.0		1.1	
Delay (s)		30.3		21.4	10.7		33.8		34.9		30.9	
Level of Service		C		C	B		C		C		C	
Approach Delay (s)		30.3			13.2			34.4			30.9	
Approach LOS		C			B			C			C	

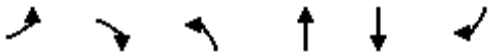
Intersection Summary			
HCM 2000 Control Delay	20.7	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.53		
Actuated Cycle Length (s)	74.3	Sum of lost time (s)	23.1
Intersection Capacity Utilization	52.6%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group



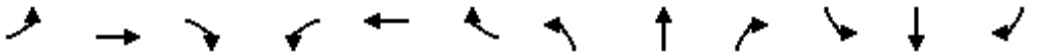
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	21	197	108	131	1008	60	28	2	14	14	3	8
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.9		4.9	5.0			4.9	4.9		4.8	4.8
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00	1.00		1.00	1.00
Frt	1.00	0.95		1.00	0.99			1.00	0.85		1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00			0.96	1.00		0.96	1.00
Satd. Flow (prot)	1770	3351		1770	3509			1779	1583		1788	1583
Flt Permitted	0.95	1.00		0.95	1.00			0.96	1.00		0.96	1.00
Satd. Flow (perm)	1770	3351		1770	3509			1779	1583		1788	1583
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	23	216	119	144	1108	66	31	2	15	15	3	9
RTOR Reduction (vph)	0	36	0	0	2	0	0	0	14	0	0	9
Lane Group Flow (vph)	23	299	0	144	1172	0	0	33	1	0	18	0
Turn Type	Prot	NA		Prot	NA		Split	NA	Perm	Split	NA	Perm
Protected Phases	1	6		5	2		4	4		3	3	
Permitted Phases									4			3
Actuated Green, G (s)	1.7	32.2		11.8	42.6			3.4	3.4		2.5	2.5
Effective Green, g (s)	1.7	32.2		11.8	42.6			3.4	3.4		2.5	2.5
Actuated g/C Ratio	0.02	0.46		0.17	0.61			0.05	0.05		0.04	0.04
Clearance Time (s)	4.5	4.9		4.9	5.0			4.9	4.9		4.8	4.8
Vehicle Extension (s)	1.0	5.8		1.0	4.9			2.0	2.0		1.0	1.0
Lane Grp Cap (vph)	43	1554		300	2153			87	77		64	57
v/s Ratio Prot	0.01	0.09		c0.08	c0.33			c0.02			c0.01	
v/s Ratio Perm									0.00			0.00
v/c Ratio	0.53	0.19		0.48	0.54			0.38	0.01		0.28	0.01
Uniform Delay, d1	33.5	10.9		26.0	7.8			32.0	31.4		32.6	32.3
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00		1.00	1.00
Incremental Delay, d2	6.3	0.2		0.4	0.5			1.0	0.0		0.9	0.0
Delay (s)	39.7	11.1		26.5	8.3			33.0	31.4		33.5	32.3
Level of Service	D	B		C	A			C	C		C	C
Approach Delay (s)		12.9			10.2			32.5			33.1	
Approach LOS		B			B			C			C	

Intersection Summary			
HCM 2000 Control Delay	11.8	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.54		
Actuated Cycle Length (s)	69.4	Sum of lost time (s)	19.5
Intersection Capacity Utilization	53.4%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			



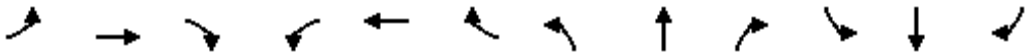
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	76	234	6	1549	1138	1314
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.6	4.6	3.5	5.3	5.3	5.3
Lane Util. Factor	0.97	0.91	1.00	0.91	0.91	1.00
Frt	0.91	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.98	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	3221	1441	1770	5085	5085	1583
Flt Permitted	0.98	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	3221	1441	1770	5085	5085	1583
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	85	263	7	1740	1279	1476
RTOR Reduction (vph)	118	117	0	0	0	365
Lane Group Flow (vph)	99	14	7	1740	1279	1111
Turn Type	Prot	Perm	Prot	NA	NA	Perm
Protected Phases	4		5	2	6	
Permitted Phases		4				6
Actuated Green, G (s)	6.7	6.7	1.0	45.2	40.7	40.7
Effective Green, g (s)	6.7	6.7	1.0	45.2	40.7	40.7
Actuated g/C Ratio	0.11	0.11	0.02	0.73	0.66	0.66
Clearance Time (s)	4.6	4.6	3.5	5.3	5.3	5.3
Vehicle Extension (s)	2.0	2.0	1.5	2.2	2.2	2.2
Lane Grp Cap (vph)	349	156	28	3719	3348	1042
v/s Ratio Prot	c0.03		0.00	c0.34	0.25	
v/s Ratio Perm		0.01				c0.70
v/c Ratio	0.28	0.09	0.25	0.47	0.38	1.07
Uniform Delay, d1	25.3	24.8	30.0	3.4	4.8	10.5
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.2	0.1	1.7	0.0	0.0	47.2
Delay (s)	25.5	24.9	31.7	3.4	4.9	57.8
Level of Service	C	C	C	A	A	E
Approach Delay (s)	25.3			3.6	33.2	
Approach LOS	C			A	C	

Intersection Summary			
HCM 2000 Control Delay	21.9	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.95		
Actuated Cycle Length (s)	61.8	Sum of lost time (s)	13.4
Intersection Capacity Utilization	94.1%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	558	0	42	0	0	0	16	50	0	0	173	961
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.5		5.5				5.5	4.7			4.7	4.7
Lane Util. Factor	0.97		1.00				0.97	0.95			0.95	1.00
Frt	1.00		0.85				1.00	1.00			1.00	0.85
Flt Protected	0.95		1.00				0.95	1.00			1.00	1.00
Satd. Flow (prot)	3433		1583				3433	3539			3539	1583
Flt Permitted	0.95		1.00				0.95	1.00			1.00	1.00
Satd. Flow (perm)	3433		1583				3433	3539			3539	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	607	0	46	0	0	0	17	54	0	0	188	1045
RTOR Reduction (vph)	0	0	33	0	0	0	0	0	0	0	0	535
Lane Group Flow (vph)	607	0	13	0	0	0	17	54	0	0	188	510
Turn Type	Prot		pm+ov	Prot		pm+ov	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	7	4	1	3	8	5	1	6		5	2	
Permitted Phases			4			8			6			2
Actuated Green, G (s)	16.6		18.3				1.7	39.6			32.4	32.4
Effective Green, g (s)	16.6		18.3				1.7	39.6			32.4	32.4
Actuated g/C Ratio	0.25		0.28				0.03	0.60			0.49	0.49
Clearance Time (s)	5.5		5.5				5.5	4.7			4.7	4.7
Vehicle Extension (s)	1.0		1.0				1.0	1.0			1.0	1.0
Lane Grp Cap (vph)	858		567				87	2110			1726	772
v/s Ratio Prot	c0.18		0.00				c0.00	0.02			0.05	
v/s Ratio Perm			0.01									c0.32
v/c Ratio	0.71		0.02				0.20	0.03			0.11	0.66
Uniform Delay, d1	22.7		17.5				31.7	5.5			9.2	12.8
Progression Factor	1.00		1.00				1.00	1.00			1.00	1.00
Incremental Delay, d2	2.2		0.0				0.4	0.0			0.1	4.4
Delay (s)	24.9		17.5				32.1	5.5			9.3	17.3
Level of Service	C		B				C	A			A	B
Approach Delay (s)		24.4			0.0			11.9			16.0	
Approach LOS		C			A			B			B	

Intersection Summary			
HCM 2000 Control Delay	18.7	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	66.4	Sum of lost time (s)	21.2
Intersection Capacity Utilization	70.7%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	164	182	418	522	0	673	0	304	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.8	4.8	5.5	4.8		5.5	5.5	5.5			
Lane Util. Factor		1.00	1.00	0.97	1.00		0.97	0.95	0.95			
Frt		1.00	0.85	1.00	1.00		1.00	0.85	0.85			
Flt Protected		1.00	1.00	0.95	1.00		0.95	1.00	1.00			
Satd. Flow (prot)		1863	1583	3433	1863		3433	1504	1504			
Flt Permitted		1.00	1.00	0.95	1.00		0.95	1.00	1.00			
Satd. Flow (perm)		1863	1583	3433	1863		3433	1504	1504			
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	178	198	454	567	0	732	0	330	0	0	0
RTOR Reduction (vph)	0	0	169	0	0	0	0	102	102	0	0	0
Lane Group Flow (vph)	0	178	29	454	567	0	732	63	63	0	0	0
Turn Type	Prot	NA	Prot	Prot	NA		Split	NA	Perm			
Protected Phases	7	4	4	3	8		2	2		6	6	
Permitted Phases									2			
Actuated Green, G (s)		9.6	9.6	14.7	29.8		25.0	25.0	25.0			
Effective Green, g (s)		9.6	9.6	14.7	29.8		25.0	25.0	25.0			
Actuated g/C Ratio		0.15	0.15	0.23	0.46		0.38	0.38	0.38			
Clearance Time (s)		4.8	4.8	5.5	4.8		5.5	5.5	5.5			
Vehicle Extension (s)		1.0	1.0	1.0	1.0		1.0	1.0	1.0			
Lane Grp Cap (vph)		274	233	775	852		1318	577	577			
v/s Ratio Prot		0.10	0.02	0.13	c0.30		c0.21	0.04				
v/s Ratio Perm									0.04			
v/c Ratio		0.65	0.13	0.59	0.67		0.56	0.11	0.11			
Uniform Delay, d1		26.2	24.1	22.5	13.8		15.7	12.9	12.9			
Progression Factor		1.00	1.00	1.00	1.00		1.00	1.00	1.00			
Incremental Delay, d2		3.9	0.1	0.7	1.5		1.7	0.4	0.4			
Delay (s)		30.1	24.2	23.2	15.3		17.4	13.3	13.3			
Level of Service		C	C	C	B		B	B	B			
Approach Delay (s)		27.0			18.8			16.1			0.0	
Approach LOS		C			B			B			A	

Intersection Summary			
HCM 2000 Control Delay	18.9	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.77		
Actuated Cycle Length (s)	65.1	Sum of lost time (s)	21.3
Intersection Capacity Utilization	63.2%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	172	7	209	8	1	3	133	1032	8	2	2966	286
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		0.98	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1900	1863	1863	1863	1863	1863	1900
Adj Flow Rate, veh/h	177	7	215	8	1	3	137	1064	8	2	3058	295
Adj No. of Lanes	2	1	1	1	1	0	2	3	1	1	4	0
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	224	284	240	10	37	111	180	3521	1096	3	3852	363
Arrive On Green	0.07	0.15	0.15	0.01	0.09	0.09	0.10	1.00	1.00	0.00	0.64	0.64
Sat Flow, veh/h	3442	1863	1577	1774	406	1218	3442	5085	1583	1774	6003	566
Grp Volume(v), veh/h	177	7	215	8	0	4	137	1064	8	2	2434	919
Grp Sat Flow(s),veh/h/ln	1721	1863	1577	1774	0	1623	1721	1695	1583	1774	1602	1763
Q Serve(g_s), s	7.6	0.5	20.1	0.7	0.0	0.3	5.8	0.0	0.0	0.2	55.2	58.5
Cycle Q Clear(g_c), s	7.6	0.5	20.1	0.7	0.0	0.3	5.8	0.0	0.0	0.2	55.2	58.5
Prop In Lane	1.00		1.00	1.00		0.75	1.00		1.00	1.00		0.32
Lane Grp Cap(c), veh/h	224	284	240	10	0	149	180	3521	1096	3	3084	1131
V/C Ratio(X)	0.79	0.02	0.90	0.80	0.00	0.03	0.76	0.30	0.01	0.70	0.79	0.81
Avail Cap(c_a), veh/h	493	524	444	221	0	423	287	3521	1096	148	3084	1131
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	0.00	1.00	0.95	0.95	0.95	1.00	1.00	1.00
Uniform Delay (d), s/veh	69.1	54.1	62.4	74.5	0.0	62.1	66.2	0.0	0.0	74.8	19.5	20.1
Incr Delay (d2), s/veh	2.4	0.0	4.7	39.1	0.0	0.0	2.4	0.2	0.0	76.8	2.1	6.4
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	3.7	0.2	9.0	0.4	0.0	0.2	2.8	0.1	0.0	0.1	24.7	30.3
LnGrp Delay(d),s/veh	71.5	54.1	67.1	113.6	0.0	62.1	68.6	0.2	0.0	151.7	21.6	26.5
LnGrp LOS	E	D	E	F		E	E	A	A	F	C	C
Approach Vol, veh/h		399			12			1209			3355	
Approach Delay, s/veh		68.8			96.4			8.0			23.1	
Approach LOS		E			F			A			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	13.3	101.8	15.3	19.6	5.7	109.4	6.2	28.7
Change Period (Y+Rc), s	5.5	* 5.5	5.5	5.9	5.5	* 5.5	* 5.3	* 5.9
Max Green Setting (Gmax), s	12.5	* 55	21.5	39.1	12.5	* 55	* 19	* 42
Max Q Clear Time (g_c+I1), s	7.8	60.5	9.6	2.3	2.2	2.0	2.7	22.1
Green Ext Time (p_c), s	0.1	0.0	0.2	0.3	0.0	11.1	0.0	0.2

Intersection Summary	
HCM 2010 Ctrl Delay	23.2
HCM 2010 LOS	C

Notes

* HCM 2010 computational engine requires equal clearance times for the phases crossing the barrier.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	892	0	138	0	0	0	0	511	97	0	996	896
Number	3	8	18				1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0				0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00				1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	0	1863				0	1863	1863	0	1863	1863
Adj Flow Rate, veh/h	920	0	142				0	527	0	0	1027	0
Adj No. of Lanes	3	0	2				0	3	1	0	3	1
Peak Hour Factor	0.97	0.97	0.97				0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	2	0	2				0	2	2	0	2	2
Cap, veh/h	1100	0	613				0	3411	1062	0	3411	1062
Arrive On Green	0.22	0.00	0.22				0.00	0.67	0.00	0.00	1.00	0.00
Sat Flow, veh/h	5003	0	2787				0	5253	1583	0	5253	1583
Grp Volume(v), veh/h	920	0	142				0	527	0	0	1027	0
Grp Sat Flow(s),veh/h/ln	1668	0	1393				0	1695	1583	0	1695	1583
Q Serve(g_s), s	13.2	0.0	3.1				0.0	2.9	0.0	0.0	0.0	0.0
Cycle Q Clear(g_c), s	13.2	0.0	3.1				0.0	2.9	0.0	0.0	0.0	0.0
Prop In Lane	1.00		1.00				0.00		1.00	0.00		1.00
Lane Grp Cap(c), veh/h	1100	0	613				0	3411	1062	0	3411	1062
V/C Ratio(X)	0.84	0.00	0.23				0.00	0.15	0.00	0.00	0.30	0.00
Avail Cap(c_a), veh/h	1301	0	725				0	3411	1062	0	3411	1062
HCM Platoon Ratio	1.00	1.00	1.00				1.00	1.00	1.00	1.00	2.00	2.00
Upstream Filter(I)	1.00	0.00	1.00				0.00	0.74	0.00	0.00	1.00	0.00
Uniform Delay (d), s/veh	28.0	0.0	24.0				0.0	4.5	0.0	0.0	0.0	0.0
Incr Delay (d2), s/veh	3.7	0.0	0.1				0.0	0.1	0.0	0.0	0.2	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0				0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	6.4	0.0	1.2				0.0	1.3	0.0	0.0	0.1	0.0
LnGrp Delay(d),s/veh	31.6	0.0	24.1				0.0	4.6	0.0	0.0	0.2	0.0
LnGrp LOS	C		C					A			A	
Approach Vol, veh/h		1062						527			1027	
Approach Delay, s/veh		30.6						4.6			0.2	
Approach LOS		C						A			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2				6		8
Phs Duration (G+Y+Rc), s		55.0				55.0		20.0
Change Period (Y+Rc), s		4.7				4.7		3.5
Max Green Setting (Gmax), s		47.3				47.3		19.5
Max Q Clear Time (g_c+I1), s		2.0				4.9		15.2
Green Ext Time (p_c), s		2.2				2.2		1.3

Intersection Summary	
HCM 2010 Ctrl Delay	13.4
HCM 2010 LOS	B

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	1344	42	19	211	1216	156
Number	7	14	5	2	6	16
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	1600	0	23	251	1448	0
Adj No. of Lanes	3	1	1	2	2	1
Peak Hour Factor	0.84	0.84	0.84	0.84	0.84	0.84
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	1836	581	36	1784	1551	694
Arrive On Green	0.37	0.00	0.02	0.50	0.44	0.00
Sat Flow, veh/h	5003	1583	1774	3632	3632	1583
Grp Volume(v), veh/h	1600	0	23	251	1448	0
Grp Sat Flow(s),veh/h/ln	1668	1583	1774	1770	1770	1583
Q Serve(g_s), s	22.8	0.0	1.0	2.9	29.8	0.0
Cycle Q Clear(g_c), s	22.8	0.0	1.0	2.9	29.8	0.0
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	1836	581	36	1784	1551	694
V/C Ratio(X)	0.87	0.00	0.64	0.14	0.93	0.00
Avail Cap(c_a), veh/h	2308	730	497	1784	1601	716
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	22.6	0.0	37.3	10.2	20.5	0.0
Incr Delay (d2), s/veh	2.8	0.0	6.9	0.0	10.1	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	10.8	0.0	0.5	1.4	16.7	0.0
LnGrp Delay(d),s/veh	25.4	0.0	44.2	10.2	30.6	0.0
LnGrp LOS	C		D	B	C	
Approach Vol, veh/h	1600			274	1448	
Approach Delay, s/veh	25.4			13.0	30.6	
Approach LOS	C			B	C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		
Phs Duration (G+Y+Rc), s		44.0		32.8	5.1	38.9		
Change Period (Y+Rc), s		5.3		4.6	3.5	5.3		
Max Green Setting (Gmax), s		34.7		35.4	21.5	34.7		
Max Q Clear Time (g_c+I1), s		4.9		24.8	3.0	31.8		
Green Ext Time (p_c), s		9.9		3.3	0.0	1.8		

Intersection Summary	
HCM 2010 Ctrl Delay	26.6
HCM 2010 LOS	C

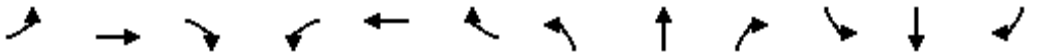
Intersection	
Int Delay, s/veh	1

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	75	317	976	27	9	22
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	175	-	-	-	0	0
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	97	97	97	97	97	97
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	77	327	1006	28	9	23

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	1034	0	-	0	1338	517
Stage 1	-	-	-	-	1020	-
Stage 2	-	-	-	-	318	-
Critical Hdwy	4.14	-	-	-	6.84	6.94
Critical Hdwy Stg 1	-	-	-	-	5.84	-
Critical Hdwy Stg 2	-	-	-	-	5.84	-
Follow-up Hdwy	2.22	-	-	-	3.52	3.32
Pot Cap-1 Maneuver	668	-	-	-	144	503
Stage 1	-	-	-	-	309	-
Stage 2	-	-	-	-	710	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	668	-	-	-	127	503
Mov Cap-2 Maneuver	-	-	-	-	127	-
Stage 1	-	-	-	-	309	-
Stage 2	-	-	-	-	628	-

Approach	EB	WB	SB
HCM Control Delay, s	2.1	0	19.2
HCM LOS			C

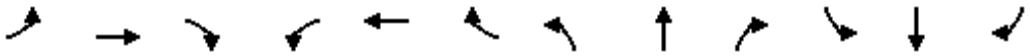
Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	668	-	-	-	127	503
HCM Lane V/C Ratio	0.116	-	-	-	0.073	0.045
HCM Control Delay (s)	11.1	-	-	-	35.6	12.5
HCM Lane LOS	B	-	-	-	E	B
HCM 95th %tile Q(veh)	0.4	-	-	-	0.2	0.1



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	423	43	297	652	241	2141	0	0	1536	67
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)			4.6		6.2	6.2	4.6	5.0			5.3	5.3
Lane Util. Factor			1.00		1.00	0.88	0.97	0.91			0.86	1.00
Frpb, ped/bikes			1.00		1.00	1.00	1.00	1.00			1.00	0.99
Flpb, ped/bikes			1.00		1.00	1.00	1.00	1.00			1.00	1.00
Frt			0.86		1.00	0.85	1.00	1.00			1.00	0.85
Flt Protected			1.00		0.99	1.00	0.95	1.00			1.00	1.00
Satd. Flow (prot)			1611		1851	2787	3433	5085			6408	1564
Flt Permitted			1.00		0.99	1.00	0.95	1.00			1.00	1.00
Satd. Flow (perm)			1611		1851	2787	3433	5085			6408	1564
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	445	45	313	686	254	2254	0	0	1617	71
RTOR Reduction (vph)	0	0	392	0	0	37	0	0	0	0	0	28
Lane Group Flow (vph)	0	0	53	0	358	649	254	2254	0	0	1617	43
Confl. Bikes (#/hr)												1
Turn Type			Over	Split	NA	Perm	Prot	NA			NA	Perm
Protected Phases			1	4	4		1	6			2	
Permitted Phases						4						2
Actuated Green, G (s)			18.0		39.5	39.5	18.0	99.3			76.4	76.4
Effective Green, g (s)			18.0		39.5	39.5	18.0	99.3			76.4	76.4
Actuated g/C Ratio			0.12		0.26	0.26	0.12	0.66			0.51	0.51
Clearance Time (s)			4.6		6.2	6.2	4.6	5.0			5.3	5.3
Vehicle Extension (s)			1.0		1.0	1.0	1.0	1.0			1.0	1.0
Lane Grp Cap (vph)			193		487	733	411	3366			3263	796
v/s Ratio Prot			0.03		0.19		0.07	c0.44			0.25	
v/s Ratio Perm						c0.23						0.03
v/c Ratio			0.28		0.74	0.89	0.62	0.67			0.50	0.05
Uniform Delay, d1			60.1		50.5	53.1	62.7	15.4			24.2	18.6
Progression Factor			1.00		1.00	1.00	0.99	0.75			0.64	0.16
Incremental Delay, d2			0.3		4.9	12.1	1.4	0.8			0.5	0.1
Delay (s)			60.4		55.4	65.2	63.7	12.4			15.8	3.0
Level of Service			E		E	E	E	B			B	A
Approach Delay (s)		60.4			61.8			17.6			15.3	
Approach LOS		E			E			B			B	

Intersection Summary			
HCM 2000 Control Delay	28.4	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.76		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	16.1
Intersection Capacity Utilization	79.9%	ICU Level of Service	D
Analysis Period (min)	15		

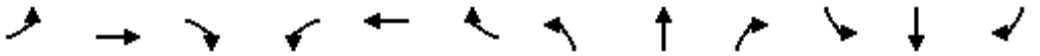
c Critical Lane Group



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	747	18	30	502	0	366	0	247	35	10	29
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.8		3.8	5.4		5.5		5.5		5.5	
Lane Util. Factor		0.95		1.00	0.95		1.00		1.00		0.95	
Frpb, ped/bikes		1.00		1.00	1.00		1.00		1.00		1.00	
Flpb, ped/bikes		1.00		1.00	1.00		1.00		1.00		1.00	
Frt		1.00		1.00	1.00		1.00		0.85		0.94	
Flt Protected		1.00		0.95	1.00		0.95		1.00		0.98	
Satd. Flow (prot)		3526		1770	3539		1770		1583		3255	
Flt Permitted		1.00		0.95	1.00		0.95		1.00		0.98	
Satd. Flow (perm)		3526		1770	3539		1770		1583		3255	
Peak-hour factor, PHF	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Adj. Flow (vph)	0	879	21	35	591	0	431	0	291	41	12	34
RTOR Reduction (vph)	0	1	0	0	0	0	0	0	126	0	32	0
Lane Group Flow (vph)	0	899	0	35	591	0	431	0	165	0	55	0
Confl. Bikes (#/hr)			1						4			
Turn Type		NA		Prot	NA		Prot		Prot	Split	NA	
Protected Phases		6		5	2		3 8		3	4	4	
Permitted Phases												
Actuated Green, G (s)		34.7		5.1	43.0		39.6		24.0		5.8	
Effective Green, g (s)		34.7		5.1	43.0		39.6		24.0		5.8	
Actuated g/C Ratio		0.32		0.05	0.40		0.37		0.22		0.05	
Clearance Time (s)		4.8		3.8	5.4				5.5		5.5	
Vehicle Extension (s)		1.0		1.0	1.0				1.0		1.0	
Lane Grp Cap (vph)		1129		83	1405		647		350		174	
v/s Ratio Prot		c0.26		0.02	c0.17		c0.24		0.10		c0.02	
v/s Ratio Perm												
v/c Ratio		0.80		0.42	0.42		0.67		0.47		0.32	
Uniform Delay, d1		33.6		50.2	23.6		28.8		36.6		49.3	
Progression Factor		1.00		1.00	1.00		1.00		1.00		1.00	
Incremental Delay, d2		3.7		1.3	0.1		2.0		0.4		0.4	
Delay (s)		37.3		51.4	23.7		30.8		37.0		49.7	
Level of Service		D		D	C		C		D		D	
Approach Delay (s)		37.3			25.3			33.3			49.7	
Approach LOS		D			C			C			D	

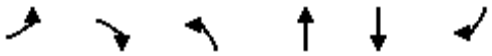
Intersection Summary			
HCM 2000 Control Delay	33.3	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	108.3	Sum of lost time (s)	23.1
Intersection Capacity Utilization	59.7%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group



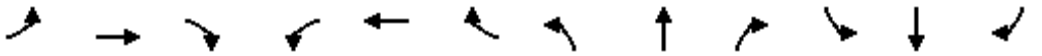
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	9	994	22	20	344	23	98	1	125	49	0	46
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.9		4.9	5.0			4.9	4.9		4.8	4.8
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00	1.00		1.00	1.00
Frt	1.00	1.00		1.00	0.99			1.00	0.85		1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00			0.95	1.00		0.95	1.00
Satd. Flow (prot)	1770	3528		1770	3506			1775	1583		1770	1583
Flt Permitted	0.95	1.00		0.95	1.00			0.95	1.00		0.95	1.00
Satd. Flow (perm)	1770	3528		1770	3506			1775	1583		1770	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	10	1080	24	22	374	25	107	1	136	53	0	50
RTOR Reduction (vph)	0	0	0	0	2	0	0	0	118	0	0	47
Lane Group Flow (vph)	10	1104	0	22	397	0	0	108	18	0	53	3
Turn Type	Prot	NA		Prot	NA		Split	NA	Perm	Split	NA	Perm
Protected Phases	1	6		5	2		4	4		3	3	
Permitted Phases									4			3
Actuated Green, G (s)	0.7	45.1		1.9	46.6			11.0	11.0		5.5	5.5
Effective Green, g (s)	0.7	45.1		1.9	46.6			11.0	11.0		5.5	5.5
Actuated g/C Ratio	0.01	0.54		0.02	0.56			0.13	0.13		0.07	0.07
Clearance Time (s)	4.5	4.9		4.9	5.0			4.9	4.9		4.8	4.8
Vehicle Extension (s)	1.0	5.8		1.0	4.9			2.0	2.0		1.0	1.0
Lane Grp Cap (vph)	14	1917		40	1968			235	209		117	104
v/s Ratio Prot	0.01	c0.31		c0.01	0.11			c0.06			c0.03	
v/s Ratio Perm									0.01			0.00
v/c Ratio	0.71	0.58		0.55	0.20			0.46	0.09		0.45	0.03
Uniform Delay, d1	41.1	12.6		40.1	9.0			33.3	31.6		37.3	36.3
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00		1.00	1.00
Incremental Delay, d2	87.8	0.8		9.0	0.1			0.5	0.1		1.0	0.0
Delay (s)	128.9	13.4		49.1	9.1			33.8	31.7		38.3	36.3
Level of Service	F	B		D	A			C	C		D	D
Approach Delay (s)		14.4			11.2			32.6			37.3	
Approach LOS		B			B			C			D	

Intersection Summary			
HCM 2000 Control Delay	17.3	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.54		
Actuated Cycle Length (s)	83.0	Sum of lost time (s)	19.5
Intersection Capacity Utilization	51.4%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			



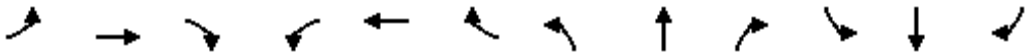
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	141	97	42	2229	409	1421
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.6	4.6	3.5	5.3	5.3	5.3
Lane Util. Factor	0.97	0.91	1.00	0.91	0.91	1.00
Frt	0.98	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.96	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	3394	1441	1770	5085	5085	1583
Flt Permitted	0.96	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	3394	1441	1770	5085	5085	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	148	102	44	2346	431	1496
RTOR Reduction (vph)	20	69	0	0	0	486
Lane Group Flow (vph)	151	10	44	2346	431	1010
Turn Type	Prot	Perm	Prot	NA	NA	Perm
Protected Phases	4		5	2	6	
Permitted Phases		4				6
Actuated Green, G (s)	5.4	5.4	2.2	27.1	21.4	21.4
Effective Green, g (s)	5.4	5.4	2.2	27.1	21.4	21.4
Actuated g/C Ratio	0.13	0.13	0.05	0.64	0.50	0.50
Clearance Time (s)	4.6	4.6	3.5	5.3	5.3	5.3
Vehicle Extension (s)	2.0	2.0	1.5	2.2	2.2	2.2
Lane Grp Cap (vph)	432	183	91	3250	2566	798
v/s Ratio Prot	c0.04		0.02	c0.46	0.08	
v/s Ratio Perm		0.01				c0.64
v/c Ratio	0.35	0.05	0.48	0.72	0.17	1.27
Uniform Delay, d1	16.9	16.3	19.5	5.1	5.7	10.5
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.2	0.0	1.5	0.7	0.0	129.5
Delay (s)	17.1	16.3	21.0	5.8	5.7	140.0
Level of Service	B	B	C	A	A	F
Approach Delay (s)	16.8			6.1	110.0	
Approach LOS	B			A	F	

Intersection Summary			
HCM 2000 Control Delay	50.5	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	1.08		
Actuated Cycle Length (s)	42.4	Sum of lost time (s)	13.4
Intersection Capacity Utilization	100.7%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	1244	0	7	0	0	0	58	159	0	0	3	403
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.5		5.5				5.5	4.7			4.7	4.7
Lane Util. Factor	0.97		1.00				0.97	0.95			0.95	1.00
Frt	1.00		0.85				1.00	1.00			1.00	0.85
Flt Protected	0.95		1.00				0.95	1.00			1.00	1.00
Satd. Flow (prot)	3433		1583				3433	3539			3539	1583
Flt Permitted	0.95		1.00				0.95	1.00			1.00	1.00
Satd. Flow (perm)	3433		1583				3433	3539			3539	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	1352	0	8	0	0	0	63	173	0	0	3	438
RTOR Reduction (vph)	0	0	4	0	0	0	0	0	0	0	0	298
Lane Group Flow (vph)	1352	0	4	0	0	0	63	173	0	0	3	140
Turn Type	Prot		pm+ov	Prot		pm+ov	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	7	4	1	3	8	5	1	6		5	2	
Permitted Phases			4			8			6			2
Actuated Green, G (s)	49.7		53.5				3.8	41.9			32.6	32.6
Effective Green, g (s)	49.7		53.5				3.8	41.9			32.6	32.6
Actuated g/C Ratio	0.49		0.53				0.04	0.41			0.32	0.32
Clearance Time (s)	5.5		5.5				5.5	4.7			4.7	4.7
Vehicle Extension (s)	3.0		3.0				3.0	3.0			3.0	3.0
Lane Grp Cap (vph)	1676		917				128	1456			1133	506
v/s Ratio Prot	c0.39		0.00				c0.02	0.05			0.00	
v/s Ratio Perm			0.00									c0.09
v/c Ratio	0.81		0.00				0.49	0.12			0.00	0.28
Uniform Delay, d1	22.0		11.5				48.1	18.5			23.5	25.8
Progression Factor	1.00		1.00				1.00	1.00			1.00	1.00
Incremental Delay, d2	2.9		0.0				3.0	0.2			0.0	1.4
Delay (s)	24.9		11.5				51.0	18.7			23.5	27.2
Level of Service	C		B				D	B			C	C
Approach Delay (s)		24.9			0.0			27.3			27.1	
Approach LOS		C			A			C			C	

Intersection Summary			
HCM 2000 Control Delay	25.6	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	101.8	Sum of lost time (s)	21.2
Intersection Capacity Utilization	52.3%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	660	652	599	314	0	226	0	235	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.8	4.8	5.5	4.8		5.5	5.5	5.5			
Lane Util. Factor		1.00	1.00	0.97	1.00		0.97	0.95	0.95			
Frt		1.00	0.85	1.00	1.00		1.00	0.85	0.85			
Flt Protected		1.00	1.00	0.95	1.00		0.95	1.00	1.00			
Satd. Flow (prot)		1863	1583	3433	1863		3433	1504	1504			
Flt Permitted		1.00	1.00	0.95	1.00		0.95	1.00	1.00			
Satd. Flow (perm)		1863	1583	3433	1863		3433	1504	1504			
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	717	709	651	341	0	246	0	255	0	0	0
RTOR Reduction (vph)	0	0	233	0	0	0	0	99	98	0	0	0
Lane Group Flow (vph)	0	717	476	651	341	0	246	29	29	0	0	0
Turn Type	Prot	NA	Prot	Prot	NA		Split	NA	Perm			
Protected Phases	7	4	4	3	8		2	2		6	6	
Permitted Phases									2			
Actuated Green, G (s)		49.2	49.2	23.5	78.2		26.0	26.0	26.0			
Effective Green, g (s)		49.2	49.2	23.5	78.2		26.0	26.0	26.0			
Actuated g/C Ratio		0.43	0.43	0.21	0.68		0.23	0.23	0.23			
Clearance Time (s)		4.8	4.8	5.5	4.8		5.5	5.5	5.5			
Vehicle Extension (s)		3.0	3.0	3.0	3.0		3.0	3.0	3.0			
Lane Grp Cap (vph)		800	680	704	1272		779	341	341			
v/s Ratio Prot		c0.38	0.30	c0.19	0.18		c0.07	0.02				
v/s Ratio Perm									0.02			
v/c Ratio		0.90	0.70	0.92	0.27		0.32	0.09	0.08			
Uniform Delay, d1		30.3	26.6	44.6	7.0		36.8	34.9	34.9			
Progression Factor		1.00	1.00	1.00	1.00		1.00	1.00	1.00			
Incremental Delay, d2		12.6	3.2	17.9	0.1		1.1	0.5	0.5			
Delay (s)		42.9	29.8	62.5	7.2		37.9	35.4	35.4			
Level of Service		D	C	E	A		D	D	D			
Approach Delay (s)		36.4			43.5			36.6			0.0	
Approach LOS		D			D			D			A	

Intersection Summary			
HCM 2000 Control Delay	38.8	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	114.5	Sum of lost time (s)	21.3
Intersection Capacity Utilization	70.9%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	294	9	226	37	14	4	68	2666	59	28	1340	174
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		0.97	1.00		1.00	1.00		0.99
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1900	1863	1863	1863	1863	1863	1900
Adj Flow Rate, veh/h	306	9	235	39	15	4	71	2777	61	29	1396	181
Adj No. of Lanes	2	1	1	1	1	0	2	3	1	1	4	0
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	287	310	264	50	155	41	109	3241	1009	35	3613	467
Arrive On Green	0.08	0.17	0.17	0.03	0.11	0.11	0.06	1.00	1.00	0.02	0.63	0.63
Sat Flow, veh/h	3442	1863	1583	1774	1409	376	3442	5085	1583	1774	5777	747
Grp Volume(v), veh/h	306	9	235	39	0	19	71	2777	61	29	1161	416
Grp Sat Flow(s),veh/h/ln	1721	1863	1583	1774	0	1784	1721	1695	1583	1774	1602	1718
Q Serve(g_s), s	12.5	0.6	21.8	3.3	0.0	1.4	3.0	0.0	0.0	2.4	17.9	18.0
Cycle Q Clear(g_c), s	12.5	0.6	21.8	3.3	0.0	1.4	3.0	0.0	0.0	2.4	17.9	18.0
Prop In Lane	1.00		1.00	1.00		0.21	1.00		1.00	1.00		0.43
Lane Grp Cap(c), veh/h	287	310	264	50	0	196	109	3241	1009	35	3006	1075
V/C Ratio(X)	1.07	0.03	0.89	0.78	0.00	0.10	0.65	0.86	0.06	0.82	0.39	0.39
Avail Cap(c_a), veh/h	287	533	453	105	0	464	158	3241	1009	35	3006	1075
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	0.00	1.00	0.62	0.62	0.62	1.00	1.00	1.00
Uniform Delay (d), s/veh	68.8	52.4	61.2	72.4	0.0	60.0	69.4	0.0	0.0	73.2	13.9	13.9
Incr Delay (d2), s/veh	72.0	0.0	5.8	9.2	0.0	0.1	1.5	2.0	0.1	77.5	0.4	1.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	8.8	0.3	10.0	1.7	0.0	0.7	1.5	0.6	0.0	2.0	8.0	8.8
LnGrp Delay(d),s/veh	140.7	52.4	67.0	81.6	0.0	60.1	70.9	2.0	0.1	150.8	14.2	14.9
LnGrp LOS	F	D	E	F		E	E	A	A	F	B	B
Approach Vol, veh/h		550			58			2909			1606	
Approach Delay, s/veh		107.8			74.6			3.6			16.9	
Approach LOS		F			E			A			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	10.3	99.3	18.0	22.4	8.5	101.1	9.5	30.9
Change Period (Y+Rc), s	5.5	* 5.5	5.5	5.9	5.5	* 5.5	* 5.3	* 5.9
Max Green Setting (Gmax), s	6.9	* 69	12.5	39.0	3.0	* 73	* 8.9	* 43
Max Q Clear Time (g_c+I1), s	5.0	20.0	14.5	3.4	4.4	2.0	5.3	23.8
Green Ext Time (p_c), s	0.0	12.1	0.0	0.3	0.0	12.4	0.0	0.3

Intersection Summary	
HCM 2010 Ctrl Delay	19.8
HCM 2010 LOS	B

Notes

* HCM 2010 computational engine requires equal clearance times for the phases crossing the barrier.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	1505	0	104	0	0	0	0	1230	173	0	302	831
Number	3	8	18				1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0				0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00				1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	0	1863				0	1863	1863	0	1863	1863
Adj Flow Rate, veh/h	1618	0	112				0	1323	0	0	325	0
Adj No. of Lanes	3	0	2				0	3	1	0	3	1
Peak Hour Factor	0.93	0.93	0.93				0.93	0.93	0.93	0.93	0.93	0.93
Percent Heavy Veh, %	2	0	2				0	2	2	0	2	2
Cap, veh/h	1811	0	1009				0	2688	837	0	2688	837
Arrive On Green	0.36	0.00	0.36				0.00	0.53	0.00	0.00	0.17	0.00
Sat Flow, veh/h	5003	0	2787				0	5253	1583	0	5253	1583
Grp Volume(v), veh/h	1618	0	112				0	1323	0	0	325	0
Grp Sat Flow(s),veh/h/ln	1668	0	1393				0	1695	1583	0	1695	1583
Q Serve(g_s), s	22.9	0.0	2.0				0.0	12.4	0.0	0.0	4.0	0.0
Cycle Q Clear(g_c), s	22.9	0.0	2.0				0.0	12.4	0.0	0.0	4.0	0.0
Prop In Lane	1.00		1.00				0.00		1.00	0.00		1.00
Lane Grp Cap(c), veh/h	1811	0	1009				0	2688	837	0	2688	837
V/C Ratio(X)	0.89	0.00	0.11				0.00	0.49	0.00	0.00	0.12	0.00
Avail Cap(c_a), veh/h	1968	0	1096				0	2688	837	0	2688	837
HCM Platoon Ratio	1.00	1.00	1.00				1.00	1.00	1.00	1.00	0.33	0.33
Upstream Filter(I)	1.00	0.00	1.00				0.00	0.61	0.00	0.00	1.00	0.00
Uniform Delay (d), s/veh	22.6	0.0	15.9				0.0	11.3	0.0	0.0	16.3	0.0
Incr Delay (d2), s/veh	5.1	0.0	0.0				0.0	0.4	0.0	0.0	0.1	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0				0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	11.3	0.0	0.8				0.0	5.9	0.0	0.0	1.9	0.0
LnGrp Delay(d),s/veh	27.6	0.0	15.9				0.0	11.7	0.0	0.0	16.4	0.0
LnGrp LOS	C		B					B			B	
Approach Vol, veh/h		1730						1323			325	
Approach Delay, s/veh		26.9						11.7			16.4	
Approach LOS		C						B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2				6		8
Phs Duration (G+Y+Rc), s		44.3				44.3		30.7
Change Period (Y+Rc), s		4.7				4.7		3.5
Max Green Setting (Gmax), s		37.3				37.3		29.5
Max Q Clear Time (g_c+I1), s		6.0				14.4		24.9
Green Ext Time (p_c), s		2.4				2.4		2.3

Intersection Summary	
HCM 2010 Ctrl Delay	19.9
HCM 2010 LOS	B



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	1322	29	295	949	367	139
Number	7	14	5	2	6	16
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	1377	0	307	989	382	0
Adj No. of Lanes	3	1	1	2	2	1
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	1690	535	361	1765	840	376
Arrive On Green	0.34	0.00	0.20	0.50	0.24	0.00
Sat Flow, veh/h	5003	1583	1774	3632	3632	1583
Grp Volume(v), veh/h	1377	0	307	989	382	0
Grp Sat Flow(s),veh/h/ln	1668	1583	1774	1770	1770	1583
Q Serve(g_s), s	15.2	0.0	10.1	11.8	5.6	0.0
Cycle Q Clear(g_c), s	15.2	0.0	10.1	11.8	5.6	0.0
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	1690	535	361	1765	840	376
V/C Ratio(X)	0.81	0.00	0.85	0.56	0.45	0.00
Avail Cap(c_a), veh/h	2926	926	630	2029	2029	908
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	18.3	0.0	23.2	10.6	19.7	0.0
Incr Delay (d2), s/veh	0.4	0.0	2.2	0.2	0.2	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	6.9	0.0	5.2	5.7	2.7	0.0
LnGrp Delay(d),s/veh	18.7	0.0	25.4	10.7	19.9	0.0
LnGrp LOS	B		C	B	B	
Approach Vol, veh/h	1377			1296	382	
Approach Delay, s/veh	18.7			14.2	19.9	
Approach LOS	B			B	B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		
Phs Duration (G+Y+Rc), s		35.5		25.0	15.8	19.7		
Change Period (Y+Rc), s		5.3		4.6	3.5	5.3		
Max Green Setting (Gmax), s		34.7		35.4	21.5	34.7		
Max Q Clear Time (g_c+I1), s		13.8		17.2	12.1	7.6		
Green Ext Time (p_c), s		6.3		3.2	0.3	6.8		

Intersection Summary	
HCM 2010 Ctrl Delay	16.9
HCM 2010 LOS	B

Intersection	
Int Delay, s/veh	1

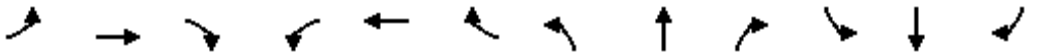
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	35	994	453	18	31	51
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	175	-	-	-	0	0
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	94	94	94	94	94	94
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	37	1057	482	19	33	54

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	501	0	-	0	1094	251
Stage 1	-	-	-	-	491	-
Stage 2	-	-	-	-	603	-
Critical Hdwy	4.14	-	-	-	6.84	6.94
Critical Hdwy Stg 1	-	-	-	-	5.84	-
Critical Hdwy Stg 2	-	-	-	-	5.84	-
Follow-up Hdwy	2.22	-	-	-	3.52	3.32
Pot Cap-1 Maneuver	1059	-	-	-	208	749
Stage 1	-	-	-	-	581	-
Stage 2	-	-	-	-	509	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1059	-	-	-	201	749
Mov Cap-2 Maneuver	-	-	-	-	201	-
Stage 1	-	-	-	-	581	-
Stage 2	-	-	-	-	491	-

Approach	EB	WB	SB
HCM Control Delay, s	0.3	0	16.3
HCM LOS			C

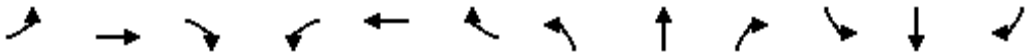
Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	1059	-	-	-	201	749
HCM Lane V/C Ratio	0.035	-	-	-	0.164	0.072
HCM Control Delay (s)	8.5	-	-	-	26.4	10.2
HCM Lane LOS	A	-	-	-	D	B
HCM 95th %tile Q(veh)	0.1	-	-	-	0.6	0.2

Appendix A3
Existing (2015) with Alternative 2
Synchro Calculations



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	350	75	405	1051	100	122	0	0	3017	166
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)			4.6		6.2	4.0	4.6	5.0			5.3	5.3
Lane Util. Factor			1.00		0.95	0.76	0.97	0.91			0.86	1.00
Frpb, ped/bikes			1.00		1.00	1.00	1.00	1.00			1.00	0.98
Flpb, ped/bikes			1.00		1.00	1.00	1.00	1.00			1.00	1.00
Frt			0.86		1.00	0.85	1.00	1.00			1.00	0.85
Flt Protected			1.00		0.99	1.00	0.95	1.00			1.00	1.00
Satd. Flow (prot)			1611		3512	3610	3433	5085			6408	1559
Flt Permitted			1.00		0.99	1.00	0.95	1.00			1.00	1.00
Satd. Flow (perm)			1611		3512	3610	3433	5085			6408	1559
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	0	0	365	78	422	1095	104	127	0	0	3143	173
RTOR Reduction (vph)	0	0	113	0	0	235	0	0	0	0	0	40
Lane Group Flow (vph)	0	0	252	0	500	860	104	127	0	0	3143	133
Confl. Peds. (#/hr)												1
Confl. Bikes (#/hr)												2
Turn Type			Over	Split	NA	custom	Prot	NA			NA	Perm
Protected Phases			1	4	4	5	1	6			2	
Permitted Phases						4						2
Actuated Green, G (s)			26.0		22.4	117.8	26.0	17.0			85.5	85.5
Effective Green, g (s)			26.0		22.4	117.8	26.0	17.0			85.5	85.5
Actuated g/C Ratio			0.17		0.15	0.79	0.17	0.11			0.57	0.57
Clearance Time (s)			4.6		6.2	4.0	4.6	5.0			5.3	5.3
Vehicle Extension (s)			1.0		1.0	3.0	1.0	1.0			1.0	1.0
Lane Grp Cap (vph)			279		524	2931	595	576			3652	888
v/s Ratio Prot			c0.16		c0.14	0.19	0.03	0.02			c0.49	
v/s Ratio Perm						0.05						0.09
v/c Ratio			0.90		0.95	0.29	0.17	0.22			0.86	0.15
Uniform Delay, d1			60.8		63.3	4.5	52.9	60.5			27.2	15.2
Progression Factor			1.00		1.00	1.00	1.00	1.00			0.52	0.27
Incremental Delay, d2			29.3		27.8	0.1	0.1	0.9			2.0	0.2
Delay (s)			90.1		91.0	4.5	52.9	61.4			16.3	4.3
Level of Service			F		F	A	D	E			B	A
Approach Delay (s)		90.1			31.7			57.6			15.7	
Approach LOS		F			C			E			B	

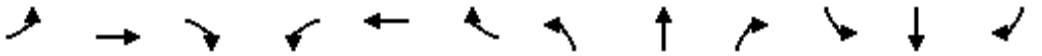
Intersection Summary			
HCM 2000 Control Delay	27.0	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.88		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	16.1
Intersection Capacity Utilization	92.2%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	278	169	236	775	0	20	0	19	95	172	9
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.8		3.8	5.4		5.5		5.5		5.5	
Lane Util. Factor		0.95		1.00	0.95		1.00		1.00		0.95	
Frpb, ped/bikes		1.00		1.00	1.00		1.00		1.00		1.00	
Flpb, ped/bikes		1.00		1.00	1.00		1.00		1.00		1.00	
Frt		0.94		1.00	1.00		1.00		0.85		0.99	
Flt Protected		1.00		0.95	1.00		0.95		1.00		0.98	
Satd. Flow (prot)		3322		1770	3539		1770		1583		3462	
Flt Permitted		1.00		0.95	1.00		0.95		1.00		0.98	
Satd. Flow (perm)		3322		1770	3539		1770		1583		3462	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	296	180	251	824	0	21	0	20	101	183	10
RTOR Reduction (vph)	0	55	0	0	0	0	0	0	19	0	2	0
Lane Group Flow (vph)	0	421	0	251	824	0	21	0	1	0	292	0
Confl. Bikes (#/hr)			1						2			
Turn Type		NA		Prot	NA		Prot		Prot	Split	NA	
Protected Phases		6		5	2		3 8		3	4	4	
Permitted Phases												
Actuated Green, G (s)		14.0		22.3	39.5		4.2		2.3		10.7	
Effective Green, g (s)		14.0		22.3	39.5		4.2		2.3		10.7	
Actuated g/C Ratio		0.19		0.30	0.53		0.06		0.03		0.14	
Clearance Time (s)		4.8		3.8	5.4				5.5		5.5	
Vehicle Extension (s)		1.0		1.0	1.0				1.0		1.0	
Lane Grp Cap (vph)		625		531	1881		100		49		498	
v/s Ratio Prot		c0.13		c0.14	0.23		c0.01		0.00		c0.08	
v/s Ratio Perm												
v/c Ratio		0.67		0.47	0.44		0.21		0.01		0.59	
Uniform Delay, d1		28.0		21.2	10.6		33.5		34.9		29.7	
Progression Factor		1.00		1.00	1.00		1.00		1.00		1.00	
Incremental Delay, d2		2.3		0.2	0.1		0.4		0.0		1.1	
Delay (s)		30.3		21.4	10.7		33.8		34.9		30.9	
Level of Service		C		C	B		C		C		C	
Approach Delay (s)		30.3			13.2			34.4			30.9	
Approach LOS		C			B			C			C	

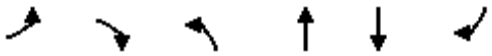
Intersection Summary			
HCM 2000 Control Delay	20.7	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.53		
Actuated Cycle Length (s)	74.3	Sum of lost time (s)	23.1
Intersection Capacity Utilization	52.6%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group



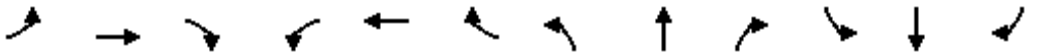
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	21	197	108	131	1008	60	28	2	14	14	3	8
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.9		4.9	5.0			4.9	4.9		4.8	4.8
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00	1.00		1.00	1.00
Frt	1.00	0.95		1.00	0.99			1.00	0.85		1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00			0.96	1.00		0.96	1.00
Satd. Flow (prot)	1770	3351		1770	3509			1779	1583		1788	1583
Flt Permitted	0.95	1.00		0.95	1.00			0.96	1.00		0.96	1.00
Satd. Flow (perm)	1770	3351		1770	3509			1779	1583		1788	1583
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	23	216	119	144	1108	66	31	2	15	15	3	9
RTOR Reduction (vph)	0	36	0	0	2	0	0	0	14	0	0	9
Lane Group Flow (vph)	23	299	0	144	1172	0	0	33	1	0	18	0
Turn Type	Prot	NA		Prot	NA		Split	NA	Perm	Split	NA	Perm
Protected Phases	1	6		5	2		4	4		3	3	
Permitted Phases									4			3
Actuated Green, G (s)	1.7	32.2		11.8	42.6			3.4	3.4		2.5	2.5
Effective Green, g (s)	1.7	32.2		11.8	42.6			3.4	3.4		2.5	2.5
Actuated g/C Ratio	0.02	0.46		0.17	0.61			0.05	0.05		0.04	0.04
Clearance Time (s)	4.5	4.9		4.9	5.0			4.9	4.9		4.8	4.8
Vehicle Extension (s)	1.0	5.8		1.0	4.9			2.0	2.0		1.0	1.0
Lane Grp Cap (vph)	43	1554		300	2153			87	77		64	57
v/s Ratio Prot	0.01	0.09		c0.08	c0.33			c0.02			c0.01	
v/s Ratio Perm									0.00			0.00
v/c Ratio	0.53	0.19		0.48	0.54			0.38	0.01		0.28	0.01
Uniform Delay, d1	33.5	10.9		26.0	7.8			32.0	31.4		32.6	32.3
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00		1.00	1.00
Incremental Delay, d2	6.3	0.2		0.4	0.5			1.0	0.0		0.9	0.0
Delay (s)	39.7	11.1		26.5	8.3			33.0	31.4		33.5	32.3
Level of Service	D	B		C	A			C	C		C	C
Approach Delay (s)		12.9			10.2			32.5			33.1	
Approach LOS		B			B			C			C	

Intersection Summary			
HCM 2000 Control Delay	11.8	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.54		
Actuated Cycle Length (s)	69.4	Sum of lost time (s)	19.5
Intersection Capacity Utilization	53.4%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			



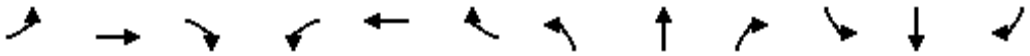
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	76	234	6	1549	1138	1314
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.6	4.6	3.5	5.3	5.3	5.3
Lane Util. Factor	0.97	0.91	1.00	0.91	0.91	1.00
Frt	0.91	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.98	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	3221	1441	1770	5085	5085	1583
Flt Permitted	0.98	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	3221	1441	1770	5085	5085	1583
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	85	263	7	1740	1279	1476
RTOR Reduction (vph)	118	117	0	0	0	365
Lane Group Flow (vph)	99	14	7	1740	1279	1111
Turn Type	Prot	Perm	Prot	NA	NA	Perm
Protected Phases	4		5	2	6	
Permitted Phases		4				6
Actuated Green, G (s)	6.7	6.7	1.0	45.2	40.7	40.7
Effective Green, g (s)	6.7	6.7	1.0	45.2	40.7	40.7
Actuated g/C Ratio	0.11	0.11	0.02	0.73	0.66	0.66
Clearance Time (s)	4.6	4.6	3.5	5.3	5.3	5.3
Vehicle Extension (s)	2.0	2.0	1.5	2.2	2.2	2.2
Lane Grp Cap (vph)	349	156	28	3719	3348	1042
v/s Ratio Prot	c0.03		0.00	c0.34	0.25	
v/s Ratio Perm		0.01				c0.70
v/c Ratio	0.28	0.09	0.25	0.47	0.38	1.07
Uniform Delay, d1	25.3	24.8	30.0	3.4	4.8	10.5
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.2	0.1	1.7	0.0	0.0	47.2
Delay (s)	25.5	24.9	31.7	3.4	4.9	57.8
Level of Service	C	C	C	A	A	E
Approach Delay (s)	25.3			3.6	33.2	
Approach LOS	C			A	C	

Intersection Summary			
HCM 2000 Control Delay	21.9	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.95		
Actuated Cycle Length (s)	61.8	Sum of lost time (s)	13.4
Intersection Capacity Utilization	94.1%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	558	0	42	0	0	0	16	50	0	0	173	961
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.5		5.5				5.5	4.7			4.7	4.7
Lane Util. Factor	0.97		1.00				0.97	0.95			0.95	1.00
Frt	1.00		0.85				1.00	1.00			1.00	0.85
Flt Protected	0.95		1.00				0.95	1.00			1.00	1.00
Satd. Flow (prot)	3433		1583				3433	3539			3539	1583
Flt Permitted	0.95		1.00				0.95	1.00			1.00	1.00
Satd. Flow (perm)	3433		1583				3433	3539			3539	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	607	0	46	0	0	0	17	54	0	0	188	1045
RTOR Reduction (vph)	0	0	33	0	0	0	0	0	0	0	0	535
Lane Group Flow (vph)	607	0	13	0	0	0	17	54	0	0	188	510
Turn Type	Prot		pm+ov	Prot		pm+ov	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	7	4	1	3	8	5	1	6		5	2	
Permitted Phases			4			8			6			2
Actuated Green, G (s)	16.6		18.3				1.7	39.6			32.4	32.4
Effective Green, g (s)	16.6		18.3				1.7	39.6			32.4	32.4
Actuated g/C Ratio	0.25		0.28				0.03	0.60			0.49	0.49
Clearance Time (s)	5.5		5.5				5.5	4.7			4.7	4.7
Vehicle Extension (s)	1.0		1.0				1.0	1.0			1.0	1.0
Lane Grp Cap (vph)	858		567				87	2110			1726	772
v/s Ratio Prot	c0.18		0.00				c0.00	0.02			0.05	
v/s Ratio Perm			0.01									c0.32
v/c Ratio	0.71		0.02				0.20	0.03			0.11	0.66
Uniform Delay, d1	22.7		17.5				31.7	5.5			9.2	12.8
Progression Factor	1.00		1.00				1.00	1.00			1.00	1.00
Incremental Delay, d2	2.2		0.0				0.4	0.0			0.1	4.4
Delay (s)	24.9		17.5				32.1	5.5			9.3	17.3
Level of Service	C		B				C	A			A	B
Approach Delay (s)		24.4			0.0			11.9			16.0	
Approach LOS		C			A			B			B	

Intersection Summary			
HCM 2000 Control Delay	18.7	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	66.4	Sum of lost time (s)	21.2
Intersection Capacity Utilization	70.7%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	164	182	418	522	0	673	0	304	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.8	4.8	5.5	4.8		5.5	5.5	5.5			
Lane Util. Factor		1.00	1.00	0.97	1.00		0.97	0.95	0.95			
Frt		1.00	0.85	1.00	1.00		1.00	0.85	0.85			
Flt Protected		1.00	1.00	0.95	1.00		0.95	1.00	1.00			
Satd. Flow (prot)		1863	1583	3433	1863		3433	1504	1504			
Flt Permitted		1.00	1.00	0.95	1.00		0.95	1.00	1.00			
Satd. Flow (perm)		1863	1583	3433	1863		3433	1504	1504			
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	178	198	454	567	0	732	0	330	0	0	0
RTOR Reduction (vph)	0	0	169	0	0	0	0	102	102	0	0	0
Lane Group Flow (vph)	0	178	29	454	567	0	732	63	63	0	0	0
Turn Type	Prot	NA	Prot	Prot	NA		Split	NA	Perm			
Protected Phases	7	4	4	3	8		2	2		6	6	
Permitted Phases									2			
Actuated Green, G (s)		9.6	9.6	14.7	29.8		25.0	25.0	25.0			
Effective Green, g (s)		9.6	9.6	14.7	29.8		25.0	25.0	25.0			
Actuated g/C Ratio		0.15	0.15	0.23	0.46		0.38	0.38	0.38			
Clearance Time (s)		4.8	4.8	5.5	4.8		5.5	5.5	5.5			
Vehicle Extension (s)		1.0	1.0	1.0	1.0		1.0	1.0	1.0			
Lane Grp Cap (vph)		274	233	775	852		1318	577	577			
v/s Ratio Prot		0.10	0.02	0.13	c0.30		c0.21	0.04				
v/s Ratio Perm									0.04			
v/c Ratio		0.65	0.13	0.59	0.67		0.56	0.11	0.11			
Uniform Delay, d1		26.2	24.1	22.5	13.8		15.7	12.9	12.9			
Progression Factor		1.00	1.00	1.00	1.00		1.00	1.00	1.00			
Incremental Delay, d2		3.9	0.1	0.7	1.5		1.7	0.4	0.4			
Delay (s)		30.1	24.2	23.2	15.3		17.4	13.3	13.3			
Level of Service		C	C	C	B		B	B	B			
Approach Delay (s)		27.0			18.8			16.1			0.0	
Approach LOS		C			B			B			A	

Intersection Summary			
HCM 2000 Control Delay	18.9	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.77		
Actuated Cycle Length (s)	65.1	Sum of lost time (s)	21.3
Intersection Capacity Utilization	63.2%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	172	7	209	8	1	3	133	1032	8	2	2966	286
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		0.98	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1900	1863	1863	1863	1863	1863	1900
Adj Flow Rate, veh/h	177	7	215	8	1	3	137	1064	8	2	3058	295
Adj No. of Lanes	2	1	1	1	1	0	2	3	1	1	4	0
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	224	284	240	10	37	111	180	3521	1096	3	3852	363
Arrive On Green	0.07	0.15	0.15	0.01	0.09	0.09	0.10	1.00	1.00	0.00	0.64	0.64
Sat Flow, veh/h	3442	1863	1577	1774	406	1218	3442	5085	1583	1774	6003	566
Grp Volume(v), veh/h	177	7	215	8	0	4	137	1064	8	2	2434	919
Grp Sat Flow(s),veh/h/ln	1721	1863	1577	1774	0	1623	1721	1695	1583	1774	1602	1763
Q Serve(g_s), s	7.6	0.5	20.1	0.7	0.0	0.3	5.8	0.0	0.0	0.2	55.2	58.5
Cycle Q Clear(g_c), s	7.6	0.5	20.1	0.7	0.0	0.3	5.8	0.0	0.0	0.2	55.2	58.5
Prop In Lane	1.00		1.00	1.00		0.75	1.00		1.00	1.00		0.32
Lane Grp Cap(c), veh/h	224	284	240	10	0	149	180	3521	1096	3	3084	1131
V/C Ratio(X)	0.79	0.02	0.90	0.80	0.00	0.03	0.76	0.30	0.01	0.70	0.79	0.81
Avail Cap(c_a), veh/h	493	524	444	221	0	423	287	3521	1096	148	3084	1131
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	0.00	1.00	0.95	0.95	0.95	1.00	1.00	1.00
Uniform Delay (d), s/veh	69.1	54.1	62.4	74.5	0.0	62.1	66.2	0.0	0.0	74.8	19.5	20.1
Incr Delay (d2), s/veh	2.4	0.0	4.7	39.1	0.0	0.0	2.4	0.2	0.0	76.8	2.1	6.4
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	3.7	0.2	9.0	0.4	0.0	0.2	2.8	0.1	0.0	0.1	24.7	30.3
LnGrp Delay(d),s/veh	71.5	54.1	67.1	113.6	0.0	62.1	68.6	0.2	0.0	151.7	21.6	26.5
LnGrp LOS	E	D	E	F		E	E	A	A	F	C	C
Approach Vol, veh/h		399			12			1209			3355	
Approach Delay, s/veh		68.8			96.4			8.0			23.1	
Approach LOS		E			F			A			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	13.3	101.8	15.3	19.6	5.7	109.4	6.2	28.7
Change Period (Y+Rc), s	5.5	* 5.5	5.5	5.9	5.5	* 5.5	* 5.3	* 5.9
Max Green Setting (Gmax), s	12.5	* 55	21.5	39.1	12.5	* 55	* 19	* 42
Max Q Clear Time (g_c+I1), s	7.8	60.5	9.6	2.3	2.2	2.0	2.7	22.1
Green Ext Time (p_c), s	0.1	0.0	0.2	0.3	0.0	11.1	0.0	0.2

Intersection Summary	
HCM 2010 Ctrl Delay	23.2
HCM 2010 LOS	C

Notes

* HCM 2010 computational engine requires equal clearance times for the phases crossing the barrier.

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	1344	42	19	211	1216	156
Number	7	14	5	2	6	16
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	1600	0	23	251	1448	0
Adj No. of Lanes	3	1	1	2	2	1
Peak Hour Factor	0.84	0.84	0.84	0.84	0.84	0.84
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	1836	581	36	1784	1551	694
Arrive On Green	0.37	0.00	0.02	0.50	0.44	0.00
Sat Flow, veh/h	5003	1583	1774	3632	3632	1583
Grp Volume(v), veh/h	1600	0	23	251	1448	0
Grp Sat Flow(s),veh/h/ln	1668	1583	1774	1770	1770	1583
Q Serve(g_s), s	22.8	0.0	1.0	2.9	29.8	0.0
Cycle Q Clear(g_c), s	22.8	0.0	1.0	2.9	29.8	0.0
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	1836	581	36	1784	1551	694
V/C Ratio(X)	0.87	0.00	0.64	0.14	0.93	0.00
Avail Cap(c_a), veh/h	2308	730	497	1784	1601	716
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	22.6	0.0	37.3	10.2	20.5	0.0
Incr Delay (d2), s/veh	2.8	0.0	6.9	0.0	10.1	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	10.8	0.0	0.5	1.4	16.7	0.0
LnGrp Delay(d),s/veh	25.4	0.0	44.2	10.2	30.6	0.0
LnGrp LOS	C		D	B	C	
Approach Vol, veh/h	1600			274	1448	
Approach Delay, s/veh	25.4			13.0	30.6	
Approach LOS	C			B	C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		
Phs Duration (G+Y+Rc), s		44.0		32.8	5.1	38.9		
Change Period (Y+Rc), s		5.3		4.6	3.5	5.3		
Max Green Setting (Gmax), s		34.7		35.4	21.5	34.7		
Max Q Clear Time (g_c+I1), s		4.9		24.8	3.0	31.8		
Green Ext Time (p_c), s		9.9		3.3	0.0	1.8		

Intersection Summary	
HCM 2010 Ctrl Delay	26.6
HCM 2010 LOS	C

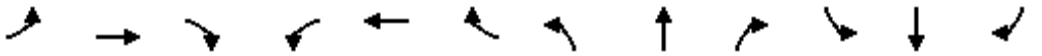
Intersection	
Int Delay, s/veh	1

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	75	317	976	27	9	22
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	175	-	-	-	0	0
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	97	97	97	97	97	97
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	77	327	1006	28	9	23

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	1034	0	-	0	1338	517
Stage 1	-	-	-	-	1020	-
Stage 2	-	-	-	-	318	-
Critical Hdwy	4.14	-	-	-	6.84	6.94
Critical Hdwy Stg 1	-	-	-	-	5.84	-
Critical Hdwy Stg 2	-	-	-	-	5.84	-
Follow-up Hdwy	2.22	-	-	-	3.52	3.32
Pot Cap-1 Maneuver	668	-	-	-	144	503
Stage 1	-	-	-	-	309	-
Stage 2	-	-	-	-	710	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	668	-	-	-	127	503
Mov Cap-2 Maneuver	-	-	-	-	127	-
Stage 1	-	-	-	-	309	-
Stage 2	-	-	-	-	628	-

Approach	EB	WB	SB
HCM Control Delay, s	2.1	0	19.2
HCM LOS			C

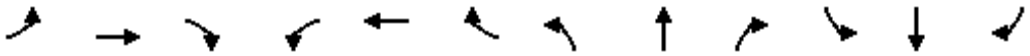
Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	668	-	-	-	127	503
HCM Lane V/C Ratio	0.116	-	-	-	0.073	0.045
HCM Control Delay (s)	11.1	-	-	-	35.6	12.5
HCM Lane LOS	B	-	-	-	E	B
HCM 95th %tile Q(veh)	0.4	-	-	-	0.2	0.1



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	423	43	472	1982	66	811	0	0	1536	67
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)			4.6		6.2	4.0	4.6	5.0			5.3	5.3
Lane Util. Factor			1.00		0.95	0.76	0.97	0.91			0.86	1.00
Frpb, ped/bikes			1.00		1.00	1.00	1.00	1.00			1.00	0.99
Flpb, ped/bikes			1.00		1.00	1.00	1.00	1.00			1.00	1.00
Frt			0.86		1.00	0.85	1.00	1.00			1.00	0.85
Flt Protected			1.00		1.00	1.00	0.95	1.00			1.00	1.00
Satd. Flow (prot)			1611		3525	3610	3433	5085			6408	1564
Flt Permitted			1.00		1.00	1.00	0.95	1.00			1.00	1.00
Satd. Flow (perm)			1611		3525	3610	3433	5085			6408	1564
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	445	45	497	2086	69	854	0	0	1617	71
RTOR Reduction (vph)	0	0	257	0	0	6	0	0	0	0	0	30
Lane Group Flow (vph)	0	0	188	0	542	2080	69	854	0	0	1617	41
Confl. Bikes (#/hr)												1
Turn Type			Over	Split	NA	custom	Prot	NA			NA	Perm
Protected Phases			1	4	4	5	1	6			2	
Permitted Phases						4						2
Actuated Green, G (s)			21.4		26.6	102.8	21.4	32.0			85.9	85.9
Effective Green, g (s)			21.4		26.6	102.8	21.4	32.0			85.9	85.9
Actuated g/C Ratio			0.14		0.18	0.69	0.14	0.21			0.57	0.57
Clearance Time (s)			4.6		6.2	4.0	4.6	5.0			5.3	5.3
Vehicle Extension (s)			1.0		1.0	3.0	1.0	1.0			1.0	1.0
Lane Grp Cap (vph)			229		625	2570	489	1084			3669	895
v/s Ratio Prot			0.12		0.15	c0.41	0.02	c0.17			0.25	
v/s Ratio Perm						0.17						0.03
v/c Ratio			0.82		0.87	0.81	0.14	0.79			0.44	0.05
Uniform Delay, d1			62.4		60.0	16.7	56.3	55.8			18.3	14.1
Progression Factor			1.00		1.00	1.00	1.00	1.00			0.55	0.03
Incremental Delay, d2			19.5		11.8	2.0	0.0	5.8			0.4	0.1
Delay (s)			81.9		71.7	18.7	56.3	61.6			10.4	0.5
Level of Service			F		E	B	E	E			B	A
Approach Delay (s)		81.9			29.6			61.2			10.0	
Approach LOS		F			C			E			A	

Intersection Summary			
HCM 2000 Control Delay	33.0	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.83		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	16.1
Intersection Capacity Utilization	76.2%	ICU Level of Service	D
Analysis Period (min)	15		

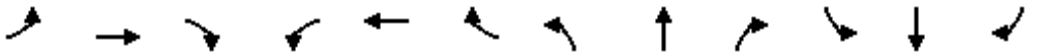
c Critical Lane Group



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	747	18	30	502	0	366	0	247	35	10	29
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.8		3.8	5.4		5.5		5.5		5.5	
Lane Util. Factor		0.95		1.00	0.95		1.00		1.00		0.95	
Frpb, ped/bikes		1.00		1.00	1.00		1.00		1.00		1.00	
Flpb, ped/bikes		1.00		1.00	1.00		1.00		1.00		1.00	
Frt		1.00		1.00	1.00		1.00		0.85		0.94	
Flt Protected		1.00		0.95	1.00		0.95		1.00		0.98	
Satd. Flow (prot)		3526		1770	3539		1770		1583		3255	
Flt Permitted		1.00		0.95	1.00		0.95		1.00		0.98	
Satd. Flow (perm)		3526		1770	3539		1770		1583		3255	
Peak-hour factor, PHF	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Adj. Flow (vph)	0	879	21	35	591	0	431	0	291	41	12	34
RTOR Reduction (vph)	0	1	0	0	0	0	0	0	126	0	32	0
Lane Group Flow (vph)	0	899	0	35	591	0	431	0	165	0	55	0
Confl. Bikes (#/hr)			1						4			
Turn Type		NA		Prot	NA		Prot		Prot	Split	NA	
Protected Phases		6		5	2		3 8		3	4	4	
Permitted Phases												
Actuated Green, G (s)		34.7		5.1	43.0		39.6		24.0		5.8	
Effective Green, g (s)		34.7		5.1	43.0		39.6		24.0		5.8	
Actuated g/C Ratio		0.32		0.05	0.40		0.37		0.22		0.05	
Clearance Time (s)		4.8		3.8	5.4				5.5		5.5	
Vehicle Extension (s)		1.0		1.0	1.0				1.0		1.0	
Lane Grp Cap (vph)		1129		83	1405		647		350		174	
v/s Ratio Prot		c0.26		0.02	c0.17		c0.24		0.10		c0.02	
v/s Ratio Perm												
v/c Ratio		0.80		0.42	0.42		0.67		0.47		0.32	
Uniform Delay, d1		33.6		50.2	23.6		28.8		36.6		49.3	
Progression Factor		1.00		1.00	1.00		1.00		1.00		1.00	
Incremental Delay, d2		3.7		1.3	0.1		2.0		0.4		0.4	
Delay (s)		37.3		51.4	23.7		30.8		37.0		49.7	
Level of Service		D		D	C		C		D		D	
Approach Delay (s)		37.3			25.3			33.3			49.7	
Approach LOS		D			C			C			D	

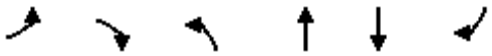
Intersection Summary			
HCM 2000 Control Delay	33.3	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	108.3	Sum of lost time (s)	23.1
Intersection Capacity Utilization	59.7%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group



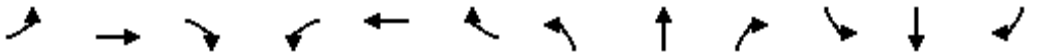
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	9	994	22	20	344	23	98	1	125	49	0	46
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.9		4.9	5.0			4.9	4.9		4.8	4.8
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00	1.00		1.00	1.00
Frt	1.00	1.00		1.00	0.99			1.00	0.85		1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00			0.95	1.00		0.95	1.00
Satd. Flow (prot)	1770	3528		1770	3506			1775	1583		1770	1583
Flt Permitted	0.95	1.00		0.95	1.00			0.95	1.00		0.95	1.00
Satd. Flow (perm)	1770	3528		1770	3506			1775	1583		1770	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	10	1080	24	22	374	25	107	1	136	53	0	50
RTOR Reduction (vph)	0	0	0	0	2	0	0	0	118	0	0	47
Lane Group Flow (vph)	10	1104	0	22	397	0	0	108	18	0	53	3
Turn Type	Prot	NA		Prot	NA		Split	NA	Perm	Split	NA	Perm
Protected Phases	1	6		5	2		4	4		3	3	
Permitted Phases									4			3
Actuated Green, G (s)	0.7	45.1		1.9	46.6			11.0	11.0		5.5	5.5
Effective Green, g (s)	0.7	45.1		1.9	46.6			11.0	11.0		5.5	5.5
Actuated g/C Ratio	0.01	0.54		0.02	0.56			0.13	0.13		0.07	0.07
Clearance Time (s)	4.5	4.9		4.9	5.0			4.9	4.9		4.8	4.8
Vehicle Extension (s)	1.0	5.8		1.0	4.9			2.0	2.0		1.0	1.0
Lane Grp Cap (vph)	14	1917		40	1968			235	209		117	104
v/s Ratio Prot	0.01	c0.31		c0.01	0.11			c0.06			c0.03	
v/s Ratio Perm									0.01			0.00
v/c Ratio	0.71	0.58		0.55	0.20			0.46	0.09		0.45	0.03
Uniform Delay, d1	41.1	12.6		40.1	9.0			33.3	31.6		37.3	36.3
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00		1.00	1.00
Incremental Delay, d2	87.8	0.8		9.0	0.1			0.5	0.1		1.0	0.0
Delay (s)	128.9	13.4		49.1	9.1			33.8	31.7		38.3	36.3
Level of Service	F	B		D	A			C	C		D	D
Approach Delay (s)		14.4			11.2			32.6			37.3	
Approach LOS		B			B			C			D	

Intersection Summary			
HCM 2000 Control Delay	17.3	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.54		
Actuated Cycle Length (s)	83.0	Sum of lost time (s)	19.5
Intersection Capacity Utilization	51.4%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			



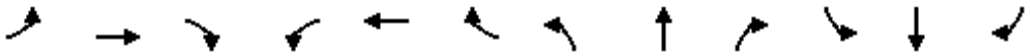
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	141	97	42	2229	409	1421
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.6	4.6	3.5	5.3	5.3	5.3
Lane Util. Factor	0.97	0.91	1.00	0.91	0.91	1.00
Frt	0.98	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.96	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	3394	1441	1770	5085	5085	1583
Flt Permitted	0.96	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	3394	1441	1770	5085	5085	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	148	102	44	2346	431	1496
RTOR Reduction (vph)	20	69	0	0	0	486
Lane Group Flow (vph)	151	10	44	2346	431	1010
Turn Type	Prot	Perm	Prot	NA	NA	Perm
Protected Phases	4		5	2	6	
Permitted Phases		4				6
Actuated Green, G (s)	5.4	5.4	2.2	27.1	21.4	21.4
Effective Green, g (s)	5.4	5.4	2.2	27.1	21.4	21.4
Actuated g/C Ratio	0.13	0.13	0.05	0.64	0.50	0.50
Clearance Time (s)	4.6	4.6	3.5	5.3	5.3	5.3
Vehicle Extension (s)	2.0	2.0	1.5	2.2	2.2	2.2
Lane Grp Cap (vph)	432	183	91	3250	2566	798
v/s Ratio Prot	c0.04		0.02	c0.46	0.08	
v/s Ratio Perm		0.01				c0.64
v/c Ratio	0.35	0.05	0.48	0.72	0.17	1.27
Uniform Delay, d1	16.9	16.3	19.5	5.1	5.7	10.5
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.2	0.0	1.5	0.7	0.0	129.5
Delay (s)	17.1	16.3	21.0	5.8	5.7	140.0
Level of Service	B	B	C	A	A	F
Approach Delay (s)	16.8			6.1	110.0	
Approach LOS	B			A	F	

Intersection Summary			
HCM 2000 Control Delay	50.5	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	1.08		
Actuated Cycle Length (s)	42.4	Sum of lost time (s)	13.4
Intersection Capacity Utilization	100.7%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	1244	0	7	0	0	0	58	159	0	0	3	403
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.5		5.5				5.5	4.7			4.7	4.7
Lane Util. Factor	0.97		1.00				0.97	0.95			0.95	1.00
Frt	1.00		0.85				1.00	1.00			1.00	0.85
Flt Protected	0.95		1.00				0.95	1.00			1.00	1.00
Satd. Flow (prot)	3433		1583				3433	3539			3539	1583
Flt Permitted	0.95		1.00				0.95	1.00			1.00	1.00
Satd. Flow (perm)	3433		1583				3433	3539			3539	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	1352	0	8	0	0	0	63	173	0	0	3	438
RTOR Reduction (vph)	0	0	4	0	0	0	0	0	0	0	0	298
Lane Group Flow (vph)	1352	0	4	0	0	0	63	173	0	0	3	140
Turn Type	Prot		pm+ov	Prot		pm+ov	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	7	4	1	3	8	5	1	6		5	2	
Permitted Phases			4			8			6			2
Actuated Green, G (s)	49.7		53.5				3.8	41.9			32.6	32.6
Effective Green, g (s)	49.7		53.5				3.8	41.9			32.6	32.6
Actuated g/C Ratio	0.49		0.53				0.04	0.41			0.32	0.32
Clearance Time (s)	5.5		5.5				5.5	4.7			4.7	4.7
Vehicle Extension (s)	3.0		3.0				3.0	3.0			3.0	3.0
Lane Grp Cap (vph)	1676		917				128	1456			1133	506
v/s Ratio Prot	c0.39		0.00				c0.02	0.05			0.00	
v/s Ratio Perm			0.00									c0.09
v/c Ratio	0.81		0.00				0.49	0.12			0.00	0.28
Uniform Delay, d1	22.0		11.5				48.1	18.5			23.5	25.8
Progression Factor	1.00		1.00				1.00	1.00			1.00	1.00
Incremental Delay, d2	2.9		0.0				3.0	0.2			0.0	1.4
Delay (s)	24.9		11.5				51.0	18.7			23.5	27.2
Level of Service	C		B				D	B			C	C
Approach Delay (s)		24.9			0.0			27.3			27.1	
Approach LOS		C			A			C			C	

Intersection Summary			
HCM 2000 Control Delay	25.6	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	101.8	Sum of lost time (s)	21.2
Intersection Capacity Utilization	52.3%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	660	652	599	314	0	226	0	235	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.8	4.8	5.5	4.8		5.5	5.5	5.5			
Lane Util. Factor		1.00	1.00	0.97	1.00		0.97	0.95	0.95			
Frt		1.00	0.85	1.00	1.00		1.00	0.85	0.85			
Flt Protected		1.00	1.00	0.95	1.00		0.95	1.00	1.00			
Satd. Flow (prot)		1863	1583	3433	1863		3433	1504	1504			
Flt Permitted		1.00	1.00	0.95	1.00		0.95	1.00	1.00			
Satd. Flow (perm)		1863	1583	3433	1863		3433	1504	1504			
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	717	709	651	341	0	246	0	255	0	0	0
RTOR Reduction (vph)	0	0	233	0	0	0	0	99	98	0	0	0
Lane Group Flow (vph)	0	717	476	651	341	0	246	29	29	0	0	0
Turn Type	Prot	NA	Prot	Prot	NA		Split	NA	Perm			
Protected Phases	7	4	4	3	8		2	2		6	6	
Permitted Phases									2			
Actuated Green, G (s)		49.2	49.2	23.5	78.2		26.0	26.0	26.0			
Effective Green, g (s)		49.2	49.2	23.5	78.2		26.0	26.0	26.0			
Actuated g/C Ratio		0.43	0.43	0.21	0.68		0.23	0.23	0.23			
Clearance Time (s)		4.8	4.8	5.5	4.8		5.5	5.5	5.5			
Vehicle Extension (s)		3.0	3.0	3.0	3.0		3.0	3.0	3.0			
Lane Grp Cap (vph)		800	680	704	1272		779	341	341			
v/s Ratio Prot		c0.38	0.30	c0.19	0.18		c0.07	0.02				
v/s Ratio Perm									0.02			
v/c Ratio		0.90	0.70	0.92	0.27		0.32	0.09	0.08			
Uniform Delay, d1		30.3	26.6	44.6	7.0		36.8	34.9	34.9			
Progression Factor		1.00	1.00	1.00	1.00		1.00	1.00	1.00			
Incremental Delay, d2		12.6	3.2	17.9	0.1		1.1	0.5	0.5			
Delay (s)		42.9	29.8	62.5	7.2		37.9	35.4	35.4			
Level of Service		D	C	E	A		D	D	D			
Approach Delay (s)		36.4			43.5			36.6			0.0	
Approach LOS		D			D			D			A	

Intersection Summary			
HCM 2000 Control Delay	38.8	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	114.5	Sum of lost time (s)	21.3
Intersection Capacity Utilization	70.9%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	294	9	226	37	14	4	68	2666	59	28	1340	174
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		0.97	1.00		1.00	1.00		0.99
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1900	1863	1863	1863	1863	1863	1900
Adj Flow Rate, veh/h	306	9	235	39	15	4	71	2777	61	29	1396	181
Adj No. of Lanes	2	1	1	1	1	0	2	3	1	1	4	0
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	287	310	264	50	155	41	110	3241	1009	35	3612	467
Arrive On Green	0.08	0.17	0.17	0.03	0.11	0.11	0.04	0.85	0.85	0.02	0.63	0.63
Sat Flow, veh/h	3442	1863	1583	1774	1409	376	3442	5085	1583	1774	5777	747
Grp Volume(v), veh/h	306	9	235	39	0	19	71	2777	61	29	1161	416
Grp Sat Flow(s),veh/h/ln	1721	1863	1583	1774	0	1784	1721	1695	1583	1774	1602	1718
Q Serve(g_s), s	12.5	0.6	21.8	3.3	0.0	1.4	3.0	45.6	0.9	2.4	17.9	18.0
Cycle Q Clear(g_c), s	12.5	0.6	21.8	3.3	0.0	1.4	3.0	45.6	0.9	2.4	17.9	18.0
Prop In Lane	1.00		1.00	1.00		0.21	1.00		1.00	1.00		0.43
Lane Grp Cap(c), veh/h	287	310	264	50	0	196	110	3241	1009	35	3005	1075
V/C Ratio(X)	1.07	0.03	0.89	0.78	0.00	0.10	0.65	0.86	0.06	0.82	0.39	0.39
Avail Cap(c_a), veh/h	287	533	453	105	0	464	158	3241	1009	35	3005	1075
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.33	1.33	1.33	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	0.00	1.00	0.51	0.51	0.51	1.00	1.00	1.00
Uniform Delay (d), s/veh	68.8	52.4	61.2	72.4	0.0	60.0	71.0	7.6	4.2	73.2	13.9	13.9
Incr Delay (d2), s/veh	72.0	0.0	5.8	9.2	0.0	0.1	1.2	1.7	0.1	77.5	0.4	1.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	8.8	0.3	10.0	1.7	0.0	0.7	1.5	20.9	0.4	2.0	8.0	8.8
LnGrp Delay(d),s/veh	140.7	52.4	67.0	81.6	0.0	60.1	72.2	9.3	4.3	150.8	14.3	14.9
LnGrp LOS	F	D	E	F		E	E	A	A	F	B	B
Approach Vol, veh/h		550			58			2909			1606	
Approach Delay, s/veh		107.8			74.6			10.7			16.9	
Approach LOS		F			E			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	10.3	99.3	18.0	22.4	8.5	101.1	9.5	30.9
Change Period (Y+Rc), s	5.5	* 5.5	5.5	5.9	5.5	* 5.5	* 5.3	* 5.9
Max Green Setting (Gmax), s	6.9	* 69	12.5	39.0	3.0	* 73	* 8.9	* 43
Max Q Clear Time (g_c+I1), s	5.0	20.0	14.5	3.4	4.4	47.6	5.3	23.8
Green Ext Time (p_c), s	0.0	12.1	0.0	0.3	0.0	10.6	0.0	0.3

Intersection Summary	
HCM 2010 Ctrl Delay	23.8
HCM 2010 LOS	C

Notes

* HCM 2010 computational engine requires equal clearance times for the phases crossing the barrier.

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	1322	29	295	949	367	139
Number	7	14	5	2	6	16
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	1377	0	307	989	382	0
Adj No. of Lanes	3	1	1	2	2	1
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	1690	535	361	1765	840	376
Arrive On Green	0.34	0.00	0.20	0.50	0.24	0.00
Sat Flow, veh/h	5003	1583	1774	3632	3632	1583
Grp Volume(v), veh/h	1377	0	307	989	382	0
Grp Sat Flow(s),veh/h/ln	1668	1583	1774	1770	1770	1583
Q Serve(g_s), s	15.2	0.0	10.1	11.8	5.6	0.0
Cycle Q Clear(g_c), s	15.2	0.0	10.1	11.8	5.6	0.0
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	1690	535	361	1765	840	376
V/C Ratio(X)	0.81	0.00	0.85	0.56	0.45	0.00
Avail Cap(c_a), veh/h	2926	926	630	2029	2029	908
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	18.3	0.0	23.2	10.6	19.7	0.0
Incr Delay (d2), s/veh	0.4	0.0	2.2	0.2	0.2	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	6.9	0.0	5.2	5.7	2.7	0.0
LnGrp Delay(d),s/veh	18.7	0.0	25.4	10.7	19.9	0.0
LnGrp LOS	B		C	B	B	
Approach Vol, veh/h	1377			1296	382	
Approach Delay, s/veh	18.7			14.2	19.9	
Approach LOS	B			B	B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		
Phs Duration (G+Y+Rc), s		35.5		25.0	15.8	19.7		
Change Period (Y+Rc), s		5.3		4.6	3.5	5.3		
Max Green Setting (Gmax), s		34.7		35.4	21.5	34.7		
Max Q Clear Time (g_c+I1), s		13.8		17.2	12.1	7.6		
Green Ext Time (p_c), s		6.3		3.2	0.3	6.8		

Intersection Summary	
HCM 2010 Ctrl Delay	16.9
HCM 2010 LOS	B

Intersection	
Int Delay, s/veh	1

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	35	994	453	18	31	51
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	175	-	-	-	0	0
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	94	94	94	94	94	94
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	37	1057	482	19	33	54

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	501	0	-	0	1094	251
Stage 1	-	-	-	-	491	-
Stage 2	-	-	-	-	603	-
Critical Hdwy	4.14	-	-	-	6.84	6.94
Critical Hdwy Stg 1	-	-	-	-	5.84	-
Critical Hdwy Stg 2	-	-	-	-	5.84	-
Follow-up Hdwy	2.22	-	-	-	3.52	3.32
Pot Cap-1 Maneuver	1059	-	-	-	208	749
Stage 1	-	-	-	-	581	-
Stage 2	-	-	-	-	509	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1059	-	-	-	201	749
Mov Cap-2 Maneuver	-	-	-	-	201	-
Stage 1	-	-	-	-	581	-
Stage 2	-	-	-	-	491	-

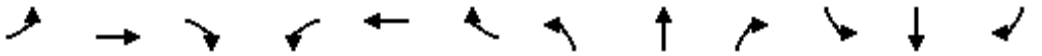
Approach	EB	WB	SB
HCM Control Delay, s	0.3	0	16.3
HCM LOS			C

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	1059	-	-	-	201	749
HCM Lane V/C Ratio	0.035	-	-	-	0.164	0.072
HCM Control Delay (s)	8.5	-	-	-	26.4	10.2
HCM Lane LOS	A	-	-	-	D	B
HCM 95th %tile Q(veh)	0.1	-	-	-	0.6	0.2

Appendix A4

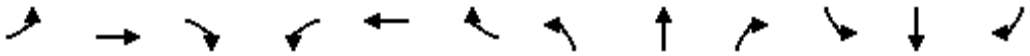
Opening Year (2022) No Build

Synchro Calculations



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	390	90	160	610	430	1270	0	0	3150	160
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)			4.6	6.2	6.2	6.2	4.6	5.0			5.3	5.3
Lane Util. Factor			1.00	1.00	0.91	0.91	0.97	0.91			0.86	1.00
Frpb, ped/bikes			1.00	1.00	1.00	1.00	1.00	1.00			1.00	0.98
Flpb, ped/bikes			1.00	1.00	1.00	1.00	1.00	1.00			1.00	1.00
Frt			0.86	1.00	0.93	0.85	1.00	1.00			1.00	0.85
Flt Protected			1.00	0.95	1.00	1.00	0.95	1.00			1.00	1.00
Satd. Flow (prot)			1611	1770	1571	2882	3433	5085			6408	1559
Flt Permitted			1.00	0.95	1.00	1.00	0.95	1.00			1.00	1.00
Satd. Flow (perm)			1611	1770	1571	2882	3433	5085			6408	1559
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	0	0	406	94	167	635	448	1323	0	0	3281	167
RTOR Reduction (vph)	0	0	115	0	23	160	0	0	0	0	0	39
Lane Group Flow (vph)	0	0	291	94	303	316	448	1323	0	0	3281	128
Confl. Peds. (#/hr)												1
Confl. Bikes (#/hr)												2
Turn Type			Over	Split	NA	Perm	Prot	NA			NA	Perm
Protected Phases			1	4	4		1	6			2	
Permitted Phases						4						2
Actuated Green, G (s)			29.3	26.0	26.0	26.0	29.3	112.8			78.6	78.6
Effective Green, g (s)			29.3	26.0	26.0	26.0	29.3	112.8			78.6	78.6
Actuated g/C Ratio			0.20	0.17	0.17	0.17	0.20	0.75			0.52	0.52
Clearance Time (s)			4.6	6.2	6.2	6.2	4.6	5.0			5.3	5.3
Vehicle Extension (s)			1.0	1.0	1.0	1.0	1.0	1.0			1.0	1.0
Lane Grp Cap (vph)			314	306	272	499	670	3823			3357	816
v/s Ratio Prot			c0.18	0.05	c0.19		0.13	0.26			c0.51	
v/s Ratio Perm						0.11						0.08
v/c Ratio			0.93	0.31	1.11	0.63	0.67	0.35			0.98	0.16
Uniform Delay, d1			59.3	54.1	62.0	57.6	55.9	6.2			34.8	18.5
Progression Factor			1.00	1.00	1.00	1.00	0.91	0.84			0.52	0.28
Incremental Delay, d2			31.6	0.2	88.5	1.9	1.6	0.2			7.7	0.2
Delay (s)			90.9	54.3	150.5	59.5	52.6	5.4			26.0	5.4
Level of Service			F	D	F	E	D	A			C	A
Approach Delay (s)		90.9			92.1			17.4			25.0	
Approach LOS		F			F			B			C	

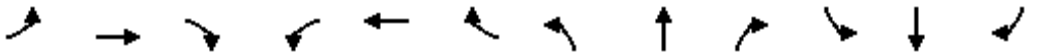
Intersection Summary			
HCM 2000 Control Delay	36.2	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.99		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	16.1
Intersection Capacity Utilization	88.2%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	270	340	280	830	0	250	0	200	100	190	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.8		3.8	5.4		5.5		5.5		5.5	
Lane Util. Factor		0.95		1.00	0.95		1.00		1.00		0.95	
Frpb, ped/bikes		0.99		1.00	1.00		1.00		1.00		1.00	
Flpb, ped/bikes		1.00		1.00	1.00		1.00		1.00		1.00	
Frt		0.92		1.00	1.00		1.00		0.85		0.99	
Flt Protected		1.00		0.95	1.00		0.95		1.00		0.98	
Satd. Flow (prot)		3219		1770	3539		1770		1583		3463	
Flt Permitted		1.00		0.95	1.00		0.95		1.00		0.98	
Satd. Flow (perm)		3219		1770	3539		1770		1583		3463	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	287	362	298	883	0	266	0	213	106	202	11
RTOR Reduction (vph)	0	134	0	0	0	0	0	0	166	0	2	0
Lane Group Flow (vph)	0	515	0	298	883	0	266	0	47	0	317	0
Confl. Bikes (#/hr)			1						2			
Turn Type		NA		Prot	NA		Prot		Prot	Split	NA	
Protected Phases		6		5	2		3 8		3	4	4	
Permitted Phases												
Actuated Green, G (s)		22.5		21.6	47.3		24.6		14.4		14.6	
Effective Green, g (s)		22.5		21.6	47.3		24.6		14.4		14.6	
Actuated g/C Ratio		0.21		0.20	0.44		0.23		0.14		0.14	
Clearance Time (s)		4.8		3.8	5.4				5.5		5.5	
Vehicle Extension (s)		1.0		1.0	1.0				1.0		1.0	
Lane Grp Cap (vph)		680		359	1573		409		214		475	
v/s Ratio Prot		c0.16		c0.17	0.25		c0.15		0.03		c0.09	
v/s Ratio Perm												
v/c Ratio		0.76		0.83	0.56		0.65		0.22		0.67	
Uniform Delay, d1		39.4		40.6	21.9		37.0		41.0		43.6	
Progression Factor		1.00		1.00	1.00		1.00		1.00		1.00	
Incremental Delay, d2		4.3		14.3	0.3		2.8		0.2		2.8	
Delay (s)		43.7		55.0	22.1		39.8		41.2		46.4	
Level of Service		D		D	C		D		D		D	
Approach Delay (s)		43.7			30.4			40.4			46.4	
Approach LOS		D			C			D			D	

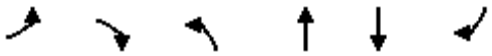
Intersection Summary			
HCM 2000 Control Delay	37.5	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.73		
Actuated Cycle Length (s)	106.4	Sum of lost time (s)	23.1
Intersection Capacity Utilization	71.5%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	270	210	270	860	60	250	10	130	10	0	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.9		4.9	5.0			4.9	4.9		4.8	4.8
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00	1.00		1.00	1.00
Frt	1.00	0.93		1.00	0.99			1.00	0.85		1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00			0.95	1.00		0.95	1.00
Satd. Flow (prot)	1770	3307		1770	3505			1777	1583		1770	1583
Flt Permitted	0.95	1.00		0.95	1.00			0.95	1.00		0.95	1.00
Satd. Flow (perm)	1770	3307		1770	3505			1777	1583		1770	1583
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	22	297	231	297	945	66	275	11	143	11	0	11
RTOR Reduction (vph)	0	90	0	0	2	0	0	0	109	0	0	11
Lane Group Flow (vph)	22	438	0	297	1009	0	0	286	34	0	11	0
Turn Type	Prot	NA		Prot	NA		Split	NA	Perm	Split	NA	Perm
Protected Phases	1	6		5	2		4	4		3	3	
Permitted Phases									4			3
Actuated Green, G (s)	3.0	27.8		21.4	46.5			21.7	21.7		2.5	2.5
Effective Green, g (s)	3.0	27.8		21.4	46.5			21.7	21.7		2.5	2.5
Actuated g/C Ratio	0.03	0.30		0.23	0.50			0.23	0.23		0.03	0.03
Clearance Time (s)	4.5	4.9		4.9	5.0			4.9	4.9		4.8	4.8
Vehicle Extension (s)	1.0	5.8		1.0	4.9			2.0	2.0		1.0	1.0
Lane Grp Cap (vph)	57	989		407	1754			415	369		47	42
v/s Ratio Prot	0.01	0.13		c0.17	c0.29			c0.16			c0.01	
v/s Ratio Perm									0.02			0.00
v/c Ratio	0.39	0.44		0.73	0.57			0.69	0.09		0.23	0.01
Uniform Delay, d1	44.0	26.3		33.1	16.3			32.5	27.9		44.3	44.0
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00		1.00	1.00
Incremental Delay, d2	1.6	0.8		5.5	0.7			3.8	0.0		0.9	0.0
Delay (s)	45.6	27.1		38.6	17.0			36.3	27.9		45.2	44.0
Level of Service	D	C		D	B			D	C		D	D
Approach Delay (s)		27.9			21.9			33.5			44.6	
Approach LOS		C			C			C			D	

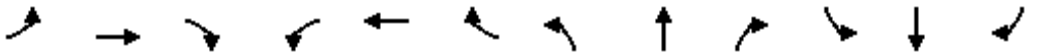
Intersection Summary			
HCM 2000 Control Delay	25.7	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	92.9	Sum of lost time (s)	19.5
Intersection Capacity Utilization	62.5%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	80	240	60	1660	1040	1380
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.6	4.6	3.5	5.3	5.3	5.3
Lane Util. Factor	0.97	0.91	1.00	0.91	0.91	1.00
Frt	0.91	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.98	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	3224	1441	1770	5085	5085	1583
Flt Permitted	0.98	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	3224	1441	1770	5085	5085	1583
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	90	270	67	1865	1169	1551
RTOR Reduction (vph)	121	121	0	0	0	351
Lane Group Flow (vph)	104	14	67	1865	1169	1200
Turn Type	Prot	Perm	Prot	NA	NA	Perm
Protected Phases	4		5	2	6	
Permitted Phases		4				6
Actuated Green, G (s)	7.0	7.0	4.3	48.4	40.6	40.6
Effective Green, g (s)	7.0	7.0	4.3	48.4	40.6	40.6
Actuated g/C Ratio	0.11	0.11	0.07	0.74	0.62	0.62
Clearance Time (s)	4.6	4.6	3.5	5.3	5.3	5.3
Vehicle Extension (s)	2.0	2.0	1.5	2.2	2.2	2.2
Lane Grp Cap (vph)	345	154	116	3768	3161	984
v/s Ratio Prot	c0.03		0.04	c0.37	0.23	
v/s Ratio Perm		0.01				c0.76
v/c Ratio	0.30	0.09	0.58	0.49	0.37	1.22
Uniform Delay, d1	26.9	26.3	29.6	3.5	6.1	12.3
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.2	0.1	4.3	0.1	0.0	108.2
Delay (s)	27.1	26.4	33.9	3.5	6.1	120.6
Level of Service	C	C	C	A	A	F
Approach Delay (s)	26.8			4.6	71.4	
Approach LOS	C			A	E	

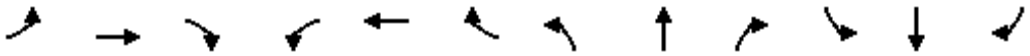
Intersection Summary			
HCM 2000 Control Delay	42.4	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	1.05		
Actuated Cycle Length (s)	65.3	Sum of lost time (s)	13.4
Intersection Capacity Utilization	98.2%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	730	0	40	0	0	0	80	240	0	0	200	1330
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.5		5.5				5.5	4.7			4.7	4.7
Lane Util. Factor	0.97		1.00				0.97	0.95			0.95	1.00
Frt	1.00		0.85				1.00	1.00			1.00	0.85
Flt Protected	0.95		1.00				0.95	1.00			1.00	1.00
Satd. Flow (prot)	3433		1583				3433	3539			3539	1583
Flt Permitted	0.95		1.00				0.95	1.00			1.00	1.00
Satd. Flow (perm)	3433		1583				3433	3539			3539	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	793	0	43	0	0	0	87	261	0	0	217	1446
RTOR Reduction (vph)	0	0	31	0	0	0	0	0	0	0	0	449
Lane Group Flow (vph)	793	0	12	0	0	0	87	261	0	0	217	997
Turn Type	Prot		pm+ov	Prot		pm+ov	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	7	4	1	3	8	5	1	6		5	2	
Permitted Phases			4			8			6			2
Actuated Green, G (s)	27.5		31.0				3.5	69.8			60.8	60.8
Effective Green, g (s)	27.5		31.0				3.5	69.8			60.8	60.8
Actuated g/C Ratio	0.26		0.29				0.03	0.65			0.57	0.57
Clearance Time (s)	5.5		5.5				5.5	4.7			4.7	4.7
Vehicle Extension (s)	1.0		1.0				1.0	1.0			1.0	1.0
Lane Grp Cap (vph)	878		537				111	2297			2001	895
v/s Ratio Prot	c0.23		0.00				c0.03	0.07			0.06	
v/s Ratio Perm			0.01									c0.63
v/c Ratio	0.90		0.02				0.78	0.11			0.11	1.11
Uniform Delay, d1	38.7		27.4				51.6	7.1			10.8	23.4
Progression Factor	1.00		1.00				1.00	1.00			1.00	1.00
Incremental Delay, d2	12.2		0.0				27.5	0.1			0.1	66.4
Delay (s)	51.0		27.4				79.1	7.2			10.9	89.7
Level of Service	D		C				E	A			B	F
Approach Delay (s)		49.7			0.0			25.2			79.4	
Approach LOS		D			A			C			E	

Intersection Summary			
HCM 2000 Control Delay	64.1	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.10		
Actuated Cycle Length (s)	107.5	Sum of lost time (s)	21.2
Intersection Capacity Utilization	94.2%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	160	180	590	480	0	900	0	510	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.8	4.8	5.5	4.8		5.5	5.5	5.5			
Lane Util. Factor		1.00	1.00	0.97	1.00		0.97	0.95	0.95			
Frt		1.00	0.85	1.00	1.00		1.00	0.85	0.85			
Flt Protected		1.00	1.00	0.95	1.00		0.95	1.00	1.00			
Satd. Flow (prot)		1863	1583	3433	1863		3433	1504	1504			
Flt Permitted		1.00	1.00	0.95	1.00		0.95	1.00	1.00			
Satd. Flow (perm)		1863	1583	3433	1863		3433	1504	1504			
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	174	196	641	522	0	978	0	554	0	0	0
RTOR Reduction (vph)	0	0	170	0	0	0	0	154	154	0	0	0
Lane Group Flow (vph)	0	174	26	641	522	0	978	123	123	0	0	0
Turn Type	Prot	NA	Prot	Prot	NA		Split	NA	Perm			
Protected Phases	7	4	4	3	8		2	2		6	6	
Permitted Phases									2			
Actuated Green, G (s)		12.5	12.5	24.3	42.3		42.3	42.3	42.3			
Effective Green, g (s)		12.5	12.5	24.3	42.3		42.3	42.3	42.3			
Actuated g/C Ratio		0.13	0.13	0.26	0.45		0.45	0.45	0.45			
Clearance Time (s)		4.8	4.8	5.5	4.8		5.5	5.5	5.5			
Vehicle Extension (s)		1.0	1.0	1.0	1.0		1.0	1.0	1.0			
Lane Grp Cap (vph)		245	208	879	830		1530	670	670			
v/s Ratio Prot		0.09	0.02	c0.19	c0.28		c0.28	0.08				
v/s Ratio Perm									0.08			
v/c Ratio		0.71	0.12	0.73	0.63		0.64	0.18	0.18			
Uniform Delay, d1		39.5	36.4	32.3	20.3		20.4	15.9	15.9			
Progression Factor		1.00	1.00	1.00	1.00		1.00	1.00	1.00			
Incremental Delay, d2		7.8	0.1	2.6	1.1		2.1	0.6	0.6			
Delay (s)		47.3	36.5	34.9	21.3		22.4	16.5	16.5			
Level of Service		D	D	C	C		C	B	B			
Approach Delay (s)		41.6			28.8			20.3			0.0	
Approach LOS		D			C			C			A	

Intersection Summary			
HCM 2000 Control Delay	26.1	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	94.9	Sum of lost time (s)	21.3
Intersection Capacity Utilization	67.4%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	213	7	100	10	10	10	160	1710	10	10	3200	310
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		0.98	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1900	1863	1863	1863	1863	1863	1900
Adj Flow Rate, veh/h	220	7	103	10	10	10	165	1763	10	10	3299	320
Adj No. of Lanes	2	1	1	1	1	0	2	3	1	1	4	0
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	195	246	208	12	69	69	149	3592	1118	12	4022	378
Arrive On Green	0.06	0.13	0.13	0.01	0.08	0.08	0.09	1.00	1.00	0.01	0.67	0.67
Sat Flow, veh/h	3442	1863	1576	1774	848	848	3442	5085	1583	1774	6005	564
Grp Volume(v), veh/h	220	7	103	10	0	20	165	1763	10	10	2619	1000
Grp Sat Flow(s),veh/h/ln	1721	1863	1576	1774	0	1695	1721	1695	1583	1774	1602	1763
Q Serve(g_s), s	8.5	0.5	9.1	0.8	0.0	1.6	6.5	0.0	0.0	0.8	59.3	64.9
Cycle Q Clear(g_c), s	8.5	0.5	9.1	0.8	0.0	1.6	6.5	0.0	0.0	0.8	59.3	64.9
Prop In Lane	1.00		1.00	1.00		0.50	1.00		1.00	1.00		0.32
Lane Grp Cap(c), veh/h	195	246	208	12	0	137	149	3592	1118	12	3219	1181
V/C Ratio(X)	1.13	0.03	0.49	0.83	0.00	0.15	1.11	0.49	0.01	0.83	0.81	0.85
Avail Cap(c_a), veh/h	195	550	465	41	0	441	149	3592	1118	41	3219	1181
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	0.00	1.00	0.90	0.90	0.90	1.00	1.00	1.00
Uniform Delay (d), s/veh	70.8	56.7	60.4	74.4	0.0	64.1	68.5	0.0	0.0	74.4	18.0	18.9
Incr Delay (d2), s/veh	103.1	0.0	0.7	38.2	0.0	0.2	101.1	0.4	0.0	38.2	2.4	7.6
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	6.8	0.3	4.0	0.5	0.0	0.8	5.2	0.1	0.0	0.5	26.7	33.9
LnGrp Delay(d),s/veh	173.8	56.7	61.1	112.6	0.0	64.3	169.6	0.4	0.0	112.6	20.3	26.5
LnGrp LOS	F	E	E	F		E	F	A	A	F	C	C
Approach Vol, veh/h		330			30			1938			3629	
Approach Delay, s/veh		136.2			80.4			14.8			22.3	
Approach LOS		F			F			B			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	12.0	106.0	14.0	18.0	6.5	111.4	6.3	25.7
Change Period (Y+Rc), s	5.5	* 5.5	5.5	5.9	5.5	* 5.5	* 5.3	* 5.9
Max Green Setting (Gmax), s	6.5	* 74	8.5	39.0	3.5	* 77	* 3.5	* 44
Max Q Clear Time (g_c+I1), s	8.5	66.9	10.5	3.6	2.8	2.0	2.8	11.1
Green Ext Time (p_c), s	0.0	5.4	0.0	0.1	0.0	18.7	0.0	0.1

Intersection Summary	
HCM 2010 Ctrl Delay	26.5
HCM 2010 LOS	C

Notes

* HCM 2010 computational engine requires equal clearance times for the phases crossing the barrier.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	1270	0	370	0	0	0	0	870	100	0	1160	910
Number	3	8	18				1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0				0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00				1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	0	1863				0	1863	1863	0	1863	1863
Adj Flow Rate, veh/h	1309	0	381				0	897	0	0	1196	0
Adj No. of Lanes	3	0	2				0	3	1	0	3	1
Peak Hour Factor	0.97	0.97	0.97				0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	2	0	2				0	2	2	0	2	2
Cap, veh/h	1503	0	837				0	3001	934	0	3001	934
Arrive On Green	0.30	0.00	0.30				0.00	0.59	0.00	0.00	1.00	0.00
Sat Flow, veh/h	5003	0	2787				0	5253	1583	0	5253	1583
Grp Volume(v), veh/h	1309	0	381				0	897	0	0	1196	0
Grp Sat Flow(s),veh/h/ln	1668	0	1393				0	1695	1583	0	1695	1583
Q Serve(g_s), s	18.6	0.0	8.3				0.0	6.6	0.0	0.0	0.0	0.0
Cycle Q Clear(g_c), s	18.6	0.0	8.3				0.0	6.6	0.0	0.0	0.0	0.0
Prop In Lane	1.00		1.00				0.00		1.00	0.00		1.00
Lane Grp Cap(c), veh/h	1503	0	837				0	3001	934	0	3001	934
V/C Ratio(X)	0.87	0.00	0.46				0.00	0.30	0.00	0.00	0.40	0.00
Avail Cap(c_a), veh/h	1634	0	910				0	3001	934	0	3001	934
HCM Platoon Ratio	1.00	1.00	1.00				1.00	1.00	1.00	1.00	2.00	2.00
Upstream Filter(I)	1.00	0.00	1.00				0.00	0.64	0.00	0.00	1.00	0.00
Uniform Delay (d), s/veh	24.9	0.0	21.3				0.0	7.6	0.0	0.0	0.0	0.0
Incr Delay (d2), s/veh	4.7	0.0	0.1				0.0	0.2	0.0	0.0	0.4	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0				0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	9.1	0.0	3.2				0.0	3.1	0.0	0.0	0.1	0.0
LnGrp Delay(d),s/veh	29.6	0.0	21.4				0.0	7.8	0.0	0.0	0.4	0.0
LnGrp LOS	C		C					A			A	
Approach Vol, veh/h		1690						897			1196	
Approach Delay, s/veh		27.7						7.8			0.4	
Approach LOS		C						A			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2				6		8
Phs Duration (G+Y+Rc), s		49.0				49.0		26.0
Change Period (Y+Rc), s		4.7				4.7		3.5
Max Green Setting (Gmax), s		42.3				42.3		24.5
Max Q Clear Time (g_c+I1), s		2.0				8.6		20.6
Green Ext Time (p_c), s		3.2				3.2		1.9

Intersection Summary	
HCM 2010 Ctrl Delay	14.4
HCM 2010 LOS	B



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	1350	70	40	370	1120	160
Number	7	14	5	2	6	16
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	1607	0	48	440	1333	0
Adj No. of Lanes	3	1	1	2	2	1
Peak Hour Factor	0.84	0.84	0.84	0.84	0.84	0.84
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	1848	585	61	1768	1483	663
Arrive On Green	0.37	0.00	0.03	0.50	0.42	0.00
Sat Flow, veh/h	5003	1583	1774	3632	3632	1583
Grp Volume(v), veh/h	1607	0	48	440	1333	0
Grp Sat Flow(s),veh/h/ln	1668	1583	1774	1770	1770	1583
Q Serve(g_s), s	22.5	0.0	2.0	5.4	26.5	0.0
Cycle Q Clear(g_c), s	22.5	0.0	2.0	5.4	26.5	0.0
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	1848	585	61	1768	1483	663
V/C Ratio(X)	0.87	0.00	0.79	0.25	0.90	0.00
Avail Cap(c_a), veh/h	2345	742	505	1768	1626	727
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	22.1	0.0	36.2	10.8	20.5	0.0
Incr Delay (d2), s/veh	2.6	0.0	8.4	0.0	6.4	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	10.7	0.0	1.1	2.6	14.1	0.0
LnGrp Delay(d),s/veh	24.7	0.0	44.6	10.8	26.9	0.0
LnGrp LOS	C		D	B	C	
Approach Vol, veh/h	1607			488	1333	
Approach Delay, s/veh	24.7			14.2	26.9	
Approach LOS	C			B	C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		
Phs Duration (G+Y+Rc), s		43.0		32.5	6.1	36.9		
Change Period (Y+Rc), s		5.3		4.6	3.5	5.3		
Max Green Setting (Gmax), s		34.7		35.4	21.5	34.7		
Max Q Clear Time (g_c+I1), s		7.4		24.5	4.0	28.5		
Green Ext Time (p_c), s		9.8		3.4	0.0	3.1		

Intersection Summary	
HCM 2010 Ctrl Delay	24.1
HCM 2010 LOS	C

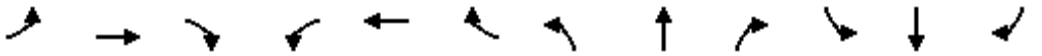
Intersection	
Int Delay, s/veh	1

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	80	490	1090	30	10	20
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	175	-	-	-	0	0
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	97	97	97	97	97	97
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	82	505	1124	31	10	21

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	1155	0	-	0	1557	577
Stage 1	-	-	-	-	1139	-
Stage 2	-	-	-	-	418	-
Critical Hdwy	4.14	-	-	-	6.84	6.94
Critical Hdwy Stg 1	-	-	-	-	5.84	-
Critical Hdwy Stg 2	-	-	-	-	5.84	-
Follow-up Hdwy	2.22	-	-	-	3.52	3.32
Pot Cap-1 Maneuver	601	-	-	-	103	460
Stage 1	-	-	-	-	267	-
Stage 2	-	-	-	-	632	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	601	-	-	-	89	460
Mov Cap-2 Maneuver	-	-	-	-	89	-
Stage 1	-	-	-	-	267	-
Stage 2	-	-	-	-	546	-

Approach	EB	WB	SB
HCM Control Delay, s	1.7	0	25.7
HCM LOS			D

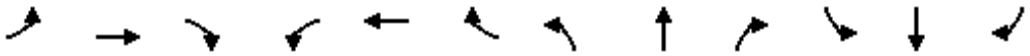
Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	601	-	-	-	89	460
HCM Lane V/C Ratio	0.137	-	-	-	0.116	0.045
HCM Control Delay (s)	11.9	-	-	-	50.7	13.2
HCM Lane LOS	B	-	-	-	F	B
HCM 95th %tile Q(veh)	0.5	-	-	-	0.4	0.1



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	490	140	300	560	290	3150	0	0	1770	80
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)			4.6	6.2	6.2	6.2	4.6	5.0			5.3	5.3
Lane Util. Factor			1.00	1.00	0.91	0.91	0.97	0.91			0.86	1.00
Frpb, ped/bikes			1.00	1.00	1.00	1.00	1.00	1.00			1.00	0.99
Flpb, ped/bikes			1.00	1.00	1.00	1.00	1.00	1.00			1.00	1.00
Frt			0.86	1.00	0.95	0.85	1.00	1.00			1.00	0.85
Flt Protected			1.00	0.95	1.00	1.00	0.95	1.00			1.00	1.00
Satd. Flow (prot)			1611	1770	1614	2882	3433	5085			6408	1563
Flt Permitted			1.00	0.95	1.00	1.00	0.95	1.00			1.00	1.00
Satd. Flow (perm)			1611	1770	1614	2882	3433	5085			6408	1563
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	516	147	316	589	305	3316	0	0	1863	84
RTOR Reduction (vph)	0	0	201	0	1	36	0	0	0	0	0	34
Lane Group Flow (vph)	0	0	315	147	462	406	305	3316	0	0	1863	50
Confl. Bikes (#/hr)												1
Turn Type			Over	Split	NA	Perm	Prot	NA			NA	Perm
Protected Phases			1	4	4		1	6			2	
Permitted Phases						4						2
Actuated Green, G (s)			31.5	42.8	42.8	42.8	31.5	96.0			59.6	59.6
Effective Green, g (s)			31.5	42.8	42.8	42.8	31.5	96.0			59.6	59.6
Actuated g/C Ratio			0.21	0.29	0.29	0.29	0.21	0.64			0.40	0.40
Clearance Time (s)			4.6	6.2	6.2	6.2	4.6	5.0			5.3	5.3
Vehicle Extension (s)			1.0	1.0	1.0	1.0	1.0	1.0			1.0	1.0
Lane Grp Cap (vph)			338	505	460	822	720	3254			2546	621
v/s Ratio Prot			0.20	0.08	c0.29		0.09	c0.65			0.29	
v/s Ratio Perm						0.14						0.03
v/c Ratio			0.93	0.29	1.00	0.49	0.42	1.02			0.73	0.08
Uniform Delay, d1			58.2	41.8	53.6	44.6	51.4	27.0			38.4	28.1
Progression Factor			1.00	1.00	1.00	1.00	1.02	0.96			0.74	0.50
Incremental Delay, d2			31.2	0.1	43.2	0.2	0.1	15.2			1.7	0.2
Delay (s)			89.4	41.9	96.8	44.8	52.2	41.2			30.1	14.2
Level of Service			F	D	F	D	D	D			C	B
Approach Delay (s)		89.4			67.3			42.1			29.4	
Approach LOS		F			E			D			C	

Intersection Summary			
HCM 2000 Control Delay	45.8	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	1.05		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	16.1
Intersection Capacity Utilization	92.8%	ICU Level of Service	F
Analysis Period (min)	15		

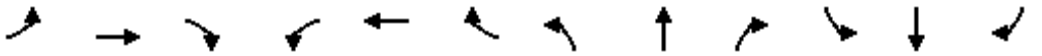
c Critical Lane Group



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	810	160	100	660	0	510	0	300	40	60	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.8		3.8	5.4		5.5		5.5		5.5	
Lane Util. Factor		0.95		1.00	0.95		1.00		1.00		0.95	
Frpb, ped/bikes		1.00		1.00	1.00		1.00		1.00		1.00	
Flpb, ped/bikes		1.00		1.00	1.00		1.00		1.00		1.00	
Frt		0.98		1.00	1.00		1.00		0.85		0.96	
Flt Protected		1.00		0.95	1.00		0.95		1.00		0.99	
Satd. Flow (prot)		3445		1770	3539		1770		1583		3340	
Flt Permitted		1.00		0.95	1.00		0.95		1.00		0.99	
Satd. Flow (perm)		3445		1770	3539		1770		1583		3340	
Peak-hour factor, PHF	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Adj. Flow (vph)	0	953	188	118	776	0	600	0	353	47	71	47
RTOR Reduction (vph)	0	7	0	0	0	0	0	0	112	0	24	0
Lane Group Flow (vph)	0	1134	0	118	776	0	600	0	241	0	141	0
Confl. Bikes (#/hr)			1						4			
Turn Type		NA		Prot	NA		Prot		Prot	Split	NA	
Protected Phases		6		5	2		3 8		3	4	4	
Permitted Phases												
Actuated Green, G (s)		63.3		14.7	81.2		56.2		34.6		10.6	
Effective Green, g (s)		63.3		14.7	81.2		56.2		34.6		10.6	
Actuated g/C Ratio		0.38		0.09	0.48		0.33		0.21		0.06	
Clearance Time (s)		4.8		3.8	5.4				5.5		5.5	
Vehicle Extension (s)		1.0		1.0	1.0				1.0		1.0	
Lane Grp Cap (vph)		1298		154	1711		592		326		210	
v/s Ratio Prot		c0.33		c0.07	0.22		c0.34		0.15		c0.04	
v/s Ratio Perm												
v/c Ratio		0.87		0.77	0.45		1.01		0.74		0.67	
Uniform Delay, d1		48.6		74.9	28.7		55.9		62.4		76.9	
Progression Factor		1.00		1.00	1.00		1.00		1.00		1.00	
Incremental Delay, d2		6.6		18.3	0.1		40.4		7.4		6.1	
Delay (s)		55.1		93.2	28.7		96.3		69.8		83.1	
Level of Service		E		F	C		F		E		F	
Approach Delay (s)		55.1			37.3			86.5			83.1	
Approach LOS		E			D			F			F	

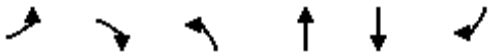
Intersection Summary			
HCM 2000 Control Delay	61.0	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	0.90		
Actuated Cycle Length (s)	167.9	Sum of lost time (s)	23.1
Intersection Capacity Utilization	78.6%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group



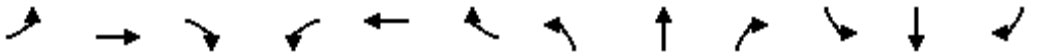
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	1010	120	390	460	30	220	10	190	50	0	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.9		4.9	5.0			4.9	4.9		4.8	4.8
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00	1.00		1.00	1.00
Frt	1.00	0.98		1.00	0.99			1.00	0.85		1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00			0.95	1.00		0.95	1.00
Satd. Flow (prot)	1770	3483		1770	3506			1778	1583		1770	1583
Flt Permitted	0.95	1.00		0.95	1.00			0.95	1.00		0.95	1.00
Satd. Flow (perm)	1770	3483		1770	3506			1778	1583		1770	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	11	1098	130	424	500	33	239	11	207	54	0	54
RTOR Reduction (vph)	0	5	0	0	2	0	0	0	174	0	0	51
Lane Group Flow (vph)	11	1223	0	424	531	0	0	250	33	0	54	3
Turn Type	Prot	NA		Prot	NA		Split	NA	Perm	Split	NA	Perm
Protected Phases	1	6		5	2		4	4		3	3	
Permitted Phases									4			3
Actuated Green, G (s)	1.4	53.2		35.7	87.8			21.5	21.5		6.6	6.6
Effective Green, g (s)	1.4	53.2		35.7	87.8			21.5	21.5		6.6	6.6
Actuated g/C Ratio	0.01	0.39		0.26	0.64			0.16	0.16		0.05	0.05
Clearance Time (s)	4.5	4.9		4.9	5.0			4.9	4.9		4.8	4.8
Vehicle Extension (s)	1.0	5.8		1.0	4.9			2.0	2.0		1.0	1.0
Lane Grp Cap (vph)	18	1357		462	2255			280	249		85	76
v/s Ratio Prot	0.01	c0.35		c0.24	0.15			c0.14			c0.03	
v/s Ratio Perm									0.02			0.00
v/c Ratio	0.61	0.90		0.92	0.24			0.89	0.13		0.64	0.03
Uniform Delay, d1	67.3	39.2		49.0	10.2			56.4	49.5		63.8	61.9
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00		1.00	1.00
Incremental Delay, d2	36.2	9.3		22.6	0.1			27.4	0.1		10.9	0.1
Delay (s)	103.5	48.5		71.6	10.3			83.8	49.6		74.6	62.0
Level of Service	F	D		E	B			F	D		E	E
Approach Delay (s)		49.0			37.5			68.3			68.3	
Approach LOS		D			D			E			E	

Intersection Summary			
HCM 2000 Control Delay	48.9	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.89		
Actuated Cycle Length (s)	136.5	Sum of lost time (s)	19.5
Intersection Capacity Utilization	85.0%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			



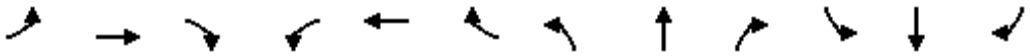
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	130	150	50	2030	640	1470
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.6	4.6	3.5	5.3	5.3	5.3
Lane Util. Factor	0.97	0.91	1.00	0.91	0.91	1.00
Frt	0.95	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.97	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	3326	1441	1770	5085	5085	1583
Flt Permitted	0.97	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	3326	1441	1770	5085	5085	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	137	158	53	2137	674	1547
RTOR Reduction (vph)	41	86	0	0	0	177
Lane Group Flow (vph)	161	7	53	2137	674	1370
Turn Type	Prot	Perm	Prot	NA	NA	Perm
Protected Phases	4		5	2	6	
Permitted Phases		4				6
Actuated Green, G (s)	11.1	11.1	5.1	121.5	112.9	112.9
Effective Green, g (s)	11.1	11.1	5.1	121.5	112.9	112.9
Actuated g/C Ratio	0.08	0.08	0.04	0.85	0.79	0.79
Clearance Time (s)	4.6	4.6	3.5	5.3	5.3	5.3
Vehicle Extension (s)	2.0	2.0	1.5	2.2	2.2	2.2
Lane Grp Cap (vph)	259	112	63	4335	4028	1254
v/s Ratio Prot	c0.05		c0.03	0.42	0.13	
v/s Ratio Perm		0.01				c0.87
v/c Ratio	0.62	0.06	0.84	0.49	0.17	1.09
Uniform Delay, d1	63.7	60.9	68.3	2.7	3.5	14.8
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	3.1	0.1	59.0	0.0	0.0	54.5
Delay (s)	66.7	61.0	127.3	2.7	3.6	69.3
Level of Service	E	E	F	A	A	E
Approach Delay (s)	64.9			5.7	49.4	
Approach LOS	E			A	D	

Intersection Summary			
HCM 2000 Control Delay	30.0	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	1.04		
Actuated Cycle Length (s)	142.5	Sum of lost time (s)	13.4
Intersection Capacity Utilization	103.8%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	1360	0	20	0	0	0	60	400	0	0	80	430
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.5		5.5				5.5	4.7			4.7	4.7
Lane Util. Factor	0.97		1.00				0.97	0.95			0.95	1.00
Frt	1.00		0.85				1.00	1.00			1.00	0.85
Flt Protected	0.95		1.00				0.95	1.00			1.00	1.00
Satd. Flow (prot)	3433		1583				3433	3539			3539	1583
Flt Permitted	0.95		1.00				0.95	1.00			1.00	1.00
Satd. Flow (perm)	3433		1583				3433	3539			3539	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	1478	0	22	0	0	0	65	435	0	0	87	467
RTOR Reduction (vph)	0	0	9	0	0	0	0	0	0	0	0	331
Lane Group Flow (vph)	1478	0	13	0	0	0	65	435	0	0	87	136
Turn Type	Prot		pm+ov	Prot		pm+ov	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	7	4	1	3	8	5	1	6		5	2	
Permitted Phases			4			8			6			2
Actuated Green, G (s)	60.5		64.1				3.6	41.8			32.7	32.7
Effective Green, g (s)	60.5		64.1				3.6	41.8			32.7	32.7
Actuated g/C Ratio	0.54		0.57				0.03	0.37			0.29	0.29
Clearance Time (s)	5.5		5.5				5.5	4.7			4.7	4.7
Vehicle Extension (s)	3.0		3.0				3.0	3.0			3.0	3.0
Lane Grp Cap (vph)	1846		979				109	1314			1028	460
v/s Ratio Prot	c0.43		0.00				0.02	c0.12			0.02	
v/s Ratio Perm			0.01									0.09
v/c Ratio	0.80		0.01				0.60	0.33			0.08	0.30
Uniform Delay, d1	21.1		10.5				53.7	25.3			29.0	31.0
Progression Factor	1.00		1.00				1.00	1.00			1.00	1.00
Incremental Delay, d2	2.6		0.0				8.5	0.7			0.2	1.6
Delay (s)	23.7		10.5				62.2	26.0			29.2	32.6
Level of Service	C		B				E	C			C	C
Approach Delay (s)		23.5			0.0			30.7			32.1	
Approach LOS		C			A			C			C	

Intersection Summary			
HCM 2000 Control Delay	26.8	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.68		
Actuated Cycle Length (s)	112.5	Sum of lost time (s)	21.2
Intersection Capacity Utilization	58.4%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	660	660	720	590	0	130	0	360	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.8	4.8	5.5	4.8		5.5	5.5	5.5			
Lane Util. Factor		1.00	1.00	0.97	1.00		0.97	0.95	0.95			
Frt		1.00	0.85	1.00	1.00		1.00	0.85	0.85			
Flt Protected		1.00	1.00	0.95	1.00		0.95	1.00	1.00			
Satd. Flow (prot)		1863	1583	3433	1863		3433	1504	1504			
Flt Permitted		1.00	1.00	0.95	1.00		0.95	1.00	1.00			
Satd. Flow (perm)		1863	1583	3433	1863		3433	1504	1504			
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	717	717	783	641	0	141	0	391	0	0	0
RTOR Reduction (vph)	0	0	238	0	0	0	0	151	151	0	0	0
Lane Group Flow (vph)	0	717	479	783	641	0	141	45	44	0	0	0
Turn Type	Prot	NA	Prot	Prot	NA		Split	NA	Perm			
Protected Phases	7	4	4	3	8		2	2		6	6	
Permitted Phases									2			
Actuated Green, G (s)		47.2	47.2	25.5	78.2		26.0	26.0	26.0			
Effective Green, g (s)		47.2	47.2	25.5	78.2		26.0	26.0	26.0			
Actuated g/C Ratio		0.41	0.41	0.22	0.68		0.23	0.23	0.23			
Clearance Time (s)		4.8	4.8	5.5	4.8		5.5	5.5	5.5			
Vehicle Extension (s)		3.0	3.0	3.0	3.0		3.0	3.0	3.0			
Lane Grp Cap (vph)		767	652	764	1272		779	341	341			
v/s Ratio Prot		c0.38	0.30	c0.23	0.34		c0.04	0.03				
v/s Ratio Perm									0.03			
v/c Ratio		0.93	0.73	1.02	0.50		0.18	0.13	0.13			
Uniform Delay, d1		32.2	28.4	44.5	8.8		35.7	35.2	35.2			
Progression Factor		1.00	1.00	1.00	1.00		1.00	1.00	1.00			
Incremental Delay, d2		18.4	4.3	39.0	0.3		0.5	0.8	0.8			
Delay (s)		50.6	32.7	83.5	9.1		36.2	36.0	36.0			
Level of Service		D	C	F	A		D	D	D			
Approach Delay (s)		41.6			50.0			36.1			0.0	
Approach LOS		D			D			D			A	

Intersection Summary			
HCM 2000 Control Delay	44.3	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.80		
Actuated Cycle Length (s)	114.5	Sum of lost time (s)	21.3
Intersection Capacity Utilization	75.9%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	300	10	240	40	10	10	70	3580	60	30	1570	230
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		0.98	1.00		1.00	1.00		0.99
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1900	1863	1863	1863	1863	1863	1900
Adj Flow Rate, veh/h	312	10	250	42	10	10	73	3729	62	31	1635	240
Adj No. of Lanes	2	1	1	1	1	0	2	3	1	1	4	0
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	218	326	277	54	119	119	112	3186	992	35	3484	511
Arrive On Green	0.06	0.18	0.18	0.03	0.14	0.14	0.06	1.00	1.00	0.02	0.61	0.61
Sat Flow, veh/h	3442	1863	1583	1774	845	845	3442	5085	1583	1774	5675	833
Grp Volume(v), veh/h	312	10	250	42	0	20	73	3729	62	31	1385	490
Grp Sat Flow(s),veh/h/ln	1721	1863	1583	1774	0	1690	1721	1695	1583	1774	1602	1702
Q Serve(g_s), s	9.5	0.7	23.2	3.5	0.0	1.5	3.1	0.0	0.0	2.6	23.4	23.4
Cycle Q Clear(g_c), s	9.5	0.7	23.2	3.5	0.0	1.5	3.1	0.0	0.0	2.6	23.4	23.4
Prop In Lane	1.00		1.00	1.00		0.50	1.00		1.00	1.00		0.49
Lane Grp Cap(c), veh/h	218	326	277	54	0	238	112	3186	992	35	2951	1045
V/C Ratio(X)	1.43	0.03	0.90	0.78	0.00	0.08	0.65	1.17	0.06	0.87	0.47	0.47
Avail Cap(c_a), veh/h	218	493	419	108	0	439	161	3186	992	35	2951	1045
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	0.00	1.00	0.18	0.18	0.18	1.00	1.00	1.00
Uniform Delay (d), s/veh	70.3	51.3	60.6	72.2	0.0	56.0	69.3	0.0	0.0	73.3	15.7	15.7
Incr Delay (d2), s/veh	218.5	0.0	12.1	8.6	0.0	0.1	0.4	77.5	0.0	98.5	0.5	1.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	11.1	0.3	11.1	1.9	0.0	0.7	1.5	22.9	0.0	2.3	10.5	11.5
LnGrp Delay(d),s/veh	288.7	51.3	72.7	80.8	0.0	56.1	69.7	77.5	0.0	171.9	16.2	17.2
LnGrp LOS	F	D	E	F		E	E	F	A	F	B	B
Approach Vol, veh/h		572			62			3864			1906	
Approach Delay, s/veh		190.1			72.8			76.1			19.0	
Approach LOS		F			E			E			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	10.4	97.6	15.0	27.0	8.5	99.5	9.9	32.2
Change Period (Y+Rc), s	5.5	* 5.5	5.5	5.9	5.5	* 5.5	* 5.3	* 5.9
Max Green Setting (Gmax), s	7.0	* 72	9.5	39.0	3.0	* 76	* 9.1	* 40
Max Q Clear Time (g_c+I1), s	5.1	25.4	11.5	3.5	4.6	2.0	5.5	25.2
Green Ext Time (p_c), s	0.0	24.7	0.0	0.3	0.0	29.4	0.0	0.3

Intersection Summary	
HCM 2010 Ctrl Delay	69.3
HCM 2010 LOS	E

Notes

* HCM 2010 computational engine requires equal clearance times for the phases crossing the barrier.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	2220	0	240	0	0	0	0	1580	180	0	270	860
Number	3	8	18				1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0				0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00				1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	0	1863				0	1863	1863	0	1863	1863
Adj Flow Rate, veh/h	2387	0	258				0	1699	0	0	290	0
Adj No. of Lanes	3	0	2				0	3	1	0	3	1
Peak Hour Factor	0.93	0.93	0.93				0.93	0.93	0.93	0.93	0.93	0.93
Percent Heavy Veh, %	2	0	2				0	2	2	0	2	2
Cap, veh/h	2527	0	1408				0	1960	610	0	1960	610
Arrive On Green	0.51	0.00	0.51				0.00	0.39	0.00	0.00	0.64	0.00
Sat Flow, veh/h	5003	0	2787				0	5253	1583	0	5253	1583
Grp Volume(v), veh/h	2387	0	258				0	1699	0	0	290	0
Grp Sat Flow(s),veh/h/ln	1668	0	1393				0	1695	1583	0	1695	1583
Q Serve(g_s), s	33.9	0.0	3.8				0.0	23.1	0.0	0.0	1.7	0.0
Cycle Q Clear(g_c), s	33.9	0.0	3.8				0.0	23.1	0.0	0.0	1.7	0.0
Prop In Lane	1.00		1.00				0.00		1.00	0.00		1.00
Lane Grp Cap(c), veh/h	2527	0	1408				0	1960	610	0	1960	610
V/C Ratio(X)	0.94	0.00	0.18				0.00	0.87	0.00	0.00	0.15	0.00
Avail Cap(c_a), veh/h	2568	0	1430				0	1960	610	0	1960	610
HCM Platoon Ratio	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.67	1.67
Upstream Filter(I)	1.00	0.00	1.00				0.00	0.66	0.00	0.00	1.00	0.00
Uniform Delay (d), s/veh	17.6	0.0	10.1				0.0	21.3	0.0	0.0	8.5	0.0
Incr Delay (d2), s/veh	8.0	0.0	0.0				0.0	3.7	0.0	0.0	0.2	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0				0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	17.3	0.0	1.4				0.0	11.4	0.0	0.0	0.8	0.0
LnGrp Delay(d),s/veh	25.5	0.0	10.1				0.0	25.0	0.0	0.0	8.7	0.0
LnGrp LOS	C		B					C			A	
Approach Vol, veh/h		2645						1699			290	
Approach Delay, s/veh		24.0						25.0			8.7	
Approach LOS		C						C			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2				6		8
Phs Duration (G+Y+Rc), s		33.6				33.6		41.4
Change Period (Y+Rc), s		4.7				4.7		3.5
Max Green Setting (Gmax), s		28.3				28.3		38.5
Max Q Clear Time (g_c+I1), s		3.7				25.1		35.9
Green Ext Time (p_c), s		3.1				1.4		2.0

Intersection Summary	
HCM 2010 Ctrl Delay	23.4
HCM 2010 LOS	C



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	1130	230	300	950	650	140
Number	7	14	5	2	6	16
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	1177	0	312	990	677	0
Adj No. of Lanes	3	1	1	2	2	1
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	1455	460	363	1967	1050	470
Arrive On Green	0.29	0.00	0.20	0.56	0.30	0.00
Sat Flow, veh/h	5003	1583	1774	3632	3632	1583
Grp Volume(v), veh/h	1177	0	312	990	677	0
Grp Sat Flow(s),veh/h/ln	1668	1583	1774	1770	1770	1583
Q Serve(g_s), s	14.1	0.0	10.9	11.1	10.7	0.0
Cycle Q Clear(g_c), s	14.1	0.0	10.9	11.1	10.7	0.0
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	1455	460	363	1967	1050	470
V/C Ratio(X)	0.81	0.00	0.86	0.50	0.64	0.00
Avail Cap(c_a), veh/h	2747	869	592	1967	1905	852
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	21.2	0.0	24.7	8.8	19.7	0.0
Incr Delay (d2), s/veh	0.4	0.0	3.7	0.1	0.4	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	6.5	0.0	5.8	5.4	5.2	0.0
LnGrp Delay(d),s/veh	21.6	0.0	28.5	8.9	20.1	0.0
LnGrp LOS	C		C	A	C	
Approach Vol, veh/h	1177			1302	677	
Approach Delay, s/veh	21.6			13.6	20.1	
Approach LOS	C			B	C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		
Phs Duration (G+Y+Rc), s		41.1		23.3	16.7	24.4		
Change Period (Y+Rc), s		5.3		4.6	3.5	5.3		
Max Green Setting (Gmax), s		34.7		35.4	21.5	34.7		
Max Q Clear Time (g_c+I1), s		13.1		16.1	12.9	12.7		
Green Ext Time (p_c), s		8.0		2.7	0.3	6.4		

Intersection Summary	
HCM 2010 Ctrl Delay	18.0
HCM 2010 LOS	B

Intersection	
Int Delay, s/veh	1.2

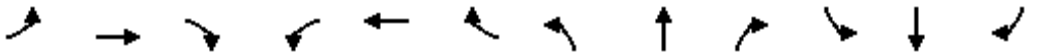
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	40	1110	710	20	30	50
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	175	-	-	-	0	0
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	94	94	94	94	94	94
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	43	1181	755	21	32	53

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	777	0	-	0	1442	388
Stage 1	-	-	-	-	766	-
Stage 2	-	-	-	-	676	-
Critical Hdwy	4.14	-	-	-	6.84	6.94
Critical Hdwy Stg 1	-	-	-	-	5.84	-
Critical Hdwy Stg 2	-	-	-	-	5.84	-
Follow-up Hdwy	2.22	-	-	-	3.52	3.32
Pot Cap-1 Maneuver	835	-	-	-	123	611
Stage 1	-	-	-	-	419	-
Stage 2	-	-	-	-	467	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	835	-	-	-	117	611
Mov Cap-2 Maneuver	-	-	-	-	117	-
Stage 1	-	-	-	-	419	-
Stage 2	-	-	-	-	443	-

Approach	EB	WB	SB
HCM Control Delay, s	0.3	0	24.8
HCM LOS			C

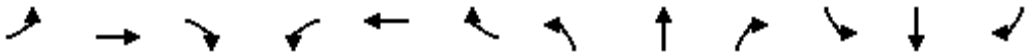
Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	835	-	-	-	117	611
HCM Lane V/C Ratio	0.051	-	-	-	0.273	0.087
HCM Control Delay (s)	9.5	-	-	-	46.9	11.5
HCM Lane LOS	A	-	-	-	E	B
HCM 95th %tile Q(veh)	0.2	-	-	-	1	0.3

Appendix A5
Opening Year (2022) with Alternative 1/1A
Synchro Calculations



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	390	90	160	610	430	1270	0	0	3150	160
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)			4.6		6.2	6.2	4.6	5.0			5.3	5.3
Lane Util. Factor			1.00		1.00	0.88	0.97	0.91			0.86	1.00
Frpb, ped/bikes			1.00		1.00	1.00	1.00	1.00			1.00	0.98
Flpb, ped/bikes			1.00		1.00	1.00	1.00	1.00			1.00	1.00
Frt			0.86		1.00	0.85	1.00	1.00			1.00	0.85
Flt Protected			1.00		0.98	1.00	0.95	1.00			1.00	1.00
Satd. Flow (prot)			1611		1830	2787	3433	5085			6408	1559
Flt Permitted			1.00		0.98	1.00	0.95	1.00			1.00	1.00
Satd. Flow (perm)			1611		1830	2787	3433	5085			6408	1559
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	0	0	406	94	167	635	448	1323	0	0	3281	167
RTOR Reduction (vph)	0	0	115	0	0	155	0	0	0	0	0	39
Lane Group Flow (vph)	0	0	291	0	261	480	448	1323	0	0	3281	128
Confl. Peds. (#/hr)												1
Confl. Bikes (#/hr)												2
Turn Type			Over	Split	NA	Perm	Prot	NA			NA	Perm
Protected Phases			1	4	4		1	6			2	
Permitted Phases						4						2
Actuated Green, G (s)			29.3		26.0	26.0	29.3	112.8			78.6	78.6
Effective Green, g (s)			29.3		26.0	26.0	29.3	112.8			78.6	78.6
Actuated g/C Ratio			0.20		0.17	0.17	0.20	0.75			0.52	0.52
Clearance Time (s)			4.6		6.2	6.2	4.6	5.0			5.3	5.3
Vehicle Extension (s)			1.0		1.0	1.0	1.0	1.0			1.0	1.0
Lane Grp Cap (vph)			314		317	483	670	3823			3357	816
v/s Ratio Prot			c0.18		0.14		0.13	0.26			c0.51	
v/s Ratio Perm						c0.17						0.08
v/c Ratio			0.93		0.82	0.99	0.67	0.35			0.98	0.16
Uniform Delay, d1			59.3		59.8	61.9	55.9	6.2			34.8	18.5
Progression Factor			1.00		1.00	1.00	0.91	0.84			0.52	0.28
Incremental Delay, d2			31.6		15.0	39.3	1.6	0.2			7.7	0.2
Delay (s)			90.9		74.8	101.2	52.6	5.4			26.0	5.4
Level of Service			F		E	F	D	A			C	A
Approach Delay (s)		90.9			93.5			17.4			25.0	
Approach LOS		F			F			B			C	

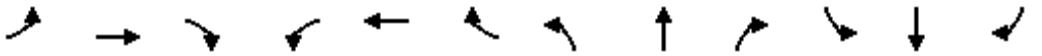
Intersection Summary			
HCM 2000 Control Delay	36.4	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.97		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	16.1
Intersection Capacity Utilization	96.6%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	270	340	280	830	0	250	0	200	100	190	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.8		3.8	5.4		5.5		5.5		5.5	
Lane Util. Factor		0.95		1.00	0.95		1.00		1.00		0.95	
Frpb, ped/bikes		0.99		1.00	1.00		1.00		1.00		1.00	
Flpb, ped/bikes		1.00		1.00	1.00		1.00		1.00		1.00	
Frt		0.92		1.00	1.00		1.00		0.85		0.99	
Flt Protected		1.00		0.95	1.00		0.95		1.00		0.98	
Satd. Flow (prot)		3219		1770	3539		1770		1583		3463	
Flt Permitted		1.00		0.95	1.00		0.95		1.00		0.98	
Satd. Flow (perm)		3219		1770	3539		1770		1583		3463	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	287	362	298	883	0	266	0	213	106	202	11
RTOR Reduction (vph)	0	134	0	0	0	0	0	0	166	0	2	0
Lane Group Flow (vph)	0	515	0	298	883	0	266	0	47	0	317	0
Confl. Bikes (#/hr)			1						2			
Turn Type		NA		Prot	NA		Prot		Prot	Split	NA	
Protected Phases		6		5	2		3 8		3	4	4	
Permitted Phases												
Actuated Green, G (s)		22.5		21.6	47.3		24.6		14.4		14.6	
Effective Green, g (s)		22.5		21.6	47.3		24.6		14.4		14.6	
Actuated g/C Ratio		0.21		0.20	0.44		0.23		0.14		0.14	
Clearance Time (s)		4.8		3.8	5.4				5.5		5.5	
Vehicle Extension (s)		1.0		1.0	1.0				1.0		1.0	
Lane Grp Cap (vph)		680		359	1573		409		214		475	
v/s Ratio Prot		c0.16		c0.17	0.25		c0.15		0.03		c0.09	
v/s Ratio Perm												
v/c Ratio		0.76		0.83	0.56		0.65		0.22		0.67	
Uniform Delay, d1		39.4		40.6	21.9		37.0		41.0		43.6	
Progression Factor		1.00		1.00	1.00		1.00		1.00		1.00	
Incremental Delay, d2		4.3		14.3	0.3		2.8		0.2		2.8	
Delay (s)		43.7		55.0	22.1		39.8		41.2		46.4	
Level of Service		D		D	C		D		D		D	
Approach Delay (s)		43.7			30.4			40.4			46.4	
Approach LOS		D			C			D			D	

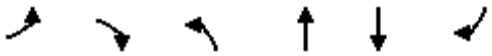
Intersection Summary			
HCM 2000 Control Delay	37.5	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.73		
Actuated Cycle Length (s)	106.4	Sum of lost time (s)	23.1
Intersection Capacity Utilization	71.5%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	270	210	270	860	60	250	10	130	10	0	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.9		4.9	5.0			4.9	4.9		4.8	4.8
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00	1.00		1.00	1.00
Frt	1.00	0.93		1.00	0.99			1.00	0.85		1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00			0.95	1.00		0.95	1.00
Satd. Flow (prot)	1770	3307		1770	3505			1777	1583		1770	1583
Flt Permitted	0.95	1.00		0.95	1.00			0.95	1.00		0.95	1.00
Satd. Flow (perm)	1770	3307		1770	3505			1777	1583		1770	1583
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	22	297	231	297	945	66	275	11	143	11	0	11
RTOR Reduction (vph)	0	90	0	0	2	0	0	0	109	0	0	11
Lane Group Flow (vph)	22	438	0	297	1009	0	0	286	34	0	11	0
Turn Type	Prot	NA		Prot	NA		Split	NA	Perm	Split	NA	Perm
Protected Phases	1	6		5	2		4	4		3	3	
Permitted Phases									4			3
Actuated Green, G (s)	3.0	27.8		21.4	46.5			21.7	21.7		2.5	2.5
Effective Green, g (s)	3.0	27.8		21.4	46.5			21.7	21.7		2.5	2.5
Actuated g/C Ratio	0.03	0.30		0.23	0.50			0.23	0.23		0.03	0.03
Clearance Time (s)	4.5	4.9		4.9	5.0			4.9	4.9		4.8	4.8
Vehicle Extension (s)	1.0	5.8		1.0	4.9			2.0	2.0		1.0	1.0
Lane Grp Cap (vph)	57	989		407	1754			415	369		47	42
v/s Ratio Prot	0.01	0.13		c0.17	c0.29			c0.16			c0.01	
v/s Ratio Perm									0.02			0.00
v/c Ratio	0.39	0.44		0.73	0.57			0.69	0.09		0.23	0.01
Uniform Delay, d1	44.0	26.3		33.1	16.3			32.5	27.9		44.3	44.0
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00		1.00	1.00
Incremental Delay, d2	1.6	0.8		5.5	0.7			3.8	0.0		0.9	0.0
Delay (s)	45.6	27.1		38.6	17.0			36.3	27.9		45.2	44.0
Level of Service	D	C		D	B			D	C		D	D
Approach Delay (s)		27.9			21.9			33.5			44.6	
Approach LOS		C			C			C			D	

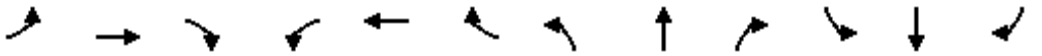
Intersection Summary			
HCM 2000 Control Delay	25.7	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	92.9	Sum of lost time (s)	19.5
Intersection Capacity Utilization	62.5%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	80	240	60	1660	1040	1380
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.6	4.6	3.5	5.3	5.3	5.3
Lane Util. Factor	0.97	0.91	1.00	0.91	0.91	1.00
Frt	0.91	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.98	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	3224	1441	1770	5085	5085	1583
Flt Permitted	0.98	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	3224	1441	1770	5085	5085	1583
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	90	270	67	1865	1169	1551
RTOR Reduction (vph)	121	121	0	0	0	351
Lane Group Flow (vph)	104	14	67	1865	1169	1200
Turn Type	Prot	Perm	Prot	NA	NA	Perm
Protected Phases	4		5	2	6	
Permitted Phases		4				6
Actuated Green, G (s)	7.0	7.0	4.3	48.4	40.6	40.6
Effective Green, g (s)	7.0	7.0	4.3	48.4	40.6	40.6
Actuated g/C Ratio	0.11	0.11	0.07	0.74	0.62	0.62
Clearance Time (s)	4.6	4.6	3.5	5.3	5.3	5.3
Vehicle Extension (s)	2.0	2.0	1.5	2.2	2.2	2.2
Lane Grp Cap (vph)	345	154	116	3768	3161	984
v/s Ratio Prot	c0.03		0.04	c0.37	0.23	
v/s Ratio Perm		0.01				c0.76
v/c Ratio	0.30	0.09	0.58	0.49	0.37	1.22
Uniform Delay, d1	26.9	26.3	29.6	3.5	6.1	12.3
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.2	0.1	4.3	0.1	0.0	108.2
Delay (s)	27.1	26.4	33.9	3.5	6.1	120.6
Level of Service	C	C	C	A	A	F
Approach Delay (s)	26.8			4.6	71.4	
Approach LOS	C			A	E	

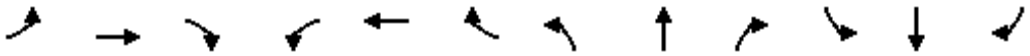
Intersection Summary			
HCM 2000 Control Delay	42.4	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	1.05		
Actuated Cycle Length (s)	65.3	Sum of lost time (s)	13.4
Intersection Capacity Utilization	98.2%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	730	0	40	0	0	0	80	240	0	0	200	1330
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.5		5.5				5.5	4.7			4.7	4.7
Lane Util. Factor	0.97		1.00				0.97	0.95			0.95	1.00
Frt	1.00		0.85				1.00	1.00			1.00	0.85
Flt Protected	0.95		1.00				0.95	1.00			1.00	1.00
Satd. Flow (prot)	3433		1583				3433	3539			3539	1583
Flt Permitted	0.95		1.00				0.95	1.00			1.00	1.00
Satd. Flow (perm)	3433		1583				3433	3539			3539	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	793	0	43	0	0	0	87	261	0	0	217	1446
RTOR Reduction (vph)	0	0	31	0	0	0	0	0	0	0	0	449
Lane Group Flow (vph)	793	0	12	0	0	0	87	261	0	0	217	997
Turn Type	Prot		pm+ov	Prot		pm+ov	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	7	4	1	3	8	5	1	6		5	2	
Permitted Phases			4			8			6			2
Actuated Green, G (s)	27.5		31.0				3.5	69.8			60.8	60.8
Effective Green, g (s)	27.5		31.0				3.5	69.8			60.8	60.8
Actuated g/C Ratio	0.26		0.29				0.03	0.65			0.57	0.57
Clearance Time (s)	5.5		5.5				5.5	4.7			4.7	4.7
Vehicle Extension (s)	1.0		1.0				1.0	1.0			1.0	1.0
Lane Grp Cap (vph)	878		537				111	2297			2001	895
v/s Ratio Prot	c0.23		0.00				c0.03	0.07			0.06	
v/s Ratio Perm			0.01									c0.63
v/c Ratio	0.90		0.02				0.78	0.11			0.11	1.11
Uniform Delay, d1	38.7		27.4				51.6	7.1			10.8	23.4
Progression Factor	1.00		1.00				1.00	1.00			1.00	1.00
Incremental Delay, d2	12.2		0.0				27.5	0.1			0.1	66.4
Delay (s)	51.0		27.4				79.1	7.2			10.9	89.7
Level of Service	D		C				E	A			B	F
Approach Delay (s)		49.7			0.0			25.2			79.4	
Approach LOS		D			A			C			E	

Intersection Summary			
HCM 2000 Control Delay	64.1	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.10		
Actuated Cycle Length (s)	107.5	Sum of lost time (s)	21.2
Intersection Capacity Utilization	94.2%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	160	180	590	480	0	900	0	510	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.8	4.8	5.5	4.8		5.5	5.5	5.5			
Lane Util. Factor		1.00	1.00	0.97	1.00		0.97	0.95	0.95			
Frt		1.00	0.85	1.00	1.00		1.00	0.85	0.85			
Flt Protected		1.00	1.00	0.95	1.00		0.95	1.00	1.00			
Satd. Flow (prot)		1863	1583	3433	1863		3433	1504	1504			
Flt Permitted		1.00	1.00	0.95	1.00		0.95	1.00	1.00			
Satd. Flow (perm)		1863	1583	3433	1863		3433	1504	1504			
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	174	196	641	522	0	978	0	554	0	0	0
RTOR Reduction (vph)	0	0	170	0	0	0	0	154	154	0	0	0
Lane Group Flow (vph)	0	174	26	641	522	0	978	123	123	0	0	0
Turn Type	Prot	NA	Prot	Prot	NA		Split	NA	Perm			
Protected Phases	7	4	4	3	8		2	2		6	6	
Permitted Phases									2			
Actuated Green, G (s)		12.5	12.5	24.3	42.3		42.3	42.3	42.3			
Effective Green, g (s)		12.5	12.5	24.3	42.3		42.3	42.3	42.3			
Actuated g/C Ratio		0.13	0.13	0.26	0.45		0.45	0.45	0.45			
Clearance Time (s)		4.8	4.8	5.5	4.8		5.5	5.5	5.5			
Vehicle Extension (s)		1.0	1.0	1.0	1.0		1.0	1.0	1.0			
Lane Grp Cap (vph)		245	208	879	830		1530	670	670			
v/s Ratio Prot		0.09	0.02	c0.19	c0.28		c0.28	0.08				
v/s Ratio Perm									0.08			
v/c Ratio		0.71	0.12	0.73	0.63		0.64	0.18	0.18			
Uniform Delay, d1		39.5	36.4	32.3	20.3		20.4	15.9	15.9			
Progression Factor		1.00	1.00	1.00	1.00		1.00	1.00	1.00			
Incremental Delay, d2		7.8	0.1	2.6	1.1		2.1	0.6	0.6			
Delay (s)		47.3	36.5	34.9	21.3		22.4	16.5	16.5			
Level of Service		D	D	C	C		C	B	B			
Approach Delay (s)		41.6			28.8			20.3			0.0	
Approach LOS		D			C			C			A	

Intersection Summary			
HCM 2000 Control Delay	26.1	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	94.9	Sum of lost time (s)	21.3
Intersection Capacity Utilization	67.4%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	213	7	100	10	10	10	160	1710	10	10	3200	310
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		0.98	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1900	1863	1863	1863	1863	1863	1900
Adj Flow Rate, veh/h	220	7	103	10	10	10	165	1763	10	10	3299	320
Adj No. of Lanes	2	1	1	1	1	0	2	3	1	1	4	0
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	195	246	208	12	69	69	149	3592	1118	12	4022	378
Arrive On Green	0.06	0.13	0.13	0.01	0.08	0.08	0.09	1.00	1.00	0.01	0.67	0.67
Sat Flow, veh/h	3442	1863	1576	1774	848	848	3442	5085	1583	1774	6005	564
Grp Volume(v), veh/h	220	7	103	10	0	20	165	1763	10	10	2619	1000
Grp Sat Flow(s),veh/h/ln	1721	1863	1576	1774	0	1695	1721	1695	1583	1774	1602	1763
Q Serve(g_s), s	8.5	0.5	9.1	0.8	0.0	1.6	6.5	0.0	0.0	0.8	59.3	64.9
Cycle Q Clear(g_c), s	8.5	0.5	9.1	0.8	0.0	1.6	6.5	0.0	0.0	0.8	59.3	64.9
Prop In Lane	1.00		1.00	1.00		0.50	1.00		1.00	1.00		0.32
Lane Grp Cap(c), veh/h	195	246	208	12	0	137	149	3592	1118	12	3219	1181
V/C Ratio(X)	1.13	0.03	0.49	0.83	0.00	0.15	1.11	0.49	0.01	0.83	0.81	0.85
Avail Cap(c_a), veh/h	195	550	465	41	0	441	149	3592	1118	41	3219	1181
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	0.00	1.00	0.90	0.90	0.90	1.00	1.00	1.00
Uniform Delay (d), s/veh	70.8	56.7	60.4	74.4	0.0	64.1	68.5	0.0	0.0	74.4	18.0	18.9
Incr Delay (d2), s/veh	103.1	0.0	0.7	38.2	0.0	0.2	101.1	0.4	0.0	38.2	2.4	7.6
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	6.8	0.3	4.0	0.5	0.0	0.8	5.2	0.1	0.0	0.5	26.7	33.9
LnGrp Delay(d),s/veh	173.8	56.7	61.1	112.6	0.0	64.3	169.6	0.4	0.0	112.6	20.3	26.5
LnGrp LOS	F	E	E	F		E	F	A	A	F	C	C
Approach Vol, veh/h		330			30			1938			3629	
Approach Delay, s/veh		136.2			80.4			14.8			22.3	
Approach LOS		F			F			B			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	12.0	106.0	14.0	18.0	6.5	111.4	6.3	25.7
Change Period (Y+Rc), s	5.5	* 5.5	5.5	5.9	5.5	* 5.5	* 5.3	* 5.9
Max Green Setting (Gmax), s	6.5	* 74	8.5	39.0	3.5	* 77	* 3.5	* 44
Max Q Clear Time (g_c+I1), s	8.5	66.9	10.5	3.6	2.8	2.0	2.8	11.1
Green Ext Time (p_c), s	0.0	5.4	0.0	0.1	0.0	18.7	0.0	0.1

Intersection Summary	
HCM 2010 Ctrl Delay	26.5
HCM 2010 LOS	C

Notes

* HCM 2010 computational engine requires equal clearance times for the phases crossing the barrier.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	1270	0	370	0	0	0	0	870	100	0	1160	910
Number	3	8	18				1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0				0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00				1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	0	1863				0	1863	1863	0	1863	1863
Adj Flow Rate, veh/h	1309	0	381				0	897	0	0	1196	0
Adj No. of Lanes	3	0	2				0	3	1	0	3	1
Peak Hour Factor	0.97	0.97	0.97				0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	2	0	2				0	2	2	0	2	2
Cap, veh/h	1503	0	837				0	3001	934	0	3001	934
Arrive On Green	0.30	0.00	0.30				0.00	0.59	0.00	0.00	1.00	0.00
Sat Flow, veh/h	5003	0	2787				0	5253	1583	0	5253	1583
Grp Volume(v), veh/h	1309	0	381				0	897	0	0	1196	0
Grp Sat Flow(s),veh/h/ln	1668	0	1393				0	1695	1583	0	1695	1583
Q Serve(g_s), s	18.6	0.0	8.3				0.0	6.6	0.0	0.0	0.0	0.0
Cycle Q Clear(g_c), s	18.6	0.0	8.3				0.0	6.6	0.0	0.0	0.0	0.0
Prop In Lane	1.00		1.00				0.00		1.00	0.00		1.00
Lane Grp Cap(c), veh/h	1503	0	837				0	3001	934	0	3001	934
V/C Ratio(X)	0.87	0.00	0.46				0.00	0.30	0.00	0.00	0.40	0.00
Avail Cap(c_a), veh/h	1634	0	910				0	3001	934	0	3001	934
HCM Platoon Ratio	1.00	1.00	1.00				1.00	1.00	1.00	1.00	2.00	2.00
Upstream Filter(I)	1.00	0.00	1.00				0.00	0.64	0.00	0.00	1.00	0.00
Uniform Delay (d), s/veh	24.9	0.0	21.3				0.0	7.6	0.0	0.0	0.0	0.0
Incr Delay (d2), s/veh	4.7	0.0	0.1				0.0	0.2	0.0	0.0	0.4	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0				0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	9.1	0.0	3.2				0.0	3.1	0.0	0.0	0.1	0.0
LnGrp Delay(d),s/veh	29.6	0.0	21.4				0.0	7.8	0.0	0.0	0.4	0.0
LnGrp LOS	C		C					A			A	
Approach Vol, veh/h		1690						897			1196	
Approach Delay, s/veh		27.7						7.8			0.4	
Approach LOS		C						A			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2				6		8
Phs Duration (G+Y+Rc), s		49.0				49.0		26.0
Change Period (Y+Rc), s		4.7				4.7		3.5
Max Green Setting (Gmax), s		42.3				42.3		24.5
Max Q Clear Time (g_c+I1), s		2.0				8.6		20.6
Green Ext Time (p_c), s		3.2				3.2		1.9

Intersection Summary	
HCM 2010 Ctrl Delay	14.4
HCM 2010 LOS	B

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	1350	70	40	370	1120	160
Number	7	14	5	2	6	16
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	1607	0	48	440	1333	0
Adj No. of Lanes	3	1	1	2	2	1
Peak Hour Factor	0.84	0.84	0.84	0.84	0.84	0.84
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	1848	585	61	1768	1483	663
Arrive On Green	0.37	0.00	0.03	0.50	0.42	0.00
Sat Flow, veh/h	5003	1583	1774	3632	3632	1583
Grp Volume(v), veh/h	1607	0	48	440	1333	0
Grp Sat Flow(s),veh/h/ln	1668	1583	1774	1770	1770	1583
Q Serve(g_s), s	22.5	0.0	2.0	5.4	26.5	0.0
Cycle Q Clear(g_c), s	22.5	0.0	2.0	5.4	26.5	0.0
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	1848	585	61	1768	1483	663
V/C Ratio(X)	0.87	0.00	0.79	0.25	0.90	0.00
Avail Cap(c_a), veh/h	2345	742	505	1768	1626	727
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	22.1	0.0	36.2	10.8	20.5	0.0
Incr Delay (d2), s/veh	2.6	0.0	8.4	0.0	6.4	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	10.7	0.0	1.1	2.6	14.1	0.0
LnGrp Delay(d),s/veh	24.7	0.0	44.6	10.8	26.9	0.0
LnGrp LOS	C		D	B	C	
Approach Vol, veh/h	1607			488	1333	
Approach Delay, s/veh	24.7			14.2	26.9	
Approach LOS	C			B	C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		
Phs Duration (G+Y+Rc), s		43.0		32.5	6.1	36.9		
Change Period (Y+Rc), s		5.3		4.6	3.5	5.3		
Max Green Setting (Gmax), s		34.7		35.4	21.5	34.7		
Max Q Clear Time (g_c+I1), s		7.4		24.5	4.0	28.5		
Green Ext Time (p_c), s		9.8		3.4	0.0	3.1		

Intersection Summary	
HCM 2010 Ctrl Delay	24.1
HCM 2010 LOS	C

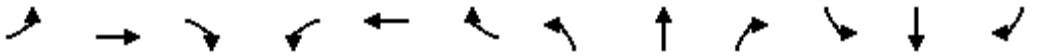
Intersection	
Int Delay, s/veh	1

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	80	490	1090	30	10	20
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	175	-	-	-	0	0
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	97	97	97	97	97	97
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	82	505	1124	31	10	21

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	1155	0	-	0	1557	577
Stage 1	-	-	-	-	1139	-
Stage 2	-	-	-	-	418	-
Critical Hdwy	4.14	-	-	-	6.84	6.94
Critical Hdwy Stg 1	-	-	-	-	5.84	-
Critical Hdwy Stg 2	-	-	-	-	5.84	-
Follow-up Hdwy	2.22	-	-	-	3.52	3.32
Pot Cap-1 Maneuver	601	-	-	-	103	460
Stage 1	-	-	-	-	267	-
Stage 2	-	-	-	-	632	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	601	-	-	-	89	460
Mov Cap-2 Maneuver	-	-	-	-	89	-
Stage 1	-	-	-	-	267	-
Stage 2	-	-	-	-	546	-

Approach	EB	WB	SB
HCM Control Delay, s	1.7	0	25.7
HCM LOS			D

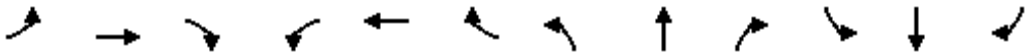
Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	601	-	-	-	89	460
HCM Lane V/C Ratio	0.137	-	-	-	0.116	0.045
HCM Control Delay (s)	11.9	-	-	-	50.7	13.2
HCM Lane LOS	B	-	-	-	F	B
HCM 95th %tile Q(veh)	0.5	-	-	-	0.4	0.1



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	490	140	300	560	290	3150	0	0	1770	80
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)			4.6		6.2	6.2	4.6	5.0			5.3	5.3
Lane Util. Factor			1.00		1.00	0.88	0.97	0.91			0.86	1.00
Frpb, ped/bikes			1.00		1.00	1.00	1.00	1.00			1.00	0.99
Flpb, ped/bikes			1.00		1.00	1.00	1.00	1.00			1.00	1.00
Frt			0.86		1.00	0.85	1.00	1.00			1.00	0.85
Flt Protected			1.00		0.98	1.00	0.95	1.00			1.00	1.00
Satd. Flow (prot)			1611		1834	2787	3433	5085			6408	1563
Flt Permitted			1.00		0.98	1.00	0.95	1.00			1.00	1.00
Satd. Flow (perm)			1611		1834	2787	3433	5085			6408	1563
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	516	147	316	589	305	3316	0	0	1863	84
RTOR Reduction (vph)	0	0	201	0	0	37	0	0	0	0	0	33
Lane Group Flow (vph)	0	0	315	0	463	552	305	3316	0	0	1863	51
Confl. Bikes (#/hr)												1
Turn Type			Over	Split	NA	Perm	Prot	NA			NA	Perm
Protected Phases			1	4	4		1	6			2	
Permitted Phases						4						2
Actuated Green, G (s)			31.5		40.0	40.0	31.5	98.8			62.4	62.4
Effective Green, g (s)			31.5		40.0	40.0	31.5	98.8			62.4	62.4
Actuated g/C Ratio			0.21		0.27	0.27	0.21	0.66			0.42	0.42
Clearance Time (s)			4.6		6.2	6.2	4.6	5.0			5.3	5.3
Vehicle Extension (s)			1.0		1.0	1.0	1.0	1.0			1.0	1.0
Lane Grp Cap (vph)			338		489	743	720	3349			2665	650
v/s Ratio Prot			0.20		c0.25		0.09	c0.65			0.29	
v/s Ratio Perm						0.20						0.03
v/c Ratio			0.93		0.95	0.74	0.42	0.99			0.70	0.08
Uniform Delay, d1			58.2		54.0	50.3	51.4	25.1			36.1	26.4
Progression Factor			1.00		1.00	1.00	0.99	0.96			0.72	0.49
Incremental Delay, d2			31.2		27.3	3.5	0.1	7.8			1.4	0.2
Delay (s)			89.4		81.3	53.8	51.1	31.8			27.5	13.3
Level of Service			F		F	D	D	C			C	B
Approach Delay (s)		89.4			65.9			33.4			26.9	
Approach LOS		F			E			C			C	

Intersection Summary			
HCM 2000 Control Delay	40.5	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	1.01		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	16.1
Intersection Capacity Utilization	93.7%	ICU Level of Service	F
Analysis Period (min)	15		

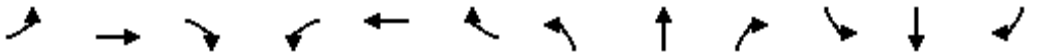
c Critical Lane Group



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	810	160	100	660	0	510	0	300	40	60	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.8		3.8	5.4		5.5		5.5		5.5	
Lane Util. Factor		0.95		1.00	0.95		1.00		1.00		0.95	
Frpb, ped/bikes		1.00		1.00	1.00		1.00		1.00		1.00	
Flpb, ped/bikes		1.00		1.00	1.00		1.00		1.00		1.00	
Frt		0.98		1.00	1.00		1.00		0.85		0.96	
Flt Protected		1.00		0.95	1.00		0.95		1.00		0.99	
Satd. Flow (prot)		3445		1770	3539		1770		1583		3340	
Flt Permitted		1.00		0.95	1.00		0.95		1.00		0.99	
Satd. Flow (perm)		3445		1770	3539		1770		1583		3340	
Peak-hour factor, PHF	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Adj. Flow (vph)	0	953	188	118	776	0	600	0	353	47	71	47
RTOR Reduction (vph)	0	7	0	0	0	0	0	0	112	0	24	0
Lane Group Flow (vph)	0	1134	0	118	776	0	600	0	241	0	141	0
Confl. Bikes (#/hr)			1						4			
Turn Type		NA		Prot	NA		Prot		Prot	Split	NA	
Protected Phases		6		5	2		3 8		3	4	4	
Permitted Phases												
Actuated Green, G (s)		63.3		14.7	81.2		56.2		34.6		10.6	
Effective Green, g (s)		63.3		14.7	81.2		56.2		34.6		10.6	
Actuated g/C Ratio		0.38		0.09	0.48		0.33		0.21		0.06	
Clearance Time (s)		4.8		3.8	5.4				5.5		5.5	
Vehicle Extension (s)		1.0		1.0	1.0				1.0		1.0	
Lane Grp Cap (vph)		1298		154	1711		592		326		210	
v/s Ratio Prot		c0.33		c0.07	0.22		c0.34		0.15		c0.04	
v/s Ratio Perm												
v/c Ratio		0.87		0.77	0.45		1.01		0.74		0.67	
Uniform Delay, d1		48.6		74.9	28.7		55.9		62.4		76.9	
Progression Factor		1.00		1.00	1.00		1.00		1.00		1.00	
Incremental Delay, d2		6.6		18.3	0.1		40.4		7.4		6.1	
Delay (s)		55.1		93.2	28.7		96.3		69.8		83.1	
Level of Service		E		F	C		F		E		F	
Approach Delay (s)		55.1			37.3			86.5			83.1	
Approach LOS		E			D			F			F	

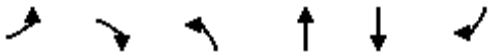
Intersection Summary			
HCM 2000 Control Delay	61.0	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	0.90		
Actuated Cycle Length (s)	167.9	Sum of lost time (s)	23.1
Intersection Capacity Utilization	78.6%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group



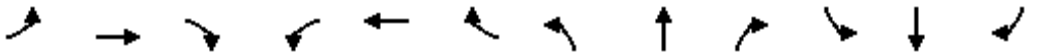
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	1010	120	390	460	30	220	10	190	50	0	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.9		4.9	5.0			4.9	4.9		4.8	4.8
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00	1.00		1.00	1.00
Frt	1.00	0.98		1.00	0.99			1.00	0.85		1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00			0.95	1.00		0.95	1.00
Satd. Flow (prot)	1770	3483		1770	3506			1778	1583		1770	1583
Flt Permitted	0.95	1.00		0.95	1.00			0.95	1.00		0.95	1.00
Satd. Flow (perm)	1770	3483		1770	3506			1778	1583		1770	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	11	1098	130	424	500	33	239	11	207	54	0	54
RTOR Reduction (vph)	0	4	0	0	2	0	0	0	171	0	0	51
Lane Group Flow (vph)	11	1224	0	424	531	0	0	250	36	0	54	3
Turn Type	Prot	NA		Prot	NA		Split	NA	Perm	Split	NA	Perm
Protected Phases	1	6		5	2		4	4		3	3	
Permitted Phases									4			3
Actuated Green, G (s)	2.0	63.9		20.4	82.6			23.5	23.5		7.6	7.6
Effective Green, g (s)	2.0	63.9		20.4	82.6			23.5	23.5		7.6	7.6
Actuated g/C Ratio	0.01	0.47		0.15	0.61			0.17	0.17		0.06	0.06
Clearance Time (s)	4.5	4.9		4.9	5.0			4.9	4.9		4.8	4.8
Vehicle Extension (s)	1.0	5.8		1.0	4.9			2.0	2.0		1.0	1.0
Lane Grp Cap (vph)	26	1649		267	2146			309	275		99	89
v/s Ratio Prot	0.01	c0.35		c0.24	0.15			c0.14			c0.03	
v/s Ratio Perm									0.02			0.00
v/c Ratio	0.42	0.74		1.59	0.25			0.81	0.13		0.55	0.03
Uniform Delay, d1	65.9	28.8		57.2	12.0			53.5	47.1		62.0	60.2
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00		1.00	1.00
Incremental Delay, d2	4.0	2.4		281.7	0.1			13.6	0.1		3.3	0.1
Delay (s)	69.9	31.2		339.0	12.1			67.2	47.2		65.2	60.2
Level of Service	E	C		F	B			E	D		E	E
Approach Delay (s)		31.6			156.9			58.1			62.7	
Approach LOS		C			F			E			E	

Intersection Summary			
HCM 2000 Control Delay	80.6	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	0.89		
Actuated Cycle Length (s)	134.9	Sum of lost time (s)	19.5
Intersection Capacity Utilization	85.0%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			



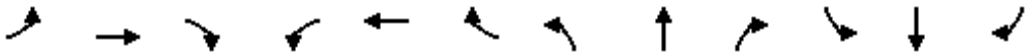
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	130	150	50	2030	640	1470
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.6	4.6	3.5	5.3	5.3	5.3
Lane Util. Factor	0.97	0.91	1.00	0.91	0.91	1.00
Frt	0.95	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.97	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	3326	1441	1770	5085	5085	1583
Flt Permitted	0.97	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	3326	1441	1770	5085	5085	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	137	158	53	2137	674	1547
RTOR Reduction (vph)	57	81	0	0	0	482
Lane Group Flow (vph)	145	12	53	2137	674	1065
Turn Type	Prot	Perm	Prot	NA	NA	Perm
Protected Phases	4		5	2	6	
Permitted Phases		4				6
Actuated Green, G (s)	5.5	5.5	2.2	26.8	21.1	21.1
Effective Green, g (s)	5.5	5.5	2.2	26.8	21.1	21.1
Actuated g/C Ratio	0.13	0.13	0.05	0.64	0.50	0.50
Clearance Time (s)	4.6	4.6	3.5	5.3	5.3	5.3
Vehicle Extension (s)	2.0	2.0	1.5	2.2	2.2	2.2
Lane Grp Cap (vph)	433	187	92	3229	2542	791
v/s Ratio Prot	c0.04		0.03	c0.42	0.13	
v/s Ratio Perm		0.01				c0.67
v/c Ratio	0.34	0.06	0.58	0.66	0.27	1.35
Uniform Delay, d1	16.7	16.1	19.5	4.8	6.1	10.6
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.2	0.1	5.3	0.4	0.0	164.0
Delay (s)	16.9	16.1	24.9	5.3	6.1	174.5
Level of Service	B	B	C	A	A	F
Approach Delay (s)	16.6			5.7	123.4	
Approach LOS	B			A	F	

Intersection Summary			
HCM 2000 Control Delay	62.0	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.12		
Actuated Cycle Length (s)	42.2	Sum of lost time (s)	13.4
Intersection Capacity Utilization	103.8%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	1360	0	20	0	0	0	60	400	0	0	80	430
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.5		5.5				5.5	4.7			4.7	4.7
Lane Util. Factor	0.97		1.00				0.97	0.95			0.95	1.00
Frt	1.00		0.85				1.00	1.00			1.00	0.85
Flt Protected	0.95		1.00				0.95	1.00			1.00	1.00
Satd. Flow (prot)	3433		1583				3433	3539			3539	1583
Flt Permitted	0.95		1.00				0.95	1.00			1.00	1.00
Satd. Flow (perm)	3433		1583				3433	3539			3539	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	1478	0	22	0	0	0	65	435	0	0	87	467
RTOR Reduction (vph)	0	0	9	0	0	0	0	0	0	0	0	331
Lane Group Flow (vph)	1478	0	13	0	0	0	65	435	0	0	87	136
Turn Type	Prot		pm+ov	Prot		pm+ov	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	7	4	1	3	8	5	1	6		5	2	
Permitted Phases			4			8			6			2
Actuated Green, G (s)	60.5		64.1				3.6	41.8			32.7	32.7
Effective Green, g (s)	60.5		64.1				3.6	41.8			32.7	32.7
Actuated g/C Ratio	0.54		0.57				0.03	0.37			0.29	0.29
Clearance Time (s)	5.5		5.5				5.5	4.7			4.7	4.7
Vehicle Extension (s)	3.0		3.0				3.0	3.0			3.0	3.0
Lane Grp Cap (vph)	1846		979				109	1314			1028	460
v/s Ratio Prot	c0.43		0.00				0.02	c0.12			0.02	
v/s Ratio Perm			0.01									0.09
v/c Ratio	0.80		0.01				0.60	0.33			0.08	0.30
Uniform Delay, d1	21.1		10.5				53.7	25.3			29.0	31.0
Progression Factor	1.00		1.00				1.00	1.00			1.00	1.00
Incremental Delay, d2	2.6		0.0				8.5	0.7			0.2	1.6
Delay (s)	23.7		10.5				62.2	26.0			29.2	32.6
Level of Service	C		B				E	C			C	C
Approach Delay (s)		23.5			0.0			30.7			32.1	
Approach LOS		C			A			C			C	

Intersection Summary			
HCM 2000 Control Delay	26.8	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.68		
Actuated Cycle Length (s)	112.5	Sum of lost time (s)	21.2
Intersection Capacity Utilization	58.4%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	660	660	720	590	0	130	0	360	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.8	4.8	5.5	4.8		5.5	5.5	5.5			
Lane Util. Factor		1.00	1.00	0.97	1.00		0.97	0.95	0.95			
Frt		1.00	0.85	1.00	1.00		1.00	0.85	0.85			
Flt Protected		1.00	1.00	0.95	1.00		0.95	1.00	1.00			
Satd. Flow (prot)		1863	1583	3433	1863		3433	1504	1504			
Flt Permitted		1.00	1.00	0.95	1.00		0.95	1.00	1.00			
Satd. Flow (perm)		1863	1583	3433	1863		3433	1504	1504			
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	717	717	783	641	0	141	0	391	0	0	0
RTOR Reduction (vph)	0	0	238	0	0	0	0	151	151	0	0	0
Lane Group Flow (vph)	0	717	479	783	641	0	141	45	44	0	0	0
Turn Type	Prot	NA	Prot	Prot	NA		Split	NA	Perm			
Protected Phases	7	4	4	3	8		2	2		6	6	
Permitted Phases									2			
Actuated Green, G (s)		47.2	47.2	25.5	78.2		26.0	26.0	26.0			
Effective Green, g (s)		47.2	47.2	25.5	78.2		26.0	26.0	26.0			
Actuated g/C Ratio		0.41	0.41	0.22	0.68		0.23	0.23	0.23			
Clearance Time (s)		4.8	4.8	5.5	4.8		5.5	5.5	5.5			
Vehicle Extension (s)		3.0	3.0	3.0	3.0		3.0	3.0	3.0			
Lane Grp Cap (vph)		767	652	764	1272		779	341	341			
v/s Ratio Prot		c0.38	0.30	c0.23	0.34		c0.04	0.03				
v/s Ratio Perm									0.03			
v/c Ratio		0.93	0.73	1.02	0.50		0.18	0.13	0.13			
Uniform Delay, d1		32.2	28.4	44.5	8.8		35.7	35.2	35.2			
Progression Factor		1.00	1.00	1.00	1.00		1.00	1.00	1.00			
Incremental Delay, d2		18.4	4.3	39.0	0.3		0.5	0.8	0.8			
Delay (s)		50.6	32.7	83.5	9.1		36.2	36.0	36.0			
Level of Service		D	C	F	A		D	D	D			
Approach Delay (s)		41.6			50.0			36.1			0.0	
Approach LOS		D			D			D			A	

Intersection Summary			
HCM 2000 Control Delay	44.3	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.80		
Actuated Cycle Length (s)	114.5	Sum of lost time (s)	21.3
Intersection Capacity Utilization	75.9%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	300	10	240	40	10	10	70	3580	60	30	1570	230
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		0.98	1.00		1.00	1.00		0.99
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1900	1863	1863	1863	1863	1863	1900
Adj Flow Rate, veh/h	312	10	250	42	10	10	73	3729	62	31	1635	240
Adj No. of Lanes	2	1	1	1	1	0	2	3	1	1	4	0
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	218	326	277	54	119	119	112	3186	992	35	3484	511
Arrive On Green	0.06	0.18	0.18	0.03	0.14	0.14	0.06	1.00	1.00	0.02	0.61	0.61
Sat Flow, veh/h	3442	1863	1583	1774	845	845	3442	5085	1583	1774	5675	833
Grp Volume(v), veh/h	312	10	250	42	0	20	73	3729	62	31	1385	490
Grp Sat Flow(s),veh/h/ln	1721	1863	1583	1774	0	1690	1721	1695	1583	1774	1602	1702
Q Serve(g_s), s	9.5	0.7	23.2	3.5	0.0	1.5	3.1	0.0	0.0	2.6	23.4	23.4
Cycle Q Clear(g_c), s	9.5	0.7	23.2	3.5	0.0	1.5	3.1	0.0	0.0	2.6	23.4	23.4
Prop In Lane	1.00		1.00	1.00		0.50	1.00		1.00	1.00		0.49
Lane Grp Cap(c), veh/h	218	326	277	54	0	238	112	3186	992	35	2951	1045
V/C Ratio(X)	1.43	0.03	0.90	0.78	0.00	0.08	0.65	1.17	0.06	0.87	0.47	0.47
Avail Cap(c_a), veh/h	218	493	419	108	0	439	161	3186	992	35	2951	1045
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	0.00	1.00	0.18	0.18	0.18	1.00	1.00	1.00
Uniform Delay (d), s/veh	70.3	51.3	60.6	72.2	0.0	56.0	69.3	0.0	0.0	73.3	15.7	15.7
Incr Delay (d2), s/veh	218.5	0.0	12.1	8.6	0.0	0.1	0.4	77.5	0.0	98.5	0.5	1.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	11.1	0.3	11.1	1.9	0.0	0.7	1.5	22.9	0.0	2.3	10.5	11.5
LnGrp Delay(d),s/veh	288.7	51.3	72.7	80.8	0.0	56.1	69.7	77.5	0.0	171.9	16.2	17.2
LnGrp LOS	F	D	E	F		E	E	F	A	F	B	B
Approach Vol, veh/h		572			62			3864			1906	
Approach Delay, s/veh		190.1			72.8			76.1			19.0	
Approach LOS		F			E			E			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	10.4	97.6	15.0	27.0	8.5	99.5	9.9	32.2
Change Period (Y+Rc), s	5.5	* 5.5	5.5	5.9	5.5	* 5.5	* 5.3	* 5.9
Max Green Setting (Gmax), s	7.0	* 72	9.5	39.0	3.0	* 76	* 9.1	* 40
Max Q Clear Time (g_c+I1), s	5.1	25.4	11.5	3.5	4.6	2.0	5.5	25.2
Green Ext Time (p_c), s	0.0	24.7	0.0	0.3	0.0	29.4	0.0	0.3

Intersection Summary	
HCM 2010 Ctrl Delay	69.3
HCM 2010 LOS	E

Notes

* HCM 2010 computational engine requires equal clearance times for the phases crossing the barrier.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	2220	0	240	0	0	0	0	1580	180	0	270	860
Number	3	8	18				1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0				0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00				1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	0	1863				0	1863	1863	0	1863	1863
Adj Flow Rate, veh/h	2387	0	258				0	1699	0	0	290	0
Adj No. of Lanes	3	0	2				0	3	1	0	3	1
Peak Hour Factor	0.93	0.93	0.93				0.93	0.93	0.93	0.93	0.93	0.93
Percent Heavy Veh, %	2	0	2				0	2	2	0	2	2
Cap, veh/h	2527	0	1408				0	1960	610	0	1960	610
Arrive On Green	0.51	0.00	0.51				0.00	0.39	0.00	0.00	0.64	0.00
Sat Flow, veh/h	5003	0	2787				0	5253	1583	0	5253	1583
Grp Volume(v), veh/h	2387	0	258				0	1699	0	0	290	0
Grp Sat Flow(s),veh/h/ln	1668	0	1393				0	1695	1583	0	1695	1583
Q Serve(g_s), s	33.9	0.0	3.8				0.0	23.1	0.0	0.0	1.7	0.0
Cycle Q Clear(g_c), s	33.9	0.0	3.8				0.0	23.1	0.0	0.0	1.7	0.0
Prop In Lane	1.00		1.00				0.00		1.00	0.00		1.00
Lane Grp Cap(c), veh/h	2527	0	1408				0	1960	610	0	1960	610
V/C Ratio(X)	0.94	0.00	0.18				0.00	0.87	0.00	0.00	0.15	0.00
Avail Cap(c_a), veh/h	2568	0	1430				0	1960	610	0	1960	610
HCM Platoon Ratio	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.67	1.67
Upstream Filter(I)	1.00	0.00	1.00				0.00	0.66	0.00	0.00	1.00	0.00
Uniform Delay (d), s/veh	17.6	0.0	10.1				0.0	21.3	0.0	0.0	8.5	0.0
Incr Delay (d2), s/veh	8.0	0.0	0.0				0.0	3.7	0.0	0.0	0.2	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0				0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	17.3	0.0	1.4				0.0	11.4	0.0	0.0	0.8	0.0
LnGrp Delay(d),s/veh	25.5	0.0	10.1				0.0	25.0	0.0	0.0	8.7	0.0
LnGrp LOS	C		B					C			A	
Approach Vol, veh/h		2645						1699			290	
Approach Delay, s/veh		24.0						25.0			8.7	
Approach LOS		C						C			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2				6		8
Phs Duration (G+Y+Rc), s		33.6				33.6		41.4
Change Period (Y+Rc), s		4.7				4.7		3.5
Max Green Setting (Gmax), s		28.3				28.3		38.5
Max Q Clear Time (g_c+I1), s		3.7				25.1		35.9
Green Ext Time (p_c), s		3.1				1.4		2.0

Intersection Summary	
HCM 2010 Ctrl Delay	23.4
HCM 2010 LOS	C



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	1130	230	300	950	650	140
Number	7	14	5	2	6	16
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	1177	0	312	990	677	0
Adj No. of Lanes	3	1	1	2	2	1
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	1455	460	363	1967	1050	470
Arrive On Green	0.29	0.00	0.20	0.56	0.30	0.00
Sat Flow, veh/h	5003	1583	1774	3632	3632	1583
Grp Volume(v), veh/h	1177	0	312	990	677	0
Grp Sat Flow(s),veh/h/ln	1668	1583	1774	1770	1770	1583
Q Serve(g_s), s	14.1	0.0	10.9	11.1	10.7	0.0
Cycle Q Clear(g_c), s	14.1	0.0	10.9	11.1	10.7	0.0
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	1455	460	363	1967	1050	470
V/C Ratio(X)	0.81	0.00	0.86	0.50	0.64	0.00
Avail Cap(c_a), veh/h	2747	869	592	1967	1905	852
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	21.2	0.0	24.7	8.8	19.7	0.0
Incr Delay (d2), s/veh	0.4	0.0	3.7	0.1	0.4	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	6.5	0.0	5.8	5.4	5.2	0.0
LnGrp Delay(d),s/veh	21.6	0.0	28.5	8.9	20.1	0.0
LnGrp LOS	C		C	A	C	
Approach Vol, veh/h	1177			1302	677	
Approach Delay, s/veh	21.6			13.6	20.1	
Approach LOS	C			B	C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		
Phs Duration (G+Y+Rc), s		41.1		23.3	16.7	24.4		
Change Period (Y+Rc), s		5.3		4.6	3.5	5.3		
Max Green Setting (Gmax), s		34.7		35.4	21.5	34.7		
Max Q Clear Time (g_c+I1), s		13.1		16.1	12.9	12.7		
Green Ext Time (p_c), s		8.0		2.7	0.3	6.4		

Intersection Summary	
HCM 2010 Ctrl Delay	18.0
HCM 2010 LOS	B

Intersection	
Int Delay, s/veh	1.2

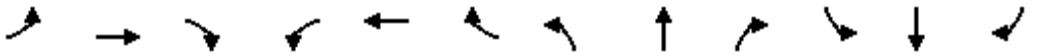
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	40	1110	710	20	30	50
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	175	-	-	-	0	0
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	94	94	94	94	94	94
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	43	1181	755	21	32	53

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	777	0	-	0	1442	388
Stage 1	-	-	-	-	766	-
Stage 2	-	-	-	-	676	-
Critical Hdwy	4.14	-	-	-	6.84	6.94
Critical Hdwy Stg 1	-	-	-	-	5.84	-
Critical Hdwy Stg 2	-	-	-	-	5.84	-
Follow-up Hdwy	2.22	-	-	-	3.52	3.32
Pot Cap-1 Maneuver	835	-	-	-	123	611
Stage 1	-	-	-	-	419	-
Stage 2	-	-	-	-	467	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	835	-	-	-	117	611
Mov Cap-2 Maneuver	-	-	-	-	117	-
Stage 1	-	-	-	-	419	-
Stage 2	-	-	-	-	443	-

Approach	EB	WB	SB
HCM Control Delay, s	0.3	0	24.8
HCM LOS			C

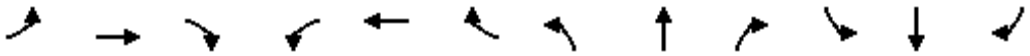
Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	835	-	-	-	117	611
HCM Lane V/C Ratio	0.051	-	-	-	0.273	0.087
HCM Control Delay (s)	9.5	-	-	-	46.9	11.5
HCM Lane LOS	A	-	-	-	E	B
HCM 95th %tile Q(veh)	0.2	-	-	-	1	0.3

Appendix A6
Opening Year (2022) with Alternative 2
Synchro Calculations



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	390	90	450	1590	140	290	0	0	3150	160
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)			4.6		6.2	4.0	4.6	5.0			5.3	5.3
Lane Util. Factor			1.00		0.95	0.76	0.97	0.91			0.86	1.00
Frpb, ped/bikes			1.00		1.00	1.00	1.00	1.00			1.00	0.98
Flpb, ped/bikes			1.00		1.00	1.00	1.00	1.00			1.00	1.00
Frt			0.86		1.00	0.85	1.00	1.00			1.00	0.85
Flt Protected			1.00		0.99	1.00	0.95	1.00			1.00	1.00
Satd. Flow (prot)			1611		3510	3610	3433	5085			6408	1559
Flt Permitted			1.00		0.99	1.00	0.95	1.00			1.00	1.00
Satd. Flow (perm)			1611		3510	3610	3433	5085			6408	1559
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	0	0	406	94	469	1656	146	302	0	0	3281	167
RTOR Reduction (vph)	0	0	95	0	0	247	0	0	0	0	0	40
Lane Group Flow (vph)	0	0	311	0	563	1409	146	302	0	0	3281	127
Confl. Peds. (#/hr)												1
Confl. Bikes (#/hr)												2
Turn Type			Over	Split	NA	custom	Prot	NA			NA	Perm
Protected Phases			1	4	4	5	1	6			2	
Permitted Phases						4						2
Actuated Green, G (s)			30.9		22.8	122.0	30.9	12.8			80.2	80.2
Effective Green, g (s)			30.9		22.8	122.0	30.9	12.8			80.2	80.2
Actuated g/C Ratio			0.21		0.15	0.81	0.21	0.09			0.53	0.53
Clearance Time (s)			4.6		6.2	4.0	4.6	5.0			5.3	5.3
Vehicle Extension (s)			1.0		1.0	3.0	1.0	1.0			1.0	1.0
Lane Grp Cap (vph)			331		533	3032	707	433			3426	833
v/s Ratio Prot			c0.19		c0.16	0.31	0.04	0.06			c0.51	
v/s Ratio Perm						0.08						0.08
v/c Ratio			0.94		1.06	0.46	0.21	0.70			0.96	0.15
Uniform Delay, d1			58.6		63.6	4.2	49.4	66.7			33.3	17.7
Progression Factor			1.00		1.00	1.00	1.00	1.00			0.35	0.14
Incremental Delay, d2			33.1		54.7	0.1	0.1	9.0			4.8	0.2
Delay (s)			91.7		118.3	4.3	49.4	75.7			16.6	2.7
Level of Service			F		F	A	D	E			B	A
Approach Delay (s)		91.7			33.2			67.1			15.9	
Approach LOS		F			C			E			B	

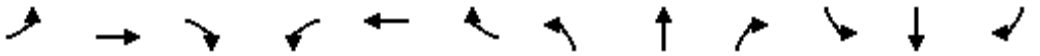
Intersection Summary			
HCM 2000 Control Delay	30.0	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.97		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	16.1
Intersection Capacity Utilization	98.3%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	270	340	280	830	0	250	0	200	100	190	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.8		3.8	5.4		5.5		5.5		5.5	
Lane Util. Factor		0.95		1.00	0.95		1.00		1.00		0.95	
Frpb, ped/bikes		0.99		1.00	1.00		1.00		1.00		1.00	
Flpb, ped/bikes		1.00		1.00	1.00		1.00		1.00		1.00	
Frt		0.92		1.00	1.00		1.00		0.85		0.99	
Flt Protected		1.00		0.95	1.00		0.95		1.00		0.98	
Satd. Flow (prot)		3219		1770	3539		1770		1583		3463	
Flt Permitted		1.00		0.95	1.00		0.95		1.00		0.98	
Satd. Flow (perm)		3219		1770	3539		1770		1583		3463	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	287	362	298	883	0	266	0	213	106	202	11
RTOR Reduction (vph)	0	134	0	0	0	0	0	0	166	0	2	0
Lane Group Flow (vph)	0	515	0	298	883	0	266	0	47	0	317	0
Confl. Bikes (#/hr)			1						2			
Turn Type		NA		Prot	NA		Prot		Prot	Split	NA	
Protected Phases		6		5	2		3 8		3	4	4	
Permitted Phases												
Actuated Green, G (s)		22.5		21.6	47.3		24.6		14.4		14.6	
Effective Green, g (s)		22.5		21.6	47.3		24.6		14.4		14.6	
Actuated g/C Ratio		0.21		0.20	0.44		0.23		0.14		0.14	
Clearance Time (s)		4.8		3.8	5.4				5.5		5.5	
Vehicle Extension (s)		1.0		1.0	1.0				1.0		1.0	
Lane Grp Cap (vph)		680		359	1573		409		214		475	
v/s Ratio Prot		c0.16		c0.17	0.25		c0.15		0.03		c0.09	
v/s Ratio Perm												
v/c Ratio		0.76		0.83	0.56		0.65		0.22		0.67	
Uniform Delay, d1		39.4		40.6	21.9		37.0		41.0		43.6	
Progression Factor		1.00		1.00	1.00		1.00		1.00		1.00	
Incremental Delay, d2		4.3		14.3	0.3		2.8		0.2		2.8	
Delay (s)		43.7		55.0	22.1		39.8		41.2		46.4	
Level of Service		D		D	C		D		D		D	
Approach Delay (s)		43.7			30.4			40.4			46.4	
Approach LOS		D			C			D			D	

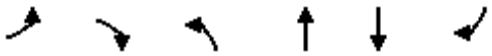
Intersection Summary			
HCM 2000 Control Delay	37.5	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.73		
Actuated Cycle Length (s)	106.4	Sum of lost time (s)	23.1
Intersection Capacity Utilization	71.5%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group



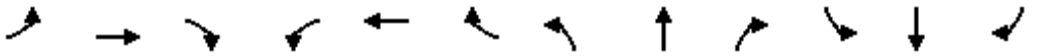
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	270	210	270	860	60	250	10	130	10	0	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.9		4.9	5.0			4.9	4.9		4.8	4.8
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00	1.00		1.00	1.00
Frt	1.00	0.93		1.00	0.99			1.00	0.85		1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00			0.95	1.00		0.95	1.00
Satd. Flow (prot)	1770	3307		1770	3505			1777	1583		1770	1583
Flt Permitted	0.95	1.00		0.95	1.00			0.95	1.00		0.95	1.00
Satd. Flow (perm)	1770	3307		1770	3505			1777	1583		1770	1583
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	22	297	231	297	945	66	275	11	143	11	0	11
RTOR Reduction (vph)	0	90	0	0	2	0	0	0	109	0	0	11
Lane Group Flow (vph)	22	438	0	297	1009	0	0	286	34	0	11	0
Turn Type	Prot	NA		Prot	NA		Split	NA	Perm	Split	NA	Perm
Protected Phases	1	6		5	2		4	4		3	3	
Permitted Phases									4			3
Actuated Green, G (s)	3.0	27.8		21.4	46.5			21.7	21.7		2.5	2.5
Effective Green, g (s)	3.0	27.8		21.4	46.5			21.7	21.7		2.5	2.5
Actuated g/C Ratio	0.03	0.30		0.23	0.50			0.23	0.23		0.03	0.03
Clearance Time (s)	4.5	4.9		4.9	5.0			4.9	4.9		4.8	4.8
Vehicle Extension (s)	1.0	5.8		1.0	4.9			2.0	2.0		1.0	1.0
Lane Grp Cap (vph)	57	989		407	1754			415	369		47	42
v/s Ratio Prot	0.01	0.13		c0.17	c0.29			c0.16			c0.01	
v/s Ratio Perm									0.02			0.00
v/c Ratio	0.39	0.44		0.73	0.57			0.69	0.09		0.23	0.01
Uniform Delay, d1	44.0	26.3		33.1	16.3			32.5	27.9		44.3	44.0
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00		1.00	1.00
Incremental Delay, d2	1.6	0.8		5.5	0.7			3.8	0.0		0.9	0.0
Delay (s)	45.6	27.1		38.6	17.0			36.3	27.9		45.2	44.0
Level of Service	D	C		D	B			D	C		D	D
Approach Delay (s)		27.9			21.9			33.5			44.6	
Approach LOS		C			C			C			D	

Intersection Summary			
HCM 2000 Control Delay	25.7	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	92.9	Sum of lost time (s)	19.5
Intersection Capacity Utilization	62.5%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			



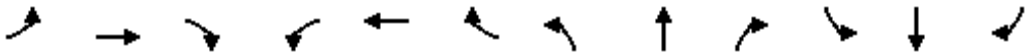
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	80	240	60	1660	1040	1380
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.6	4.6	3.5	5.3	5.3	5.3
Lane Util. Factor	0.97	0.91	1.00	0.91	0.91	1.00
Frt	0.91	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.98	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	3224	1441	1770	5085	5085	1583
Flt Permitted	0.98	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	3224	1441	1770	5085	5085	1583
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	90	270	67	1865	1169	1551
RTOR Reduction (vph)	121	121	0	0	0	351
Lane Group Flow (vph)	104	14	67	1865	1169	1200
Turn Type	Prot	Perm	Prot	NA	NA	Perm
Protected Phases	4		5	2	6	
Permitted Phases		4				6
Actuated Green, G (s)	7.0	7.0	4.3	48.4	40.6	40.6
Effective Green, g (s)	7.0	7.0	4.3	48.4	40.6	40.6
Actuated g/C Ratio	0.11	0.11	0.07	0.74	0.62	0.62
Clearance Time (s)	4.6	4.6	3.5	5.3	5.3	5.3
Vehicle Extension (s)	2.0	2.0	1.5	2.2	2.2	2.2
Lane Grp Cap (vph)	345	154	116	3768	3161	984
v/s Ratio Prot	c0.03		0.04	c0.37	0.23	
v/s Ratio Perm		0.01				c0.76
v/c Ratio	0.30	0.09	0.58	0.49	0.37	1.22
Uniform Delay, d1	26.9	26.3	29.6	3.5	6.1	12.3
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.2	0.1	4.3	0.1	0.0	108.2
Delay (s)	27.1	26.4	33.9	3.5	6.1	120.6
Level of Service	C	C	C	A	A	F
Approach Delay (s)	26.8			4.6	71.4	
Approach LOS	C			A	E	

Intersection Summary			
HCM 2000 Control Delay	42.4	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	1.05		
Actuated Cycle Length (s)	65.3	Sum of lost time (s)	13.4
Intersection Capacity Utilization	98.2%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	730	0	40	0	0	0	80	240	0	0	200	1330
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.5		5.5				5.5	4.7			4.7	4.7
Lane Util. Factor	0.97		1.00				0.97	0.95			0.95	1.00
Frt	1.00		0.85				1.00	1.00			1.00	0.85
Flt Protected	0.95		1.00				0.95	1.00			1.00	1.00
Satd. Flow (prot)	3433		1583				3433	3539			3539	1583
Flt Permitted	0.95		1.00				0.95	1.00			1.00	1.00
Satd. Flow (perm)	3433		1583				3433	3539			3539	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	793	0	43	0	0	0	87	261	0	0	217	1446
RTOR Reduction (vph)	0	0	31	0	0	0	0	0	0	0	0	449
Lane Group Flow (vph)	793	0	12	0	0	0	87	261	0	0	217	997
Turn Type	Prot		pm+ov	Prot		pm+ov	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	7	4	1	3	8	5	1	6		5	2	
Permitted Phases			4			8			6			2
Actuated Green, G (s)	27.5		31.0				3.5	69.8			60.8	60.8
Effective Green, g (s)	27.5		31.0				3.5	69.8			60.8	60.8
Actuated g/C Ratio	0.26		0.29				0.03	0.65			0.57	0.57
Clearance Time (s)	5.5		5.5				5.5	4.7			4.7	4.7
Vehicle Extension (s)	1.0		1.0				1.0	1.0			1.0	1.0
Lane Grp Cap (vph)	878		537				111	2297			2001	895
v/s Ratio Prot	c0.23		0.00				c0.03	0.07			0.06	
v/s Ratio Perm			0.01									c0.63
v/c Ratio	0.90		0.02				0.78	0.11			0.11	1.11
Uniform Delay, d1	38.7		27.4				51.6	7.1			10.8	23.4
Progression Factor	1.00		1.00				1.00	1.00			1.00	1.00
Incremental Delay, d2	12.2		0.0				27.5	0.1			0.1	66.4
Delay (s)	51.0		27.4				79.1	7.2			10.9	89.7
Level of Service	D		C				E	A			B	F
Approach Delay (s)		49.7			0.0			25.2			79.4	
Approach LOS		D			A			C			E	

Intersection Summary			
HCM 2000 Control Delay	64.1	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.10		
Actuated Cycle Length (s)	107.5	Sum of lost time (s)	21.2
Intersection Capacity Utilization	94.2%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	160	180	590	480	0	900	0	510	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.8	4.8	5.5	4.8		5.5	5.5	5.5			
Lane Util. Factor		1.00	1.00	0.97	1.00		0.97	0.95	0.95			
Frt		1.00	0.85	1.00	1.00		1.00	0.85	0.85			
Flt Protected		1.00	1.00	0.95	1.00		0.95	1.00	1.00			
Satd. Flow (prot)		1863	1583	3433	1863		3433	1504	1504			
Flt Permitted		1.00	1.00	0.95	1.00		0.95	1.00	1.00			
Satd. Flow (perm)		1863	1583	3433	1863		3433	1504	1504			
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	174	196	641	522	0	978	0	554	0	0	0
RTOR Reduction (vph)	0	0	170	0	0	0	0	154	154	0	0	0
Lane Group Flow (vph)	0	174	26	641	522	0	978	123	123	0	0	0
Turn Type	Prot	NA	Prot	Prot	NA		Split	NA	Perm			
Protected Phases	7	4	4	3	8		2	2		6	6	
Permitted Phases									2			
Actuated Green, G (s)		12.5	12.5	24.3	42.3		42.3	42.3	42.3			
Effective Green, g (s)		12.5	12.5	24.3	42.3		42.3	42.3	42.3			
Actuated g/C Ratio		0.13	0.13	0.26	0.45		0.45	0.45	0.45			
Clearance Time (s)		4.8	4.8	5.5	4.8		5.5	5.5	5.5			
Vehicle Extension (s)		1.0	1.0	1.0	1.0		1.0	1.0	1.0			
Lane Grp Cap (vph)		245	208	879	830		1530	670	670			
v/s Ratio Prot		0.09	0.02	c0.19	c0.28		c0.28	0.08				
v/s Ratio Perm									0.08			
v/c Ratio		0.71	0.12	0.73	0.63		0.64	0.18	0.18			
Uniform Delay, d1		39.5	36.4	32.3	20.3		20.4	15.9	15.9			
Progression Factor		1.00	1.00	1.00	1.00		1.00	1.00	1.00			
Incremental Delay, d2		7.8	0.1	2.6	1.1		2.1	0.6	0.6			
Delay (s)		47.3	36.5	34.9	21.3		22.4	16.5	16.5			
Level of Service		D	D	C	C		C	B	B			
Approach Delay (s)		41.6			28.8			20.3			0.0	
Approach LOS		D			C			C			A	

Intersection Summary			
HCM 2000 Control Delay	26.1	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	94.9	Sum of lost time (s)	21.3
Intersection Capacity Utilization	67.4%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	213	7	100	10	10	10	160	1710	10	10	3200	310
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		0.98	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1900	1863	1863	1863	1863	1863	1900
Adj Flow Rate, veh/h	220	7	103	10	10	10	165	1763	10	10	3299	320
Adj No. of Lanes	2	1	1	1	1	0	2	3	1	1	4	0
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	267	285	241	12	69	69	208	3485	1085	12	3794	356
Arrive On Green	0.08	0.15	0.15	0.01	0.08	0.08	0.12	1.00	1.00	0.01	0.63	0.63
Sat Flow, veh/h	3442	1863	1577	1774	848	848	3442	5085	1583	1774	6005	564
Grp Volume(v), veh/h	220	7	103	10	0	20	165	1763	10	10	2619	1000
Grp Sat Flow(s),veh/h/ln	1721	1863	1577	1774	0	1695	1721	1695	1583	1774	1602	1763
Q Serve(g_s), s	9.4	0.5	8.9	0.8	0.0	1.6	7.0	0.0	0.0	0.8	66.1	72.4
Cycle Q Clear(g_c), s	9.4	0.5	8.9	0.8	0.0	1.6	7.0	0.0	0.0	0.8	66.1	72.4
Prop In Lane	1.00		1.00	1.00		0.50	1.00		1.00	1.00		0.32
Lane Grp Cap(c), veh/h	267	285	241	12	0	137	208	3485	1085	12	3036	1114
V/C Ratio(X)	0.82	0.02	0.43	0.83	0.00	0.15	0.79	0.51	0.01	0.83	0.86	0.90
Avail Cap(c_a), veh/h	493	524	444	221	0	442	287	3485	1085	148	3036	1114
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	0.00	1.00	0.83	0.83	0.83	1.00	1.00	1.00
Uniform Delay (d), s/veh	68.2	54.0	57.6	74.4	0.0	64.1	65.0	0.0	0.0	74.4	22.3	23.5
Incr Delay (d2), s/veh	2.4	0.0	0.4	38.2	0.0	0.2	5.7	0.4	0.0	38.2	3.5	11.4
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	4.6	0.2	3.9	0.5	0.0	0.8	3.5	0.1	0.0	0.5	30.1	38.5
LnGrp Delay(d),s/veh	70.6	54.0	58.0	112.6	0.0	64.3	70.8	0.4	0.0	112.6	25.9	34.9
LnGrp LOS	E	D	E	F		E	E	A	A	F	C	C
Approach Vol, veh/h		330			30			1938			3629	
Approach Delay, s/veh		66.3			80.4			6.4			28.6	
Approach LOS		E			F			A			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	14.5	100.3	17.2	18.0	6.5	108.3	6.3	28.9
Change Period (Y+Rc), s	5.5	* 5.5	5.5	5.9	5.5	* 5.5	* 5.3	* 5.9
Max Green Setting (Gmax), s	12.5	* 55	21.5	39.1	12.5	* 55	* 19	* 42
Max Q Clear Time (g_c+I1), s	9.0	74.4	11.4	3.6	2.8	2.0	2.8	10.9
Green Ext Time (p_c), s	0.1	0.0	0.2	0.1	0.0	17.8	0.0	0.1

Intersection Summary	
HCM 2010 Ctrl Delay	23.7
HCM 2010 LOS	C

Notes

* HCM 2010 computational engine requires equal clearance times for the phases crossing the barrier.

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	1350	70	40	370	1120	160
Number	7	14	5	2	6	16
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	1607	0	48	440	1333	0
Adj No. of Lanes	3	1	1	2	2	1
Peak Hour Factor	0.84	0.84	0.84	0.84	0.84	0.84
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	1848	585	61	1768	1483	663
Arrive On Green	0.37	0.00	0.03	0.50	0.42	0.00
Sat Flow, veh/h	5003	1583	1774	3632	3632	1583
Grp Volume(v), veh/h	1607	0	48	440	1333	0
Grp Sat Flow(s),veh/h/ln	1668	1583	1774	1770	1770	1583
Q Serve(g_s), s	22.5	0.0	2.0	5.4	26.5	0.0
Cycle Q Clear(g_c), s	22.5	0.0	2.0	5.4	26.5	0.0
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	1848	585	61	1768	1483	663
V/C Ratio(X)	0.87	0.00	0.79	0.25	0.90	0.00
Avail Cap(c_a), veh/h	2345	742	505	1768	1626	727
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	22.1	0.0	36.2	10.8	20.5	0.0
Incr Delay (d2), s/veh	2.6	0.0	8.4	0.0	6.4	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	10.7	0.0	1.1	2.6	14.1	0.0
LnGrp Delay(d),s/veh	24.7	0.0	44.6	10.8	26.9	0.0
LnGrp LOS	C		D	B	C	
Approach Vol, veh/h	1607			488	1333	
Approach Delay, s/veh	24.7			14.2	26.9	
Approach LOS	C			B	C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		
Phs Duration (G+Y+Rc), s		43.0		32.5	6.1	36.9		
Change Period (Y+Rc), s		5.3		4.6	3.5	5.3		
Max Green Setting (Gmax), s		34.7		35.4	21.5	34.7		
Max Q Clear Time (g_c+I1), s		7.4		24.5	4.0	28.5		
Green Ext Time (p_c), s		9.8		3.4	0.0	3.1		

Intersection Summary	
HCM 2010 Ctrl Delay	24.1
HCM 2010 LOS	C

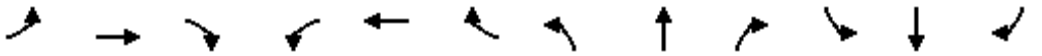
Intersection	
Int Delay, s/veh	1

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	80	490	1090	30	10	20
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	175	-	-	-	0	0
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	97	97	97	97	97	97
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	82	505	1124	31	10	21

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	1155	0	-	0	1557	577
Stage 1	-	-	-	-	1139	-
Stage 2	-	-	-	-	418	-
Critical Hdwy	4.14	-	-	-	6.84	6.94
Critical Hdwy Stg 1	-	-	-	-	5.84	-
Critical Hdwy Stg 2	-	-	-	-	5.84	-
Follow-up Hdwy	2.22	-	-	-	3.52	3.32
Pot Cap-1 Maneuver	601	-	-	-	103	460
Stage 1	-	-	-	-	267	-
Stage 2	-	-	-	-	632	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	601	-	-	-	89	460
Mov Cap-2 Maneuver	-	-	-	-	89	-
Stage 1	-	-	-	-	267	-
Stage 2	-	-	-	-	546	-

Approach	EB	WB	SB
HCM Control Delay, s	1.7	0	25.7
HCM LOS			D

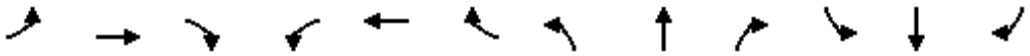
Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	601	-	-	-	89	460
HCM Lane V/C Ratio	0.137	-	-	-	0.116	0.045
HCM Control Delay (s)	11.9	-	-	-	50.7	13.2
HCM Lane LOS	B	-	-	-	F	B
HCM 95th %tile Q(veh)	0.5	-	-	-	0.4	0.1



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	490	140	510	2570	80	1140	0	0	1770	80
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)			4.6		6.2	4.0	4.6	5.0			5.3	5.3
Lane Util. Factor			1.00		0.95	0.76	0.97	0.91			0.86	1.00
Frpb, ped/bikes			1.00		1.00	1.00	1.00	1.00			1.00	0.99
Flpb, ped/bikes			1.00		1.00	1.00	1.00	1.00			1.00	1.00
Frt			0.86		1.00	0.85	1.00	1.00			1.00	0.85
Flt Protected			1.00		0.99	1.00	0.95	1.00			1.00	1.00
Satd. Flow (prot)			1611		3502	3610	3433	5085			6408	1564
Flt Permitted			1.00		0.99	1.00	0.95	1.00			1.00	1.00
Satd. Flow (perm)			1611		3502	3610	3433	5085			6408	1564
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	516	147	537	2705	84	1200	0	0	1863	84
RTOR Reduction (vph)	0	0	122	0	0	5	0	0	0	0	0	48
Lane Group Flow (vph)	0	0	394	0	684	2700	84	1200	0	0	1863	36
Confl. Bikes (#/hr)												1
Turn Type			Over	Split	NA	custom	Prot	NA			NA	Perm
Protected Phases			1	4	4	5	1	6			2	
Permitted Phases						4						2
Actuated Green, G (s)			38.2		31.2	97.5	38.2	37.3			64.5	64.5
Effective Green, g (s)			38.2		31.2	97.5	38.2	37.3			64.5	64.5
Actuated g/C Ratio			0.25		0.21	0.65	0.25	0.25			0.43	0.43
Clearance Time (s)			4.6		6.2	4.0	4.6	5.0			5.3	5.3
Vehicle Extension (s)			1.0		1.0	3.0	1.0	1.0			1.0	1.0
Lane Grp Cap (vph)			410		728	2442	874	1264			2755	672
v/s Ratio Prot			c0.24		0.20	c0.49	0.02	0.24			0.29	
v/s Ratio Perm						0.26						0.02
v/c Ratio			0.96		0.94	1.11	0.10	0.95			0.68	0.05
Uniform Delay, d1			55.2		58.5	26.2	42.7	55.4			34.4	24.9
Progression Factor			1.00		1.00	1.00	1.00	1.00			0.71	0.30
Incremental Delay, d2			34.0		19.5	54.3	0.0	15.8			1.2	0.1
Delay (s)			89.1		78.0	80.5	42.7	71.2			25.7	7.5
Level of Service			F		E	F	D	E			C	A
Approach Delay (s)		89.1			80.0			69.3			24.9	
Approach LOS		F			F			E			C	

Intersection Summary			
HCM 2000 Control Delay	63.7	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.11		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	16.1
Intersection Capacity Utilization	89.5%	ICU Level of Service	E
Analysis Period (min)	15		

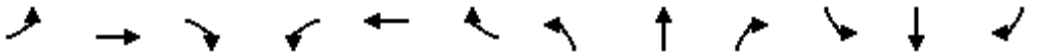
c Critical Lane Group



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	810	160	100	660	0	510	0	300	40	60	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.8		3.8	5.4		5.5		5.5		5.5	
Lane Util. Factor		0.95		1.00	0.95		1.00		1.00		0.95	
Frpb, ped/bikes		1.00		1.00	1.00		1.00		1.00		1.00	
Flpb, ped/bikes		1.00		1.00	1.00		1.00		1.00		1.00	
Frt		0.98		1.00	1.00		1.00		0.85		0.96	
Flt Protected		1.00		0.95	1.00		0.95		1.00		0.99	
Satd. Flow (prot)		3445		1770	3539		1770		1583		3340	
Flt Permitted		1.00		0.95	1.00		0.95		1.00		0.99	
Satd. Flow (perm)		3445		1770	3539		1770		1583		3340	
Peak-hour factor, PHF	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Adj. Flow (vph)	0	953	188	118	776	0	600	0	353	47	71	47
RTOR Reduction (vph)	0	7	0	0	0	0	0	0	112	0	24	0
Lane Group Flow (vph)	0	1134	0	118	776	0	600	0	241	0	141	0
Confl. Bikes (#/hr)			1						4			
Turn Type		NA		Prot	NA		Prot		Prot	Split	NA	
Protected Phases		6		5	2		3 8		3	4	4	
Permitted Phases												
Actuated Green, G (s)		63.3		14.7	81.2		56.2		34.6		10.6	
Effective Green, g (s)		63.3		14.7	81.2		56.2		34.6		10.6	
Actuated g/C Ratio		0.38		0.09	0.48		0.33		0.21		0.06	
Clearance Time (s)		4.8		3.8	5.4				5.5		5.5	
Vehicle Extension (s)		1.0		1.0	1.0				1.0		1.0	
Lane Grp Cap (vph)		1298		154	1711		592		326		210	
v/s Ratio Prot		c0.33		c0.07	0.22		c0.34		0.15		c0.04	
v/s Ratio Perm												
v/c Ratio		0.87		0.77	0.45		1.01		0.74		0.67	
Uniform Delay, d1		48.6		74.9	28.7		55.9		62.4		76.9	
Progression Factor		1.00		1.00	1.00		1.00		1.00		1.00	
Incremental Delay, d2		6.6		18.3	0.1		40.4		7.4		6.1	
Delay (s)		55.1		93.2	28.7		96.3		69.8		83.1	
Level of Service		E		F	C		F		E		F	
Approach Delay (s)		55.1			37.3			86.5			83.1	
Approach LOS		E			D			F			F	

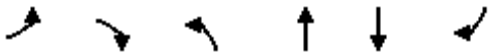
Intersection Summary			
HCM 2000 Control Delay	61.0	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	0.90		
Actuated Cycle Length (s)	167.9	Sum of lost time (s)	23.1
Intersection Capacity Utilization	78.6%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group



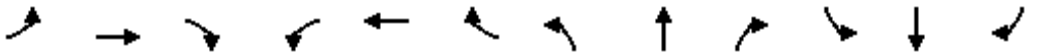
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	1010	120	390	460	30	220	10	190	50	0	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.9		4.9	5.0			4.9	4.9		4.8	4.8
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00	1.00		1.00	1.00
Frt	1.00	0.98		1.00	0.99			1.00	0.85		1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00			0.95	1.00		0.95	1.00
Satd. Flow (prot)	1770	3483		1770	3506			1778	1583		1770	1583
Flt Permitted	0.95	1.00		0.95	1.00			0.95	1.00		0.95	1.00
Satd. Flow (perm)	1770	3483		1770	3506			1778	1583		1770	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	11	1098	130	424	500	33	239	11	207	54	0	54
RTOR Reduction (vph)	0	4	0	0	2	0	0	0	171	0	0	51
Lane Group Flow (vph)	11	1224	0	424	531	0	0	250	36	0	54	3
Turn Type	Prot	NA		Prot	NA		Split	NA	Perm	Split	NA	Perm
Protected Phases	1	6		5	2		4	4		3	3	
Permitted Phases									4			3
Actuated Green, G (s)	2.0	63.9		20.4	82.6			23.5	23.5		7.6	7.6
Effective Green, g (s)	2.0	63.9		20.4	82.6			23.5	23.5		7.6	7.6
Actuated g/C Ratio	0.01	0.47		0.15	0.61			0.17	0.17		0.06	0.06
Clearance Time (s)	4.5	4.9		4.9	5.0			4.9	4.9		4.8	4.8
Vehicle Extension (s)	1.0	5.8		1.0	4.9			2.0	2.0		1.0	1.0
Lane Grp Cap (vph)	26	1649		267	2146			309	275		99	89
v/s Ratio Prot	0.01	c0.35		c0.24	0.15			c0.14			c0.03	
v/s Ratio Perm									0.02			0.00
v/c Ratio	0.42	0.74		1.59	0.25			0.81	0.13		0.55	0.03
Uniform Delay, d1	65.9	28.8		57.2	12.0			53.5	47.1		62.0	60.2
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00		1.00	1.00
Incremental Delay, d2	4.0	2.4		281.7	0.1			13.6	0.1		3.3	0.1
Delay (s)	69.9	31.2		339.0	12.1			67.2	47.2		65.2	60.2
Level of Service	E	C		F	B			E	D		E	E
Approach Delay (s)		31.6			156.9			58.1			62.7	
Approach LOS		C			F			E			E	

Intersection Summary			
HCM 2000 Control Delay	80.6	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	0.89		
Actuated Cycle Length (s)	134.9	Sum of lost time (s)	19.5
Intersection Capacity Utilization	85.0%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			



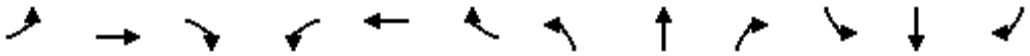
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	130	150	50	2030	640	1470
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.6	4.6	3.5	5.3	5.3	5.3
Lane Util. Factor	0.97	0.91	1.00	0.91	0.91	1.00
Frt	0.95	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.97	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	3326	1441	1770	5085	5085	1583
Flt Permitted	0.97	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	3326	1441	1770	5085	5085	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	137	158	53	2137	674	1547
RTOR Reduction (vph)	57	81	0	0	0	482
Lane Group Flow (vph)	145	12	53	2137	674	1065
Turn Type	Prot	Perm	Prot	NA	NA	Perm
Protected Phases	4		5	2	6	
Permitted Phases		4				6
Actuated Green, G (s)	5.5	5.5	2.2	26.8	21.1	21.1
Effective Green, g (s)	5.5	5.5	2.2	26.8	21.1	21.1
Actuated g/C Ratio	0.13	0.13	0.05	0.64	0.50	0.50
Clearance Time (s)	4.6	4.6	3.5	5.3	5.3	5.3
Vehicle Extension (s)	2.0	2.0	1.5	2.2	2.2	2.2
Lane Grp Cap (vph)	433	187	92	3229	2542	791
v/s Ratio Prot	c0.04		0.03	c0.42	0.13	
v/s Ratio Perm		0.01				c0.67
v/c Ratio	0.34	0.06	0.58	0.66	0.27	1.35
Uniform Delay, d1	16.7	16.1	19.5	4.8	6.1	10.6
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.2	0.1	5.3	0.4	0.0	164.0
Delay (s)	16.9	16.1	24.9	5.3	6.1	174.5
Level of Service	B	B	C	A	A	F
Approach Delay (s)	16.6			5.7	123.4	
Approach LOS	B			A	F	

Intersection Summary			
HCM 2000 Control Delay	62.0	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.12		
Actuated Cycle Length (s)	42.2	Sum of lost time (s)	13.4
Intersection Capacity Utilization	103.8%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	1360	0	20	0	0	0	60	400	0	0	80	430
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.5		5.5				5.5	4.7			4.7	4.7
Lane Util. Factor	0.97		1.00				0.97	0.95			0.95	1.00
Frt	1.00		0.85				1.00	1.00			1.00	0.85
Flt Protected	0.95		1.00				0.95	1.00			1.00	1.00
Satd. Flow (prot)	3433		1583				3433	3539			3539	1583
Flt Permitted	0.95		1.00				0.95	1.00			1.00	1.00
Satd. Flow (perm)	3433		1583				3433	3539			3539	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	1478	0	22	0	0	0	65	435	0	0	87	467
RTOR Reduction (vph)	0	0	9	0	0	0	0	0	0	0	0	332
Lane Group Flow (vph)	1478	0	13	0	0	0	65	435	0	0	87	135
Turn Type	Prot		pm+ov	Prot		pm+ov	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	7	4	1	3	8	5	1	6		5	2	
Permitted Phases			4			8			6			2
Actuated Green, G (s)	60.5		64.3				3.8	41.8			32.5	32.5
Effective Green, g (s)	60.5		64.3				3.8	41.8			32.5	32.5
Actuated g/C Ratio	0.54		0.57				0.03	0.37			0.29	0.29
Clearance Time (s)	5.5		5.5				5.5	4.7			4.7	4.7
Vehicle Extension (s)	3.0		3.0				3.0	3.0			3.0	3.0
Lane Grp Cap (vph)	1846		982				115	1314			1022	457
v/s Ratio Prot	c0.43		0.00				0.02	c0.12			0.02	
v/s Ratio Perm			0.01									0.09
v/c Ratio	0.80		0.01				0.57	0.33			0.09	0.30
Uniform Delay, d1	21.1		10.4				53.5	25.3			29.2	31.1
Progression Factor	1.00		1.00				1.00	1.00			1.00	1.00
Incremental Delay, d2	2.6		0.0				6.2	0.7			0.2	1.6
Delay (s)	23.7		10.4				59.8	26.0			29.3	32.7
Level of Service	C		B				E	C			C	C
Approach Delay (s)		23.5			0.0			30.4			32.2	
Approach LOS		C			A			C			C	

Intersection Summary			
HCM 2000 Control Delay	26.7	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.68		
Actuated Cycle Length (s)	112.5	Sum of lost time (s)	21.2
Intersection Capacity Utilization	58.4%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	660	660	720	590	0	130	0	360	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.8	4.8	5.5	4.8		5.5	5.5	5.5			
Lane Util. Factor		1.00	1.00	0.97	1.00		0.97	0.95	0.95			
Frt		1.00	0.85	1.00	1.00		1.00	0.85	0.85			
Flt Protected		1.00	1.00	0.95	1.00		0.95	1.00	1.00			
Satd. Flow (prot)		1863	1583	3433	1863		3433	1504	1504			
Flt Permitted		1.00	1.00	0.95	1.00		0.95	1.00	1.00			
Satd. Flow (perm)		1863	1583	3433	1863		3433	1504	1504			
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	717	717	783	641	0	141	0	391	0	0	0
RTOR Reduction (vph)	0	0	238	0	0	0	0	151	151	0	0	0
Lane Group Flow (vph)	0	717	479	783	641	0	141	45	44	0	0	0
Turn Type	Prot	NA	Prot	Prot	NA		Split	NA	Perm			
Protected Phases	7	4	4	3	8		2	2		6	6	
Permitted Phases									2			
Actuated Green, G (s)		47.2	47.2	25.5	78.2		26.0	26.0	26.0			
Effective Green, g (s)		47.2	47.2	25.5	78.2		26.0	26.0	26.0			
Actuated g/C Ratio		0.41	0.41	0.22	0.68		0.23	0.23	0.23			
Clearance Time (s)		4.8	4.8	5.5	4.8		5.5	5.5	5.5			
Vehicle Extension (s)		3.0	3.0	3.0	3.0		3.0	3.0	3.0			
Lane Grp Cap (vph)		767	652	764	1272		779	341	341			
v/s Ratio Prot		c0.38	0.30	c0.23	0.34		c0.04	0.03				
v/s Ratio Perm									0.03			
v/c Ratio		0.93	0.73	1.02	0.50		0.18	0.13	0.13			
Uniform Delay, d1		32.2	28.4	44.5	8.8		35.7	35.2	35.2			
Progression Factor		1.00	1.00	1.00	1.00		1.00	1.00	1.00			
Incremental Delay, d2		18.4	4.3	39.0	0.3		0.5	0.8	0.8			
Delay (s)		50.6	32.7	83.5	9.1		36.2	36.0	36.0			
Level of Service		D	C	F	A		D	D	D			
Approach Delay (s)		41.6			50.0			36.1			0.0	
Approach LOS		D			D			D			A	

Intersection Summary			
HCM 2000 Control Delay	44.3	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.80		
Actuated Cycle Length (s)	114.5	Sum of lost time (s)	21.3
Intersection Capacity Utilization	75.9%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	300	10	240	40	10	10	70	3580	60	30	1570	230
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		0.97	1.00		1.00	1.00		0.99
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1900	1863	1863	1863	1863	1863	1900
Adj Flow Rate, veh/h	312	10	250	42	10	10	73	3729	62	31	1635	240
Adj No. of Lanes	2	1	1	1	1	0	2	3	1	1	4	0
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	287	326	277	54	102	102	113	3185	992	35	3482	511
Arrive On Green	0.08	0.18	0.18	0.03	0.12	0.12	0.03	0.63	0.63	0.02	0.61	0.61
Sat Flow, veh/h	3442	1863	1583	1774	844	844	3442	5085	1583	1774	5675	833
Grp Volume(v), veh/h	312	10	250	42	0	20	73	3729	62	31	1385	490
Grp Sat Flow(s),veh/h/ln	1721	1863	1583	1774	0	1688	1721	1695	1583	1774	1602	1702
Q Serve(g_s), s	12.5	0.7	23.2	3.5	0.0	1.6	3.1	94.0	2.3	2.6	23.5	23.5
Cycle Q Clear(g_c), s	12.5	0.7	23.2	3.5	0.0	1.6	3.1	94.0	2.3	2.6	23.5	23.5
Prop In Lane	1.00		1.00	1.00		0.50	1.00		1.00	1.00		0.49
Lane Grp Cap(c), veh/h	287	326	277	54	0	204	113	3185	992	35	2949	1044
V/C Ratio(X)	1.09	0.03	0.90	0.78	0.00	0.10	0.65	1.17	0.06	0.87	0.47	0.47
Avail Cap(c_a), veh/h	287	533	453	105	0	439	158	3185	992	35	2949	1044
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	0.00	1.00	0.09	0.09	0.09	1.00	1.00	1.00
Uniform Delay (d), s/veh	68.8	51.3	60.6	72.2	0.0	58.6	71.7	28.0	10.9	73.3	15.7	15.7
Incr Delay (d2), s/veh	78.6	0.0	8.7	8.6	0.0	0.1	0.2	77.2	0.0	98.5	0.5	1.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	9.1	0.3	10.9	1.9	0.0	0.7	1.5	66.4	1.0	2.3	10.5	11.5
LnGrp Delay(d),s/veh	147.4	51.3	69.3	80.8	0.0	58.7	71.9	105.2	10.9	171.9	16.3	17.2
LnGrp LOS	F	D	E	F		E	E	F	B	F	B	B
Approach Vol, veh/h		572			62			3864			1906	
Approach Delay, s/veh		111.6			73.7			103.1			19.0	
Approach LOS		F			E			F			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	10.4	97.5	18.0	24.0	8.5	99.5	9.9	32.2
Change Period (Y+Rc), s	5.5	* 5.5	5.5	5.9	5.5	* 5.5	* 5.3	* 5.9
Max Green Setting (Gmax), s	6.9	* 69	12.5	39.0	3.0	* 73	* 8.9	* 43
Max Q Clear Time (g_c+I1), s	5.1	25.5	14.5	3.6	4.6	96.0	5.5	25.2
Green Ext Time (p_c), s	0.0	24.0	0.0	0.3	0.0	0.0	0.0	0.3

Intersection Summary	
HCM 2010 Ctrl Delay	78.5
HCM 2010 LOS	E

Notes

* HCM 2010 computational engine requires equal clearance times for the phases crossing the barrier.



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	1130	230	300	950	650	140
Number	7	14	5	2	6	16
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	1177	0	312	990	677	0
Adj No. of Lanes	3	1	1	2	2	1
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	1455	460	363	1967	1050	470
Arrive On Green	0.29	0.00	0.20	0.56	0.30	0.00
Sat Flow, veh/h	5003	1583	1774	3632	3632	1583
Grp Volume(v), veh/h	1177	0	312	990	677	0
Grp Sat Flow(s),veh/h/ln	1668	1583	1774	1770	1770	1583
Q Serve(g_s), s	14.1	0.0	10.9	11.1	10.7	0.0
Cycle Q Clear(g_c), s	14.1	0.0	10.9	11.1	10.7	0.0
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	1455	460	363	1967	1050	470
V/C Ratio(X)	0.81	0.00	0.86	0.50	0.64	0.00
Avail Cap(c_a), veh/h	2747	869	592	1967	1905	852
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	21.2	0.0	24.7	8.8	19.7	0.0
Incr Delay (d2), s/veh	0.4	0.0	3.7	0.1	0.4	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	6.5	0.0	5.8	5.4	5.2	0.0
LnGrp Delay(d),s/veh	21.6	0.0	28.5	8.9	20.1	0.0
LnGrp LOS	C		C	A	C	
Approach Vol, veh/h	1177			1302	677	
Approach Delay, s/veh	21.6			13.6	20.1	
Approach LOS	C			B	C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		
Phs Duration (G+Y+Rc), s		41.1		23.3	16.7	24.4		
Change Period (Y+Rc), s		5.3		4.6	3.5	5.3		
Max Green Setting (Gmax), s		34.7		35.4	21.5	34.7		
Max Q Clear Time (g_c+I1), s		13.1		16.1	12.9	12.7		
Green Ext Time (p_c), s		8.0		2.7	0.3	6.4		

Intersection Summary	
HCM 2010 Ctrl Delay	18.0
HCM 2010 LOS	B

Intersection	
Int Delay, s/veh	1.2

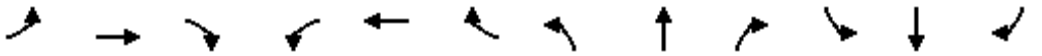
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	40	1110	710	20	30	50
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	175	-	-	-	0	0
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	94	94	94	94	94	94
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	43	1181	755	21	32	53

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	777	0	-	0	1442	388
Stage 1	-	-	-	-	766	-
Stage 2	-	-	-	-	676	-
Critical Hdwy	4.14	-	-	-	6.84	6.94
Critical Hdwy Stg 1	-	-	-	-	5.84	-
Critical Hdwy Stg 2	-	-	-	-	5.84	-
Follow-up Hdwy	2.22	-	-	-	3.52	3.32
Pot Cap-1 Maneuver	835	-	-	-	123	611
Stage 1	-	-	-	-	419	-
Stage 2	-	-	-	-	467	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	835	-	-	-	117	611
Mov Cap-2 Maneuver	-	-	-	-	117	-
Stage 1	-	-	-	-	419	-
Stage 2	-	-	-	-	443	-

Approach	EB	WB	SB
HCM Control Delay, s	0.3	0	24.8
HCM LOS			C

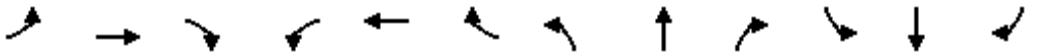
Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	835	-	-	-	117	611
HCM Lane V/C Ratio	0.051	-	-	-	0.273	0.087
HCM Control Delay (s)	9.5	-	-	-	46.9	11.5
HCM Lane LOS	A	-	-	-	E	B
HCM 95th %tile Q(veh)	0.2	-	-	-	1	0.3

Appendix A7
Horizon Year (2042) No Build
Synchro Calculations



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	310	80	180	680	380	1870	0	0	3230	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)			4.6		6.2	6.2	4.6	5.0			5.3	5.3
Lane Util. Factor			1.00		1.00	0.88	0.97	0.91			0.86	1.00
Frpb, ped/bikes			1.00		1.00	1.00	1.00	1.00			1.00	0.98
Flpb, ped/bikes			1.00		1.00	1.00	1.00	1.00			1.00	1.00
Frt			0.86		1.00	0.85	1.00	1.00			1.00	0.85
Flt Protected			1.00		0.98	1.00	0.95	1.00			1.00	1.00
Satd. Flow (prot)			1611		1835	2787	3433	5085			6408	1559
Flt Permitted			1.00		0.98	1.00	0.95	1.00			1.00	1.00
Satd. Flow (perm)			1611		1835	2787	3433	5085			6408	1559
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	0	0	323	83	188	708	396	1948	0	0	3365	42
RTOR Reduction (vph)	0	0	154	0	0	44	0	0	0	0	0	19
Lane Group Flow (vph)	0	0	169	0	271	664	396	1948	0	0	3365	23
Confl. Peds. (#/hr)												1
Confl. Bikes (#/hr)												2
Turn Type			Over	Split	NA	Perm	Prot	NA			NA	Perm
Protected Phases			1	4	4		1	6			2	
Permitted Phases						4						2
Actuated Green, G (s)			22.7		28.3	28.3	22.7	110.5			82.9	82.9
Effective Green, g (s)			22.7		28.3	28.3	22.7	110.5			82.9	82.9
Actuated g/C Ratio			0.15		0.19	0.19	0.15	0.74			0.55	0.55
Clearance Time (s)			4.6		6.2	6.2	4.6	5.0			5.3	5.3
Vehicle Extension (s)			1.0		1.0	1.0	1.0	1.0			1.0	1.0
Lane Grp Cap (vph)			243		346	525	519	3745			3541	861
v/s Ratio Prot			0.10		0.15		c0.12	0.38			c0.53	
v/s Ratio Perm						c0.24						0.01
v/c Ratio			0.69		0.78	1.27	0.76	0.52			0.95	0.03
Uniform Delay, d1			60.4		57.9	60.9	61.1	8.4			31.6	15.2
Progression Factor			1.00		1.00	1.00	1.06	1.42			0.49	0.06
Incremental Delay, d2			6.7		10.2	133.9	4.3	0.4			4.9	0.0
Delay (s)			67.1		68.1	194.7	68.8	12.3			20.3	1.0
Level of Service			E		E	F	E	B			C	A
Approach Delay (s)		67.1			159.7			21.8			20.1	
Approach LOS		E			F			C			C	

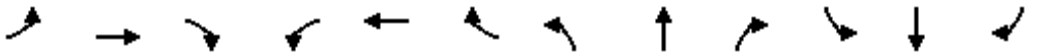
Intersection Summary			
HCM 2000 Control Delay	42.2	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.98		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	16.1
Intersection Capacity Utilization	93.3%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	1290	0	1100	0	0	0	0	1660	340	0	1130	920
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.5	3.5	3.5					4.7			4.7	4.7
Lane Util. Factor	0.95	0.91	0.95					0.95			0.95	1.00
Frpb, ped/bikes	1.00	1.00	1.00					1.00			1.00	0.98
Flpb, ped/bikes	1.00	1.00	1.00					1.00			1.00	1.00
Frt	1.00	1.00	0.85					0.97			1.00	0.85
Flt Protected	0.95	0.95	1.00					1.00			1.00	1.00
Satd. Flow (prot)	1681	1610	1504					3449			3539	1550
Flt Permitted	0.95	0.95	1.00					1.00			1.00	1.00
Satd. Flow (perm)	1681	1610	1504					3449			3539	1550
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	1330	0	1134	0	0	0	0	1711	351	0	1165	948
RTOR Reduction (vph)	0	0	13	0	0	0	0	0	0	0	0	549
Lane Group Flow (vph)	665	665	1121	0	0	0	0	2062	0	0	1165	399
Confl. Bikes (#/hr)												1
Turn Type	Split	NA	Perm					NA			NA	Perm
Protected Phases	8!	8!						6 8!			2	
Permitted Phases			8									2
Actuated Green, G (s)	37.0	37.0	37.0					75.0			29.8	29.8
Effective Green, g (s)	37.0	37.0	37.0					71.5			29.8	29.8
Actuated g/C Ratio	0.49	0.49	0.49					0.95			0.40	0.40
Clearance Time (s)	3.5	3.5	3.5								4.7	4.7
Vehicle Extension (s)	1.5	1.5	1.5								1.0	1.0
Lane Grp Cap (vph)	829	794	741					3288			1406	615
v/s Ratio Prot	0.40	0.41						0.60			c0.33	
v/s Ratio Perm			c0.75									0.26
v/c Ratio	0.80	0.84	1.51					0.63			0.83	0.65
Uniform Delay, d1	15.9	16.4	19.0					0.2			20.3	18.4
Progression Factor	1.00	1.00	1.00					1.00			1.15	9.50
Incremental Delay, d2	5.3	7.4	237.9					0.3			2.3	2.1
Delay (s)	21.2	23.8	256.9					0.5			25.8	176.4
Level of Service	C	C	F					A			C	F
Approach Delay (s)		130.4			0.0			0.5			93.3	
Approach LOS		F			A			A			F	

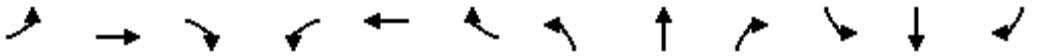
Intersection Summary			
HCM 2000 Control Delay	78.2	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.21		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	8.2
Intersection Capacity Utilization	110.9%	ICU Level of Service	H
Analysis Period (min)	15		

! Phase conflict between lane groups.
c Critical Lane Group



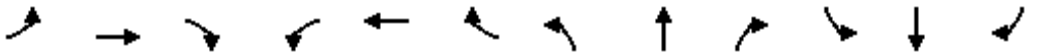
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	140	130	170	150	330	110	300	1750	120	70	1960	200
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.5	5.0		4.1	5.0	5.0	5.5	4.0	4.0	5.5	4.0	4.0
Lane Util. Factor	0.97	0.95		1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Frpb, ped/bikes	1.00	1.00		1.00	1.00	0.99	1.00	1.00	0.99	1.00	1.00	0.99
Flpb, ped/bikes	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.91		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	3238		1770	1863	1562	1770	3539	1561	1770	3539	1561
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	3238		1770	1863	1562	1770	3539	1561	1770	3539	1561
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	146	135	177	156	344	115	312	1823	125	73	2042	208
RTOR Reduction (vph)	0	154	0	0	0	93	0	0	52	0	0	63
Lane Group Flow (vph)	146	158	0	156	344	22	312	1823	73	73	2042	145
Confl. Peds. (#/hr)						1			1			1
Confl. Bikes (#/hr)												1
Turn Type	Prot	NA		Prot	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	1	6		5	2		3	8		7	4	
Permitted Phases						2			8			4
Actuated Green, G (s)	5.5	19.8		15.5	28.4	28.4	21.5	87.3	87.3	8.2	74.0	74.0
Effective Green, g (s)	5.5	19.8		15.5	28.4	28.4	21.5	87.3	87.3	8.2	74.0	74.0
Actuated g/C Ratio	0.04	0.13		0.10	0.19	0.19	0.14	0.58	0.58	0.05	0.50	0.50
Clearance Time (s)	5.5	5.0		4.1	5.0	5.0	5.5	4.0	4.0	5.5	4.0	4.0
Vehicle Extension (s)	1.0	1.0		1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Lane Grp Cap (vph)	126	429		183	354	296	254	2067	912	97	1752	773
v/s Ratio Prot	0.04	0.05		c0.09	c0.18		c0.18	0.52		0.04	c0.58	
v/s Ratio Perm						0.01			0.05			0.09
v/c Ratio	1.16	0.37		0.85	0.97	0.07	1.23	0.88	0.08	0.75	1.17	0.19
Uniform Delay, d1	72.0	59.1		65.8	60.1	49.7	64.0	26.6	13.5	69.6	37.7	21.0
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	129.1	0.2		28.9	39.9	0.0	132.4	4.7	0.0	24.9	81.1	0.0
Delay (s)	201.1	59.3		94.7	100.0	49.7	196.3	31.3	13.6	94.5	118.8	21.0
Level of Service	F	E		F	F	D	F	C	B	F	F	C
Approach Delay (s)		104.5			89.3			53.1			109.3	
Approach LOS		F			F			D			F	

Intersection Summary			
HCM 2000 Control Delay	84.3	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	1.14		
Actuated Cycle Length (s)	149.4	Sum of lost time (s)	20.0
Intersection Capacity Utilization	109.1%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	30	320	110	130	830	60	30	10	20	20	10	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.9		4.9	5.0			4.9	4.9		4.8	4.8
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00	1.00		1.00	1.00
Frt	1.00	0.96		1.00	0.99			1.00	0.85		1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00			0.96	1.00		0.97	1.00
Satd. Flow (prot)	1770	3403		1770	3503			1795	1583		1803	1583
Flt Permitted	0.95	1.00		0.95	1.00			0.96	1.00		0.97	1.00
Satd. Flow (perm)	1770	3403		1770	3503			1795	1583		1803	1583
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	33	352	121	143	912	66	33	11	22	22	11	11
RTOR Reduction (vph)	0	18	0	0	2	0	0	0	20	0	0	11
Lane Group Flow (vph)	33	455	0	143	976	0	0	44	2	0	33	0
Turn Type	Prot	NA		Prot	NA		Split	NA	Perm	Split	NA	Perm
Protected Phases	1	6		5	2		4	4		3	3	
Permitted Phases									4			3
Actuated Green, G (s)	3.1	29.0		11.1	37.3			5.6	5.6		3.1	3.1
Effective Green, g (s)	3.1	29.0		11.1	37.3			5.6	5.6		3.1	3.1
Actuated g/C Ratio	0.05	0.42		0.16	0.55			0.08	0.08		0.05	0.05
Clearance Time (s)	4.5	4.9		4.9	5.0			4.9	4.9		4.8	4.8
Vehicle Extension (s)	1.0	5.8		1.0	4.9			2.0	2.0		1.0	1.0
Lane Grp Cap (vph)	80	1444		287	1913			147	129		81	71
v/s Ratio Prot	0.02	0.13		c0.08	c0.28			c0.02			c0.02	
v/s Ratio Perm									0.00			0.00
v/c Ratio	0.41	0.32		0.50	0.51			0.30	0.01		0.41	0.01
Uniform Delay, d1	31.7	13.1		26.1	9.8			29.5	28.8		31.7	31.1
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00		1.00	1.00
Incremental Delay, d2	1.3	0.3		0.5	0.4			0.4	0.0		1.2	0.0
Delay (s)	33.0	13.4		26.6	10.2			29.9	28.8		32.9	31.1
Level of Service	C	B		C	B			C	C		C	C
Approach Delay (s)		14.7			12.3			29.6			32.5	
Approach LOS		B			B			C			C	

Intersection Summary			
HCM 2000 Control Delay	14.1	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.50		
Actuated Cycle Length (s)	68.3	Sum of lost time (s)	19.5
Intersection Capacity Utilization	49.0%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	1290	180	50	110	0	120	60	260	40	100	910	150
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.6	4.6	4.6	4.6		4.6	3.5	5.3	5.3	3.5	5.3	5.3
Lane Util. Factor	0.91	0.91	1.00	1.00		1.00	1.00	0.91	1.00	1.00	0.91	1.00
Frt	1.00	1.00	0.85	1.00		0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.97	1.00	0.95		1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3221	1641	1583	1770		1583	1770	5085	1583	1770	5085	1583
Flt Permitted	0.95	0.97	1.00	0.95		1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3221	1641	1583	1770		1583	1770	5085	1583	1770	5085	1583
Peak-hour factor, PHF	0.84	0.92	0.84	0.92	0.92	0.92	0.84	0.84	0.92	0.92	0.84	0.84
Adj. Flow (vph)	1536	196	60	120	0	130	71	310	43	109	1083	179
RTOR Reduction (vph)	0	0	36	0	0	124	0	0	31	0	0	131
Lane Group Flow (vph)	1152	580	24	120	0	6	71	310	12	109	1083	48
Turn Type	Split	NA	Perm	Split		Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases			4			8			2			6
Actuated Green, G (s)	33.7	33.7	33.7	4.1		4.1	4.8	23.1	23.1	4.1	22.4	22.4
Effective Green, g (s)	33.7	33.7	33.7	4.1		4.1	4.8	23.1	23.1	4.1	22.4	22.4
Actuated g/C Ratio	0.41	0.41	0.41	0.05		0.05	0.06	0.28	0.28	0.05	0.27	0.27
Clearance Time (s)	4.6	4.6	4.6	4.6		4.6	3.5	5.3	5.3	3.5	5.3	5.3
Vehicle Extension (s)	2.0	2.0	2.0	3.0		3.0	2.0	2.2	2.2	3.0	2.2	2.2
Lane Grp Cap (vph)	1307	666	642	87		78	102	1415	440	87	1372	427
v/s Ratio Prot	c0.36	0.35		c0.07			0.04	0.06		c0.06	c0.21	
v/s Ratio Perm			0.02			0.00			0.01			0.03
v/c Ratio	0.88	0.87	0.04	1.38		0.08	0.70	0.22	0.03	1.25	0.79	0.11
Uniform Delay, d1	22.8	22.7	14.9	39.5		37.7	38.4	23.0	21.8	39.5	28.1	22.8
Progression Factor	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	7.1	11.6	0.0	227.2		0.5	15.3	0.0	0.0	179.0	2.9	0.1
Delay (s)	29.9	34.3	14.9	266.7		38.1	53.7	23.1	21.8	218.4	31.0	22.9
Level of Service	C	C	B	F		D	D	C	C	F	C	C
Approach Delay (s)		30.8			147.8			28.1			44.9	
Approach LOS		C			F			C			D	

Intersection Summary			
HCM 2000 Control Delay	43.1	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.89		
Actuated Cycle Length (s)	83.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	69.4%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	170	10	220	10	10	10	290	2240	20	10	3040	290
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		0.98	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1900	1863	1863	1863	1863	1863	1900
Adj Flow Rate, veh/h	175	10	227	10	10	10	299	2309	21	10	3134	299
Adj No. of Lanes	2	1	1	1	1	0	2	3	1	1	4	0
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	149	297	252	12	103	103	264	3451	1075	12	3660	341
Arrive On Green	0.04	0.16	0.16	0.01	0.12	0.12	0.15	1.00	1.00	0.01	0.61	0.61
Sat Flow, veh/h	3442	1863	1577	1774	849	849	3442	5085	1583	1774	6011	559
Grp Volume(v), veh/h	175	10	227	10	0	20	299	2309	21	10	2490	943
Grp Sat Flow(s),veh/h/ln	1721	1863	1577	1774	0	1697	1721	1695	1583	1774	1602	1764
Q Serve(g_s), s	6.5	0.7	21.2	0.8	0.0	1.6	11.5	0.0	0.0	0.8	63.1	67.4
Cycle Q Clear(g_c), s	6.5	0.7	21.2	0.8	0.0	1.6	11.5	0.0	0.0	0.8	63.1	67.4
Prop In Lane	1.00		1.00	1.00		0.50	1.00		1.00	1.00		0.32
Lane Grp Cap(c), veh/h	149	297	252	12	0	207	264	3451	1075	12	2926	1074
V/C Ratio(X)	1.17	0.03	0.90	0.83	0.00	0.10	1.13	0.67	0.02	0.83	0.85	0.88
Avail Cap(c_a), veh/h	149	525	445	41	0	441	264	3451	1075	35	2926	1074
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	0.00	1.00	0.63	0.63	0.63	1.00	1.00	1.00
Uniform Delay (d), s/veh	71.8	53.2	61.9	74.4	0.0	58.5	63.5	0.0	0.0	74.4	23.8	24.7
Incr Delay (d2), s/veh	127.9	0.0	5.7	38.2	0.0	0.1	85.6	0.7	0.0	38.2	3.3	10.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	5.7	0.4	9.7	0.5	0.0	0.7	8.6	0.2	0.0	0.5	28.6	35.5
LnGrp Delay(d),s/veh	199.6	53.3	67.6	112.6	0.0	58.6	149.1	0.7	0.0	112.6	27.2	34.8
LnGrp LOS	F	D	E	F		E	F	A	A	F	C	C
Approach Vol, veh/h		412			30			2629			3443	
Approach Delay, s/veh		123.3			76.6			17.5			29.5	
Approach LOS		F			E			B			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	17.0	96.8	12.0	24.2	6.5	107.3	6.3	29.8
Change Period (Y+Rc), s	5.5	* 5.5	5.5	5.9	5.5	* 5.5	* 5.3	* 5.9
Max Green Setting (Gmax), s	11.5	* 71	6.5	39.0	3.0	* 79	* 3.5	* 42
Max Q Clear Time (g_c+I1), s	13.5	69.4	8.5	3.6	2.8	2.0	2.8	23.2
Green Ext Time (p_c), s	0.0	1.1	0.0	0.3	0.0	22.7	0.0	0.3

Intersection Summary	
HCM 2010 Ctrl Delay	30.8
HCM 2010 LOS	C

Notes

* HCM 2010 computational engine requires equal clearance times for the phases crossing the barrier.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	290	50	260	560	0	110	0	230	30	340	30
Number	1	6	16	5	2	12	3	8	18	7	4	14
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.98	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	0	1863	1900	1863	1863	0	1863	0	1863	1900	1863	1900
Adj Flow Rate, veh/h	0	309	53	277	596	0	117	0	245	32	362	32
Adj No. of Lanes	0	2	0	1	2	0	2	0	2	0	2	0
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Percent Heavy Veh, %	0	2	2	2	2	0	2	0	2	2	2	2
Cap, veh/h	0	543	92	349	1740	0	0	0	0	47	554	51
Arrive On Green	0.00	0.18	0.18	0.20	0.49	0.00	0.00	0.00	0.00	0.18	0.18	0.18
Sat Flow, veh/h	0	3111	511	1774	3632	0		0		264	3110	288
Grp Volume(v), veh/h	0	180	182	277	596	0		0.0		225	0	201
Grp Sat Flow(s),veh/h/ln	0	1770	1759	1774	1770	0				1850	0	1812
Q Serve(g_s), s	0.0	3.1	3.1	4.9	3.4	0.0				3.7	0.0	3.4
Cycle Q Clear(g_c), s	0.0	3.1	3.1	4.9	3.4	0.0				3.7	0.0	3.4
Prop In Lane	0.00		0.29	1.00		0.00				0.14		0.16
Lane Grp Cap(c), veh/h	0	318	316	349	1740	0				329	0	323
V/C Ratio(X)	0.00	0.56	0.58	0.79	0.34	0.00				0.68	0.00	0.62
Avail Cap(c_a), veh/h	0	1195	1188	828	4385	0				656	0	642
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00				1.00	1.00	1.00
Upstream Filter(I)	0.00	1.00	1.00	1.00	1.00	0.00				1.00	0.00	1.00
Uniform Delay (d), s/veh	0.0	12.4	12.4	12.6	5.1	0.0				12.7	0.0	12.5
Incr Delay (d2), s/veh	0.0	0.6	0.6	1.6	0.0	0.0				0.9	0.0	0.7
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0				0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	0.0	1.5	1.6	2.5	1.6	0.0				2.0	0.0	1.7
LnGrp Delay(d),s/veh	0.0	12.9	13.0	14.2	5.2	0.0				13.6	0.0	13.3
LnGrp LOS		B	B	B	A					B		B
Approach Vol, veh/h		362			873						426	
Approach Delay, s/veh		13.0			8.0						13.5	
Approach LOS		B			A						B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		
Phs Duration (G+Y+Rc), s		21.6		11.4	10.3	11.3		
Change Period (Y+Rc), s		* 5.4		5.5	* 3.8	* 5.4		
Max Green Setting (Gmax), s		* 41		11.7	* 15	* 22		
Max Q Clear Time (g_c+I1), s		5.4		5.7	6.9	5.1		
Green Ext Time (p_c), s		0.8		0.3	0.1	0.8		

Intersection Summary	
HCM 2010 Ctrl Delay	10.5
HCM 2010 LOS	B

Notes

* HCM 2010 computational engine requires equal clearance times for the phases crossing the barrier.

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	110	220	10	1660	940	1620
Number	7	14	5	2	6	16
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	124	247	11	1865	1056	0
Adj No. of Lanes	2	1	1	3	3	1
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	458	211	30	3611	3244	1010
Arrive On Green	0.13	0.13	0.02	0.71	0.64	0.00
Sat Flow, veh/h	3442	1583	1774	5253	5253	1583
Grp Volume(v), veh/h	124	247	11	1865	1056	0
Grp Sat Flow(s),veh/h/ln	1721	1583	1774	1695	1695	1583
Q Serve(g_s), s	2.0	8.4	0.4	10.6	6.0	0.0
Cycle Q Clear(g_c), s	2.0	8.4	0.4	10.6	6.0	0.0
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	458	211	30	3611	3244	1010
V/C Ratio(X)	0.27	1.17	0.37	0.52	0.33	0.00
Avail Cap(c_a), veh/h	458	211	169	10610	9845	3065
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	24.6	27.4	30.7	4.2	5.2	0.0
Incr Delay (d2), s/veh	0.1	116.3	2.9	0.1	0.0	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	1.0	13.7	0.2	4.9	2.7	0.0
LnGrp Delay(d),s/veh	24.7	143.6	33.6	4.3	5.3	0.0
LnGrp LOS	C	F	C	A	A	
Approach Vol, veh/h	371			1876	1056	
Approach Delay, s/veh	103.9			4.4	5.3	
Approach LOS	F			A	A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		
Phs Duration (G+Y+Rc), s		50.1		13.0	4.6	45.6		
Change Period (Y+Rc), s		5.3		4.6	3.5	5.3		
Max Green Setting (Gmax), s		131.7		8.4	6.0	122.2		
Max Q Clear Time (g_c+I1), s		12.6		10.4	2.4	8.0		
Green Ext Time (p_c), s		32.2		0.0	0.0	32.1		

Intersection Summary	
HCM 2010 Ctrl Delay	15.9
HCM 2010 LOS	B

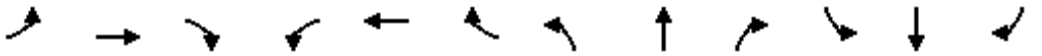
Intersection	
Int Delay, s/veh	1.2

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	100	450	800	30	10	30
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	175	-	-	-	0	0
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	97	97	97	97	97	97
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	103	464	825	31	10	31

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	856	0	-	0	1278	428
Stage 1	-	-	-	-	840	-
Stage 2	-	-	-	-	438	-
Critical Hdwy	4.14	-	-	-	6.84	6.94
Critical Hdwy Stg 1	-	-	-	-	5.84	-
Critical Hdwy Stg 2	-	-	-	-	5.84	-
Follow-up Hdwy	2.22	-	-	-	3.52	3.32
Pot Cap-1 Maneuver	780	-	-	-	158	575
Stage 1	-	-	-	-	384	-
Stage 2	-	-	-	-	618	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	780	-	-	-	137	575
Mov Cap-2 Maneuver	-	-	-	-	137	-
Stage 1	-	-	-	-	384	-
Stage 2	-	-	-	-	536	-

Approach	EB	WB	SB
HCM Control Delay, s	1.9	0	17.1
HCM LOS			C

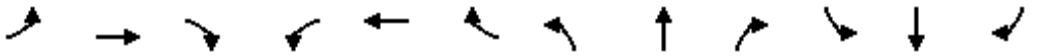
Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	780	-	-	-	137	575
HCM Lane V/C Ratio	0.132	-	-	-	0.075	0.054
HCM Control Delay (s)	10.3	-	-	-	33.4	11.6
HCM Lane LOS	B	-	-	-	D	B
HCM 95th %tile Q(veh)	0.5	-	-	-	0.2	0.2



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	500	190	110	710	290	2970	0	0	3030	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)			4.6		6.2	6.2	4.6	5.0			5.3	5.3
Lane Util. Factor			1.00		1.00	0.88	0.97	0.91			0.86	1.00
Frpb, ped/bikes			1.00		1.00	1.00	1.00	1.00			1.00	0.99
Flpb, ped/bikes			1.00		1.00	1.00	1.00	1.00			1.00	1.00
Frt			0.86		1.00	0.85	1.00	1.00			1.00	0.85
Flt Protected			1.00		0.97	1.00	0.95	1.00			1.00	1.00
Satd. Flow (prot)			1611		1806	2787	3433	5085			6408	1563
Flt Permitted			1.00		0.97	1.00	0.95	1.00			1.00	1.00
Satd. Flow (perm)			1611		1806	2787	3433	5085			6408	1563
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	526	200	116	747	305	3126	0	0	3189	53
RTOR Reduction (vph)	0	0	84	0	0	42	0	0	0	0	0	32
Lane Group Flow (vph)	0	0	442	0	316	705	305	3126	0	0	3189	21
Confl. Bikes (#/hr)												1
Turn Type			Over	Split	NA	Perm	Prot	NA			NA	Perm
Protected Phases			1	4	4		1	6			2	
Permitted Phases						4						2
Actuated Green, G (s)			37.4		30.2	30.2	37.4	98.6			56.3	56.3
Effective Green, g (s)			37.4		30.2	30.2	37.4	98.6			56.3	56.3
Actuated g/C Ratio			0.27		0.22	0.22	0.27	0.70			0.40	0.40
Clearance Time (s)			4.6		6.2	6.2	4.6	5.0			5.3	5.3
Vehicle Extension (s)			1.0		1.0	1.0	1.0	1.0			1.0	1.0
Lane Grp Cap (vph)			430		389	601	917	3581			2576	628
v/s Ratio Prot			c0.27		0.18		0.09	0.61			c0.50	
v/s Ratio Perm						c0.25						0.01
v/c Ratio			1.03		0.81	1.17	0.33	0.87			1.24	0.03
Uniform Delay, d1			51.3		52.2	54.9	41.3	15.9			41.9	25.4
Progression Factor			1.00		1.00	1.00	0.85	1.58			0.65	0.86
Incremental Delay, d2			51.0		11.6	94.4	0.0	1.6			109.2	0.1
Delay (s)			102.3		63.8	149.3	35.1	26.8			136.2	21.8
Level of Service			F		E	F	D	C			F	C
Approach Delay (s)		102.3			123.8			27.5			134.4	
Approach LOS		F			F			C			F	

Intersection Summary			
HCM 2000 Control Delay	86.6	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	1.16		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	16.1
Intersection Capacity Utilization	104.6%	ICU Level of Service	G
Analysis Period (min)	15		

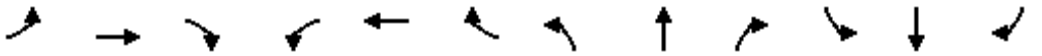
c Critical Lane Group



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	1710	0	1160	0	0	0	0	2450	370	0	1000	920
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.5	3.5	3.5					4.7			4.7	4.7
Lane Util. Factor	0.95	0.91	0.95					0.95			0.95	1.00
Frpb, ped/bikes	1.00	1.00	1.00					1.00			1.00	0.98
Flpb, ped/bikes	1.00	1.00	1.00					1.00			1.00	1.00
Frt	1.00	1.00	0.85					0.98			1.00	0.85
Flt Protected	0.95	0.95	1.00					1.00			1.00	1.00
Satd. Flow (prot)	1681	1610	1504					3470			3539	1549
Flt Permitted	0.95	0.95	1.00					1.00			1.00	1.00
Satd. Flow (perm)	1681	1610	1504					3470			3539	1549
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	1839	0	1247	0	0	0	0	2634	398	0	1075	989
RTOR Reduction (vph)	0	0	4	0	0	0	0	0	0	0	0	332
Lane Group Flow (vph)	919	920	1243	0	0	0	0	3032	0	0	1075	657
Confl. Bikes (#/hr)												1
Turn Type	Split	NA	Perm					NA			NA	Perm
Protected Phases	8!	8!						6 8!			2	
Permitted Phases			8									2
Actuated Green, G (s)	94.5	94.5	94.5					140.0			37.3	37.3
Effective Green, g (s)	94.5	94.5	94.5					136.5			37.3	37.3
Actuated g/C Ratio	0.68	0.68	0.68					0.98			0.27	0.27
Clearance Time (s)	3.5	3.5	3.5								4.7	4.7
Vehicle Extension (s)	1.5	1.5	1.5								1.0	1.0
Lane Grp Cap (vph)	1134	1086	1015					3383			942	412
v/s Ratio Prot	0.55	0.57						0.87			0.30	
v/s Ratio Perm			c0.83									c0.42
v/c Ratio	0.81	0.85	1.22					0.90			1.14	1.59
Uniform Delay, d1	16.3	17.3	22.8					0.3			51.4	51.4
Progression Factor	1.00	1.00	1.00					1.00			1.47	2.18
Incremental Delay, d2	4.3	6.0	109.9					3.4			64.9	268.3
Delay (s)	20.6	23.3	132.6					3.8			140.2	380.3
Level of Service	C	C	F					A			F	F
Approach Delay (s)		66.7			0.0			3.8			255.2	
Approach LOS		E			A			A			F	

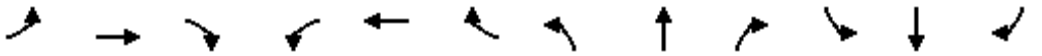
Intersection Summary			
HCM 2000 Control Delay	90.9	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	1.33		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.2
Intersection Capacity Utilization	145.9%	ICU Level of Service	H
Analysis Period (min)	15		

! Phase conflict between lane groups.
c Critical Lane Group



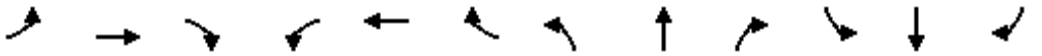
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	450	800	570	250	860	190	420	2180	250	80	1960	120
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.5	5.0		4.1	5.0	5.0	5.5	4.0	4.0	5.5	4.0	4.0
Lane Util. Factor	0.97	0.95		1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Frpb, ped/bikes	1.00	0.99		1.00	1.00	0.97	1.00	1.00	1.00	1.00	1.00	0.99
Flpb, ped/bikes	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.94		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	3299		1770	1863	1543	1770	3539	1583	1770	3539	1563
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	3299		1770	1863	1543	1770	3539	1583	1770	3539	1563
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	495	879	626	275	945	209	462	2396	275	88	2154	132
RTOR Reduction (vph)	0	86	0	0	0	87	0	0	52	0	0	61
Lane Group Flow (vph)	495	1419	0	275	945	122	462	2396	223	88	2154	71
Confl. Peds. (#/hr)						9						
Confl. Bikes (#/hr)			3									1
Turn Type	Prot	NA		Prot	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	1	6		5	2		3	8		7	4	
Permitted Phases						2			8			4
Actuated Green, G (s)	10.5	47.0		11.9	47.0	47.0	18.5	68.0	68.0	4.5	54.0	54.0
Effective Green, g (s)	10.5	47.0		11.9	47.0	47.0	18.5	68.0	68.0	4.5	54.0	54.0
Actuated g/C Ratio	0.07	0.31		0.08	0.31	0.31	0.12	0.45	0.45	0.03	0.36	0.36
Clearance Time (s)	5.5	5.0		4.1	5.0	5.0	5.5	4.0	4.0	5.5	4.0	4.0
Vehicle Extension (s)	1.0	1.0		1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Lane Grp Cap (vph)	240	1033		140	583	483	218	1604	717	53	1274	562
v/s Ratio Prot	0.14	0.43		c0.16	c0.51		c0.26	0.68		0.05	c0.61	
v/s Ratio Perm						0.08			0.14			0.05
v/c Ratio	2.06	1.37		1.96	1.62	0.25	2.12	1.49	0.31	1.66	1.69	0.13
Uniform Delay, d1	69.8	51.5		69.0	51.5	38.4	65.8	41.0	26.1	72.8	48.0	32.2
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	492.3	174.4		458.7	287.3	0.1	518.8	225.5	0.1	366.4	314.3	0.0
Delay (s)	562.0	225.9		527.8	338.8	38.5	584.6	266.5	26.2	439.2	362.3	32.2
Level of Service	F	F		F	F	D	F	F	C	F	F	C
Approach Delay (s)		309.1			331.2			292.3			346.8	
Approach LOS		F			F			F			F	

Intersection Summary			
HCM 2000 Control Delay	316.8	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	1.77		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	152.2%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	1400	30	20	1150	30	100	10	130	50	0	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.9		4.9	5.0			4.9	4.9		4.8	4.8
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00	1.00		1.00	1.00
Frt	1.00	1.00		1.00	1.00			1.00	0.85		1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00			0.96	1.00		0.95	1.00
Satd. Flow (prot)	1770	3528		1770	3526			1782	1583		1770	1583
Flt Permitted	0.95	1.00		0.95	1.00			0.96	1.00		0.95	1.00
Satd. Flow (perm)	1770	3528		1770	3526			1782	1583		1770	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	11	1522	33	22	1250	33	109	11	141	54	0	54
RTOR Reduction (vph)	0	0	0	0	1	0	0	0	126	0	0	51
Lane Group Flow (vph)	11	1555	0	22	1282	0	0	120	15	0	54	3
Turn Type	Prot	NA		Prot	NA		Split	NA	Perm	Split	NA	Perm
Protected Phases	1	6		5	2		4	4		3	3	
Permitted Phases									4			3
Actuated Green, G (s)	0.9	67.1		2.2	68.7			11.5	11.5		5.8	5.8
Effective Green, g (s)	0.9	67.1		2.2	68.7			11.5	11.5		5.8	5.8
Actuated g/C Ratio	0.01	0.63		0.02	0.65			0.11	0.11		0.05	0.05
Clearance Time (s)	4.5	4.9		4.9	5.0			4.9	4.9		4.8	4.8
Vehicle Extension (s)	1.0	5.8		1.0	4.9			2.0	2.0		1.0	1.0
Lane Grp Cap (vph)	15	2231		36	2283			193	171		96	86
v/s Ratio Prot	0.01	c0.44		c0.01	0.36			c0.07			c0.03	
v/s Ratio Perm									0.01			0.00
v/c Ratio	0.73	0.70		0.61	0.56			0.62	0.09		0.56	0.03
Uniform Delay, d1	52.5	12.8		51.5	10.4			45.2	42.6		48.9	47.5
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00		1.00	1.00
Incremental Delay, d2	93.0	1.4		19.6	0.5			4.4	0.1		4.4	0.1
Delay (s)	145.5	14.2		71.2	10.9			49.6	42.7		53.3	47.6
Level of Service	F	B		E	B			D	D		D	D
Approach Delay (s)		15.1			11.9			45.9			50.5	
Approach LOS		B			B			D			D	

Intersection Summary			
HCM 2000 Control Delay	17.5	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.67		
Actuated Cycle Length (s)	106.1	Sum of lost time (s)	19.5
Intersection Capacity Utilization	63.2%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	1200	140	30	120	0	160	210	1260	110	120	1060	240
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.6	4.6	4.6	4.6		4.6	3.5	5.3	5.3	3.5	5.3	5.3
Lane Util. Factor	0.91	0.91	1.00	1.00		1.00	1.00	0.91	1.00	1.00	0.91	1.00
Frt	1.00	1.00	0.85	1.00		0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.97	1.00	0.95		1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3221	1639	1583	1770		1583	1770	5085	1583	1770	5085	1583
Flt Permitted	0.95	0.97	1.00	0.95		1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3221	1639	1583	1770		1583	1770	5085	1583	1770	5085	1583
Peak-hour factor, PHF	0.96	0.92	0.96	0.92	0.92	0.92	0.96	0.96	0.92	0.92	0.96	0.96
Adj. Flow (vph)	1250	152	31	130	0	174	219	1312	120	130	1104	250
RTOR Reduction (vph)	0	0	21	0	0	153	0	0	85	0	0	189
Lane Group Flow (vph)	925	477	10	130	0	21	219	1312	35	130	1104	61
Turn Type	Split	NA	Perm	Split		Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases			4			8			2			6
Actuated Green, G (s)	28.6	28.6	28.6	7.6		7.6	12.2	25.9	25.9	7.6	21.3	21.3
Effective Green, g (s)	28.6	28.6	28.6	7.6		7.6	12.2	25.9	25.9	7.6	21.3	21.3
Actuated g/C Ratio	0.33	0.33	0.33	0.09		0.09	0.14	0.30	0.30	0.09	0.24	0.24
Clearance Time (s)	4.6	4.6	4.6	4.6		4.6	3.5	5.3	5.3	3.5	5.3	5.3
Vehicle Extension (s)	2.0	2.0	2.0	3.0		3.0	2.0	2.2	2.2	3.0	2.2	2.2
Lane Grp Cap (vph)	1050	534	516	153		137	246	1501	467	153	1235	384
v/s Ratio Prot	0.29	c0.29		c0.07			c0.12	c0.26		0.07	0.22	
v/s Ratio Perm			0.01			0.01			0.02			0.04
v/c Ratio	0.88	0.89	0.02	0.85		0.15	0.89	0.87	0.08	0.85	0.89	0.16
Uniform Delay, d1	27.9	28.1	20.0	39.5		37.1	37.1	29.4	22.3	39.5	32.1	26.1
Progression Factor	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	8.6	16.8	0.0	33.2		0.5	29.7	5.8	0.0	33.2	8.5	0.1
Delay (s)	36.5	44.9	20.0	72.7		37.6	66.8	35.2	22.3	72.7	40.6	26.2
Level of Service	D	D	C	E		D	E	D	C	E	D	C
Approach Delay (s)		38.9			52.6			38.4			41.0	
Approach LOS		D			D			D			D	

Intersection Summary			
HCM 2000 Control Delay	40.2	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.91		
Actuated Cycle Length (s)	87.7	Sum of lost time (s)	18.0
Intersection Capacity Utilization	78.8%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	300	10	250	50	20	10	240	3360	80	30	2780	180
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		0.97	1.00		1.00	1.00		0.99
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1900	1863	1863	1863	1863	1863	1900
Adj Flow Rate, veh/h	312	10	260	52	21	10	250	3500	83	31	2896	188
Adj No. of Lanes	2	1	1	1	1	0	2	3	1	1	4	0
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	347	340	289	67	140	67	293	3046	948	39	3321	213
Arrive On Green	0.10	0.18	0.18	0.04	0.12	0.12	0.17	1.00	1.00	0.02	0.54	0.54
Sat Flow, veh/h	3442	1863	1583	1774	1183	563	3442	5085	1583	1774	6194	398
Grp Volume(v), veh/h	312	10	260	52	0	31	250	3500	83	31	2240	844
Grp Sat Flow(s),veh/h/ln	1721	1863	1583	1774	0	1746	1721	1695	1583	1774	1602	1786
Q Serve(g_s), s	12.6	0.6	22.5	4.1	0.0	2.2	9.9	0.0	0.0	2.4	56.7	58.2
Cycle Q Clear(g_c), s	12.6	0.6	22.5	4.1	0.0	2.2	9.9	0.0	0.0	2.4	56.7	58.2
Prop In Lane	1.00		1.00	1.00		0.32	1.00		1.00	1.00		0.22
Lane Grp Cap(c), veh/h	347	340	289	67	0	206	293	3046	948	39	2576	957
V/C Ratio(X)	0.90	0.03	0.90	0.78	0.00	0.15	0.85	1.15	0.09	0.79	0.87	0.88
Avail Cap(c_a), veh/h	347	482	409	234	0	503	312	3046	948	161	2576	957
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	0.00	1.00	0.25	0.25	0.25	1.00	1.00	1.00
Uniform Delay (d), s/veh	62.3	47.0	56.0	66.8	0.0	55.4	57.3	0.0	0.0	68.1	28.2	28.6
Incr Delay (d2), s/veh	24.7	0.0	14.0	7.0	0.0	0.1	5.4	68.3	0.0	12.0	4.3	11.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	7.2	0.3	11.0	2.1	0.0	1.1	4.9	19.3	0.0	1.3	25.9	31.7
LnGrp Delay(d),s/veh	86.9	47.0	70.0	73.8	0.0	55.5	62.6	68.3	0.0	80.1	32.5	40.1
LnGrp LOS	F	D	E	E		E	E	F	A	F	C	D
Approach Vol, veh/h		582			83			3833			3115	
Approach Delay, s/veh		78.7			67.0			66.4			35.1	
Approach LOS		E			E			E			D	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	17.4	80.6	19.6	22.4	8.6	89.3	10.6	31.5
Change Period (Y+Rc), s	5.5	* 5.5	5.5	5.9	5.5	* 5.5	* 5.3	* 5.9
Max Green Setting (Gmax), s	12.7	* 51	14.1	40.3	12.7	* 51	* 19	* 36
Max Q Clear Time (g_c+I1), s	11.9	60.2	14.6	4.2	4.4	2.0	6.1	24.5
Green Ext Time (p_c), s	0.0	0.0	0.0	0.3	0.0	30.6	0.0	0.3

Intersection Summary	
HCM 2010 Ctrl Delay	54.5
HCM 2010 LOS	D

Notes

* HCM 2010 computational engine requires equal clearance times for the phases crossing the barrier.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	1100	120	330	1020	0	370	0	260	90	160	60
Number	1	6	16	5	2	12	3	8	18	7	4	14
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.98	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	0	1863	1900	1863	1863	0	1863	0	1863	1900	1863	1900
Adj Flow Rate, veh/h	0	1196	130	359	1109	0	402	0	283	98	174	65
Adj No. of Lanes	0	2	0	1	2	0	2	0	2	0	2	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	0	2	2	2	2	0	2	0	2	2	2	2
Cap, veh/h	0	1333	144	407	2488	0	0	0	0	128	237	92
Arrive On Green	0.00	0.41	0.41	0.23	0.70	0.00	0.00	0.00	0.00	0.13	0.13	0.13
Sat Flow, veh/h	0	3307	348	1774	3632	0		0		995	1842	713
Grp Volume(v), veh/h	0	657	669	359	1109	0		0.0		179	0	158
Grp Sat Flow(s),veh/h/ln	0	1770	1793	1774	1770	0				1813	0	1737
Q Serve(g_s), s	0.0	22.4	22.6	12.7	8.8	0.0				6.2	0.0	5.7
Cycle Q Clear(g_c), s	0.0	22.4	22.6	12.7	8.8	0.0				6.2	0.0	5.7
Prop In Lane	0.00		0.19	1.00		0.00				0.55		0.41
Lane Grp Cap(c), veh/h	0	734	743	407	2488	0				233	0	223
V/C Ratio(X)	0.00	0.90	0.90	0.88	0.45	0.00				0.77	0.00	0.71
Avail Cap(c_a), veh/h	0	1492	1511	800	4755	0				378	0	362
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00				1.00	1.00	1.00
Upstream Filter(I)	0.00	1.00	1.00	1.00	1.00	0.00				1.00	0.00	1.00
Uniform Delay (d), s/veh	0.0	17.6	17.7	24.1	4.2	0.0				27.3	0.0	27.1
Incr Delay (d2), s/veh	0.0	1.6	1.7	2.5	0.0	0.0				2.0	0.0	1.6
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0				0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	0.0	11.1	11.3	6.5	4.2	0.0				3.2	0.0	2.8
LnGrp Delay(d),s/veh	0.0	19.3	19.4	26.6	4.2	0.0				29.2	0.0	28.6
LnGrp LOS		B	B	C	A					C		C
Approach Vol, veh/h		1326			1468						337	
Approach Delay, s/veh		19.3			9.7						28.9	
Approach LOS		B			A						C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		
Phs Duration (G+Y+Rc), s		50.9		13.8	18.7	32.3		
Change Period (Y+Rc), s		* 5.4		5.5	* 3.8	* 5.4		
Max Green Setting (Gmax), s		* 87		13.5	* 29	* 55		
Max Q Clear Time (g_c+I1), s		10.8		8.2	14.7	24.6		
Green Ext Time (p_c), s		2.3		0.2	0.2	2.3		

Intersection Summary	
HCM 2010 Ctrl Delay	15.8
HCM 2010 LOS	B

Notes

* HCM 2010 computational engine requires equal clearance times for the phases crossing the barrier.

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	180	140	110	2510	1280	1520
Number	7	14	5	2	6	16
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	189	147	116	2642	1347	0
Adj No. of Lanes	2	1	1	3	3	1
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	384	176	118	4073	3578	1114
Arrive On Green	0.11	0.11	0.07	0.80	0.70	0.00
Sat Flow, veh/h	3442	1583	1774	5253	5253	1583
Grp Volume(v), veh/h	189	147	116	2642	1347	0
Grp Sat Flow(s),veh/h/ln	1721	1583	1774	1695	1695	1583
Q Serve(g_s), s	5.8	10.3	7.4	24.3	12.1	0.0
Cycle Q Clear(g_c), s	5.8	10.3	7.4	24.3	12.1	0.0
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	384	176	118	4073	3578	1114
V/C Ratio(X)	0.49	0.83	0.98	0.65	0.38	0.00
Avail Cap(c_a), veh/h	530	244	118	5524	5029	1566
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	47.2	49.2	52.7	4.7	6.8	0.0
Incr Delay (d2), s/veh	0.4	11.8	77.8	0.1	0.0	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	2.8	9.3	6.2	11.0	5.6	0.0
LnGrp Delay(d),s/veh	47.5	61.0	130.5	4.8	6.8	0.0
LnGrp LOS	D	E	F	A	A	
Approach Vol, veh/h	336			2758	1347	
Approach Delay, s/veh	53.4			10.0	6.8	
Approach LOS	D			B	A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		
Phs Duration (G+Y+Rc), s		95.8		17.2	11.0	84.8		
Change Period (Y+Rc), s		5.3		4.6	3.5	5.3		
Max Green Setting (Gmax), s		122.7		17.4	7.5	111.7		
Max Q Clear Time (g_c+I1), s		26.3		12.3	9.4	14.1		
Green Ext Time (p_c), s		64.1		0.3	0.0	64.7		

Intersection Summary	
HCM 2010 Ctrl Delay	12.3
HCM 2010 LOS	B

Intersection	
Int Delay, s/veh	3.5

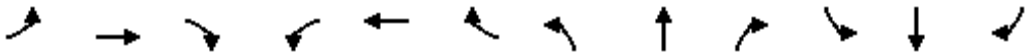
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	40	1410	1260	20	30	60
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	175	-	-	-	0	0
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	94	94	94	94	94	94
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	43	1500	1340	21	32	64

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	1362	0	-	0	2186	681
Stage 1	-	-	-	-	1351	-
Stage 2	-	-	-	-	835	-
Critical Hdwy	4.14	-	-	-	6.84	6.94
Critical Hdwy Stg 1	-	-	-	-	5.84	-
Critical Hdwy Stg 2	-	-	-	-	5.84	-
Follow-up Hdwy	2.22	-	-	-	3.52	3.32
Pot Cap-1 Maneuver	501	-	-	-	39	393
Stage 1	-	-	-	-	206	-
Stage 2	-	-	-	-	386	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	501	-	-	-	36	393
Mov Cap-2 Maneuver	-	-	-	-	36	-
Stage 1	-	-	-	-	206	-
Stage 2	-	-	-	-	353	-

Approach	EB	WB	SB
HCM Control Delay, s	0.4	0	104.2
HCM LOS			F

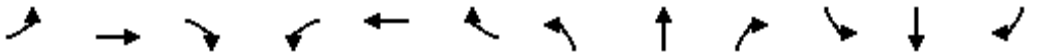
Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	501	-	-	-	36	393
HCM Lane V/C Ratio	0.085	-	-	-	0.887	0.162
HCM Control Delay (s)	12.9	-	-	-	280.8	15.9
HCM Lane LOS	B	-	-	-	F	C
HCM 95th %tile Q(veh)	0.3	-	-	-	3.2	0.6

Appendix A8
Horizon Year (2042) with Alternative 1/1A
Synchro Calculations



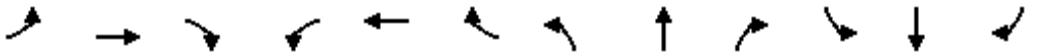
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	170	10	220	10	10	10	290	2240	20	10	3040	290
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.5	5.8	5.8	5.3	5.9		5.5	5.3	5.3	5.5	5.5	
Lane Util. Factor	0.97	0.95	0.95	1.00	1.00		0.97	0.91	1.00	1.00	0.86	
Frpb, ped/bikes	1.00	1.00	0.99	1.00	0.99		1.00	1.00	1.00	1.00	1.00	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	0.93		1.00	1.00	0.85	1.00	0.99	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	3433	1770	1482	1770	1708		3433	5085	1583	1770	6324	
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	3433	1770	1482	1770	1708		3433	5085	1583	1770	6324	
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	175	10	227	10	10	10	299	2309	21	10	3134	299
RTOR Reduction (vph)	0	0	120	0	9	0	0	0	6	0	7	0
Lane Group Flow (vph)	175	10	107	10	11	0	299	2309	15	10	3426	0
Confl. Peds. (#/hr)			2									
Confl. Bikes (#/hr)						2						
Turn Type	Prot	NA	Perm	Prot	NA		Prot	NA	Perm	Prot	NA	
Protected Phases	3	8		7	4		1	6		5	2	
Permitted Phases			8						6			
Actuated Green, G (s)	7.1	18.3	18.3	1.4	12.3		11.5	107.2	107.2	1.2	96.7	
Effective Green, g (s)	7.1	18.3	18.3	1.4	12.3		11.5	107.2	107.2	1.2	96.7	
Actuated g/C Ratio	0.05	0.12	0.12	0.01	0.08		0.08	0.71	0.71	0.01	0.64	
Clearance Time (s)	5.5	5.8	5.8	5.3	5.9		5.5	5.3	5.3	5.5	5.5	
Vehicle Extension (s)	1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0	1.0	
Lane Grp Cap (vph)	162	215	180	16	140		263	3634	1131	14	4076	
v/s Ratio Prot	c0.05	0.01		0.01	0.01		c0.09	0.45		0.01	c0.54	
v/s Ratio Perm			c0.07						0.01			
v/c Ratio	1.08	0.05	0.59	0.62	0.08		1.14	0.64	0.01	0.71	0.84	
Uniform Delay, d1	71.5	58.1	62.3	74.0	63.6		69.2	11.2	6.2	74.2	20.7	
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.14	0.51	1.00	1.00	1.00	
Incremental Delay, d2	93.7	0.0	3.5	44.0	0.1		88.6	0.6	0.0	87.8	2.3	
Delay (s)	165.2	58.2	65.8	118.1	63.7		167.6	6.3	6.2	162.1	22.9	
Level of Service	F	E	E	F	E		F	A	A	F	C	
Approach Delay (s)		107.8			81.8			24.7			23.3	
Approach LOS		F			F			C			C	

Intersection Summary			
HCM 2000 Control Delay	29.5	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.87		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	22.4
Intersection Capacity Utilization	83.8%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			



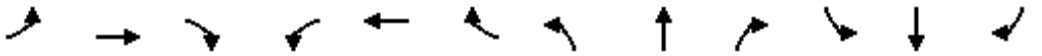
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	310	80	180	680	380	1870	0	0	3230	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)			4.6		6.2	6.2	4.6	5.0			5.3	5.3
Lane Util. Factor			1.00		1.00	0.88	0.97	0.91			0.86	1.00
Frpb, ped/bikes			1.00		1.00	1.00	1.00	1.00			1.00	0.98
Flpb, ped/bikes			1.00		1.00	1.00	1.00	1.00			1.00	1.00
Frt			0.86		1.00	0.85	1.00	1.00			1.00	0.85
Flt Protected			1.00		0.98	1.00	0.95	1.00			1.00	1.00
Satd. Flow (prot)			1611		1835	2787	3433	5085			6408	1559
Flt Permitted			1.00		0.98	1.00	0.95	1.00			1.00	1.00
Satd. Flow (perm)			1611		1835	2787	3433	5085			6408	1559
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	0	0	323	83	188	708	396	1948	0	0	3365	42
RTOR Reduction (vph)	0	0	147	0	0	45	0	0	0	0	0	19
Lane Group Flow (vph)	0	0	176	0	271	663	396	1948	0	0	3365	23
Confl. Peds. (#/hr)												1
Confl. Bikes (#/hr)												2
Turn Type			Over	Split	NA	Perm	Prot	NA			NA	Perm
Protected Phases			1	4	4		1	6			2	
Permitted Phases						4						2
Actuated Green, G (s)			22.8		27.8	27.8	22.8	111.0			83.3	83.3
Effective Green, g (s)			22.8		27.8	27.8	22.8	111.0			83.3	83.3
Actuated g/C Ratio			0.15		0.19	0.19	0.15	0.74			0.56	0.56
Clearance Time (s)			4.6		6.2	6.2	4.6	5.0			5.3	5.3
Vehicle Extension (s)			1.0		1.0	1.0	1.0	1.0			1.0	1.0
Lane Grp Cap (vph)			244		340	516	521	3762			3558	865
v/s Ratio Prot			0.11		0.15		c0.12	0.38			c0.53	
v/s Ratio Perm						c0.24						0.01
v/c Ratio			0.72		0.80	1.29	0.76	0.52			0.95	0.03
Uniform Delay, d1			60.6		58.4	61.1	61.0	8.2			31.2	15.1
Progression Factor			1.00		1.00	1.00	1.06	1.21			0.46	0.08
Incremental Delay, d2			8.6		11.5	142.5	4.6	0.4			4.5	0.0
Delay (s)			69.2		69.9	203.6	69.4	10.4			19.0	1.2
Level of Service			E		E	F	E	B			B	A
Approach Delay (s)		69.2			166.6			20.4			18.8	
Approach LOS		E			F			C			B	

Intersection Summary			
HCM 2000 Control Delay	42.1	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.98		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	16.1
Intersection Capacity Utilization	93.3%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			



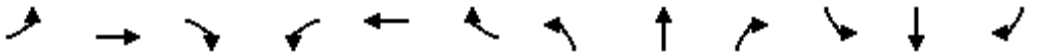
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	30	320	110	130	830	60	30	10	20	20	10	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.9		4.9	5.0			4.9	4.9		4.8	4.8
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00	1.00		1.00	1.00
Frt	1.00	0.96		1.00	0.99			1.00	0.85		1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00			0.96	1.00		0.97	1.00
Satd. Flow (prot)	1770	3403		1770	3504			1795	1583		1803	1583
Flt Permitted	0.95	1.00		0.95	1.00			0.96	1.00		0.97	1.00
Satd. Flow (perm)	1770	3403		1770	3504			1795	1583		1803	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	33	348	120	141	902	65	33	11	22	22	11	11
RTOR Reduction (vph)	0	37	0	0	5	0	0	0	21	0	0	11
Lane Group Flow (vph)	33	431	0	141	962	0	0	44	1	0	33	0
Turn Type	Prot	NA		Prot	NA		Split	NA	Perm	Split	NA	Perm
Protected Phases	1	6		5	2		4	4		3	3	
Permitted Phases									4			3
Actuated Green, G (s)	1.2	23.1		7.2	29.4			1.7	1.7		1.7	1.7
Effective Green, g (s)	1.2	23.1		7.2	29.4			1.7	1.7		1.7	1.7
Actuated g/C Ratio	0.02	0.43		0.14	0.55			0.03	0.03		0.03	0.03
Clearance Time (s)	4.5	4.9		4.9	5.0			4.9	4.9		4.8	4.8
Vehicle Extension (s)	1.0	5.8		1.0	4.9			2.0	2.0		1.0	1.0
Lane Grp Cap (vph)	39	1477		239	1936			57	50		57	50
v/s Ratio Prot	0.02	0.13		c0.08	c0.27			c0.02			c0.02	
v/s Ratio Perm									0.00			0.00
v/c Ratio	0.85	0.29		0.59	0.50			0.77	0.01		0.58	0.01
Uniform Delay, d1	25.9	9.8		21.6	7.3			25.6	24.9		25.4	24.9
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00		1.00	1.00
Incremental Delay, d2	82.5	0.3		2.4	0.4			43.5	0.0		8.6	0.0
Delay (s)	108.4	10.0		24.0	7.7			69.1	25.0		34.0	25.0
Level of Service	F	B		C	A			E	C		C	C
Approach Delay (s)		16.5			9.8			54.4			31.7	
Approach LOS		B			A			D			C	

Intersection Summary			
HCM 2000 Control Delay	14.0	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.57		
Actuated Cycle Length (s)	53.2	Sum of lost time (s)	19.5
Intersection Capacity Utilization	49.0%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			



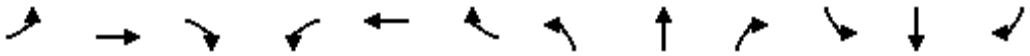
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	1290	180	50	110	0	120	60	260	40	100	910	150
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.6	4.6	4.6	4.6		4.6	3.5	5.3	5.3	3.5	5.3	5.3
Lane Util. Factor	0.91	0.91	1.00	1.00		1.00	1.00	0.91	1.00	1.00	0.91	1.00
Frt	1.00	1.00	0.85	1.00		0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.97	1.00	0.95		1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3221	1643	1583	1770		1583	1770	5085	1583	1770	5085	1583
Flt Permitted	0.95	0.97	1.00	0.95		1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3221	1643	1583	1770		1583	1770	5085	1583	1770	5085	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	1402	196	54	120	0	130	65	283	43	109	989	163
RTOR Reduction (vph)	0	0	34	0	0	118	0	0	33	0	0	120
Lane Group Flow (vph)	1066	532	20	120	0	13	65	283	10	109	989	43
Turn Type	Split	NA	Perm	Split		Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases			4			8			2			6
Actuated Green, G (s)	30.9	30.9	30.9	8.0		8.0	4.5	19.0	19.0	7.3	21.8	21.8
Effective Green, g (s)	30.9	30.9	30.9	8.0		8.0	4.5	19.0	19.0	7.3	21.8	21.8
Actuated g/C Ratio	0.37	0.37	0.37	0.10		0.10	0.05	0.23	0.23	0.09	0.26	0.26
Clearance Time (s)	4.6	4.6	4.6	4.6		4.6	3.5	5.3	5.3	3.5	5.3	5.3
Vehicle Extension (s)	2.0	2.0	2.0	2.0		2.0	2.0	2.2	2.2	2.0	2.2	2.2
Lane Grp Cap (vph)	1196	610	587	170		152	95	1161	361	155	1332	414
v/s Ratio Prot	c0.33	0.32		c0.07			0.04	0.06		c0.06	c0.19	
v/s Ratio Perm			0.01			0.01			0.01			0.03
v/c Ratio	0.89	0.87	0.03	0.71		0.08	0.68	0.24	0.03	0.70	0.74	0.10
Uniform Delay, d1	24.6	24.3	16.6	36.5		34.3	38.7	26.2	24.9	36.9	28.1	23.3
Progression Factor	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	8.4	12.6	0.0	10.4		0.1	15.0	0.1	0.0	11.2	2.1	0.1
Delay (s)	33.0	37.0	16.7	46.8		34.3	53.7	26.3	24.9	48.1	30.2	23.3
Level of Service	C	D	B	D		C	D	C	C	D	C	C
Approach Delay (s)		33.7			40.3			30.7			30.8	
Approach LOS		C			D			C			C	

Intersection Summary			
HCM 2000 Control Delay	32.8	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	83.2	Sum of lost time (s)	18.0
Intersection Capacity Utilization	69.4%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	250	130	190	130	30	260	390	1490	110	420	1540	270
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.5	5.5	5.5	5.5	5.5	5.5	5.5	4.7	4.7	5.5	4.7	4.7
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95	1.00	0.97	0.91	1.00	0.97	0.91	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	3539	1583	1770	3539	1583	3433	5085	1583	3433	5085	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	3539	1583	1770	3539	1583	3433	5085	1583	3433	5085	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	272	141	207	141	33	283	424	1620	120	457	1674	293
RTOR Reduction (vph)	0	0	41	0	0	40	0	0	48	0	0	111
Lane Group Flow (vph)	272	141	166	141	33	243	424	1620	72	457	1674	182
Turn Type	Prot	NA	pm+ov	Prot	NA	pm+ov	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	7	4	1	3	8	5	1	6		5	2	
Permitted Phases			4			8			6			2
Actuated Green, G (s)	18.3	10.5	32.8	17.2	9.4	33.4	22.3	77.1	77.1	24.0	78.8	78.8
Effective Green, g (s)	18.3	10.5	32.8	17.2	9.4	33.4	22.3	77.1	77.1	24.0	78.8	78.8
Actuated g/C Ratio	0.12	0.07	0.22	0.11	0.06	0.22	0.15	0.51	0.51	0.16	0.53	0.53
Clearance Time (s)	5.5	5.5	5.5	5.5	5.5	5.5	5.5	4.7	4.7	5.5	4.7	4.7
Vehicle Extension (s)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Lane Grp Cap (vph)	418	247	404	202	221	410	510	2613	813	549	2671	831
v/s Ratio Prot	0.08	0.04	0.06	c0.08	0.01	c0.09	0.12	0.32		c0.13	c0.33	
v/s Ratio Perm			0.04			0.06			0.05			0.12
v/c Ratio	0.65	0.57	0.41	0.70	0.15	0.59	0.83	0.62	0.09	0.83	0.63	0.22
Uniform Delay, d1	62.8	67.6	50.3	63.9	66.5	52.2	62.0	26.0	18.6	61.1	25.2	19.1
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.03	0.71	0.69
Incremental Delay, d2	2.8	2.0	0.2	8.2	0.1	1.5	10.6	1.1	0.2	8.0	0.9	0.5
Delay (s)	65.6	69.5	50.6	72.1	66.6	53.7	72.6	27.1	18.8	71.1	18.8	13.6
Level of Service	E	E	D	E	E	D	E	C	B	E	B	B
Approach Delay (s)		61.5			60.3			35.6			28.0	
Approach LOS		E			E			D			C	

Intersection Summary			
HCM 2000 Control Delay	37.2	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	21.2
Intersection Capacity Utilization	69.3%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	130	310	260	330	0	500	0	190	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.8	4.8	5.5	4.8		5.5	5.5	5.5			
Lane Util. Factor		1.00	1.00	0.97	1.00		0.97	0.95	0.95			
Frt		1.00	0.85	1.00	1.00		1.00	0.85	0.85			
Flt Protected		1.00	1.00	0.95	1.00		0.95	1.00	1.00			
Satd. Flow (prot)		1863	1583	3433	1863		3433	1504	1504			
Flt Permitted		1.00	1.00	0.95	1.00		0.95	1.00	1.00			
Satd. Flow (perm)		1863	1583	3433	1863		3433	1504	1504			
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	141	337	283	359	0	543	0	207	0	0	0
RTOR Reduction (vph)	0	0	274	0	0	0	0	75	74	0	0	0
Lane Group Flow (vph)	0	141	63	283	359	0	543	29	29	0	0	0
Turn Type	Prot	NA	Perm	Prot	NA		Split	NA	Perm			
Protected Phases	7	4		3	8		2	2		6	6	
Permitted Phases			4						2			
Actuated Green, G (s)		7.1	7.1	4.6	17.2		10.7	10.7	10.7			
Effective Green, g (s)		7.1	7.1	4.6	17.2		10.7	10.7	10.7			
Actuated g/C Ratio		0.19	0.19	0.12	0.45		0.28	0.28	0.28			
Clearance Time (s)		4.8	4.8	5.5	4.8		5.5	5.5	5.5			
Vehicle Extension (s)		1.0	1.0	1.0	1.0		1.0	1.0	1.0			
Lane Grp Cap (vph)		346	294	413	838		961	421	421			
v/s Ratio Prot		0.08		0.08	c0.19		c0.16	0.02				
v/s Ratio Perm			0.04						0.02			
v/c Ratio		0.41	0.21	0.69	0.43		0.57	0.07	0.07			
Uniform Delay, d1		13.7	13.2	16.1	7.2		11.8	10.1	10.1			
Progression Factor		1.00	1.00	1.00	1.00		1.00	1.00	1.00			
Incremental Delay, d2		0.3	0.1	3.7	0.1		0.5	0.0	0.0			
Delay (s)		14.0	13.3	19.8	7.3		12.2	10.1	10.1			
Level of Service		B	B	B	A		B	B	B			
Approach Delay (s)		13.5			12.8			11.6			0.0	
Approach LOS		B			B			B			A	

Intersection Summary			
HCM 2000 Control Delay	12.5	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	38.2	Sum of lost time (s)	21.3
Intersection Capacity Utilization	48.1%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	1290	0	1100	0	0	0	0	1660	340	0	1130	920
Number	3	8	18				1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0				0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00				1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	0	1863				0	1863	1863	0	1863	1863
Adj Flow Rate, veh/h	1330	0	1134				0	1711	0	0	1165	0
Adj No. of Lanes	3	0	2				0	3	1	0	3	1
Peak Hour Factor	0.97	0.97	0.97				0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	2	0	2				0	2	2	0	2	2
Cap, veh/h	2168	0	1207				0	2604	811	0	2604	811
Arrive On Green	0.43	0.00	0.43				0.00	1.00	0.00	0.00	0.34	0.00
Sat Flow, veh/h	5003	0	2787				0	5253	1583	0	5253	1583
Grp Volume(v), veh/h	1330	0	1134				0	1711	0	0	1165	0
Grp Sat Flow(s),veh/h/ln	1668	0	1393				0	1695	1583	0	1695	1583
Q Serve(g_s), s	30.8	0.0	58.3				0.0	0.0	0.0	0.0	26.7	0.0
Cycle Q Clear(g_c), s	30.8	0.0	58.3				0.0	0.0	0.0	0.0	26.7	0.0
Prop In Lane	1.00		1.00				0.00		1.00	0.00		1.00
Lane Grp Cap(c), veh/h	2168	0	1207				0	2604	811	0	2604	811
V/C Ratio(X)	0.61	0.00	0.94				0.00	0.66	0.00	0.00	0.45	0.00
Avail Cap(c_a), veh/h	2285	0	1273				0	2604	811	0	2604	811
HCM Platoon Ratio	1.00	1.00	1.00				1.00	2.00	2.00	1.00	0.67	0.67
Upstream Filter(I)	1.00	0.00	1.00				0.00	0.76	0.00	0.00	1.00	0.00
Uniform Delay (d), s/veh	32.8	0.0	40.6				0.0	0.0	0.0	0.0	32.8	0.0
Incr Delay (d2), s/veh	0.3	0.0	12.6				0.0	1.0	0.0	0.0	0.6	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0				0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	14.2	0.0	24.5				0.0	0.2	0.0	0.0	12.6	0.0
LnGrp Delay(d),s/veh	33.1	0.0	53.2				0.0	1.0	0.0	0.0	33.4	0.0
LnGrp LOS	C		D					A			C	
Approach Vol, veh/h		2464						1711			1165	
Approach Delay, s/veh		42.4						1.0			33.4	
Approach LOS		D						A			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2				6		8
Phs Duration (G+Y+Rc), s		81.5				81.5		68.5
Change Period (Y+Rc), s		4.7				4.7		3.5
Max Green Setting (Gmax), s		73.3				73.3		68.5
Max Q Clear Time (g_c+I1), s		28.7				2.0		60.3
Green Ext Time (p_c), s		5.2				5.2		4.7

Intersection Summary	
HCM 2010 Ctrl Delay	27.1
HCM 2010 LOS	C

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	290	50	260	560	0	110	0	230	30	340	30
Number	1	6	16	5	2	12	3	8	18	7	4	14
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.98	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	0	1863	1900	1863	1863	0	1863	0	1863	1900	1863	1900
Adj Flow Rate, veh/h	0	309	53	277	596	0	117	0	245	32	362	32
Adj No. of Lanes	0	2	0	1	2	0	2	0	2	0	2	0
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Percent Heavy Veh, %	0	2	2	2	2	0	2	0	2	2	2	2
Cap, veh/h	0	543	92	349	1740	0	0	0	0	47	554	51
Arrive On Green	0.00	0.18	0.18	0.20	0.49	0.00	0.00	0.00	0.00	0.18	0.18	0.18
Sat Flow, veh/h	0	3111	511	1774	3632	0		0		264	3110	288
Grp Volume(v), veh/h	0	180	182	277	596	0		0.0		225	0	201
Grp Sat Flow(s),veh/h/ln	0	1770	1759	1774	1770	0				1850	0	1812
Q Serve(g_s), s	0.0	3.1	3.1	4.9	3.4	0.0				3.7	0.0	3.4
Cycle Q Clear(g_c), s	0.0	3.1	3.1	4.9	3.4	0.0				3.7	0.0	3.4
Prop In Lane	0.00		0.29	1.00		0.00				0.14		0.16
Lane Grp Cap(c), veh/h	0	318	316	349	1740	0				329	0	323
V/C Ratio(X)	0.00	0.56	0.58	0.79	0.34	0.00				0.68	0.00	0.62
Avail Cap(c_a), veh/h	0	1195	1188	828	4385	0				656	0	642
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00				1.00	1.00	1.00
Upstream Filter(I)	0.00	1.00	1.00	1.00	1.00	0.00				1.00	0.00	1.00
Uniform Delay (d), s/veh	0.0	12.4	12.4	12.6	5.1	0.0				12.7	0.0	12.5
Incr Delay (d2), s/veh	0.0	0.6	0.6	1.6	0.0	0.0				0.9	0.0	0.7
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0				0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	0.0	1.5	1.6	2.5	1.6	0.0				2.0	0.0	1.7
LnGrp Delay(d),s/veh	0.0	12.9	13.0	14.2	5.2	0.0				13.6	0.0	13.3
LnGrp LOS		B	B	B	A					B		B
Approach Vol, veh/h		362			873						426	
Approach Delay, s/veh		13.0			8.0						13.5	
Approach LOS		B			A						B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		
Phs Duration (G+Y+Rc), s		21.6		11.4	10.3	11.3		
Change Period (Y+Rc), s		* 5.4		5.5	* 3.8	* 5.4		
Max Green Setting (Gmax), s		* 41		11.7	* 15	* 22		
Max Q Clear Time (g_c+I1), s		5.4		5.7	6.9	5.1		
Green Ext Time (p_c), s		0.8		0.3	0.1	0.8		

Intersection Summary	
HCM 2010 Ctrl Delay	10.5
HCM 2010 LOS	B

Notes

* HCM 2010 computational engine requires equal clearance times for the phases crossing the barrier.



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	110	220	10	1660	940	1620
Number	7	14	5	2	6	16
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	120	239	11	1804	1022	0
Adj No. of Lanes	2	1	1	3	3	1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	434	200	30	3587	3199	996
Arrive On Green	0.13	0.13	0.02	0.71	0.63	0.00
Sat Flow, veh/h	3442	1583	1774	5253	5253	1583
Grp Volume(v), veh/h	120	239	11	1804	1022	0
Grp Sat Flow(s),veh/h/ln	1721	1583	1774	1695	1695	1583
Q Serve(g_s), s	1.9	7.4	0.4	9.5	5.5	0.0
Cycle Q Clear(g_c), s	1.9	7.4	0.4	9.5	5.5	0.0
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	434	200	30	3587	3199	996
V/C Ratio(X)	0.28	1.20	0.37	0.50	0.32	0.00
Avail Cap(c_a), veh/h	434	200	181	11491	10668	3322
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	23.2	25.7	28.6	3.9	5.1	0.0
Incr Delay (d2), s/veh	0.1	127.3	2.8	0.1	0.0	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	0.9	13.1	0.2	4.4	2.6	0.0
LnGrp Delay(d),s/veh	23.4	153.0	31.4	4.0	5.1	0.0
LnGrp LOS	C	F	C	A	A	
Approach Vol, veh/h	359			1815	1022	
Approach Delay, s/veh	109.6			4.2	5.1	
Approach LOS	F			A	A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		
Phs Duration (G+Y+Rc), s		46.7		12.0	4.5	42.2		
Change Period (Y+Rc), s		5.3		4.6	3.5	5.3		
Max Green Setting (Gmax), s		132.7		7.4	6.0	123.2		
Max Q Clear Time (g_c+I1), s		11.5		9.4	2.4	7.5		
Green Ext Time (p_c), s		29.6		0.0	0.0	29.5		

Intersection Summary	
HCM 2010 Ctrl Delay	16.3
HCM 2010 LOS	B

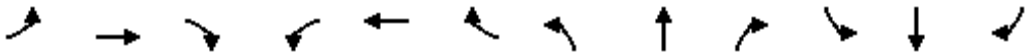
Intersection	
Int Delay, s/veh	1.2

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	100	450	800	30	10	30
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	175	-	-	-	0	0
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	97	97	97	97	97	97
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	103	464	825	31	10	31

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	856	0	-	0	1278	428
Stage 1	-	-	-	-	840	-
Stage 2	-	-	-	-	438	-
Critical Hdwy	4.14	-	-	-	6.84	6.94
Critical Hdwy Stg 1	-	-	-	-	5.84	-
Critical Hdwy Stg 2	-	-	-	-	5.84	-
Follow-up Hdwy	2.22	-	-	-	3.52	3.32
Pot Cap-1 Maneuver	780	-	-	-	158	575
Stage 1	-	-	-	-	384	-
Stage 2	-	-	-	-	618	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	780	-	-	-	137	575
Mov Cap-2 Maneuver	-	-	-	-	137	-
Stage 1	-	-	-	-	384	-
Stage 2	-	-	-	-	536	-

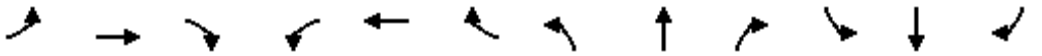
Approach	EB	WB	SB
HCM Control Delay, s	1.9	0	17.1
HCM LOS			C

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	780	-	-	-	137	575
HCM Lane V/C Ratio	0.132	-	-	-	0.075	0.054
HCM Control Delay (s)	10.3	-	-	-	33.4	11.6
HCM Lane LOS	B	-	-	-	D	B
HCM 95th %tile Q(veh)	0.5	-	-	-	0.2	0.2



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	300	10	250	50	20	10	240	3360	80	30	2780	180
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.5	5.8	5.8	5.3	5.9		5.5	5.3	5.3	5.5	5.5	
Lane Util. Factor	0.97	0.95	0.95	1.00	1.00		0.97	0.91	1.00	1.00	0.86	
Frpb, ped/bikes	1.00	1.00	1.00	1.00	0.99		1.00	1.00	1.00	1.00	1.00	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	0.95		1.00	1.00	0.85	1.00	0.99	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	3433	1770	1504	1770	1761		3433	5085	1583	1770	6343	
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	3433	1770	1504	1770	1761		3433	5085	1583	1770	6343	
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	312	10	260	52	21	10	250	3500	83	31	2896	188
RTOR Reduction (vph)	0	0	83	0	9	0	0	0	31	0	5	0
Lane Group Flow (vph)	312	10	177	52	22	0	250	3500	52	31	3079	0
Confl. Peds. (#/hr)						4						2
Confl. Bikes (#/hr)						2						3
Turn Type	Prot	NA	Perm	Prot	NA		Prot	NA	Perm	Prot	NA	
Protected Phases	3	8		7	4		1	6		5	2	
Permitted Phases			8						6			
Actuated Green, G (s)	13.4	23.6	23.6	6.7	16.6		8.5	94.8	94.8	3.0	89.1	
Effective Green, g (s)	13.4	23.6	23.6	6.7	16.6		8.5	94.8	94.8	3.0	89.1	
Actuated g/C Ratio	0.09	0.16	0.16	0.04	0.11		0.06	0.63	0.63	0.02	0.59	
Clearance Time (s)	5.5	5.8	5.8	5.3	5.9		5.5	5.3	5.3	5.5	5.5	
Vehicle Extension (s)	1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0	1.0	
Lane Grp Cap (vph)	306	278	236	79	194		194	3213	1000	35	3767	
v/s Ratio Prot	c0.09	0.01		0.03	0.01		c0.07	c0.69		0.02	0.49	
v/s Ratio Perm			c0.12						0.03			
v/c Ratio	1.02	0.04	0.75	0.66	0.11		1.29	1.09	0.05	0.89	0.82	
Uniform Delay, d1	68.3	53.6	60.4	70.5	60.1		70.8	27.6	10.5	73.3	24.0	
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.08	0.66	0.36	1.00	1.00	
Incremental Delay, d2	56.6	0.0	11.3	14.1	0.1		142.8	42.4	0.0	103.6	2.1	
Delay (s)	124.9	53.6	71.7	84.6	60.2		219.2	60.7	3.8	177.0	26.1	
Level of Service	F	D	E	F	E		F	E	A	F	C	
Approach Delay (s)		99.9			75.5			69.8			27.6	
Approach LOS		F			E			E			C	

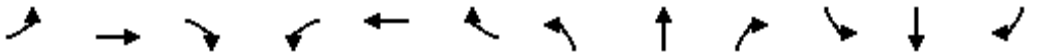
Intersection Summary			
HCM 2000 Control Delay	54.9	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	1.09		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	22.4
Intersection Capacity Utilization	97.3%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	500	190	110	710	290	2970	0	0	3030	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)			4.6		6.2	6.2	4.6	5.0			5.3	5.3
Lane Util. Factor			1.00		1.00	0.88	0.97	0.91			0.86	1.00
Frpb, ped/bikes			1.00		1.00	1.00	1.00	1.00			1.00	0.99
Flpb, ped/bikes			1.00		1.00	1.00	1.00	1.00			1.00	1.00
Frt			0.86		1.00	0.85	1.00	1.00			1.00	0.85
Flt Protected			1.00		0.97	1.00	0.95	1.00			1.00	1.00
Satd. Flow (prot)			1611		1806	2787	3433	5085			6408	1564
Flt Permitted			1.00		0.97	1.00	0.95	1.00			1.00	1.00
Satd. Flow (perm)			1611		1806	2787	3433	5085			6408	1564
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	526	200	116	747	305	3126	0	0	3189	53
RTOR Reduction (vph)	0	0	46	0	0	42	0	0	0	0	0	28
Lane Group Flow (vph)	0	0	480	0	316	705	305	3126	0	0	3189	25
Confl. Bikes (#/hr)												1
Turn Type			Over	Split	NA	Perm	Prot	NA			NA	Perm
Protected Phases			1	4	4		1	6			2	
Permitted Phases						4						2
Actuated Green, G (s)			39.4		24.8	24.8	39.4	114.0			69.7	69.7
Effective Green, g (s)			39.4		24.8	24.8	39.4	114.0			69.7	69.7
Actuated g/C Ratio			0.26		0.17	0.17	0.26	0.76			0.46	0.46
Clearance Time (s)			4.6		6.2	6.2	4.6	5.0			5.3	5.3
Vehicle Extension (s)			1.0		1.0	1.0	1.0	1.0			1.0	1.0
Lane Grp Cap (vph)			423		298	460	901	3864			2977	726
v/s Ratio Prot			c0.30		0.18		0.09	0.61			c0.50	
v/s Ratio Perm						c0.25						0.02
v/c Ratio			1.14		1.06	1.53	0.34	0.81			1.07	0.03
Uniform Delay, d1			55.3		62.6	62.6	44.8	11.2			40.1	21.8
Progression Factor			1.00		1.00	1.00	1.00	1.17			0.57	0.12
Incremental Delay, d2			86.2		69.0	250.7	0.0	0.7			37.0	0.1
Delay (s)			141.5		131.6	313.3	44.8	13.8			59.8	2.7
Level of Service			F		F	F	D	B			E	A
Approach Delay (s)		141.5			259.3			16.6			58.9	
Approach LOS		F			F			B			E	

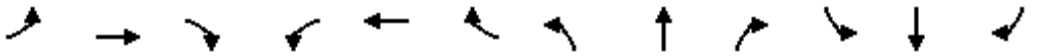
Intersection Summary			
HCM 2000 Control Delay	72.4	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.17		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	16.1
Intersection Capacity Utilization	104.6%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group



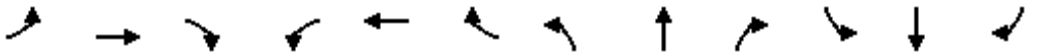
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	1400	30	20	1150	30	100	10	130	50	0	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.9		4.9	5.0			4.9	4.9		4.8	4.8
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00	1.00		1.00	1.00
Frt	1.00	1.00		1.00	1.00			1.00	0.85		1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00			0.96	1.00		0.95	1.00
Satd. Flow (prot)	1770	3528		1770	3526			1782	1583		1770	1583
Flt Permitted	0.95	1.00		0.95	1.00			0.96	1.00		0.95	1.00
Satd. Flow (perm)	1770	3528		1770	3526			1782	1583		1770	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	11	1522	33	22	1250	33	109	11	141	54	0	54
RTOR Reduction (vph)	0	1	0	0	2	0	0	0	128	0	0	50
Lane Group Flow (vph)	11	1554	0	22	1281	0	0	120	13	0	54	4
Turn Type	Prot	NA		Prot	NA		Split	NA	Perm	Split	NA	Perm
Protected Phases	1	6		5	2		4	4		3	3	
Permitted Phases									4			3
Actuated Green, G (s)	0.6	41.3		1.2	42.2			6.9	6.9		4.9	4.9
Effective Green, g (s)	0.6	41.3		1.2	42.2			6.9	6.9		4.9	4.9
Actuated g/C Ratio	0.01	0.56		0.02	0.57			0.09	0.09		0.07	0.07
Clearance Time (s)	4.5	4.9		4.9	5.0			4.9	4.9		4.8	4.8
Vehicle Extension (s)	1.0	5.8		1.0	4.9			2.0	2.0		1.0	1.0
Lane Grp Cap (vph)	14	1974		28	2016			166	148		117	105
v/s Ratio Prot	0.01	c0.44		c0.01	0.36			c0.07			c0.03	
v/s Ratio Perm									0.01			0.00
v/c Ratio	0.79	0.79		0.79	0.64			0.72	0.09		0.46	0.03
Uniform Delay, d1	36.5	12.8		36.2	10.6			32.5	30.6		33.2	32.2
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00		1.00	1.00
Incremental Delay, d2	123.8	2.6		78.1	0.9			12.4	0.1		1.1	0.0
Delay (s)	160.4	15.4		114.3	11.5			44.9	30.7		34.2	32.3
Level of Service	F	B		F	B			D	C		C	C
Approach Delay (s)		16.4			13.3			37.2			33.3	
Approach LOS		B			B			D			C	

Intersection Summary			
HCM 2000 Control Delay	17.4	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	73.8	Sum of lost time (s)	19.5
Intersection Capacity Utilization	63.2%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			



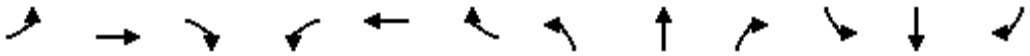
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	1200	140	30	120	0	160	210	1260	110	120	1060	240
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.6	4.6	4.6	4.6		4.6	3.5	5.3	5.3	3.5	5.3	5.3
Lane Util. Factor	0.91	0.91	1.00	1.00		1.00	1.00	0.91	1.00	1.00	0.91	1.00
Frt	1.00	1.00	0.85	1.00		0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.97	1.00	0.95		1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3221	1639	1583	1770		1583	1770	5085	1583	1770	5085	1583
Flt Permitted	0.95	0.97	1.00	0.95		1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3221	1639	1583	1770		1583	1770	5085	1583	1770	5085	1583
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	1250	146	31	125	0	167	219	1312	115	125	1104	250
RTOR Reduction (vph)	0	0	21	0	0	153	0	0	81	0	0	189
Lane Group Flow (vph)	925	471	10	125	0	14	219	1312	34	125	1104	61
Turn Type	Split	NA	Perm	Split		Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases			4			8			2			6
Actuated Green, G (s)	28.6	28.6	28.6	7.4		7.4	12.2	26.2	26.2	7.5	21.5	21.5
Effective Green, g (s)	28.6	28.6	28.6	7.4		7.4	12.2	26.2	26.2	7.5	21.5	21.5
Actuated g/C Ratio	0.33	0.33	0.33	0.08		0.08	0.14	0.30	0.30	0.09	0.25	0.25
Clearance Time (s)	4.6	4.6	4.6	4.6		4.6	3.5	5.3	5.3	3.5	5.3	5.3
Vehicle Extension (s)	2.0	2.0	2.0	2.0		2.0	2.0	2.2	2.2	2.0	2.2	2.2
Lane Grp Cap (vph)	1050	534	516	149		133	246	1519	472	151	1246	388
v/s Ratio Prot	0.29	c0.29		c0.07			c0.12	c0.26		0.07	0.22	
v/s Ratio Perm			0.01			0.01			0.02			0.04
v/c Ratio	0.88	0.88	0.02	0.84		0.11	0.89	0.86	0.07	0.83	0.89	0.16
Uniform Delay, d1	27.9	28.0	20.0	39.6		37.1	37.1	29.1	22.0	39.5	31.9	26.0
Progression Factor	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	8.6	15.3	0.0	30.7		0.1	29.7	5.2	0.0	28.4	7.7	0.1
Delay (s)	36.5	43.3	20.0	70.2		37.2	66.8	34.3	22.1	67.8	39.6	26.1
Level of Service	D	D	C	E		D	E	C	C	E	D	C
Approach Delay (s)		38.4			51.4			37.8			39.7	
Approach LOS		D			D			D			D	

Intersection Summary			
HCM 2000 Control Delay	39.4	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.90		
Actuated Cycle Length (s)	87.7	Sum of lost time (s)	18.0
Intersection Capacity Utilization	78.8%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	640	230	590	180	210	570	460	1610	160	380	1580	200
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.5	5.5	5.5	5.5	5.5	5.5	5.5	4.7	4.7	5.5	4.7	4.7
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95	1.00	0.97	0.91	1.00	0.97	0.91	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	3539	1583	1770	3539	1583	3433	5085	1583	3433	5085	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	3539	1583	1770	3539	1583	3433	5085	1583	3433	5085	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	696	250	641	196	228	620	500	1750	174	413	1717	217
RTOR Reduction (vph)	0	0	31	0	0	60	0	0	90	0	0	100
Lane Group Flow (vph)	696	250	610	196	228	560	500	1750	84	413	1717	117
Turn Type	Prot	NA	pm+ov	Prot	NA	pm+ov	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	7	4	1	3	8	5	1	6		5	2	
Permitted Phases			4			8			6			2
Actuated Green, G (s)	24.5	23.4	60.8	14.3	13.2	51.9	37.4	52.4	52.4	38.7	53.7	53.7
Effective Green, g (s)	24.5	23.4	60.8	14.3	13.2	51.9	37.4	52.4	52.4	38.7	53.7	53.7
Actuated g/C Ratio	0.16	0.16	0.41	0.10	0.09	0.35	0.25	0.35	0.35	0.26	0.36	0.36
Clearance Time (s)	5.5	5.5	5.5	5.5	5.5	5.5	5.5	4.7	4.7	5.5	4.7	4.7
Vehicle Extension (s)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Lane Grp Cap (vph)	560	552	699	168	311	605	855	1776	552	885	1820	566
v/s Ratio Prot	c0.20	0.07	c0.22	0.11	0.06	c0.24	0.15	c0.34		0.12	0.34	
v/s Ratio Perm			0.17			0.12			0.05			0.07
v/c Ratio	1.24	0.45	0.87	1.17	0.73	0.93	0.58	0.99	0.15	0.47	0.94	0.21
Uniform Delay, d1	62.8	57.5	41.0	67.8	66.7	47.2	49.5	48.4	33.5	46.9	46.7	33.4
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.15	0.87	0.67
Incremental Delay, d2	123.8	0.2	11.3	121.4	7.5	19.8	0.7	18.2	0.6	0.1	8.4	0.6
Delay (s)	186.6	57.7	52.3	189.2	74.2	67.0	50.1	66.6	34.1	54.1	49.1	22.9
Level of Service	F	E	D	F	E	E	D	E	C	D	D	C
Approach Delay (s)		112.0			91.5			60.9			47.5	
Approach LOS		F			F			E			D	

Intersection Summary			
HCM 2000 Control Delay	71.9	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.06		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	21.2
Intersection Capacity Utilization	97.7%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	790	1010	440	850	10	530	10	330	10	10	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.5	4.8	4.8	5.5	4.8		5.5	5.5	5.5		5.5	
Lane Util. Factor	1.00	1.00	1.00	0.97	1.00		0.97	0.95	0.95		1.00	
Frt	1.00	1.00	0.85	1.00	1.00		1.00	0.86	0.85		0.95	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00		0.98	
Satd. Flow (prot)	1770	1863	1583	3433	1859		3433	1520	1504		1750	
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00		0.98	
Satd. Flow (perm)	1770	1863	1583	3433	1859		3433	1520	1504		1750	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	11	859	1098	478	924	11	576	11	359	11	11	11
RTOR Reduction (vph)	0	0	295	0	0	0	0	143	148	0	11	0
Lane Group Flow (vph)	11	859	803	478	935	0	576	44	35	0	22	0
Turn Type	Prot	NA	Perm	Prot	NA		Split	NA	Perm	Split	NA	
Protected Phases	7	4		3	8		2	2		6	6	
Permitted Phases			4						2			
Actuated Green, G (s)	0.7	60.9	60.9	16.6	76.8		23.8	23.8	23.8		3.6	
Effective Green, g (s)	0.7	60.9	60.9	16.6	76.8		23.8	23.8	23.8		3.6	
Actuated g/C Ratio	0.01	0.48	0.48	0.13	0.61		0.19	0.19	0.19		0.03	
Clearance Time (s)	5.5	4.8	4.8	5.5	4.8		5.5	5.5	5.5		5.5	
Vehicle Extension (s)	3.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0		1.0	
Lane Grp Cap (vph)	9	899	763	451	1131		647	286	283		49	
v/s Ratio Prot	0.01	0.46		c0.14	0.50		c0.17	0.03			c0.01	
v/s Ratio Perm			c0.51						0.02			
v/c Ratio	1.22	0.96	1.05	1.06	0.83		0.89	0.15	0.12		0.46	
Uniform Delay, d1	62.8	31.3	32.7	54.8	19.4		49.9	42.8	42.5		60.3	
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00		1.00	
Incremental Delay, d2	385.4	19.7	47.3	59.1	4.8		14.1	0.1	0.1		2.4	
Delay (s)	448.2	51.1	79.9	113.9	24.3		64.0	42.9	42.6		62.8	
Level of Service	F	D	E	F	C		E	D	D		E	
Approach Delay (s)		69.4			54.6			55.7			62.8	
Approach LOS		E			D			E			E	

Intersection Summary			
HCM 2000 Control Delay	61.6	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.00		
Actuated Cycle Length (s)	126.2	Sum of lost time (s)	21.3
Intersection Capacity Utilization	91.6%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	1710	0	1160	0	0	0	0	2450	370	0	1000	920
Number	3	8	18				1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0				0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00				1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	0	1863				0	1863	1863	0	1863	1863
Adj Flow Rate, veh/h	1839	0	1247				0	2634	0	0	1075	0
Adj No. of Lanes	3	0	2				0	3	1	0	3	1
Peak Hour Factor	0.93	0.93	0.93				0.93	0.93	0.93	0.93	0.93	0.93
Percent Heavy Veh, %	2	0	2				0	2	2	0	2	2
Cap, veh/h	2085	0	1161				0	2688	837	0	2688	837
Arrive On Green	0.42	0.00	0.42				0.00	1.00	0.00	0.00	0.17	0.00
Sat Flow, veh/h	5003	0	2787				0	5253	1583	0	5253	1583
Grp Volume(v), veh/h	1839	0	1247				0	2634	0	0	1075	0
Grp Sat Flow(s),veh/h/ln	1668	0	1393				0	1695	1583	0	1695	1583
Q Serve(g_s), s	50.9	0.0	62.5				0.0	0.0	0.0	0.0	28.1	0.0
Cycle Q Clear(g_c), s	50.9	0.0	62.5				0.0	0.0	0.0	0.0	28.1	0.0
Prop In Lane	1.00		1.00				0.00		1.00	0.00		1.00
Lane Grp Cap(c), veh/h	2085	0	1161				0	2688	837	0	2688	837
V/C Ratio(X)	0.88	0.00	1.07				0.00	0.98	0.00	0.00	0.40	0.00
Avail Cap(c_a), veh/h	2085	0	1161				0	2688	837	0	2688	837
HCM Platoon Ratio	1.00	1.00	1.00				1.00	2.00	2.00	1.00	0.33	0.33
Upstream Filter(I)	1.00	0.00	1.00				0.00	0.09	0.00	0.00	1.00	0.00
Uniform Delay (d), s/veh	40.4	0.0	43.8				0.0	0.0	0.0	0.0	40.8	0.0
Incr Delay (d2), s/veh	4.7	0.0	48.7				0.0	2.3	0.0	0.0	0.4	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0				0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	24.2	0.0	31.9				0.0	0.6	0.0	0.0	13.3	0.0
LnGrp Delay(d),s/veh	45.0	0.0	92.4				0.0	2.3	0.0	0.0	41.2	0.0
LnGrp LOS	D		F					A			D	
Approach Vol, veh/h		3086						2634			1075	
Approach Delay, s/veh		64.2						2.3			41.2	
Approach LOS		E						A			D	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2				6		8
Phs Duration (G+Y+Rc), s		84.0				84.0		66.0
Change Period (Y+Rc), s		4.7				4.7		3.5
Max Green Setting (Gmax), s		79.3				79.3		62.5
Max Q Clear Time (g_c+I1), s		30.1				2.0		64.5
Green Ext Time (p_c), s		9.0				9.1		0.0

Intersection Summary	
HCM 2010 Ctrl Delay	36.6
HCM 2010 LOS	D

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	1100	120	330	1020	0	370	0	260	90	160	60
Number	1	6	16	5	2	12	3	8	18	7	4	14
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.98	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	0	1863	1900	1863	1863	0	1863	0	1863	1900	1863	1900
Adj Flow Rate, veh/h	0	1196	130	359	1109	0	402	0	283	98	174	65
Adj No. of Lanes	0	2	0	1	2	0	2	0	2	0	2	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	0	2	2	2	2	0	2	0	2	2	2	2
Cap, veh/h	0	1333	144	407	2488	0	0	0	0	128	237	92
Arrive On Green	0.00	0.41	0.41	0.23	0.70	0.00	0.00	0.00	0.00	0.13	0.13	0.13
Sat Flow, veh/h	0	3307	348	1774	3632	0		0		995	1842	713
Grp Volume(v), veh/h	0	657	669	359	1109	0		0.0		179	0	158
Grp Sat Flow(s),veh/h/ln	0	1770	1793	1774	1770	0				1813	0	1737
Q Serve(g_s), s	0.0	22.4	22.6	12.7	8.8	0.0				6.2	0.0	5.7
Cycle Q Clear(g_c), s	0.0	22.4	22.6	12.7	8.8	0.0				6.2	0.0	5.7
Prop In Lane	0.00		0.19	1.00		0.00				0.55		0.41
Lane Grp Cap(c), veh/h	0	734	743	407	2488	0				233	0	223
V/C Ratio(X)	0.00	0.90	0.90	0.88	0.45	0.00				0.77	0.00	0.71
Avail Cap(c_a), veh/h	0	1492	1511	800	4755	0				378	0	362
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00				1.00	1.00	1.00
Upstream Filter(I)	0.00	1.00	1.00	1.00	1.00	0.00				1.00	0.00	1.00
Uniform Delay (d), s/veh	0.0	17.6	17.7	24.1	4.2	0.0				27.3	0.0	27.1
Incr Delay (d2), s/veh	0.0	1.6	1.7	2.5	0.0	0.0				2.0	0.0	1.6
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0				0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	0.0	11.1	11.3	6.5	4.2	0.0				3.2	0.0	2.8
LnGrp Delay(d),s/veh	0.0	19.3	19.4	26.6	4.2	0.0				29.2	0.0	28.6
LnGrp LOS		B	B	C	A					C		C
Approach Vol, veh/h		1326			1468						337	
Approach Delay, s/veh		19.3			9.7						28.9	
Approach LOS		B			A						C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		
Phs Duration (G+Y+Rc), s		50.9		13.8	18.7	32.3		
Change Period (Y+Rc), s		* 5.4		5.5	* 3.8	* 5.4		
Max Green Setting (Gmax), s		* 87		13.5	* 29	* 55		
Max Q Clear Time (g_c+I1), s		10.8		8.2	14.7	24.6		
Green Ext Time (p_c), s		2.3		0.2	0.2	2.3		

Intersection Summary	
HCM 2010 Ctrl Delay	15.8
HCM 2010 LOS	B

Notes

* HCM 2010 computational engine requires equal clearance times for the phases crossing the barrier.

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	180	140	110	2510	1280	1520
Number	7	14	5	2	6	16
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	189	147	116	2642	1347	0
Adj No. of Lanes	2	1	1	3	3	1
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	239	110	141	4261	3689	1149
Arrive On Green	0.07	0.07	0.08	0.84	0.73	0.00
Sat Flow, veh/h	3442	1583	1774	5253	5253	1583
Grp Volume(v), veh/h	189	147	116	2642	1347	0
Grp Sat Flow(s),veh/h/ln	1721	1583	1774	1695	1695	1583
Q Serve(g_s), s	5.8	7.4	6.9	18.7	10.6	0.0
Cycle Q Clear(g_c), s	5.8	7.4	6.9	18.7	10.6	0.0
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	239	110	141	4261	3689	1149
V/C Ratio(X)	0.79	1.34	0.82	0.62	0.37	0.00
Avail Cap(c_a), veh/h	239	110	141	5846	5274	1642
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	48.9	49.7	48.4	2.9	5.5	0.0
Incr Delay (d2), s/veh	15.3	201.7	28.9	0.1	0.0	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	3.3	12.4	4.5	8.6	4.9	0.0
LnGrp Delay(d),s/veh	64.2	251.3	77.3	3.0	5.5	0.0
LnGrp LOS	E	F	E	A	A	
Approach Vol, veh/h	336			2758	1347	
Approach Delay, s/veh	146.1			6.1	5.5	
Approach LOS	F			A	A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		
Phs Duration (G+Y+Rc), s		94.7		12.0	12.0	82.7		
Change Period (Y+Rc), s		5.3		4.6	3.5	5.3		
Max Green Setting (Gmax), s		122.7		7.4	8.5	110.7		
Max Q Clear Time (g_c+I1), s		20.7		9.4	8.9	12.6		
Green Ext Time (p_c), s		66.5		0.0	0.0	64.9		

Intersection Summary	
HCM 2010 Ctrl Delay	16.5
HCM 2010 LOS	B

Intersection	
Int Delay, s/veh	3.5

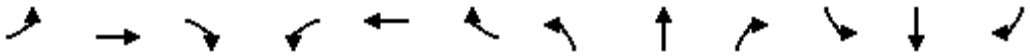
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	40	1410	1260	20	30	60
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	175	-	-	-	0	0
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	94	94	94	94	94	94
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	43	1500	1340	21	32	64

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	1362	0	-	0	2186	681
Stage 1	-	-	-	-	1351	-
Stage 2	-	-	-	-	835	-
Critical Hdwy	4.14	-	-	-	6.84	6.94
Critical Hdwy Stg 1	-	-	-	-	5.84	-
Critical Hdwy Stg 2	-	-	-	-	5.84	-
Follow-up Hdwy	2.22	-	-	-	3.52	3.32
Pot Cap-1 Maneuver	501	-	-	-	39	393
Stage 1	-	-	-	-	206	-
Stage 2	-	-	-	-	386	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	501	-	-	-	36	393
Mov Cap-2 Maneuver	-	-	-	-	36	-
Stage 1	-	-	-	-	206	-
Stage 2	-	-	-	-	353	-

Approach	EB	WB	SB
HCM Control Delay, s	0.4	0	104.2
HCM LOS			F

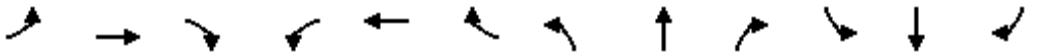
Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	501	-	-	-	36	393
HCM Lane V/C Ratio	0.085	-	-	-	0.887	0.162
HCM Control Delay (s)	12.9	-	-	-	280.8	15.9
HCM Lane LOS	B	-	-	-	F	C
HCM 95th %tile Q(veh)	0.3	-	-	-	3.2	0.6

Appendix A9
Horizon Year (2042) with Alternative 2
Synchro Calculations



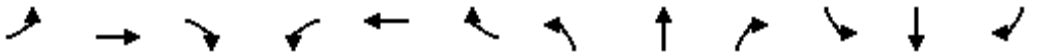
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	170	10	220	10	10	10	290	2240	20	10	3040	290
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.5	5.8	5.8	5.3	5.9		5.5	5.3	5.3	5.5	5.5	
Lane Util. Factor	0.97	0.95	0.95	1.00	1.00		0.97	0.91	1.00	1.00	0.86	
Frpb, ped/bikes	1.00	1.00	0.99	1.00	0.99		1.00	1.00	1.00	1.00	1.00	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	0.93		1.00	1.00	0.85	1.00	0.99	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	3433	1770	1482	1770	1708		3433	5085	1583	1770	6324	
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	3433	1770	1482	1770	1708		3433	5085	1583	1770	6324	
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	175	10	227	10	10	10	299	2309	21	10	3134	299
RTOR Reduction (vph)	0	0	120	0	9	0	0	0	6	0	7	0
Lane Group Flow (vph)	175	10	107	10	11	0	299	2309	15	10	3426	0
Confl. Peds. (#/hr)			2									
Confl. Bikes (#/hr)						2						
Turn Type	Prot	NA	Perm	Prot	NA		Prot	NA	Perm	Prot	NA	
Protected Phases	3	8		7	4		1	6		5	2	
Permitted Phases			8						6			
Actuated Green, G (s)	7.1	18.3	18.3	1.4	12.3		11.5	107.2	107.2	1.2	96.7	
Effective Green, g (s)	7.1	18.3	18.3	1.4	12.3		11.5	107.2	107.2	1.2	96.7	
Actuated g/C Ratio	0.05	0.12	0.12	0.01	0.08		0.08	0.71	0.71	0.01	0.64	
Clearance Time (s)	5.5	5.8	5.8	5.3	5.9		5.5	5.3	5.3	5.5	5.5	
Vehicle Extension (s)	1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0	1.0	
Lane Grp Cap (vph)	162	215	180	16	140		263	3634	1131	14	4076	
v/s Ratio Prot	c0.05	0.01		0.01	0.01		c0.09	0.45		0.01	c0.54	
v/s Ratio Perm			c0.07						0.01			
v/c Ratio	1.08	0.05	0.59	0.62	0.08		1.14	0.64	0.01	0.71	0.84	
Uniform Delay, d1	71.5	58.1	62.3	74.0	63.6		69.2	11.2	6.2	74.2	20.7	
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.08	0.72	1.00	1.00	1.00	
Incremental Delay, d2	93.7	0.0	3.5	44.0	0.1		92.2	0.7	0.0	87.8	2.3	
Delay (s)	165.2	58.2	65.8	118.1	63.7		166.8	8.7	6.2	162.1	22.9	
Level of Service	F	E	E	F	E		F	A	A	F	C	
Approach Delay (s)		107.8			81.8			26.7			23.3	
Approach LOS		F			F			C			C	

Intersection Summary			
HCM 2000 Control Delay	30.3	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.87		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	22.4
Intersection Capacity Utilization	83.8%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			



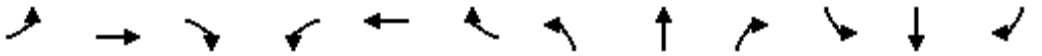
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	310	80	460	1690	100	860	0	0	3230	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)			4.6		6.2	4.0	4.6	5.0			5.3	5.3
Lane Util. Factor			1.00		0.95	0.76	0.97	0.91			0.86	1.00
Frpb, ped/bikes			1.00		1.00	1.00	1.00	1.00			1.00	0.98
Flpb, ped/bikes			1.00		1.00	1.00	1.00	1.00			1.00	1.00
Frt			0.86		1.00	0.85	1.00	1.00			1.00	0.85
Flt Protected			1.00		0.99	1.00	0.95	1.00			1.00	1.00
Satd. Flow (prot)			1611		3513	3610	3433	5085			6408	1559
Flt Permitted			1.00		0.99	1.00	0.95	1.00			1.00	1.00
Satd. Flow (perm)			1611		3513	3610	3433	5085			6408	1559
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	0	0	323	83	479	1760	104	896	0	0	3365	42
RTOR Reduction (vph)	0	0	112	0	0	30	0	0	0	0	0	17
Lane Group Flow (vph)	0	0	211	0	562	1730	104	896	0	0	3365	25
Confl. Peds. (#/hr)												1
Confl. Bikes (#/hr)												2
Turn Type			Over	Split	NA	custom	Prot	NA			NA	Perm
Protected Phases			1	4	4	5	1	6			2	
Permitted Phases						4						2
Actuated Green, G (s)			23.0		22.8	103.9	23.0	30.9			88.1	88.1
Effective Green, g (s)			23.0		22.8	103.9	23.0	30.9			88.1	88.1
Actuated g/C Ratio			0.15		0.15	0.69	0.15	0.21			0.59	0.59
Clearance Time (s)			4.6		6.2	4.0	4.6	5.0			5.3	5.3
Vehicle Extension (s)			1.0		1.0	3.0	1.0	1.0			1.0	1.0
Lane Grp Cap (vph)			247		533	2596	526	1047			3763	915
v/s Ratio Prot			0.13		c0.16	0.36	0.03	c0.18			c0.53	
v/s Ratio Perm						0.12						0.02
v/c Ratio			0.86		1.05	0.67	0.20	0.86			0.89	0.03
Uniform Delay, d1			61.9		63.6	13.2	55.4	57.4			26.9	13.0
Progression Factor			1.00		1.00	1.00	1.00	1.00			0.39	0.05
Incremental Delay, d2			23.2		54.1	0.7	0.1	9.0			2.3	0.0
Delay (s)			85.1		117.7	13.8	55.5	66.4			12.9	0.7
Level of Service			F		F	B	E	E			B	A
Approach Delay (s)		85.1			39.0			65.2			12.8	
Approach LOS		F			D			E			B	

Intersection Summary			
HCM 2000 Control Delay	32.1	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.93		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	16.1
Intersection Capacity Utilization	94.5%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			



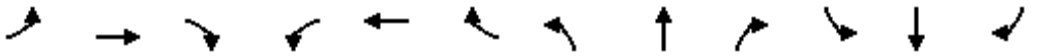
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	30	320	110	130	830	60	30	10	20	20	10	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.9		4.9	5.0			4.9	4.9		4.8	4.8
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00	1.00		1.00	1.00
Frt	1.00	0.96		1.00	0.99			1.00	0.85		1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00			0.96	1.00		0.97	1.00
Satd. Flow (prot)	1770	3403		1770	3504			1795	1583		1803	1583
Flt Permitted	0.95	1.00		0.95	1.00			0.96	1.00		0.97	1.00
Satd. Flow (perm)	1770	3403		1770	3504			1795	1583		1803	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	33	348	120	141	902	65	33	11	22	22	11	11
RTOR Reduction (vph)	0	37	0	0	5	0	0	0	21	0	0	11
Lane Group Flow (vph)	33	431	0	141	962	0	0	44	1	0	33	0
Turn Type	Prot	NA		Prot	NA		Split	NA	Perm	Split	NA	Perm
Protected Phases	1	6		5	2		4	4		3	3	
Permitted Phases									4			3
Actuated Green, G (s)	1.2	23.1		7.2	29.4			1.7	1.7		1.7	1.7
Effective Green, g (s)	1.2	23.1		7.2	29.4			1.7	1.7		1.7	1.7
Actuated g/C Ratio	0.02	0.43		0.14	0.55			0.03	0.03		0.03	0.03
Clearance Time (s)	4.5	4.9		4.9	5.0			4.9	4.9		4.8	4.8
Vehicle Extension (s)	1.0	5.8		1.0	4.9			2.0	2.0		1.0	1.0
Lane Grp Cap (vph)	39	1477		239	1936			57	50		57	50
v/s Ratio Prot	0.02	0.13		c0.08	c0.27			c0.02			c0.02	
v/s Ratio Perm									0.00			0.00
v/c Ratio	0.85	0.29		0.59	0.50			0.77	0.01		0.58	0.01
Uniform Delay, d1	25.9	9.8		21.6	7.3			25.6	24.9		25.4	24.9
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00		1.00	1.00
Incremental Delay, d2	82.5	0.3		2.4	0.4			43.5	0.0		8.6	0.0
Delay (s)	108.4	10.0		24.0	7.7			69.1	25.0		34.0	25.0
Level of Service	F	B		C	A			E	C		C	C
Approach Delay (s)		16.5			9.8			54.4			31.7	
Approach LOS		B			A			D			C	

Intersection Summary			
HCM 2000 Control Delay	14.0	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.57		
Actuated Cycle Length (s)	53.2	Sum of lost time (s)	19.5
Intersection Capacity Utilization	49.0%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			



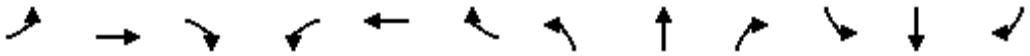
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	1290	180	50	110	0	120	60	260	40	100	910	150
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.6	4.6	4.6	4.6		4.6	3.5	5.3	5.3	3.5	5.3	5.3
Lane Util. Factor	0.91	0.91	1.00	1.00		1.00	1.00	0.91	1.00	1.00	0.91	1.00
Frt	1.00	1.00	0.85	1.00		0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.97	1.00	0.95		1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3221	1643	1583	1770		1583	1770	5085	1583	1770	5085	1583
Flt Permitted	0.95	0.97	1.00	0.95		1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3221	1643	1583	1770		1583	1770	5085	1583	1770	5085	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	1402	196	54	120	0	130	65	283	43	109	989	163
RTOR Reduction (vph)	0	0	34	0	0	118	0	0	33	0	0	120
Lane Group Flow (vph)	1066	532	20	120	0	13	65	283	10	109	989	43
Turn Type	Split	NA	Perm	Split		Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases			4			8			2			6
Actuated Green, G (s)	30.9	30.9	30.9	8.0		8.0	4.5	19.0	19.0	7.3	21.8	21.8
Effective Green, g (s)	30.9	30.9	30.9	8.0		8.0	4.5	19.0	19.0	7.3	21.8	21.8
Actuated g/C Ratio	0.37	0.37	0.37	0.10		0.10	0.05	0.23	0.23	0.09	0.26	0.26
Clearance Time (s)	4.6	4.6	4.6	4.6		4.6	3.5	5.3	5.3	3.5	5.3	5.3
Vehicle Extension (s)	2.0	2.0	2.0	2.0		2.0	2.0	2.2	2.2	2.0	2.2	2.2
Lane Grp Cap (vph)	1196	610	587	170		152	95	1161	361	155	1332	414
v/s Ratio Prot	c0.33	0.32		c0.07			0.04	0.06		c0.06	c0.19	
v/s Ratio Perm			0.01			0.01			0.01			0.03
v/c Ratio	0.89	0.87	0.03	0.71		0.08	0.68	0.24	0.03	0.70	0.74	0.10
Uniform Delay, d1	24.6	24.3	16.6	36.5		34.3	38.7	26.2	24.9	36.9	28.1	23.3
Progression Factor	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	8.4	12.6	0.0	10.4		0.1	15.0	0.1	0.0	11.2	2.1	0.1
Delay (s)	33.0	37.0	16.7	46.8		34.3	53.7	26.3	24.9	48.1	30.2	23.3
Level of Service	C	D	B	D		C	D	C	C	D	C	C
Approach Delay (s)		33.7			40.3			30.7			30.8	
Approach LOS		C			D			C			C	

Intersection Summary			
HCM 2000 Control Delay	32.8	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	83.2	Sum of lost time (s)	18.0
Intersection Capacity Utilization	69.4%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	250	130	190	130	30	260	390	1490	110	420	1540	270
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.5	5.5	5.5	5.5	5.5	5.5	5.5	4.7	4.7	5.5	4.7	4.7
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95	1.00	0.97	0.91	1.00	0.97	0.91	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	3539	1583	1770	3539	1583	3433	5085	1583	3433	5085	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	3539	1583	1770	3539	1583	3433	5085	1583	3433	5085	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	272	141	207	141	33	283	424	1620	120	457	1674	293
RTOR Reduction (vph)	0	0	38	0	0	41	0	0	60	0	0	140
Lane Group Flow (vph)	272	141	169	141	33	242	424	1620	60	457	1674	153
Turn Type	Prot	NA	pm+ov	Prot	NA	pm+ov	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	7	4	1	3	8	5	1	6		5	2	
Permitted Phases			4			8			6			2
Actuated Green, G (s)	18.3	10.5	27.8	11.4	3.6	22.2	17.3	39.1	39.1	18.6	40.4	40.4
Effective Green, g (s)	18.3	10.5	27.8	11.4	3.6	22.2	17.3	39.1	39.1	18.6	40.4	40.4
Actuated g/C Ratio	0.18	0.10	0.28	0.11	0.04	0.22	0.17	0.39	0.39	0.18	0.40	0.40
Clearance Time (s)	5.5	5.5	5.5	5.5	5.5	5.5	5.5	4.7	4.7	5.5	4.7	4.7
Vehicle Extension (s)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Lane Grp Cap (vph)	623	368	522	200	126	435	589	1972	614	633	2038	634
v/s Ratio Prot	c0.08	0.04	0.06	c0.08	0.01	c0.10	0.12	0.32		c0.13	c0.33	
v/s Ratio Perm			0.05			0.05			0.04			0.10
v/c Ratio	0.44	0.38	0.32	0.70	0.26	0.56	0.72	0.82	0.10	0.72	0.82	0.24
Uniform Delay, d1	36.7	42.1	29.0	43.1	47.3	34.9	39.5	27.7	19.6	38.7	27.0	20.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.2	0.2	0.1	8.9	0.4	0.9	3.5	2.7	0.0	3.4	2.7	0.1
Delay (s)	36.8	42.4	29.2	52.0	47.7	35.8	43.0	30.5	19.7	42.1	29.6	20.1
Level of Service	D	D	C	D	D	D	D	C	B	D	C	C
Approach Delay (s)		35.5			41.7			32.3			30.8	
Approach LOS		D			D			C			C	

Intersection Summary			
HCM 2000 Control Delay	32.8	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	100.8	Sum of lost time (s)	21.2
Intersection Capacity Utilization	69.3%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	130	310	260	330	0	500	0	190	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.8	4.8	5.5	4.8		5.5	5.5	5.5			
Lane Util. Factor		1.00	1.00	0.97	1.00		0.97	0.95	0.95			
Frt		1.00	0.85	1.00	1.00		1.00	0.85	0.85			
Flt Protected		1.00	1.00	0.95	1.00		0.95	1.00	1.00			
Satd. Flow (prot)		1863	1583	3433	1863		3433	1504	1504			
Flt Permitted		1.00	1.00	0.95	1.00		0.95	1.00	1.00			
Satd. Flow (perm)		1863	1583	3433	1863		3433	1504	1504			
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	141	337	283	359	0	543	0	207	0	0	0
RTOR Reduction (vph)	0	0	274	0	0	0	0	75	74	0	0	0
Lane Group Flow (vph)	0	141	63	283	359	0	543	29	29	0	0	0
Turn Type	Prot	NA	Perm	Prot	NA		Split	NA	Perm			
Protected Phases	7	4		3	8		2	2		6	6	
Permitted Phases			4						2			
Actuated Green, G (s)		7.1	7.1	4.6	17.2		10.7	10.7	10.7			
Effective Green, g (s)		7.1	7.1	4.6	17.2		10.7	10.7	10.7			
Actuated g/C Ratio		0.19	0.19	0.12	0.45		0.28	0.28	0.28			
Clearance Time (s)		4.8	4.8	5.5	4.8		5.5	5.5	5.5			
Vehicle Extension (s)		1.0	1.0	1.0	1.0		1.0	1.0	1.0			
Lane Grp Cap (vph)		346	294	413	838		961	421	421			
v/s Ratio Prot		0.08		0.08	c0.19		c0.16	0.02				
v/s Ratio Perm			0.04						0.02			
v/c Ratio		0.41	0.21	0.69	0.43		0.57	0.07	0.07			
Uniform Delay, d1		13.7	13.2	16.1	7.2		11.8	10.1	10.1			
Progression Factor		1.00	1.00	1.00	1.00		1.00	1.00	1.00			
Incremental Delay, d2		0.3	0.1	3.7	0.1		0.5	0.0	0.0			
Delay (s)		14.0	13.3	19.8	7.3		12.2	10.1	10.1			
Level of Service		B	B	B	A		B	B	B			
Approach Delay (s)		13.5			12.8			11.6			0.0	
Approach LOS		B			B			B			A	

Intersection Summary			
HCM 2000 Control Delay	12.5	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	38.2	Sum of lost time (s)	21.3
Intersection Capacity Utilization	48.1%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	290	50	260	560	0	110	0	230	30	340	30
Number	1	6	16	5	2	12	3	8	18	7	4	14
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.98	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	0	1863	1900	1863	1863	0	1863	0	1863	1900	1863	1900
Adj Flow Rate, veh/h	0	309	53	277	596	0	117	0	245	32	362	32
Adj No. of Lanes	0	2	0	1	2	0	2	0	2	0	2	0
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Percent Heavy Veh, %	0	2	2	2	2	0	2	0	2	2	2	2
Cap, veh/h	0	543	92	349	1740	0	0	0	0	47	554	51
Arrive On Green	0.00	0.18	0.18	0.20	0.49	0.00	0.00	0.00	0.00	0.18	0.18	0.18
Sat Flow, veh/h	0	3111	511	1774	3632	0		0		264	3110	288
Grp Volume(v), veh/h	0	180	182	277	596	0		0.0		225	0	201
Grp Sat Flow(s),veh/h/ln	0	1770	1759	1774	1770	0				1850	0	1812
Q Serve(g_s), s	0.0	3.1	3.1	4.9	3.4	0.0				3.7	0.0	3.4
Cycle Q Clear(g_c), s	0.0	3.1	3.1	4.9	3.4	0.0				3.7	0.0	3.4
Prop In Lane	0.00		0.29	1.00		0.00				0.14		0.16
Lane Grp Cap(c), veh/h	0	318	316	349	1740	0				329	0	323
V/C Ratio(X)	0.00	0.56	0.58	0.79	0.34	0.00				0.68	0.00	0.62
Avail Cap(c_a), veh/h	0	1195	1188	828	4385	0				656	0	642
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00				1.00	1.00	1.00
Upstream Filter(I)	0.00	1.00	1.00	1.00	1.00	0.00				1.00	0.00	1.00
Uniform Delay (d), s/veh	0.0	12.4	12.4	12.6	5.1	0.0				12.7	0.0	12.5
Incr Delay (d2), s/veh	0.0	0.6	0.6	1.6	0.0	0.0				0.9	0.0	0.7
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0				0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	0.0	1.5	1.6	2.5	1.6	0.0				2.0	0.0	1.7
LnGrp Delay(d),s/veh	0.0	12.9	13.0	14.2	5.2	0.0				13.6	0.0	13.3
LnGrp LOS		B	B	B	A					B		B
Approach Vol, veh/h		362			873						426	
Approach Delay, s/veh		13.0			8.0						13.5	
Approach LOS		B			A						B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		
Phs Duration (G+Y+Rc), s		21.6		11.4	10.3	11.3		
Change Period (Y+Rc), s		* 5.4		5.5	* 3.8	* 5.4		
Max Green Setting (Gmax), s		* 41		11.7	* 15	* 22		
Max Q Clear Time (g_c+I1), s		5.4		5.7	6.9	5.1		
Green Ext Time (p_c), s		0.8		0.3	0.1	0.8		

Intersection Summary	
HCM 2010 Ctrl Delay	10.5
HCM 2010 LOS	B

Notes

* HCM 2010 computational engine requires equal clearance times for the phases crossing the barrier.



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	110	220	10	1660	940	1620
Number	7	14	5	2	6	16
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	120	239	11	1804	1022	0
Adj No. of Lanes	2	1	1	3	3	1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	431	198	40	3597	3182	991
Arrive On Green	0.13	0.13	0.02	0.71	0.63	0.00
Sat Flow, veh/h	3442	1583	1774	5253	5253	1583
Grp Volume(v), veh/h	120	239	11	1804	1022	0
Grp Sat Flow(s),veh/h/ln	1721	1583	1774	1695	1695	1583
Q Serve(g_s), s	1.9	7.4	0.4	9.5	5.6	0.0
Cycle Q Clear(g_c), s	1.9	7.4	0.4	9.5	5.6	0.0
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	431	198	40	3597	3182	991
V/C Ratio(X)	0.28	1.21	0.28	0.50	0.32	0.00
Avail Cap(c_a), veh/h	431	198	240	11420	10430	3247
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	23.4	25.8	28.4	3.9	5.2	0.0
Incr Delay (d2), s/veh	0.1	130.2	1.4	0.1	0.0	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	0.9	13.3	0.2	4.4	2.6	0.0
LnGrp Delay(d),s/veh	23.6	156.1	29.8	4.0	5.2	0.0
LnGrp LOS	C	F	C	A	A	
Approach Vol, veh/h	359			1815	1022	
Approach Delay, s/veh	111.8			4.1	5.2	
Approach LOS	F			A	A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		
Phs Duration (G+Y+Rc), s		47.1		12.0	4.8	42.3		
Change Period (Y+Rc), s		5.3		4.6	3.5	5.3		
Max Green Setting (Gmax), s		132.7		7.4	8.0	121.2		
Max Q Clear Time (g_c+I1), s		11.5		9.4	2.4	7.6		
Green Ext Time (p_c), s		29.6		0.0	0.0	29.4		

Intersection Summary	
HCM 2010 Ctrl Delay	16.6
HCM 2010 LOS	B

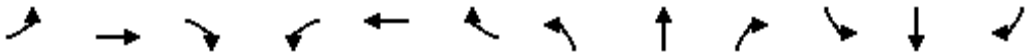
Intersection	
Int Delay, s/veh	1.2

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	100	450	800	30	10	30
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	175	-	-	-	0	0
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	97	97	97	97	97	97
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	103	464	825	31	10	31

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	856	0	-	0	1278	428
Stage 1	-	-	-	-	840	-
Stage 2	-	-	-	-	438	-
Critical Hdwy	4.14	-	-	-	6.84	6.94
Critical Hdwy Stg 1	-	-	-	-	5.84	-
Critical Hdwy Stg 2	-	-	-	-	5.84	-
Follow-up Hdwy	2.22	-	-	-	3.52	3.32
Pot Cap-1 Maneuver	780	-	-	-	158	575
Stage 1	-	-	-	-	384	-
Stage 2	-	-	-	-	618	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	780	-	-	-	137	575
Mov Cap-2 Maneuver	-	-	-	-	137	-
Stage 1	-	-	-	-	384	-
Stage 2	-	-	-	-	536	-

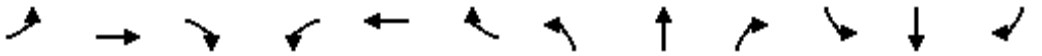
Approach	EB	WB	SB
HCM Control Delay, s	1.9	0	17.1
HCM LOS			C

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	780	-	-	-	137	575
HCM Lane V/C Ratio	0.132	-	-	-	0.075	0.054
HCM Control Delay (s)	10.3	-	-	-	33.4	11.6
HCM Lane LOS	B	-	-	-	D	B
HCM 95th %tile Q(veh)	0.5	-	-	-	0.2	0.2



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	300	10	250	50	20	10	240	3360	80	30	2780	180
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.5	5.8	5.8	5.3	5.9		5.5	5.3	5.3	5.5	5.5	
Lane Util. Factor	0.97	0.95	0.95	1.00	1.00		0.97	0.91	1.00	1.00	0.86	
Frpb, ped/bikes	1.00	1.00	1.00	1.00	0.99		1.00	1.00	1.00	1.00	1.00	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	0.95		1.00	1.00	0.85	1.00	0.99	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	3433	1770	1504	1770	1761		3433	5085	1583	1770	6343	
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	3433	1770	1504	1770	1761		3433	5085	1583	1770	6343	
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	312	10	260	52	21	10	250	3500	83	31	2896	188
RTOR Reduction (vph)	0	0	83	0	9	0	0	0	31	0	5	0
Lane Group Flow (vph)	312	10	177	52	22	0	250	3500	52	31	3079	0
Confl. Peds. (#/hr)						4						2
Confl. Bikes (#/hr)						2						3
Turn Type	Prot	NA	Perm	Prot	NA		Prot	NA	Perm	Prot	NA	
Protected Phases	3	8		7	4		1	6		5	2	
Permitted Phases			8						6			
Actuated Green, G (s)	13.4	23.6	23.6	6.7	16.6		8.5	94.8	94.8	3.0	89.1	
Effective Green, g (s)	13.4	23.6	23.6	6.7	16.6		8.5	94.8	94.8	3.0	89.1	
Actuated g/C Ratio	0.09	0.16	0.16	0.04	0.11		0.06	0.63	0.63	0.02	0.59	
Clearance Time (s)	5.5	5.8	5.8	5.3	5.9		5.5	5.3	5.3	5.5	5.5	
Vehicle Extension (s)	1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0	1.0	
Lane Grp Cap (vph)	306	278	236	79	194		194	3213	1000	35	3767	
v/s Ratio Prot	c0.09	0.01		0.03	0.01		c0.07	c0.69		0.02	0.49	
v/s Ratio Perm			c0.12						0.03			
v/c Ratio	1.02	0.04	0.75	0.66	0.11		1.29	1.09	0.05	0.89	0.82	
Uniform Delay, d1	68.3	53.6	60.4	70.5	60.1		70.8	27.6	10.5	73.3	24.0	
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	56.6	0.0	11.3	14.1	0.1		162.9	46.1	0.1	103.6	2.1	
Delay (s)	124.9	53.6	71.7	84.6	60.2		233.7	73.7	10.6	177.0	26.1	
Level of Service	F	D	E	F	E		F	E	B	F	C	
Approach Delay (s)		99.9			75.5			82.8			27.6	
Approach LOS		F			E			F			C	

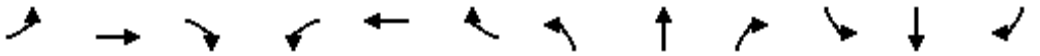
Intersection Summary			
HCM 2000 Control Delay	61.5	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.09		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	22.4
Intersection Capacity Utilization	97.3%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	500	190	200	2330	200	1350	0	0	3030	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)			4.6		6.2	4.0	4.6	5.0			5.3	5.3
Lane Util. Factor			1.00		0.95	0.76	0.97	0.91			0.86	1.00
Frpb, ped/bikes			1.00		1.00	1.00	1.00	1.00			1.00	0.99
Flpb, ped/bikes			1.00		1.00	1.00	1.00	1.00			1.00	1.00
Frt			0.86		1.00	0.85	1.00	1.00			1.00	0.85
Flt Protected			1.00		0.98	1.00	0.95	1.00			1.00	1.00
Satd. Flow (prot)			1611		3455	3610	3433	5085			6408	1564
Flt Permitted			1.00		0.98	1.00	0.95	1.00			1.00	1.00
Satd. Flow (perm)			1611		3455	3610	3433	5085			6408	1564
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	526	200	211	2453	211	1421	0	0	3189	53
RTOR Reduction (vph)	0	0	77	0	0	21	0	0	0	0	0	27
Lane Group Flow (vph)	0	0	449	0	411	2432	211	1421	0	0	3189	26
Confl. Bikes (#/hr)												1
Turn Type			Over	Split	NA	custom	Prot	NA			NA	Perm
Protected Phases			1	4	4	5	1	6			2	
Permitted Phases						4						2
Actuated Green, G (s)			37.6		16.8	82.9	37.6	41.9			69.5	69.5
Effective Green, g (s)			37.6		16.8	82.9	37.6	41.9			69.5	69.5
Actuated g/C Ratio			0.27		0.12	0.59	0.27	0.30			0.50	0.50
Clearance Time (s)			4.6		6.2	4.0	4.6	5.0			5.3	5.3
Vehicle Extension (s)			1.0		1.0	3.0	1.0	1.0			1.0	1.0
Lane Grp Cap (vph)			432		414	2240	922	1521			3181	776
v/s Ratio Prot			c0.28		0.12	c0.51	0.06	0.28			c0.50	
v/s Ratio Perm						0.16						0.02
v/c Ratio			1.04		0.99	1.09	0.23	0.93			1.00	0.03
Uniform Delay, d1			51.2		61.5	28.5	39.9	47.7			35.2	18.1
Progression Factor			1.00		1.00	1.00	1.00	1.00			1.00	1.00
Incremental Delay, d2			54.0		42.1	47.0	0.0	12.0			16.6	0.1
Delay (s)			105.2		103.6	75.5	39.9	59.7			51.8	18.1
Level of Service			F		F	E	D	E			D	B
Approach Delay (s)		105.2			79.6			57.1			51.3	
Approach LOS		F			E			E			D	

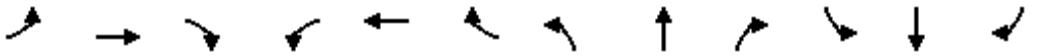
Intersection Summary			
HCM 2000 Control Delay	65.7	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.09		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	16.1
Intersection Capacity Utilization	99.3%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group



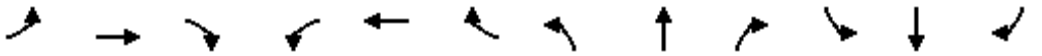
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	1400	30	20	1150	30	100	10	130	50	0	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.9		4.9	5.0			4.9	4.9		4.8	4.8
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00	1.00		1.00	1.00
Frt	1.00	1.00		1.00	1.00			1.00	0.85		1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00			0.96	1.00		0.95	1.00
Satd. Flow (prot)	1770	3528		1770	3526			1782	1583		1770	1583
Flt Permitted	0.95	1.00		0.95	1.00			0.96	1.00		0.95	1.00
Satd. Flow (perm)	1770	3528		1770	3526			1782	1583		1770	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	11	1522	33	22	1250	33	109	11	141	54	0	54
RTOR Reduction (vph)	0	1	0	0	2	0	0	0	128	0	0	50
Lane Group Flow (vph)	11	1554	0	22	1281	0	0	120	13	0	54	4
Turn Type	Prot	NA		Prot	NA		Split	NA	Perm	Split	NA	Perm
Protected Phases	1	6		5	2		4	4		3	3	
Permitted Phases									4			3
Actuated Green, G (s)	0.6	41.3		1.2	42.2			6.9	6.9		4.9	4.9
Effective Green, g (s)	0.6	41.3		1.2	42.2			6.9	6.9		4.9	4.9
Actuated g/C Ratio	0.01	0.56		0.02	0.57			0.09	0.09		0.07	0.07
Clearance Time (s)	4.5	4.9		4.9	5.0			4.9	4.9		4.8	4.8
Vehicle Extension (s)	1.0	5.8		1.0	4.9			2.0	2.0		1.0	1.0
Lane Grp Cap (vph)	14	1974		28	2016			166	148		117	105
v/s Ratio Prot	0.01	c0.44		c0.01	0.36			c0.07			c0.03	
v/s Ratio Perm									0.01			0.00
v/c Ratio	0.79	0.79		0.79	0.64			0.72	0.09		0.46	0.03
Uniform Delay, d1	36.5	12.8		36.2	10.6			32.5	30.6		33.2	32.2
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00		1.00	1.00
Incremental Delay, d2	123.8	2.6		78.1	0.9			12.4	0.1		1.1	0.0
Delay (s)	160.4	15.4		114.3	11.5			44.9	30.7		34.2	32.3
Level of Service	F	B		F	B			D	C		C	C
Approach Delay (s)		16.4			13.3			37.2			33.3	
Approach LOS		B			B			D			C	

Intersection Summary			
HCM 2000 Control Delay	17.4	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	73.8	Sum of lost time (s)	19.5
Intersection Capacity Utilization	63.2%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			



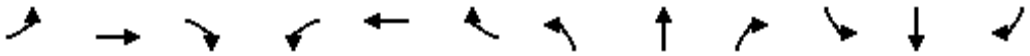
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	1200	140	30	120	0	160	210	1260	110	120	1060	240
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.6	4.6	4.6	4.6		4.6	3.5	5.3	5.3	3.5	5.3	5.3
Lane Util. Factor	0.91	0.91	1.00	1.00		1.00	1.00	0.91	1.00	1.00	0.91	1.00
Frt	1.00	1.00	0.85	1.00		0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.97	1.00	0.95		1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3221	1639	1583	1770		1583	1770	5085	1583	1770	5085	1583
Flt Permitted	0.95	0.97	1.00	0.95		1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3221	1639	1583	1770		1583	1770	5085	1583	1770	5085	1583
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	1250	146	31	125	0	167	219	1312	115	125	1104	250
RTOR Reduction (vph)	0	0	21	0	0	153	0	0	81	0	0	189
Lane Group Flow (vph)	925	471	10	125	0	14	219	1312	34	125	1104	61
Turn Type	Split	NA	Perm	Split		Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases			4			8			2			6
Actuated Green, G (s)	28.6	28.6	28.6	7.4		7.4	12.2	26.2	26.2	7.5	21.5	21.5
Effective Green, g (s)	28.6	28.6	28.6	7.4		7.4	12.2	26.2	26.2	7.5	21.5	21.5
Actuated g/C Ratio	0.33	0.33	0.33	0.08		0.08	0.14	0.30	0.30	0.09	0.25	0.25
Clearance Time (s)	4.6	4.6	4.6	4.6		4.6	3.5	5.3	5.3	3.5	5.3	5.3
Vehicle Extension (s)	2.0	2.0	2.0	2.0		2.0	2.0	2.2	2.2	2.0	2.2	2.2
Lane Grp Cap (vph)	1050	534	516	149		133	246	1519	472	151	1246	388
v/s Ratio Prot	0.29	c0.29		c0.07			c0.12	c0.26		0.07	0.22	
v/s Ratio Perm			0.01			0.01			0.02			0.04
v/c Ratio	0.88	0.88	0.02	0.84		0.11	0.89	0.86	0.07	0.83	0.89	0.16
Uniform Delay, d1	27.9	28.0	20.0	39.6		37.1	37.1	29.1	22.0	39.5	31.9	26.0
Progression Factor	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	8.6	15.3	0.0	30.7		0.1	29.7	5.2	0.0	28.4	7.7	0.1
Delay (s)	36.5	43.3	20.0	70.2		37.2	66.8	34.3	22.1	67.8	39.6	26.1
Level of Service	D	D	C	E		D	E	C	C	E	D	C
Approach Delay (s)		38.4			51.4			37.8			39.7	
Approach LOS		D			D			D			D	

Intersection Summary			
HCM 2000 Control Delay	39.4	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.90		
Actuated Cycle Length (s)	87.7	Sum of lost time (s)	18.0
Intersection Capacity Utilization	78.8%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	640	230	590	180	210	570	460	1610	160	380	1580	200
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.5	5.5	5.5	5.5	5.5	5.5	5.5	4.7	4.7	5.5	4.7	4.7
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95	1.00	0.97	0.91	1.00	0.97	0.91	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	3539	1583	1770	3539	1583	3433	5085	1583	3433	5085	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	3539	1583	1770	3539	1583	3433	5085	1583	3433	5085	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	696	250	641	196	228	620	500	1750	174	413	1717	217
RTOR Reduction (vph)	0	0	35	0	0	72	0	0	82	0	0	96
Lane Group Flow (vph)	696	250	606	196	228	548	500	1750	92	413	1717	121
Turn Type	Prot	NA	pm+ov	Prot	NA	pm+ov	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	7	4	1	3	8	5	1	6		5	2	
Permitted Phases			4			8			6			2
Actuated Green, G (s)	24.5	21.5	40.0	14.3	11.3	26.8	18.5	49.8	49.8	15.5	46.8	46.8
Effective Green, g (s)	24.5	21.5	40.0	14.3	11.3	26.8	18.5	49.8	49.8	15.5	46.8	46.8
Actuated g/C Ratio	0.20	0.18	0.33	0.12	0.09	0.22	0.15	0.41	0.41	0.13	0.38	0.38
Clearance Time (s)	5.5	5.5	5.5	5.5	5.5	5.5	5.5	4.7	4.7	5.5	4.7	4.7
Vehicle Extension (s)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Lane Grp Cap (vph)	687	622	588	206	326	418	519	2070	644	435	1945	605
v/s Ratio Prot	c0.20	0.07	c0.16	0.11	0.06	c0.17	0.15	c0.34		0.12	0.34	
v/s Ratio Perm			0.23			0.18			0.06			0.08
v/c Ratio	1.01	0.40	1.03	0.95	0.70	1.31	0.96	0.85	0.14	0.95	0.88	0.20
Uniform Delay, d1	48.9	44.7	41.1	53.7	53.9	47.8	51.6	32.8	22.8	53.0	35.2	25.2
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	37.6	0.2	45.2	48.4	5.2	156.4	30.0	3.2	0.0	29.9	5.0	0.1
Delay (s)	86.5	44.9	86.3	102.1	59.1	204.1	81.6	36.0	22.9	82.9	40.2	25.3
Level of Service	F	D	F	F	E	F	F	D	C	F	D	C
Approach Delay (s)		79.9			153.3			44.5			46.3	
Approach LOS		E			F			D			D	

Intersection Summary			
HCM 2000 Control Delay	68.0	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.09		
Actuated Cycle Length (s)	122.3	Sum of lost time (s)	21.2
Intersection Capacity Utilization	97.7%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	790	1010	440	850	10	530	10	330	10	10	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.5	4.8	4.8	5.5	4.8		5.5	5.5	5.5		5.5	
Lane Util. Factor	1.00	1.00	1.00	0.97	1.00		0.97	0.95	0.95		1.00	
Frt	1.00	1.00	0.85	1.00	1.00		1.00	0.86	0.85		0.95	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00		0.98	
Satd. Flow (prot)	1770	1863	1583	3433	1859		3433	1520	1504		1750	
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00		0.98	
Satd. Flow (perm)	1770	1863	1583	3433	1859		3433	1520	1504		1750	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	11	859	1098	478	924	11	576	11	359	11	11	11
RTOR Reduction (vph)	0	0	295	0	0	0	0	143	148	0	11	0
Lane Group Flow (vph)	11	859	803	478	935	0	576	44	35	0	22	0
Turn Type	Prot	NA	Perm	Prot	NA		Split	NA	Perm	Split	NA	
Protected Phases	7	4		3	8		2	2		6	6	
Permitted Phases			4						2			
Actuated Green, G (s)	0.7	60.9	60.9	16.6	76.8		23.8	23.8	23.8		3.6	
Effective Green, g (s)	0.7	60.9	60.9	16.6	76.8		23.8	23.8	23.8		3.6	
Actuated g/C Ratio	0.01	0.48	0.48	0.13	0.61		0.19	0.19	0.19		0.03	
Clearance Time (s)	5.5	4.8	4.8	5.5	4.8		5.5	5.5	5.5		5.5	
Vehicle Extension (s)	3.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0		1.0	
Lane Grp Cap (vph)	9	899	763	451	1131		647	286	283		49	
v/s Ratio Prot	0.01	0.46		c0.14	0.50		c0.17	0.03			c0.01	
v/s Ratio Perm			c0.51						0.02			
v/c Ratio	1.22	0.96	1.05	1.06	0.83		0.89	0.15	0.12		0.46	
Uniform Delay, d1	62.8	31.3	32.7	54.8	19.4		49.9	42.8	42.5		60.3	
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00		1.00	
Incremental Delay, d2	385.4	19.7	47.3	59.1	4.8		14.1	0.1	0.1		2.4	
Delay (s)	448.2	51.1	79.9	113.9	24.3		64.0	42.9	42.6		62.8	
Level of Service	F	D	E	F	C		E	D	D		E	
Approach Delay (s)		69.4			54.6			55.7			62.8	
Approach LOS		E			D			E			E	

Intersection Summary			
HCM 2000 Control Delay	61.6	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.00		
Actuated Cycle Length (s)	126.2	Sum of lost time (s)	21.3
Intersection Capacity Utilization	91.6%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	1100	120	330	1020	0	370	0	260	90	160	60
Number	1	6	16	5	2	12	3	8	18	7	4	14
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.98	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	0	1863	1900	1863	1863	0	1863	0	1863	1900	1863	1900
Adj Flow Rate, veh/h	0	1196	130	359	1109	0	402	0	283	98	174	65
Adj No. of Lanes	0	2	0	1	2	0	2	0	2	0	2	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	0	2	2	2	2	0	2	0	2	2	2	2
Cap, veh/h	0	1333	144	407	2488	0	0	0	0	128	237	92
Arrive On Green	0.00	0.41	0.41	0.23	0.70	0.00	0.00	0.00	0.00	0.13	0.13	0.13
Sat Flow, veh/h	0	3307	348	1774	3632	0		0		995	1842	713
Grp Volume(v), veh/h	0	657	669	359	1109	0		0.0		179	0	158
Grp Sat Flow(s),veh/h/ln	0	1770	1793	1774	1770	0				1813	0	1737
Q Serve(g_s), s	0.0	22.4	22.6	12.7	8.8	0.0				6.2	0.0	5.7
Cycle Q Clear(g_c), s	0.0	22.4	22.6	12.7	8.8	0.0				6.2	0.0	5.7
Prop In Lane	0.00		0.19	1.00		0.00				0.55		0.41
Lane Grp Cap(c), veh/h	0	734	743	407	2488	0				233	0	223
V/C Ratio(X)	0.00	0.90	0.90	0.88	0.45	0.00				0.77	0.00	0.71
Avail Cap(c_a), veh/h	0	1492	1511	800	4755	0				378	0	362
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00				1.00	1.00	1.00
Upstream Filter(I)	0.00	1.00	1.00	1.00	1.00	0.00				1.00	0.00	1.00
Uniform Delay (d), s/veh	0.0	17.6	17.7	24.1	4.2	0.0				27.3	0.0	27.1
Incr Delay (d2), s/veh	0.0	1.6	1.7	2.5	0.0	0.0				2.0	0.0	1.6
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0				0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	0.0	11.1	11.3	6.5	4.2	0.0				3.2	0.0	2.8
LnGrp Delay(d),s/veh	0.0	19.3	19.4	26.6	4.2	0.0				29.2	0.0	28.6
LnGrp LOS		B	B	C	A					C		C
Approach Vol, veh/h		1326			1468						337	
Approach Delay, s/veh		19.3			9.7						28.9	
Approach LOS		B			A						C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		
Phs Duration (G+Y+Rc), s		50.9		13.8	18.7	32.3		
Change Period (Y+Rc), s		* 5.4		5.5	* 3.8	* 5.4		
Max Green Setting (Gmax), s		* 87		13.5	* 29	* 55		
Max Q Clear Time (g_c+I1), s		10.8		8.2	14.7	24.6		
Green Ext Time (p_c), s		2.3		0.2	0.2	2.3		

Intersection Summary	
HCM 2010 Ctrl Delay	15.8
HCM 2010 LOS	B

Notes

* HCM 2010 computational engine requires equal clearance times for the phases crossing the barrier.

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	180	140	110	2510	1280	1520
Number	7	14	5	2	6	16
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	189	147	116	2642	1347	0
Adj No. of Lanes	2	1	1	3	3	1
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	239	110	141	4261	3689	1149
Arrive On Green	0.07	0.07	0.08	0.84	0.73	0.00
Sat Flow, veh/h	3442	1583	1774	5253	5253	1583
Grp Volume(v), veh/h	189	147	116	2642	1347	0
Grp Sat Flow(s),veh/h/ln	1721	1583	1774	1695	1695	1583
Q Serve(g_s), s	5.8	7.4	6.9	18.7	10.6	0.0
Cycle Q Clear(g_c), s	5.8	7.4	6.9	18.7	10.6	0.0
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	239	110	141	4261	3689	1149
V/C Ratio(X)	0.79	1.34	0.82	0.62	0.37	0.00
Avail Cap(c_a), veh/h	239	110	141	5846	5274	1642
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	48.9	49.7	48.4	2.9	5.5	0.0
Incr Delay (d2), s/veh	15.3	201.7	28.9	0.1	0.0	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	3.3	12.4	4.5	8.6	4.9	0.0
LnGrp Delay(d),s/veh	64.2	251.3	77.3	3.0	5.5	0.0
LnGrp LOS	E	F	E	A	A	
Approach Vol, veh/h	336			2758	1347	
Approach Delay, s/veh	146.1			6.1	5.5	
Approach LOS	F			A	A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		
Phs Duration (G+Y+Rc), s		94.7		12.0	12.0	82.7		
Change Period (Y+Rc), s		5.3		4.6	3.5	5.3		
Max Green Setting (Gmax), s		122.7		7.4	8.5	110.7		
Max Q Clear Time (g_c+I1), s		20.7		9.4	8.9	12.6		
Green Ext Time (p_c), s		66.5		0.0	0.0	64.9		

Intersection Summary	
HCM 2010 Ctrl Delay	16.5
HCM 2010 LOS	B

Intersection	
Int Delay, s/veh	3.5

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	40	1410	1260	20	30	60
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	175	-	-	-	0	0
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	94	94	94	94	94	94
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	43	1500	1340	21	32	64

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	1362	0	-	0	2186	681
Stage 1	-	-	-	-	1351	-
Stage 2	-	-	-	-	835	-
Critical Hdwy	4.14	-	-	-	6.84	6.94
Critical Hdwy Stg 1	-	-	-	-	5.84	-
Critical Hdwy Stg 2	-	-	-	-	5.84	-
Follow-up Hdwy	2.22	-	-	-	3.52	3.32
Pot Cap-1 Maneuver	501	-	-	-	39	393
Stage 1	-	-	-	-	206	-
Stage 2	-	-	-	-	386	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	501	-	-	-	36	393
Mov Cap-2 Maneuver	-	-	-	-	36	-
Stage 1	-	-	-	-	206	-
Stage 2	-	-	-	-	353	-

Approach	EB	WB	SB
HCM Control Delay, s	0.4	0	104.2
HCM LOS			F

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	501	-	-	-	36	393
HCM Lane V/C Ratio	0.085	-	-	-	0.887	0.162
HCM Control Delay (s)	12.9	-	-	-	280.8	15.9
HCM Lane LOS	B	-	-	-	F	C
HCM 95th %tile Q(veh)	0.3	-	-	-	3.2	0.6

Appendix B: HCS2010 Calculations

This appendix contains HCS2010 calculation sheets used to conduct freeway capacity analysis:

Appendix B-1: Existing (2015) No Build Scenario

Appendix B-2: Existing (2015) with Alternative 1/1A/2 Scenario

Appendix B-3: Opening Year (2022) No Build Scenario

Appendix B-4: Opening Year (2022) with Alternative 1/1A/2 Scenario

Appendix B-5: Horizon Year (2042) No Build Scenario

Appendix B-6: Horizon Year (2042) with Alternative 1/1A/2 Scenario

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Appendix B1

Existing (2015) No Build

HCS2010 Calculations

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	10/28/2015
Analysis Time Period:	7:15 - 8:15 AM
Freeway/Direction:	US 50 EB
From/To:	Sunrise Avenue to Hazel Avenue
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	

Flow Inputs and Adjustments

Volume, V	2788	veh/h
Peak-hour factor, PHF	0.92	
Peak 15-min volume, v15	758	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1040	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.50	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.5	mi/h
Free-flow speed, FFS	70.9	mi/h

LOS and Performance Measures

Flow rate, vp	1040	pc/h/ln
Free-flow speed, FFS	70.9	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	3	
Density, D	14.9	pc/mi/ln
Level of service, LOS	B	

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Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 EB
Junction:	Hazel Avenue Off-ramp
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	2788	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-Flow speed on ramp	40.0	mph
Volume on ramp	1030	vph
Length of first accel/decel lane	0	ft
Length of second accel/decel lane	1420	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	896	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1340	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2788	1030	896	vph
Peak-hour factor, PHF	0.92	0.92	0.92	
Peak 15-min volume, v15	758	280	243	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

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Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	3121	1153	1003	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.450 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 2039 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	3121	7200	No
$v_{FO} = v_F - v_R$	1968	7200	No
v_R	1153	4200	No
v_3 or v_{av34}	1082 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	No	

If yes, v_{12A} = 2039 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	2039	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 9.0 pc/mi/ln

Level of service for ramp-freeway junction areas of influence A

Speed Estimation

Intermediate speed variable,	D_S = 0.467	
Space mean speed in ramp influence area,	S_R = 57.5	mph
Space mean speed in outer lanes,	S_O = 77.6	mph
Space mean speed for all vehicles,	S = 63.1	mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 EB
Junction:	SB Hazel Avenue Loop On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	1758	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	896	vph
Length of first accel/decel lane	350	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	1030	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1340	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1758	896	1030	vph
Peak-hour factor, PHF	0.92	0.92	0.92	
Peak 15-min volume, v15	478	243	280	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	1968	1003	1153	pcph

Estimation of V12 Merge Areas

L_{EQ} = 219.39 (Equation 13-6 or 13-7)

P_{FM} = 0.587 Using Equation 3

$v_{12} = v_F (P_{FM})$ = 1156 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	2971	7200	No
v_3 or v_{av34}	812 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	Yes	

If yes, v_{12A} = 1156 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	2159	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$ = 19.7 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable,	M_S = 0.330	
Space mean speed in ramp influence area,	S_R = 61.4	mph
Space mean speed in outer lanes,	S_O = 69.9	mph
Space mean speed for all vehicles,	S = 63.5	mph

DRAFT

HCS 2010: Freeway Weaving Release 6.65

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date Performed:	11/2/2015
Analysis Time Period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 EB
Weaving Location:	Hazel to Aerojet Weave
Analysis Year:	2015
Description:	

Inputs

Segment Type	Freeway	
Weaving configuration	One-Sided	
Number of lanes, N	4	ln
Weaving segment length, LS	640	ft
Freeway free-flow speed, FFS	71	mi/h
Minimum segment speed, SMIN	15	mi/h
Freeway maximum capacity, cIFL	2400	pc/h/ln
Terrain type	Level	
Grade	0.00	%
Length	0.00	mi

Conversion to pc/h Under Base Conditions

	Volume Components				
	VFF	VRF	VFR	VRR	
Volume, V	3584	97	276	0	veh/h
Peak hour factor, PHF	0.92	0.92	0.92	0.92	
Peak 15-min volume, v15	974	26	75	0	
Trucks and buses	6	6	6	6	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	0.971	0.971	0.971	0.971	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	4013	109	309	0	pc/h

Volume ratio, VR	0.094	

Configuration Characteristics

Number of maneuver lanes, NWL	2	ln
Interchange density, ID	0.8	int/mi
Minimum RF lane changes, LCRF	0	lc/pc
Minimum FR lane changes, LCFR	1	lc/pc
Minimum RR lane changes, LCRR		lc/pc
Minimum weaving lane changes, LCMIN	309	lc/h
Weaving lane changes, LCW	496	lc/h
Non-weaving vehicle index, INW	213	
Non-weaving lane change, LCNW	403	lc/h
Total lane changes, LCALL	899	lc/h

Weaving and Non-Weaving Speeds

Weaving intensity factor, W	0.295	

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Average weaving speed, SW	58.2	mi/h
Average non-weaving speed, SNW	63.5	mi/h

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	62.9	mi/h
Weaving segment density, D	17.6	pc/mi/ln
Level of service, LOS	B	
Weaving segment v/c ratio	0.508	
Weaving segment flow rate, v	4302	veh/h
Weaving segment capacity, cW	8474	veh/h

Limitations on Weaving Segments

If limit reached, see note.

	Minimum	Maximum	Actual	Note
Weaving length (ft)	300	3485	640	a,b
		Maximum	Analyzed	
Density-based capacty, cIWL (pc/h/ln)		2400	2182	c
		Maximum	Analyzed	
v/c ratio		1.00	0.508	d

Notes:

a. In weaving segments shorter than 300 ft, weaving vehicles are assumed to make only necessary lane changes.

b. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments."

c. The density-based capacity exceeds the capacity of a basic freeway segment, under equivalent ideal conditions.

d. Volumes exceed the weaving segment capacity. The level of service is F.

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	10/28/2015
Analysis Time Period:	7:15 - 8:15 AM
Freeway/Direction:	US 50 EB
From/To:	Aerojet Road to Folsom Blvd
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	

Flow Inputs and Adjustments

Volume, V	3683	veh/h
Peak-hour factor, PHF	0.92	
Peak 15-min volume, v15	1001	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1374	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.33	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.1	mi/h
Free-flow speed, FFS	71.3	mi/h

LOS and Performance Measures

Flow rate, vp	1374	pc/h/ln
Free-flow speed, FFS	71.3	mi/h
Average passenger-car speed, S	69.6	mi/h
Number of lanes, N	3	
Density, D	19.7	pc/mi/ln
Level of service, LOS	C	

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Overall results are not computed when free-flow speed is less than 55 mph.

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Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 EB
Junction:	Folsom Boulevard Off-ramp
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	71.0	mph
Volume on freeway	3683	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-Flow speed on ramp	40.0	mph
Volume on ramp	1386	vph
Length of first accel/decel lane	0	ft
Length of second accel/decel lane	1500	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	175	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1390	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	3683	1386	175	vph
Peak-hour factor, PHF	0.92	0.92	0.92	
Peak 15-min volume, v15	1001	377	48	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

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Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	4123	1552	196	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 4123 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	4123	4800	No
$v_{FO} = v_F - v_R$	2571	4800	No
v_R	1552	4200	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		No	

If yes, v_{12A} = 4123 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	4123	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 26.2 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable, D_S = 0.503

Space mean speed in ramp influence area, S_R = 56.4 mph

Space mean speed in outer lanes, S_O = N/A mph

Space mean speed for all vehicles, S = 56.4 mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 EB
Junction:	Folsom Boulevard On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	71.0	mph
Volume on freeway	2297	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	175	vph
Length of first accel/decel lane	400	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	1386	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1390	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2297	175	1386	vph
Peak-hour factor, PHF	0.92	0.92	0.92	
Peak 15-min volume, v15	624	48	377	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	2572	196	1552	pcph

Estimation of V12 Merge Areas

L_{EQ} = 219.39 (Equation 13-6 or 13-7)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 2572 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	2768	4800	No

v_3 or v_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 2572 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	2768	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 24.5 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable,	M_S = 0.355	
Space mean speed in ramp influence area,	S_R = 60.7	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 60.7	mph

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	10/28/2015
Analysis Time Period:	7:15 - 8:15 AM
Freeway/Direction:	US 50 EB
From/To:	Folsom Blvd to Prairie City Rd
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	

Flow Inputs and Adjustments

Volume, V	2432	veh/h
Peak-hour factor, PHF	0.92	
Peak 15-min volume, v15	661	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1361	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.50	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.5	mi/h
Free-flow speed, FFS	70.9	mi/h

LOS and Performance Measures

Flow rate, vp	1361	pc/h/ln
Free-flow speed, FFS	70.9	mi/h
Average passenger-car speed, S	69.7	mi/h
Number of lanes, N	2	
Density, D	19.5	pc/mi/ln
Level of service, LOS	C	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	11/3/2015
Analysis Time Period:	7:15 - 8:15 AM
Freeway/Direction:	US 50 WB
From/To:	Prairie City Rd to Folsom Blvd
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	

Flow Inputs and Adjustments

Volume, V	2886	veh/h
Peak-hour factor, PHF	0.91	
Peak 15-min volume, v15	793	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1633	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.33	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.1	mi/h
Free-flow speed, FFS	71.3	mi/h

LOS and Performance Measures

Flow rate, vp	1633	pc/h/ln
Free-flow speed, FFS	71.3	mi/h
Average passenger-car speed, S	67.8	mi/h
Number of lanes, N	2	
Density, D	24.1	pc/mi/ln
Level of service, LOS	C	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 WB
Junction:	Folsom Boulevard Off-ramp
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	71.0	mph
Volume on freeway	2886	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	310	vph
Length of first accel/decel lane	0	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	1320	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1800	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2886	310	1320	vph
Peak-hour factor, PHF	0.91	0.91	0.91	
Peak 15-min volume, v15	793	85	363	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	3267	351	1494	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 3267 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	3267	4800	No
$v_{FO} = v_F - v_R$	2916	4800	No
v_R	351	2000	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	No	

If yes, v_{12A} = 3267 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	3267	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086 v_R - 0.009 L_{12}$ = 32.3 pc/mi/ln

Level of service for ramp-freeway junction areas of influence D

Speed Estimation

Intermediate speed variable,	D_S = 0.460	
Space mean speed in ramp influence area,	S_R = 57.7	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 57.7	mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 WB
Junction:	Folsom Boulevard On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	71.0	mph
Volume on freeway	2576	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	50.0	mph
Volume on ramp	1320	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	310	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1800	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2576	1320	310	vph
Peak-hour factor, PHF	0.91	0.91	0.91	
Peak 15-min volume, v15	708	363	85	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	2916	1494	351	pcph

Estimation of V12 Merge Areas

L_{EQ} = 219.39 (Equation 13-6 or 13-7)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 2916 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	4410	4800	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	No	

If yes, v_{12A} = 2916 (Equation 13-15, 13-16, 18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	4410	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 29.8 pc/mi/ln

Level of service for ramp-freeway junction areas of influence D

Speed Estimation

Intermediate speed variable,	M_S = 0.492	
Space mean speed in ramp influence area,	S_R = 56.7	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 56.7	mph

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	11/3/2015
Analysis Time Period:	7:15 - 8:15 AM
Freeway/Direction:	US 50 WB
From/To:	Folsom Blvd to Hazel Ave
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	

Flow Inputs and Adjustments

Volume, V	4652	veh/h
Peak-hour factor, PHF	0.91	
Peak 15-min volume, v15	1278	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1755	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.17	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	3.7	mi/h
Free-flow speed, FFS	71.7	mi/h

LOS and Performance Measures

Flow rate, vp	1755	pc/h/ln
Free-flow speed, FFS	71.7	mi/h
Average passenger-car speed, S	66.4	mi/h
Number of lanes, N	3	
Density, D	26.4	pc/mi/ln
Level of service, LOS	D	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 WB
Junction:	Hazel Avenue Off-ramp
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	4	
Free-flow speed on freeway	71.0	mph
Volume on freeway	4652	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-Flow speed on ramp	40.0	mph
Volume on ramp	639	vph
Length of first accel/decel lane	0	ft
Length of second accel/decel lane	1400	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	289	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1740	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4652	639	289	vph
Peak-hour factor, PHF	0.91	0.91	0.91	
Peak 15-min volume, v15	1278	176	79	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	5265	723	327	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.260 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 1904 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	5265	9600	No
$v_{FO} = v_F - v_R$	4542	9600	No
v_R	723	4200	No
v_3 or v_{av34}	1680 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	Yes	

If yes, v_{12A} = 2106 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	2106	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$ = 9.8 pc/mi/ln

Level of service for ramp-freeway junction areas of influence A

Speed Estimation

Intermediate speed variable,	D_S = 0.428	
Space mean speed in ramp influence area,	S_R = 58.6	mph
Space mean speed in outer lanes,	S_O = 75.6	mph
Space mean speed for all vehicles,	S = 67.7	mph

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Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 WB
Junction:	NB Hazel Loop On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	4013	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	289	vph
Length of first accel/decel lane	600	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	1550	vph
Position of adjacent Ramp	Downstream	
Type of adjacent Ramp	On	
Distance to adjacent Ramp	350	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4013	289	1550	vph
Peak-hour factor, PHF	0.91	0.91	0.91	
Peak 15-min volume, v15	1102	79	426	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	4542	327	1754	pcph

Estimation of V12 Merge Areas

L_{EQ} = 6493.89 (Equation 13-6 or 13-7)

P_{FM} = 0.594 Using Equation 3

$v_{12} = v_F (P_{FM})$ = 2699 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	4869	7200	No
v_3 or v_{av34}	1843 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		Yes	

If yes, v_{12A} = 2699 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	3026	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 25.2 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable,	M_S = 0.359	
Space mean speed in ramp influence area,	S_R = 60.6	mph
Space mean speed in outer lanes,	S_O = 66.2	mph
Space mean speed for all vehicles,	S = 62.6	mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 WB
Junction:	Folsom Boulevard On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	4302	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	50.0	mph
Volume on ramp	1550	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	289	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	On	
Distance to adjacent Ramp	350	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4302	1550	289	vph
Peak-hour factor, PHF	0.91	0.91	0.91	
Peak 15-min volume, v15	1182	426	79	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

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Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	4869	1754	327	pcph

Estimation of V12 Merge Areas

L_{EQ} = 2296.32 (Equation 13-6 or 13-7)

P_{FM} = 0.619 Using Equation 3

$v_{12} = v_F (P_{FM})$ = 3016 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	6623	7200	No
v_3 or v_{av34}	1853 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	Yes	

If yes, v_{12A} = 3016 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	4770	4600	Yes

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$ = 32.5 pc/mi/ln

Level of service for ramp-freeway junction areas of influence D

Speed Estimation

Intermediate speed variable,	M_S = 0.631	
Space mean speed in ramp influence area,	S_R = 52.7	mph
Space mean speed in outer lanes,	S_O = 66.1	mph
Space mean speed for all vehicles,	S = 55.9	mph

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	11/3/2015
Analysis Time Period:	7:15 - 8:15 AM
Freeway/Direction:	US 50 WB
From/To:	Hazel Ave to Sunrise Blvd
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	

Flow Inputs and Adjustments

Volume, V	5149	veh/h
Peak-hour factor, PHF	0.91	
Peak 15-min volume, v15	1415	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1943	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.50	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.5	mi/h
Free-flow speed, FFS	70.9	mi/h

LOS and Performance Measures

Flow rate, vp	1943	pc/h/ln
Free-flow speed, FFS	70.9	mi/h
Average passenger-car speed, S	63.6	mi/h
Number of lanes, N	3	
Density, D	30.6	pc/mi/ln
Level of service, LOS	D	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

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Phone: Fax:
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Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	10/28/2015
Analysis Time Period:	4:45 - 5:45 PM
Freeway/Direction:	US 50 EB
From/To:	Sunrise Avenue to Hazel Avenue
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	

Flow Inputs and Adjustments

Volume, V	3024	veh/h
Peak-hour factor, PHF	0.91	
Peak 15-min volume, v15	831	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1141	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.50	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.5	mi/h
Free-flow speed, FFS	70.9	mi/h

LOS and Performance Measures

Flow rate, vp	1141	pc/h/ln
Free-flow speed, FFS	70.9	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	3	
Density, D	16.3	pc/mi/ln
Level of service, LOS	B	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 EB
Junction:	Hazel Avenue Off-ramp
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	3024	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-Flow speed on ramp	40.0	mph
Volume on ramp	1609	vph
Length of first accel/decel lane	0	ft
Length of second accel/decel lane	1420	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	831	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1340	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp		
Volume, V (vph)	3024		1609		831		vph
Peak-hour factor, PHF	0.91		0.91		0.91		
Peak 15-min volume, v15	831		442		228		v
Trucks and buses	6		6		6		%
Recreational vehicles	0		0		0		%
Terrain type:	Level		Level		Level		
Grade	0.00	%	0.00	%	0.00	%	
Length	0.00	mi	0.00	mi	0.00	mi	
Trucks and buses PCE, ET	1.5		1.5		1.5		
Recreational vehicle PCE, ER	1.2		1.2		1.2		

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Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	3423	1821	941	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.450 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 2542 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	3423	7200	No
$v_{FO} = v_F - v_R$	1602	7200	No
v_R	1821	4200	No
v_3 or v_{av34}	881 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		No	

If yes, v_{12A} = 2542 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	2542	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 13.3 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable,	D_S = 0.527	
Space mean speed in ramp influence area,	S_R = 55.7	mph
Space mean speed in outer lanes,	S_0 = 77.9	mph
Space mean speed for all vehicles,	S = 60.1	mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 EB
Junction:	SB Hazel Avenue Loop On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	1415	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	831	vph
Length of first accel/decel lane	350	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	1609	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1340	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1415	831	1609	vph
Peak-hour factor, PHF	0.91	0.91	0.91	
Peak 15-min volume, v15	389	228	442	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

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Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	1602	941	1821	pcph

Estimation of V12 Merge Areas

L_{EQ} = 127.80 (Equation 13-6 or 13-7)

P_{FM} = 0.587 Using Equation 3

$v_{12} = v_F (P_{FM}) =$ 941 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	2543	7200	No
v_3 or v_{av34}	661 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		Yes	

If yes, v_{12A} = 941 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	1882	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A =$ 17.5 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable,	M_S = 0.322	
Space mean speed in ramp influence area,	S_R = 61.7	mph
Space mean speed in outer lanes,	S_O = 70.4	mph
Space mean speed for all vehicles,	S = 63.7	mph

DRAFT

HCS 2010: Freeway Weaving Release 6.65

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date Performed:	11/2/2015
Analysis Time Period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 EB
Weaving Location:	Hazel to Aerojet Weave
Analysis Year:	2015
Description:	

Inputs

Segment Type	Freeway	
Weaving configuration	One-Sided	
Number of lanes, N	4	ln
Weaving segment length, LS	640	ft
Freeway free-flow speed, FFS	71	mi/h
Minimum segment speed, SMIN	15	mi/h
Freeway maximum capacity, cIFL	2400	pc/h/ln
Terrain type	Level	
Grade	0.00	%
Length	0.00	mi

Conversion to pc/h Under Base Conditions

	Volume Components				
	VFF	VRF	VFR	VRR	
Volume, V	2983	173	74	0	veh/h
Peak hour factor, PHF	0.91	0.91	0.91	0.91	
Peak 15-min volume, v15	820	48	20	0	
Trucks and buses	6	6	6	6	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	0.971	0.971	0.971	0.971	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	3376	196	84	0	pc/h

Volume ratio, VR	0.077	

Configuration Characteristics

Number of maneuver lanes, NWL	2	ln
Interchange density, ID	0.8	int/mi
Minimum RF lane changes, LCRF	0	lc/pc
Minimum FR lane changes, LCFR	1	lc/pc
Minimum RR lane changes, LCRR		lc/pc
Minimum weaving lane changes, LCMIN	84	lc/h
Weaving lane changes, LCW	268	lc/h
Non-weaving vehicle index, INW	173	
Non-weaving lane change, LCNW	272	lc/h
Total lane changes, LCALL	540	lc/h

Weaving and Non-Weaving Speeds

Weaving intensity factor, W	0.198	

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Average weaving speed, SW	61.8	mi/h
Average non-weaving speed, SNW	66.0	mi/h

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	65.7	mi/h
Weaving segment density, D	13.9	pc/mi/ln
Level of service, LOS	B	
Weaving segment v/c ratio	0.416	
Weaving segment flow rate, v	3550	veh/h
Weaving segment capacity, cW	8524	veh/h

Limitations on Weaving Segments

If limit reached, see note.

	Minimum	Maximum	Actual	Note
Weaving length (ft)	300	3314	640	a,b
		Maximum	Analyzed	
Density-based capacty, cIWL (pc/h/ln)		2400	2195	c
		Maximum	Analyzed	
v/c ratio		1.00	0.416	d

Notes:

a. In weaving segments shorter than 300 ft, weaving vehicles are assumed to make only necessary lane changes.
b. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments."
c. The density-based capacity exceeds the capacity of a basic freeway segment, under equivalent ideal conditions.
d. Volumes exceed the weaving segment capacity. The level of service is F.

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	10/28/2015
Analysis Time Period:	4:45 - 5:45 PM
Freeway/Direction:	US 50 EB
From/To:	Aerojet Road to Folsom Blvd
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	

Flow Inputs and Adjustments

Volume, V	3135	veh/h
Peak-hour factor, PHF	0.91	
Peak 15-min volume, v15	861	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1183	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.33	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.1	mi/h
Free-flow speed, FFS	71.3	mi/h

LOS and Performance Measures

Flow rate, vp	1183	pc/h/ln
Free-flow speed, FFS	71.3	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	3	
Density, D	16.9	pc/mi/ln
Level of service, LOS	B	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 EB
Junction:	Folsom Boulevard Off-ramp
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	71.0	mph
Volume on freeway	3135	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-Flow speed on ramp	40.0	mph
Volume on ramp	1351	vph
Length of first accel/decel lane	0	ft
Length of second accel/decel lane	1500	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	434	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1390	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	3135	1351	434	vph
Peak-hour factor, PHF	0.91	0.91	0.91	
Peak 15-min volume, v15	861	371	119	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	3548	1529	491	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 3548 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	3548	4800	No
$v_{FO} = v_F - v_R$	2019	4800	No
v_R	1529	4200	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	No	

If yes, v_{12A} = 3548 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	3548	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086 v_R - 0.009 L_{12}$ = 21.3 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable,	D_S = 0.501	
Space mean speed in ramp influence area,	S_R = 56.5	mph
Space mean speed in outer lanes,	S_O = N/A	mph
Space mean speed for all vehicles,	S = 56.5	mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 EB
Junction:	Folsom Boulevard On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	71.0	mph
Volume on freeway	1784	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	434	vph
Length of first accel/decel lane	400	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	1351	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1390	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1784	434	1351	vph
Peak-hour factor, PHF	0.91	0.91	0.91	
Peak 15-min volume, v15	490	119	371	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	2019	491	1529	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM}) =$ 2019 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	2510	4800	No

v_3 or v_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 2019 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	2510	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 22.3 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable,	M_S = 0.341	
Space mean speed in ramp influence area,	S_R = 61.1	mph
Space mean speed in outer lanes,	S_O = N/A	mph
Space mean speed for all vehicles,	S = 61.1	mph

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	10/28/2015
Analysis Time Period:	4:45 - 5:45 PM
Freeway/Direction:	US 50 EB
From/To:	Folsom Blvd to Prairie City Rd
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	

Flow Inputs and Adjustments

Volume, V	2149	veh/h
Peak-hour factor, PHF	0.91	
Peak 15-min volume, v15	590	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1216	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.50	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.5	mi/h
Free-flow speed, FFS	70.9	mi/h

LOS and Performance Measures

Flow rate, vp	1216	pc/h/ln
Free-flow speed, FFS	70.9	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	17.4	pc/mi/ln
Level of service, LOS	B	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	11/3/2015
Analysis Time Period:	4:45 - 5:45 PM
Freeway/Direction:	US 50 WB
From/To:	Prairie City Rd to Folsom Blvd
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	

Flow Inputs and Adjustments

Volume, V	2230	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	587	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1209	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.33	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.1	mi/h
Free-flow speed, FFS	71.3	mi/h

LOS and Performance Measures

Flow rate, vp	1209	pc/h/ln
Free-flow speed, FFS	71.3	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	17.3	pc/mi/ln
Level of service, LOS	B	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 WB
Junction:	Folsom Boulevard Off-ramp
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	71.0	mph
Volume on freeway	2230	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	238	vph
Length of first accel/decel lane	0	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	1463	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1800	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2230	238	1463	vph
Peak-hour factor, PHF	0.95	0.95	0.95	
Peak 15-min volume, v15	587	63	385	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	2418	258	1586	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 2418 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	2418	4800	No
$v_{FO} = v_F - v_R$	2160	4800	No
v_R	258	2000	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	No	

If yes, v_{12A} = 2418 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	2418	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 25.0 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable, D_S = 0.451

Space mean speed in ramp influence area, S_R = 57.9 mph

Space mean speed in outer lanes, S_0 = N/A mph

Space mean speed for all vehicles, S = 57.9 mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 WB
Junction:	Folsom Boulevard On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	71.0	mph
Volume on freeway	1992	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	50.0	mph
Volume on ramp	1463	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	238	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1800	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1992	1463	238	vph
Peak-hour factor, PHF	0.95	0.95	0.95	
Peak 15-min volume, v15	524	385	63	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	2160	1586	258	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 2160 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	3746	4800	No

v_3 or v_{av34} = 0 pc/h (Equation 13-14 or 13-17)

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 2160 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	3746	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 24.6 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable,	M_S = 0.336	
Space mean speed in ramp influence area,	S_R = 61.3	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 61.3	mph

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	11/3/2015
Analysis Time Period:	4:45 - 5:45 PM
Freeway/Direction:	US 50 WB
From/To:	Folsom Blvd to Hazel Ave
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	

Flow Inputs and Adjustments

Volume, V	4136	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1088	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1495	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.17	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	3.7	mi/h
Free-flow speed, FFS	71.7	mi/h

LOS and Performance Measures

Flow rate, vp	1495	pc/h/ln
Free-flow speed, FFS	71.7	mi/h
Average passenger-car speed, S	69.0	mi/h
Number of lanes, N	3	
Density, D	21.7	pc/mi/ln
Level of service, LOS	C	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 WB
Junction:	Hazel Avenue Off-ramp
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	4	
Free-flow speed on freeway	71.0	mph
Volume on freeway	4136	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-Flow speed on ramp	40.0	mph
Volume on ramp	992	vph
Length of first accel/decel lane	0	ft
Length of second accel/decel lane	1400	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	353	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1740	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4136	992	353	vph
Peak-hour factor, PHF	0.95	0.95	0.95	
Peak 15-min volume, v15	1088	261	93	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	4484	1076	383	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.260 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 1962 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	4484	9600	No
$v_{FO} = v_F - v_R$	3408	9600	No
v_R	1076	4200	No
v_3 or v_{av34}	1261 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 1962 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	1962	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086 v_R - 0.009 L_D$ = 8.5 pc/mi/ln

Level of service for ramp-freeway junction areas of influence A

Speed Estimation

Intermediate speed variable,	D_S = 0.460	
Space mean speed in ramp influence area,	S_R = 57.7	mph
Space mean speed in outer lanes,	S_O = 76.9	mph
Space mean speed for all vehicles,	S = 67.1	mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 WB
Junction:	NB Hazel Loop On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	3144	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	353	vph
Length of first accel/decel lane	600	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	863	vph
Position of adjacent Ramp	Downstream	
Type of adjacent Ramp	On	
Distance to adjacent Ramp	350	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	3144	353	863	vph
Peak-hour factor, PHF	0.95	0.95	0.95	
Peak 15-min volume, v15	827	93	227	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	3409	383	936	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.594 Using Equation 3

$v_{12} = v_F (P_{FM})$ = 2026 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	3792	7200	No
v_3 or v_{av34}	1383 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		Yes	

If yes, v_{12A} = 2026 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	2409	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 20.3 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable,	M_S = 0.322	
Space mean speed in ramp influence area,	S_R = 61.7	mph
Space mean speed in outer lanes,	S_O = 67.8	mph
Space mean speed for all vehicles,	S = 63.8	mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 WB
Junction:	Folsom Boulevard On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	3497	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	50.0	mph
Volume on ramp	863	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	353	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	On	
Distance to adjacent Ramp	350	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	3497	863	353	vph
Peak-hour factor, PHF	0.95	0.95	0.95	
Peak 15-min volume, v15	920	227	93	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	3791	936	383	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.619 Using Equation 3

$v_{12} = v_F (P_{FM})$ = 2349 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	4727	7200	No
v_3 or v_{av34}	1442 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 Yes

If yes, v_{12A} = 2349 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	3285	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 21.3 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable,	M_S = 0.275	
Space mean speed in ramp influence area,	S_R = 63.0	mph
Space mean speed in outer lanes,	S_O = 67.6	mph
Space mean speed for all vehicles,	S = 64.4	mph

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	11/3/2015
Analysis Time Period:	4:45 - 5:45 PM
Freeway/Direction:	US 50 WB
From/To:	Hazel Ave to Sunrise Blvd
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	

Flow Inputs and Adjustments

Volume, V	3740	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	984	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1352	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.50	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.5	mi/h
Free-flow speed, FFS	70.9	mi/h

LOS and Performance Measures

Flow rate, vp	1352	pc/h/ln
Free-flow speed, FFS	70.9	mi/h
Average passenger-car speed, S	69.7	mi/h
Number of lanes, N	3	
Density, D	19.4	pc/mi/ln
Level of service, LOS	C	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Appendix B2

Existing (2015) with Alternative 1/1A and Alternative 2

HCS2010 Calculations

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	10/28/2015
Analysis Time Period:	7:15 - 8:15 AM
Freeway/Direction:	US 50 EB
From/To:	Sunrise Avenue to Hazel Avenue
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	Alternative 1

Flow Inputs and Adjustments

Volume, V	2788	veh/h
Peak-hour factor, PHF	0.92	
Peak 15-min volume, v15	758	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1040	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.25	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	3.9	mi/h
Free-flow speed, FFS	71.5	mi/h

LOS and Performance Measures

Flow rate, vp	1040	pc/h/ln
Free-flow speed, FFS	71.5	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	3	
Density, D	14.9	pc/mi/ln
Level of service, LOS	B	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 EB
Junction:	Hazel Avenue Off-ramp
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	Alternative 1

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	2788	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-Flow speed on ramp	40.0	mph
Volume on ramp	1306	vph
Length of first accel/decel lane	0	ft
Length of second accel/decel lane	1420	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	896	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1340	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2788	1306	896	vph
Peak-hour factor, PHF	0.92	0.92	0.92	
Peak 15-min volume, v15	758	355	243	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

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Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	3121	1462	1003	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.450 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 2209 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	3121	7200	No
$v_{FO} = v_F - v_R$	1659	7200	No
v_R	1462	4200	No
v_3 or v_{av34}	912 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	No	

If yes, v_{12A} = 2209 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	2209	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 10.5 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable, D_S = 0.495

Space mean speed in ramp influence area, S_R = 56.7 mph

Space mean speed in outer lanes, S_O = 77.9 mph

Space mean speed for all vehicles, S = 61.6 mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 EB
Junction:	SB Hazel Avenue Loop On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	Alternative 1

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	1482	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	896	vph
Length of first accel/decel lane	350	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	1306	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1340	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1482	896	1306	vph
Peak-hour factor, PHF	0.92	0.92	0.92	
Peak 15-min volume, v15	403	243	355	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

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Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	1659	1003	1462	pcph

Estimation of V12 Merge Areas

L_{EQ} = 153.27 (Equation 13-6 or 13-7)

P_{FM} = 0.587 Using Equation 3

$v_{12} = v_F (P_{FM})$ = 974 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	2662	7200	No
v_3 or v_{av34}	685 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		Yes	

If yes, v_{12A} = 974 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	1977	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 18.2 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable,	M_S = 0.325	
Space mean speed in ramp influence area,	S_R = 61.6	mph
Space mean speed in outer lanes,	S_O = 70.3	mph
Space mean speed for all vehicles,	S = 63.6	mph

DRAFT

HCS 2010: Freeway Weaving Release 6.65

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date Performed:	11/2/2015
Analysis Time Period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 EB
Weaving Location:	Hazel to Folsom Weave
Analysis Year:	2015
Description:	Alternative 1

Inputs

Segment Type	Freeway	
Weaving configuration	One-Sided	
Number of lanes, N	4	ln
Weaving segment length, LS	3650	ft
Freeway free-flow speed, FFS	71	mi/h
Minimum segment speed, SMIN	15	mi/h
Freeway maximum capacity, cIFL	2400	pc/h/ln
Terrain type	Level	
Grade	0.00	%
Length	0.00	mi

Conversion to pc/h Under Base Conditions

	Volume Components				
	VFF	VRF	VFR	VRR	
Volume, V	2230	67	1356	30	veh/h
Peak hour factor, PHF	0.92	0.92	0.92	0.92	
Peak 15-min volume, v15	606	18	368	8	
Trucks and buses	6	6	6	6	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	0.971	0.971	0.971	0.971	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	2497	75	1518	34	pc/h

Volume ratio, VR	0.386	

Configuration Characteristics

Number of maneuver lanes, NWL	2	ln
Interchange density, ID	1.2	int/mi
Minimum RF lane changes, LCRF	1	lc/pc
Minimum FR lane changes, LCFR	0	lc/pc
Minimum RR lane changes, LCRR		lc/pc
Minimum weaving lane changes, LCMIN	75	lc/h
Weaving lane changes, LCW	754	lc/h
Non-weaving vehicle index, INW	1109	
Non-weaving lane change, LCNW	1729	lc/h
Total lane changes, LCALL	2483	lc/h

Weaving and Non-Weaving Speeds

Weaving intensity factor, W	0.167	

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Average weaving speed, SW	63.0	mi/h
Average non-weaving speed, SNW	65.5	mi/h

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	64.5	mi/h
Weaving segment density, D	16.0	pc/mi/ln
Level of service, LOS	B	
Weaving segment v/c ratio	0.664	
Weaving segment flow rate, v	4004	veh/h
Weaving segment capacity, cW	6032	veh/h

Limitations on Weaving Segments

If limit reached, see note.

	Minimum	Maximum	Actual	Note
Weaving length (ft)	300	6528	3650	a,b
		Maximum	Analyzed	
Density-based capacty, cIWL (pc/h/ln)		2400	2180	c
		Maximum	Analyzed	
v/c ratio		1.00	0.664	d

Notes:

a. In weaving segments shorter than 300 ft, weaving vehicles are assumed to make only necessary lane changes.

b. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments."

c. The density-based capacity exceeds the capacity of a basic freeway segment, under equivalent ideal conditions.

d. Volumes exceed the weaving segment capacity. The level of service is F.

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 EB
Junction:	Folsom Boulevard On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	Alternative 1

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	2297	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	175	vph
Length of first accel/decel lane	400	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	1386	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1390	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2297	175	1386	vph
Peak-hour factor, PHF	0.92	0.92	0.92	
Peak 15-min volume, v15	624	48	377	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

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Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	2572	196	1552	pcph

Estimation of V12 Merge Areas

L_{EQ} = 198.15 (Equation 13-6 or 13-7)

P_{FM} = 0.589 Using Equation 3

$v_{12} = v_F (P_{FM})$ = 1514 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	2768	7200	No
v_3 or v_{av34}	1058 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 Yes

If yes, v_{12A} = 1514 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	1710	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 16.2 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable,	M_S = 0.315	
Space mean speed in ramp influence area,	S_R = 61.9	mph
Space mean speed in outer lanes,	S_O = 69.0	mph
Space mean speed for all vehicles,	S = 64.4	mph

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	10/28/2015
Analysis Time Period:	7:15 - 8:15 AM
Freeway/Direction:	US 50 EB
From/To:	Folsom Blvd to Prairie City Rd
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	Alternative 1

Flow Inputs and Adjustments

Volume, V	2432	veh/h
Peak-hour factor, PHF	0.92	
Peak 15-min volume, v15	661	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1361	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.33	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.1	mi/h
Free-flow speed, FFS	71.3	mi/h

LOS and Performance Measures

Flow rate, vp	1361	pc/h/ln
Free-flow speed, FFS	71.3	mi/h
Average passenger-car speed, S	69.7	mi/h
Number of lanes, N	2	
Density, D	19.5	pc/mi/ln
Level of service, LOS	C	

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Overall results are not computed when free-flow speed is less than 55 mph.

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Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	11/3/2015
Analysis Time Period:	7:15 - 8:15 AM
Freeway/Direction:	US 50 WB
From/To:	Prairie City Rd to Folsom Blvd
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	Alternative 1

Flow Inputs and Adjustments

Volume, V	2886	veh/h
Peak-hour factor, PHF	0.91	
Peak 15-min volume, v15	793	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1633	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.33	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.1	mi/h
Free-flow speed, FFS	71.3	mi/h

LOS and Performance Measures

Flow rate, vp	1633	pc/h/ln
Free-flow speed, FFS	71.3	mi/h
Average passenger-car speed, S	67.8	mi/h
Number of lanes, N	2	
Density, D	24.1	pc/mi/ln
Level of service, LOS	C	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 WB
Junction:	Folsom Boulevard Off-ramp
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	Alternative 1

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	71.0	mph
Volume on freeway	2886	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	310	vph
Length of first accel/decel lane	0	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	1320	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1800	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2886	310	1320	vph
Peak-hour factor, PHF	0.91	0.91	0.91	
Peak 15-min volume, v15	793	85	363	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

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Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	3267	351	1494	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 3267 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	3267	4800	No
$v_{FO} = v_F - v_R$	2916	4800	No
v_R	351	2000	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	No	

If yes, v_{12A} = 3267 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	3267	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086 v_R - 0.009 L_{12}$ = 32.3 pc/mi/ln

Level of service for ramp-freeway junction areas of influence D

Speed Estimation

Intermediate speed variable,	D_S = 0.460	
Space mean speed in ramp influence area,	S_R = 57.7	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 57.7	mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 WB
Junction:	Folsom Boulevard On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	Alternative 1

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	71.0	mph
Volume on freeway	2576	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	50.0	mph
Volume on ramp	1320	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	310	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1800	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2576	1320	310	vph
Peak-hour factor, PHF	0.91	0.91	0.91	
Peak 15-min volume, v15	708	363	85	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	2916	1494	351	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 2916 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	4410	4800	No

v_3 or v_{av34} = 0 pc/h (Equation 13-14 or 13-17)

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 2916 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	4410	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 29.8 pc/mi/ln

Level of service for ramp-freeway junction areas of influence D

Speed Estimation

Intermediate speed variable,	M_S = 0.492	
Space mean speed in ramp influence area,	S_R = 56.7	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 56.7	mph

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	11/3/2015
Analysis Time Period:	7:15 - 8:15 AM
Freeway/Direction:	US 50 WB
From/To:	Folsom Blvd to Hazel Ave
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	Alternative 1

Flow Inputs and Adjustments

Volume, V	4652	veh/h
Peak-hour factor, PHF	0.91	
Peak 15-min volume, v15	1278	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1755	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.17	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	3.7	mi/h
Free-flow speed, FFS	71.7	mi/h

LOS and Performance Measures

Flow rate, vp	1755	pc/h/ln
Free-flow speed, FFS	71.7	mi/h
Average passenger-car speed, S	66.4	mi/h
Number of lanes, N	3	
Density, D	26.4	pc/mi/ln
Level of service, LOS	D	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 WB
Junction:	Hazel Avenue Off-ramp
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	Alternative 1

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	4	
Free-flow speed on freeway	71.0	mph
Volume on freeway	4652	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-Flow speed on ramp	40.0	mph
Volume on ramp	639	vph
Length of first accel/decel lane	0	ft
Length of second accel/decel lane	1400	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	289	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1740	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4652	639	289	vph
Peak-hour factor, PHF	0.91	0.91	0.91	
Peak 15-min volume, v15	1278	176	79	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	5265	723	327	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.260 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 1904 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	5265	9600	No
$v_{FO} = v_F - v_R$	4542	9600	No
v_R	723	4200	No
v_3 or v_{av34}	1680 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	Yes	

If yes, v_{12A} = 2106 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	2106	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$ = 9.8 pc/mi/ln

Level of service for ramp-freeway junction areas of influence A

Speed Estimation

Intermediate speed variable,	D_S = 0.428	
Space mean speed in ramp influence area,	S_R = 58.6	mph
Space mean speed in outer lanes,	S_O = 75.6	mph
Space mean speed for all vehicles,	S = 67.7	mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 WB
Junction:	NB Hazel Loop On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	Alternative 1

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	4013	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	289	vph
Length of first accel/decel lane	600	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	1550	vph
Position of adjacent Ramp	Downstream	
Type of adjacent Ramp	On	
Distance to adjacent Ramp	350	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4013	289	1550	vph
Peak-hour factor, PHF	0.91	0.91	0.91	
Peak 15-min volume, v15	1102	79	426	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	4542	327	1754	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.594 Using Equation 3

$v_{12} = v_F (P_{FM})$ = 2699 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	4869	7200	No
v_3 or v_{av34}	1843 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 Yes

If yes, v_{12A} = 2699 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	3026	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 25.2 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable,	M_S = 0.359	
Space mean speed in ramp influence area,	S_R = 60.6	mph
Space mean speed in outer lanes,	S_O = 66.2	mph
Space mean speed for all vehicles,	S = 62.6	mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 WB
Junction:	Folsom Boulevard On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	Alternative 1

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	4302	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	50.0	mph
Volume on ramp	1550	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	289	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	On	
Distance to adjacent Ramp	350	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4302	1550	289	vph
Peak-hour factor, PHF	0.91	0.91	0.91	
Peak 15-min volume, v15	1182	426	79	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	4869	1754	327	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.619 Using Equation 3

$v_{12} = v_F (P_{FM}) =$ 3016 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	6623	7200	No
v_3 or v_{av34}	1853 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		Yes	

If yes, v_{12A} = 3016 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	4770	4600	Yes

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A =$ 32.5 pc/mi/ln

Level of service for ramp-freeway junction areas of influence D

Speed Estimation

Intermediate speed variable,	M_S = 0.631	
Space mean speed in ramp influence area,	S_R = 52.7	mph
Space mean speed in outer lanes,	S_O = 66.1	mph
Space mean speed for all vehicles,	S = 55.9	mph

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	11/3/2015
Analysis Time Period:	7:15 - 8:15 AM
Freeway/Direction:	US 50 WB
From/To:	Hazel Ave to Sunrise Blvd
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	Alternative 1

Flow Inputs and Adjustments

Volume, V	5149	veh/h
Peak-hour factor, PHF	0.91	
Peak 15-min volume, v15	1415	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1943	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.50	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.5	mi/h
Free-flow speed, FFS	70.9	mi/h

LOS and Performance Measures

Flow rate, vp	1943	pc/h/ln
Free-flow speed, FFS	70.9	mi/h
Average passenger-car speed, S	63.6	mi/h
Number of lanes, N	3	
Density, D	30.6	pc/mi/ln
Level of service, LOS	D	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

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Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	10/28/2015
Analysis Time Period:	4:45 - 5:45 PM
Freeway/Direction:	US 50 EB
From/To:	Sunrise Avenue to Hazel Avenue
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	Alternative 1

Flow Inputs and Adjustments

Volume, V	3024	veh/h
Peak-hour factor, PHF	0.91	
Peak 15-min volume, v15	831	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1141	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.25	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	3.9	mi/h
Free-flow speed, FFS	71.5	mi/h

LOS and Performance Measures

Flow rate, vp	1141	pc/h/ln
Free-flow speed, FFS	71.5	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	3	
Density, D	16.3	pc/mi/ln
Level of service, LOS	B	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 EB
Junction:	Hazel Avenue Off-ramp
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	Alternative 1

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	3024	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-Flow speed on ramp	40.0	mph
Volume on ramp	1683	vph
Length of first accel/decel lane	0	ft
Length of second accel/decel lane	1420	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	831	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1340	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	3024	1683	831	vph
Peak-hour factor, PHF	0.91	0.91	0.91	
Peak 15-min volume, v15	831	462	228	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	3423	1905	941	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.450 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 2588 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	3423	7200	No
$v_{FO} = v_F - v_R$	1518	7200	No
v_R	1905	4200	No
v_3 or v_{av34}	835 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		No	

If yes, v_{12A} = 2588 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	2588	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 13.7 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable,	D_S = 0.534	
Space mean speed in ramp influence area,	S_R = 55.5	mph
Space mean speed in outer lanes,	S_O = 77.9	mph
Space mean speed for all vehicles,	S = 59.7	mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 EB
Junction:	SB Hazel Avenue Loop On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	Alternative 1

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	1341	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	831	vph
Length of first accel/decel lane	350	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	1683	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1340	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1341	831	1683	vph
Peak-hour factor, PHF	0.91	0.91	0.91	
Peak 15-min volume, v15	368	228	462	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	1518	941	1905	pcph

Estimation of V12 Merge Areas

L_{EQ} = 109.83 (Equation 13-6 or 13-7)

P_{FM} = 0.587 Using Equation 3

$v_{12} = v_F (P_{FM})$ = 892 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	2459	7200	No
v_3 or v_{av34}	626 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		Yes	

If yes, v_{12A} = 892 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	1833	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 17.1 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable,	M_S = 0.321	
Space mean speed in ramp influence area,	S_R = 61.7	mph
Space mean speed in outer lanes,	S_O = 70.5	mph
Space mean speed for all vehicles,	S = 63.7	mph

DRAFT

HCS 2010: Freeway Weaving Release 6.65

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date Performed:	11/2/2015
Analysis Time Period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 EB
Weaving Location:	Hazel to Folsom Weave
Analysis Year:	2015
Description:	Alternative 1

Inputs

Segment Type	Freeway	
Weaving configuration	One-Sided	
Number of lanes, N	4	ln
Weaving segment length, LS	3650	ft
Freeway free-flow speed, FFS	71	mi/h
Minimum segment speed, SMIN	15	mi/h
Freeway maximum capacity, cIFL	2400	pc/h/ln
Terrain type	Level	
Grade	0.00	%
Length	0.00	mi

Conversion to pc/h Under Base Conditions

	Volume Components				
	VFF	VRF	VFR	VRR	
Volume, V	1686	98	1276	75	veh/h
Peak hour factor, PHF	0.91	0.91	0.91	0.91	
Peak 15-min volume, v15	463	27	351	21	
Trucks and buses	6	6	6	6	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	0.971	0.971	0.971	0.971	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	1908	111	1444	85	pc/h

Volume ratio, VR 0.438

Configuration Characteristics

Number of maneuver lanes, NWL	2	ln
Interchange density, ID	1.2	int/mi
Minimum RF lane changes, LCRF	1	lc/pc
Minimum FR lane changes, LCFR	0	lc/pc
Minimum RR lane changes, LCRR		lc/pc
Minimum weaving lane changes, LCMIN	111	lc/h
Weaving lane changes, LCW	790	lc/h
Non-weaving vehicle index, INW	873	
Non-weaving lane change, LCNW	1618	lc/h
Total lane changes, LCALL	2408	lc/h

Weaving and Non-Weaving Speeds

Weaving intensity factor, W 0.163

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Average weaving speed, SW	63.2	mi/h
Average non-weaving speed, SNW	65.9	mi/h

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	64.7	mi/h
Weaving segment density, D	13.7	pc/mi/ln
Level of service, LOS	B	
Weaving segment v/c ratio	0.648	
Weaving segment flow rate, v	3446	veh/h
Weaving segment capacity, cW	5317	veh/h

Limitations on Weaving Segments

If limit reached, see note.

	Minimum	Maximum	Actual	Note
Weaving length (ft)	300	7114	3650	a,b
		Maximum	Analyzed	
Density-based capacty, cIWL (pc/h/ln)		2400	2135	c
		Maximum	Analyzed	
v/c ratio		1.00	0.648	d

Notes:

a. In weaving segments shorter than 300 ft, weaving vehicles are assumed to make only necessary lane changes.

b. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments."

c. The density-based capacity exceeds the capacity of a basic freeway segment, under equivalent ideal conditions.

d. Volumes exceed the weaving segment capacity. The level of service is F.

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 EB
Junction:	Folsom Boulevard On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	Alternative 1

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	1784	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	434	vph
Length of first accel/decel lane	400	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	1351	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1390	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1784	434	1351	vph
Peak-hour factor, PHF	0.91	0.91	0.91	
Peak 15-min volume, v15	490	119	371	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

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Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	2019	491	1529	pcph

Estimation of V12 Merge Areas

L_{EQ} = 142.94 (Equation 13-6 or 13-7)

P_{FM} = 0.589 Using Equation 3

$v_{12} = v_F (P_{FM})$ = 1189 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	2510	7200	No
v_3 or v_{av34}	830 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		Yes	

If yes, v_{12A} = 1189 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	1680	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 15.8 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable,	M_S = 0.314		
Space mean speed in ramp influence area,	S_R = 61.9	mph	
Space mean speed in outer lanes,	S_0 = 69.8	mph	
Space mean speed for all vehicles,	S = 64.3	mph	

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	10/28/2015
Analysis Time Period:	4:45 - 5:45 PM
Freeway/Direction:	US 50 EB
From/To:	Folsom Blvd to Prairie City Rd
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	Alternative 1

Flow Inputs and Adjustments

Volume, V	2149	veh/h
Peak-hour factor, PHF	0.91	
Peak 15-min volume, v15	590	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1216	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.33	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.1	mi/h
Free-flow speed, FFS	71.3	mi/h

LOS and Performance Measures

Flow rate, vp	1216	pc/h/ln
Free-flow speed, FFS	71.3	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	17.4	pc/mi/ln
Level of service, LOS	B	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	11/3/2015
Analysis Time Period:	4:45 - 5:45 PM
Freeway/Direction:	US 50 WB
From/To:	Prairie City Rd to Folsom Blvd
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	Alternative 1

Flow Inputs and Adjustments

Volume, V	2230	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	587	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1209	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.33	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.1	mi/h
Free-flow speed, FFS	71.3	mi/h

LOS and Performance Measures

Flow rate, vp	1209	pc/h/ln
Free-flow speed, FFS	71.3	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	17.3	pc/mi/ln
Level of service, LOS	B	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 WB
Junction:	Folsom Boulevard Off-ramp
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	Alternative 1

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	71.0	mph
Volume on freeway	2230	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	238	vph
Length of first accel/decel lane	0	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	1463	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1800	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2230	238	1463	vph
Peak-hour factor, PHF	0.95	0.95	0.95	
Peak 15-min volume, v15	587	63	385	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	2418	258	1586	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 2418 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	2418	4800	No
$v_{FO} = v_F - v_R$	2160	4800	No
v_R	258	2000	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	No	

If yes, v_{12A} = 2418 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	2418	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 25.0 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable, D_S = 0.451

Space mean speed in ramp influence area, S_R = 57.9 mph

Space mean speed in outer lanes, S_0 = N/A mph

Space mean speed for all vehicles, S = 57.9 mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 WB
Junction:	Folsom Boulevard On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	Alternative 1

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	71.0	mph
Volume on freeway	1992	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	50.0	mph
Volume on ramp	1463	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	238	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1800	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1992	1463	238	vph
Peak-hour factor, PHF	0.95	0.95	0.95	
Peak 15-min volume, v15	524	385	63	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	2160	1586	258	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 2160 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	3746	4800	No

v_3 or v_{av34} = 0 pc/h (Equation 13-14 or 13-17)

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 2160 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	3746	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 24.6 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable,	M_S = 0.336	
Space mean speed in ramp influence area,	S_R = 61.3	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 61.3	mph

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	11/3/2015
Analysis Time Period:	4:45 - 5:45 PM
Freeway/Direction:	US 50 WB
From/To:	Folsom Blvd to Hazel Ave
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	Alternative 1

Flow Inputs and Adjustments

Volume, V	4136	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1088	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1495	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.17	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	3.7	mi/h
Free-flow speed, FFS	71.7	mi/h

LOS and Performance Measures

Flow rate, vp	1495	pc/h/ln
Free-flow speed, FFS	71.7	mi/h
Average passenger-car speed, S	69.0	mi/h
Number of lanes, N	3	
Density, D	21.7	pc/mi/ln
Level of service, LOS	C	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

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Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 WB
Junction:	Hazel Avenue Off-ramp
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	Alternative 1

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	4	
Free-flow speed on freeway	71.0	mph
Volume on freeway	4136	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-Flow speed on ramp	40.0	mph
Volume on ramp	992	vph
Length of first accel/decel lane	0	ft
Length of second accel/decel lane	1400	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	353	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1740	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4136	992	353	vph
Peak-hour factor, PHF	0.95	0.95	0.95	
Peak 15-min volume, v15	1088	261	93	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	4484	1076	383	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.260 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 1962 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	4484	9600	No
$v_{FO} = v_F - v_R$	3408	9600	No
v_R	1076	4200	No
v_3 or v_{av34}	1261 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 1962 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	1962	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086 v_R - 0.009 L_D$ = 8.5 pc/mi/ln

Level of service for ramp-freeway junction areas of influence A

Speed Estimation

Intermediate speed variable,	D_S = 0.460	
Space mean speed in ramp influence area,	S_R = 57.7	mph
Space mean speed in outer lanes,	S_O = 76.9	mph
Space mean speed for all vehicles,	S = 67.1	mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 WB
Junction:	NB Hazel Loop On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	Alternative 1

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	3144	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	353	vph
Length of first accel/decel lane	600	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	863	vph
Position of adjacent Ramp	Downstream	
Type of adjacent Ramp	On	
Distance to adjacent Ramp	350	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	3144	353	863	vph
Peak-hour factor, PHF	0.95	0.95	0.95	
Peak 15-min volume, v15	827	93	227	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	3409	383	936	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.594 Using Equation 3

$v_{12} = v_F (P_{FM})$ = 2026 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	3792	7200	No
v_3 or v_{av34}	1383 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		Yes	

If yes, v_{12A} = 2026 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	2409	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 20.3 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable,	M_S = 0.322	
Space mean speed in ramp influence area,	S_R = 61.7	mph
Space mean speed in outer lanes,	S_O = 67.8	mph
Space mean speed for all vehicles,	S = 63.8	mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 WB
Junction:	Folsom Boulevard On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	Alternative 1

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	3497	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	50.0	mph
Volume on ramp	863	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	353	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	On	
Distance to adjacent Ramp	350	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	3497	863	353	vph
Peak-hour factor, PHF	0.95	0.95	0.95	
Peak 15-min volume, v15	920	227	93	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	3791	936	383	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.619 Using Equation 3

$v_{12} = v_F (P_{FM})$ = 2349 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	4727	7200	No
v_3 or v_{av34}	1442 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 Yes

If yes, v_{12A} = 2349 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	3285	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 21.3 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable,	M_S = 0.275	
Space mean speed in ramp influence area,	S_R = 63.0	mph
Space mean speed in outer lanes,	S_O = 67.6	mph
Space mean speed for all vehicles,	S = 64.4	mph

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	11/3/2015
Analysis Time Period:	4:45 - 5:45 PM
Freeway/Direction:	US 50 WB
From/To:	Hazel Ave to Sunrise Blvd
Jurisdiction:	Caltrans
Analysis Year:	2015
Description:	Alternative 1

Flow Inputs and Adjustments

Volume, V	3740	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	984	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1352	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.50	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.5	mi/h
Free-flow speed, FFS	70.9	mi/h

LOS and Performance Measures

Flow rate, vp	1352	pc/h/ln
Free-flow speed, FFS	70.9	mi/h
Average passenger-car speed, S	69.7	mi/h
Number of lanes, N	3	
Density, D	19.4	pc/mi/ln
Level of service, LOS	C	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Appendix B3

Opening Year (2022) No Build

HCS2010 Calculations

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	12/17/2015
Analysis Time Period:	7:15 - 8:15 AM
Freeway/Direction:	US 50 EB
From/To:	Sunrise Avenue to Hazel Avenue
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	No Build

Flow Inputs and Adjustments

Volume, V	4050	veh/h
Peak-hour factor, PHF	0.92	
Peak 15-min volume, v15	1101	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1511	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.50	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.5	mi/h
Free-flow speed, FFS	70.9	mi/h

LOS and Performance Measures

Flow rate, vp	1511	pc/h/ln
Free-flow speed, FFS	70.9	mi/h
Average passenger-car speed, S	68.9	mi/h
Number of lanes, N	3	
Density, D	21.9	pc/mi/ln
Level of service, LOS	C	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	12/17/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 EB
Junction:	Hazel Avenue Off-ramp
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	No Build

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	4050	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-Flow speed on ramp	40.0	mph
Volume on ramp	1640	vph
Length of first accel/decel lane	0	ft
Length of second accel/decel lane	1420	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	910	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1340	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4050	1640	910	vph
Peak-hour factor, PHF	0.92	0.92	0.92	
Peak 15-min volume, v15	1101	446	247	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	4534	1836	1019	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.450 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 3050 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	4534	7200	No
$v_{FO} = v_F - v_R$	2698	7200	No
v_R	1836	4200	No
v_3 or v_{av34}	1484 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	No	

If yes, v_{12A} = 3050 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	3050	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 17.7 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable,	D_S = 0.528	
Space mean speed in ramp influence area,	S_R = 55.7	mph
Space mean speed in outer lanes,	S_O = 76.0	mph
Space mean speed for all vehicles,	S = 61.0	mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	12/17/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 EB
Junction:	SB Hazel Avenue Loop On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	No Build

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	2410	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	910	vph
Length of first accel/decel lane	350	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	1640	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1340	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2410	910	1640	vph
Peak-hour factor, PHF	0.92	0.92	0.92	
Peak 15-min volume, v15	655	247	446	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	2698	1019	1836	pcph

Estimation of V12 Merge Areas

L_{EQ} = 379.04 (Equation 13-6 or 13-7)

P_{FM} = 0.587 Using Equation 3

$v_{12} = v_F (P_{FM})$ = 1585 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	3717	7200	No
v_3 or v_{av34}	1113 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		Yes	

If yes, v_{12A} = 1585 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	2604	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 23.1 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable,	M_S = 0.349	
Space mean speed in ramp influence area,	S_R = 60.9	mph
Space mean speed in outer lanes,	S_O = 68.8	mph
Space mean speed for all vehicles,	S = 63.0	mph

DRAFT

HCS 2010: Freeway Weaving Release 6.65

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date Performed:	12/17/2015
Analysis Time Period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 EB
Weaving Location:	Hazel to Aerojet Weave
Analysis Year:	2022
Description:	No Build

Inputs

Segment Type	Freeway	
Weaving configuration	One-Sided	
Number of lanes, N	4	ln
Weaving segment length, LS	640	ft
Freeway free-flow speed, FFS	71	mi/h
Minimum segment speed, SMIN	15	mi/h
Freeway maximum capacity, cIFL	2400	pc/h/ln
Terrain type	Level	
Grade	0.00	%
Length	0.00	mi

Conversion to pc/h Under Base Conditions

	Volume Components				
	VFF	VRF	VFR	VRR	
Volume, V	4270	100	300	0	veh/h
Peak hour factor, PHF	0.92	0.92	0.92	0.92	
Peak 15-min volume, v15	1160	27	82	0	
Trucks and buses	6	6	6	6	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	0.971	0.971	0.971	0.971	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	4781	112	336	0	pc/h

Volume ratio, VR	0.086	

Configuration Characteristics

Number of maneuver lanes, NWL	2	ln
Interchange density, ID	0.8	int/mi
Minimum RF lane changes, LCRF	0	lc/pc
Minimum FR lane changes, LCFR	1	lc/pc
Minimum RR lane changes, LCRR		lc/pc
Minimum weaving lane changes, LCMIN	336	lc/h
Weaving lane changes, LCW	520	lc/h
Non-weaving vehicle index, INW	245	
Non-weaving lane change, LCNW	561	lc/h
Total lane changes, LCALL	1081	lc/h

Weaving and Non-Weaving Speeds

Weaving intensity factor, W	0.342	

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Average weaving speed, SW	56.7	mi/h
Average non-weaving speed, SNW	62.3	mi/h

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	61.8	mi/h
Weaving segment density, D	21.2	pc/mi/ln
Level of service, LOS	C	
Weaving segment v/c ratio	0.597	
Weaving segment flow rate, v	5077	veh/h
Weaving segment capacity, cW	8501	veh/h

Limitations on Weaving Segments

If limit reached, see note.

	Minimum	Maximum	Actual	Note
Weaving length (ft)	300	3401	640	a,b
		Maximum	Analyzed	
Density-based capacty, cIWL (pc/h/ln)		2400	2189	c
		Maximum	Analyzed	
v/c ratio		1.00	0.597	d

Notes:

a. In weaving segments shorter than 300 ft, weaving vehicles are assumed to make only necessary lane changes.

b. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments."

c. The density-based capacity exceeds the capacity of a basic freeway segment, under equivalent ideal conditions.

d. Volumes exceed the weaving segment capacity. The level of service is F.

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	12/17/2015
Analysis Time Period:	7:15 - 8:15 AM
Freeway/Direction:	US 50 EB
From/To:	Aerojet Road to Folsom Blvd
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	No Build

Flow Inputs and Adjustments

Volume, V	4370	veh/h
Peak-hour factor, PHF	0.92	
Peak 15-min volume, v15	1187	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1631	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.33	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.1	mi/h
Free-flow speed, FFS	71.3	mi/h

LOS and Performance Measures

Flow rate, vp	1631	pc/h/ln
Free-flow speed, FFS	71.3	mi/h
Average passenger-car speed, S	67.8	mi/h
Number of lanes, N	3	
Density, D	24.0	pc/mi/ln
Level of service, LOS	C	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	12/17/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 EB
Junction:	Folsom Boulevard Off-ramp
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	No Build

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	71.0	mph
Volume on freeway	4370	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-Flow speed on ramp	40.0	mph
Volume on ramp	1420	vph
Length of first accel/decel lane	0	ft
Length of second accel/decel lane	1500	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	200	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1390	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4370	1420	200	vph
Peak-hour factor, PHF	0.92	0.92	0.92	
Peak 15-min volume, v15	1187	386	54	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

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Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	4892	1590	224	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 4892 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	4892	4800	Yes
$v_{FO} = v_F - v_R$	3302	4800	No
v_R	1590	4200	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		No	

If yes, v_{12A} = 4892 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	4892	4400	Yes

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 32.8 pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable, D_S = 0.506

Space mean speed in ramp influence area, S_R = 56.3 mph

Space mean speed in outer lanes, S_O = N/A mph

Space mean speed for all vehicles, S = 56.3 mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	12/17/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 EB
Junction:	Folsom Boulevard On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	No Build

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	71.0	mph
Volume on freeway	2950	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	200	vph
Length of first accel/decel lane	400	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	1420	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1390	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2950	200	1420	vph
Peak-hour factor, PHF	0.92	0.92	0.92	
Peak 15-min volume, v15	802	54	386	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	3303	224	1590	pcph

Estimation of V12 Merge Areas

L_{EQ} = 360.58 (Equation 13-6 or 13-7)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 3303 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	3527	4800	No

v_3 or v_{av34} = 0 pc/h (Equation 13-14 or 13-17)

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 3303 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	3527	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 30.4 pc/mi/ln

Level of service for ramp-freeway junction areas of influence D

Speed Estimation

Intermediate speed variable,	M_S = 0.426	
Space mean speed in ramp influence area,	S_R = 58.7	mph
Space mean speed in outer lanes,	S_O = N/A	mph
Space mean speed for all vehicles,	S = 58.7	mph

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	12/17/2015
Analysis Time Period:	7:15 - 8:15 AM
Freeway/Direction:	US 50 EB
From/To:	Folsom Blvd to Prairie City Rd
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	No Build

Flow Inputs and Adjustments

Volume, V	3100	veh/h
Peak-hour factor, PHF	0.92	
Peak 15-min volume, v15	842	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1735	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.33	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.1	mi/h
Free-flow speed, FFS	71.3	mi/h

LOS and Performance Measures

Flow rate, vp	1735	pc/h/ln
Free-flow speed, FFS	71.3	mi/h
Average passenger-car speed, S	66.7	mi/h
Number of lanes, N	2	
Density, D	26.0+	pc/mi/ln
Level of service, LOS	D	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	12/17/2015
Analysis Time Period:	7:15 - 8:15 AM
Freeway/Direction:	US 50 WB
From/To:	Prairie City Rd to Folsom Blvd
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	No Build

Flow Inputs and Adjustments

Volume, V	3130	veh/h
Peak-hour factor, PHF	0.91	
Peak 15-min volume, v15	860	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1771	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.33	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.1	mi/h
Free-flow speed, FFS	71.3	mi/h

LOS and Performance Measures

Flow rate, vp	1771	pc/h/ln
Free-flow speed, FFS	71.3	mi/h
Average passenger-car speed, S	66.2	mi/h
Number of lanes, N	2	
Density, D	26.7	pc/mi/ln
Level of service, LOS	D	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	12/17/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 WB
Junction:	Folsom Boulevard Off-ramp
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	No Build

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	71.0	mph
Volume on freeway	3130	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	320	vph
Length of first accel/decel lane	0	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	1440	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1800	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	3130	320	1440	vph
Peak-hour factor, PHF	0.91	0.91	0.91	
Peak 15-min volume, v15	860	88	396	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	3543	362	1630	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v - v_F) P_{FD} =$ 3543 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	3543	4800	No
$v_{FO} = v - v_R$	3181	4800	No
v_R	362	2000	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	No	

If yes, v_{12A} = 3543 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	3543	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086\ v_R - 0.009\ L_D =$ 34.7 pc/mi/ln

Level of service for ramp-freeway junction areas of influence D

Speed Estimation

Intermediate speed variable,	D_S = 0.461	
Space mean speed in ramp influence area,	S_R = 57.6	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 57.6	mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	12/17/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 WB
Junction:	Folsom Boulevard On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	No Build

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	71.0	mph
Volume on freeway	2810	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	50.0	mph
Volume on ramp	1440	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	320	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1800	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2810	1440	320	vph
Peak-hour factor, PHF	0.91	0.91	0.91	
Peak 15-min volume, v15	772	396	88	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	3181	1630	362	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 3181 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	4811	4800	Yes

v_3 or v_{av34} = 0 pc/h (Equation 13-14 or 13-17)

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 3181 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	4811	4600	Yes

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 32.8 pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable,	M_S = 0.650	
Space mean speed in ramp influence area,	S_R = 52.1	mph
Space mean speed in outer lanes,	S_O = N/A	mph
Space mean speed for all vehicles,	S = 52.1	mph

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	12/17/2015
Analysis Time Period:	7:15 - 8:15 AM
Freeway/Direction:	US 50 WB
From/To:	Folsom Blvd to Hazel Ave
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	No Build

Flow Inputs and Adjustments

Volume, V	5110	veh/h
Peak-hour factor, PHF	0.91	
Peak 15-min volume, v15	1404	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1928	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.17	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	3.7	mi/h
Free-flow speed, FFS	71.7	mi/h

LOS and Performance Measures

Flow rate, vp	1928	pc/h/ln
Free-flow speed, FFS	71.7	mi/h
Average passenger-car speed, S	63.9	mi/h
Number of lanes, N	3	
Density, D	30.2	pc/mi/ln
Level of service, LOS	D	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	12/17/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 WB
Junction:	Hazel Avenue Off-ramp
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	No Build

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	4	
Free-flow speed on freeway	71.0	mph
Volume on freeway	5110	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-Flow speed on ramp	40.0	mph
Volume on ramp	860	vph
Length of first accel/decel lane	0	ft
Length of second accel/decel lane	1400	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	440	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1740	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	5110	860	440	vph
Peak-hour factor, PHF	0.91	0.91	0.91	
Peak 15-min volume, v15	1404	236	121	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	5784	973	498	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.260 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 2224 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	5784	9600	No
$v_{FO} = v_F - v_R$	4811	9600	No
v_R	973	4200	No
v_3 or v_{av34}	1780 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	Yes	

If yes, v_{12A} = 2313 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	2313	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$ = 11.5 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable,	D_S = 0.451	
Space mean speed in ramp influence area,	S_R = 57.9	mph
Space mean speed in outer lanes,	S_O = 75.0	mph
Space mean speed for all vehicles,	S = 67.1	mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	12/17/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 WB
Junction:	NB Hazel Loop On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	No Build

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	4250	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	440	vph
Length of first accel/decel lane	600	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	1560	vph
Position of adjacent Ramp	Downstream	
Type of adjacent Ramp	On	
Distance to adjacent Ramp	350	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4250	440	1560	vph
Peak-hour factor, PHF	0.91	0.91	0.91	
Peak 15-min volume, v15	1168	121	429	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	4810	498	1766	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.594 Using Equation 3

$v_{12} = v_F (P_{FM})$ = 2859 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	5308	7200	No
v_3 or v_{av34}	1951 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		Yes	

If yes, v_{12A} = 2859 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	3357	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 27.7 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable,	M_S = 0.391		
Space mean speed in ramp influence area,	S_R = 59.7	mph	
Space mean speed in outer lanes,	S_0 = 65.8	mph	
Space mean speed for all vehicles,	S = 61.8	mph	

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	12/17/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 WB
Junction:	Folsom Boulevard On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	No Build

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	4690	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	50.0	mph
Volume on ramp	1560	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	440	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	On	
Distance to adjacent Ramp	350	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4690	1560	440	vph
Peak-hour factor, PHF	0.91	0.91	0.91	
Peak 15-min volume, v15	1288	429	121	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	5308	1766	498	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.619 Using Equation 3

$v_{12} = v_F (P_{FM})$ = 3288 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	7074	7200	No
v_3 or v_{av34}	2020 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		Yes	

If yes, v_{12A} = 3288 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	5054	4600	Yes

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 34.7 pc/mi/ln

Level of service for ramp-freeway junction areas of influence D

Speed Estimation

Intermediate speed variable,	M_S = 0.782	
Space mean speed in ramp influence area,	S_R = 48.3	mph
Space mean speed in outer lanes,	S_O = 65.5	mph
Space mean speed for all vehicles,	S = 52.2	mph

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	12/17/2015
Analysis Time Period:	7:15 - 8:15 AM
Freeway/Direction:	US 50 WB
From/To:	Hazel Ave to Sunrise Blvd
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	No Build

Flow Inputs and Adjustments

Volume, V	5540	veh/h
Peak-hour factor, PHF	0.91	
Peak 15-min volume, v15	1522	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	2090	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.50	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.5	mi/h
Free-flow speed, FFS	70.9	mi/h

LOS and Performance Measures

Flow rate, vp	2090	pc/h/ln
Free-flow speed, FFS	70.9	mi/h
Average passenger-car speed, S	60.8	mi/h
Number of lanes, N	3	
Density, D	34.4	pc/mi/ln
Level of service, LOS	D	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	12/17/2015
Analysis Time Period:	4:45 - 5:45 PM
Freeway/Direction:	US 50 EB
From/To:	Sunrise Avenue to Hazel Avenue
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	No Build

Flow Inputs and Adjustments

Volume, V	4280	veh/h
Peak-hour factor, PHF	0.91	
Peak 15-min volume, v15	1176	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1615	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.50	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.5	mi/h
Free-flow speed, FFS	70.9	mi/h

LOS and Performance Measures

Flow rate, vp	1615	pc/h/ln
Free-flow speed, FFS	70.9	mi/h
Average passenger-car speed, S	68.0	mi/h
Number of lanes, N	3	
Density, D	23.7	pc/mi/ln
Level of service, LOS	C	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	12/17/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 EB
Junction:	Hazel Avenue Off-ramp
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	No Build

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	4280	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-Flow speed on ramp	40.0	mph
Volume on ramp	2460	vph
Length of first accel/decel lane	0	ft
Length of second accel/decel lane	1420	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	860	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1340	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4280	2460	860	vph
Peak-hour factor, PHF	0.91	0.91	0.91	
Peak 15-min volume, v15	1176	676	236	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	4844	2784	973	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.450 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 3711 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	4844	7200	No
$v_{FO} = v_F - v_R$	2060	7200	No
v_R	2784	4200	No
v_3 or v_{av34}	1133 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 3711 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	3711	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 23.4 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable, D_S = 0.614

Space mean speed in ramp influence area, S_R = 53.2 mph

Space mean speed in outer lanes, S_O = 77.4 mph

Space mean speed for all vehicles, S = 57.4 mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	12/17/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 EB
Junction:	SB Hazel Avenue Loop On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	No Build

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	1820	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	860	vph
Length of first accel/decel lane	350	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	2460	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1340	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1820	860	2460	vph
Peak-hour factor, PHF	0.91	0.91	0.91	
Peak 15-min volume, v15	500	236	676	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	2060	973	2784	pcph

Estimation of V12 Merge Areas

L_{EQ} = 232.66 (Equation 13-6 or 13-7)

P_{FM} = 0.587 Using Equation 3

$v_{12} = v_F (P_{FM})$ = 1210 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	3033	7200	No
v_3 or v_{av34}	850 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	Yes	

If yes, v_{12A} = 1210 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	2183	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 19.9 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable,	M_S = 0.331	
Space mean speed in ramp influence area,	S_R = 61.4	mph
Space mean speed in outer lanes,	S_O = 69.7	mph
Space mean speed for all vehicles,	S = 63.5	mph

DRAFT

HCS 2010: Freeway Weaving Release 6.65

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date Performed:	12/17/2015
Analysis Time Period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 EB
Weaving Location:	Hazel to Aerojet Weave
Analysis Year:	2022
Description:	No Build

Inputs

Segment Type	Freeway	
Weaving configuration	One-Sided	
Number of lanes, N	4	ln
Weaving segment length, LS	640	ft
Freeway free-flow speed, FFS	71	mi/h
Minimum segment speed, SMIN	15	mi/h
Freeway maximum capacity, cIFL	2400	pc/h/ln
Terrain type	Level	
Grade	0.00	%
Length	0.00	mi

Conversion to pc/h Under Base Conditions

	Volume Components				
	VFF	VRF	VFR	VRR	
Volume, V	3170	180	140	0	veh/h
Peak hour factor, PHF	0.91	0.91	0.91	0.91	
Peak 15-min volume, v15	871	49	38	0	
Trucks and buses	6	6	6	6	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	0.971	0.971	0.971	0.971	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	3588	204	158	0	pc/h

Volume ratio, VR	0.092	

Configuration Characteristics

Number of maneuver lanes, NWL	2	ln
Interchange density, ID	0.8	int/mi
Minimum RF lane changes, LCRF	0	lc/pc
Minimum FR lane changes, LCFR	1	lc/pc
Minimum RR lane changes, LCRR		lc/pc
Minimum weaving lane changes, LCMIN	158	lc/h
Weaving lane changes, LCW	342	lc/h
Non-weaving vehicle index, INW	184	
Non-weaving lane change, LCNW	316	lc/h
Total lane changes, LCALL	658	lc/h

Weaving and Non-Weaving Speeds

Weaving intensity factor, W	0.231

DRAFT

Average weaving speed, SW	60.5	mi/h
Average non-weaving speed, SNW	65.1	mi/h

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	64.7	mi/h
Weaving segment density, D	15.3	pc/mi/ln
Level of service, LOS	B	
Weaving segment v/c ratio	0.452	
Weaving segment flow rate, v	3836	veh/h
Weaving segment capacity, cW	8482	veh/h

Limitations on Weaving Segments

If limit reached, see note.

	Minimum	Maximum	Actual	Note
Weaving length (ft)	300	3459	640	a,b
		Maximum	Analyzed	
Density-based capacty, cIWL (pc/h/ln)		2400	2184	c
		Maximum	Analyzed	
v/c ratio		1.00	0.452	d

Notes:

a. In weaving segments shorter than 300 ft, weaving vehicles are assumed to make only necessary lane changes.

b. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments."

c. The density-based capacity exceeds the capacity of a basic freeway segment, under equivalent ideal conditions.

d. Volumes exceed the weaving segment capacity. The level of service is F.

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	12/17/2015
Analysis Time Period:	4:45 - 5:45 PM
Freeway/Direction:	US 50 EB
From/To:	Aerojet Road to Folsom Blvd
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	No Build

Flow Inputs and Adjustments

Volume, V	3350	veh/h
Peak-hour factor, PHF	0.91	
Peak 15-min volume, v15	920	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1264	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.33	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.1	mi/h
Free-flow speed, FFS	71.3	mi/h

LOS and Performance Measures

Flow rate, vp	1264	pc/h/ln
Free-flow speed, FFS	71.3	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	3	
Density, D	18.1	pc/mi/ln
Level of service, LOS	C	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	12/17/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 EB
Junction:	Folsom Boulevard Off-ramp
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	No Build

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	71.0	mph
Volume on freeway	3350	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-Flow speed on ramp	40.0	mph
Volume on ramp	1360	vph
Length of first accel/decel lane	0	ft
Length of second accel/decel lane	1500	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	440	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1390	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	3350	1360	440	vph
Peak-hour factor, PHF	0.91	0.91	0.91	
Peak 15-min volume, v15	920	374	121	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

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Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	3792	1539	498	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 3792 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	3792	4800	No
$v_{FO} = v_F - v_R$	2253	4800	No
v_R	1539	4200	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	No	

If yes, v_{12A} = 3792 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	3792	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 23.4 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable, D_S = 0.502

Space mean speed in ramp influence area, S_R = 56.5 mph

Space mean speed in outer lanes, S_0 = N/A mph

Space mean speed for all vehicles, S = 56.5 mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	12/17/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 EB
Junction:	Folsom Boulevard On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	No Build

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	71.0	mph
Volume on freeway	1990	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	440	vph
Length of first accel/decel lane	400	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	1360	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1390	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1990	440	1360	vph
Peak-hour factor, PHF	0.91	0.91	0.91	
Peak 15-min volume, v15	547	121	374	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	2252	498	1539	pcph

Estimation of V12 Merge Areas

L_{EQ} = 194.30 (Equation 13-6 or 13-7)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 2252 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	2750	4800	No

v_3 or v_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 2252 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	2750	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 24.2 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable,	M_S = 0.354	
Space mean speed in ramp influence area,	S_R = 60.7	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 60.7	mph

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	12/17/2015
Analysis Time Period:	4:45 - 5:45 PM
Freeway/Direction:	US 50 EB
From/To:	Folsom Blvd to Prairie City Rd
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	No Build

Flow Inputs and Adjustments

Volume, V	2370	veh/h
Peak-hour factor, PHF	0.91	
Peak 15-min volume, v15	651	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1341	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.33	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.1	mi/h
Free-flow speed, FFS	71.3	mi/h

LOS and Performance Measures

Flow rate, vp	1341	pc/h/ln
Free-flow speed, FFS	71.3	mi/h
Average passenger-car speed, S	69.8	mi/h
Number of lanes, N	2	
Density, D	19.2	pc/mi/ln
Level of service, LOS	C	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	12/17/2015
Analysis Time Period:	4:45 - 5:45 PM
Freeway/Direction:	US 50 WB
From/To:	Prairie City Rd to Folsom Blvd
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	No Build

Flow Inputs and Adjustments

Volume, V	2490	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	655	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1350	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.33	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.1	mi/h
Free-flow speed, FFS	71.3	mi/h

LOS and Performance Measures

Flow rate, vp	1350	pc/h/ln
Free-flow speed, FFS	71.3	mi/h
Average passenger-car speed, S	69.7	mi/h
Number of lanes, N	2	
Density, D	19.4	pc/mi/ln
Level of service, LOS	C	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	12/17/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 WB
Junction:	Folsom Boulevard Off-ramp
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	No Build

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	71.0	mph
Volume on freeway	2490	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	280	vph
Length of first accel/decel lane	0	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	1520	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1800	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2490	280	1520	vph
Peak-hour factor, PHF	0.95	0.95	0.95	
Peak 15-min volume, v15	655	74	400	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	2700	304	1648	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v - v_F) P_{FD}$ = 2700 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	2700	4800	No
$v_{FO} = v - v_R$	2396	4800	No
v_R	304	2000	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	No	

If yes, v_{12A} = 2700 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	2700	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086\, v_R - 0.009\, L_D$ = 27.5 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable,	D_S = 0.455	
Space mean speed in ramp influence area,	S_R = 57.8	mph
Space mean speed in outer lanes,	S_O = N/A	mph
Space mean speed for all vehicles,	S = 57.8	mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	12/17/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 WB
Junction:	Folsom Boulevard On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	No Build

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	71.0	mph
Volume on freeway	2210	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	50.0	mph
Volume on ramp	1520	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	280	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1800	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2210	1520	280	vph
Peak-hour factor, PHF	0.95	0.95	0.95	
Peak 15-min volume, v15	582	400	74	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	2396	1648	304	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 2396 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	4044	4800	No

v_3 or v_{av34} = 0 pc/h (Equation 13-14 or 13-17)

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 2396 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	4044	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 26.9 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable,	M_S = 0.394	
Space mean speed in ramp influence area,	S_R = 59.6	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 59.6	mph

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	12/17/2015
Analysis Time Period:	4:45 - 5:45 PM
Freeway/Direction:	US 50 WB
From/To:	Folsom Blvd to Hazel Ave
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	No Build

Flow Inputs and Adjustments

Volume, V	4400	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1158	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1590	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.17	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	3.7	mi/h
Free-flow speed, FFS	71.7	mi/h

LOS and Performance Measures

Flow rate, vp	1590	pc/h/ln
Free-flow speed, FFS	71.7	mi/h
Average passenger-car speed, S	68.2	mi/h
Number of lanes, N	3	
Density, D	23.3	pc/mi/ln
Level of service, LOS	C	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	12/17/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 WB
Junction:	Hazel Avenue Off-ramp
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	No Build

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	4	
Free-flow speed on freeway	71.0	mph
Volume on freeway	4400	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-Flow speed on ramp	40.0	mph
Volume on ramp	1000	vph
Length of first accel/decel lane	0	ft
Length of second accel/decel lane	1400	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	360	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1740	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4400	1000	360	vph
Peak-hour factor, PHF	0.95	0.95	0.95	
Peak 15-min volume, v15	1158	263	95	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	4771	1084	390	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.260 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 2043 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	4771	9600	No
$v_{FO} = v_F - v_R$	3687	9600	No
v_R	1084	4200	No
v_3 or v_{av34}	1364 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		No	

If yes, v_{12A} = 2043 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	2043	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086 v_R - 0.009 L_{12} = D_D$ 9.2 pc/mi/ln

Level of service for ramp-freeway junction areas of influence A

Speed Estimation

Intermediate speed variable,	D_S = 0.461	
Space mean speed in ramp influence area,	S_R = 57.6	mph
Space mean speed in outer lanes,	S_O = 76.5	mph
Space mean speed for all vehicles,	S = 67.1	mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	12/17/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 WB
Junction:	NB Hazel Loop On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	No Build

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	3400	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	360	vph
Length of first accel/decel lane	600	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	1270	vph
Position of adjacent Ramp	Downstream	
Type of adjacent Ramp	On	
Distance to adjacent Ramp	350	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	3400	360	1270	vph
Peak-hour factor, PHF	0.95	0.95	0.95	
Peak 15-min volume, v15	895	95	334	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	3686	390	1377	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.594 Using Equation 3

$v_{12} = v_F (P_{FM})$ = 2191 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	4076	7200	No
v_3 or v_{av34}	1495 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		Yes	

If yes, v_{12A} = 2191 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	2581	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 21.7 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable,	M_S = 0.331	
Space mean speed in ramp influence area,	S_R = 61.4	mph
Space mean speed in outer lanes,	S_O = 67.4	mph
Space mean speed for all vehicles,	S = 63.5	mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	12/17/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 WB
Junction:	Folsom Boulevard On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	No Build

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	3760	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	50.0	mph
Volume on ramp	1270	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	360	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	On	
Distance to adjacent Ramp	350	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	3760	1270	360	vph
Peak-hour factor, PHF	0.95	0.95	0.95	
Peak 15-min volume, v15	989	334	95	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	4077	1377	390	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.619 Using Equation 3

$v_{12} = v_F (P_{FM})$ = 2526 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	5454	7200	No
v_3 or v_{av34}	1551 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 Yes

If yes, v_{12A} = 2526 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	3903	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 25.9 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable,	M_S = 0.364	
Space mean speed in ramp influence area,	S_R = 60.4	mph
Space mean speed in outer lanes,	S_O = 67.2	mph
Space mean speed for all vehicles,	S = 62.2	mph

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	12/17/2015
Analysis Time Period:	4:45 - 5:45 PM
Freeway/Direction:	US 50 WB
From/To:	Hazel Ave to Sunrise Blvd
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	No Build

Flow Inputs and Adjustments

Volume, V	4470	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1176	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1615	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.50	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.5	mi/h
Free-flow speed, FFS	70.9	mi/h

LOS and Performance Measures

Flow rate, vp	1615	pc/h/ln
Free-flow speed, FFS	70.9	mi/h
Average passenger-car speed, S	68.0	mi/h
Number of lanes, N	3	
Density, D	23.7	pc/mi/ln
Level of service, LOS	C	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Appendix B4

Opening Year (2022) with Alternative 1/1A and Alternative 2

HCS2010 Calculations

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	10/28/2015
Analysis Time Period:	7:15 - 8:15 AM
Freeway/Direction:	US 50 EB
From/To:	Sunrise Avenue to Hazel Avenue
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	Alternative 1

Flow Inputs and Adjustments

Volume, V	4050	veh/h
Peak-hour factor, PHF	0.92	
Peak 15-min volume, v15	1101	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1511	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.25	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	3.9	mi/h
Free-flow speed, FFS	71.5	mi/h

LOS and Performance Measures

Flow rate, vp	1511	pc/h/ln
Free-flow speed, FFS	71.5	mi/h
Average passenger-car speed, S	68.9	mi/h
Number of lanes, N	3	
Density, D	21.9	pc/mi/ln
Level of service, LOS	C	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 EB
Junction:	Hazel Avenue Off-ramp
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	Alternative 1

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	4050	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-Flow speed on ramp	40.0	mph
Volume on ramp	1940	vph
Length of first accel/decel lane	0	ft
Length of second accel/decel lane	1420	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	910	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1340	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4050	1940	910	vph
Peak-hour factor, PHF	0.92	0.92	0.92	
Peak 15-min volume, v15	1101	527	247	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

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Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	4534	2172	1019	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.450 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 3235 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	4534	7200	No
$v_{FO} = v_F - v_R$	2362	7200	No
v_R	2172	4200	No
v_3 or v_{av34}	1299 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		No	

If yes, v_{12A} = 3235 (Equation 13-15, 13-16, 18, or 19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	3235	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 19.3 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable,	D_S = 0.558	
Space mean speed in ramp influence area,	S_R = 54.8	mph
Space mean speed in outer lanes,	S_0 = 76.7	mph
Space mean speed for all vehicles,	S = 59.7	mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 EB
Junction:	SB Hazel Avenue Loop On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	Alternative 1

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	2110	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	910	vph
Length of first accel/decel lane	350	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	1940	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1340	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2110	910	1940	vph
Peak-hour factor, PHF	0.92	0.92	0.92	
Peak 15-min volume, v15	573	247	527	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	2362	1019	2172	pcph

Estimation of V12 Merge Areas

L_{EQ} = 307.13 (Equation 13-6 or 13-7)

P_{FM} = 0.587 Using Equation 3

$v_{12} = v_F (P_{FM})$ = 1387 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	3381	7200	No
v_3 or v_{av34}	975 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		Yes	

If yes, v_{12A} = 1387 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	2406	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 21.6 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable,	M_S = 0.340	
Space mean speed in ramp influence area,	S_R = 61.1	mph
Space mean speed in outer lanes,	S_O = 69.3	mph
Space mean speed for all vehicles,	S = 63.3	mph

DRAFT

HCS 2010: Freeway Weaving Release 6.65

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date Performed:	11/2/2015
Analysis Time Period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 EB
Weaving Location:	Hazel to Folsom Weave
Analysis Year:	2022
Description:	Alternative 1

Inputs

Segment Type	Freeway	
Weaving configuration	One-Sided	
Number of lanes, N	4	ln
Weaving segment length, LS	3650	ft
Freeway free-flow speed, FFS	71	mi/h
Minimum segment speed, SMIN	15	mi/h
Freeway maximum capacity, cIFL	2400	pc/h/ln
Terrain type	Level	
Grade	0.00	%
Length	0.00	mi

Conversion to pc/h Under Base Conditions

	Volume Components				
	VFF	VRF	VFR	VRR	
Volume, V	2880	70	1390	30	veh/h
Peak hour factor, PHF	0.92	0.92	0.92	0.92	
Peak 15-min volume, v15	783	19	378	8	
Trucks and buses	6	6	6	6	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	0.971	0.971	0.971	0.971	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	3224	78	1556	34	pc/h

Volume ratio, VR 0.334

Configuration Characteristics

Number of maneuver lanes, NWL	2	ln
Interchange density, ID	1.2	int/mi
Minimum RF lane changes, LCRF	1	lc/pc
Minimum FR lane changes, LCFR	0	lc/pc
Minimum RR lane changes, LCRR		lc/pc
Minimum weaving lane changes, LCMIN	78	lc/h
Weaving lane changes, LCW	757	lc/h
Non-weaving vehicle index, INW	1427	
Non-weaving lane change, LCNW	1984	lc/h
Total lane changes, LCALL	2741	lc/h

Weaving and Non-Weaving Speeds

Weaving intensity factor, W 0.180

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Average weaving speed, SW	62.4	mi/h
Average non-weaving speed, SNW	64.6	mi/h

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	63.8	mi/h
Weaving segment density, D	19.2	pc/mi/ln
Level of service, LOS	B	
Weaving segment v/c ratio	0.681	
Weaving segment flow rate, v	4750	veh/h
Weaving segment capacity, cW	6976	veh/h

Limitations on Weaving Segments

If limit reached, see note.

	Minimum	Maximum	Actual	Note
Weaving length (ft)	300	5952	3650	a,b
		Maximum	Analyzed	
Density-based capacty, cIWL (pc/h/ln)		2400	2224	c
		Maximum	Analyzed	
v/c ratio		1.00	0.681	d

Notes:

a. In weaving segments shorter than 300 ft, weaving vehicles are assumed to make only necessary lane changes.

b. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments."

c. The density-based capacity exceeds the capacity of a basic freeway segment, under equivalent ideal conditions.

d. Volumes exceed the weaving segment capacity. The level of service is F.

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 EB
Junction:	Folsom Boulevard On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	Alternative 1

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	2950	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	200	vph
Length of first accel/decel lane	400	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	1420	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1390	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2950	200	1420	vph
Peak-hour factor, PHF	0.92	0.92	0.92	
Peak 15-min volume, v15	802	54	386	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

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Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	3303	224	1590	pcph

Estimation of V12 Merge Areas

L_{EQ} = 360.58 (Equation 13-6 or 13-7)

P_{FM} = 0.589 Using Equation 3

$v_{12} = v_F (P_{FM})$ = 1944 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	3527	7200	No
v_3 or v_{av34}	1359 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	Yes	

If yes, v_{12A} = 1944 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	2168	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 19.8 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable,	M_S = 0.327	
Space mean speed in ramp influence area,	S_R = 61.5	mph
Space mean speed in outer lanes,	S_O = 67.9	mph
Space mean speed for all vehicles,	S = 63.8	mph

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	10/28/2015
Analysis Time Period:	7:15 - 8:15 AM
Freeway/Direction:	US 50 EB
From/To:	Folsom Blvd to Prairie City Rd
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	Alternative 1

Flow Inputs and Adjustments

Volume, V	3100	veh/h
Peak-hour factor, PHF	0.92	
Peak 15-min volume, v15	842	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1735	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.33	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.1	mi/h
Free-flow speed, FFS	71.3	mi/h

LOS and Performance Measures

Flow rate, vp	1735	pc/h/ln
Free-flow speed, FFS	71.3	mi/h
Average passenger-car speed, S	66.7	mi/h
Number of lanes, N	2	
Density, D	26.0+	pc/mi/ln
Level of service, LOS	D	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	11/3/2015
Analysis Time Period:	7:15 - 8:15 AM
Freeway/Direction:	US 50 WB
From/To:	Prairie City Rd to Folsom Blvd
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	Alternative 1

Flow Inputs and Adjustments

Volume, V	3130	veh/h
Peak-hour factor, PHF	0.91	
Peak 15-min volume, v15	860	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1771	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.33	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.1	mi/h
Free-flow speed, FFS	71.3	mi/h

LOS and Performance Measures

Flow rate, vp	1771	pc/h/ln
Free-flow speed, FFS	71.3	mi/h
Average passenger-car speed, S	66.2	mi/h
Number of lanes, N	2	
Density, D	26.7	pc/mi/ln
Level of service, LOS	D	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 WB
Junction:	Folsom Boulevard Off-ramp
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	Alternative 1

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	71.0	mph
Volume on freeway	3130	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	320	vph
Length of first accel/decel lane	0	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	1440	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1800	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	3130	320	1440	vph
Peak-hour factor, PHF	0.91	0.91	0.91	
Peak 15-min volume, v15	860	88	396	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	3543	362	1630	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v - v_F) P_{FD} =$ 3543 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	3543	4800	No
$v_{FO} = v - v_R$	3181	4800	No
v_R	362	2000	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	No	

If yes, v_{12A} = 3543 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	3543	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086\ v_R - 0.009\ L_D =$ 34.7 pc/mi/ln

Level of service for ramp-freeway junction areas of influence D

Speed Estimation

Intermediate speed variable,	D_S = 0.461	
Space mean speed in ramp influence area,	S_R = 57.6	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 57.6	mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 WB
Junction:	Folsom Boulevard On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	Alternative 1

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	71.0	mph
Volume on freeway	2810	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	50.0	mph
Volume on ramp	1440	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	320	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1800	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2810	1440	320	vph
Peak-hour factor, PHF	0.91	0.91	0.91	
Peak 15-min volume, v15	772	396	88	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	3181	1630	362	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 3181 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	4811	4800	Yes

v_3 or v_{av34} = 0 pc/h (Equation 13-14 or 13-17)

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 3181 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	4811	4600	Yes

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 32.8 pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable,	M_S = 0.650	
Space mean speed in ramp influence area,	S_R = 52.1	mph
Space mean speed in outer lanes,	S_O = N/A	mph
Space mean speed for all vehicles,	S = 52.1	mph

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	11/3/2015
Analysis Time Period:	7:15 - 8:15 AM
Freeway/Direction:	US 50 WB
From/To:	Folsom Blvd to Hazel Ave
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	Alternative 1

Flow Inputs and Adjustments

Volume, V	5110	veh/h
Peak-hour factor, PHF	0.91	
Peak 15-min volume, v15	1404	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1928	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.17	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	3.7	mi/h
Free-flow speed, FFS	71.7	mi/h

LOS and Performance Measures

Flow rate, vp	1928	pc/h/ln
Free-flow speed, FFS	71.7	mi/h
Average passenger-car speed, S	63.9	mi/h
Number of lanes, N	3	
Density, D	30.2	pc/mi/ln
Level of service, LOS	D	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 WB
Junction:	Hazel Avenue Off-ramp
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	Alternative 1

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	4	
Free-flow speed on freeway	71.0	mph
Volume on freeway	5110	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-Flow speed on ramp	40.0	mph
Volume on ramp	860	vph
Length of first accel/decel lane	0	ft
Length of second accel/decel lane	1400	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	440	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1740	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	5110	860	440	vph
Peak-hour factor, PHF	0.91	0.91	0.91	
Peak 15-min volume, v15	1404	236	121	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	5784	973	498	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.260 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 2224 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	5784	9600	No
$v_{FO} = v_F - v_R$	4811	9600	No
v_R	973	4200	No
v_3 or v_{av34}	1780 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	Yes	

If yes, v_{12A} = 2313 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	2313	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$ = 11.5 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable,	D_S = 0.451	
Space mean speed in ramp influence area,	S_R = 57.9	mph
Space mean speed in outer lanes,	S_O = 75.0	mph
Space mean speed for all vehicles,	S = 67.1	mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 WB
Junction:	NB Hazel Loop On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	Alternative 1

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	4250	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	440	vph
Length of first accel/decel lane	600	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	1560	vph
Position of adjacent Ramp	Downstream	
Type of adjacent Ramp	On	
Distance to adjacent Ramp	350	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4250	440	1560	vph
Peak-hour factor, PHF	0.91	0.91	0.91	
Peak 15-min volume, v15	1168	121	429	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

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Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	4810	498	1766	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.594 Using Equation 3

$v_{12} = v_F (P_{FM})$ = 2859 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	5308	7200	No
v_3 or v_{av34}	1951 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		Yes	

If yes, v_{12A} = 2859 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	3357	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 27.7 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable,	M_S = 0.391		
Space mean speed in ramp influence area,	S_R = 59.7	mph	
Space mean speed in outer lanes,	S_0 = 65.8	mph	
Space mean speed for all vehicles,	S = 61.8	mph	

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 WB
Junction:	Folsom Boulevard On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	Alternative 1

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	4690	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	50.0	mph
Volume on ramp	1560	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	440	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	On	
Distance to adjacent Ramp	350	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4690	1560	440	vph
Peak-hour factor, PHF	0.91	0.91	0.91	
Peak 15-min volume, v15	1288	429	121	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	5308	1766	498	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.619 Using Equation 3

$v_{12} = v_F (P_{FM})$ = 3288 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	7074	7200	No
v_3 or v_{av34}	2020 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		Yes	

If yes, v_{12A} = 3288 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	5054	4600	Yes

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 34.7 pc/mi/ln

Level of service for ramp-freeway junction areas of influence D

Speed Estimation

Intermediate speed variable,	M_S = 0.782	
Space mean speed in ramp influence area,	S_R = 48.3	mph
Space mean speed in outer lanes,	S_O = 65.5	mph
Space mean speed for all vehicles,	S = 52.2	mph

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	11/3/2015
Analysis Time Period:	7:15 - 8:15 AM
Freeway/Direction:	US 50 WB
From/To:	Hazel Ave to Sunrise Blvd
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	Alternative 1

Flow Inputs and Adjustments

Volume, V	5540	veh/h
Peak-hour factor, PHF	0.91	
Peak 15-min volume, v15	1522	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	2090	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.50	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.5	mi/h
Free-flow speed, FFS	70.9	mi/h

LOS and Performance Measures

Flow rate, vp	2090	pc/h/ln
Free-flow speed, FFS	70.9	mi/h
Average passenger-car speed, S	60.8	mi/h
Number of lanes, N	3	
Density, D	34.4	pc/mi/ln
Level of service, LOS	D	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	10/28/2015
Analysis Time Period:	4:45 - 5:45 PM
Freeway/Direction:	US 50 EB
From/To:	Sunrise Avenue to Hazel Avenue
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	Alternative 1

Flow Inputs and Adjustments

Volume, V	4280	veh/h
Peak-hour factor, PHF	0.91	
Peak 15-min volume, v15	1176	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1615	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.25	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	3.9	mi/h
Free-flow speed, FFS	71.5	mi/h

LOS and Performance Measures

Flow rate, vp	1615	pc/h/ln
Free-flow speed, FFS	71.5	mi/h
Average passenger-car speed, S	68.0	mi/h
Number of lanes, N	3	
Density, D	23.7	pc/mi/ln
Level of service, LOS	C	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 EB
Junction:	Hazel Avenue Off-ramp
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	Alternative 1

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	4280	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-Flow speed on ramp	40.0	mph
Volume on ramp	2600	vph
Length of first accel/decel lane	0	ft
Length of second accel/decel lane	1420	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	860	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1340	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4280	2600	860	vph
Peak-hour factor, PHF	0.91	0.91	0.91	
Peak 15-min volume, v15	1176	714	236	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	4844	2943	973	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.450 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 3798 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	4844	7200	No
$v_{FO} = v_F - v_R$	1901	7200	No
v_R	2943	4200	No
v_3 or v_{av34}	1046 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	No	

If yes, v_{12A} = 3798 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	3798	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086 v_R - 0.009 L_D$ = 24.1 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable, D_S = 0.628

Space mean speed in ramp influence area, S_R = 52.8 mph

Space mean speed in outer lanes, S_O = 77.7 mph

Space mean speed for all vehicles, S = 56.7 mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 EB
Junction:	SB Hazel Avenue Loop On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	Alternative 1

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	1680	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	860	vph
Length of first accel/decel lane	350	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	2600	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1340	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1680	860	2600	vph
Peak-hour factor, PHF	0.91	0.91	0.91	
Peak 15-min volume, v15	462	236	714	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	1902	973	2943	pcph

Estimation of V12 Merge Areas

L_{EQ} = 198.85 (Equation 13-6 or 13-7)

P_{FM} = 0.587 Using Equation 3

$v_{12} = v_F (P_{FM})$ = 1117 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	2875	7200	No
v_3 or v_{av34}	785 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	Yes	

If yes, v_{12A} = 1117 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	2090	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$ = 19.1 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable,	M_S = 0.328	
Space mean speed in ramp influence area,	S_R = 61.5	mph
Space mean speed in outer lanes,	S_O = 70.0	mph
Space mean speed for all vehicles,	S = 63.6	mph

DRAFT

HCS 2010: Freeway Weaving Release 6.65

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date Performed:	11/2/2015
Analysis Time Period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 EB
Weaving Location:	Hazel to Folsom Weave
Analysis Year:	2022
Description:	Alternative 1

Inputs

Segment Type	Freeway	
Weaving configuration	One-Sided	
Number of lanes, N	4	ln
Weaving segment length, LS	3650	ft
Freeway free-flow speed, FFS	71	mi/h
Minimum segment speed, SMIN	15	mi/h
Freeway maximum capacity, cIFL	2400	pc/h/ln
Terrain type	Level	
Grade	0.00	%
Length	0.00	mi

Conversion to pc/h Under Base Conditions

	Volume Components				
	VFF	VRF	VFR	VRR	
Volume, V	1880	110	1290	70	veh/h
Peak hour factor, PHF	0.91	0.91	0.91	0.91	
Peak 15-min volume, v15	516	30	354	19	
Trucks and buses	6	6	6	6	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	0.971	0.971	0.971	0.971	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	2128	125	1460	79	pc/h

Volume ratio, VR 0.418

Configuration Characteristics

Number of maneuver lanes, NWL	2	ln
Interchange density, ID	1.2	int/mi
Minimum RF lane changes, LCRF	1	lc/pc
Minimum FR lane changes, LCFR	0	lc/pc
Minimum RR lane changes, LCRR		lc/pc
Minimum weaving lane changes, LCMIN	125	lc/h
Weaving lane changes, LCW	804	lc/h
Non-weaving vehicle index, INW	967	
Non-weaving lane change, LCNW	1663	lc/h
Total lane changes, LCALL	2467	lc/h

Weaving and Non-Weaving Speeds

Weaving intensity factor, W 0.166

DRAFT

Average weaving speed, SW	63.0	mi/h
Average non-weaving speed, SNW	65.5	mi/h

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	64.5	mi/h
Weaving segment density, D	14.7	pc/mi/ln
Level of service, LOS	B	
Weaving segment v/c ratio	0.660	
Weaving segment flow rate, v	3682	veh/h
Weaving segment capacity, cW	5575	veh/h

Limitations on Weaving Segments

If limit reached, see note.

	Minimum	Maximum	Actual	Note
Weaving length (ft)	300	6884	3650	a,b
		Maximum	Analyzed	
Density-based capacty, cIWL (pc/h/ln)		2400	2153	c
		Maximum	Analyzed	
v/c ratio		1.00	0.660	d

Notes:

a. In weaving segments shorter than 300 ft, weaving vehicles are assumed to make only necessary lane changes.

b. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments."

c. The density-based capacity exceeds the capacity of a basic freeway segment, under equivalent ideal conditions.

d. Volumes exceed the weaving segment capacity. The level of service is F.

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 EB
Junction:	Folsom Boulevard On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	Alternative 1

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	1990	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	440	vph
Length of first accel/decel lane	400	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	1360	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1390	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1990	440	1360	vph
Peak-hour factor, PHF	0.91	0.91	0.91	
Peak 15-min volume, v15	547	121	374	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	2252	498	1539	pcph

Estimation of V12 Merge Areas

L_{EQ} = 194.30 (Equation 13-6 or 13-7)

P_{FM} = 0.589 Using Equation 3

$v_{12} = v_F (P_{FM})$ = 1326 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	2750	7200	No
v_3 or v_{av34}	926 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	Yes	

If yes, v_{12A} = 1326 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	1824	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 17.0 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable,	M_S = 0.317	
Space mean speed in ramp influence area,	S_R = 61.8	mph
Space mean speed in outer lanes,	S_O = 69.5	mph
Space mean speed for all vehicles,	S = 64.2	mph

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	10/28/2015
Analysis Time Period:	4:45 - 5:45 PM
Freeway/Direction:	US 50 EB
From/To:	Folsom Blvd to Prairie City Rd
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	Alternative 1

Flow Inputs and Adjustments

Volume, V	2370	veh/h
Peak-hour factor, PHF	0.91	
Peak 15-min volume, v15	651	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1341	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.33	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.1	mi/h
Free-flow speed, FFS	71.3	mi/h

LOS and Performance Measures

Flow rate, vp	1341	pc/h/ln
Free-flow speed, FFS	71.3	mi/h
Average passenger-car speed, S	69.8	mi/h
Number of lanes, N	2	
Density, D	19.2	pc/mi/ln
Level of service, LOS	C	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

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Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	11/3/2015
Analysis Time Period:	4:45 - 5:45 PM
Freeway/Direction:	US 50 WB
From/To:	Prairie City Rd to Folsom Blvd
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	Alternative 1

Flow Inputs and Adjustments

Volume, V	2490	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	655	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1350	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.33	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.1	mi/h
Free-flow speed, FFS	71.3	mi/h

LOS and Performance Measures

Flow rate, vp	1350	pc/h/ln
Free-flow speed, FFS	71.3	mi/h
Average passenger-car speed, S	69.7	mi/h
Number of lanes, N	2	
Density, D	19.4	pc/mi/ln
Level of service, LOS	C	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 WB
Junction:	Folsom Boulevard Off-ramp
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	Alternative 1

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	71.0	mph
Volume on freeway	2490	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	280	vph
Length of first accel/decel lane	0	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	1520	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1800	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2490	280	1520	vph
Peak-hour factor, PHF	0.95	0.95	0.95	
Peak 15-min volume, v15	655	74	400	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

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Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	2700	304	1648	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v - v_F) P_{FD}$ = 2700 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	2700	4800	No
$v_{FO} = v - v_R$	2396	4800	No
v_R	304	2000	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	No	

If yes, v_{12A} = 2700 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	2700	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086\, v_R - 0.009\, L_D$ = 27.5 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable,	D_S = 0.455	
Space mean speed in ramp influence area,	S_R = 57.8	mph
Space mean speed in outer lanes,	S_O = N/A	mph
Space mean speed for all vehicles,	S = 57.8	mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 WB
Junction:	Folsom Boulevard On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	Alternative 1

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	71.0	mph
Volume on freeway	2210	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	50.0	mph
Volume on ramp	1520	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	280	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1800	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2210	1520	280	vph
Peak-hour factor, PHF	0.95	0.95	0.95	
Peak 15-min volume, v15	582	400	74	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	2396	1648	304	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 2396 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	4044	4800	No

v_3 or v_{av34} = 0 pc/h (Equation 13-14 or 13-17)

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 2396 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	4044	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 26.9 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable,	M_S = 0.394	
Space mean speed in ramp influence area,	S_R = 59.6	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 59.6	mph

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	11/3/2015
Analysis Time Period:	4:45 - 5:45 PM
Freeway/Direction:	US 50 WB
From/To:	Folsom Blvd to Hazel Ave
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	Alternative 1

Flow Inputs and Adjustments

Volume, V	4400	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1158	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1590	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.17	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	3.7	mi/h
Free-flow speed, FFS	71.7	mi/h

LOS and Performance Measures

Flow rate, vp	1590	pc/h/ln
Free-flow speed, FFS	71.7	mi/h
Average passenger-car speed, S	68.2	mi/h
Number of lanes, N	3	
Density, D	23.3	pc/mi/ln
Level of service, LOS	C	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 WB
Junction:	Hazel Avenue Off-ramp
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	Alternative 1

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	4	
Free-flow speed on freeway	71.0	mph
Volume on freeway	4400	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-Flow speed on ramp	40.0	mph
Volume on ramp	1000	vph
Length of first accel/decel lane	0	ft
Length of second accel/decel lane	1400	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	360	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1740	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4400	1000	360	vph
Peak-hour factor, PHF	0.95	0.95	0.95	
Peak 15-min volume, v15	1158	263	95	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	4771	1084	390	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.260 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 2043 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	4771	9600	No
$v_{FO} = v_F - v_R$	3687	9600	No
v_R	1084	4200	No
v_3 or v_{av34}	1364 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		No	

If yes, v_{12A} = 2043 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	2043	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086 v_R - 0.009 L_{12} = D_D$ 9.2 pc/mi/ln

Level of service for ramp-freeway junction areas of influence A

Speed Estimation

Intermediate speed variable,	D_S = 0.461	
Space mean speed in ramp influence area,	S_R = 57.6	mph
Space mean speed in outer lanes,	S_O = 76.5	mph
Space mean speed for all vehicles,	S = 67.1	mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 WB
Junction:	NB Hazel Loop On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	Alternative 1

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	3400	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	360	vph
Length of first accel/decel lane	600	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	1270	vph
Position of adjacent Ramp	Downstream	
Type of adjacent Ramp	On	
Distance to adjacent Ramp	350	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	3400	360	1270	vph
Peak-hour factor, PHF	0.95	0.95	0.95	
Peak 15-min volume, v15	895	95	334	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	3686	390	1377	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.594 Using Equation 3

$v_{12} = v_F (P_{FM})$ = 2191 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	4076	7200	No
v_3 or v_{av34}	1495 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		Yes	

If yes, v_{12A} = 2191 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	2581	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 21.7 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable,	M_S = 0.331	
Space mean speed in ramp influence area,	S_R = 61.4	mph
Space mean speed in outer lanes,	S_O = 67.4	mph
Space mean speed for all vehicles,	S = 63.5	mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 WB
Junction:	Folsom Boulevard On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	Alternative 1

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	3760	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	50.0	mph
Volume on ramp	1270	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	360	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	On	
Distance to adjacent Ramp	350	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	3760	1270	360	vph
Peak-hour factor, PHF	0.95	0.95	0.95	
Peak 15-min volume, v15	989	334	95	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	4077	1377	390	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.619 Using Equation 3

$v_{12} = v_F (P_{FM})$ = 2526 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	5454	7200	No
v_3 or v_{av34}	1551 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 Yes

If yes, v_{12A} = 2526 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	3903	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 25.9 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable,	M_S = 0.364	
Space mean speed in ramp influence area,	S_R = 60.4	mph
Space mean speed in outer lanes,	S_O = 67.2	mph
Space mean speed for all vehicles,	S = 62.2	mph

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	11/3/2015
Analysis Time Period:	4:45 - 5:45 PM
Freeway/Direction:	US 50 WB
From/To:	Hazel Ave to Sunrise Blvd
Jurisdiction:	Caltrans
Analysis Year:	2022
Description:	Alternative 1

Flow Inputs and Adjustments

Volume, V	4470	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1176	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1615	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.50	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.5	mi/h
Free-flow speed, FFS	70.9	mi/h

LOS and Performance Measures

Flow rate, vp	1615	pc/h/ln
Free-flow speed, FFS	70.9	mi/h
Average passenger-car speed, S	68.0	mi/h
Number of lanes, N	3	
Density, D	23.7	pc/mi/ln
Level of service, LOS	C	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Appendix B5

Horizon Year (2042) No Build

HCS2010 Calculations

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	10/28/2015
Analysis Time Period:	7:15 - 8:15 AM
Freeway/Direction:	US 50 EB
From/To:	Sunrise Avenue to Hazel Avenue
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	No Build

Flow Inputs and Adjustments

Volume, V	6930	veh/h
Peak-hour factor, PHF	0.92	
Peak 15-min volume, v15	1883	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	2586	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.50	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.5	mi/h
Free-flow speed, FFS	70.9	mi/h

LOS and Performance Measures

Flow rate, vp	2586	pc/h/ln
Free-flow speed, FFS	70.9	mi/h
Average passenger-car speed, S	47.7	mi/h
Number of lanes, N	3	
Density, D	54.2	pc/mi/ln
Level of service, LOS	F	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 EB
Junction:	Hazel Avenue Off-ramp
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	No Build

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	6930	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-Flow speed on ramp	40.0	mph
Volume on ramp	2390	vph
Length of first accel/decel lane	0	ft
Length of second accel/decel lane	1420	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	920	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1340	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	6930	2390	920	vph
Peak-hour factor, PHF	0.92	0.92	0.92	
Peak 15-min volume, v15	1883	649	250	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	7759	2676	1030	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.450 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 4963 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	7759	7200	Yes
$v_{FO} = v_F - v_R$	5083	7200	No
v_R	2676	4200	No
v_3 or v_{av34}	2796 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	Yes	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	No	

If yes, v_{12A} = 5059 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	5059	4400	Yes

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086 v_R - 0.009 L_D$ = 35.0 pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable,	D_S = 0.604	
Space mean speed in ramp influence area,	S_R = 53.5	mph
Space mean speed in outer lanes,	S_O = 71.3	mph
Space mean speed for all vehicles,	S = 58.6	mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 EB
Junction:	SB Hazel Avenue Loop On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	No Build

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	4540	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	920	vph
Length of first accel/decel lane	350	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	2790	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1340	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4540	920	2790	vph
Peak-hour factor, PHF	0.92	0.92	0.92	
Peak 15-min volume, v15	1234	250	758	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

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Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	5083	1030	3124	pcph

Estimation of V12 Merge Areas

L_{EQ} = 891.78 (Equation 13-6 or 13-7)

P_{FM} = 0.587 Using Equation 3

$v_{12} = v_F (P_{FM}) =$ 2985 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	6113	7200	No
v_3 or v_{av34}	2098 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		Yes	

If yes, v_{12A} = 2985 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	4015	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A =$ 34.1 pc/mi/ln

Level of service for ramp-freeway junction areas of influence D

Speed Estimation

Intermediate speed variable,	M_S = 0.513	
Space mean speed in ramp influence area,	S_R = 56.1	mph
Space mean speed in outer lanes,	S_O = 65.2	mph
Space mean speed for all vehicles,	S = 59.0	mph

DRAFT

HCS 2010: Freeway Weaving Release 6.65

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date Performed:	11/2/2015
Analysis Time Period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 EB
Weaving Location:	Hazel to Aerojet Weave
Analysis Year:	2042
Description:	No Build

Inputs

Segment Type	Freeway	
Weaving configuration	One-Sided	
Number of lanes, N	4	ln
Weaving segment length, LS	640	ft
Freeway free-flow speed, FFS	71	mi/h
Minimum segment speed, SMIN	15	mi/h
Freeway maximum capacity, cIFL	2400	pc/h/ln
Terrain type	Level	
Grade	0.00	%
Length	0.00	mi

Conversion to pc/h Under Base Conditions

	Volume Components				
	VFF	VRF	VFR	VRR	
Volume, V	5300	340	400	0	veh/h
Peak hour factor, PHF	0.92	0.92	0.92	0.92	
Peak 15-min volume, v15	1440	92	109	0	
Trucks and buses	6	6	6	6	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	0.971	0.971	0.971	0.971	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	5934	381	448	0	pc/h

Volume ratio, VR	0.123	

Configuration Characteristics

Number of maneuver lanes, NWL	2	ln
Interchange density, ID	0.8	int/mi
Minimum RF lane changes, LCRF	0	lc/pc
Minimum FR lane changes, LCFR	1	lc/pc
Minimum RR lane changes, LCRR		lc/pc
Minimum weaving lane changes, LCMIN	448	lc/h
Weaving lane changes, LCW	632	lc/h
Non-weaving vehicle index, INW	304	
Non-weaving lane change, LCNW	799	lc/h
Total lane changes, LCALL	1431	lc/h

Weaving and Non-Weaving Speeds

Weaving intensity factor, W	0.426	

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Average weaving speed, SW	54.3	mi/h
Average non-weaving speed, SNW	59.7	mi/h

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	58.9	mi/h
Weaving segment density, D	28.7	pc/mi/ln
Level of service, LOS	D	
Weaving segment v/c ratio	0.782	
Weaving segment flow rate, v	6566	veh/h
Weaving segment capacity, cW	8392	veh/h

Limitations on Weaving Segments

If limit reached, see note.

	Minimum	Maximum	Actual	Note
Weaving length (ft)	300	3760	640	a,b
		Maximum	Analyzed	
Density-based capacty, cIWL (pc/h/ln)		2400	2161	c
		Maximum	Analyzed	
v/c ratio		1.00	0.782	d

Notes:

a. In weaving segments shorter than 300 ft, weaving vehicles are assumed to make only necessary lane changes.

b. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments."

c. The density-based capacity exceeds the capacity of a basic freeway segment, under equivalent ideal conditions.

d. Volumes exceed the weaving segment capacity. The level of service is F.

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	10/28/2015
Analysis Time Period:	7:15 - 8:15 AM
Freeway/Direction:	US 50 EB
From/To:	Aerojet Road to Folsom Blvd
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	No Build

Flow Inputs and Adjustments

Volume, V	5720	veh/h
Peak-hour factor, PHF	0.92	
Peak 15-min volume, v15	1554	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	2135	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.33	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.1	mi/h
Free-flow speed, FFS	71.3	mi/h

LOS and Performance Measures

Flow rate, vp	2135	pc/h/ln
Free-flow speed, FFS	71.3	mi/h
Average passenger-car speed, S	59.9	mi/h
Number of lanes, N	3	
Density, D	35.7	pc/mi/ln
Level of service, LOS	E	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 EB
Junction:	Folsom Boulevard Off-ramp
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	No Build

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	71.0	mph
Volume on freeway	5720	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-Flow speed on ramp	40.0	mph
Volume on ramp	1520	vph
Length of first accel/decel lane	0	ft
Length of second accel/decel lane	1500	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	210	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1390	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	5720	1520	210	vph
Peak-hour factor, PHF	0.92	0.92	0.92	
Peak 15-min volume, v15	1554	413	57	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	6404	1702	235	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 6404 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	6404	4800	Yes
$v_{FO} = v_F - v_R$	4702	4800	No
v_R	1702	4200	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	No	

If yes, v_{12A} = 6404 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	6404	4400	Yes

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086 v_R - 0.009 L_D$ = 45.8 pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable,	D_S = 0.516	
Space mean speed in ramp influence area,	S_R = 56.0	mph
Space mean speed in outer lanes,	S_O = N/A	mph
Space mean speed for all vehicles,	S = 56.0	mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 EB
Junction:	Folsom Boulevard On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	No Build

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	71.0	mph
Volume on freeway	4200	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	210	vph
Length of first accel/decel lane	400	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	1520	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1390	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4200	210	1520	vph
Peak-hour factor, PHF	0.92	0.92	0.92	
Peak 15-min volume, v15	1141	57	413	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	4702	235	1702	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 4702 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	4937	4800	Yes

v_3 or v_{av34} = 0 pc/h (Equation 13-14 or 13-17)

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 4702 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	4937	4600	Yes

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 41.4 pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable,	M_S = 0.836	
Space mean speed in ramp influence area,	S_R = 46.7	mph
Space mean speed in outer lanes,	S_O = N/A	mph
Space mean speed for all vehicles,	S = 46.7	mph

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	10/28/2015
Analysis Time Period:	7:15 - 8:15 AM
Freeway/Direction:	US 50 EB
From/To:	Folsom Blvd to Prairie City Rd
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	No Build

Flow Inputs and Adjustments

Volume, V	4680	veh/h
Peak-hour factor, PHF	0.92	
Peak 15-min volume, v15	1272	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	2620	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.50	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.5	mi/h
Free-flow speed, FFS	70.9	mi/h

LOS and Performance Measures

Flow rate, vp	2620	pc/h/ln
Free-flow speed, FFS	70.9	mi/h
Average passenger-car speed, S	46.6	mi/h
Number of lanes, N	2	
Density, D	56.2	pc/mi/ln
Level of service, LOS	F	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	11/3/2015
Analysis Time Period:	7:15 - 8:15 AM
Freeway/Direction:	US 50 WB
From/To:	Prairie City Rd to Folsom Blvd
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	No Build

Flow Inputs and Adjustments

Volume, V	4080	veh/h
Peak-hour factor, PHF	0.91	
Peak 15-min volume, v15	1121	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	2309	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.33	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.1	mi/h
Free-flow speed, FFS	71.3	mi/h

LOS and Performance Measures

Flow rate, vp	2309	pc/h/ln
Free-flow speed, FFS	71.3	mi/h
Average passenger-car speed, S	55.7	mi/h
Number of lanes, N	2	
Density, D	41.4	pc/mi/ln
Level of service, LOS	E	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 WB
Junction:	Folsom Boulevard Off-ramp
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	No Build

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	71.0	mph
Volume on freeway	4080	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	330	vph
Length of first accel/decel lane	0	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	1630	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1800	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4080	330	1630	vph
Peak-hour factor, PHF	0.91	0.91	0.91	
Peak 15-min volume, v15	1121	91	448	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	4618	374	1845	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 4618 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	4618	4800	No
$v_{FO} = v_F - v_R$	4244	4800	No
v_R	374	2000	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	No	

If yes, v_{12A} = 4618 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	4618	4400	Yes

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086\ v_R - 0.009\ L_D$ = 44.0 pc/mi/ln

Level of service for ramp-freeway junction areas of influence E

Speed Estimation

Intermediate speed variable,	D_S = 0.462	
Space mean speed in ramp influence area,	S_R = 57.6	mph
Space mean speed in outer lanes,	S_O = N/A	mph
Space mean speed for all vehicles,	S = 57.6	mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 WB
Junction:	Folsom Boulevard On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	No Build

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	71.0	mph
Volume on freeway	3750	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	50.0	mph
Volume on ramp	1630	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	330	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1800	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	3750	1630	330	vph
Peak-hour factor, PHF	0.91	0.91	0.91	
Peak 15-min volume, v15	1030	448	91	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	4245	1845	374	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM}) =$ 4245 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	6090	4800	Yes

v_3 or v_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 4245 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	6090	4600	Yes

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A =$ 42.7 pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable,	M_S = 1.893	
Space mean speed in ramp influence area,	S_R = 16.1	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 16.1	mph

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	11/3/2015
Analysis Time Period:	7:15 - 8:15 AM
Freeway/Direction:	US 50 WB
From/To:	Folsom Blvd to Hazel Ave
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	No Build

Flow Inputs and Adjustments

Volume, V	5100	veh/h
Peak-hour factor, PHF	0.91	
Peak 15-min volume, v15	1401	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1924	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.17	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	3.7	mi/h
Free-flow speed, FFS	71.7	mi/h

LOS and Performance Measures

Flow rate, vp	1924	pc/h/ln
Free-flow speed, FFS	71.7	mi/h
Average passenger-car speed, S	63.9	mi/h
Number of lanes, N	3	
Density, D	30.1	pc/mi/ln
Level of service, LOS	D	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

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Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 WB
Junction:	Hazel Avenue Off-ramp
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	No Build

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	4	
Free-flow speed on freeway	71.0	mph
Volume on freeway	5100	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-Flow speed on ramp	40.0	mph
Volume on ramp	940	vph
Length of first accel/decel lane	0	ft
Length of second accel/decel lane	1400	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	700	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1740	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	5100	940	700	vph
Peak-hour factor, PHF	0.91	0.91	0.91	
Peak 15-min volume, v15	1401	258	192	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	5773	1064	792	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.260 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 2288 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	5773	9600	No
$v_{FO} = v_F - v_R$	4709	9600	No
v_R	1064	4200	No
v_3 or v_{av34}	1742 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		Yes	

If yes, v_{12A} = 2309 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	2309	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086\, v_R - 0.009\, v_{12} - L_D$ = 11.5 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable,	D_S = 0.459	
Space mean speed in ramp influence area,	S_R = 57.7	mph
Space mean speed in outer lanes,	S_0 = 75.0	mph
Space mean speed for all vehicles,	S = 67.0	mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 WB
Junction:	NB Hazel Loop On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	No Build

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	4160	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	700	vph
Length of first accel/decel lane	600	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	1570	vph
Position of adjacent Ramp	Downstream	
Type of adjacent Ramp	On	
Distance to adjacent Ramp	350	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4160	700	1570	vph
Peak-hour factor, PHF	0.91	0.91	0.91	
Peak 15-min volume, v15	1143	192	431	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

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Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	4709	792	1777	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.594 Using Equation 3

$v_{12} = v_F (P_{FM})$ = 2799 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	5501	7200	No
v_3 or v_{av34}	1910 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		Yes	

If yes, v_{12A} = 2799 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	3591	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 29.4 pc/mi/ln

Level of service for ramp-freeway junction areas of influence D

Speed Estimation

Intermediate speed variable,	M_S = 0.420	
Space mean speed in ramp influence area,	S_R = 58.8	mph
Space mean speed in outer lanes,	S_O = 65.9	mph
Space mean speed for all vehicles,	S = 61.1	mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 WB
Junction:	Folsom Boulevard On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	No Build

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	4860	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	50.0	mph
Volume on ramp	1570	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	700	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	On	
Distance to adjacent Ramp	350	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4860	1570	700	vph
Peak-hour factor, PHF	0.91	0.91	0.91	
Peak 15-min volume, v15	1335	431	192	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

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Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	5501	1777	792	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.619 Using Equation 3

$v_{12} = v_F (P_{FM}) =$ 3408 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	7278	7200	Yes
v_3 or v_{av34}	2093 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		Yes	

If yes, v_{12A} = 3408 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	5185	4600	Yes

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A =$ 35.7 pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable,	M_S = 0.867	
Space mean speed in ramp influence area,	S_R = 45.8	mph
Space mean speed in outer lanes,	S_0 = 65.3	mph
Space mean speed for all vehicles,	S = 50.1	mph

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	11/3/2015
Analysis Time Period:	7:15 - 8:15 AM
Freeway/Direction:	US 50 WB
From/To:	Hazel Ave to Sunrise Blvd
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	No Build

Flow Inputs and Adjustments

Volume, V	6150	veh/h
Peak-hour factor, PHF	0.91	
Peak 15-min volume, v15	1690	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	2320	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.50	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.5	mi/h
Free-flow speed, FFS	70.9	mi/h

LOS and Performance Measures

Flow rate, vp	2320	pc/h/ln
Free-flow speed, FFS	70.9	mi/h
Average passenger-car speed, S	55.4	mi/h
Number of lanes, N	3	
Density, D	41.8	pc/mi/ln
Level of service, LOS	E	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

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Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	10/28/2015
Analysis Time Period:	4:45 - 5:45 PM
Freeway/Direction:	US 50 EB
From/To:	Sunrise Avenue to Hazel Avenue
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	No Build

Flow Inputs and Adjustments

Volume, V	7130	veh/h
Peak-hour factor, PHF	0.91	
Peak 15-min volume, v15	1959	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	2690	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.50	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.5	mi/h
Free-flow speed, FFS	70.9	mi/h

LOS and Performance Measures

Flow rate, vp	2690	pc/h/ln
Free-flow speed, FFS	70.9	mi/h
Average passenger-car speed, S	44.2	mi/h
Number of lanes, N	3	
Density, D	60.8	pc/mi/ln
Level of service, LOS	F	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 EB
Junction:	Hazel Avenue Off-ramp
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	No Build

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	7130	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-Flow speed on ramp	40.0	mph
Volume on ramp	2870	vph
Length of first accel/decel lane	0	ft
Length of second accel/decel lane	1420	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	920	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1340	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	7130	2870	920	vph
Peak-hour factor, PHF	0.91	0.91	0.91	
Peak 15-min volume, v15	1959	788	253	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	8070	3248	1041	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.450 Using Equation 0

$v_{12} = v_R + (v - v_F) P_{FD}$ = 5418 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	8070	7200	Yes
$v_{FO} = v - v_F - v_R$	4822	7200	No
v_R	3248	4200	No
v_3 or v_{av34}	2652 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	No	

If yes, v_{12A} = 5418 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	5418	4400	Yes

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$ = 38.1 pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable,	D_S = 0.655	
Space mean speed in ramp influence area,	S_R = 52.0	mph
Space mean speed in outer lanes,	S_0 = 71.4	mph
Space mean speed for all vehicles,	S = 57.1	mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 EB
Junction:	SB Hazel Avenue Loop On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	No Build

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	4260	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	920	vph
Length of first accel/decel lane	350	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	3180	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1340	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4260	920	3180	vph
Peak-hour factor, PHF	0.91	0.91	0.91	
Peak 15-min volume, v15	1170	253	874	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	4822	1041	3599	pcph

Estimation of V12 Merge Areas

L_{EQ} = 838.28 (Equation 13-6 or 13-7)

P_{FM} = 0.587 Using Equation 3

$v_{12} = v_F (P_{FM})$ = 2832 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	5863	7200	No
v_3 or v_{av34}	1990 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	Yes	

If yes, v_{12A} = 2832 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	3873	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$ = 33.0 pc/mi/ln

Level of service for ramp-freeway junction areas of influence D

Speed Estimation

Intermediate speed variable,	M_S = 0.484	
Space mean speed in ramp influence area,	S_R = 57.0	mph
Space mean speed in outer lanes,	S_O = 65.6	mph
Space mean speed for all vehicles,	S = 59.6	mph

DRAFT

HCS 2010: Freeway Weaving Release 6.65

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date Performed:	11/2/2015
Analysis Time Period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 EB
Weaving Location:	Hazel to Aerojet Weave
Analysis Year:	2042
Description:	No Build

Inputs

Segment Type	Freeway	
Weaving configuration	One-Sided	
Number of lanes, N	4	ln
Weaving segment length, LS	640	ft
Freeway free-flow speed, FFS	71	mi/h
Minimum segment speed, SMIN	15	mi/h
Freeway maximum capacity, cIFL	2400	pc/h/ln
Terrain type	Level	
Grade	0.00	%
Length	0.00	mi

Conversion to pc/h Under Base Conditions

	Volume Components				
	VFF	VRF	VFR	VRR	
Volume, V	5210	370	310	0	veh/h
Peak hour factor, PHF	0.91	0.91	0.91	0.91	
Peak 15-min volume, v15	1431	102	85	0	
Trucks and buses	6	6	6	6	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	0.971	0.971	0.971	0.971	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	5897	419	351	0	pc/h

Volume ratio, VR	0.115	

Configuration Characteristics

Number of maneuver lanes, NWL	2	ln
Interchange density, ID	0.8	int/mi
Minimum RF lane changes, LCRF	0	lc/pc
Minimum FR lane changes, LCFR	1	lc/pc
Minimum RR lane changes, LCRR		lc/pc
Minimum weaving lane changes, LCMIN	351	lc/h
Weaving lane changes, LCW	535	lc/h
Non-weaving vehicle index, INW	302	
Non-weaving lane change, LCNW	791	lc/h
Total lane changes, LCALL	1326	lc/h

Weaving and Non-Weaving Speeds

Weaving intensity factor, W	0.402

DRAFT

Average weaving speed, SW	55.0	mi/h
Average non-weaving speed, SNW	60.5	mi/h

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	59.8	mi/h
Weaving segment density, D	27.9	pc/mi/ln
Level of service, LOS	C	
Weaving segment v/c ratio	0.769	
Weaving segment flow rate, v	6473	veh/h
Weaving segment capacity, cW	8416	veh/h

Limitations on Weaving Segments

If limit reached, see note.

	Minimum	Maximum	Actual	Note
Weaving length (ft)	300	3691	640	a,b
		Maximum	Analyzed	
Density-based capacty, cIWL (pc/h/ln)		2400	2167	c
		Maximum	Analyzed	
v/c ratio		1.00	0.769	d

Notes:

a. In weaving segments shorter than 300 ft, weaving vehicles are assumed to make only necessary lane changes.
b. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments."
c. The density-based capacity exceeds the capacity of a basic freeway segment, under equivalent ideal conditions.
d. Volumes exceed the weaving segment capacity. The level of service is F.

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	10/28/2015
Analysis Time Period:	4:45 - 5:45 PM
Freeway/Direction:	US 50 EB
From/To:	Aerojet Road to Folsom Blvd
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	No Build

Flow Inputs and Adjustments

Volume, V	5640	veh/h
Peak-hour factor, PHF	0.91	
Peak 15-min volume, v15	1549	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	2128	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.33	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.1	mi/h
Free-flow speed, FFS	71.3	mi/h

LOS and Performance Measures

Flow rate, vp	2128	pc/h/ln
Free-flow speed, FFS	71.3	mi/h
Average passenger-car speed, S	60.0	mi/h
Number of lanes, N	3	
Density, D	35.5	pc/mi/ln
Level of service, LOS	E	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 EB
Junction:	Folsom Boulevard Off-ramp
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	No Build

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	71.0	mph
Volume on freeway	5640	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-Flow speed on ramp	40.0	mph
Volume on ramp	1370	vph
Length of first accel/decel lane	0	ft
Length of second accel/decel lane	1500	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	450	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1390	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp		
Volume, V (vph)	5640		1370		450		vph
Peak-hour factor, PHF	0.91		0.91		0.91		
Peak 15-min volume, v15	1549		376		124		v
Trucks and buses	6		6		6		%
Recreational vehicles	0		0		0		%
Terrain type:	Level		Level		Level		
Grade	0.00	%	0.00	%	0.00	%	
Length	0.00	mi	0.00	mi	0.00	mi	
Trucks and buses PCE, ET	1.5		1.5		1.5		
Recreational vehicle PCE, ER	1.2		1.2		1.2		

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	6384	1551	509	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 6384 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	6384	4800	Yes
$v_{FO} = v_F - v_R$	4833	4800	Yes
v_R	1551	4200	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	No	

If yes, v_{12A} = 6384 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	6384	4400	Yes

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 45.7 pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable,	D_S = 0.503	
Space mean speed in ramp influence area,	S_R = 56.4	mph
Space mean speed in outer lanes,	S_O = N/A	mph
Space mean speed for all vehicles,	S = 56.4	mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 EB
Junction:	Folsom Boulevard On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	No Build

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	71.0	mph
Volume on freeway	4270	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	450	vph
Length of first accel/decel lane	400	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	1370	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1390	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4270	450	1370	vph
Peak-hour factor, PHF	0.91	0.91	0.91	
Peak 15-min volume, v15	1173	124	376	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	4833	509	1551	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 4833 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	5342	4800	Yes

v_3 or v_{av34} = 0 pc/h (Equation 13-14 or 13-17)

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 4833 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	5342	4600	Yes

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 44.4 pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable,	M_S = 1.108	
Space mean speed in ramp influence area,	S_R = 38.9	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 38.9	mph

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	10/28/2015
Analysis Time Period:	4:45 - 5:45 PM
Freeway/Direction:	US 50 EB
From/To:	Folsom Blvd to Prairie City Rd
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	No Build

Flow Inputs and Adjustments

Volume, V	4910	veh/h
Peak-hour factor, PHF	0.91	
Peak 15-min volume, v15	1349	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	2779	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.50	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.5	mi/h
Free-flow speed, FFS	70.9	mi/h

LOS and Performance Measures

Flow rate, vp	2779	pc/h/ln
Free-flow speed, FFS	70.9	mi/h
Average passenger-car speed, S	41.1	mi/h
Number of lanes, N	2	
Density, D	67.7	pc/mi/ln
Level of service, LOS	F	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	11/3/2015
Analysis Time Period:	4:45 - 5:45 PM
Freeway/Direction:	US 50 WB
From/To:	Prairie City Rd to Folsom Blvd
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	No Build

Flow Inputs and Adjustments

Volume, V	4690	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1234	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	2542	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.33	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.1	mi/h
Free-flow speed, FFS	71.3	mi/h

LOS and Performance Measures

Flow rate, vp	2542	pc/h/ln
Free-flow speed, FFS	71.3	mi/h
Average passenger-car speed, S	49.1	mi/h
Number of lanes, N	2	
Density, D	51.8	pc/mi/ln
Level of service, LOS	F	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 WB
Junction:	Folsom Boulevard Off-ramp
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	No Build

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	71.0	mph
Volume on freeway	4690	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	320	vph
Length of first accel/decel lane	0	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	1630	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1800	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4690	320	1630	vph
Peak-hour factor, PHF	0.95	0.95	0.95	
Peak 15-min volume, v15	1234	84	429	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	5085	347	1767	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 5085 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	5085	4800	Yes
$v_{FO} = v_F - v_R$	4738	4800	No
v_R	347	2000	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	No	

If yes, v_{12A} = 5085 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	5085	4400	Yes

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086 v_R - 0.009 L_D$ = 48.0 pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable,	D_S = 0.459	
Space mean speed in ramp influence area,	S_R = 57.7	mph
Space mean speed in outer lanes,	S_O = N/A	mph
Space mean speed for all vehicles,	S = 57.7	mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 WB
Junction:	Folsom Boulevard On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	No Build

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	71.0	mph
Volume on freeway	4370	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	50.0	mph
Volume on ramp	1630	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	320	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1800	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4370	1630	320	vph
Peak-hour factor, PHF	0.95	0.95	0.95	
Peak 15-min volume, v15	1150	429	84	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	4738	1767	347	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 4738 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	6505	4800	Yes

v_3 or v_{av34} = 0 pc/h (Equation 13-14 or 13-17)

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 4738 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	6505	4600	Yes

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 46.0 pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable,	M_S = 2.778	
Space mean speed in ramp influence area,	S_R = -9.6	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S =	mph

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	11/3/2015
Analysis Time Period:	4:45 - 5:45 PM
Freeway/Direction:	US 50 WB
From/To:	Folsom Blvd to Hazel Ave
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	No Build

Flow Inputs and Adjustments

Volume, V	5730	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1508	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	2071	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.17	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	3.7	mi/h
Free-flow speed, FFS	71.7	mi/h

LOS and Performance Measures

Flow rate, vp	2071	pc/h/ln
Free-flow speed, FFS	71.7	mi/h
Average passenger-car speed, S	61.2	mi/h
Number of lanes, N	3	
Density, D	33.8	pc/mi/ln
Level of service, LOS	D	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 WB
Junction:	Hazel Avenue Off-ramp
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	No Build

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	4	
Free-flow speed on freeway	71.0	mph
Volume on freeway	5730	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-Flow speed on ramp	40.0	mph
Volume on ramp	1010	vph
Length of first accel/decel lane	0	ft
Length of second accel/decel lane	1400	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	900	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1740	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	5730	1010	900	vph
Peak-hour factor, PHF	0.95	0.95	0.95	
Peak 15-min volume, v15	1508	266	237	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	6213	1095	976	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.260 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 2426 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	6213	9600	No
$v_{FO} = v_F - v_R$	5118	9600	No
v_R	1095	4200	No
v_3 or v_{av34}	1893 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	Yes	

If yes, v_{12A} = 2485 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	2485	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 13.0 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable,	D_S = 0.462	
Space mean speed in ramp influence area,	S_R = 57.6	mph
Space mean speed in outer lanes,	S_O = 74.5	mph
Space mean speed for all vehicles,	S = 66.7	mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 WB
Junction:	NB Hazel Loop On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	No Build

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	4720	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	900	vph
Length of first accel/decel lane	600	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	1800	vph
Position of adjacent Ramp	Downstream	
Type of adjacent Ramp	On	
Distance to adjacent Ramp	350	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4720	900	1800	vph
Peak-hour factor, PHF	0.95	0.95	0.95	
Peak 15-min volume, v15	1242	237	474	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	5117	976	1952	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.594 Using Equation 3

$v_{12} = v_F (P_{FM})$ = 3041 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	6093	7200	No
v_3 or v_{av34}	2076 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 Yes

If yes, v_{12A} = 3041 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	4017	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 32.6 pc/mi/ln

Level of service for ramp-freeway junction areas of influence D

Speed Estimation

Intermediate speed variable,	M_S = 0.496	
Space mean speed in ramp influence area,	S_R = 56.6	mph
Space mean speed in outer lanes,	S_O = 65.3	mph
Space mean speed for all vehicles,	S = 59.3	mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 WB
Junction:	Folsom Boulevard On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	No Build

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	5620	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	50.0	mph
Volume on ramp	1800	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	900	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	On	
Distance to adjacent Ramp	350	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	5620	1800	900	vph
Peak-hour factor, PHF	0.95	0.95	0.95	
Peak 15-min volume, v15	1479	474	237	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

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Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	6093	1952	976	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.619 Using Equation 3

$v_{12} = v_F (P_{FM})$ = 3775 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	8045	7200	Yes
v_3 or v_{av34}	2318 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		Yes	

If yes, v_{12A} = 3775 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	5727	4600	Yes

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 39.8 pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable,	M_S = 1.368	
Space mean speed in ramp influence area,	S_R = 31.3	mph
Space mean speed in outer lanes,	S_0 = 64.4	mph
Space mean speed for all vehicles,	S = 36.8	mph

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	11/3/2015
Analysis Time Period:	4:45 - 5:45 PM
Freeway/Direction:	US 50 WB
From/To:	Hazel Ave to Sunrise Blvd
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	No Build

Flow Inputs and Adjustments

Volume, V	7060	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1858	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	2552	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.50	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.5	mi/h
Free-flow speed, FFS	70.9	mi/h

LOS and Performance Measures

Flow rate, vp	2552	pc/h/ln
Free-flow speed, FFS	70.9	mi/h
Average passenger-car speed, S	48.8	mi/h
Number of lanes, N	3	
Density, D	52.3	pc/mi/ln
Level of service, LOS	F	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

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Appendix B6

Horizon Year (2042) with Alternative 1/1A and Alternative 2

HCS2010 Calculations

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	10/28/2015
Analysis Time Period:	7:15 - 8:15 AM
Freeway/Direction:	US 50 EB
From/To:	Sunrise Avenue to Hazel Avenue
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	Alternative 1

Flow Inputs and Adjustments

Volume, V	6930	veh/h
Peak-hour factor, PHF	0.92	
Peak 15-min volume, v15	1883	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	2586	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.25	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	3.9	mi/h
Free-flow speed, FFS	71.5	mi/h

LOS and Performance Measures

Flow rate, vp	2586	pc/h/ln
Free-flow speed, FFS	71.5	mi/h
Average passenger-car speed, S	47.7	mi/h
Number of lanes, N	3	
Density, D	54.2	pc/mi/ln
Level of service, LOS	F	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 EB
Junction:	Hazel Avenue Off-ramp
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	Alternative 1

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	6930	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-Flow speed on ramp	40.0	mph
Volume on ramp	2790	vph
Length of first accel/decel lane	1420	ft
Length of second accel/decel lane	0	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	920	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1340	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	6930	2790	920	vph
Peak-hour factor, PHF	0.92	0.92	0.92	
Peak 15-min volume, v15	1883	758	250	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

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Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	7759	3124	1030	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.450 Using Equation 0

$v_{12} = v_R + (v - v_F) P_{FD}$ = 5210 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	7759	7200	Yes
$v_{FO} = v - v_F - v_R$	4635	7200	No
v_R	3124	4200	No
v_3 or v_{av34}	2549 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	No	

If yes, v_{12A} = 5210 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	5210	4400	Yes

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$ = 23.5 pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable,	D_S = 0.644	
Space mean speed in ramp influence area,	S_R = 52.3	mph
Space mean speed in outer lanes,	S_0 = 71.8	mph
Space mean speed for all vehicles,	S = 57.4	mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 EB
Junction:	SB Hazel Avenue Loop On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	Alternative 1

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	4140	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	920	vph
Length of first accel/decel lane	350	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	2790	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1340	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4140	920	2790	vph
Peak-hour factor, PHF	0.92	0.92	0.92	
Peak 15-min volume, v15	1125	250	758	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

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Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	4635	1030	3124	pcph

Estimation of V12 Merge Areas

L_{EQ} = 795.91 (Equation 13-6 or 13-7)

P_{FM} = 0.587 Using Equation 3

$v_{12} = v_F (P_{FM})$ = 2722 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	5665	7200	No
v_3 or v_{av34}	1913 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 Yes

If yes, v_{12A} = 2722 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	3752	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 32.1 pc/mi/ln

Level of service for ramp-freeway junction areas of influence D

Speed Estimation

Intermediate speed variable,	M_S = 0.463	
Space mean speed in ramp influence area,	S_R = 57.6	mph
Space mean speed in outer lanes,	S_O = 65.9	mph
Space mean speed for all vehicles,	S = 60.1	mph

DRAFT

HCS 2010: Freeway Weaving Release 6.65

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date Performed:	11/2/2015
Analysis Time Period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 EB
Weaving Location:	Hazel to Folsom Weave
Analysis Year:	2042
Description:	Alternative 1

Inputs

Segment Type	Freeway	
Weaving configuration	One-Sided	
Number of lanes, N	4	ln
Weaving segment length, LS	3650	ft
Freeway free-flow speed, FFS	71	mi/h
Minimum segment speed, SMIN	15	mi/h
Freeway maximum capacity, cIFL	2400	pc/h/ln
Terrain type	Level	
Grade	0.00	%
Length	0.00	mi

Conversion to pc/h Under Base Conditions

	Volume Components				
	VFF	VRF	VFR	VRR	
Volume, V	3950	250	1430	90	veh/h
Peak hour factor, PHF	0.92	0.92	0.92	0.92	
Peak 15-min volume, v15	1073	68	389	24	
Trucks and buses	6	6	6	6	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	0.971	0.971	0.971	0.971	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	4422	280	1601	101	pc/h

Volume ratio, VR	0.294	

Configuration Characteristics

Number of maneuver lanes, NWL	2	ln
Interchange density, ID	1.2	int/mi
Minimum RF lane changes, LCRF	1	lc/pc
Minimum FR lane changes, LCFR	0	lc/pc
Minimum RR lane changes, LCRR		lc/pc
Minimum weaving lane changes, LCMIN	280	lc/h
Weaving lane changes, LCW	959	lc/h
Non-weaving vehicle index, INW	1981	
Non-weaving lane change, LCNW	2698	lc/h
Total lane changes, LCALL	3657	lc/h

Weaving and Non-Weaving Speeds

Weaving intensity factor, W	0.226	

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Average weaving speed, SW	60.7	mi/h
Average non-weaving speed, SNW	61.3	mi/h

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	61.1	mi/h
Weaving segment density, D	26.2	pc/mi/ln
Level of service, LOS	C	
Weaving segment v/c ratio	0.784	
Weaving segment flow rate, v	6218	veh/h
Weaving segment capacity, cW	7933	veh/h

Limitations on Weaving Segments

If limit reached, see note.

	Minimum	Maximum	Actual	Note
Weaving length (ft)	300	5517	3650	a,b
		Maximum	Analyzed	
Density-based capacty, cIWL (pc/h/ln)		2400	2257	c
		Maximum	Analyzed	
v/c ratio		1.00	0.784	d

Notes:

a. In weaving segments shorter than 300 ft, weaving vehicles are assumed to make only necessary lane changes.

b. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments."

c. The density-based capacity exceeds the capacity of a basic freeway segment, under equivalent ideal conditions.

d. Volumes exceed the weaving segment capacity. The level of service is F.

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 EB
Junction:	Folsom Boulevard On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	Alternative 1

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	4200	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	210	vph
Length of first accel/decel lane	400	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	1520	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1390	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4200	210	1520	vph
Peak-hour factor, PHF	0.92	0.92	0.92	
Peak 15-min volume, v15	1141	57	413	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	4702	235	1702	pcph

Estimation of V12 Merge Areas

L_{EQ} = 662.32 (Equation 13-6 or 13-7)

P_{FM} = 0.589 Using Equation 3

$v_{12} = v_F (P_{FM})$ = 2768 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	4937	7200	No
v_3 or v_{av34}	1934 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		Yes	

If yes, v_{12A} = 2768 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	3003	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 26.3 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable,	M_S = 0.372		
Space mean speed in ramp influence area,	S_R = 60.2	mph	
Space mean speed in outer lanes,	S_0 = 65.8	mph	
Space mean speed for all vehicles,	S = 62.3	mph	

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	10/28/2015
Analysis Time Period:	7:15 - 8:15 AM
Freeway/Direction:	US 50 EB
From/To:	Folsom Blvd to Prairie City Rd
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	Alternative 1

Flow Inputs and Adjustments

Volume, V	4680	veh/h
Peak-hour factor, PHF	0.92	
Peak 15-min volume, v15	1272	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	2620	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.33	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.1	mi/h
Free-flow speed, FFS	71.3	mi/h

LOS and Performance Measures

Flow rate, vp	2620	pc/h/ln
Free-flow speed, FFS	71.3	mi/h
Average passenger-car speed, S	46.6	mi/h
Number of lanes, N	2	
Density, D	56.2	pc/mi/ln
Level of service, LOS	F	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	11/3/2015
Analysis Time Period:	7:15 - 8:15 AM
Freeway/Direction:	US 50 WB
From/To:	Prairie City Rd to Folsom Blvd
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	Alternative 1

Flow Inputs and Adjustments

Volume, V	4080	veh/h
Peak-hour factor, PHF	0.91	
Peak 15-min volume, v15	1121	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	2309	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.33	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.1	mi/h
Free-flow speed, FFS	71.3	mi/h

LOS and Performance Measures

Flow rate, vp	2309	pc/h/ln
Free-flow speed, FFS	71.3	mi/h
Average passenger-car speed, S	55.7	mi/h
Number of lanes, N	2	
Density, D	41.4	pc/mi/ln
Level of service, LOS	E	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

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Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 WB
Junction:	Folsom Boulevard Off-ramp
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	Alternative 1

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	71.0	mph
Volume on freeway	4080	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	330	vph
Length of first accel/decel lane	0	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	1630	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1800	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4080	330	1630	vph
Peak-hour factor, PHF	0.91	0.91	0.91	
Peak 15-min volume, v15	1121	91	448	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	4618	374	1845	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 4618 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	4618	4800	No
$v_{FO} = v_F - v_R$	4244	4800	No
v_R	374	2000	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	No	

If yes, v_{12A} = 4618 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	4618	4400	Yes

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086\ v_R - 0.009\ L_D$ = 44.0 pc/mi/ln

Level of service for ramp-freeway junction areas of influence E

Speed Estimation

Intermediate speed variable,	D_S = 0.462	
Space mean speed in ramp influence area,	S_R = 57.6	mph
Space mean speed in outer lanes,	S_O = N/A	mph
Space mean speed for all vehicles,	S = 57.6	mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 WB
Junction:	Folsom Boulevard On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	Alternative 1

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	71.0	mph
Volume on freeway	3750	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	50.0	mph
Volume on ramp	1630	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	330	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1800	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	3750	1630	330	vph
Peak-hour factor, PHF	0.91	0.91	0.91	
Peak 15-min volume, v15	1030	448	91	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

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Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	4245	1845	374	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM}) =$ 4245 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	6090	4800	Yes

v_3 or v_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 4245 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	6090	4600	Yes

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A =$ 42.7 pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable,	M_S = 1.893	
Space mean speed in ramp influence area,	S_R = 16.1	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 16.1	mph

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Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	11/3/2015
Analysis Time Period:	7:15 - 8:15 AM
Freeway/Direction:	US 50 WB
From/To:	Folsom Blvd to Hazel Ave
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	Alternative 1

Flow Inputs and Adjustments

Volume, V	5100	veh/h
Peak-hour factor, PHF	0.91	
Peak 15-min volume, v15	1401	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	1924	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.17	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	3.7	mi/h
Free-flow speed, FFS	71.7	mi/h

LOS and Performance Measures

Flow rate, vp	1924	pc/h/ln
Free-flow speed, FFS	71.7	mi/h
Average passenger-car speed, S	63.9	mi/h
Number of lanes, N	3	
Density, D	30.1	pc/mi/ln
Level of service, LOS	D	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

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Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 WB
Junction:	Hazel Avenue Off-ramp
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	Alternative 1

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	4	
Free-flow speed on freeway	71.0	mph
Volume on freeway	5100	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-Flow speed on ramp	40.0	mph
Volume on ramp	940	vph
Length of first accel/decel lane	1400	ft
Length of second accel/decel lane	0	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	700	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1740	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp		
Volume, V (vph)	5100		940		700		vph
Peak-hour factor, PHF	0.91		0.91		0.91		
Peak 15-min volume, v15	1401		258		192		v
Trucks and buses	6		6		6		%
Recreational vehicles	0		0		0		%
Terrain type:	Level		Level		Level		
Grade	0.00	%	0.00	%	0.00	%	
Length	0.00	mi	0.00	mi	0.00	mi	
Trucks and buses PCE, ET	1.5		1.5		1.5		
Recreational vehicle PCE, ER	1.2		1.2		1.2		

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Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	5773	1064	792	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.260 Using Equation 0

$v_{12} = v_R + (v - v_F) P_{FD}$ = 2288 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	5773	9600	No
$v_{FO} = v - v_R$	4709	9600	No
v_R	1064	4200	No
v_3 or v_{av34}	1742 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	Yes	

If yes, v_{12A} = 2309 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	2309	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086\ v_R - 0.009\ L_D$ = -1.1 pc/mi/ln

Level of service for ramp-freeway junction areas of influence A

Speed Estimation

Intermediate speed variable,	D_S = 0.459	
Space mean speed in ramp influence area,	S_R = 57.7	mph
Space mean speed in outer lanes,	S_O = 75.0	mph
Space mean speed for all vehicles,	S = 67.0	mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 WB
Junction:	NB Hazel Loop On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	Alternative 1

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	4160	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	700	vph
Length of first accel/decel lane	600	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	1570	vph
Position of adjacent Ramp	Downstream	
Type of adjacent Ramp	On	
Distance to adjacent Ramp	350	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4160	700	1570	vph
Peak-hour factor, PHF	0.91	0.91	0.91	
Peak 15-min volume, v15	1143	192	431	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	4709	792	1777	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.594 Using Equation 3

$v_{12} = v_F (P_{FM})$ = 2799 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	5501	7200	No
v_3 or v_{av34}	1910 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		Yes	

If yes, v_{12A} = 2799 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	3591	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 29.4 pc/mi/ln

Level of service for ramp-freeway junction areas of influence D

Speed Estimation

Intermediate speed variable,	M_S = 0.420	
Space mean speed in ramp influence area,	S_R = 58.8	mph
Space mean speed in outer lanes,	S_O = 65.9	mph
Space mean speed for all vehicles,	S = 61.1	mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	7:15 - 8:15 AM
Freeway/Dir of Travel:	US 50 WB
Junction:	Folsom Boulevard On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	Alternative 1

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	4860	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	50.0	mph
Volume on ramp	1570	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	700	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	On	
Distance to adjacent Ramp	350	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4860	1570	700	vph
Peak-hour factor, PHF	0.91	0.91	0.91	
Peak 15-min volume, v15	1335	431	192	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

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Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	5501	1777	792	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.619 Using Equation 3

$v_{12} = v_F (P_{FM}) =$ 3408 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	7278	7200	Yes
v_3 or v_{av34}	2093 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		Yes	

If yes, v_{12A} = 3408 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	5185	4600	Yes

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A =$ 35.7 pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable,	M_S = 0.867	
Space mean speed in ramp influence area,	S_R = 45.8	mph
Space mean speed in outer lanes,	S_0 = 65.3	mph
Space mean speed for all vehicles,	S = 50.1	mph

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	11/3/2015
Analysis Time Period:	7:15 - 8:15 AM
Freeway/Direction:	US 50 WB
From/To:	Hazel Ave to Sunrise Blvd
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	Alternative 1

Flow Inputs and Adjustments

Volume, V	6150	veh/h
Peak-hour factor, PHF	0.91	
Peak 15-min volume, v15	1690	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	2320	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.50	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.5	mi/h
Free-flow speed, FFS	70.9	mi/h

LOS and Performance Measures

Flow rate, vp	2320	pc/h/ln
Free-flow speed, FFS	70.9	mi/h
Average passenger-car speed, S	55.4	mi/h
Number of lanes, N	3	
Density, D	41.8	pc/mi/ln
Level of service, LOS	E	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	10/28/2015
Analysis Time Period:	4:45 - 5:45 PM
Freeway/Direction:	US 50 EB
From/To:	Sunrise Avenue to Hazel Avenue
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	Alternative 1

Flow Inputs and Adjustments

Volume, V	7130	veh/h
Peak-hour factor, PHF	0.91	
Peak 15-min volume, v15	1959	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	2690	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.25	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	3.9	mi/h
Free-flow speed, FFS	71.5	mi/h

LOS and Performance Measures

Flow rate, vp	2690	pc/h/ln
Free-flow speed, FFS	71.5	mi/h
Average passenger-car speed, S	44.2	mi/h
Number of lanes, N	3	
Density, D	60.8	pc/mi/ln
Level of service, LOS	F	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 EB
Junction:	Hazel Avenue Off-ramp
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	Alternative 1

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	7130	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-Flow speed on ramp	40.0	mph
Volume on ramp	3180	vph
Length of first accel/decel lane	1420	ft
Length of second accel/decel lane	0	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	920	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1340	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	7130		3180		920	vph
Peak-hour factor, PHF	0.91		0.91		0.91	
Peak 15-min volume, v15	1959		874		253	v
Trucks and buses	6		6		6	%
Recreational vehicles	0		0		0	%
Terrain type:	Level		Level		Level	
Grade	0.00	%	0.00	%	0.00	%
Length	0.00	mi	0.00	mi	0.00	mi
Trucks and buses PCE, ET	1.5		1.5		1.5	
Recreational vehicle PCE, ER	1.2		1.2		1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	8070	3599	1041	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.450 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 5611 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	8070	7200	Yes
$v_{FO} = v_F - v_R$	4471	7200	No
v_R	3599	4200	No
v_3 or v_{av34}	2459 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 5611 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	5611	4400	Yes

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 26.9 pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable, D_S = 0.687

Space mean speed in ramp influence area, S_R = 51.1 mph

Space mean speed in outer lanes, S_O = 72.2 mph

Space mean speed for all vehicles, S = 56.1 mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 EB
Junction:	SB Hazel Avenue Loop On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	Alternative 1

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	3950	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	920	vph
Length of first accel/decel lane	350	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	3180	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1340	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	3950	920	3180	vph
Peak-hour factor, PHF	0.91	0.91	0.91	
Peak 15-min volume, v15	1085	253	874	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	4471	1041	3599	pcph

Estimation of V12 Merge Areas

L_{EQ} = 763.17 (Equation 13-6 or 13-7)

P_{FM} = 0.587 Using Equation 3

$v_{12} = v_F (P_{FM})$ = 2626 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	5512	7200	No
v_3 or v_{av34}	1845 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		Yes	

If yes, v_{12A} = 2626 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	3667	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 31.4 pc/mi/ln

Level of service for ramp-freeway junction areas of influence D

Speed Estimation

Intermediate speed variable,	M_S = 0.449	
Space mean speed in ramp influence area,	S_R = 58.0	mph
Space mean speed in outer lanes,	S_O = 66.2	mph
Space mean speed for all vehicles,	S = 60.5	mph

DRAFT

HCS 2010: Freeway Weaving Release 6.65

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date Performed:	11/2/2015
Analysis Time Period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 EB
Weaving Location:	Hazel to Folsom Weave
Analysis Year:	2042
Description:	Alternative 1

Inputs

Segment Type	Freeway	
Weaving configuration	One-Sided	
Number of lanes, N	4	ln
Weaving segment length, LS	3650	ft
Freeway free-flow speed, FFS	71	mi/h
Minimum segment speed, SMIN	15	mi/h
Freeway maximum capacity, cIFL	2400	pc/h/ln
Terrain type	Level	
Grade	0.00	%
Length	0.00	mi

Conversion to pc/h Under Base Conditions

	Volume Components				
	VFF	VRF	VFR	VRR	
Volume, V	3990	280	1280	90	veh/h
Peak hour factor, PHF	0.91	0.91	0.91	0.91	
Peak 15-min volume, v15	1096	77	352	25	
Trucks and buses	6	6	6	6	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	1.5	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	1.2	
Heavy vehicle adjustment, fHV	0.971	0.971	0.971	0.971	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	4516	317	1449	102	pc/h

Volume ratio, VR	0.277	

Configuration Characteristics

Number of maneuver lanes, NWL	2	ln
Interchange density, ID	1.2	int/mi
Minimum RF lane changes, LCRF	1	lc/pc
Minimum FR lane changes, LCFR	0	lc/pc
Minimum RR lane changes, LCRR		lc/pc
Minimum weaving lane changes, LCMIN	317	lc/h
Weaving lane changes, LCW	996	lc/h
Non-weaving vehicle index, INW	2023	
Non-weaving lane change, LCNW	2719	lc/h
Total lane changes, LCALL	3715	lc/h

Weaving and Non-Weaving Speeds

Weaving intensity factor, W	0.229	

DRAFT

Average weaving speed, SW	60.6	mi/h
Average non-weaving speed, SNW	61.1	mi/h

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	60.9	mi/h
Weaving segment density, D	26.2	pc/mi/ln
Level of service, LOS	C	
Weaving segment v/c ratio	0.736	
Weaving segment flow rate, v	6198	veh/h
Weaving segment capacity, cW	8423	veh/h

Limitations on Weaving Segments

If limit reached, see note.

	Minimum	Maximum	Actual	Note
Weaving length (ft)	300	5335	3650	a,b
		Maximum	Analyzed	
Density-based capacty, cIWL (pc/h/ln)		2400	2271	c
		Maximum	Analyzed	
v/c ratio		1.00	0.736	d

Notes:

a. In weaving segments shorter than 300 ft, weaving vehicles are assumed to make only necessary lane changes.

b. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments."

c. The density-based capacity exceeds the capacity of a basic freeway segment, under equivalent ideal conditions.

d. Volumes exceed the weaving segment capacity. The level of service is F.

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Phone: Fax:
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Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 EB
Junction:	Folsom Boulevard On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	Alternative 1

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	4270	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	450	vph
Length of first accel/decel lane	400	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	1370	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1390	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4270	450	1370	vph
Peak-hour factor, PHF	0.91	0.91	0.91	
Peak 15-min volume, v15	1173	124	376	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

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Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	4833	509	1551	pcph

Estimation of V12 Merge Areas

L_{EQ} = 748.99 (Equation 13-6 or 13-7)

P_{FM} = 0.589 Using Equation 3

$v_{12} = v_F (P_{FM})$ = 2845 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	5342	7200	No
v_3 or v_{av34}	1988 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 Yes

If yes, v_{12A} = 2845 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	3354	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 28.9 pc/mi/ln

Level of service for ramp-freeway junction areas of influence D

Speed Estimation

Intermediate speed variable,	M_S = 0.405	
Space mean speed in ramp influence area,	S_R = 59.3	mph
Space mean speed in outer lanes,	S_O = 65.6	mph
Space mean speed for all vehicles,	S = 61.5	mph

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	10/28/2015
Analysis Time Period:	4:45 - 5:45 PM
Freeway/Direction:	US 50 EB
From/To:	Folsom Blvd to Prairie City Rd
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	Alternative 1

Flow Inputs and Adjustments

Volume, V	4910	veh/h
Peak-hour factor, PHF	0.91	
Peak 15-min volume, v15	1349	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	2779	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.33	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.1	mi/h
Free-flow speed, FFS	71.3	mi/h

LOS and Performance Measures

Flow rate, vp	2779	pc/h/ln
Free-flow speed, FFS	71.3	mi/h
Average passenger-car speed, S	41.1	mi/h
Number of lanes, N	2	
Density, D	67.7	pc/mi/ln
Level of service, LOS	F	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	11/3/2015
Analysis Time Period:	4:45 - 5:45 PM
Freeway/Direction:	US 50 WB
From/To:	Prairie City Rd to Folsom Blvd
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	Alternative 1

Flow Inputs and Adjustments

Volume, V	4690	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1234	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	2542	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.33	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.1	mi/h
Free-flow speed, FFS	71.3	mi/h

LOS and Performance Measures

Flow rate, vp	2542	pc/h/ln
Free-flow speed, FFS	71.3	mi/h
Average passenger-car speed, S	49.1	mi/h
Number of lanes, N	2	
Density, D	51.8	pc/mi/ln
Level of service, LOS	F	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 WB
Junction:	Folsom Boulevard Off-ramp
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	Alternative 1

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	71.0	mph
Volume on freeway	4690	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	320	vph
Length of first accel/decel lane	0	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	1630	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1800	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4690	320	1630	vph
Peak-hour factor, PHF	0.95	0.95	0.95	
Peak 15-min volume, v15	1234	84	429	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	5085	347	1767	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 5085 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	5085	4800	Yes
$v_{FO} = v_F - v_R$	4738	4800	No
v_R	347	2000	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	No	

If yes, v_{12A} = 5085 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	5085	4400	Yes

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086 v_R - 0.009 L_D$ = 48.0 pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable,	D_S = 0.459	
Space mean speed in ramp influence area,	S_R = 57.7	mph
Space mean speed in outer lanes,	S_O = N/A	mph
Space mean speed for all vehicles,	S = 57.7	mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 WB
Junction:	Folsom Boulevard On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	Alternative 1

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	71.0	mph
Volume on freeway	4370	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	50.0	mph
Volume on ramp	1630	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	320	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1800	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4370	1630	320	vph
Peak-hour factor, PHF	0.95	0.95	0.95	
Peak 15-min volume, v15	1150	429	84	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	4738	1767	347	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 4738 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	6505	4800	Yes

v_3 or v_{av34} = 0 pc/h (Equation 13-14 or 13-17)

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 4738 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	6505	4600	Yes

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 46.0 pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable,	M_S = 2.778	
Space mean speed in ramp influence area,	S_R = -9.6	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S =	mph

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	11/3/2015
Analysis Time Period:	4:45 - 5:45 PM
Freeway/Direction:	US 50 WB
From/To:	Folsom Blvd to Hazel Ave
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	Alternative 1

Flow Inputs and Adjustments

Volume, V	5730	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1508	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	2071	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.17	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	3.7	mi/h
Free-flow speed, FFS	71.7	mi/h

LOS and Performance Measures

Flow rate, vp	2071	pc/h/ln
Free-flow speed, FFS	71.7	mi/h
Average passenger-car speed, S	61.2	mi/h
Number of lanes, N	3	
Density, D	33.8	pc/mi/ln
Level of service, LOS	D	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 WB
Junction:	Hazel Avenue Off-ramp
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	Alternative 1

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	4	
Free-flow speed on freeway	71.0	mph
Volume on freeway	5730	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-Flow speed on ramp	40.0	mph
Volume on ramp	1010	vph
Length of first accel/decel lane	1400	ft
Length of second accel/decel lane	0	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	900	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1740	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	5730	1010	900	vph
Peak-hour factor, PHF	0.95	0.95	0.95	
Peak 15-min volume, v15	1508	266	237	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	6213	1095	976	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.260 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 2426 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	6213	9600	No
$v_{FO} = v_F - v_R$	5118	9600	No
v_R	1095	4200	No
v_3 or v_{av34}	1893 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	Yes	

If yes, v_{12A} = 2485 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	2485	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086 v_R - 0.009 L_{12} = 0.4$ pc/mi/ln D

Level of service for ramp-freeway junction areas of influence A

Speed Estimation

Intermediate speed variable, D_S = 0.462

Space mean speed in ramp influence area, S_R = 57.6 mph

Space mean speed in outer lanes, S_0 = 74.5 mph

Space mean speed for all vehicles, S = 66.7 mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 WB
Junction:	NB Hazel Loop On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	Alternative 1

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	4720	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	900	vph
Length of first accel/decel lane	600	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	1800	vph
Position of adjacent Ramp	Downstream	
Type of adjacent Ramp	On	
Distance to adjacent Ramp	350	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	4720	900	1800	vph
Peak-hour factor, PHF	0.95	0.95	0.95	
Peak 15-min volume, v15	1242	237	474	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	5117	976	1952	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.594 Using Equation 3

$v_{12} = v_F (P_{FM})$ = 3041 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	6093	7200	No
v_3 or v_{av34}	2076 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 Yes

If yes, v_{12A} = 3041 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	4017	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 32.6 pc/mi/ln

Level of service for ramp-freeway junction areas of influence D

Speed Estimation

Intermediate speed variable,	M_S = 0.496	
Space mean speed in ramp influence area,	S_R = 56.6	mph
Space mean speed in outer lanes,	S_O = 65.3	mph
Space mean speed for all vehicles,	S = 59.3	mph

DRAFT

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	CHS
Agency/Co.:	DKS Associates
Date performed:	11/2/2015
Analysis time period:	4:45 - 5:45 PM
Freeway/Dir of Travel:	US 50 WB
Junction:	Folsom Boulevard On-ramp
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	Alternative 1

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	71.0	mph
Volume on freeway	5620	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	50.0	mph
Volume on ramp	1800	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	900	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	On	
Distance to adjacent Ramp	350	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	5620	1800	900	vph
Peak-hour factor, PHF	0.95	0.95	0.95	
Peak 15-min volume, v15	1479	474	237	v
Trucks and buses	6	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Level	Level	Level	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	1.5	1.5	1.5	
Recreational vehicle PCE, ER	1.2	1.2	1.2	

DRAFT

Heavy vehicle adjustment, fHV	0.971	0.971	0.971	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	6093	1952	976	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.619 Using Equation 3

$v_{12} = v_F (P_{FM})$ = 3775 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	8045	7200	Yes
v_3 or v_{av34}	2318 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		Yes	

If yes, v_{12A} = 3775 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	5727	4600	Yes

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 39.8 pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable,	M_S = 1.368	
Space mean speed in ramp influence area,	S_R = 31.3	mph
Space mean speed in outer lanes,	S_0 = 64.4	mph
Space mean speed for all vehicles,	S = 36.8	mph

DRAFT

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	CHS
Agency or Company:	DKS Associates
Date Performed:	11/3/2015
Analysis Time Period:	4:45 - 5:45 PM
Freeway/Direction:	US 50 WB
From/To:	Hazel Ave to Sunrise Blvd
Jurisdiction:	Caltrans
Analysis Year:	2042
Description:	Alternative 1

Flow Inputs and Adjustments

Volume, V	7060	veh/h
Peak-hour factor, PHF	0.95	
Peak 15-min volume, v15	1858	v
Trucks and buses	6	%
Recreational vehicles	0	%
Terrain type:	Level	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	1.5	
Recreational vehicle PCE, ER	1.2	
Heavy vehicle adjustment, fHV	0.971	
Driver population factor, fp	1.00	
Flow rate, vp	2552	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.50	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	4.5	mi/h
Free-flow speed, FFS	70.9	mi/h

LOS and Performance Measures

Flow rate, vp	2552	pc/h/ln
Free-flow speed, FFS	70.9	mi/h
Average passenger-car speed, S	48.8	mi/h
Number of lanes, N	3	
Density, D	52.3	pc/mi/ln
Level of service, LOS	F	

DRAFT

Overall results are not computed when free-flow speed is less than 55 mph.

DRAFT

VISUAL IMPACT ASSESSMENT

US 50/Hazel Avenue Interchange

November 2017

California Department of Transportation

District 3, Sacramento County, US 50 and
Hazel Avenue
03-SAC-50-PM 15.1/17.5
Federal Project No.: EA 03-3E380/E-FIS 0300020439
County Control Number 2011-70062

Prepared by: _____ **Date:** November 29, 2017

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Approved by: _____ **Date:** 2/21/18

Jeff Pietrzak
Licensee Number 4457
Caltrans District Landscape Architect
Office of Landscape Architecture
District 3

Statement of Compliance: Produced in compliance with National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA) requirements, as appropriate, to meet the level of analysis and documentation that has been determined necessary for this project.

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VISUAL IMPACT ASSESSMENT
US 50/Hazel Avenue Interchange

I. EXECUTIVE SUMMARY

The proposed project is in Sacramento County (Figure 1) at the US Highway 50 (US 50)/Hazel Avenue interchange (Figure 2). The project and its alternatives would modify the existing US 50/Hazel Avenue interchange, and extend and grade-separate Hazel Avenue over Folsom Boulevard and the Sacramento Placerville Transportation Corridor Joint Powers Authority (SPTCJPA) rail corridor. Hazel Avenue will be extended further south to a proposed intersection with the future Atlanta Street (a new roadway that will be constructed as part of the Easton Place development). The two build alternatives and the sub-alternative would include similar widening of US 50; reconfigured, taller, and more complex on-ramp and off-ramp systems that are similar in configuration and height; similar retaining wall structures; similar embankments; removal of several commercial properties; construction of a new Hazel Avenue bridge crossing over Folsom Boulevard and the Sacramento Regional Transit light rail tracks; construction of the Jughandle; construction of the bicycle off-ramp from Hazel Avenue; and comparable removal of associated vegetation. The primary differences between the build alternatives are the widened Hazel Avenue bridge over US 50 for Alternatives 1 and 1A, viaduct structure under Alternative 1, and the flyover structure and complete removal of the Nimbus Winery building under Alternative 2. The elements that would result in the greatest visual impacts would be the removal of commercial properties, the larger ramp embankments and associated retaining walls, vegetation removal, and new structures associated with the new bridge, viaduct, and flyover. Most of these changes would generally appear similar under all the build alternatives. Although changes to visual resources would range from low to moderate, viewer response to these changes would range from moderate-high to high, and the resulting visual impacts would range from moderate to moderate-high. Overall, all build alternatives would result in the same or very similar visual impacts. Mitigation measures include minimizing fugitive light during construction, applying minimum lighting standards, implementing landscaping, and incorporating project design aesthetics that will help to offset these visual impacts and improve project aesthetics.

II. PURPOSE AND NEED OF STUDY

The purpose of this visual impact assessment (VIA) is to document potential visual impacts caused by the proposed project and propose measures to lessen any detrimental impacts that are identified. Visual impacts are demonstrated by identifying visual resources in the project area, measuring the amount of change that would occur as a result of the project, and predicting how the affected public would respond to or perceive those changes.

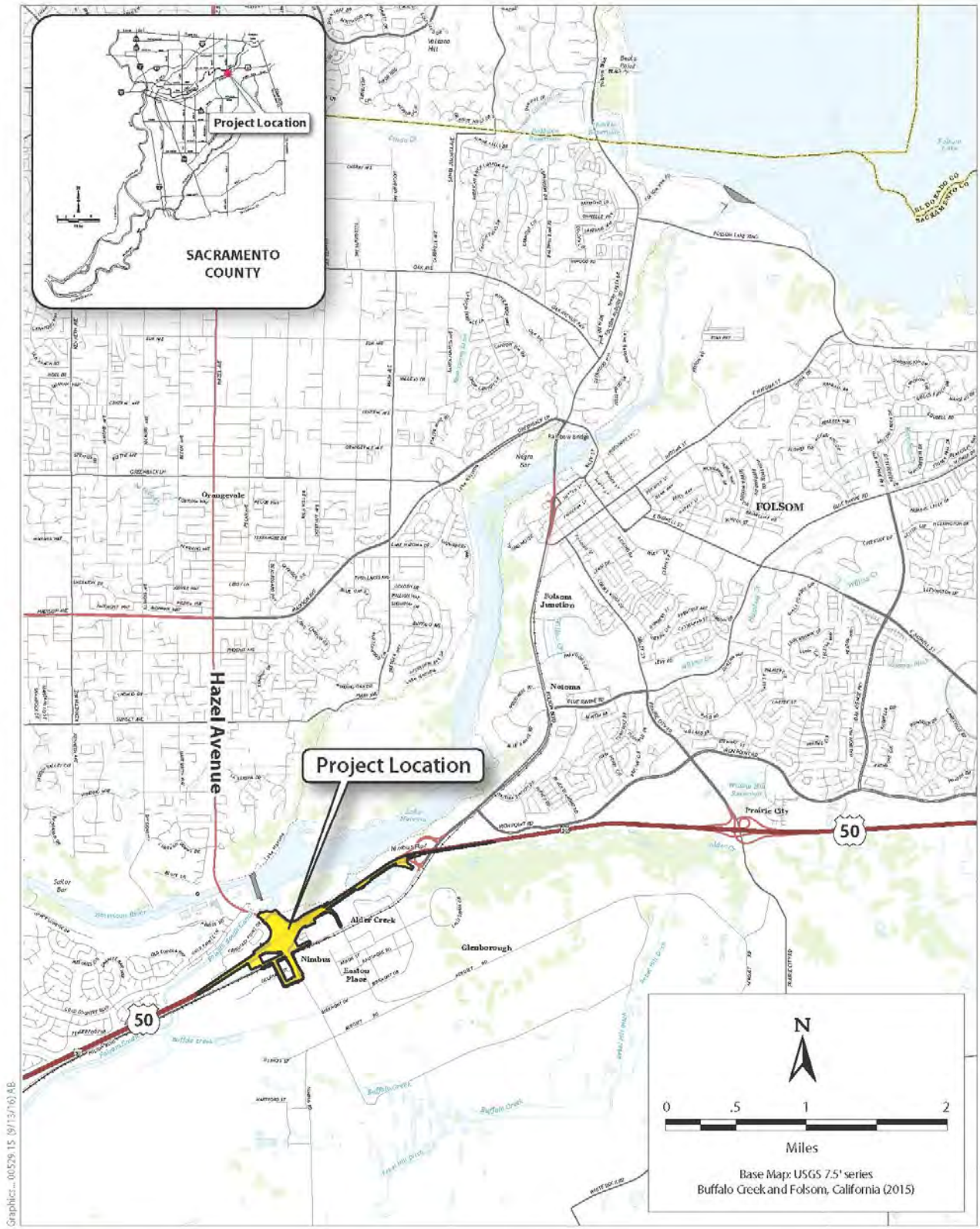


Figure 1. Project Vicinity

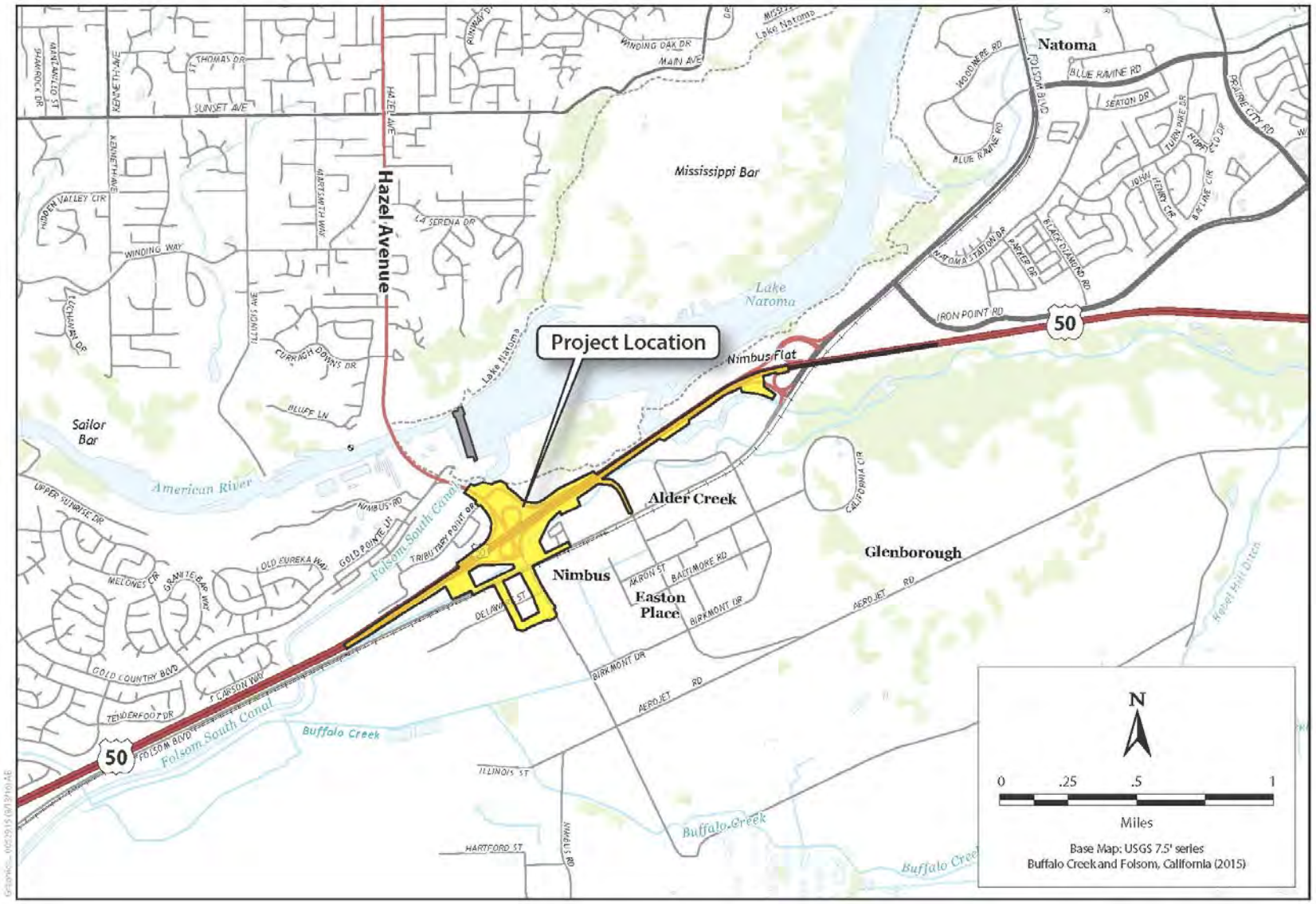


Figure 2. Project Location

III. PROJECT DESCRIPTION

The proposed project would construct modifications to the existing interchange, and grade-separate and extend Hazel Avenue to the south to a future intersection with Atlanta Street, which will be built with the approved Easton Place development. Two alternatives, with one sub-alternative, have been developed for the project. The following is a description of elements and design components that are common to all alternatives:

Roadway Modifications

- Construction of a portion of an eastbound transition auxiliary lane on US 50 from Hazel Avenue through the Folsom Boulevard Overcrossing, also known as the Natoma Overhead.
- The modification of the existing Aerojet Road off-ramp from US 50.
- The westbound loop on-ramp will be reconstructed, with the ramp intersection shifted north towards the westbound off-ramp terminus, increasing storage lengths. The ramp will be metered with two lanes (one mixed use, and one HOV bypass), and a squared-up pedestrian-friendly entrance.
- Reconstruction of the eastbound diagonal off-ramp to conform with the new Hazel Avenue profile and accommodate the Aerojet Road ramp divergence.
- The eastbound diagonal on-ramp will be reconstructed to conform with the new Hazel Avenue profile, and will be metered with two lanes; one mixed flow, and one HOV bypass.
- The eastbound loop on-ramp will be reconstructed to conform with the new Hazel Avenue profile, and will be metered with two lanes; one mixed flow, and one HOV bypass. A tie-back wall at the abutment of the overcrossing is proposed to maximize the opening through the structure. The loop ramp will develop an additional lane on US 50 that will continue on to the Folsom Boulevard interchange.
- Construction of eastbound on- and off-ramp auxiliary lanes on US 50, from west of the Hazel Avenue to the eastbound off-ramp, and from the loop on-ramp extending to the Folsom Boulevard interchange.
- Traffic signals at the ramp intersections will be modified. Safety lighting will be installed. A new signalized intersection and at-grade railroad crossing will be constructed for the Jughandle.
- Pedestrian access will be maintained on the east side of Hazel Avenue with 6-foot sidewalks; however, the existing sidewalk on the overcrossing will remain 5 feet wide. Bicyclists may utilize the County of Sacramento's standard 7-foot shoulders. It is expected that pedestrians and bicyclists will continue to use the nearby Bikeway and Pedestrian Overcrossing as the primary means for crossing US 50.
- Roadway improvements constructed along approximately 2,300 feet of Folsom Boulevard. Improvements include the removal of the existing signalized intersection with Hazel Avenue, and installation of sidewalks, street lighting, and hardscaping along the north and south sides of Folsom Boulevard. In addition, the median will be hardscaped. Landscaping may be planted along the sides of Folsom Boulevard, if feasible.

Transition Lane to US 50/Folsom Boulevard Interchange

As indicated in the California Department of Transportation (Caltrans) *2009 Corridor System Management Plan*, eastbound US 50 is shown to have one HOV lane and three mixed flow lanes to Hazel Avenue as the Concept Facility (California Department of Transportation 2009). Also, eastbound US 50 is shown to have one HOV lane and three mixed flow lanes across Folsom Boulevard as the Ultimate Facility. This project would accommodate these future facility improvements, conform to the approved Caltrans project at US 50/Folsom Boulevard interchange that is constructing a portion of those improvements in 2016, and subsequently restripe the third mixed flow lane through the US 50/Folsom Boulevard interchange.

This project is required to add the mixed flow lane because it has been determined in the traffic analysis for this project, and in studies for adjacent projects, that the additional eastbound lane on US 50 extending through the Folsom Boulevard interchange is needed for operations.

Under all alternatives, accommodating this mixed flow lane would require the eastbound loop on-ramp to extend its auxiliary lane to the US 50/Folsom Boulevard eastbound off-ramp. This would require widening and a new structure over Alder Creek.

Alder Creek currently flows under US 50 through a box culvert (Br. No. 24-0033). A Mechanically Stabilized Earth (MSE) wall (Br. No. 24-0372) is above the culvert. To widen US 50 over Alder Creek, a new bridge would be required. The new bridge is necessary because there is insufficient lateral space to construct an adjacent MSE wall on top of the culvert and the creek maintains a high operating water level.

Railroad Overhead

Hazel Avenue would extend and be grade-separated over Folsom Boulevard and the SPTC-JPA rail corridor. There is currently one light rail track located on the north side of the UPRR tracks. Sacramento Regional Transit plans to add another track at this location in the future. When the addition of that track occurs, the existing UPRR track would be relocated south to accommodate the second light rail track. The proposed design meets the requirements for all three tracks, with the clearances shown in Figure 3.

Temporary vertical clearances of 21'-6" and permanent vertical clearances of 24'-0" have been accounted for in the layout of all three alternatives for the Hazel Avenue Overhead. The vertical clearance provided would accommodate the Overhead Catenary System for the light rail.

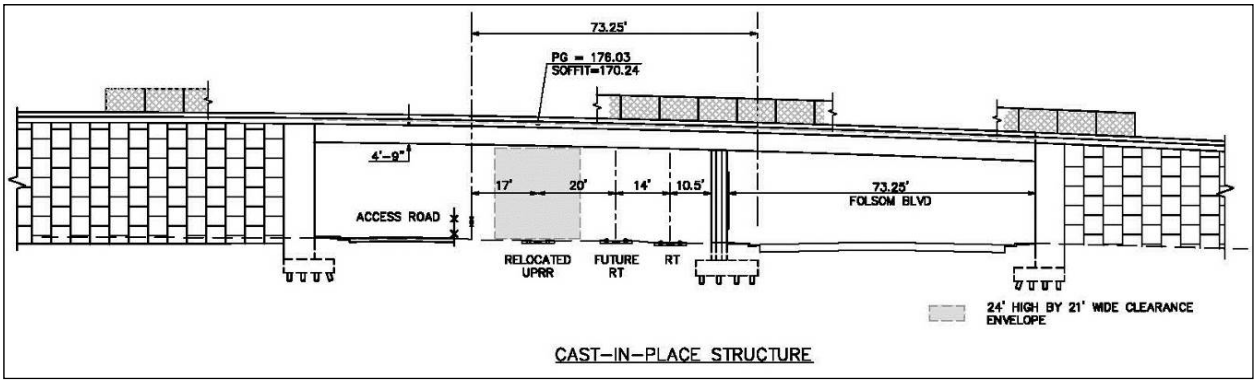


Figure 3. Grade-separated Crossing

Alternatives

This VIA examines two build alternatives, a sub-alternative, and the no-build alternative. The plans for each of the alternatives and sub-alternative are contained in Appendix A, Figures A-1 through A-3. The alternatives assessed in this study are as follows.

Alternative 1: L-9 Interchange with Viaduct Connector

Alternative 1 consists of a modified type L-9 interchange configuration. A Caltrans Type L-9 interchange entails a ramp configuration that includes a diagonal off-ramp, a diagonal on-ramp and a loop on-ramp. This alternative would provide a viaduct connection to Aerojet Road.

As with all alternatives, Hazel Avenue would grade-separate over Folsom Boulevard and the SPTC-JPA rail corridor and would extend further south to a proposed intersection with the future Atlanta Street (a new roadway as part of the Easton Place development). The existing at-grade intersection of Hazel Avenue and

Folsom Boulevard would be removed, sidewalks would be extended across the former intersection, and the lanes would be re-striped to remove left-turn lanes.

The location of the departure point of the existing Aerojet Road off-ramp from US 50 would be moved to join with the eastbound Hazel Avenue off-ramp. The eastbound Hazel Avenue off-ramp would split and introduce a direct viaduct ramp over Hazel Avenue to carry eastbound off-ramp traffic to Aerojet Road and Folsom Boulevard. The off-ramp diverge from US 50 would be shifted approximately 830 feet to the east to provide decision sight distance before the Aerojet Road split. The two-lane off-ramp would widen to five lanes at the ramp terminal intersection, with three left-turn lanes and two right-turn lanes. Retaining walls and barriers placed at the proposed right-of-way would minimize acquisition. The eastbound off-ramp would also have an auxiliary lane prior to the exit.

The Aerojet Road viaduct would land adjacent to the eastbound diagonal on-ramp and then turn southerly to conform to Folsom Boulevard along its existing alignment. Retaining walls are proposed between the viaduct and the diagonal on-ramp to accommodate the grade difference, and to the outside of the ramp after the viaduct lands, to minimize right-of-way acquisitions. Retaining walls are also proposed along Aerojet Road as it approaches the horizontal curve towards Folsom Boulevard to accommodate the grade difference between the ramp and mainline and to minimize right-of-way acquisition.

The existing Hazel Avenue Overcrossing of US 50 would be widened on the west side to accommodate eight lanes (3 through lanes and 1 freeway-only lane in both directions). The existing raised concrete median across the structure would be removed, and the roadway would be re-striped with a 6-foot striped median. The existing sidewalk and barrier on the east side of the structure would remain.

Alternative 1A: L-9 Interchange with Undercrossing Connector
Alternative 1A is the same as Alternative 1, except that the eastbound off-ramp would split and introduce a direct tunnel ramp under Hazel Avenue to carry eastbound off-ramp traffic to Aerojet Road and Folsom Boulevard.

Alternative 2: Direct Flyover to Hazel Avenue with Connector
Alternative 2 consists of a modified type L-9 interchange configuration, with a flyover ramp carrying vehicles travelling from eastbound US 50 to northbound Hazel Avenue over the freeway to join with the westbound off-ramp.

The existing Aerojet Road off-ramp from US 50 would be removed.

The eastbound off-ramp diverge from US 50 would be shifted approximately 680 feet to the east to provide decision sight distance. An auxiliary lane would precede the off-ramp. A retaining wall is proposed adjacent to the off-ramp to minimize right-of-way acquisition.

The eastbound off-ramp would split and introduce northbound and southbound Hazel Avenue ramps. The northbound ramp would also carry traffic headed for Aerojet Road/Folsom Boulevard. An overhead sign would direct vehicles heading to southbound Hazel Avenue to the right lane, and vehicles destined for northbound Hazel Avenue or Aerojet Road or Folsom Boulevard to use either lane. Retaining walls are proposed for the ramp as it approaches the horizontal curve towards Folsom Boulevard to accommodate the grade difference between the ramp and mainline and to minimize right-of-way acquisition at an apartment complex.

The northbound Hazel Avenue movement would cross under Hazel Avenue at the interchange, cross over US 50 on a two-lane flyover structure, and then merge with the westbound off-ramp and terminate at the Hazel Avenue/Tributary Point intersection. The westbound off-ramp would split so that the southbound and through movements align to the left of the ramp, and the northbound movements are to the right.

The southbound ramp would connect directly to Hazel Avenue. However, in Alternative 2 an intersection is not required at Hazel Avenue and the eastbound ramp. By eliminating an intersection at the eastbound ramp, and by removing the heavy eastbound-to-northbound movements from the Hazel Avenue overcrossing, the existing structure can remain without widening.

The two-lane westbound off-ramp would be reconstructed to provide decision sight distance between the divergence point from US 50 and a new ramp split that accommodates the flyover. The westbound off-ramp would split on either side of the flyover ramp, with one lane to the right carrying northbound Hazel Avenue traffic and the other crossing underneath the flyover ramp to join on the left side of the flyover for the southbound Hazel Avenue movements. The profiles of the three ramps have been coordinated to match grade quickly to minimize retaining wall limits and enhance driver visibility. Overhead signage would direct drivers into the appropriate lanes for northbound and southbound Hazel Avenue traffic.

No Build Alternative

The No Build Alternative would not modify the US 50/Hazel Avenue Interchange. The interchange would remain with the same existing configuration, ramps, and lanes. This alternative does not meet the purpose and need of the project.

Right of Way and Utilities

For Alternative 1, right-of-way acquisition is anticipated from parcels in the southwest quadrant of the interchange. It is anticipated that 12 parcels would be affected by the improvements, including full acquisition and demolition of structures at the Chevron gas station (APN 069-0160-012) and Cattleman's restaurant (APN 069-0060-085). The viaduct structure is proposed to cross over the northern portion of the Nimbus Winery Village parking lot (APN 069-0050-013) on an aerial easement to allow parking below the structure and minimize impacts to the business.

The right-of-way take at the Nimbus Winery Village property (APN 069-0050-013) will be larger in Alternative 1A, as acquisition is required as opposed to an aerial easement.

For Alternative 2, right-of-way acquisition is anticipated from parcels in the southwest quadrant of the interchange. It is anticipated that 13 parcels would be affected by the improvements, including full acquisition and demolition of structures at the Chevron gas station (APN 069-0160-012), Cattleman's restaurant (APN 069-0060-085) and the Nimbus Winery Village property (APN 069-0050-013).

These acquisition needs described above are preliminary and would be finalized during the right-of-way process and final design of the project.

For all alternatives, the project would require the relocation of utilities, and it is anticipated that this will include: gas lines, overhead electric lines, underground electric lines, fiber optic cables, water lines, sewer lines, and storm drain lines. The potential for effects on other unknown utilities also exists.

IV. PROJECT LOCATION AND SETTING

The project location and setting provides the context for determining the type and severity of changes to the existing visual environment. The terms *visual character* and *visual quality* are defined below and are used to further describe the visual environment. The project setting is also referred to as the corridor or project corridor, which is defined as the area of land that is visible from, adjacent to, and outside the highway right-of-way, and is determined by topography, vegetation, and viewing distance.

The proposed project is at the Hazel Avenue interchange on US 50 between approximately post mile (PM) 15 and PM 17.5 and includes the Folsom Boulevard Overcrossing, also known as the Natoma Overhead, and the Aerojet Road off-ramp. The project is within Sacramento County, California, near the city of Rancho Cordova, and just west of the base of the Sierra Nevada foothills and within the transition zone between the flat Sacramento Valley in the west and the Sierra Nevada range to the east. The westernmost portion of the region primarily consists of agricultural land uses bordering the suburban development that radiates out from the urban core of Sacramento, whereas the eastern portion of the region is characterized by the coniferous El Dorado National Forest. The landscape pattern is influenced by development sprawling from existing city cores and the major roadways, such as US 50, Interstate 80 (I-80), State Route (SR) 99, I-5, SR 16, and SR 49. This portion of the county primarily supports suburban land uses associated with Rancho Cordova, Folsom, Orangevale, Fair Oaks, and Gold River, in addition to open space and agricultural land uses.

The immediate project area is characterized by flat to gently sloping terrain. Development, transportation infrastructure, and foothills with mature trees and shrubs prevent full views of the Sierra Nevada range to the east, but the foothills are visible. Views toward the foothills improve the quality of views along the US 50 corridor; however, these views are not considered scenic vistas because highway overcrossings and vegetation along the corridor prevent more expansive, unhindered views of the foothills.

The land use within the corridor is primarily commercial, business park, and industrial uses along US 50, including Comfort Inn and Suites, California Backyard, Nimbus Winery Village including The Old Spaghetti Factory, Cattlemens, Folsom Auto Mall, and miscellaneous restaurants and office buildings. Also immediately north of the highway are recreational open space lands and associated facilities, including the American River Bike Trail, Lake Natoma Unit of the Folsom Lake State Recreation Area, Sacramento State Aquatics Center, Nimbus Fish Hatchery, and Folsom Dam. The Twilight Mobile Home Park and Oak Brook Apartments are the only residential land uses along the project corridor that are situated amongst the commercial development that is between US 50 and Folsom Boulevard. Wooden utility poles and lines, the light rail tracks, and the catenary overhead lines and support poles parallel Folsom Boulevard to the south. Lands south of Folsom Boulevard and the light rail tracks consist of a mixture of industrial warehouse facilities, paved or graveled lots, and vacant parcels that are vegetated with ruderal grasses and mature trees. The light rail station is also south of Folsom Boulevard and the light rail tracks, in addition to remnant dredger tailings from past mining operations. Transportation facilities are a dominant visual feature in the project vicinity and include US 50, Hazel Avenue, Sunrise Boulevard, Folsom Boulevard, and the light rail. In addition, the American River Bike Trail, which goes from downtown Sacramento to the city of Folsom, passes along the project area to the north. Water bodies in the project vicinity include the American River, Folsom Lake, Lake Natoma, and the Folsom South Canal.

There are no roadways in or near the project area that are designated in federal or state plans as a scenic highway or route worthy of protection for maintaining and enhancing scenic viewsheds (California Department of Transportation 2017a). In addition, the portion of US 50 affected by the proposed project is not a classified Landscaped Freeway (California Department of Transportation 2016a). However, the Sacramento County General Plan Circulation Element applies scenic corridor protections to freeway corridors in the county, which includes the portion of US 50 affected by the project (Sacramento County 2014).

V. ASSESSMENT METHOD

This visual impact assessment generally follows the guidance outlined in the publication *Visual Impact Assessment for Highway Projects* published by the Federal Highway Administration (FHWA) in March 1988 (Federal Highway Administration 1988).The following steps were followed to assess the potential visual impacts of the proposed project:

Define the project location and setting.

A. Identify visual assessment units and key views.

B. Analyze existing visual resources, resource change and viewer response.

C. Depict *(or describe)* the visual appearance of project alternatives.

D. Assess the visual impacts of project alternatives.

E. Propose measures to offset visual impacts.

Using the concepts and terminology, described above, and the criteria for determining significance (see *Section VII*, *Visual Resources and Resource Change*, below), analysis of the visual effects of the proposed project is based on the following methods.

A. Observation from vantage points, including neighboring buildings, property, and roadways (conducted April 6, 2017).

B. Photographic documentation of key views of and from the project site, as well as the regional visual context.

C. A review of project construction drawings.

D. A review of the project in regard to compliance with state and local ordinances and regulations and professional standards pertaining to visual quality.

E. Evaluation and analysis of photographic simulations.

VI. VISUAL ASSESSMENT UNITS AND KEY VIEWS

The project corridor was divided into a series of "outdoor rooms" or *visual assessment units* (VAUs). Each VAU has its own visual character and visual quality. It is typically defined by the limits of a particular viewshed. For this project, the area surrounding the project area has been subdivided into four VAUs based on specific vantage points and differing sensitivities of those affected by the proposed project. The VAUs are shown in Figure 4 and are designated as the Freeway, Recreational, Residential, and Commercial VAUs. Four key views (shown in *Section IX, Visual Impacts*) have been chosen for their representation of the VAU within which they are located and those viewers affected and are also shown in Figure 4.

- **US 50 VAU:** The existing US 50 corridor is generally at-grade, varies from three to five lanes in each direction with paved shoulders, and has a continuous concrete barrier in the median. Views of the bordering VAUs are present to the northwest and southeast when traveling either northeast or southwest (refer to Key View [KV] 1a and KV 1b in *Section IX, Visual Impacts*). Views in this unit are mostly limited by the adjacent commercial and industrial development; sound walls by residential areas; trees and shrubs associated with residential, open space, and commercial areas; and gently rolling terrain on either side of the corridor that acts to limit views to the immediate land uses bordering the highway corridor along this segment of US 50. Overcrossings also limit views down the corridor and often prevent views beyond the structure. Views in this VAU are largely of grassy terrain, trees and shrubs, buildings and signage associated with the adjacent commercial and industrial land uses to the north and south, sound walls, highway signage, bridges crossing

over US 50, and the immediate paved surface of the highway. Vegetation along the highway shoulders consists of unlandscaped grasslands and some mature trees. This VAU also includes the interchange ramps associated with the project at Hazel Avenue and Folsom Boulevard. Both interchange loops are vegetated with grasslands and mature trees and shrubs. Views toward the foothills are available to varying degrees when looking east down the highway corridor. Current lighting along the US 50 corridor is focused at the existing interchanges. Lighting is also associated with vehicle headlights and nearby businesses and residences, including interior and exterior building lighting and overhead lighting within parking lots.

- **Recreational VAU:** The Recreational VAU consists of open space lands associated with the Lake Natoma Unit of the Folsom Lake State Recreation Area (recreation area), Jedediah Smith Memorial Trail, and American River Bike Trail, which uses the bikeway and pedestrian overcrossing to cross US 50 and then terminates at Folsom Boulevard. These open space areas support land- and water-based recreational uses that border the project, in addition to parking lots for the recreation area (refer to KV 2a and 2b in *Section IX, Visual Impacts*). The trail system within the recreation area passes close to the project corridor and the Alder Creek arm of Lake Natoma abuts the highway. The trails travel over flat to gently rolling terrain, through grasslands and oak woodlands associated with upland areas, and pass by riparian corridors associated with the lake. These open space and recreational areas are used for biking, walking, running, sight-seeing, photography, swimming, canoeing, kayaking, paddle boarding, and fishing. Views within the unit include views of the natural landscape and the surrounding US 50 and Commercial VAUs. However, vegetation within the recreation area limits views within this unit and many views are focused on the surrounding natural landscape and the lake and not on US 50. The recreation area is not lit; however, the Park & Ride lot has minimal overhead security lighting.
- **Commercial VAU:** Commercial uses in this unit include furniture stores (Naturwood, La-Z-Boy, and California Backyard), Comfort Inn and Suites, restaurants (The Old Spaghetti Factory, Cattlemens, Taco Bell, Samurai Sushi, Ruby's Hideaway), Sentry Storage, Gold Point Office Park, Folsom Auto Mall, Nimbus Winery Village, gas stations, and smaller businesses, banking, and retail uses. The Hazel light rail station and Sacramento Metro Fire Station 63 are also within this VAU amongst the commercial development. Aboveground utilities (e.g., roadway lights, traffic lights, wooden utility poles, steel transmission towers, and utility lines) are prominent features in the viewshed (refer to KV 3 in *Section IX, Visual Impacts*). This unit has the most direct views of the project site because it is the largest VAU adjacent to the project site and also has the most unobstructed views of the US 50 corridor, the US 50/Hazel Avenue Interchange, and Folsom Boulevard (refer to KV 4a and 4qab in *Section IX, Visual Impacts*). Trees and shrubs buffer some views toward the project site from this unit but views of the project corridor are available from buildings and parking lots that border the project corridor where landscaping is limited. Lighting within this unit includes safety lighting from interior and exterior building lighting, vehicle headlights, parking lot lighting, landscape lighting, and street and traffic lights.
- **Residential VAU:** The single-story Twilight Mobile Home Park and two-story Oak Brook Apartments are the only residential land uses along the project corridor and abut each other. The mobile home park is separated from US 50 by a sound wall, parking for the Nimbus Winery Village and Cattlemens businesses, and mature landscaping associated with the commercial parking lot and the mobile home park. Similarly, the Oak Brook Apartments are separated from US 50 by a sound wall, apartment carports, and mature landscaping associated with the commercial parking lots and the apartments. First-story views of US 50 are not available from the mobile home park and the apartments because views are limited by residential and commercial structures, landscaping, and sound walls. However, one apartment building is located adjacent to US 50 and second story units that face US 50 have views of the highway corridor. Lighting within this VAU is concentrated within the residential developments and is associated with interior and exterior house lighting, landscape lighting, vehicle headlights, and street and parking lot lighting.

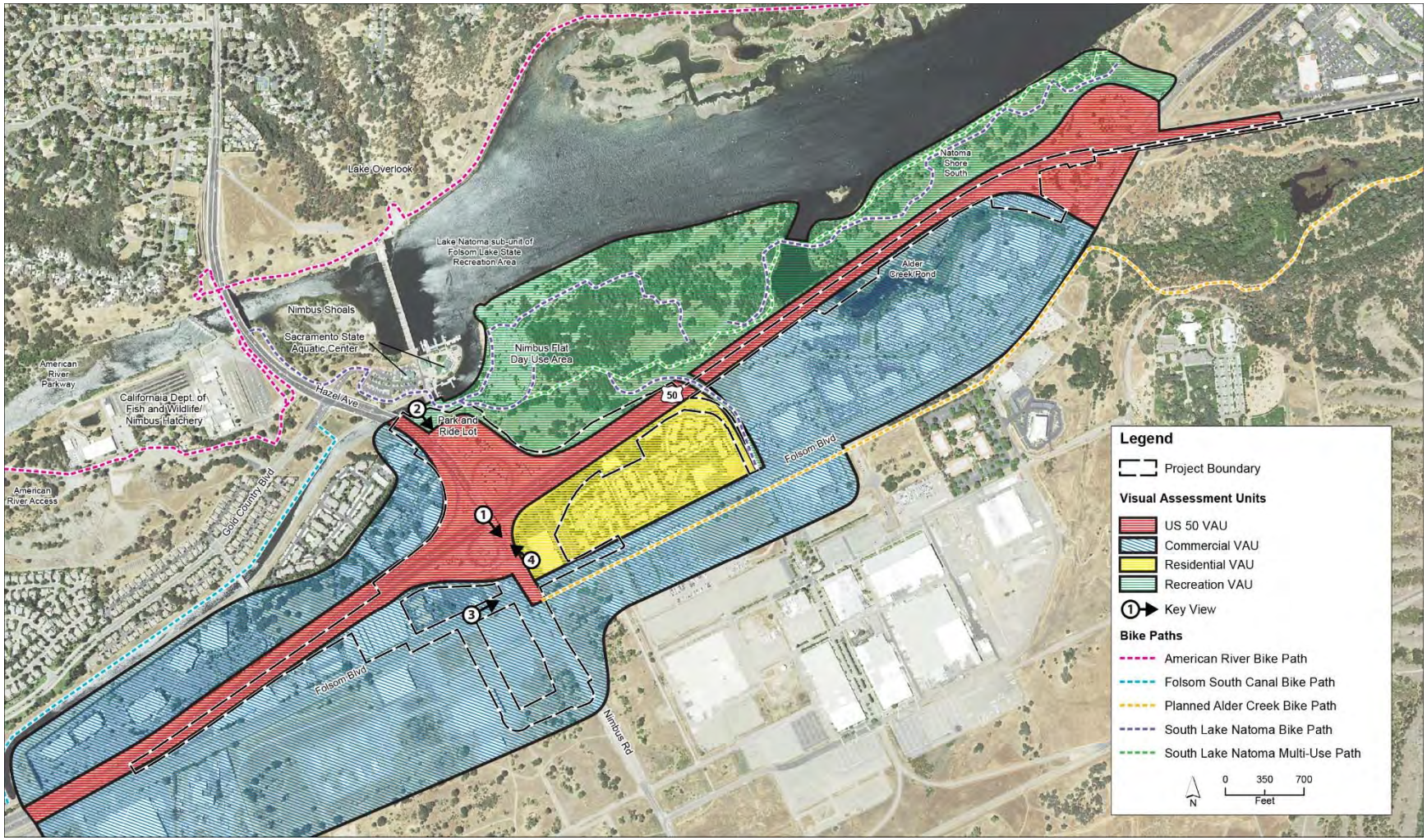


Figure 4. Visual Assessment Units—This map delineates four visual assessment units and their associated key views that will be used to assess visual impacts that may be caused by the proposed project. Each visual assessment unit is differentiated from other units both by its dimensions and its visual resources.

VII. VISUAL RESOURCES AND RESOURCE CHANGE

Resource change is assessed by evaluating the visual character and the visual quality of the visual resources that comprise the project corridor before and after the construction of the proposed project. Resource change is one of the two major variables in the equation that determine visual impacts (the other is *viewer response*, discussed below in *Section VIII, Viewers and Viewer Response*).

With an establishment of the baseline (existing) conditions, a proposed project or other change to the landscape can be systematically evaluated for its degree of impact. The degree of impact depends on both the magnitude of change in the visual resource (i.e., the visual character and quality) and on viewers' responses to and concern about those changes. This general process is similar for all established federal procedures of visual assessment (Smardon et al. 1986) and represents a suitable methodology of visual assessment for other projects and areas.

The approach for this visual assessment is adapted from the FHWA's visual impact assessment system (Federal Highway Administration 1988) in combination with other established visual assessment systems. The visual impact assessment process involves the identification of the following.

- Relevant policies and concerns for the protection of visual resources.
- Visual resources (i.e., the visual character and quality) of the region, the immediate project area, and the project site.
- Important viewing locations (e.g., roads) and the general visibility of the project area and site using descriptions and photographs.
- Viewer groups and their sensitivity.
- Potential impacts.

Visual Resources

Visual resources of the project setting are defined and identified below by assessing visual character and visual quality in the project corridor.

VISUAL CHARACTER

Visual character includes attributes such as form, line, color, texture, and is used to describe, not evaluate; accordingly, these attributes are neither considered good nor bad. However, a change in visual character can be evaluated when it is compared with the viewer response to that change. Changes in visual character can be quantified by identifying how visually compatible a proposed project would be with the existing condition by using visual character attributes as an indicator. For this project the following attributes were considered:

- **Form**—visual mass or shape.
- **Line**—edges or linear definition.
- **Color**—reflective brightness (light, dark) and hue (red, green).
- **Texture**—surface coarseness.
- **Dominance**—position, size, or contrast.
- **Scale**—apparent size as it relates to the surroundings.
- **Diversity**—a variety of visual patterns.

- **Continuity**—uninterrupted flow of form, line, color, or textural pattern.

The visual character of the proposed project would be somewhat compatible with the existing visual character of the corridor. The topography in the VAUs is flat to gently rolling along the highway corridor. Buildings associated with commercial areas are larger in form and scale than those of single- and multi-family residential development. The existing US 50 corridor has a low to moderate profile within the landscape and includes a number of interchanges and overcrossings that tend to draw attention toward transportation facilities. Although the overcrossings are visually apparent, they do not dominate viewsheds because they are in keeping with the many transportation facilities located within the project vicinity. Vegetation in the VAUs vary from grasslands that grow to a low height and are not manicured with trees and shrubs growing naturally within grassland areas and along waterways, to more manicured lawns and trees and shrubs planted for landscaping that is associated with residential and business areas—giving an overall medium- to coarse-textured appearance in the project area. The color of vegetation generally changes seasonally in correspondence to the amount of rain in the region and ranges from tan grasses and green trees in summer and dryer, warmer months to green grass and dormant trees in winter and when cool air and rain are present. In addition, evergreen species provide greenery year-round. The VAUs associated with the project are fairly well-lit, except for open space areas.

VISUAL QUALITY

Visual quality is evaluated by identifying the vividness, intactness, and unity present in the project corridor. Public attitudes validate the assessed level of quality and predict how changes to the project corridor can affect these attitudes. This process helps identify specific methods for addressing each visual impact that may occur as a result of the project. The three criteria for evaluating visual quality are defined below:

- **Vividness** is the extent to which the landscape is memorable and is associated with distinctive, contrasting, and diverse visual elements.
- **Intactness** is the integrity of visual features in the landscape and the extent to which the existing landscape is free from non-typical visual intrusions.
- **Unity** is the extent to which all visual elements combine to form a coherent, harmonious visual pattern.

In addition to their use as descriptors, vividness, intactness, and unity are used more objectively as part of a rating system to assess a landscape's visual quality. Visual quality is evaluated using the equation:

$$\text{Visual Quality (VQ)} = \frac{\text{Vividness (V)} + \text{Intactness (I)} + \text{Unity (U)}}{3}$$

Vividness, intactness, and unity are evaluated independently; each quality is assigned a rating from 0.0–7.0. On this scale, 0.0 = very low, 4.0 = average/moderate, and 7.0 = very high (see Table 1).

Table 1. Comparing Numerical and Narrative Ratings of Visual Quality (VQ)

Viewer Quality Numerical Rating	0 to 1.4	1. 5 to 2.4	2.5 to 3.4	3.5 to 4.4	4.5 to 5.4	5.5 to 6.4	6.5 to 7.0
Equivalent Visual Quality Narrative Rating	Very Low	Low	Moderate-Low	Moderate	Moderate-High	High	Very High

The overall rating for visual quality follows the same 0.0–7.0 range. Ratings have been included in parentheses (e.g., VQ = 2.0) in the visual quality description of the VAUs.

The visual quality of the existing corridor would be altered by the proposed project. *Section IX, Visual Impacts* describes proposed changes to the visual quality. The existing visual quality for each VAU is as follows.

- **US 50 VAU:** The vividness of this VAU along the US 50 corridor is moderately high (V = 5.0) because although development along the highway is noticeable and highway infrastructure (e.g., sound walls, guardrails, overcrossings, bridges, light standards, and other barriers) interrupts views of the Sierra Nevada range and foothills, the surrounding landscape and vegetation associated with nearby VAUs provides visual interest and improves the appearance of the right-of-way. Utilities along Folsom Boulevard can be seen from US 50 but they do not detract greatly from the corridor. The intactness and unity are moderate (I & U = 4.5) because sound walls and vegetation block portions of development, and mature trees and shrubs are prominent in the corridor—softening the appearance of the corridor's edges and reducing the apparent scale of overcrossings. The resulting visual quality the US 50 corridor is moderately high (VQ = 4.7). The vividness of this VAU along the Hazel Avenue corridor (KV 1) is moderate (V = 4.0) because development, the roadway corridor, and utilities along the roadway are prominent features that interrupt and draw attention away from views of the surrounding trees and landscape. The intactness and unity are moderate (I & U = 4.0) because utilities along Hazel Avenue and Nimbus Road, beyond, detract from views of the corridor. However, mature trees and shrubs are prominent in the corridor and obscure and soften views of the surrounding development. The resulting visual quality of the Hazel Avenue corridor is moderate (VQ = 4.0).
- **Recreational VAU:** The vividness of this VAU is high (V = 6.0) because the Recreational VAU provides visually appealing natural areas in an otherwise developed area. The intactness and unity are high (I & U = 5.5) because although the recreational open space area is not very disjointed, and encroachments that could detract from the unit are minimal, large, paved parking areas with little vegetation are visible elements within this VAU. Mature vegetation obscures portions of nearby development and helps to reduce the apparent scale of highway infrastructure and visible development within neighboring VAUs. The resulting visual quality is high (VQ = 5.7). The vividness of this VAU closer to the Nimbus Flat entry drive (KV 2), however, is moderate (V = 4.0) because development, the roadway corridor, and utilities along the roadway are prominent features that interrupt and draw attention away from views of the surrounding trees and landscape. The intactness and unity are moderate (I & U = 4.0) because utilities, street and traffic lighting along Hazel Avenue, and highway infrastructure are more prominent at this location. The resulting visual quality of KV2 is moderate (VQ = 4.0).
- **Commercial VAU:** The vividness of this VAU is moderate (V = 3.5) because the various commercial and industrial buildings and vacant lots in the unit that are typical of other such development in the region. They contain larger- to smaller-scale buildings and parking lots that sometimes lack mature landscaping to offset the scale of development. These areas have limited views of the US 50 corridor and of the Residential and Recreational VAUs. The intactness and unity are moderate (I & U = 3.5) because the commercial development in the area is fairly consistent but there are some abrupt transitions between developed land uses and vacant lots. In addition, smaller-scale utilities are present, but large-scale utility corridors that often detract from views in the region are minimal. The resulting visual quality is moderate (VQ = 3.5) and both KV 3 and KV 4 are consistent with this rating.
- **Residential VAU:** The vividness of this VAU is moderate (V = 4.0) because the housing units in this VAU are fairly well-kept. These areas have limited views of the US 50 corridor, open space areas, and commercial land uses in the area due to sound barriers, vegetation, and adjacent residential structures that limit views. The project corridor is not a dominant visual element in the landscape. The intactness and unity are

moderately low (I & U = 3.5) because the area is not uniformly developed and there is an abrupt transition between residential land uses and the surrounding commercial land uses. The resulting visual quality is moderately low (VQ = 3.7).

Resource Change

The proposed project would construct a larger, more complex interchange system with expanded ramps and taller structures of varying heights where a smaller, less complex interchange system with one overcrossing presently exists. The highest degree of change would occur from introducing the elevated viaduct or flyover structures, expanded roadside embankments, and retaining wall structures. The project would also require conversion of existing commercial land uses to accommodate the modified ramp systems that would be visible from the US 50, Recreational, and Commercial VAUs. In addition, vegetation removal would be required to accommodate the modified interchange and roadway widening. The resource change would range from low to moderate (refer to Tables 7, 11, 15, 19, 23, 27, 31, 35 and 39 in *Section IX, Visual Impacts*).

VIII. VIEWERS AND VIEWER RESPONSE

The population affected by the project is composed of *viewers*. Viewers are people whose views of the landscape may be altered by the proposed project—either because the landscape itself has changed or their perception of the landscape has changed.

Viewers, or more specifically the response that viewers have to changes in their visual environment, are one of two variables that determine the extent of visual impacts that will be caused by the construction and operation of the proposed project. The other variable is the change to visual resources discussed earlier in *Section VII, Visual Resources and Resource Change*.

Types of Viewers

There are two major types of viewer groups for highway projects: highway neighbors and highway users. Each viewer group has their own particular level of *viewer exposure* and *viewer sensitivity*, resulting in distinct and predictable visual concerns for each group which help to predict their responses to visual changes.

HIGHWAY NEIGHBORS (Views *to* the Road)

Highway neighbors are people who have views *to* the road. They can be subdivided into different viewer groups by land use. For example, residential, commercial, industrial, retail, institutional, civic, educational, recreational, and agricultural land uses may generate highway neighbors or viewer groups with distinct reasons for being in the corridor and therefore having distinct responses to changes in visual resources. For this project, the following highway neighbors were considered:

- Residents within the Residential VAU.
- Workers and patrons within the Commercial VAU.
- Recreationists within the Recreational and Commercial VAUs.
- Roadway users within Residential and Commercial VAUs.

HIGHWAY USERS (Views *from* the Road)

Highway users are people who have views *from* the road. They can be subdivided into different viewer groups in two different ways—by mode of travel or by reason for travel. For example, subdividing highway users by mode of travel may yield pedestrians, bicyclists, transit riders, car drivers and passengers, and truck drivers. Dividing highway users or viewer groups by reason for travel creates categories like tourists, commuters, and haulers. It is also possible to use both mode and reason for travel simultaneously, creating a

category like *bicycling tourists,* for example. For this project, the following highway users were considered within the US 50 VAU:

- Recreational travelers
- Local commuters
- Haulers

Viewer Response

Viewer response is a measure or prediction of the viewer's reaction to changes in the visual environment and has two dimensions as previously mentioned, viewer exposure and viewer sensitivity.

VIEWER EXPOSURE

Viewer exposure is a measure of the viewer's ability to see a particular object. Viewer exposure has three attributes: location, quantity, and duration. *Location* relates to the position of the viewer in relationship to the object being viewed. The closer the viewer is to the object, the more exposure. *Quantity* refers to how many people see the object. The more people who can see an object or the greater frequency an object is seen, the more exposure the object has to viewers. *Duration* refers to how long a viewer is able to keep an object in view. The longer an object can be kept in view, the more exposure. High viewer exposure helps predict that viewers will have a response to a visual change.

Roadway users within the US 50 VAU represent the largest number of viewers who would come into direct visual contact with the proposed project. It is estimated that between 2,827 and 6,779 vehicles per hour travel in each direction on US 50 through the project area during peak hours.[1] Views of the interchange from US 50 would be most apparent as drivers are about to enter the interchange because development, vegetation, and curvature of the road obscure views. However, many roadway users likely travel this route on a daily basis for work commutes. Roadway users' exposure would range from moderate-high to high based on traffic volumes.

Roadway neighbors constitute viewers who would have longer-term, stationary views (residents and businesses) and viewers who would have shorter-term, transient views (recreationists and roadway travelers on nearby local roadways) as they pass by the proposed project. Roadway neighbors' views of the project vary based on location within the landscape and distance from the project site. A limited amount of roadway neighbors have immediate and direct views of the project site, including stationary views from the buildings, parking lots, and trails that are directly adjacent to the project site. Direct views of the project site are also available to transient viewers approaching and passing the project site, such as along Folsom Boulevard. Most roadway neighbors do not have immediate and direct views of the project because views are limited by development, vegetation, and topography. Views of the project site from a distance are not available because development, vegetation, and topography intervene and prevent such views. Residents would have moderate-high exposure, businesses would have high exposure, and transient roadway neighbors would have moderate exposure.

VIEWER SENSITIVITY

Viewer sensitivity is a measure of the viewer's recognition of a particular object. It has three attributes: activity, awareness, and local values. *Activity* relates to the preoccupation of viewers—are they preoccupied, thinking of something else, or are they truly engaged in observing their surroundings. The more they are

[1] Refer to Figure 5-1 of the *Transportation Operations Report* (DKS 2016) for more information. The numbers provided include the totals for the Mixed lanes plus the HOV lanes to determine the total number of vehicles traveling at peak hours.

actually observing their surroundings, the more sensitivity viewers will have of changes to visual resources. *Awareness* relates to the focus of view—the focus is wide and the view general or the focus is narrow and the view specific. The more specific the awareness, the more sensitive a viewer is to change. *Local values* and attitudes also affect viewer sensitivity. If the viewer group values aesthetics in general or if a specific visual resource has been protected by local, state, or national designation, it is likely that viewers will be more sensitive to visible changes. High viewer sensitivity helps predict that viewers will have a high concern for any visual change.

The proposed project is in an area that is established and primarily undergoes infill land development. However, all viewer groups are familiar with maintenance and construction activities occurring on local roadways within and in proximity to the project site. Roadway users would have moderate to moderate-high sensitivity to visual changes resulting from the project. Although viewers would have direct visual contact with the project only while travelling through the area and views would be intermittent, many roadway users travel this route on a daily basis for work commutes and are familiar with the existing visual conditions. Roadway neighbors would have moderate-high to high sensitivity to visual changes resulting from the project because the neighbors that are adjacent to or in proximity to the project site have short- to long-term stationary and transient views of the US 50 corridor and the vegetation located adjacent to the right-of-way.

REGULATIONS

No roadways within or near the project area are designated in federal or state plans as a scenic highway or route worthy of protection for maintaining and enhancing scenic viewsheds (California Department of Transportation 2017a).

Sacramento County General Plan

The following local regulations from the *Sacramento County General Plan of 2005–2030* apply to visual resources in the project area.

Circulation Element Policies

The Circulation Element applies scenic corridor protections to freeway corridors, which extend 660 feet to each side beyond the right-of-way, in Sacramento County (County) and that include the portion of US 50 affected by the project (Sacramento County 2014).

CI-51. Strengthen the scenic corridor provisions of the Zoning Code to require design review of all signs and other structures within the corridor, with the exception of single-family homes and agricultural related structures and appurtenances consistent with existing zoning.

CI-52. Fully enforce all sign controls in the scenic corridors.

CI-53. Roadway improvements along established scenic corridors shall be designed and constructed so as to minimize impacts to the scenic qualities of the corridor.

CI-59. Encourage Caltrans to landscape the freeways within Sacramento County, particularly stretches which form entrances to urban areas.

CI-60. Encourage maintenance of natural roadside vegetation and landscaping with native plants which usually provide the best habitats for native wildlife.

CI-62. Investigate in coordination with other County agencies the provision along scenic corridors of rustic or distinctive sign groupings, bridges, roadside barriers, and road striping.

CI-63. Investigate in coordination with other County agencies the provision of distinctive planting schemes, vista points, and picnic areas along scenic corridors.

CI-64. Investigate in coordination with other County agencies the routing of bike trails and equestrian paths along scenic corridors.

CI-65. Incorporate Low Impact Design (LID) techniques to the greatest extent feasible to improve water quality runoff and erosion control, infiltration, groundwater recharge, visual aesthetics, etc. LID techniques may include but are not limited to:

- Bioretention techniques, such as filtration strips, swales, and tree box filters
- Permeable hardscape
- Green roofs
- Erosion and sediment controls
- Reduced street and lane widths where appropriate

CI-67. When feasible, incorporate lighter colored (higher albedo) materials and surfaces, such as lighter-colored pavements, and encourage the creation of tree canopy to reduce the built environment's absorption of heat to reduce the urban "heat island" effect.

CI-68. Smart Growth Street planning efforts shall identify specific, implementable measures to create and/or improve community identity.

CI-69. Incorporate public art into streetscape improvements to the extent feasible.

CI-70. Smart Growth Streets shall incorporate features such as shade trees and plantings, well designed benches and other street furniture, trash receptacles, news racks, outdoor dining experiences, entertainment, public art, pedestrian scaled lighting fixtures, wayfinding signage, bicycle racks and other amenities as appropriate.

Conservation Element Policies
The following Conservation Element regulations apply to visual resources in the project area (Sacramento County 2016).

CO-117. Public roads, parking, and associated fill slopes shall be located outside of the stream corridor, except at stream crossings and for purposes of extending or setting back levees. The construction of public roads and parking should utilize structural materials to facilitate permeability. Crossings shall be minimized and be aesthetically compatible with naturalistic values of the stream channel.

CO-123. The use of native plant species shall be encouraged on revegetation plans.

CO-137. Mitigate for the loss of native trees for road expansion and development consistent with General Plan policies and/or the County Tree Preservation Ordinance.

CO-138. Protect and preserve non-oak native trees along riparian areas if used by Swainson's Hawk, as well as landmark and native oak trees measuring a minimum of 6 inches in diameter or 10 inches aggregate for multi-trunk trees at 4.5 feet above ground.

CO-139. Native trees other than oaks, which cannot be protected through development, shall be replaced with in-kind species in accordance with established tree planting specifications, the combined diameter of which shall equal the combined diameter of the trees removed.

CO-140. For projects involving native oak woodlands, oak savannah or mixed riparian areas, ensure mitigation through either of the following methods:

- An adopted habitat conservation plan.
- Ensure no net loss of canopy area through a combination of the following: (1) preserving the main, central portions of consolidated and isolated groves constituting the existing canopy and (2) provide an area on-site to mitigate any canopy lost. Native oak mitigation area must be a contiguous area on-site which is equal to the size of canopy area lost and shall be adjacent to existing oak canopy to ensure opportunities for regeneration.
- Removal of native oaks shall be compensated with native oak species with a minimum of a one to one dbh replacement.
- A provision for a comparable on-site area for the propagation of oak trees may substitute for replacement tree planting requirements at the discretion of the County Tree Coordinator when removal of a mature oak tree is necessary.
- If the project site is not capable of supporting all the required replacement trees, a sum equivalent to the replacement cost of the number of trees that cannot be accommodated may be paid to the County's Tree Preservation Fund or another appropriate tree preservation fund.
- If on-site mitigation is not possible given site limitation, off-site mitigation may be considered. Such a mitigation area must meet all of the following criteria to preserve, enhance, and maintain a natural woodland habitat in perpetuity, preferably by transfer of title to an appropriate public entity. Protected woodland habitat could be used as a suitable site for replacement tree plantings required by ordinances or other mitigations.
    - Equal or greater in area to the total area that is included within a radius of 30 feet of the dripline of all trees to be removed;
    - Adjacent to protected stream corridor or other preserved natural areas;
    - Supports a significant number of native broadleaf trees; and
    - Offers good potential for continued regeneration of an integrated woodland community.

CO-141. In 15 years the native oak canopy within on-site mitigation areas shall be 50 percent canopy coverage for valley oak and 30 percent canopy coverage for blue oak and other native oaks.

CO-145. Removal of non-native tree canopy for development shall be mitigated by creation of new tree canopy equivalent to the acreage of non-native tree canopy removed. New tree canopy acreage shall be calculated using the 15-year shade cover values for tree species.

CO-146. If new tree canopy cannot be created onsite to mitigate for the non-native tree canopy removed for new development, project proponents (including public agencies) shall contribute to the Greenprint funding in an amount proportional to the tree canopy of the specific project.

CO-147. Increase the number of trees planted within residential lots and within new and existing parking lots.

CO-148. Support private foundations with local funds for their tree planting efforts.

CO-149. Trees planted within new or existing parking lots should utilize pervious cement and structured soils in a radius from the base of the tree necessary to maximize water infiltration sufficient to sustain the tree at full growth.

Economic Development Element Policies
The following Economic Development Element regulations apply to visual resources in the project area (Sacramento County 2011).

ED-12. Improve the physical appearance and character of commercial corridors to attract new retail activity, solve functional and infrastructure issues, and create active and exciting corridors that serve as integral pieces of neighborhoods and communities.

Land Use Element Policies
The following Land Use Element regulations apply to visual resources in the project area (Sacramento County 2016).

LU-18. Encourage development that complements the aesthetic style and character of existing development nearby to help build a cohesive identity for the area.

LU-19. Incompatible urban land uses should be buffered from one another by methods that retain community character, and do not consume large land areas or create pedestrian barriers.

LU-20. Planning processes for existing communities, commercial corridors and new growth areas shall provide for distinct and identifying physical elements, which may include: gateways, signage, public art, common site or street layout, shared design qualities of buildings or infrastructure, or prominent landmarks or destinations.

LU-27. Provide safe, interesting and convenient environments for pedestrians and bicyclists, including inviting and adequately-lit streetscapes, networks of trails, paths and parks and open spaces located near residences, to encourage regular exercise and reduce vehicular emissions.

LU-31. Strive to achieve a natural nighttime environment and an uncompromised public view of the night sky by reducing light pollution.

LU-38. Community Plans, Specific Plans, and development projects shall be designed to promote pedestrian movement through direct, safe, and pleasant routes that connect destinations inside and outside the plan or project area.

LU-39. Support implementation of the ADA Transitional Plan and the Pedestrian Master Plan to create a network of safe, accessible and appealing pedestrian facilities and environments.

LU-42. Master planning efforts for new growth areas shall provide for separated sidewalks along all arterials and thoroughfares to make walking a safer and more attractive transportation option.

e Focus investment of County resources in commercial corridors to facilitate improvements to streetscapes, sidewalks, landscaping, undergrounding of utilities, and other infrastructure and public amenities to encourage and stimulate private investment.

LU-102. Ensure that the structural design, aesthetics and site layout of new developments is compatible and interconnected with existing development.

LU-103. Neighborhood identity should be maintained and/or enhanced in existing and developing areas.

LU-104. All redevelopment, revitalization and commercial corridor planning efforts shall include specific provisions to create and/or enhance community identity.

Open Space Element Policies
The following Open Space Element regulations apply to visual resources in the project area (Sacramento County 2014).

OS-13. Permit development clustering in urban areas where grouping of units at a higher density would facilitate on-site protection of woodlands, wetlands, steep slopes, urban stream corridors, scenic areas, or other appropriate natural features as open space, provided that:

- Urban infrastructure capacity is available for urban use.
- On-site resource protection is appropriate and consistent with other General Plan Policies.
- General Plan policies pertaining to floodplain fill or natural preserves would not preclude development of the proposed use in the area to be protected as open space.
- The architecture and scale of development is appropriate for the area.
- Development rights for open space areas are permanently dedicated via conservation easements and appropriate long-term management is provided for by either a public agency or other appropriate entity.

Public Facilities Element Policies

The following Public Facilities Element regulations apply to visual resources in the project area (Sacramento County 2011).

PF-67. Cooperate with the serving utility in the location and design of production and distribution facilities so as to minimize visual intrusion problems in urban areas and areas of scenic and/or cultural value including the following:

- Recreation and historic areas.
- Scenic highways.
- Landscape corridors.
- State or federal designated wild and scenic rivers.
- Visually prominent locations such as ridges, designated scenic corridors, and open viewsheds.
- Native American sacred sites.

PF-68. Cooperate with the serving utility in the location and design of energy production and distribution facilities in a manner that is compatible with surrounding land uses by employing the following methods when appropriate to the site:

- Visually screen facilities with topography and existing vegetation and install site-appropriate landscaping consistent with surrounding land use zone development standards where appropriate, except where it would adversely affect access to utility facilities, photovoltaic performance or interfere with power generating capability.
- Provide site-compatible landscaping.
- Minimize glare through siting, facility design, nonreflective coatings, etc. except for the use of overhead conductors.
- Site facilities in a manner to equitably distribute their visual impacts in the immediate vicinity.

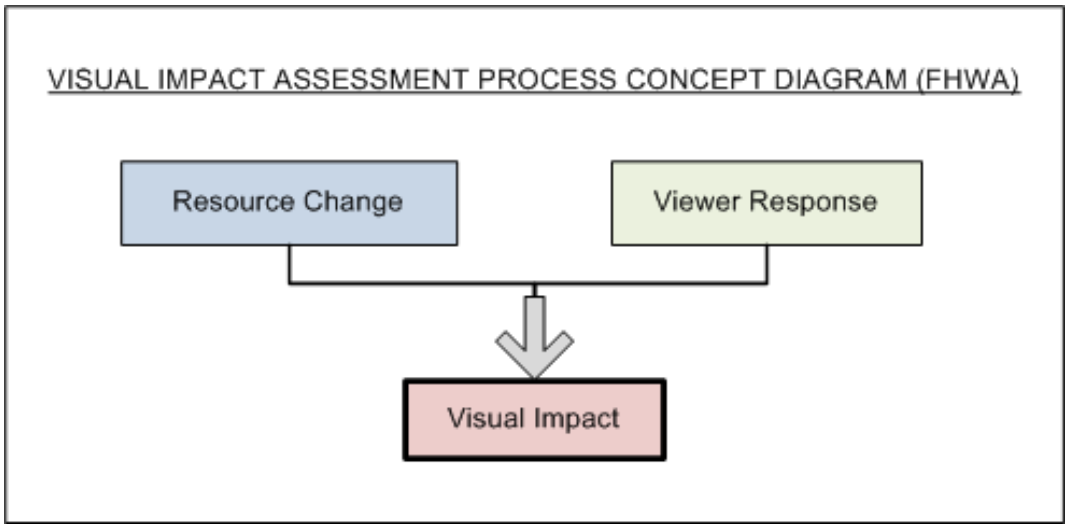
GROUP VIEWER RESPONSE

The narrative descriptions of viewer exposure and viewer sensitivity for each viewer group were merged to establish the overall viewer response of each group.

The roadway users viewer group has moderate-high to high exposure to the project site and moderate to moderate-high visual sensitivity. The response of roadway users to the project would be moderate-high to high. The roadway neighbors viewer group has a range in exposure. Residents would have moderate-high exposure, businesses would have high exposure, and transient recreationists and roadway neighbors would have moderate exposure. Roadway neighbor viewers have a moderate-high to high visual sensitivity. The response of roadway neighbors to the project would be moderate-high to high. These responses would result from project features that would alter the visual character of the interchange; remove vegetation; affect commercial parking lots and buildings, and be visually inconsistent with other nearby overcrossings, interchanges, and roadways combined with viewer familiarity with the project site.

IX. VISUAL IMPACT

Visual impacts are determined by assessing changes to the visual resources and predicting viewer response to those changes. These impacts can be beneficial or detrimental. Cumulative impacts and temporary impacts due to the contractor's operations are also considered. A generalized visual impact assessment process is illustrated in the following diagram:



Determining Resource Change

A numeric rating is used to determine the *visual resource change* and to compare the visual compatibility of project alternatives with the existing visual environment using a range from -7.0 to +7.0, where -7.0 is a highly negative change and +7.0 is a highly positive change. This is done for each key view. Visual resource change is determined using the following equation:

$$\text{Visual Resource Change (RC)} = \frac{\text{Visual Character Change (VC)} + \text{Visual Quality Change (VQ)}}{2}$$

To establish visual resource change, the change in visual character and visual quality must also first be determined for each key view. *Visual character change* evaluates the visual compatibility of each project alternative with the existing condition in terms of form, line, color, texture, dominance, scale, diversity, and continuity using a range from -3.0 to +3.0, where -3.0 represents poor compatibility and +3.0 is good compatibility.

Visual quality is determined using the equation (VQ = V+I+U/3) described in *Section VII, Visual Resources and Resource Change*. Visual quality change is determined using the following equation:

Visual Quality Change (VQC) = Alternative VQ Rating – Existing VQ Rating

If the average for "Alternative Rating" is less than the average for "Existing Rating," the VQC will be a negative change. If the average for "Alternative Rating" is greater than the average for "Existing Rating," the VQC will be a positive change.

Determining Viewer Response

Viewer response needs to be determined for each key viewpoint, considering viewer exposure and sensitivity, and using a range of 0.0 to 7.0, where a rating of 0.0 represents lower viewer response or exposure and 7.0, a higher viewer response or exposure. Visual response is determined using the following equation:

$$\text{Viewer Response (VR)} = \frac{\text{Viewer Exposure (E)} + \text{Viewer Sensitivity (S)}}{2}$$

Determining Visual Impacts

Table 2 provides a reference for comparing numerical ratings of visual resource change to the equivalent narrative ratings previously discussed in *Section VII, Visual Resources and Resource Change*.

Table 2. Comparing Numerical and Narrative Ratings of Visual Resource Change (RC)

	Negative Visual Resource Change								Positive Visual Resource Change						
(RC) Rating	-7.0	-6.0	-5.0	-4.0	-3.0	-2.0	-1.0	0	1.0	2.0	3.0	4.0	5.0	6.0	7.0
Equivalent Narrative Rating	High	High	Moderately High	Moderate	Moderate	Moderately Low	Low	No Change	Low	Moderately Low	Moderate	Moderate	Moderately High	High	High

Table 3 provides a reference for comparing numerical ratings of viewer response to the equivalent narrative ratings, to be used in *Section IX, Visual Impacts*.

Table 3. Comparing Numerical and Narrative Ratings of Viewer Response (VR)

Viewer Response Numerical Rating (VR)	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0
Equivalent Viewer Response Narrative Rating	Low	Low	Moderate-Low	Moderate	Moderate	Moderate-High	High	High

Table 4 provides a reference for determining levels of visual impact by combining resource change and viewer response.

Table 4. Visual Impact Ratings Using Viewer Response and Resource Change

		Viewer Response (VR)				
		Low (L)	Moderate-Low (ML)	Moderate (M)	Moderate-High (MH)	High (H)
Resource Change (RC)	Low (L)	L	ML	ML	M	M
	Moderate-Low (ML)	ML	ML	M	M	MH
	Moderate (M)	ML	M	M	MH	MH
	Moderate-High (MH)	M	M	MH	MH	H
	High (H)	M	MH	MH	H	H

Visual Impacts by Visual Assessment Unit and Alternative

Because it is not feasible to analyze all the views in which the proposed project would be seen, it is necessary to select a number of key views associated with VAUs that would most clearly demonstrate the change in the project's visual resources. Key views also represent the viewer groups that have the highest potential to be affected by the project considering exposure and sensitivity. In addition, these key views will be analyzed for each proposed alternative.

This VIA also considers the potential impacts of a No Build Alternative. Under the No Build Alternative, the project would not be constructed and there would be no visual impacts on the existing visual character, visual quality, or affected viewer groups. While maintenance activities such as repaving and restriping may occur in the foreseeable future along portions of the US 50 corridor, such maintenance activities are a part of the existing visual environment and they would not affect the existing visual character of the project area or negatively affect viewer groups. Such activities would be visible in the US 50 VAU and would be visible to only a limited degree to viewers in the Recreational, Residential, and Commercial VAUs.

The following section describes and illustrates visual impacts by VAU, compares existing conditions to the proposed alternatives, and includes the predicted viewer response.

US 50 VISUAL ASSESSMENT UNIT

Alternatives 1, 1A, and 2

The following construction and operation features would be the same or very similar under all three build alternatives.

Construction

There are no federal or state scenic roadways in or near the project area, so there would be no effect on such resources during construction. In addition, scenic vista views would not be affected during construction because the proposed project would not introduce features that would block or alter such views. However, the portion of US 50 affected by the project is a County scenic corridor.

The proposed project would take approximately 2 years to construct, beginning in 2020, with two major phases that have three sub-phases each. Each phase and sub-phase would occur consecutively. Alternative 2 would also have a smaller third phase with no sub-phases. Construction activities would introduce considerable heavy equipment and associated vehicles, including bulldozers/excavators, graders, water trucks, rollers/compactors, backhoes, tractors, cranes, pile drivers, asphalt pavers, and trucks, into the viewshed of highway users. Construction staging would occur within the right-of-way within the westbound US 50 ramp loops that are north of US 50 and east of Hazel Avenue and within the ramp loops for eastbound US 50 at Folsom Boulevard, which would be immediately visible to passing viewers. Construction signaling and signage would also be visible to direct traffic, signifying lane shifts and closures. The presence of construction activities and equipment would affect views of and from the project site during the construction period. Although construction would last for only 2 years, construction delays would likely be perceived as negative due to the level of traffic that passes through this area. Highway users are transient and familiar with heavy equipment associated with other highway construction projects; nevertheless, the proposed project and its alternatives constitute a major highway construction project that would affect the visual character views of roadway, which is a County scenic corridor.

Evening and nighttime construction activities would require the use of extremely bright lights, which would negatively affect highway users and nighttime views of and from the work area. Implementation of Mitigation Measure 1, *Minimize Fugitive Light from Portable Sources Used for Construction*, will reduce this impact by helping to prevent nuisance light spill during construction.

All project alternatives would include highway widening to accommodate the modified eastbound on- and off-ramps, ramp improvements, introduction of retaining wall structures and embankments, introduction of a bridge over the light rail tracks and Folsom Boulevard, a new roadway connecting Folsom Boulevard and Nimbus Road, vegetation removal, and changes to private properties. All of these project components would be visible to highway and roadway users within the US 50 VAU.

Some changes associated with the project alternatives would not greatly alter the existing visual character of the US 50 corridor, such as widening eastbound US 50 to the south between the Aerojet Road and Folsom Boulevard exits and modifying the Aerojet Road and Folsom Boulevard exit off-ramps from eastbound US 50. The widening of US 50 at this location and the widening of the Aerojet Road and Folsom Boulevard ramps would appear similar to existing visual conditions and would not constitute a substantial visual change to the roadway or scenic corridor or greatly increase daytime glare even though a few mature trees would need to be removed that are in proximity to the existing edge of pavement. In addition, the Hazel Avenue overcrossing would be replaced with a wider structure over US 50 to accommodate additional lanes under Alternatives 1 and 1A. Although the overcrossing would be widened, all of the features associated with the proposed overcrossing are visual elements of the existing overcrossing. The widened overcrossing would not significantly alter the existing visual character of the project area or scenic corridor as seen by highway users. All additions would be similar in appearance to existing facilities in the area. The Hazel Avenue overcrossing would remain the same width under Alternative 2. None of the alternatives would widen westbound US 50. Utility relocations would also occur to accommodate the proposed project alternatives but would only result in minor visual changes as the modifications are occurring and would not result in substantial visual changes once built because they are minor changes or in keeping with existing visual conditions associated with the roadway and scenic corridor.

Changes to the north of US 50 would be noticeable and focus on the ramps that are east of Hazel Avenue because the ramps to the west of Hazel Avenue would not be modified. All alternatives would create an independent bicycle off-ramp in the same location, which connects Hazel Avenue to the Nimbus Flat entrance of the recreation area, and the Hazel Avenue on-ramp to westbound US 50 would be widened and modified to skirt the outer edge of the bicycle off-ramp. The existing on-ramp would be restored by removing

the pavement, re-grading the terrain, and by hydroseeding the exposed soils. In addition, all alternatives would shift the Park & Ride lot further north to directly border the Nimbus Flat entry drive, removing the existing grassy median that separates the parking lot from the entry drive. Removal of mature trees and shrubs within the ramp loops that are north of US 50 and east of Hazel Avenue would be required because of the ramp modifications and construction staging that would occur at this location. This would reduce the amount of landscape and quality of views that is currently seen at this location and along the scenic corridor. Grassland areas along the right-of-way would also be reduced to accommodate highway widening. The visual character of the roadway and scenic corridor would be negatively affected by removal of mature trees and shrubs (that are aesthetic resources) within ramp loops and on the edges of the right-of-way to accommodate widening and the new and reconfigured interchange ramps.

Bridge and ramp embankments would also be modified and constructed to support the widenings and new ramps that would stand out slightly and increase the presence of such features in the area. Placement of fill would introduce new landforms into views, but the embankments would be similar to the existing landforms associated with US 50. Improvements to the highway are required to comply with the Caltrans Highway Design Manual (HDM), which utilizes Context Sensitive Solutions consistent with Director's Policy DP-22 (California Department of Transportation 2011). This includes implementing Design Standards 304.1, *Side Slope Standards*; 304.4, *Contour Grading and Slope Rounding*; and 902.1, *Design Considerations, Aesthetics*. These design standards require that slopes be graded to 4:1 or flatter; gentle, smooth, and well transitioned with slope rounding and topsoil replacement; have flowing contours that tie gracefully into the existing adjacent roadside and landforms; and that steep, obvious cuts and fills be avoided to improve project aesthetics associated with roadside slopes. In addition, these design standards require that replanting reflect adjacent communities and natural surroundings, serve as a visual buffer for objectionable views of the highway facility for adjacent land uses, soften visual impacts associated with graded slopes and large structures; and act to frame or enhance good views. (California Department of Transportation 2016b). The proposed project would comply with these standards. Compliance with these HDM design standards would aid in minimizing visual impacts associated with roadside grading and slopes and would reduce impacts to the scenic corridor. Implementation of Mitigation Measure 2, *Implement Interchange and Slope Landscaping and Visual Buffers*, will further reduce this impact by creating seasonal visual interest, re-landscaping ramp loops, replanting visual buffers between adjacent VAUs, and by landscaping the slopes of newly created embankments to help the embankments better blend with the existing US 50 corridor.

The remaining project-related visual changes that would occur to the south of US 50 would result in a higher degree of change, especially when the sum of the parts are seen in unison with one another. Widening to the south of US 50 and modifying eastbound US 50 on- and off-ramps would increase the amount of traffic lanes, pavement, and striping associated with the project and would slightly alter the existing visual character of the project area and the scenic corridor, as seen by highway users, by expanding the highway corridor and the amount of lanes visible. Increasing the amount of paved surfaces would contribute to slightly increasing daytime glare through the transformation of less reflective, vegetated surfaces to more reflective, paved surfaces. The widening would bring highway users nearer to adjacent land uses south of the corridor, bringing traffic closer to the commercial and residential land uses that are south of US 50. In addition, shifting and widening eastbound the US 50 off-ramp to Hazel Avenue would require the modification of the northern ends of the Sentry Storage Units and require the full take and removal of the Folsom Chevron and Cattlemens Restaurant under all alternatives. Parking lots and landscaping associated with the Comfort Inn and Suites, Samurai Sushi, Ruby's Hideaway, Sacramento Metro Fire Station 63, and the Nimbus Winery Village would also be affected to varying degrees. These changes would be visible from the US 50 VAU and would create more exposed views toward commercial areas that are south of US 50 and the scenic corridor. Implementation of Mitigation Measure 2, *Implement Interchange and Slope Landscaping and Visual Buffers*,

will reduce this impact by creating seasonal visual interest and replanting visual buffers between US 50 and commercial areas, which would also benefit nearby residential viewers.

All alternatives would also create a bridge that travels over the light rail tracks and Folsom Boulevard, in addition to creating a new roadway connecting Folsom Boulevard and Nimbus Road (i.e., the Jughandle). These changes would be visible from the southern extent of the US 50 VAU, which ends at the Hazel Avenue intersection with Folsom Boulevard, and from the eastbound US 50 off-ramp. These changes would occur within the scenic corridor of US 50 but would not be readily visible from the freeway. The existing Folsom Boulevard intersection with Hazel Avenue would be removed and replaced with the bridge structure and would increase the presence of bridge structures in the US 50 VAU. As seen in the simulations for KV 1a and KV1b, under the US 50 VAU's analysis for *Alternative 1* and *Alternative 1A*, the apex of the new bridge would block the existing view corridor that is available to the south, down the Nimbus Road corridor. Visible trees in the foreground and on the horizon line would be blocked by the bridge and the scale of utility poles and lines would be reduced because the bridge would obscure views of the lower portions of the poles. The bridge deck would become a prominent visual element in this view and the trees, utility poles, and upper portion of the Nimbus Winery Village building would be ancillary visual elements to the bridge.

Changes resulting from the construction of the off-ramp to Aerojet Road and Folsom Boulevard (Alternatives 1, 1A, and 2) and the flyover to northbound Hazel Avenue (Alternative 2) are discussed by alternative below. However, similar to the ramps north of US 50, the modified ramps that are south of US 50 would also have modified and constructed embankments to support the widenings and the reconfigured and new ramps that would stand out slightly and increase the presence of such features in the area and along the scenic corridor. However, the connectors would require fill and mounding to provide bridge clearance over other connector ramps. This would create new landforms that would obscure views beyond only to a small degree, in passing, and would alter the existing visual character. The bridge materials would be visually similar to the existing structures, but the visual prominence of the retaining walls, tunnels, and ramp structures would be greatly enhanced due to the amount of reconfigured ramps that would be introduced into the viewshed. Implementation of Mitigation Measure 3, *Implement Project Design Aesthetics*, will reduce visual impacts associated with bridges, retaining walls, tunnels, and ramp structures and improve project aesthetics.

The proposed project would result in a nominal increase in daytime glare by increasing the paved area and by removing some of the roadside vegetation that provides shade. However, the pavement would be dark and greatly reduce glare, and roadside vegetation would still be present along the right-of-way to provide some shade. In addition, retaining walls and elevated structures would create new vertical surfaces to reflect light and increase glare. However, Mitigation Measure 2, *Implement Interchange and Slope Landscaping and Visual Buffers,* and Mitigation Measure 3, *Implement Project Design Aesthetics,* will serve the dual purpose to aid in reducing glare by replacing sources of shade through replacement plantings and reducing the reflectiveness of vertical surfaces.

New light coming from ramp metering would add an inconsequential amount of light to the project area when meters are in use. Installation of traffic signals at the intersection of the Jughandle and Folsom Boulevard and Nimbus Road would result in an incremental increase in light and glare associated with the proposed project. However, street lighting is proposed along the project corridor and ramps and this lighting, if not properly designed, could negatively affect nearby roadway neighbors and roadway users. In particular, street lighting could include light-emitting diode (LED) lighting for security and safety purposes. LED lights can negatively affect humans by increasing nuisance light and glare, in addition to increasing ambient light glow, if shielding is not provided and blue-rich white light lamps (BRWL) are used (International Dark-Sky Association 2010a, 2010b, 2015). This would result in a substantial source of nighttime light and glare that could adversely affect nighttime views in the area. Implementation of Mitigation Measure 4, *Apply Minimum Lighting Standards*, will reduce the effects associated with street lighting.

Operation

There are no federal or state scenic roadways in or near the project area, so there would be no effect on these resources during operation. Scenic vista views would not be adversely affected during operation because the proposed project would not introduce features that would block or alter such views. Once in operation, the primary visual changes would be regular highway maintenance activities that pre-exist and are a common visual element. Traffic would increase over time, but the proposed project would aid in alleviating backups on the highway, reducing the visible presence of traffic congestion. Minor visual changes would result from operation of the proposed project, which would also affect the County scenic corridor. As discussed above, some utilities would be relocated but the presence of utilities would be consistent with existing conditions, because they are already an existing visual element within the project corridor. Therefore, their relocation would not alter the visual character of views of and from the project corridor or affect the scenic corridor. The interchange embankments, modified ramps, and bridge structures would result in alterations to the visual character and would increase the prominence of highway infrastructure, which would slightly degrade views associated with the County scenic corridor. Mitigation Measure 2, *Implement Interchange and Slope Landscaping and Visual Buffers,* and Mitigation Measure 3, *Implement Project Design Aesthetics*, will aid in improving the long-term aesthetics associated with the interchange embankments, ramps, and bridge structures. Mitigation Measure 4, *Apply Minimum Lighting Standards*, will ensure that the street lighting does not negatively affect nighttime views or sensitive viewers.

Alternative 1

Construction

Construction impacts under Alternative 1 would be the same as described above for *Alternatives 1, 1A, and 2.* All alternatives would create an eastbound off-ramp to carry traffic from the Hazel Avenue off-ramp to Aerojet Road and Folsom Boulevard. The primary difference between the alternatives is that Alternative 1 would create an elevated viaduct over the new raised portion of Hazel Avenue that would be located between US 50 and Folsom Boulevard (refer to Appendix A, Figure A-1), whereas Alternatives 1A and 2 would create a tunnel under this raised segment of Hazel Avenue (refer to Appendix A, Figure A-2). However, Alternative 2 would create a flyover structure to cross US 50 that is not proposed under Alternatives 1 and 1A. The off-ramp to Aerojet Road and Folsom Boulevard would transect the westbound US 50 on-ramps from Hazel Avenue that are south of US 50, cross the Nimbus Winery Village and Cattlemens parking lots, and require the removal of the Cattlemens restaurant. This construction would require the removal of the mature trees and shrubs that are located within the ramp loops and in the parking lots. The Cattlemens restaurant structure would also be completely removed and replaced with transportation infrastructure.

As seen in KV 1a, Simulated Conditions, Alternative 1 would create an elevated viaduct over Hazel Avenue that would be highly visible to roadways users and recreationists on Hazel Avenue. The new support piers and elevated roadway of the proposed connector would introduce a prominent visual structure in to the landscape and increase the amount of visible transportation infrastructure at this location and within the scenic corridor. The viaduct structure would also be highly visible to roadways users traveling in both directions on US 50. Therefore, Alternative 1 would be more visible than Alternative 1A, which would tunnel under Hazel Avenue. Overall, these changes would increase the visual prominence of the US 50/Hazel Avenue interchange. Implementation of Mitigation Measure 2, *Implement Interchange and Slope Landscaping and Visual Buffers* will further reduce impacts by creating seasonal visual interest, re-landscaping ramp loops, replanting visual buffers between adjacent VAUs, and by landscaping the slopes of newly created embankments to help the embankments better blend with the existing US 50 corridor. Mitigation Measure 3, *Implement Project Design Aesthetics*, will aid in improving the aesthetics associated with the interchange tunnels, ramps, and bridge structures.



Figure 5. Key View 1a, Existing View and Alternative 1 Simulated Conditions—from the Hazel Avenue overcrossing of US 50.

Operation

Operational impacts under Alternative 1 would be the same as described above for *Alternatives 1, 1A, and 2.* Both Alternative 1 and 1A would create an eastbound off-ramp to carry traffic from the Hazel Avenue off-ramp to Aerojet Road and Folsom Boulevard. However, Alternative 1 would create an elevated viaduct over the new raised portion of Hazel Avenue that would be located between US 50 and Folsom Boulevard (refer to Appendix A, Figure A-1), whereas Alterative 1A would create a tunnel under this raised segment of Hazel Avenue (refer to Appendix A, Figure A-2). During operation, roadways users and recreationists on Hazel Avenue would be able to see passing vehicles on the off-ramp viaduct because the structure would be elevated under Alternative 1. However, under Alternative 1A, roadways users and recreationists on Hazel Avenue would not be able to see passing vehicles on the off-ramp tunnel because the structure travel under Hazel Avenue, which would block views. Therefore, compared to Alternative 1A, Alternative 1 would be more visible during operation.

Viewer Response

Table 5 summarizes viewer exposure and viewer sensitivity ratings, and averages these viewer response ratings for the key view noted. Viewer response of highway users on Hazel Avenue (KV 1a) would be moderate-high. Viewers within the US 50 VAU have the greatest exposure to changes associated with the project area. Although they would come in direct visual contact with the project only while travelling through the area and views would be intermittent, many roadway users travel this route on a daily basis for work commutes and are familiar with the existing visual conditions. The widened bridge, addition of the new bridge and viaduct structure, and associated vegetation removal would alter the existing visual character of the project area, and highway users would likely view these changes negatively.

Table 5. Viewer Response (VR) Numerical Rating for Alternative 1 – US 50 VAU (Key View 1a)

Key View	1a
Exposure (E) rating	5.0
Sensitivity (S) rating	5.0
VR = (E+S)/2	**5.0**

Resource Change

Construction

The vividness of the US 50 VAU along Hazel Avenue (KV 1a) would be substantially affected by Alternative 1, and the rating would be reduced from moderate to low. The intactness and unity would also be reduced from moderate to moderate-low because the widened bridge and addition of the new bridge and viaduct structure would alter the appearance of the corridor and introduce substantial anthropogenic features that would block views to the surrounding landscape. The overall visual quality would be reduced from moderate to moderate-low (refer to Table 7). Construction would result in a resource change to this VAU that is moderate (refer to Table 8). When combined with viewer response, the resulting visual impacts on scenic views, the existing visual character, scenic roadways, and light and glare would be moderate-high.

Table 6 provides the average resource change (i.e., compatibility between the existing conditions and Alternative 1) for visual character for all the attributes previously identified (e.g., form, line, color, and texture) for KV 1a.

Table 6. Visual Character Numerical Evaluation for Alternative 1 – US 50 VAU (Key View 1a)

Key View	Visual Character (Compatibility) Change (VC) =
1a	-4.0

Table 7 provides individual and average ratings for vividness, intactness, and unity, and summarizes the resource change for visual quality between existing conditions and Alternative 1 for KV 1a.

Table 7. Visual Quality Numerical Evaluation for Alternative 1 – US 50 VAU (Key View 1a)

Key View		Vividness (V)	Intactness (I)	Unity (U)	Visual Quality (VQ)	Visual Quality Change (VQC) =
1a	Alternative Rating	2.0	2.5	3.0	2.5	**-1.5**
	Existing Rating	4.0	4.0	4.0	4.0	

Table 8 summarizes visual character and visual quality changes under Alternative 1 and averages these resources changes for KV 1a.

Table 8. Visual Resource Change (RC) Numerical Rating for Alternative 1 – US 50 VAU (Key View 1a)

Key View	1a
Visual character (VC) rating	-4.0
Visual quality change (VQC) rating	-1.5
RC = (VC+VQ)/2	**-2.8**

Operation

Once in operation, the visual quality, viewer response, and resource change associated with Alternative 1 would be the same as described under *Construction*, above, because regular highway maintenance activities and traffic pre-exist and are a common visual element. Therefore, operation would not further degrade the existing visual quality, heighten viewer response, or result in additional resource change. Therefore, resulting visual impacts on scenic views, the existing visual character, scenic roadways, and light and glare would also be moderate-high.

Alternative 1A

Construction

Construction impacts under Alternative 1A would be the same as described above for *Alternatives 1, 1A, and 2.* As described under the construction impacts for *Alternative 1*, the off-ramp to Aerojet Road and Folsom Boulevard would transect the westbound US 50 on-ramps from Hazel Avenue that are south of US 50, cross the Nimbus Winery Village and Cattlemens parking lots, require the complete removal of the Cattlemens restaurant and removal of mature trees and shrubs that are located within the ramp loops and in the parking lots, and would replace these features with transportation infrastructure.

As seen in KV 1b, Simulated Conditions, the tunnel under Hazel Avenue would not be visible to roadway users and recreationists on Hazel Avenue when looking straight ahead down the roadway corridor. However, viewers on the outer lanes of Hazel Avenue and on the sidewalks may be able to see the retaining walls, embankments, and paved ramp associated with the tunnel as they approach the undercrossing while looking east and west. The tunnel under Hazel Avenue would be more visible to travelers on US 50 because they would have a more direct line of sight toward the tunnel. These viewers would have a more exposed view of the retaining walls, embankments, and paved ramp in addition to being able to see the tunnel structure. Although the features associated with the tunnel would not be as visible or prominent in the landscape as the viaduct structure related to Alternative 1, these changes would still increase the visual prominence of the US 50/Hazel Avenue interchange. Overall, these changes would increase the visual prominence of the US 50/Hazel Avenue interchange and degrade views within the scenic corridor. Implementation of Mitigation Measure 2, *Implement Interchange and Slope Landscaping and Visual Buffers*, will further reduce impacts by creating seasonal visual interest, re-landscaping ramp loops, replanting visual buffers between adjacent VAUs, and by landscaping the slopes of newly created embankments to help the embankments better blend with the existing US 50 corridor. Mitigation Measure 3, *Implement Project Design Aesthetics*, will aid in improving the aesthetics associated with the interchange tunnels, ramps, and bridge structures.

Operation

Operational impacts under Alternative 1A would be the same as described above for *Alternatives 1, 1A, and 2*. However, under Alternative 1A, roadways users and recreationists on Hazel Avenue would not be able to see passing vehicles on the off-ramp tunnel because the structure would travel under Hazel Avenue, which would block views. Therefore, compared to Alternative 1, Alternative 1A would be less visible during operation.





Figure 6. Key View 1b, Existing View and Alternative 1A Simulated Conditions—from the Hazel Avenue overcrossing of US 50.

Viewer Response

Table 9 summarizes viewer exposure and viewer sensitivity ratings and averages these viewer response ratings for the key view noted. Viewer response of highway users on Hazel Avenue (KV 1b) would be moderate-high. Viewers within this unit have the greatest exposure to changes associated with the project area. Although they would come in direct visual contact with the project site only while travelling through the area and views would be intermittent, many roadway users travel this route on a daily basis for work commutes and are familiar with the existing visual conditions. The widened bridge, addition of the new bridge, and associated vegetation removal would alter the existing visual character of the project area, and highway users would likely view these changes negatively.

Table 9. Viewer Response (VR) Numerical Rating for Alternative 1A – US 50 VAU (Key View 1b)

Key View	1b
Exposure (E) rating	5.0
Sensitivity (S) rating	4.0
VR = (E+S)/2	**4.5**

Resource Change

Construction

The vividness of the US 50 VAU along Hazel Avenue (KV 1b) would be substantially affected by Alternative 1A, and the rating would be reduced from moderate to moderate-low. The intactness and unity would also be reduced from moderate to moderate-low because the widened bridge and addition of the new bridge would alter the appearance of the corridor and introduce substantial anthropogenic features that would block views to the surrounding landscape. The overall visual quality would be reduced from moderate to moderate-low (refer to Table 11). Construction would result in a resource change to this VAU that is moderate-low (refer to Table 12). When combined with viewer response, the resulting visual impacts on scenic views, the existing visual character, scenic roadways, and light and glare would be moderate.

Table 10 provides the average resource change (i.e., compatibility between the existing condition and Alternative 1A) for visual character for all attributes previously identified (e.g., form, line, color, and texture) for KV 1b.

Table 10. Visual Character Numerical Evaluation for Alternative 1A – US 50 VAU (Key View 1b)

Key View	Visual Character (Compatibility) Change (VC) =
1b	-3.0

Table 11 provides individual and average ratings for vividness, intactness, and unity, and summarizes the resource change for visual quality between the existing condition and Alternative 1A for KV 1b.

Table 11. Visual Quality Numerical Evaluation for Alternative 1A – US 50 VAU (Key View 1b)						
Key View		Vividness (V)	Intactness (I)	Unity (U)	Visual Quality (VQ)	**Visual Quality Change (VQC) =**
1b	Alternative Rating	3.0	3.0	3.0	3.0	**-1.0**
	Existing Rating	4.0	4.0	4.0	4.0	

Table 12 summarizes visual character and visual quality changes under Alternative 1A and averages these resources changes for KV 1b.

Table 12. Visual Resource Change (RC) Numerical Rating for Alternative 1A – US 50 VAU (Key View 1b)	
Key View	1b
Visual character (VC) rating	-3.0
Visual quality change (VQC) rating	-1.0
RC = (VC+VQ)/2	**-2.0**

Operation

Once in operation, the visual quality, viewer response, and resource change associated with Alternative 1A would be the same as described under *Construction*, above, because regular highway maintenance activities and traffic pre-exist and are a common visual element. Therefore, operation would not further degrade the existing visual quality, heighten viewer response, or result in additional resource change. Therefore, resulting visual impacts on scenic views, the existing visual character, scenic roadways, and light and glare would also be moderate.

Alternative 2

Construction

Construction impacts under Alternative 2 would be the same as described above for *Alternatives 1, 1A, and 2.* Under Alternative 2, a flyover ramp carrying vehicles travelling from eastbound US 50 to northbound Hazel Avenue over the freeway to join with the westbound off-ramp, and more construction and vegetation removal would be required at the westbound off-ramp than under Alternatives 1 and 1A. The US 50 westbound off-ramp would be widened to accommodate traffic from both the flyover and traffic exiting from westbound US 50. Although the flyover would be similar in appearance to the existing bike path crossing over US 50 and would not greatly contrast with the existing visual setting, the flyover would introduce another elevated crossing over US 50 that would be more visible to highway traffic and increase the visual presence of such crossings at this location and within the scenic corridor.

Similar to Alternative 1A, the off-ramp to Aerojet Road and Folsom Boulevard would transect the westbound US 50 on-ramps from Hazel Avenue that are south of US 50, cross the Nimbus Winery Village property and

Cattlemens restaurant, require the complete removal of the Nimbus Winery Village building and Cattlemens restaurant and the mature trees and shrubs that are within the ramp loops and in the parking lots, and would replace these features with transportation infrastructure. Alternative 2 would have a greater impact than Alternatives 1 and 1A due to the increased impact to private properties. In addition, the off-ramp to Aerojet Road and Folsom Boulevard would come much closer to the mobile home park, requiring the removal of residential landscaping and introducing a freeway structure much closer to residences.

Like Alternative 1A, the tunnel under Hazel Avenue would not be visible to roadways users and recreationists on Hazel Avenue when looking straight ahead down the roadway corridor. However, viewers on the outer lanes of Hazel Avenue and on the sidewalks may be able to see the retaining walls, embankments, and paved ramp associated with the tunnel as they approach the undercrossing while looking east and west. The tunnel under Hazel Avenue would be more visible to travelers on US 50 because they would have a more direct line of sight toward the tunnel from the freeway and the scenic corridor. These viewers would have a more exposed view of the retaining walls, embankments, and paved ramp in addition to being able to see the tunnel structure. The footprint of the off-ramps and tunnel occupies a larger area under Alternative 2; therefore, while features associated with the tunnel would not be as visible or prominent in the landscape as the viaduct structure related to Alternative 1, they would be more prominent than Alternative 1A and these changes would increase the visual prominence of the US 50/Hazel Avenue interchange and degrade views within the scenic corridor. Implementation Mitigation Measure 2, *Implement Interchange and Slope Landscaping and Visual Buffers*, will further reduce impacts by creating seasonal visual interest, re-landscaping ramp loops, replanting visual buffers between adjacent VAUs, and by landscaping the slopes of newly created embankments to help the embankments better blend with the existing US 50 corridor. Mitigation Measure 3, *Implement Project Design Aesthetics*, will aid in improving the aesthetics associated with the interchange flyover, tunnels, ramps, and bridge structures.

Operation

Operational impacts under Alternative 2 would be the same as described above for *Alternatives 1, 1A, and 2.* Alternative 2 would be similar to Alterative 1A because it would create a tunnel under the raised segment of Hazel Avenue (refer to Appendix A, Figures A-2 and A-3). However, Alternative 2 would also create a flyover ramp connector over US 50. During operation, roadways users and recreationists on US 50 and Hazel Avenue would be able to see passing vehicles on the viaduct over US 50 because the structure would be elevated. Therefore, Alternative 2 would be slightly more visible than Alternatives 1 and 1A.

Viewer Response

Table 13 summarizes viewer exposure and viewer sensitivity ratings for Alternative 2 within the US 50 VAU and averages these for the viewer response rating. Highway users viewer response would be moderate-high. Viewers within this unit have the greatest exposure to changes associated with the project area. Although they come in direct visual contact with the proposed project only while travelling through the area and views would be intermittent, many roadway users travel this route on a daily basis for work commutes and are familiar with the existing visual conditions. The modified bridge, removal of the Nimbus Winery Village building, and associated vegetation removal would alter the existing visual character of the project area, and highway users would likely view these changes negatively.

Table 13. Viewer Response (VR) Numerical Rating for Alternative 2 – US 50 VAU	
Key View	N/A
Exposure (E) rating	5.0
Sensitivity (S) rating	5.0
VR = (E+S)/2	**5.0**

Resource Change

Construction

The vividness of the US 50 VAU along Hazel Avenue (KV 1b) would be substantially affected by Alternative 2, and the rating would be reduced from moderate to moderate-low. The intactness and unity would also be reduced from moderate to moderate-low because the flyover, modified off- and on-ramps, removal of private properties, and addition of the new bridge would alter the appearance of the corridor and introduce substantial anthropogenic features that would block views to the surrounding landscape. The overall visual quality would be reduced from moderate to moderate-low (refer to Table 15). Construction would result in a resource change to this VAU that is moderate-low (refer to Table 16). When combined with viewer response, the resulting visual impacts on scenic views, the existing visual character, scenic roadways, and light and glare would be moderate.

Table 14 provides the average resource change (i.e., compatibility between the existing condition and Alternative 2) for visual character for all attributes previously identified (e.g., form, line, color, and texture).

Table 14. Visual Character Numerical Evaluation for Alternative 2 – US 50 VAU	
Key View	**Visual Character (Compatibility) Change (VC) =**
N/A	-3.0

Table 15 provides individual and average ratings for vividness, intactness, and unity, and summarizes the resource change for visual quality between the existing condition and Alternative 2.

Table 15. Visual Quality Numerical Evaluation for Alternative 2 – US 50 VAU						
Key View		Vividness (V)	Intactness (I)	Unity (U)	Visual Quality (VQ)	**Visual Quality Change (VQC) =**
N/A	Alternative Rating	3.0	2.5	3.0	2.8	**-1.2**
	Existing Rating	4.0	4.0	4.0	4.0	

Table 16 summarizes visual character and visual quality changes under Alternative 2 and averages these resources changes.

Table 16. Visual Resource Change (RC) Numerical Rating for Alternative 2 – US 50 VAU

Key View	N/A
Visual character (VC) rating	-3.0
Visual quality change (VQC) rating	-1.2
RC = (VC+VQ)/2	**-2.1**

Operation

Once in operation, the visual quality, viewer response, and resource change associated with Alternative 2 would be the same as described under *Construction* above, because regular highway maintenance activities and traffic pre-exist and are a common visual element. Therefore, operation would not further degrade the existing visual quality, heighten viewer response, or result in additional resource change. Therefore, resulting visual impacts on scenic views, the existing visual character, scenic roadways, and light and glare would also be moderate.

RECREATIONAL VISUAL ASSESSMENT UNIT

Alternatives 1, 1A, and 2

Construction and operation features would be the same or very similar in the Recreational VAU under all three build alternatives. Consequently, visual impacts associated with construction and operation would not vary among the build alternatives, as described below.

Construction

Construction in the Recreational VAU would occur during the same timeframe and in the same manner as described under *Alternatives 1, 1A, and 2* for the US 50 VAU. Mature trees and shrubs limit most views toward the proposed project from trails within the Recreational VAU. The widening along the south side of US 50 would occur between the Folsom Boulevard exit and the bike trail crossing over US 50. Many views toward the widening along this segment of US 50 would be obscured by gentle terrain variation, vegetation within the Recreational VAU, and concrete barriers separating east- and westbound traffic within the US 50 VAU. However, in areas where gaps in vegetation are present, small areas of vegetation removal associated with widening south of US 50 may be visible. However, when seen in conjunction with the surrounding landscape that backdrops these areas, where most of the surrounding vegetation would remain, it is not anticipated that these areas would stand out or be perceived as a negative visual change. The majority of visual changes associated with the proposed project would be visible from the bike trail crossing over US 50, which has a direct line of sight to the US 50 corridor, and from the southwestern limits of the Recreational VAU, where the Jedediah Smith Memorial and American River Auxiliary Trails connect to the bike trail crossing over US 50, in close proximity to the Nimbus Flat entry drive, and near the Nimbus Flat and Park & Ride parking lots. The focus of visual changes associated with the proposed project would be on changes occurring north of US 50, because these features would be closest to and fall within a small portion of the Recreational VAU. Visual changes to the south of US 50 would not be as notable because, as seen in the Simulations for KV 2a and KV 2b, the embankments for the Hazel Avenue bridge over US 50 and westbound on- and off-ramps limit most views toward changes south of US 50.

All alternatives would create an independent bicycle off-ramp in the same location, which connects Hazel Avenue to the Nimbus Flat entrance of the recreation area, and the Hazel Avenue on-ramp to westbound US 50 would be widened and modified to skirt the outer edge of the bicycle off-ramp, as shown in the Simulations for KV 2a and KV 2b. The existing on-ramp would be restored by removing the pavement, re-grading the terrain, and by hydroseeding the exposed soils. In addition, all alternatives would shift the Park & Ride lot further north to directly border the Nimbus Flat entry drive, removing the existing grassy median that separates the parking lot from the entry drive. As shown in the Simulations for KV 2a and KV 2b, the shifted parking lot would not greatly alter views associated with this key view. Removal of mature trees and shrubs within the ramp loops that are north of US 50 and east of Hazel Avenue would be required because of the ramp modifications and construction staging that would occur at this location, which is not readily visible in KV 2. This would reduce the amount of landscape and quality of views that is currently seen at this location. Grassland areas along the right-of-way would also be reduced to accommodate highway widening. The visual character of the corridor would be negatively affected by removal of mature trees and shrubs (that are aesthetic resources) within ramp loops and on the edges of the right-of-way to accommodate widening and the new and reconfigured interchange ramps.

Most views of construction would be obscured by vegetation within the Recreational VAU and recreationists generally do not access the Recreational VAU at night. Therefore, while evening and nighttime construction activities would require the use of extremely bright lights, it is not anticipated that this would negatively affect recreational viewers adjacent to the work area. However, implementation of Mitigation Measure 1, *Minimize Fugitive Light from Portable Sources Used for Construction*, will reduce this impact by helping to prevent nuisance light spill onto recreational areas during construction.

As shown in the Simulations for KV 2a and KV 2b, the modified ramps that are north of US 50 would have modified and constructed embankments to support the widenings and the new and reconfigured ramps that would stand out slightly and increase the presence of such features in the area. This would create new landforms that would further obscure views, beyond, to changes south of US 50 and would slightly alter the existing visual character. The most notable visual change between the alternatives would be the viaduct structure that is visible in the Simulation for KV 2a for Alternative 1, but is not visible in the Simulation for KV 2b for Alternative 1A. However, the retaining wall structure for the US 50 eastbound on-ramp would be slightly visible. Under Alternative 2, this same retaining wall for the US 50 eastbound on-ramp would be visible from the KV 2 location, in addition to the flyover that would be more prominent in the view. All of these changes would also be visible from the bike trail crossing over US 50, which has a direct line of sight to the US 50 corridor. Alternative 1A would be the least prominent from this location because it lacks elevated structures. However, Alternative 1 would be more prominent with the viaduct off-ramp and Alternative 2 would be the most prominent with the flyover structure. The bridge materials associated with the proposed project would be visually similar to the existing structures, but the visual prominence of the retaining walls, tunnels, viaduct, flyover, ramp structures, and fencing would be greatly enhanced due to the amount of reconfigured ramps that would be introduced into the viewshed. Compliance with Caltrans' HDM design standards would aid in minimizing visual impacts associated with roadside grading and slopes. Implementation of Mitigation Measure 2, *Implement Interchange and Slope Landscaping and Visual Buffers*, will further reduce impacts by creating seasonal visual interest, re-landscaping ramp loops, replanting visual buffers between adjacent VAUs, and by landscaping the slopes of newly created embankments to help the embankments better blend with the existing US 50 corridor. In addition, implementation of Mitigation Measure 3, *Implement Project Design Aesthetics*, will reduce visual impacts associated with bridges, retaining walls, tunnels, and ramp structures and improve project aesthetics.

New light coming from ramp metering would add an inconsequential amount of light to the project area when meters are in use. However, street lighting is proposed along the project corridor and ramps and this

lighting, if not properly designed, could negatively affect nearby roadway neighbors. In particular, street lighting could include LED lighting for security and safety purposes. LED lights can negatively affect humans by increasing nuisance light and glare, in addition to increasing ambient light glow, if shielding is not provided and BRWL are used (International Dark-Sky Association 2010a, 2010b, 2015). This would result in a substantial source of nighttime light and glare that could adversely affect nighttime views in the area. Implementation of Mitigation Measure 4, *Apply Minimum Lighting Standards*, will reduce the effects associated with street lighting.

Operation

Traffic using the Hazel Avenue eastbound off-ramp to Aerojet Road and Folsom Boulevard would not be visible under Alternatives 1 and 1A. If views of the Alternative 1 viaduct are present, then recreational viewers would also see vehicles using this ramp, which would not be seen under Alternative 1A. However, it is anticipated that such views would be extremely limited from within the Recreational VAU. Therefore, Alternatives 1 and 1A would result in similar operational impacts. Views of the Alternative 2 flyover ramp would likely be present, to a limited degree, so that recreational viewers would see vehicles using this ramp. However, it is anticipated that such views would be limited to the westernmost edge of the Recreational VAU. Operational impacts resulting from new ramp lighting will be reduced with the implementation of Mitigation Measure 4, *Apply Minimum Lighting Standards*.





Figure 7. Key View 2a, Existing View and Alternative 1 Simulated Conditions—from the Nimbus Flat entrance to the Lake Natoma Unit of the Folsom Lake State Recreation Area off of Hazel Avenue.





Figure 8. Key View 2b, Existing View and Alternative 1A Simulated Conditions— from the Nimbus Flat entrance to the Lake Natoma Unit of the Folsom Lake State Recreation Area off of Hazel Avenue.

Viewer Response

Table 17 summarizes viewer exposure and viewer sensitivity ratings under Alternatives 1, 1A, and 2 and averages these viewer response ratings for KV 2a and KV 2b. The viewer response of recreational highway neighbors would be moderate (KV 2b) to moderate-high (KV 2a and Alternative 2). Most viewers within this unit have less direct exposure to changes associated with the project area, but they come in direct visual contact with the proposed project while in proximity to the US 50/Hazel Avenue interchange, and views would be intermittent. Nevertheless, many recreationists value the existing visual conditions within this portion of the unit and the modified interchange, when coupled with the proposed bicycle off-ramp connection to Hazel Avenue and the Nimbus Flat entrance, may viewed as changes as negative or beneficial.

Table 17. Viewer Response (VR) Numerical Rating for Alternatives 1, 1A, & 2 – Recreational VAU (Key Views 2a and 2b)

Key View	2a	2b
Exposure (E) rating	4.0	4.0
Sensitivity (S) rating	5.5	4.0
VR = (E+S)/2	**4.8**	**4.0**

Resource Change

Construction

The vividness of the Recreational VAU would be substantially affected by Alternatives 1, 1A, and 2 and the rating would be reduced from moderate to low for Alternatives 1 and 2 and moderate-low for Alternative 1A. Intactness and unity also would be affected by these changes and the rating would be reduced from moderate to moderate-low for Alternatives 1 and 2. Intactness and unity for Alternative 1A would also be slightly affected by these changes but would remain moderate. The overall visual quality would be slightly reduced from moderate to moderate-low under all three alternatives (refer to Table 19). Therefore, construction would result in a resource change to this VAU that is moderate for Alternatives 1 and 2 and moderate-low for Alternative 1A (refer to Table 20). When combined with viewer response, the resulting visual impacts on scenic views, the existing visual character, and light and glare would be moderate-high for both Alternatives 1 and 2 and moderate for Alternative 1A.

Table 18 provides the average resource change (i.e., compatibility between the existing condition and Alternatives 1, 1A, and 2) for visual character for all attributes previously identified (e.g., form, line, color, and texture) for KV 2.

Table 18. Visual Character Numerical Evaluation for Alternatives 1, 1A, & 2 – Recreational VAU (Key View 2)

Key View	**Visual Character (Compatibility) Change (VC) =**
2a and Alternative 2	-4.0
2b	-3.0

Table 19 provides individual and average ratings for vividness, intactness, and unity, and summarizes the resource change for visual quality between the existing condition and Alternatives 1, 1A, and 2 for KV 2.

Table 19. Visual Quality Numerical Evaluation for Alternatives 1, 1A, & 2 – Recreational VAU (Key Views 2a and 2b)

Key View		Vividness (V)	Intactness (I)	Unity (U)	Visual Quality (VQ)	Visual Quality Change (VQC) =
2a	Alternative 1 Rating	2.0	3.0	3.0	2.7	**-1.3**
	Existing Rating	4.0	4.0	4.0	4.0	
2b	Alternative 1A Rating	3.0	3.5	3.5	3.3	**-0.7**
	Existing Rating	4.0	4.0	4.0	4.0	
N/A	Alternative 2 Rating	2.0	3.0	3.0	2.7	**-1.3**
	Existing Rating	4.0	4.0	4.0	4.0	

Table 20 summarizes visual character and visual quality changes under Alternatives 1, 1A, and 2 and averages these resource changes for KV 2.

Table 20. Visual Resource Change (RC) Numerical Rating for Alternatives 1, 1A, & 2 – Recreational VAU (Key Views 2a and 2b)

Key View	2a and Alternative 2	2b
Visual character (VC) rating	-4.0	-3.0
Visual quality change (VQC) rating	-1.3	-0.7
RC = (VC+VQ)/2	**-2.7**	**-1.8**

Operation

Once in operation, the visual quality, viewer response, and resource change associated with Alternatives 1, 1A, and 2 would be the same as described under *Construction* above, because regular highway maintenance activities and traffic pre-exist and are a common visual element. Therefore, operation would not further degrade the existing visual quality, heighten viewer response, or result in additional resource change. Therefore, resulting visual impacts on scenic views, the existing visual character, and light and glare would also be moderate-high for both Alternatives 1 and 2 and moderate for Alternative 1A.

COMMERCIAL VISUAL ASSESSMENT UNIT

Alternatives 1, 1A, and 2

The following construction and operation features would be the same or very similar under all three build alternatives. Where impacts differ, they are discussed under the appropriate build alternative.

Construction

Construction in the Commercial VAU would occur during the same timeframe and in the same manner as described under *Alternatives 1, 1A, and 2* for the US 50 VAU. Business workers and patrons lining the westbound on-ramp to US 50 would be able to see the construction staging within the westbound US 50 ramp loops that are north of US 50 and east of Hazel Avenue. Business workers and patrons at this location are more likely to be focused to views inside, on shopping, eating, or working, rather than having a prolonged focus on the US 50/Hazel Avenue interchange. Business workers and patrons accessing the northernmost lot for Folsom Lake Ford, which lines the eastbound US 50 off-ramp for Folsom Boulevard, would be able to see the construction staging within ramp loops. However, the loop of the nearby eastbound US 50 on-ramp from Folsom Boulevard has recently been used for construction staging so this is a common visual element at this location. Therefore, the visual effects from construction staging upon the Commercial VAU are expected to be minimal.

Evening and nighttime construction activities would require the use of extremely bright lights, which would negatively affect commercial areas and nighttime views of and from the work area. Implementation of Mitigation Measure 1, *Minimize Fugitive Light from Portable Sources Used for Construction*, will reduce this impact by helping to prevent nuisance light spill during construction.

All project alternatives would include highway widening to accommodate the modified eastbound on- and off-ramps, ramp improvements, introduction of retaining wall structures and embankments, introduction of a bridge over the light rail tracks and Folsom Boulevard, a new roadway connecting Folsom Boulevard and Nimbus Road, vegetation removal, and changes to private properties. All of these project components would be visible to highway and roadway users within the US 50 VAU.

Some changes associated with the project alternatives would not greatly alter the existing visual character as seen from the Commercial VAU, such as widening eastbound US 50 to the south between the Aerojet Road and Folsom Boulevard exits and modifications to the Aerojet Road and Folsom Boulevard exit off-ramps from eastbound US 50. The widening of US 50 at this location and the widening of the Aerojet Road and Folsom Boulevard ramps would appear similar to existing visual conditions and would not constitute a substantial visual change or greatly increase daytime glare when seen from the Commercial VAU. In addition, the features associated with the proposed widened Hazel Avenue overcrossing over US 50 are all visual elements of the existing overcrossing, so that views of the bridge would not greatly change under Alternatives 1 and 1A, because all additions would be similar in appearance to existing facilities in the area. The Hazel Avenue overcrossing would remain the same width under Alternative 2. Utility relocations would only result in minor visual changes as the modifications are occurring and would not result in substantial visual changes once built because they are minor changes or in keeping with existing visual conditions available within the Commercial VAU.

Structures and landscaping associated with commercial areas located north of US 50 would not be directly affected by construction. Visual changes to the north of US 50 would be focused on the ramps that are east of Hazel Avenue because the ramps to the west of Hazel Avenue would not be modified. The widened and modified westbound US 50 on-ramp, the independent bicycle off-ramp, ramp and bridge embankments, shifted the Park & Ride lot, and the removal of mature trees and shrubs within the ramp loops that are north of US 50 and east of Hazel Avenue are not likely to be visible from the commercial areas north of US 50, under all alternatives, because the existing ramp and bridge embankments along the westbound on-ramp

currently, and would continue to, prevent views to this area. However, if such elements are slightly visible, compliance with Caltrans' HDM design standards would aid in minimizing visual impacts associated with roadside grading and slopes. Implementation of Mitigation Measure 2, *Implement Interchange and Slope Landscaping and Visual Buffers*, will further reduce impacts by creating seasonal visual interest, re-landscaping ramp loops, replanting visual buffers between adjacent VAUs, and by landscaping the slopes of newly created embankments to help the embankments better blend with the existing US 50 corridor.

The remaining project-related visual changes that would occur to the south of US 50 would result in a higher degree of change to, and when seen from, the Commercial VAU. Widening to the south of US 50 and modifying eastbound US 50 on- and off-ramps would bring transportation infrastructure and traffic closer to commercial land uses. This would alter the existing visual character of the project area, as seen by commercial neighbors, by expanding the highway corridor and the amount of lanes visible, increasing the amount of paved surfaces. This would slightly increase daytime glare through of transformation of less reflective, vegetated surfaces to paved and concrete surfaces that are more reflective. In addition, all alternatives would require the modification of the northern ends of the Sentry Storage Units and require the full take and removal of the Folsom Chevron and Cattlemens Restaurant because of the shifted and widened eastbound US 50 off-ramp to Hazel Avenue. Parking lots and landscaping associated with the Comfort Inn and Suites, Samurai Sushi, Ruby's Hideaway, Sacramento Metro Fire Station 63, and the Nimbus Winery Village would also be affected to varying degrees. These changes would be visible from the Commercial VAU and would create more exposed views of transportation infrastructure. Implementation of Mitigation Measure 2, *Implement Interchange and Slope Landscaping and Visual Buffers*, will reduce this impact by creating seasonal visual interest and replanting visual buffers between US 50 and commercial areas.

All alternatives would also create a bridge that spans the light rail tracks and Folsom Boulevard. These changes would be visible mostly from Folsom Boulevard and commercial areas directly adjacent to the new bridge within the Commercial VAU. The existing Folsom Boulevard intersection with Hazel Avenue would be removed and replaced with the bridge structure and would introduce a bridge structure within the Commercial VAU. As seen in the Simulation for KV 3, under the Commercial VAU's analysis for Alternative 1, the new bridge would block the existing view corridor that is available to the east, down the Folsom Boulevard corridor. The bridge and the associated embankment would be a prominent feature in the view and views of the Nimbus Winery Village building would be blocked by the bridge from locations along Folsom Boulevard and the light rail tracks and from nearby businesses that are west of the bridge. However, the modified roadway corridor would not differ greatly from existing conditions. In addition, the removal of the existing Folsom Boulevard and Hazel Avenue intersection traffic light and undergrounding of utilities along the south side of Folsom Boulevard would declutter views down the roadway corridor and the bridge would frame and accentuate views of roadside landscaping and the foothills in the distance. Implementation of Mitigation Measure 3, *Implement Project Design Aesthetics*, would reduce visual impacts associated with the bridge and associated retaining walls and improve project aesthetics.

The proposed project would also create the Jughandle connecting Folsom Boulevard and Nimbus Road under all alternatives. This would transform an already degraded site into a roadway corridor in preparation for redevelopment of the area. Because this area is already degraded, the new roadway would not further degrade views and would only result in a slight visual character shift from a vacant industrial lot that is largely paved to a paved roadway corridor.

The proposed project would result in a nominal increase in daytime glare by increasing the paved area and by removing some of the roadside vegetation that provides shade. However, the pavement would be dark and greatly reduce glare, and roadside vegetation would still be present along the right-of-way to provide some shade. In addition, retaining walls and elevated structures would create new vertical surfaces to reflect light and increase glare. Implementation of Mitigation Measure 3, *Implement Project Design Aesthetics*, would

reduce visual impacts associated with vertical surfaces by improving project aesthetics. Mitigation Measure 2, *Implement Interchange and Slope Landscaping and Visual Buffers*, and Mitigation Measure 3, *Implement Project Design Aesthetics*, will also serve the dual purpose to aid in reducing glare by replacing sources of shade through replacement plantings and reducing the reflectiveness of vertical surfaces.

New light coming from ramp metering would add an inconsequential amount of light to the Commercial VAU when meters are in use. Installation of traffic signals at the intersection of the Jughandle and Folsom Boulevard and Nimbus Road would result in an incremental increase in light and glare associated with the proposed project. However, street lighting is proposed along the project corridor and ramps and this lighting, if not properly designed, could negatively affect nearby commercial neighbors. In particular, street lighting could include LED lighting for security and safety purposes. LED lights can negatively affect humans by increasing nuisance light and glare, in addition to increasing ambient light glow, if shielding is not provided and BRWL are used (International Dark-Sky Association 2010a, 2010b, 2015). This would result in a substantial source of nighttime light and glare that could adversely affect nighttime views in the area. Implementation of Mitigation Measure 4, *Apply Minimum Lighting Standards*, will reduce the effects associated with street lighting.

Operation

Once in operation, the primary visual changes would be regular highway maintenance activities that pre-exist and are a common visual element. Traffic would increase over time, but the proposed project would help the flow of traffic and reduce the visible presence of traffic congestion. Minor visual changes would result from operation of the proposed project. As discussed above, some utilities would be relocated but the presence of utilities would be consistent with existing conditions because they are already an existing visual element within the project corridor. Therefore, their relocation would not alter the visual character of views of and from the project corridor. Utility removals would improve visual conditions by removing visual clutter. The interchange embankments, modified ramps, and bridge structures would result in alterations to the visual character of the Commercial VAU and would increase the prominence of highway infrastructure. Mitigation Measure 2, *Implement Interchange and Slope Landscaping and Visual Buffers,* and Mitigation Measure 3, *Implement Project Design Aesthetics*, will aid in improving the long-term aesthetics associated with the interchange embankments, ramps, and bridge structures. Mitigation Measure 4, *Apply Minimum Lighting Standards*, will ensure that the street lighting does not negatively affect nighttime views or sensitive viewers.

Alternative 1

Construction

Construction impacts under Alternative 1 would be the same as described above for *Alternatives 1, 1A, and 2.* As seen in the Simulation for KV 3, the new bridge over the light rail tracks and Folsom Boulevard would replace the existing Folsom Boulevard and Hazel Avenue intersection. The new bridge would block views of the Nimbus Winery Village building from Folsom Boulevard, nearby businesses, and the light rail tracks that are west of the bridge because the bridge and the associated embankment would be a prominent feature. However, the slightly widened roadway corridor would not differ greatly from existing conditions and the sidewalk and fencing would help to visually delineate the Folsom Boulevard and light rail corridors. The removal of the fire station traffic light and existing Folsom Boulevard and Hazel Avenue intersection traffic light and undergrounding of utilities along the south side of Folsom Boulevard would declutter views down the roadway corridor and the bridge would frame and accentuate views of roadside landscaping and the foothills in the distance. The undergrounding of utilities along the south side of Folsom Boulevard would also declutter westward views down the roadway corridor. Implementation of Mitigation Measure 3, *Implement Project Design Aesthetics,* would reduce visual impacts associated with the bridge and associated retaining walls and improve project aesthetics.

All alternatives would create an eastbound off-ramp to carry traffic from the Hazel Avenue off-ramp to Aerojet Road and Folsom Boulevard. The primary difference between the alternatives is that Alternative 1 would create an elevated viaduct over the new raised portion of Hazel Avenue that would be between US 50 and Folsom Boulevard. As seen in the Simulation for KV 4a, the viaduct would travel through the Nimbus Winery Village parking lot, introducing a large, elevated structure on large support piers into view that would increase the amount of visible transportation infrastructure at this location and cause shading. In addition, trees lining the parking lot would be removed and replaced with a large retaining wall structure for the ramp. Tree removal would make the widened Hazel Avenue bridge a more prominent element within the view compared to existing conditions where trees limit views of the existing bridge. The viaduct structure would also require the complete removal of the Cattlemens restaurant and trees within the Cattlemens parking lot. Alternative 1 would be more visible than Alternative 1A, which would tunnel under Hazel Avenue. Overall, these changes would increase the visual prominence of the US 50/Hazel Avenue interchange. Compliance with Caltrans' HDM design standards would aid in minimizing visual impacts associated with roadside grading and slopes. Implementation of Mitigation Measure 2, *Implement Interchange and Slope Landscaping and Visual Buffers*, will further reduce impacts by creating seasonal visual interest, re-landscaping ramp loops, replanting visual buffers between adjacent VAUs, and by landscaping the slopes of newly created embankments to help the embankments better blend with the existing US 50 corridor. Mitigation Measure 3, *Implement Project Design Aesthetics*, will aid in improving the aesthetics associated with the interchange tunnels, ramps, and bridge structures. Implementation of Mitigation Measure 4, *Apply Minimum Lighting Standards*, will reduce the effects associated with street lighting.

Operation

Operational impacts under Alternative 1 would be the same as described above for *Alternatives 1, 1A, and 2.* Alternative 1 would modify the eastbound US 50 on-ramp and off-ramps and create an elevated viaduct to carry traffic from the Hazel Avenue off-ramp to Aerojet Road and Folsom Boulevard. During operation, viewers within the Commercial VAU would be able to see passing vehicles on the modified ramps and viaduct because the ramps and structure would be elevated compared to existing conditions.



Figure 9. Key View 3, Existing View and Alternatives 1, 1A, and 2 Simulated Conditions—from Folsom Boulevard looking east.



Figure 10. Key View 4a, Existing View and Alternative 1 Simulated Conditions—from the Nimbus Winery Village Parking lot looking northwest.

Viewer Response

Table 21 summarizes viewer exposure and viewer sensitivity ratings, and averages these viewer response ratings for the key view noted. Viewer response of commercial viewers on Folsom Boulevard (KV 3) would be moderate-high and high for commercial viewers that are directly adjacent to and affected by the project (KV 4a). Viewers within the Commercial VAU would be the most affected by the changes associated with the proposed project. The widened bridge, addition of the new bridge and viaduct structure, associated vegetation removal, and removal of commercial properties would alter the existing visual character of the project area, and commercial viewers would likely view these changes negatively.

Table 21. Viewer Response (VR) Numerical Rating for Alternative 1 – US 50 VAU (Key Views 3 and 4a)

Key View	3	4a
Exposure (E) rating	5.0	6.0
Sensitivity (S) rating	5.5	6.0
VR = (E+S)/2	**5.3**	**6.0**

Resource Change

Construction

The vividness of the Commercial VAU along Folsom Boulevard (KV 3) and in areas that are directly adjacent to the interchange (KV 4a) would be substantially affected by Alternative 1, and the rating would be reduced from moderate to moderate-low for KV 3 and to low for KV 4a. The intactness and unity would remain moderate for KV 3 but would be reduced from moderate to moderate-low for KV 4a because the widened bridge and addition of the new bridge and viaduct structure would alter the appearance of the corridor and introduce substantial anthropogenic features that would block views to the surrounding landscape. The overall visual quality would be reduced from moderate to moderate-low for KV 3 and to low for KV 4a (refer to Table 23). Construction would result in a resource change to this VAU that is moderate-low for KV 3 and moderate for KV 4a (refer to Table 24). When combined with viewer response, the resulting visual impacts on scenic views, the existing visual character, and light and glare would be moderate for KV 3 and moderate-high for KV 4a.

Table 22 provides the average resource change (i.e., compatibility between the existing conditions and Alternative 1) for visual character for all the attributes previously identified (e.g., form, line, color, and texture) for KV 3 and KV 4a.

Table 22. Visual Character Numerical Evaluation for Alternative 1 – US 50 VAU (Key Views 3 and 4a)	
Key View	Visual Character (Compatibility) Change (VC) =
3	-3.0
4a	-5.0

Table 23 provides individual and average ratings for vividness, intactness, and unity, and summarizes the resource change for visual quality between existing conditions and Alternative 1 for KV 3 and KV 4a.

Table 23. Visual Quality Numerical Evaluation for Alternative 1 – US 50 VAU (Key Views 3 and 4a)						
Key View		Vividness (V)	Intactness (I)	Unity (U)	Visual Quality (VQ)	**Visual Quality Change (VQC) =**
3	Alternative Rating	3.0	3.5	3.5	3.3	**-0.2**
	Existing Rating	3.5	3.5	3.5	3.5	
4a	Alternative Rating	2.0	2.5	2.5	2.3	**-1.2**
	Existing Rating	3.5	3.5	3.5	3.5	

Table 24 summarizes visual character and visual quality changes under Alternative 1 and averages these resources changes for KV 3 and KV 4a.

Table 24. Visual Resource Change (RC) Numerical Rating for Alternative 1 – US 50 VAU (Key Views 3 and 4a)		
Key View	3	4a
Visual character (VC) rating	-3.0	-5.0
Visual quality change (VQC) rating	-0.6	-1.2
RC = (VC+VQ)/2	**-1.6**	**-3.1**

Operation

Once in operation, the visual quality, viewer response, and resource change associated with Alternative 1 would be the same as described under *Construction*, above, because regular highway maintenance activities and traffic pre-exist and are a common visual element. Therefore, operation would not further degrade the existing visual quality, heighten viewer response, or result in additional resource change. Therefore, resulting visual impacts on scenic views, the existing visual character, and light and glare would also be moderate for KV 3 and moderate-high for KV 4a.

Alternative 1A

Construction

Construction impacts under Alternative 1A would be the same as described above for *Alternatives 1, 1A, and 2.* Impacts resulting from the new bridge over the light rail tracks and Folsom Boulevard would be the same as described for Alternative 1. As seen in the Simulation for KV 4b, a viaduct structure would not be constructed under Alternative 1A. However, the new ramps would still travel through the Nimbus Winery Village parking lot, substantially reducing its size. In addition, trees lining the parking lot would be removed and replaced with a large retaining wall structure for the ramp that would be slight taller than the retaining walls proposed under Alternative 1. Tree removal would make the widened Hazel Avenue bridge a more prominent element within the view compared to existing conditions where trees limit views of the existing bridge. The modified ramps would also require the complete removal of the Cattlemens restaurant and trees within the Cattlemens parking lot similar to Alternative 1. Alternative 1A would be slightly less prominent than Alternative 1 because there would be no viaduct structure. Overall, the changes would increase the visual prominence of the US 50/Hazel Avenue interchange. Compliance with Caltrans' HDM design standards would aid in minimizing visual impacts associated with roadside grading and slopes. Implementation of Mitigation Measure 2, *Implement Interchange and Slope Landscaping and Visual Buffers*, will further reduce impacts by creating seasonal visual interest, re-landscaping ramp loops, replanting visual buffers between adjacent VAUs, and by landscaping the slopes of newly created embankments to help the embankments better blend with the existing US 50 corridor. Mitigation Measure 3, *Implement Project Design Aesthetics*, will aid in improving the aesthetics associated with the interchange tunnels, ramps, and bridge structures. Implementation of Mitigation Measure 4, *Apply Minimum Lighting Standards*, will reduce the effects associated with street lighting.

Operation

Operational impacts under Alternative 1A would be the same as described above for *Alternatives 1, 1A, and 2*. Alternative 1A would modify the eastbound US 50 on-ramp and off-ramps and create ramps that are more elevated compared to existing conditions and, during operation, viewers within the Commercial VAU would have more direct views of passing vehicles on the modified ramps compared to existing conditions.



Figure 11. Key View 4b, Existing View and Alternative 1A Simulated Conditions—from the Nimbus Winery Village Parking lot looking northwest.

Viewer Response

Table 25 summarizes viewer exposure and viewer sensitivity ratings and averages these viewer response ratings for the key view noted. Viewer response of commercial viewers would be high for commercial viewers that are directly adjacent to and affected by the project (KV 4a). Viewers within the Commercial VAU would be the most affected by the changes associated with the proposed project. The widened bridge, addition of the new bridge and viaduct structure, associated vegetation removal, and removal of commercial properties would alter the existing visual character of the project area, and commercial viewers would likely view these changes negatively.

Table 25. Viewer Response (VR) Numerical Rating for Alternative 1A – US 50 VAU (Key View 4b)

Key View	4b
Exposure (E) rating	6.0
Sensitivity (S) rating	6.5
VR = (E+S)/2	**6.3**

Resource Change

Construction

The vividness of the Commercial VAU in areas that are directly adjacent to the interchange (KV 4a) would be substantially affected by Alternative 1A, and the rating would be reduced from moderate to moderate-low. The intactness and unity would also be reduced from moderate to moderate-low because the widened bridge, addition of the new bridge, and modified ramps would alter the appearance of the corridor and introduce substantial anthropogenic features that would block views to the surrounding landscape. The overall visual quality would be reduced from moderate to moderate-low (refer to Table 27). Construction would result in a resource change to this VAU that is moderate-low (refer to Table 28). When combined with viewer response, the resulting visual impacts on scenic views, the existing visual character, and light and glare would be moderate-high.

Table 26 provides the average resource change (i.e., compatibility between the existing condition and Alternative 1A) for visual character for all attributes previously identified (e.g., form, line, color, and texture) for KV 4b.

Table 26. Visual Character Numerical Evaluation for Alternative 1A – US 50 VAU (Key View 4b)

Key View	Visual Character (Compatibility) Change (VC) =
4b	-4.0

Table 27 provides individual and average ratings for vividness, intactness, and unity, and summarizes the resource change for visual quality between the existing condition and Alternative 1A for KV 4b.

Table 27. Visual Quality Numerical Evaluation for Alternative 1A – US 50 VAU (Key View 4b)

Key View		Vividness (V)	Intactness (I)	Unity (U)	Visual Quality (VQ)	Visual Quality Change (VQC) =
4b	Alternative Rating	2.5	3.0	3.0	2.8	**-0.7**
	Existing Rating	3.5	3.5	3.5	3.5	

Table 28 summarizes visual character and visual quality changes under Alternative 1A and averages these resources changes for KV 4b.

Table 28. Visual Resource Change (RC) Numerical Rating for Alternative 1A – US 50 VAU (Key View 4b)

Key View	4b
Visual character (VC) rating	-4.0
Visual quality change (VQC) rating	-0.7
RC = (VC+VQ)/2	**-2.3**

Operation

Once in operation, the visual quality, viewer response, and resource change associated with Alternative 1A would be the same as described under *Construction* above, because regular highway maintenance activities and traffic pre-exist and are a common visual element. Therefore, operation would not further degrade the existing visual quality, heighten viewer response, or result in additional resource change. Therefore, resulting visual impacts on scenic views, the existing visual character, and light and glare would also be moderate-high.

Alternative 2

Construction

Construction impacts under Alternative 2 would be the same as described above for *Alternatives 1, 1A, and 2.* Similar to Alternative 1A and the conditions seen in the Simulation for KV 4b, a viaduct structure would not be constructed under Alternative 2. However, the footprint of the off-ramps and tunnel occupies a much larger area under Alternative 2. The new flyover and eastbound on-ramp to US 50 would travel through the Nimbus Winery Village parking lot, intersecting the Nimbus Winery Village building, requiring the complete removal of the building, parking lot, and associated landscaping. Although the flyover would be similar in appearance to the existing bike path crossing over US 50 and would not greatly contrast with the existing visual setting, the flyover would introduce another elevated crossing over US 50 that would be more visible to commercial viewers and increase the visual presence of such crossings. Large retaining wall structures and embankments would also be needed to support ramps and flyover. Removal of these elements would greatly

increase the prominence of highway infrastructure seen within views from the Commercial VAU, especially in proximity to the interchange. The modified ramps would also require the complete removal of Cattlemens restaurant and trees within the Cattlemens parking lot like Alternatives 1 and 1A. Impacts resulting from the new bridge over the light rail tracks and Folsom Boulevard would be the similar to those described for Alternative 1. However, the small portion of the Nimbus Winery Village roofline would not be visible over the new bridge structure, similar to the Simulation for KV 3. Overall, the changes would increase the visual prominence of the US 50/Hazel Avenue interchange. Compliance with Caltrans' HDM design standards would aid in minimizing visual impacts associated with roadside grading and slopes. Implementation of Mitigation Measure 2, *Implement Interchange and Slope Landscaping and Visual Buffers*, will further reduce impacts by creating seasonal visual interest, re-landscaping ramp loops, replanting visual buffers between adjacent VAUs, and by landscaping the slopes of newly created embankments to help the embankments better blend with the existing US 50 corridor. Mitigation Measure 3, *Implement Project Design Aesthetics*, will aid in improving the aesthetics associated with the interchange tunnels, ramps, and bridge structures. Implementation of Mitigation Measure 4, *Apply Minimum Lighting Standards*, will reduce the effects associated with street lighting.

Operation

Operational impacts under Alternative 2 would be the same as described above for *Alternatives 1, 1A, and 2.* Alternative 2 would modify the eastbound US 50 on-ramp and off-ramps and create ramps that are more elevated compared to existing conditions and, during operation, viewers within the Commercial VAU would have more direct views of passing vehicles on the modified ramps compared to existing conditions. However, Alternative 2 would also create a flyover ramp connector over US 50. During operation, roadways users and recreationists on US 50 and Hazel Avenue would be able to see passing vehicles on the viaduct over US 50 because the structure would be elevated. Therefore, Alternative 2 would be slightly more visible than Alternatives 1 and 1A.

Viewer Response

Table 29 summarizes viewer exposure and viewer sensitivity ratings and averages these viewer response ratings for Alternative 2. Viewer response of commercial viewers would be high for commercial viewers that are directly adjacent to and affected by the project. Viewers within the Commercial VAU would be the most affected by the changes associated with the proposed project. The widened bridge, addition of the new bridge and viaduct structure, associated vegetation removal, and removal of commercial properties would alter the existing visual character of the project area, and commercial viewers would likely view these changes negatively.

Table 29. Viewer Response (VR) Numerical Rating for Alternative 2 – US 50 VAU

Key View	N/A
Exposure (E) rating	6.0
Sensitivity (S) rating	7.0
VR = (E+S)/2	**6.5**

Resource Change

Construction

The vividness of the Commercial VAU in areas that are directly adjacent to the interchange (similar to KV 4) would be substantially affected by Alternative 2, and the rating would be reduced from moderate to low. The intactness and unity would also be reduced from moderate to low because the widened bridge and addition of the new bridge and flyover structure would alter the appearance of the corridor and introduce substantial anthropogenic features that would block views to the surrounding landscape. The overall visual quality would be reduced from moderate to low (refer to Table 31). Construction would result in a resource change to this VAU that is moderate (refer to Table 32). When combined with viewer response, the resulting visual impacts on scenic views, the existing visual character, and light and glare would be moderate-high.

Table 30 provides the average resource change (i.e., compatibility between the existing condition and Alternative 2) for visual character for all attributes previously identified (e.g., form, line, color, and texture).

Table 30. Visual Character Numerical Evaluation for Alternative 2 – US 50 VAU

Key View	Visual Character (Compatibility) Change (VC) =
N/A	-6.0

Table 31 provides individual and average ratings for vividness, intactness, and unity, and summarizes the resource change for visual quality between the existing condition and Alternative 2.

Table 31. Visual Quality Numerical Evaluation for Alternative 2 – US 50 VAU

Key View		Vividness (V)	Intactness (I)	Unity (U)	Visual Quality (VQ)	Visual Quality Change (VQC) =
N/A	Alternative Rating	1.5	2.0	3.0	1.8	**-1.7**
	Existing Rating	3.5	3.5	3.5	3.5	

Table 32 summarizes visual character and visual quality changes under Alternative 2 and averages these resources changes.

Table 32. Visual Resource Change (RC) Numerical Rating for Alternative 2 – US 50 VAU

Key View	N/A
Visual character (VC) rating	-6.0
Visual quality change (VQC) rating	-1.7
RC = (VC+VQ)/2	**-3.8**

Operation

Once in operation, the visual quality, viewer response, and resource change associated with Alternative 2 would be the same as described under *Construction*, above, because regular highway maintenance activities and traffic pre-exist and are a common visual element. Therefore, operation would not further degrade the existing visual quality, heighten viewer response, or result in additional resource change. Therefore, resulting visual impacts on scenic views, the existing visual character, and light and glare would also be moderate-high.

RESIDENTIAL VISUAL ASSESSMENT UNIT

Alternatives 1 and 1A

The following construction and operation features would be the same or very similar under Alternatives 1 and 1A.

Construction

Construction in the Residential VAU would occur during the same timeframe and in the same manner as described under *Alternatives 1, 1A, and 2* for the US 50 VAU. Visual changes to the north of US 50 and changes to Hazel Avenue, the interchange ramps, and the proposed bridge over the light rail tracks and Folsom Boulevard, and the Jughandle south of US 50 would not be detectible from within the Residential VAU. Sound walls surrounding residential areas, residential landscaping, and surrounding commercial landscaping, and mature trees and shrubs in open spaces would block views of visual changes. Therefore, visible changes would only be those occurring south of US 50 and along portions of the proposed eastbound off-ramp that would carry traffic from the Hazel Avenue off-ramp to Aerojet Road and Folsom Boulevard which pass by residential areas. Although most views of construction would be obscured by residential areas and nearby landscaping, evening and nighttime construction activities would require the use of extremely bright lights, which would negatively affect residential viewers adjacent to the work area. Implementation of Mitigation Measure 1, *Minimize Fugitive Light from Portable Sources Used for Construction*, will reduce this impact by helping to prevent nuisance light spill onto residential areas during construction.

The highway widening and ramp to Aerojet Road and Folsom Boulevard would bring highway facilities and traffic closer to the Residential VAU. The raised viaduct structure would terminate at the western edge of the mobile home park (refer to Appendix A, Figures A-1 and A-2) under Alternative 1, and this structure may be slightly visible over the existing tree line that would remain. However, it is anticipated that such views would be extremely limited from within the Residential VAU. The remainder of the ramp length would not be visible beyond the sound walls surrounding residential areas under Alternative 1. Similarly, under Alternative 1A, the tunnel structure and the length of the ramp would not be visible beyond the sound walls surrounding residential areas. Therefore, it is anticipated that the primary visual change would be a slight reduction in the amount of tree canopy from surrounding commercial areas that can be seen rising above the residential sound walls. In addition, a small number of residents may no longer be able to see small portions of the roof and walls of Cattlemens Restaurant that may presently be visible. Implementation of Mitigation Measure 2, *Implement Interchange and Slope Landscaping and Visual Buffers,* and Mitigation Measure 3, *Implement Project Design Aesthetics,* will reduce this impact by replanting visual buffers between US 50 and residential areas, improve project aesthetics associated with the viaduct structure, serve the dual purpose of reducing glare by replacing sources of shade through replacement plantings, and reduce the reflectiveness of vertical surfaces.

New light coming from ramp metering would add an inconsequential amount of light to the project area when meters are in use. However, street lighting is proposed along the project corridor and ramps and this lighting, if not properly designed, could negatively affect nearby roadway neighbors. In particular, street lighting could include LED lighting for security and safety purposes. LED lights can negatively affect humans

by increasing nuisance light and glare, in addition to increasing ambient light glow, if shielding is not provided and BRWL are used (International Dark-Sky Association 2010a, 2010b, 2015). This would result in a substantial source of nighttime light and glare that could adversely affect nighttime views in the area. Implementation of Mitigation Measure 4, *Apply Minimum Lighting Standards*, will reduce the effects associated with street lighting.

Operation

Traffic using the Hazel Avenue eastbound off-ramp to Aerojet Road and Folsom Boulevard would not be visible under Alternatives 1 and 1A. If views of the Alternative 1 viaduct are present, then residential viewers would also see vehicles using this ramp, which would not be seen under Alternative 1A. However, as described under *Operation*, it is anticipated that such views would be extremely limited from within the Residential VAU. Therefore, Alternatives 1 and 1A would result in similar operational impacts. Operational impacts resulting from new ramp lighting will be reduced with the implementation of Mitigation Measure 4, *Apply Minimum Lighting Standards*.

Viewer Response

Table 33 summarizes viewer exposure and viewer sensitivity ratings under Alternatives 1 and 1A and averages these viewer response ratings for the Residential VAU. As described under *Viewer Response* in Section VIII, *Viewers and Viewer Response*, most residential highway neighbors do not have immediate or direct views of the project because views are limited by development, vegetation, and topography. However, longer-term, stationary views are available to residential highway neighbors on the edges of development that are directly adjacent to the project site. The exposure for these residents would be moderate-high because while they have prolonged views, most are obscured by sound walls and vegetation. Their sensitivity to changes associated with the project would be high because they are close to the site and would likely consider the removal of vegetation and introduction of new transportation structures in proximity to their residences as a negative change. Therefore, their viewer response would be moderate-high. Although residential viewers within the project area are familiar with these types of interchanges, the connector structures would rise above the tree line and the widened viaduct would be located much closer to residents, altering the existing visual environment and visual character of the project area.

Table 33. Viewer Response (VR) Numerical Rating for Alternatives 1 and 1A – Residential VAU

Key View	N/A
Exposure (E) rating	5.0
Sensitivity (S) rating	5.5
VR = (E+S)/2	**5.3**

Resource Change

Construction

The vividness of the Residential VAU would be affected by the project and would be reduced slightly but would still remain moderate because the changes resulting from the project would not be very visible. Intactness and unity also would be slightly affected by these changes but would remain moderate for Alternative 1. The intactness for Alternative 1A would be reduced to moderate-low due to vegetation removal that would be visible above sound walls, but the unity would remain much the same and the rating

would remain moderate. The overall visual quality would remain moderate for Alternative 1 and be slightly reduced from moderate to moderate-low under Alternative 1A (refer to Table 35). Therefore, construction would result in a resource change to this VAU that is low for Alternative 1 and moderate-low for Alternative 1A (refer to Table 36). When combined with viewer response, the resulting visual impacts on scenic views, the existing visual character, and light and glare would be moderate for both Alternatives 1 and 1A.

Table 34 provides the average resource change (i.e., compatibility between the existing condition and Alternatives 1 and 1A) for visual character for all attributes previously identified (e.g., form, line, color, and texture) for the VAU.

Table 34. Visual Character Numerical Evaluation for Alternatives 1 and 1A – Residential VAU

Alternative	Visual Character (Compatibility) Change(VC) =
Alternative 1	-2.0
Alternative 1A	-3.0

Table 35 provides individual and average ratings for vividness, intactness, and unity, and summarizes the resource change for visual quality between the existing condition and Alternatives 1 and 1A for the VAU.

Table 35. Visual Quality Numerical Evaluation for Alternatives 1 and 1A – Residential VAU

Key View		Vividness (V)	Intactness (I)	Unity (U)	Visual Quality (VQ)	Visual Quality Change (VQC) =
N/A	Alternative 1 Rating	4.0	3.5	3.5	3.7	0.0
	Existing Rating	4.0	3.5	3.5	3.7	
N/A	Alternative 1A Rating	3.5	3.0	3.5	3.3	-0.3
	Existing Rating	4.0	3.5	3.5	3.7	

Table 36 summarizes visual character and visual quality changes under Alternatives 1 and 1A and averages these resources changes for the VAU.

Table 36. Visual Resource Change (RC) Numerical Rating for Alternatives 1 and 1A – Residential VAU

Alternative	Alternative 1	Alternative 1A
Visual character (VC) rating	-2.0	-3.0
Visual quality change (VQC) rating	0.0	-0.3
RC = (VC+VQ)/2	**-1.0**	**-1.7**

Operation

Once in operation, the visual quality, viewer response, and resource change associated with Alternative 1 would be the same as described under *Construction* above, because regular highway maintenance activities and traffic pre-exist and are a common visual element. Therefore, operation would not further degrade the existing visual quality, heighten viewer response, or result in additional resource change. Therefore, resulting visual impacts on scenic views, the existing visual character, and light and glare would also be moderate.

Alternative 2

Construction

Construction impacts under Alternative 2 would be the same as described above for *Alternatives 1, 1A, and 2.* Under Alternative 2, the flyover ramp would have a greater effect than Alternatives 1 and 1A due to the increased impact to private properties. In addition, the off-ramp to Aerojet Road and Folsom Boulevard would come much closer to the mobile home park, requiring the removal of landscaping that is immediately adjacent to residences and introducing a freeway infrastructure much closer to residences. However, the ramp would not be elevated so the sound walls surrounding residential areas would obscure direct views of the ramp. Therefore, it is anticipated that the primary visual change would be a slight reduction in the amount of tree canopy from surrounding commercial areas that can be seen rising above the residential sound walls. In addition, a small number of residents may no longer be able to see small portions of the roof and walls of Cattlemens Restaurant that may presently be visible. Implementation of Mitigation Measure 2, *Implement Interchange and Slope Landscaping and Visual Buffers,* and Mitigation Measure 3, *Implement Project Design Aesthetics,* will reduce this impact by replanting visual buffers between US 50 and residential areas, improve project aesthetics associated with the viaduct structure, serve the dual purpose of reducing glare by replacing sources of shade through replacement plantings, and reduce the reflectiveness of vertical surfaces.

New light coming from ramp metering would add an inconsequential amount of light to the project area when meters are in use. However, street lighting is proposed along the project corridor and ramps and this lighting, if not properly designed, could negatively affect nearby roadway neighbors. In particular, street lighting could include LED lighting for security and safety purposes. LED lights can negatively affect humans by increasing nuisance light and glare, in addition to increasing ambient light glow, if shielding is not provided and BRWL are used (International Dark-Sky Association 2010a, 2010b, 2015). This would result in a substantial source of nighttime light and glare that could adversely affect nighttime views in the area. Implementation of Mitigation Measure 4, *Apply Minimum Lighting Standards*, will reduce the effects associated with street lighting.

Operation

Operational impacts under Alternative 2 would be the same as described above for *Alternatives 1 and 1A.* Alternative 2 would be similar to Alterative 1A in that it would create a tunnel under the raised segment of Hazel Avenue (refer to Appendix A, Figures A-2 and A-3). However, Alternative 2 would also create a flyover ramp connector over US 50 but the flyover and associated traffic would not be visible from the Residential VAU. Traffic using the Hazel Avenue eastbound off-ramp to Aerojet Road and Folsom Boulevard would also not be visible under Alternative 2. Therefore, Alternative 2 would primarily have operational impacts resulting from new ramp lighting. However, implementation of Mitigation Measure 4, *Apply Minimum Lighting Standards*, will reduce the effects associated with street lighting.

Viewer Response

Table 37 summarizes viewer exposure and viewer sensitivity ratings for Alternative 2 within the US 50 VAU and averages these for the viewer response rating. As described under *Viewer Response* in Section VIII, *Viewers and Viewer Response*, most residential highway neighbors do not have immediate or direct views of the project because views are limited by development, vegetation, and topography. However, longer-term, stationary views are available to residential highway neighbors on the edges of development that are directly adjacent to the project site. The exposure for these residents would be moderate-high because while they have prolonged views, most are obscured by sound walls and vegetation. Their sensitivity to changes associated with the project would be high because they are close to the site and would likely consider the removal of vegetation and introduction of new transportation structures in proximity to their residences as a negative change. Therefore, their viewer response would be moderate-high. Although residential viewers within the project area are familiar with these types of interchanges, the connector structures would rise above the tree line and the widened viaduct would be located much closer to residents, altering the existing visual environment and visual character of the project area.

Table 37. Viewer Response (VR) Numerical Rating for Alternative 2 – US 50 VAU

Key View	N/A
Exposure (E) rating	5.0
Sensitivity (S) rating	6.0
VR = (E+S)/2	**5.5**

Resource Change

Construction

The vividness of the Residential VAU would be affected by Alternative 2 and would be reduced from moderate to moderate-low because the project would remove trees in proximity to residences and these changes would be fairly visible. Intactness and unity also would be affected by these changes and would also be reduced from moderate to moderate-low. The overall visual quality would be reduced from moderate to moderate-low (refer to Table 39). Therefore, construction would result in a resource change to this VAU that is moderate-low for Alternative 2 (refer to Table 40). When combined with viewer response, the resulting visual impacts on scenic views, the existing visual character, and light and glare would be moderate.

Table 38 provides the average resource change (i.e., compatibility between the existing condition and Alternative 2) for visual character for all attributes previously identified (e.g., form, line, color, and texture).

Table 38. Visual Character Numerical Evaluation for Alternative 2 – US 50 VAU	
Key View	**Visual Character (Compatibility) Change (VC) =**
N/A	-4.0

Table 39 provides individual and average ratings for vividness, intactness, and unity, and summarizes the resource change for visual quality between the existing condition and Alternative 2.

Table 39. Visual Quality Numerical Evaluation for Alternative 2 – US 50 VAU						
Key View		**Vividness (V)**	**Intactness (I)**	**Unity (U)**	**Visual Quality (VQ)**	**Visual Quality Change (VQC) =**
N/A	Alternative Rating	3.0	3.0	3.0	3.0	-0.7
	Existing Rating	4.0	3.5	3.5	3.7	

Table 40 summarizes visual character and visual quality changes under Alternative 2 and averages these resources changes.

Table 40. Visual Resource Change (RC) Numerical Rating for Alternative 2 – US 50 VAU	
Key View	N/A
Visual character (VC) rating	-4.0
Visual quality change (VQC) rating	-0.7
RC = (VC+VQ)/2	**-2.3**

Operation

Once in operation, the visual quality, viewer response, and resource change associated with Alternative 2 would be the same as described under *Construction* above, because regular highway maintenance activities and traffic pre-exist and are a common visual element. Therefore, operation would not further degrade the existing visual quality, heighten viewer response, or result in additional resource change. Accordingly, resulting visual impacts on scenic views, the existing visual character, and light and glare would also be moderate-high.

SUMMARY OF VISUAL IMPACTS BY VISUAL ASSESSMENT UNIT AND ALTERNATIVE

Construction and operation impacts for Alternatives 1, 1A, and 2 are described above. The table below summarizes and compares the narrative ratings for visual resource change, viewer response, and visual impacts between alternatives for each VAU and associated key views, if applicable.

Table 41. Summary of Key View Narrative Ratings					
Visual Assessment Unit	**Key View**	**Alternative**	**Resource Change**	**Viewer Response**	**Visual Impact**
US 50 Corridor	1a	1	M	MH	MH
	1b	1A	ML	MH	M
	N/A	2	ML	MH	M
Recreational	2a	1	M	MH	MH
	2b	1A	ML	M	M
	N/A	2	M	MH	MH
Commercial	3	1 and 1A	ML	MH	M
	4a	1	M	H	MH
	4b	1A	ML	H	MH
	N/A	2	M	H	MH
Residential	N/A	1	MH	M	M
	N/A	1A	MH	ML	M
	N/A	2	H	ML	MH

Impacts from each build alternative would be comparable; therefore, the summary has been condensed into a singular discussion and a detailed comparison is not provided. As identified and described earlier in this section, each of the three build alternatives would include similar widening of US 50; reconfigured, taller and more complex on-ramp and off-ramp systems that are similar in configuration and height; similar retaining wall structures; similar embankments; removal of several commercial properties; construction of a new Hazel Avenue bridge crossing over Folsom Boulevard and the light rail tracks; construction of the Jughandle; construction of the bicycle off-ramp from Hazel Avenue; and comparable removal of associated vegetation. The primary differences between the build alternatives are the widened Hazel Avenue bridge over US 50 for Alternatives 1 and 1A; viaduct structure under Alternative 1; flyover structure and the complete removal of the Nimbus Winery Village building under Alternative 2. The elements that would result in the greatest visual impacts would be the removal of commercial properties, the larger ramp embankments and associated retaining walls, vegetation removal, and new structures associated with the new bridge, viaduct, and flyover. Most of these changes would generally appear similar under all the build alternatives. Although changes to visual resources would range from low to moderate, viewer response to these changes would range from moderate-high to high, and the resulting visual impacts would range from moderate to moderate-high. Overall, all build alternatives would result in the same or very similar visual impacts. Mitigation measures include minimizing fugitive light during construction, applying minimum lighting standards, implementing landscaping, and incorporating project design aesthetics that will help to offset these visual impacts and improve project aesthetics.

X. PROJECT VISUAL IMPACTS SUMMARY

The project visual impacts summary is provided under Summary of Visual Impacts by Visual Assessment Unit and Alternative, above.

Temporary Construction Visual Impacts

Temporary visual impacts resulting from construction were described earlier in this section. Please refer to those sections for more detail.

XI. CUMULATIVE VISUAL IMPACTS

Cumulative impacts are those resulting from past, present and reasonably foreseeable future actions, combined with the potential visual impacts of this project. For this project, it has been determined that the following cumulative visual impacts may occur. The combined visual effect of this proposed project and other development projects planned, recently in construction, or currently in construction would change the visual character of the region. As described in the *Community Impact Assessment*, Sacramento County General Plan and the Sacramento Area Council of Governments' *Metropolitan Transportation Plan/Sustainable Communities Strategy* will contribute to growth and development within and surrounding the project area (California Department of Transportation 2017b). These plans, once implemented, will expand and improve existing and create new and reconfigured transportation corridors and induce development and infill of open space areas and vacant lots within the project vicinity. These plans will also allow for continued growth and development to occur around the project area.

The proposed project is driven by implementation of the plans described above, to provide access and to support future land uses in the vicinity, and all three build alternatives would result in the same cumulative visual impacts. Temporary construction impacts associated with the proposed project would result in cumulative visual impacts because even though they would be temporary, they would compound the visual presence of construction in the area, especially when combined with other larger scale development and transportation projects. Planned development and transportation projects would also alter the existing visual character of the area in the long-term and affect the area's visual character, including the open space areas and vacant lots located in the project vicinity. Development in the project vicinity would contribute to changes in the visual quality of views as seen from all VAUs. Roadway users, residents, businesses, and recreationists will be able to see open space areas and vacant lots within the landscape gradually transition and infill to industrial, mixed-use, commercial, and residential development and this development will include the associated transportation and utility infrastructure needed to support it.

Other large-scale transportation projects would widen segments of US 50 and local connectors and create larger roadways and widening associated with the US 50/Hazel Avenue project would contribute to cumulative visual impacts by replacing simpler interchanges with more complex interchanges and impacting associated vegetation, private properties, and viewers. Future development and roadway improvements would also add to ambient atmospheric lighting and glare in the area by infilling unlit open space areas with lit buildings and roadways, using BRWL LED lighting, and by adding reflective surfaces to areas that are currently undeveloped or moderately developed. The proposed project, however, would only have an incremental contribution to cumulative impacts associated with lighting, because highway lighting would not greatly increase as a result of the project. However, the project would contribute to visual changes related to planned and/or proposed development in the area because it would alter the existing visual landscape, degrade the visual quality of the project area, and negatively affect highways users and highway neighbors. Implementation of the mitigation measures below will reduce the project's impact on visual resources but not to a less than cumulatively considerable level. Therefore, the project's cumulative effects would be cumulatively considerable.

XII. AVOIDANCE, MINIMIZATION, AND/OR MITIGATION MEASURES

Caltrans and the FHWA mandate that a qualitative/aesthetic approach should be taken to address visual quality loss in the project area. This approach fulfills the letter and the spirit of FHWA requirements because it addresses the actual cumulative loss of visual quality due to a project. This approach also results in avoidance, minimization, and/or mitigation measures that can lessen or compensate for a loss in visual quality. The inclusion of aesthetic features in the project design, discussed in *Section III*, can help generate public acceptance of a project. This section describes additional avoidance, minimization, and/or mitigation measures to address specific visual impacts. These will be designed and implemented with concurrence of the District Landscape Architect.

Avoidance and minimization measures are not proposed. The following mitigation measures to offset visual impacts will be incorporated into the project.

1. **Minimize Fugitive Light from Portable Sources Used for Construction.** At a minimum, the construction contractor shall minimize project-related light and glare to the maximum extent feasible, given safety considerations. Color-corrected halide lights will be used. Portable lights will be operated at the lowest allowable wattage and height and will be raised to a height no greater than 20 feet. All lights will be screened and directed downward toward work activities and away from the night sky and roadway users and highway neighbors to the maximum extent possible. The number of nighttime lights used will be minimized to the greatest extent possible.
2. **Implement Interchange and Slope Landscaping and Visual Buffers.** Landscaping within interchange loops and on constructed earth slopes will improve the visual quality of the roadway corridor by improving corridor aesthetics and helping to reduce the apparent scale of new and reconfigured aerial connectors. Visual buffers will also be planted to replace or supplement existing visual buffers for visual assessment units bordering the US 50 Corridor that are affected by the project. This landscaping will also serve as a buffer and screen against nuisance lighting resulting from oncoming vehicle headlights and roadway lighting and help to prevent or greatly reduce nuisance lighting from affecting nearby sensitive viewers. Prior to approval of the roadway design, the Caltrans project landscape architect shall review project designs to ensure that the following elements are implemented in the project landscaping plan:
    a. The majority of the species composition will reflect species that are native and indigenous to the Plan Area and California. Native plant species can be used to create attractive spaces, high in aesthetic quality, that are not only drought-tolerant but attract more wildlife than traditional landscape plant palettes. Use of native species promotes a visual character of California that is being lost through development and reliance on non-native ornamental plant species. Non-invasive, non-native plant species may be used where native plant species will not achieve the desired design intent.
    b. The species list will include trees, shrubs, and an herbaceous understory of varying heights, as well as both evergreen and deciduous types. Plant variety will increase the effectiveness of the roadside planting areas by providing multiple layers, seasonality, diverse habitat, and reduced susceptibility to disease. Evergreen groundcovers or low-growing plants, such as *Ceanothus* spp., should be used in areas where taller vegetation would potentially cause driving hazards by obscuring site distances.
    c. Special attention should be paid to plant choices near residences to ensure that species chosen are of an appropriate height and rely on evergreen species to provide year-round light screening from nuisance light.
    d. Vegetation shall be planted within the first 12 months following project completion.
    e. The design may also incorporate aesthetic features, such as a cobbling swales or shallow detention areas, which can reduce or eliminate the need for irrigation in certain areas.

3. **Implement Project Design Aesthetics.** The project will implement an aesthetic design treatment with a consistent motif for new and reconfigured structures such as retaining walls, tunnels, and viaduct structures. Choosing earth-toned colors for the surfaces would be less distracting to viewers than light or brightly colored surfaces. The design motif applied to structures will reflect a combination of naturally colored surfaces and surfaces that are textured to appear as natural materials (e.g., rock or cobble) or that incorporates a design theme (e.g., wildlife and plants of local, native oak woodlands; traditional architectural elements such as inset panels; or other design reflecting local heritage or environment associated with the Nimbus Winery Village and the Lake Natoma Unit) using form liners. This would reduce visual monotony, soften verticality, reduce glare, and be more visually pleasing to viewers than plain surfaces for retaining walls, exterior facing barriers and girders on bridges that would be visible to traffic passing under the overcrossing, decking, abutments and side supports, and columns. Local examples of such treatments include I-5/French Camp interchange in Stockton and SR 99/Sheldon Road overcrossing in Elk Grove. Non-local examples include Maryland 216 in Prince Georges County, Maryland; US 54/East Kellogg Drive and South Oliver Street Interchange, Wichita, Kansas; and Roberts Road Bridge in Los Gatos, California. Roughened retaining wall surfaces would soften the verticality of the wall faces by providing visual texture and reducing the amount of smooth surface that can reflect light. Furthermore, if possible, a plantable wall surface, such as a retaining wall structure that allows interstices for planting shall be evaluated for use as a possible best management practice to help introduce more landscaping. A nearby, local example includes the slopes east and west of the Rocklin Road/I-80 undercrossing. However, a plantable wall surface shall not be used if it would require more space and create a greater impact on adjacent visual assessment units. The shade of the wall will also be carefully considered. Studies have shown that structures 2 to 3 degrees darker than the color of the general surrounding area creates less of a visual impact than matching or lighter hues[2] In general, very light buff/tan, brown, or gray colors stand out more than darker colors such as deep browns, deep red-browns, and deep warm grays that have the ability to complement the surrounding vegetation.

4. **Apply Minimum Lighting Standards.** All artificial outdoor lighting and overhead street lighting will be limited to safety and security requirements and the minimum required for driver safety. Lighting will be designed using Illuminating Engineering Society's design guidelines and in compliance with International Dark-Sky Association-approved fixtures. All lighting will be designed to have minimum impact on the surrounding environment and will use downcast, cut-off type fixtures that are shielded and direct the light only toward objects requiring illumination. Therefore, lights will be installed at the lowest allowable height and cast low-angle illumination while minimizing incidental light spill onto adjacent properties or open spaces, or backscatter into the nighttime sky. The lowest allowable wattage will be used for all lighted areas, and the number of nighttime lights needed to light an area will be minimized. Light fixtures will have non-glare finishes that will not cause reflective daytime glare. Lighting will be designed for energy efficiency, with daylight sensors or timers with an on/off program. Lights will provide good color rendering with natural light qualities, with the minimum intensity feasible for security, safety, and personnel access. Lighting, including light color rendering and fixture types, will be designed to be aesthetically pleasing. LED lighting will avoid the use of BRWL lamps and use a correlated color temperature that is no higher than 3,000 Kelvin, consistent with the International Dark-Sky Association's Fixture Seal of Approval Program (International Dark-Sky Association 2010a, 2010b, 2015). In addition, LED lights will use shielding to ensure that nuisance glare and light spill does not affect sensitive residential viewers. Technologies to reduce light pollution evolve over time; design measures that are currently available may help but may not be the most effective means of controlling light pollution once the project is designed. Therefore, all

[2] Refer to https://www.ntc.blm.gov/krc/viewresource.php?courseID=972&programAreaId=50, *Unit 5 Visual Design Fundamentals,* for more information on this technique and other best management practices and techniques for visual screening.

design measures used to reduce light pollution will use the technologies available at the time of project design to allow for the highest potential reduction in light pollution.

Summary of Avoidance, Minimization, and/or Mitigation Measures by Alternative

The table below summarizes the numbered mitigation measures from above for each alternative.

Table 42. Summary of Avoidance, Minimization, and/or Mitigation Measures by Alternative

Alternative	Avoidance and Minimization	Mitigation
Alternatives 1, 1A, and 2	None	1. Minimize Fugitive Light from Portable Sources Used for Construction 2. Implement Interchange and Slope Landscaping and Visual Buffers 3. Implement Project Design Aesthetics 4. Apply Minimum Lighting Standards

XIII. CONCLUSIONS

The project would not affect any scenic resources along a State scenic route or classified Landscaped Freeway. In addition, scenic vista views would not be affected during construction or operation. The proposed project would result in moderate to moderate-high visual changes to the project area that would result in adverse visual impacts and negatively impact existing viewer groups. Each of the three build alternatives would include similar widening of US 50; reconfigured, taller and more complex on-ramp and off-ramp systems that are similar in configuration and height; similar retaining wall structures; similar embankments; removal of several commercial properties; construction of a new Hazel Avenue bridge crossing over Folsom Boulevard and the light rail tracks; construction of the Jughandle; construction of the bicycle off-ramp from Hazel Avenue; and comparable removal of associated vegetation. The elements that would result in the greatest visual impacts would be the removal of commercial properties, the larger ramp embankments and associated retaining walls, vegetation removal, and new structures associated with the new bridge, viaduct, and flyover. The alternatives could increase light and glare in the project area, if not properly designed. Implementation of the mitigation measures will reduce light impacts during construction and operation, reduce impacts on residences and sensitive receptors during construction, provide seasonal visual interest of areas disturbed by construction, and improve project aesthetics through landscaping and hardscape design. The proposed project would be detrimental in adding to the cumulative visual impacts associated with construction and presence of built features, when factored with the continued growth and development of the area surrounding the proposed project.

XIV. REFERENCES

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APPENDIX A. ALTERNATIVE DESIGN PLANS



Figure A-1. Alternative 1. L-9 Interchange with Viaduct Connector



Figure A-2. Alternative 1A. L-9 Interchange with Undercrossing Connector



Figure A-3. Alternative 2. Direct Flyover to Hazel Avenue with Connector

U.S. 50 / Hazel Avenue Interchange Project
HPSR



Historic Property Survey Report

Hazel Avenue State Route 50 Interchange Project

Sacramento County

03-SAC-50/PM 15.1-17.4

Federal Project No.: EA 03-3E380/E-FIS 0300020439

September 2018

Caltrans
CALIFORNIA DEPARTMENT OF TRANSPORTATION

HISTORIC PROPERTY SURVEY REPORT

1. UNDERTAKING DESCRIPTION AND LOCATION

District	County	Route	Post Mile(s)	EA	E-FIS Project Number
03	SAC	50	15.1-17.5		0300020439

The environmental review, consultation, and any other actions required by applicable Federal environmental laws for this project are being, or have been, carried out by Caltrans pursuant to 23 U.S.C. 327 and the Memorandum of Understanding dated December 23, 2016, and executed by FHWA and Caltrans.

The studies for this undertaking were carried out in a manner consistent with Caltrans' regulatory responsibilities under Section 106 of the National Historic Preservation Act (36 CFR Part 800) and pursuant to the January 2014 *First Amended Programmatic Agreement among the Federal Highway Administration, the Advisory Council on Historic Preservation, the California State Historic Preservation Officer, and the California Department of Transportation Regarding Compliance with Section 106 of the National Historic Preservation Act* (Section 106 PA), as well as under Public Resources Code 5024 and pursuant to the January 2015 *Memorandum of Understanding Between the California Department of Transportation and the California State Historic Preservation Office Regarding Compliance with Public Resources Code Section 5024 and Governor's Executive Order W-26-92* (5024 MOU) as applicable.

Project Description:

The County of Sacramento, in cooperation with the California Department of Transportation (Caltrans) and the City of Rancho Cordova, proposes to modify the existing U.S. Route 50 (U.S. 50)/Hazel Avenue interchange, and extend and grade-separate Hazel Avenue over Folsom Boulevard and the Sacramento Placerville Transportation Corridor Joint Powers Authority (SPTC-JPA) rail corridor. The project is being proposed to relieve existing congestion at the interchange and to accommodate planned and approved developments identified by the adopted Sacramento County General Plan and the Sacramento Area Council of Government's Regional Transportation Plan. Caltrans is the lead agency under NEPA and the County of Sacramento is the lead agency under CEQA.

Two alternatives, with one sub-alternative, have been developed for the project:

- Alternative 1: This alternative consists of a modified type L-9 interchange configuration.
- Alternative 1a: This alternative is the same as Alternative 1 with the exception that the eastbound off-ramp will split and introduce a direct tunnel ramp under Hazel Avenue to carry eastbound off-ramp traffic to Aerojet Road and Folsom Boulevard.
- Alternative 2: This alternative consists of a modified type L-9 interchange configuration, with a flyover ramp carrying vehicles traveling from eastbound U.S. 50 to northbound Hazel Avenue over the freeway to join with the westbound U.S. 50 off-ramp.

The full project description and project location and vicinity maps are located in **Attachment A** of this HPSR.

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2. AREA OF POTENTIAL EFFECTS

In accordance with Section 106 Programmatic Agreement Stipulation VIII.A, the Area of Potential Effects (APE) for the project was established in consultation with Lisa Machado (PI-Historical Archaeology and Co-PI-Prehistoric Archaeology), Joan Fine (PQS: Principal Architectural Historian), and John Holder (Project Manager). The APE maps are located in **Attachment A** of this HPSR.

The APE for the project includes a *direct APE*, also known as the *archaeological APE*, that considers the maximum extent of potential direct effects to cultural resources that could result from the project, and an *architectural APE* that considers the maximum extent of potential direct *and* indirect effects to cultural resources that could result from the project.

The archaeological APE consists of both the horizontal and vertical maximum potential extent of direct impacts resulting from the project. The horizontal APE encompasses the project footprint and includes those areas of new construction, easements, utilities, and operations-related activities associated with the project. The vertical APE is the maximum extent of ground disturbance within the horizontal APE (i.e., ground surface to maximum depth of soil disturbance). For the vast majority of the project, the vertical APE ranges from 2 to 4 feet deep. Where pile driving for structures will occur, a a maximum depth of 50 to 80 feet below ground surface (bgs) is anticipated.

The vertical APE for the project is expected to include the following:

- Clearing and grubbing: 1 foot bgs
- Construction of abutments/new bridge: 5 to 15 feet bgs
- Construction of retaining walls: 15 feet bgs
- Removal of existing retaining wall: 3 feet bgs
- Removal of tree: 2 feet bgs
- Removal of building: 5 feet bgs
- Removal of gas station: unknown (to be determined)
- Removal of existing signal removal: 3 feet bgs
- Pile driving for structures: 50 to 80 feet bgs
- Construction of ramps below undercrossings:
  1. Alt 1A: 17 to 20 feet bgs near ramps, 15 feet for retaining walls.
  2. Alt 2: 5 feet bgs

The architectural APE encompasses the maximum project footprint, including existing rights-of-way and those parcels from which new rights-of-way would be acquired where proposed project activities would take place, in order to assess the potential for direct and indirect effects to historic properties.

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3. CONSULTING PARTIES / PUBLIC PARTICIPATION

☒ Native American Heritage Commission

On December 7, 2015, and May 31, 2016, ICF sent letters to the Native American Heritage Commission (NAHC) requesting a Sacred Lands File Search on behalf of the County of Sacramento. The NAHC provided a response letter on June 15, 2016, stating that no Sacred Lands were identified as part of their search. The NAHC also provided a list of 17 Native American contacts. The list of contacts was forwarded to the County of Sacramento who sent outreach letters to all 17 contacts on October 31, 2016 and follow-up emails on November 1, 2016 (See **Attachment A** for consultation documentation with the NAHC).

☒ Native American Tribes, Groups and Individuals

The following Native American representatives were contacted:

- Rhonda Morningstar Pope, Chairperson, Buena Vista Rancheria
- Judith Marks, Colfax-Todds Valley Consolidated Tribe
- Pamela Cubbler, Colfax-Todds Valley Consolidated Tribe
- Ione Band of Miwok Indians (IBMI) Cultural Committee
- Randy Yonemura of the IBMI
- Yvonne Miller, Chairperson, IBMI
- Cosme Valdez, Interim Chief Executive Officer, Nashville-El Dorado Miwok
- Herma Olanio, Vice Chairperson, Shingle Springs Band of Miwok Indians
- Nicholas Fonseca, Chairperson, Shingle Springs Band of Miwok Indians
- Daniel Fonseca, Cultural Resources Director, Shingle Springs Band of Miwok Indians
- Jason Ryberg, Vice Chairperson, Tsi Akim Maidu
- Grayson Coney, Cultural Director, Tsi Akim Maidu
- Don Ryberg, Chairperson, Tsi Akim Maidu
- Marcos Guerrero, Tribal Preservation Committee, UAIC
- Gene Whitehouse, Chairperson, United Auburn Indian Community of the Auburn Rancheria (UAIC)
- Mathew Moore, THPO, UAIC
- Raymond Hitchcock, Chairperson, Wilton Rancheria
- Steven Hutchason, Executive Director Environmental, Wilton Rancheria
- Ed Silva, Tribal Resources Coordinator, Wilton Rancheria

Through their consultation efforts, the County received several responses from the Native Americans listed above and other tribal representatives. Detailed accounts of Native American consultation efforts can be found in the ASR (**Attachment A**).

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☒ Local Historical Society / Historic Preservation Group

On March 25, 2016, ICF sent contact letters to the Sacramento County Historical Society, Rancho Cordova Historical Society, Folsom Historical Society, Heritage Preservation League, and the California Historical Society. The letters briefly described the proposed project and requested information about cultural resources near the proposed project area. ICF sent a letter to an additional interested party, the Heritage Preservation League of Folsom on August 30, 2016. On November 16, 2016, ICF received email communication from Beth Kelly of the Heritage Preservation League informing ICF that the organization did not have any information pertaining to the property in their files, and mentioned that Folsom Historical Society Museum might have photos or information. They also mentioned that they are interested in preserving the Nimbus Winery. The same day, ICF sent a response email thanking them for reaching out with the information. As of the date of publication of this HPSR, ICF has not received further responses from any of the other historical societies/groups. Copies of letters sent to the interested parties and all correspondence is provided in **Attachment B** of this HPSR.

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4. SUMMARY OF IDENTIFICATION EFFORTS

☒ National Register of Historic Places (NRHP)

☒ California Register of Historical Resources (CRHR)

☒ Caltrans Historic Bridge Inventory

☒ California Historical Landmarks (CHL)

☒ California Points of Historical Interest

☒ California Historical Resources Information System (CHRIS)

☒ Other Sources consulted:

- Available Sacramento County Assessor parcel information was obtained in June 2016 from the County of Sacramento website for the properties in the APE.
- Aerial images of the project area were reviewed through historicaerials.com in July 2012.

☒ Results: Results of identification efforts are summarized in Tables 1 through 3 below, and detailed results are provided in the attached ASR (**Attachment A**).

Table 1. Cultural Resources Previously Recorded in the APE

Primary (P-34-)	Trinomial (CA-SAC-)	Type*	Description	Previous NRHP Finding	Recorder
455	428-H	BE	Sacramento Valley Railroad	Eligible	Portion w/in APE: Syda and Shapiro (1991)
1667	[none]	BE	Nimbus Winery	Not eligible	Liu (2007)
2183	[none]	BE	Industrial building (Aerojet facility)	Not eligible	Allen (2008)
* BE = built environment					

Table 2. Additional Cultural Resource Identified in the APE

Resource Name	Address	APN	HRI Program #	HRI Status Code	NRHP Finding
Sacramento County Fire Station #63	12395 Folsom Blvd.	069-0160-011	DSA_34-SPS-3039 (1995)	6J	Landmark or Points of Interest found ineligible for designation by the State Historic Resources Commission

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Table 3. Demolished/Non-Extant Cultural Resources Previously Recorded in the APE

Primary (P-34-)	Trinomial (CA-SAC-)	Type*	Description	Previous NRHP Finding	Recorder
596	[none]	BE	Single-story shed associated with Nimbus Winery (no longer exists)	Not eligible	Maniery (1991)

* BE = built environment; A = archaeological

The architectural APE includes 13 historic-era properties that were exempted from evaluation because they meet the criteria presented in Attachment 4 (Properties Exempt from Evaluation) of the 2014 PA under Property Type 2, 4, and 7. Three category 5 (not eligible for listing in the NRHP) Caltrans bridges are present in the APE. One property (Sacramento Valley Railroad - segment) previously determined eligible for listing in the NRHP is located in the APE and that NRHP recommendation is still valid. Three properties were previously determined not eligible for listing in the NRHP and those recommendations are still valid. There are no other historic-era properties located in the APE that required evaluation under NRHP and CR criteria in the APE, and all properties in the APE have been documented in this HPSR. See Section 5, Properties Identified.

5. PROPERTIES IDENTIFIED

☒ Aisha Fike [ICF, consultant], who meets the Professionally Qualified Staff (PQS) Standards in Section 106 PA Attachment 1 and as applicable PRC 5024 MOU Attachment 1 as a(n) Architectural Historian, has determined that the only/only other properties present within the APE meet the criteria for Section 106 PA Attachment 4 (**Properties Exempt from Evaluation**) and as applicable PRC 5024 MOU Stipulation VIII.C.1 and Attachment 4.

- 12401 Folsom Boulevard, Rancho Cordova, CA. APN-069-0060-088. Built 1987. Exempt Property Type 2.
- 12399 Folsom Boulevard, Rancho Cordova, CA. APN-069-0160-012. Built 2006. Exempt Property Type 2.
- 12303 Folsom Boulevard, Rancho Cordova, CA. APN-069-0160-014. Built ca. 1980. Exempt Property Type 4.
- 12251 Folsom Boulevard, Rancho Cordova, CA. APN-069-0160-020. Built 1989. Exempt Property Type 2.

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- 12249 Folsom Boulevard, Rancho Cordova, CA. APN-069-0160-019. Built 1988. Exempt Property Type 2.
- 12233 Folsom Boulevard, Rancho Cordova, CA. APN-069-0160-015. Built 1986. Exempt Property Type 2.
- 12189 Folsom Boulevard, Rancho Cordova, CA. APN-069-0160-008. Built 2007. Exempt Property Type 2.
- 12161/12181 Folsom Boulevard, Rancho Cordova, CA. APN-069-0160-007/069-0160-006. Built 1983. Exempt Property Type 4.
- 12137 Folsom Boulevard, Rancho Cordova, CA. APN-069-0160-005. Built 1991. Exempt Property Type 2.
- 12125 Folsom Boulevard, Rancho Cordova, CA. APN-069-0160-022. Built 1984. Exempt Property Type 4.
- 12423 Folsom Boulevard, Rancho Cordova, CA. APN-069-0150-008. Built ca. 1960. Exempt Property Type 7: Mobile Home Park.
- 12499 Folsom Boulevard, Rancho Cordova, CA. APN-069-0060-107. Built 2001. Exempt Property Type 2.
- Bridge #24-0168. Hazel Avenue overcrossing. Category 4: No Evaluated. Built 1994. Exempt Property Type 2.

☒ Caltrans, in accordance with Section 106 PA Stipulation VIII.C.5 and as applicable PRC 5024 MOU Stipulation VIII.C.5 has determined there are cultural resources within the APE that were **previously determined not eligible** for inclusion in the NRHP and/or not eligible for registration as a CHL with SHPO concurrence and those determinations remain valid. Copy of SHPO/Keeper correspondence is attached.

- 1. APN-069-0160-011. Sacramento County Fire Station #63. 12395 Folsom Boulevard, Rancho Cordova, CA. HRI status code: 6J-Landmark or Points of Interest found ineligible for designation by the SHRC (1995). HRI Reference Number: DSA-34-SPS-3039. (see **Attachment D**)
- 2. APN 069-0050-013. P-34-001667. Nimbus Winery. HRI status code: 6Y Determined ineligible for NRHP listing by consensus through Section 106 process. Evaluated in 2007 by Liu and Sikes HRI Reference Number: BUR920110A. (see **Attachment D**)
- 3. APN 072-0231-125. P-34-002183. Aerojet Building 49015. HRI status code: 6X-. Evaluated and determined ineligible for the NRHP listing through the Section 106 process under the MOA for the Glenborough at Easton and Easton Place Project (Easton Project). Correspondence between the U.S. Army Corps of Engineers (USACE), Past Forward Inc. (Rebecca Allen), and SHPO regarding the ineligibly of Aerojet Building 49015 is in **Attachment D**. In 2010, the USACE and Past Forward Inc. submitted a request to SHPO for concurrence on Aerojet Building 49015. That

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same year Past Forward Inc. responded to questions SHPO had on the eligibility and the evaluations completed as part of the Easton Project. In efforts to gather concurrence documentation as part of this study, final formal concurrence on the subject property was not located. However, the building is not noted in the MOA for the Easton Project and SHPO concurrence on its ineligibility is assumed per Section II. C. of that MOA (see **Attachment D**).

☒ Bridges listed as **Category 5** (previously determined not eligible for listing in the NRHP) in the Caltrans Historic Bridge Inventory are present within the APE and those determinations remain valid. Appropriate pages from the Caltrans Historic Bridge Inventory are attached. See **Attachment C**.

- Bridge # 24C-0189. Folsom South Canal Bridge (Hazel Avenue). Built 1966.
- Bridge # 24-0366. Hazel/Folsom pedestrian overcrossing bridge. Built 2000.
- Bridge # 24-0366. Hazel/Folsom pedestrian overcrossing bridge. Built 2000.

☒ Caltrans, in accordance with Section 106 PA Stipulation VIII.C.5 and as applicable PRC 5024 MOU Stipulation VIII.C.5 has determined there are properties within the APE that were **previously determined eligible** for inclusion in the NRHP and/or as CHLs and those determinations remain valid. Copy of SHPO/Keeper correspondence is attached (see **Attachment D**).

- 4. P-34-000455. CA-Sac-000428. Sacramento Valley Railroad. HRI status code: 2S2-Determined eligible for NRHP listing by consensus through Section 106 process. Listed in the CRHR and evaluated in 1993.

6. FINDING FOR THE UNDERTAKING

☒ Caltrans, pursuant to Section 106 PA Stipulation IX.A and as applicable PRC 5024 MOU Stipulation IX.A.2, has determined a Finding of **No Historic Properties Affected** is appropriate for this undertaking because there are no historic properties within the APE / the following historic properties will not be affected.

- The Sacramento Valley Railroad (SVRR) (P-34-455; CA-SAC-428-H): The SVRR is well documented and was previously determined eligible for listing in the NRHP in 1993 under Criterion A, as the state's first passenger railroad west of the Mississippi River and for its role in the growth of the cities of Sacramento and Folsom, and under Criterion B, for its association with Theodore Judah. The character-defining features of the SVRR are the rail alignment, its historic setting, and location. Although the resource is located in the APE, no proposed project construction will compromise the character-defining features that help define why the rail line is significant under NRHP Criteria A and B. Consequently, as currently designed, the proposed project does not have the potential to affect, either directly or indirectly, the SVRR alignment.

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7. CEQA CONSIDERATIONS

☒ Not applicable; **Caltrans is not the lead agency under CEQA**.

8. LIST OF ATTACHED DOCUMENTATION

☒ Project Vicinity, Location, and APE, and Survey Coverage Maps (Appendix A of Attachment A)

☒ Caltrans Historic Bridge Inventory Sheet (Attachment C)

☒ Archaeological Survey Report (ASR) (Attachment A)

- Stephen Pappas, MA, RPA, ICF Associate Archaeologist (author) July 2018

☒ Other

- Local Historical Society Letters (Attachment B)
- Documentation on Previous Determinations (SHPO Concurrence Letters, OHP Historic Property Data File) (Attachment D)

9. HPSR PREPARATION AND CALTRANS APPROVAL

Prepared by: _____ August 15, 2018
Stephen Pappas, Associate Archaeologist — Date
ICF, Sacramento, CA

Reviewed for Approval by: _____ 9/5/18
District 3 Caltrans PQS: Joan Fine — Date
PQS: Principal Architectural Historian

Reviewed for Approval by: _____ 9/6/18
District 3 Caltrans PQS: Lisa Machado — Date
PQS: PI-Historical Archaeology
Co-PI-Prehistoric Archaeology

Approved by: _____ 9/6/18
District 3 EBC: Kendall Schinke — Date
Chief, Environmental Management

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Attachment A
Archaeological Survey Report

U.S. 50 / Hazel Avenue Interchange Project
ASR



Archaeological Survey Report

Hazel Avenue State Route 50 Interchange Project

Sacramento County

03-SAC-50/PM 15.1-17.4

Federal Project No.: EA 03-3E380/E-FIS 0300020439

August 2018

Caltrans
CALIFORNIA DEPARTMENT OF TRANSPORTATION

Archaeological Survey Report for the U.S. 50/Hazel Avenue Interchange Project, Sacramento County, California

03-SAC-50/PM 15.1-17.5, EA 03-3E380/E-FIS 0300020439
County Control Number 2011-70062

PREPARED FOR:

Sacramento County
Marianne Biner, Senior Environmental Analyst
Department of Community Development – Planning and Environmental Review
827 7th Street, Room 225
Sacramento, CA 95814

PREPARED BY:

Date: August 15, 2018

Stephen Pappas, Associate Archaeologist
630 K Street, Suite 400
Sacramento, CA 95814

REVIEWED BY:

Lisa Machado

Date: 9/6/18

Lisa Machado
PQS: PI –Historical Archaeology and Co-PI-Prehistoric Archaeology Caltrans District 3, Environmental Management

APPROVED BY:

Kendall Schinke

Date: 9/6/18

Kendall Schinke, Chief
Caltrans District 3, Environmental Management

USGS Topo:	Folsom and Buffalo Creek, California (7.5' series)
Acreage:	90.26 acres
Resources:	Natomas-Aerojet Dredge Fields (CA-SAC-1013H, P-34-1710), Folsom Mining District (CA-SAC-308H, P-34-335)

August 2018

ICF. 2018. *Archaeological Survey Report for the U.S. 50/Hazel Avenue Interchange Project, Sacramento County, California*. August (ICF 00529.15.) Sacramento, CA. Prepared for Sacramento County, Sacramento, CA, and the California Department of Transportation, District 3. Marysville, CA.

Summary of Findings

The County of Sacramento, in cooperation with the California Department of Transportation (Caltrans) and the City of Rancho Cordova, proposes to modify the existing U.S. Route 50 (U.S. 50)/Hazel Avenue interchange, and extend and grade-separate Hazel Avenue over Folsom Boulevard and the Sacramento Placerville Transportation Corridor Joint Powers Authority (SPTC-JPA) rail corridor. The project is being proposed to relieve existing congestion at the interchange and to accommodate planned and approved developments identified by the adopted Sacramento County General Plan and the Sacramento Area Council of Government's (SACOG) Regional Transportation Plan. Caltrans is the lead agency under the National Environmental Policy Act (NEPA) and the County of Sacramento is the lead agency under the California Environmental Quality Act (CEQA). The project Expenditure Authorization number is 03-3E380 and the E-FIS number is 0300020439.

This project will receive federal funding, therefore the environmental review, consultation, and any other action required in accordance with applicable federal laws for this project is being, or has been carried out by Caltrans as part of its NEPA assignment of federal responsibilities by the FHWA, effective October 1, 2012, and pursuant to U.S.C. 327. Given that the undertaking is subject to federal involvement, cultural resource studies are therefore mandated by the Advisory Council on Historic Preservation (ACHP) regulations 36 Code of Federal Regulations (CFR) §800 for implementation Section 106 of the National Historic Preservation Act of 1966 (NHPA). The studies for this undertaking were carried out in a manner consistent with Caltrans' regulatory responsibilities under Section 106 of the NHPA (36 CFR § 800) and pursuant to the January 2014 First Amended Programmatic Agreement among the Federal Highway Administration, the Advisory Council on Historic Preservation, the California State Historic Preservation Officer, and the California Department of Transportation Regarding Compliance with Section 106 of the National Historic Preservation Act (Section 106 PA), as well as under Public Resources Code (PRC) § 5024 and pursuant to the January 2015 Memorandum of Understanding Between the California Department of Transportation and the California State Historic Preservation Office Regarding Compliance with Public Resources Code Section 5024 and Governor's Executive Order W-26-92 (5024 MOU). In addition, the project is subject to state historic preservation laws set forth in CEQA (PRC § 210000et seq.).The study included an archival records search, coordination with the California Native American Heritage Commission (NAHC), and an intensive archaeological pedestrian survey. The purpose of this study was to identify and record cultural resources within the Area of Potential Effects (APE) and to assess whether cultural resources might be adversely affected by the project.

A records search at the North Central Information Center (NCIC) at California State University, Sacramento, indicated that two archaeological sites have been recorded within the APE.

The results of a search of the NAHC's Sacred Lands File (SLF) for the APE indicated that the NAHC has no record of any Native American cultural resources in or within the immediate

vicinity of the APE. The NAHC provided a list of 17 Native American contacts who may be interested in the project. The County of Sacramento sent letters to all 17 individuals and continued consultation with the interested parties was carried out by the County with assistance from ICF. See Appendix C and HPSR Attachment F for the Native American correspondence.

In June 2016, ICF archaeologists conducted an archaeological survey of the APE where access was available. In summary, this study concludes that no archaeological resources are present in the APE.

It is Caltrans' policy to avoid cultural resources whenever possible. If buried cultural materials are encountered during construction, it is Caltrans' policy that work stop in that area until a qualified archaeologist can evaluate the nature and significance of the find. Additional survey will be required if the project changes to include areas not previously surveyed.

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Appendix B NCIC Records Search

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NOT PUBLICLY AVAILABLE

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Acronyms

2014 PA	*First Amended Programmatic Agreement among the Federal Highway Administration, the Advisory Council on Historic Preservation, the California Historic Preservation Officer, and the California Department of Transportation Regarding Compliance with Section 106 of the National Historic Preservation Act, as It Pertains to the Administration of Federal-Aid Highway Program in California (January 2014)*
APE	Area of Potential Effects
ASR	Archaeological Study Report
BP	before present
CCTS	Central California Taxonomic System
Central Valley	California Central Valley
CEQA	California Environmental Quality Act
CHRIS	California Historical Resources Information System's
CRHR	California Register of Historical Resources
FHWA	Federal Highway Administration
HDM	Caltrans Highway Design Manual
HOV	high occupancy vehicle
HPSR	Historical Property Survey Report
IBMI	Ione Band of Miwok Indians
ICF	ICF
LOS	Level of Service
MSE	Mechanically Stabilized Earth
MTP	Metropolitan Transportation Plan
NAHC	California Native American Heritage Commission
NCIC	North Central Information Center
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NRHP	National Register of Historic Places
PEAR	Preliminary Environmental Analysis Report
PER	Planning and Environmental Review
proposed project	U.S. 50/Hazel Avenue interchange project
ROW	right-of-way
SACOG	Sacramento Area Council of Government
SHPO	State Historic Preservation Office
SLF	Sacred Lands File
SPTC-JPA	Sacramento Placerville Transportation Corridor Joint Powers Authority
TCL	Traditional Cultural Landscape
TCP	Traditional Cultural Properties
UPRR	Union Pacific Railroad
USGS	U.S. Geological Survey
UST	underground storage tank
U.S. 50	U.S. Route 50

Chapter 1 Introduction

The County of Sacramento, in cooperation with the California Department of Transportation (Caltrans) and the City of Rancho Cordova, proposes to modify the existing U.S. Route 50 (U.S. 50)/Hazel Avenue interchange, and extend and grade-separate Hazel Avenue over Folsom Boulevard and the Sacramento Placerville Transportation Corridor Joint Powers Authority (SPTC-JPA) rail corridor (Figures 1 through 7, Appendix A). The project is being proposed to relieve existing congestion at the interchange and to accommodate planned and approved developments identified by the adopted Sacramento County General Plan and the Sacramento Area Council of Government's (SACOG) Regional Transportation Plan. Caltrans is the lead agency under the National Environmental Policy Act (NEPA) and the County of Sacramento is the lead agency under the California Environmental Quality Act (CEQA). The project Expenditure Authorization number is 03-3E380 and the E-FIS number is 0300020439.

This project will receive federal funding, therefore the environmental review, consultation, and any other action required in accordance with applicable federal laws for this project is being, or has been carried out by Caltrans as part of its NEPA assignment of federal responsibilities by the FHWA, effective October 1, 2012, and pursuant to 23 U.S.C. 327. Given that the undertaking is subject to federal involvement, cultural resource studies are therefore mandated by the Advisory Council on Historic Preservation (ACHP) regulations 36 Code of Federal Regulations (CFR) § 800 for implementation Section 106 of the National Historic Preservation Act of 1966 (NHPA). Compliance with Section 106 is being carried out in accordance with the January 1, 2014 *First Amended Programmatic Agreement Among the Federal Highway Administration, the Advisory Council on Historic Preservation, the California State Historic Preservation Officer, and the California Department of Transportation Regarding Compliance with Section 106 of the National Historic Preservation Act, as it pertains to the Administration of the Federal-Aid-Highway Program in California* (Section 106 PA) as well as under Public Resources Code (PRC) § 5024 and pursuant to the January 2015 Memorandum of Understanding Between the California Department of Transportation and the California State Historic Preservation Office Regarding Compliance with Public Resources Code Section 5024 and Governor's Executive Order W-26-92 (5024 MOU). In addition, the project is subject to state historic preservation laws set forth in CEQA (PRC § 210000et seq.).

The study included an archival records search, coordination with the California Native American Heritage Commission (NAHC), and an intensive archaeological pedestrian survey. The pedestrian survey was conducted on June 8, 2016, to identify and record archaeological resources within the Area of Potential Effects (APE). The survey was carried out by ICF archaeologist Stephen Pappas, M.A., who has more than 13 years of cultural resources experience throughout the western United States. The survey resulted in no cultural resources identified within the APE.

Chapter 2 Project Location and Description

2.1 Location

The proposed project is in the City of Rancho Cordova and unincorporated County of Sacramento at the interchange of Hazel Avenue and U.S. 50. The APE is bounded along Hazel Avenue by the Tributary Point/westbound off-ramp intersection to the north, and extends approximately 1,000 feet south of Folsom Boulevard to a future intersection within the proposed and approved Easton Place residential community development. The project limits along U.S. 50 begin approximately 3,200 feet west of the existing Hazel Avenue overcrossing, and extend 2,500 feet east of the Natoma overhead. Improvements along Folsom Boulevard would extend from approximately 1,200 feet west of the Hazel Avenue intersection to 900 feet to the east.

2.2 Description

This section describes the proposed project and the design alternatives developed to meet the identified need through accomplishing the defined purpose while avoiding or minimizing environmental impacts. Two alternatives, with one sub-alternative, have been developed for the project.

- Alternative 1: This alternative consists of a modified type L-9 interchange configuration.
- Alternative 1a: This alternative is the same as Alternative 1 with the exception that the eastbound off-ramp will split and introduce a direct tunnel ramp under Hazel Avenue to carry eastbound off-ramp traffic to Aerojet Road and Folsom Boulevard.
- Alternative 2: This alternative consists of a modified type L-9 interchange configuration, with a flyover ramp carrying vehicles traveling from eastbound U.S. 50 to northbound Hazel Avenue over the freeway to join with the westbound U.S. 50 off-ramp.

U.S. 50 is owned and maintained by Caltrans, and the improvements to the highway are required to comply with the *Caltrans Highway Design Manual* (HDM).

2.2.1 Project Alternatives

The proposed project would construct modifications to the existing interchange, and grade-separate and extend Hazel Avenue to the south to a future intersection with Atlanta Street, which will be built with the approved Easton Place residential community development. Two alternatives, with one sub-alternative, have been developed for the project, as described in Section 2.4, Description. Depictions of the build alternatives are included in Appendix A.

2.2.1.1 Common Design Features of the Build Alternatives

The following is a description of elements and design components that are common to all alternatives.

Roadway Modifications

- Construction of a portion of an eastbound transition auxiliary lane on U.S. 50 from Hazel Avenue through the Folsom Boulevard overcrossing, also known as the Natoma overhead.
- Modification of the existing Aerojet Road off-ramp from U.S. 50.
- Reconstruction of the westbound loop on-ramp, with the ramp intersection shifted north towards the westbound off-ramp terminus, increasing storage lengths. The ramp would be metered with two lanes (one mixed use, and one high occupancy vehicle [HOV]) bypass), and a squared-up, pedestrian-friendly entrance.
- Reconstruction of the eastbound diagonal off-ramp to conform with the new Hazel Avenue profile and accommodate the Aerojet Road ramp divergence.
- Reconstruction of the eastbound diagonal on-ramp to conform with the new Hazel Avenue profile. The ramp would be metered with two lanes (one mixed flow, and one HOV bypass).
- Reconstruction of the eastbound loop on-ramp to conform with the new Hazel Avenue profile. The ramp would be metered with two lanes (one mixed flow, and one HOV bypass). A tie-back wall at the abutment of the overcrossing is proposed to maximize the opening through the structure. The loop ramp would develop an additional lane on U.S. 50 that will continue on to the Folsom Boulevard interchange.
- Construction of eastbound on- and off-ramp auxiliary lanes on U.S. 50, from west of the Hazel Avenue interchange to the eastbound off-ramp, and from the loop on-ramp extending to the Folsom Boulevard interchange.
- Modification of traffic signals and installation of safety lighting at the ramp intersections.
- Installation of new signalized intersection and at-grade railroad crossing for the jughandle.
- Maintenance of pedestrian access on the east side of Hazel Avenue with 6-foot-wide sidewalks; however, the existing sidewalk on the overcrossing will remain 5 feet wide. Bicyclists may utilize the County standard 7-foot-wide shoulders. It is expected that pedestrians and bicyclists would continue to use the nearby bikeway and pedestrian overcrossing as the primary means for crossing U.S. 50.
- Construction of roadway improvements along approximately 2,300 feet of Folsom Boulevard. Improvements include the removal of the existing signalized intersection with Hazel Avenue, and installation of sidewalks, street lighting, and landscaping along the north side of Folsom Boulevard, and landscaping and lighting along the south.

Transition Lane to Folsom Boulevard/U.S. 50 Interchange

As indicated in Caltrans' 2009 Corridor System Management Plan, eastbound U.S. 50 is shown to have one HOV lane and three mixed-flow lanes to Hazel Avenue as the Concept Facility. Additionally, eastbound U.S. 50 is shown to have one HOV lane and three mixed-flow lanes across Folsom Boulevard as the Ultimate Facility. The proposed project would accommodate these future facility improvements; conform to the approved Caltrans improvements at the Folsom Boulevard/U.S. 50 interchange, some of which will occur in 2016; and would restripe the third mixed-flow lane through the Folsom Boulevard/U.S. 50 interchange.

The proposed project is required to add the mixed-flow lane because the traffic analysis for this project, and studies for adjacent projects, determined that the additional eastbound lane on U.S. 50 extending through the Folsom Boulevard interchange is needed for operations.

Under all proposed project alternatives, accommodating this mixed-flow lane will require the eastbound loop on-ramp to extend its auxiliary lane to the Folsom Boulevard/U.S. 50 eastbound off-ramp. This extension would require widening and a new structure over Alder Creek.

Alder Creek currently flows under U.S. 50 through a box culvert (Br. No. 24-0033). A mechanically stabilized earth (MSE) wall (Br. No. 24-0372) is above the culvert. A new bridge would be required to widen U.S. 50 over Alder Creek. The new bridge is necessary because there is insufficient lateral space to construct an adjacent MSE wall on top of the culvert and because the creek maintains a high operating water level.

Railroad Overhead

Hazel Avenue would extend and be grade-separated over Folsom Boulevard and the SPTC-JPA rail corridor. One light rail track currently exists on the north side of the Union Pacific Railroad (UPRR) tracks. As a separate unrelated project, Sacramento Regional Transit plans to add another track at this location; when the addition occurs, the existing UPRR track will be relocated south to accommodate the second light rail track. The proposed project design meets the requirements for all three tracks.

Temporary vertical clearances of 21.5 feet and permanent vertical clearances of 24 feet have been accounted for in the layout of all three alternatives for the Hazel Avenue railroad overhead. The vertical clearance provided would accommodate the overhead catenary system for the light rail train.

Construction Information

The section describes the major construction activities anticipated with the project.

Clearing and Grubbing

The existing ground would be cleared and grubbed to accommodate the new roadway, embankments, and structures. This work would remove aboveground material including all vegetation, non-salvageable trees, and debris.

Construction of Roadway

This work would involve the obliteration of existing roadway, where applicable, and placement of new embankment, aggregate base, hot mix asphalt pavement, and curb, gutter and sidewalk.

Construction of Undercrossing Connector Ramp (Alt 1A)

Along with the elements noted for the "Construction of Roadway," this work is anticipated to be built using "top-down" construction methods. First, soldier piles would be installed to stabilize

the slope. These piles will be steel beams set into vertical holes filled with concrete and temporary lagging spanning between the beams. The area between the abutments would be excavated down to the final roadway surface. Dewatering may be required. Abutments would be supported by the steel piling in the soldier pile wall. Precast superstructures would be utilized to minimize construction duration and impacts to traffic.

Construction of Hazel Ave Overcrossing, Aerojet Ramp Viaduct, Hazel Ave Overhead, Hazel Avenue Ramp Overcrossing

The new bridges are anticipated to be cast-in-place concrete box girder bridges. These structures would be built on deep foundations. Due to the presence of cobbles, steel piles with driving shoes are anticipated. Bridge superstructures would be constructed on temporary falsework. An alternative to the cast-in-place superstructure is a precast bridge where the primary superstructure is fabricated off site. After fabrication, the bridge members would be shipped to the site and erected with cranes.

Construction of Bridge over Alder Creek

Because dewatering is not feasible at Alder Creek, the widening of U.S. 50 would be accommodated with a bridge constructed over the waterway. Driven concrete pile extensions would be utilized for the columns. Piles would be driven using temporary or permanent casings. The concrete piles/columns would be cast. The superstructure would be cast-in-place and would be temporarily supported by falsework.

Construction of Sub-Horizontal Ground Anchor Wall

The ground anchor wall would be constructed in lifts using "top-down" construction methods and tiebacks. Tieback anchors would be drilled below the existing Hazel Ave overcrossing abutments, which are on deep foundations. Shotcrete facing would be installed to stabilize the slope while subsequent lifts are constructed. Finally, a cast-in-place facing would be applied to the wall, providing long-term durability and an aesthetically pleasing texture.

Building Removal

The removal of the Cattleman's restaurant or the Nimbus Winery building would require testing for asbestos-containing materials and lead-based paint. The Chevron gas station at the northwest corner of Hazel Avenue and Folsom Boulevard has underground storage tanks (USTs) that would need to be removed as part of the closure. There are no groundwater monitoring reports available for the property, and there is potential of leaks associated with the USTs or fuel dispenser areas.

Vertical Area of Potential Effects

The vertical Area of Potential Effects for the project is expected to include the following:

- Clearing and grubbing: 1 foot below ground surface (bgs)
- Construction of abutments/new bridge: 5 to 15 feet bgs

- Construction of retaining walls: 15 feet bgs
- Removal of existing retaining wall: 3 feet bgs
- Removal of tree: 2 feet bgs
- Removal of building: 5 feet bgs
- Removal of gas station: unknown (to be determined)
- Removal of existing signal: 3 feet bgs
- Pile driving for structures: 50 to 80 feet bgs
- Construction of ramps below undercrossings:
  - Alt 1A: 17 to 20 feet bgs near ramps, 15 feet for retaining walls.
  - Alt 2: 5 feet bgs

2.2.1.2 Alternative 1: L-9 Interchange with Viaduct Connector

Alternative 1 consists of a modified type L-9 interchange configuration. A Caltrans Type L-9 interchange indicates a ramp configuration that includes a diagonal off-ramp, a diagonal on-ramp and a loop on-ramp. This alternative will provide a viaduct connection to Aerojet Road.

As with all alternatives, Hazel Avenue would grade-separate over Folsom Boulevard and the SPTC-JPA rail corridor and would extend south to a proposed intersection with the future Atlanta Street. The existing at-grade intersection of Hazel Avenue and Folsom Boulevard would be removed, sidewalks would be extended across the former intersection, and the lanes would be restriped to remove left-turn lanes.

The location of the departure point of the existing Aerojet Road off-ramp from U.S. 50 would be moved to join with the eastbound Hazel Avenue off-ramp. The eastbound Hazel Avenue off-ramp would split and introduce a direct viaduct ramp over Hazel Avenue to carry eastbound off-ramp traffic to Aerojet Road and Folsom Boulevard. The off-ramp diverge from U.S. 50 would be shifted approximately 830 feet to the east to provide decision sight distance before the Aerojet Road split. The two-lane off-ramp would widen to five lanes at the ramp terminal intersection, with three left-turn lanes and two right-turn lanes. Retaining walls and barriers placed at the proposed right-of-way (ROW) would minimize acquisition. The eastbound off-ramp would also have an auxiliary lane prior to the exit.

The Aerojet Road viaduct would land adjacent to the eastbound diagonal on-ramp and then turn southerly to conform to Folsom Boulevard along its existing alignment. Retaining walls are proposed between the viaduct and the diagonal on-ramp to accommodate the grade difference, and to the outside of the ramp after the viaduct lands, to minimize ROW acquisitions. Retaining walls are also proposed along Aerojet Road as it approaches the horizontal curve towards Folsom Boulevard to accommodate the grade difference between the ramp and mainline and to minimize ROW acquisition.

The existing Hazel Avenue overcrossing of U.S. 50 would be widened on the west side to accommodate eight lanes (three through lanes and one freeway-only lane in both directions). The existing raised concrete median across the structure would be removed, and the roadway would be restriped with a 6-foot striped median. The existing sidewalk and barrier on the east side of the structure would remain.

2.2.1.3 Alternative 1A: L-9 Interchange with Undercrossing Connector

Alternative 1A is the same as Alternative 1, except that the eastbound off-ramp would split and introduce a direct tunnel ramp under Hazel Avenue to carry eastbound off-ramp traffic to Aerojet Road and Folsom Boulevard.

2.2.1.4 Alternative 2: Direct Flyover to Hazel Avenue With Connector

Alternative 2 consists of a modified type L-9 interchange configuration, with a flyover ramp carrying vehicles traveling from eastbound U.S. 50 to northbound Hazel Avenue over the freeway to join with the westbound off-ramp.

The existing Aerojet Road off-ramp from U.S. 50 would be removed. The eastbound off-ramp divergence point from U.S. 50 would be shifted approximately 680 feet to the east to provide decision sight distance. An auxiliary lane would precede the off-ramp. A retaining wall is proposed adjacent to the off-ramp to minimize ROW acquisition.

The eastbound off-ramp would split and introduce northbound and southbound Hazel Avenue ramps. The northbound ramp would also carry traffic headed for Aerojet Road/Folsom Boulevard. An overhead sign would direct vehicles heading to southbound Hazel Avenue into the right lane and direct vehicles destined for northbound Hazel Avenue or Aerojet Road or Folsom Boulevard to use either lane. Retaining walls are proposed for the ramp as it approaches the horizontal curve towards Folsom Boulevard to accommodate the grade difference between the ramp and mainline and to minimize ROW acquisition at an apartment complex.

The northbound Hazel Avenue movement would cross under Hazel Avenue at the interchange, cross over U.S. 50 on a two-lane flyover structure, and then merge with the westbound off-ramp and terminate at the Hazel Avenue/Tributary Point intersection. The westbound off-ramp would split so that the southbound and through movements align to the left of the ramp, and the northbound movements are to the right.

The southbound ramp would connect directly to Hazel Avenue; however, for Alternative 2 an intersection is not required at Hazel Avenue and the eastbound ramp. By eliminating an intersection at the eastbound ramp, and by removing the heavy eastbound-to-northbound movements from the Hazel Avenue overcrossing, the existing southbound ramp could remain without widening.

The two-lane westbound off-ramp would be reconstructed to provide decision sight distance between the divergence point from U.S. 50 and a new ramp split that accommodates the flyover. The westbound off-ramp would split on either side of the flyover ramp, with one lane to the right carrying northbound Hazel Avenue traffic and the other crossing underneath the flyover ramp to

join up on the left side of the flyover for the southbound Hazel Avenue movements. The profiles of the three ramps have been coordinated to match grade quickly to minimize retaining wall limits and enhance driver visibility. Overhead signage would direct drivers into the appropriate lanes for northbound and southbound Hazel Avenue traffic.

2.2.1.5 Alternative 3: No Build Alternative

Alternative 3, the No Build Alternative, would not modify the existing interchange, would retain the same existing configuration, ramps, and lanes. The No Build Alternative does not meet the purpose and need of the proposed project.

2.2.1.6 Right of Way and Utilities

For Alternative 1, ROW acquisition is anticipated from parcels in the southwest quadrant of the interchange. It is anticipated that 12 parcels would be affected by the improvements, including full acquisition and demolition of structures at the Chevron gas station (APN 069-0160-012) and Cattleman's restaurant (APN 069-0060-085). The viaduct structure is proposed to cross over the northern portion of the Nimbus Winery parking lot (APN 069-0050-013) on an aerial easement, to allow parking below the structure and minimize project effects on the business.

The ROW take at the Nimbus Winery property (APN 069-0050-013) would be larger in Alternative 1A because acquisition would be required instead of using an aerial easement.

For Alternative 2, ROW acquisition is anticipated from parcels in the southwest quadrant of the interchange. It is anticipated that 13 parcels would be affected by the improvements, including full acquisition and demolition of structures at the Chevron gas station (APN 069-0160-012), Cattleman's restaurant (APN 069-0060-085) and the Nimbus Winery property (APN 069-0050-013).

These acquisition needs described above are preliminary and would be finalized during the ROW acquisition process and Final Design of the project

The proposed project would require the relocation of utilities for all build alternatives, and it is anticipated that this effort would include moving gas lines, overhead electric lines, underground electric lines, fiber optic cables, water lines, sewer lines, and storm drain lines. There is also potential for project effects on other unknown utilities.

Currently, the project will not require designated disposal, staging and borrow sites (DSBs). However, if the contactor requires such areas outside the current study limits, they must be cleared by either Caltrans Professionally Qualified Staff (PQS) or contractor provided cultural resource specialists who meet the Secretary of Interior's Professional Qualification Standards. Sacramento County would be responsible for clearing any DSBs and submitting documentation to Caltrans PQS staff for approval. Any DSBs proposed outside of Caltrans right of way must also be cleared for cultural resources. Per *Design Information Bulletin Number 85, Guidance for the Consideration of Material Disposal, Staging, and Borrow Sites, Original signed by Mark Leja, Division Chief, Division of Design, May 15, 2007 and Section7-103 Protection of Environmental Resources, in Chapter 7 of the August 2006 Caltrans Construction Manual,* for

DSBs outside of Caltrans right of way, the contractor will provide to Caltrans environmental documentation prepared by appropriately qualified environmental specialists. The contractor will also obtain or update all necessary permits, licenses, and agreements including supporting environmental documents from appropriate regulatory and governmental agencies. This project is state and federally funded.

2.2.2 Area of Potential Effects

The APE considers the maximum extent of potential direct effects to cultural resources that could result from the project. In accordance with Section 106 PA Stipulations VI.B.7 and VIII.A, the APE for the project was established in consultation with Lisa Machado (PQS-PI-Historical Archaeology and Co-PI-Prehistoric Archaeology), Joan Fine (PQS: Principal Architectural Historian), and John Holder (Project Manager).

The APE consists of both the horizontal and vertical maximum potential extent of direct impacts resulting from the project. Figure 3, in Appendix A, illustrates the APE. The horizontal APE encompasses the project footprint and includes those areas of new construction, easements, utilities, and operations-related activities associated with the project. The vertical APE is the maximum extent of ground disturbance within the horizontal APE (i.e., ground surface to maximum depth of soil disturbance) and varies by project component. For the vast majority of the project, the vertical APE ranges from 2 to 4 feet deep with a maximum vertical depth of 50 to 80 feet bgs for pile-driving of structures.

Chapter 3 Sources Consulted

3.1 Record Search Methods and Results

A cultural resources records search was conducted at the California Historical Resources Information System's (CHRIS) North Central Information Center (NCIC) located on the campus of California State University, Sacramento on December 4, 2015 (Record Search #SAC-15-191; Appendix B). The record search was conducted by ICF archaeologist Erik Allen for the project Preliminary Environmental Analysis Report (PEAR) with additional records obtained on April 6, 2016. The records search covered the APE and all areas within a 0.25-mile radius of the APE. Because the project is limited mostly to existing roadways and built environments, a 0.25-mile radius was deemed appropriate for the record search. The purpose was to identify any previously recorded cultural resources in the APE and vicinity, and to assess the potential for cultural resources in the APE. Also included in the search were previous cultural resources studies that have included portions of the APE or areas within 0.25 mile of the APE.

The records search was performed on data from the following sources:

- All available cultural resource survey and site records on file at the NCIC
- National Register of Historic Places (NRHP) (1988, and computer listings 1966 to 2008)
- California Register of Historical Resources (CRHR) (2008 to present)
- California Inventory of Historic Resources (1976)
- California State Historical Landmarks (1996)
- California State Points of Historical Interest (1992)
- Office of Historic Preservation Archaeological Determinations of Eligibility
- Local inventories

The following historical maps and aerial photographs were reviewed to identify buildings, features, and landforms that may aid in the identification of cultural resources:

- 1871 GLO Plat map for Township 9 North, Range 7 East
- 1891 U.S. Geological Survey (USGS) California, Sacramento Sheet (1:125,000)
- 1914 USGS Folsom, California (1:31,680)
- 1941 USGS Folsom, California (1:62,500)
- Aerial photograph taken in 1952
- 1954 USGS Folsom, California (7.5-minute scale)
- Aerial photograph taken in 1957
- Aerial photograph taken in 1964

- Aerial photograph taken in 1966
- 1967 (photo revised 1975 and 1980) USGS Roseville, California (7.5-minute scale)

The results of the records search were provided in the following forms:

- Mapped locations of previously recorded archaeological resources
- Mapped locations of previous cultural resources studies
- Copies of resource records for previously recorded archaeological resources
- List and details of reports from previous studies

3.1.1 Previous Studies

According to the records search, 46 previous cultural resources studies have been conducted within 0.25 mile of the APE. Of the 46 previous studies, 20 contain a portion of the APE (Table 1 - removed from public version). The previous studies account for surveys of approximately 75% of the area within the records search radius and 75% of the APE. Most of the surveys covering the APE were conducted more than 10 years ago and are not considered current according to State Historic Preservation Office (SHPO) standards. The studies within the APE consisted mostly of studies associated with U.S. 50, Folsom Boulevard, and Light Rail improvements, and development projects on Aerojet lands.

3.1.2 Previously Recorded Cultural Resources

The record search revealed that 31 cultural resources were previously recorded within 0.25 mile of the APE. Of those 31 cultural resources, 17 were archaeological and 14 were built environment resources.

Description of these resources removed from public version.

3.2 Native American Consultation

On December 7, 2015, ICF requested, by email with attached formal request form and map, a records search of the NAHC Sacred Lands File (SLF) for the APE and a list of Native American representatives who may be able to provide information about resources of concern located within or adjacent to the APE. No reply was received from the NAHC and a follow-up request was emailed on June 1, 2016. The NAHC replied with the results of the SLF records search on June 15, 2016, stating that the SLF contains no record of any Native American cultural resources in or within the immediate vicinity of the APE, and provided a list of 17 Native American contacts who may be interested in the project (see Appendix C). A copy of the NAHC letter and list of Native American contacts was provided to the County of Sacramento, Department of Community Development, Planning and Environmental Review (PER) Division.

The County of Sacramento sent letters on October 31, 2016 and follow-up emails on November 1 and 2, 2016 to all Native American contacts provided by the NAHC as part of their Native American consultation obligations under the National Historic Preservation Act (NHPA). Additionally, the County of Sacramento, Department of Community Development, PER Division conducted consultation with California Native American Tribes for California Assembly Bill 52 (Public Resources Code Section 21080.3) purposes. The following Native American representatives were contacted by the County:

- Rhonda Morningstar Pope, Chairperson, Buena Vista Rancheria
- Judith Marks, Colfax-Todds Valley Consolidated Tribe
- Pamela Cubbler, Colfax-Todds Valley Consolidated Tribe
- Yvonne Miller, Chairperson, Ione Band of Miwok Indians (IBMI)
- IBMI Cultural Committee
- Cosme Valdez, Interim Chief Executive Officer, Nashville-El Dorado Miwok
- Herma Olanio, Vice Chairperson, Shingle Springs Band of Miwok Indians
- Nicholas Fonseca, Chairperson, Shingle Springs Band of Miwok Indians
- Daniel Fonseca, Cultural Resources Director, Shingle Springs Band of Miwok Indians
- Jason Ryberg, Vice Chairperson, Tsi Akim Maidu
- Grayson Coney, Cultural Director, Tsi Akim Maidu
- Don Ryberg, Chairperson, Tsi Akim Maidu
- Gene Whitehouse, Chairperson, United Auburn Indian Community of the Auburn Rancheria (UAIC)
- Marcos Guerrero, Tribal Preservation Committee, UAIC
- Mathew Moore, THPO, UAIC
- Raymond Hitchcock, Chairperson, Wilton Rancheria
- Steven Hutchason, Executive Director Environmental, Wilton Rancheria
- Ed Silva, Tribal Resources Coordinator, Wilton Rancheria

Through their consultation efforts, the County received several responses from the Native Americans listed above and other tribal representatives. Detailed accounts of Native American consultation efforts to-date can be found in the CONFIDENTIAL Appendix C. Consultation is ongoing and will continue throughout the life of the proposed project. Native American groups and individuals will be kept apprised of any developments concerning cultural resources.

3.3 Historical Society Consultation

ICF sent letters describing the project and requested information on potential cultural resources in the APE to the Sacramento County Historical Society, Rancho Cordova Historical Society, Folsom Historical Society, Heritage Preservation League, and the California Historical Society. These letters were sent on March 25, 2016. ICF sent a letter to an additional interested party, the Heritage Preservation League of Folsom, on August 30, 2016. On November 16, 2016, ICF received email communication from Beth Kelly of the Heritage Preservation League informing ICF that the organization did not have any information pertaining to the property in their files and mentioning that Folsom Historical Society Museum might have photos or information. They also mentioned that they are interested in preserving the Nimbus Winery. The same day, ICF sent a response email thanking them for reaching out with the information. All correspondence with the historical societies is documented in Attachment B of the HPSR.

Chapter 4 Background

4.1 Environment

The APE is in the eastern portion of the Sacramento Valley, approximately 8 miles west of the foothills of the Sierra Nevada Mountains at an elevation ranging from 130 to 150 feet above mean sea level. Directly north of the APE is Nimbus Dam, which created Lake Natoma and serves as an after bay for Folsom Lake. Folsom Dam, 5.5 miles east of the APE, was constructed in 1955 concurrently with Nimbus Dam, and both have since greatly changed the flow of the American River. The majority of the landscape south and southeast of the APE consists of thousands of acres of dredge tailings created from dredge mining operations performed from late 1890s into the 1950s by the Natomas Company. Since the 1950s, when dredging operations ceased, the lands south and east of the APE have been used for rocket propulsion testing and manufacturing carried out by Aerojet General. The land north of the APE contains Lake Natoma, and north of the lake are historically mined gravel bars known as Mississippi Bar and Sailor Bar. Both bars contain similar dredged lands and shoreline, with residential development to the north. The area west of the APE contains office and industrial retail businesses. Overall, the environment surrounding the APE has been heavily modified by placer mining, particularly gold dredging, and construction of residential, commercial, industrial, and transportation land uses.

4.1.1 Geology

The geology surrounding the APE is part of a stepped braided floodplain that formed during the Pleistocene to Holocene migration of the American River. During the Pleistocene, as the ancestral American River flowed down from the Sierra Nevada and past what is now the city of Folsom, it formed a complex of alluvial fan and channel deposits and created river terraces. During this time, as the river migrated north, it created several channels and formed the distinct channel deposits present in the area surrounding the APE today (Shelmon 1972). The two Pleistocene alluvial deposits underlying the APE are the Riverbank and Modesto Formations.

The area on the south side of the American River from Folsom south to the former Mather Air Force Base was dredge mined for gold from the 1880s to the 1950s by several companies that eventually merged to become the Natomas Company (Clark 1998). This mining left behind dredge tailings, which are mounds of gravel and cobble with fine sediments between the mounds.

Geologic mapping by the California Geological Survey (2010) shows that most of the interchange, which is in the southcentral portion of the APE, is underlain by Pliocene-Pleistocene marine and non-marine sedimentary rocks. The materials consist of sandstone, shale, and gravel rocks that are loosely consolidated.

Much of the area, however, is developed and the surface is disturbed by road and building construction. In addition, artificial fill has been placed for road base and to elevate on-ramps and off-ramps.

4.2 Prehistory

Continuing research and interpretation have led to two fundamentally different approaches to the archaeological record of the California Central Valley (Central Valley); the first is chronological, and the second involves the elucidation of contemporaneous cultural patterns. The discussion below provides a succinct description of both approaches to Central Valley prehistory, beginning with the nascent, salvage-oriented archaeology of the late nineteenth century, followed by the development of cultural historical frameworks for the Central Valley under the aegis of Sacramento Junior College and the University of California, Berkeley. The discussion moves from this chronologically-oriented approach to the functional and systems approaches favored in California archaeology from the 1960s into the present.

In the late nineteenth century and early twentieth century, knowledge of the area's prehistory was derived largely from local collectors. The collections of J. A. Barr and E. J. Dawson, amateur archaeologists working in the Stockton area from 1893 to the early 1930s, provided the groundwork for the later development of a three-phase chronological sequence for central California (Ragir 1972). Professional archaeological research in the lower Sacramento Valley was initiated during the 1920s and 1930s. Lillard and Purves (1936) worked at several mound sites near the Deer Creek/Cosumnes River confluence in Sacramento County. From the relative sequences in stratified occupational and burial sites, Lillard and Purves identified a three-stage chronology based on artifacts, burial orientation, and condition. Simply called the Early, Transitional (later called Middle), and Late horizons, these stages were defined by shifting patterns in site assemblages and mortuary morphology. Although interpretations varied, explanations for change usually were linked to the movements of people. In 1939, a synthesis of this research was published and later expanded into the Central California Taxonomic System (CCTS) (Lillard et al. 1939). Later refined by Heizer (1949) and Beardsley (1948, 1954a, 1954b), the CCTS was characterized by specific artifact types, mortuary practices, and other cultural features.

Subsequent archaeological research was aimed at refining the CCTS and incorporating the study of paleoenvironmental change, settlement patterns, population movement, subsistence strategies, and development of exchange networks. These studies led to the development of a second approach. As absolute dates became available for sites with Early, Middle, and Late assemblages, it was discovered that sites with different assemblages actually were contemporaneous. This was particularly true with sites from the Early and Middle horizons. This discovery, along with a change in archaeological paradigms in the 1960s to a more economic and functional orientation, led to a reorganization of the CCTS. This new scheme used the same archaeological manifestations to differentiate sites as did the CCTS, but ordered sites into functional groups rather than temporal ones, which led to the establishment of different cultural models for many localities of central California.

This approach was advanced by Fredrickson (1973), who used the term *pattern* to describe an "adaptive mode extending across one or more regions, characterized by particular technological skills and devices, and particular economic modes." Three patterns were introduced: Windmiller, Berkeley, and Augustine. These patterns, while generally corresponding to the Early, Middle, and Late horizons within the Central Valley, were conceptually different and free of spatial and temporal constraints. By changing the paradigm from a cultural/historical orientation to a more

processual/adaptive one and introducing the concept of pattern, Fredrickson addressed problems with the chronological and regional sequences that had been nagging archaeologists for several decades (King 1974).

The taxonomic framework of the Sacramento Valley is described in the following sections in terms of chronology with archaeological patterns discussed where they apply, following Fredrickson's (1973) system.

4.2.1 Paleo-Indian (13550 to 10550 BP)

At the end of the Pleistocene, circa 13,500–10,550 years before present (BP), parts of the Sierra Nevada range adjacent to the Central Valley were covered with large glaciers (West et al. 2007:27), and the Central Valley provided a major transportation route for animals and people. This transportation corridor, perhaps rivaled only by maritime coastal travel (Erlandson et al. 2007), was undoubtedly used heavily by early Californians. Evidence for human occupation during this period, however, is scarce, likely because remains have been buried by deep alluvial sediments that accumulated rapidly during the late Holocene (Westwood 2005:17).

Although rare, archaeological remains of this early period have been reported in and around the Central Valley (Peak 1981; Johnson 1967; Treganza and Heizer 1953). Johnson (1967:283–284) presents evidence for some use of the Mokelumne River area, under what is now Camanche Reservoir, during the late Pleistocene. At Rancho Murieta, approximately 11 miles south of the APE, lithic artifacts spanning the reduction sequence, as well as unworked raw material, were recovered from gravel deposits attributed to the late Pleistocene (Peak 1981).

4.2.2 Lower Archaic (10550 to 7550 BP)

Using a wider range of smaller resources meant people needed access to larger areas of land to hunt and collect the food and other resources they required. Small groups of people probably moved through the Central Valley, foothills, and Sierra Nevada range to take advantage of seasonally available resources and resources limited to particular ecozones. This mobile foraging strategy was essential to their survival with a reliance on a diverse number of smaller plants and animals. More specialized tools were necessary to procure and process the wider range of plants and animals that were being used.

During the Lower Archaic Period, beginning approximately 10550 BP, a shift to a more specialized subsistence strategy began, focusing on ways of increasing the amount of food that could be produced from smaller portions of land. This change can be at least partially explained by the increasing numbers of people living in the Central Valley, which is indicated by a much more abundant archaeological record and by dietary stress, as indicated by dental pathologies (Moratto 1984:203–204). As the population slowly increased, it became more difficult for people to obtain seasonally available resources across large areas of land.

4.2.3 Middle Archaic (7550 to 2550 BP)

The beginnings of the intensification emerging in the Lower Archaic is manifested more intensely in the Middle Archaic Windmiller Pattern (4500–2800 BP), based on the assemblage at

the Windmiller site (CA-SAC-107). Windmiller Pattern origins are believed to be linked to the arrival of Utian peoples (ancestors to the Maidu) from outside California who were adapted to riverine and wetland environments (Moratto 1984). Windmiller sites are concentrated on low rises or knolls within the floodplains of major creeks or rivers with habitation sites in the valley occupied during the winter with population movements into the foothills during the summer (Moratto 1984).

The result of the settlement and subsistence reorientation was a coeval, adaptive pattern with the Windmiller Pattern labeled the Berkeley Pattern (3500–2500 BP) (Fredrickson 1973). Windmiller Pattern sites seem to occur with more frequency in or near the Delta, while Berkeley Pattern sites tend to be more prevalent farther north. Berkeley Pattern sites are more numerous and more widely distributed than Windmiller sites; they are characterized by deep midden deposits, suggesting intensified occupation and a broadened subsistence base. The Berkeley Pattern also has a greater emphasis on the exploitation of the acorn as a staple. Although gathered resources gained importance during this period, the continued presence of projectile points and atlatls (spear-throwers) in the archaeological record indicates that hunting was still an important activity (Fredrickson 1973).

A restricted land base, coupled with a more specialized resource base, meant that people had to develop economic relationships with other groups of people with different specialized resources living in other areas. Although resources and commodities were being exchanged throughout the region before this period, more extensive and more frequently used economic networks developed during this time. Transported resources likely included foods—trans-Sierra acorn movement is known from later periods (d'Azevedo 1986)—and commodities more visible in the archaeological record, such as shell and lithic materials (Rosenthal et al. 2007:155).

4.2.4 Upper Archaic (2550 to AD 1100) and Emergent (AD 1100 to Historic)

The trends toward specialization, exchange, and spatial circumscription that characterized prior periods continued in the Late Horizon. Population continued to increase, and group territories continued to become smaller and more defined. Patterns in the activities, social relationships, belief systems, and material culture continued to develop during this period and took forms similar to those described by the first Europeans that entered the area.

The predominant generalized subsistence pattern during this period is called the Augustine Pattern (1200 BP to Historic Period) and shows a high degree of technological specialization (Fredrickson 1973). Development of the Augustine Pattern was apparently stimulated by the southward expansion of Wintuan populations into the Sacramento Valley and reflects a change in subsistence and land use patterns to those of the ethnographically known people of the historic era. (Moratto 1984). Traits associated with the Augustine Pattern include the introduction of preinterment burning of offerings in a grave pit during a mortuary ritual, increased village sedentism, maintenance of extensive exchange networks, population growth, and an incipient monetary economy in which beads were used as a standard of exchange (Moratto 1984). Overall, the Upper Archaic is characterized by a proliferation and increased distinction of artifact types, burial positions, and specialized technologies, such as widespread manufacture of ceremonial blades, obsidian biface blanks, *Olivella* and *Haliotis* beads and ornaments, and groundstone netsinkers (Rosenthal et al. 2007).

A generalized subsistence pattern with a high degree of technological specialization, termed the Augustine Pattern (1200 BP to Historic Period), is first evident during the Lower Archaic (Fredrickson 1973). Development of the Augustine Pattern was apparently stimulated by the southward expansion of Wintuan populations into the Sacramento Valley (Moratto 1984). The Augustine Pattern reflects a change in subsistence and land use patterns to those of the ethnographically known people of the historic era. This pattern exhibits a great elaboration of ceremonial and social organization, including the development of social stratification. Exchange became well developed, and an even more intensive emphasis was placed on the use of the acorn, as evidenced by the presence of shaped mortars and pestles and numerous hopper mortars in the archaeological record.

The trends toward specialization, exchange, and spatial circumscription that characterized prior periods continued in the Emergent Period. Population continued to increase, and group territories continued to become smaller and more defined. Patterns in the activities, social relationships, belief systems, and material culture continued to develop during this period and took forms similar to those described by the first Europeans that entered the area.

4.3 Ethnography

The study area is within the lands occupied and used by the Nisenan, or Southern Maidu. The language of the Nisenan, which includes several dialects, is classified in the Maiduan family of the Penutian linguistic stock (Kroeber 1976; Shipley 1978). The western boundary of Nisenan territory was the western bank of the Sacramento River. The eastern boundary was “the line in the Sierra Nevada mountains where the snow lay on the ground all winter” (Littlejohn 1928).

Nisenan settlement locations depended primarily on elevation, exposure, and proximity to water and other resources. Permanent villages usually were established on low rises along major watercourses such as the American and Sacramento Rivers. Village size ranged from 3 houses to 40 or 50. Larger villages often had semisubterranean dance houses that were covered in earth and tule or brush and had a central smoke hole at the top and an east-facing entrance. Tribal territory with selected major villages were located approximately 1 mile west of the APE on the north side of the American River (Wilson and Towne 1978: Figure 1).

The Nisenan occupied permanent settlements from which specific task groups set out to harvest the seasonal bounty of flora and fauna that the rich valley environment provided. The Valley Nisenan economy involved riparian resources, in contrast to the Hill Nisenan, whose resource base consisted primarily of acorn and game procurement. The only domestic plant was native tobacco (*Nicotiana* sp.), but many wild species were closely husbanded. The acorn crop from the blue oak (*Quercus douglasii*) and black oak (*Q. kelloggii*) was so carefully managed that its management served as the equivalent of agriculture. Acorns could be stored in anticipation of winter shortfalls in resource abundance. Deer, rabbit, and salmon were the chief sources of animal protein in the aboriginal diet, but many other insect and animal species were consumed when available.

The Gold Rush of 1849 had a devastating effect on the Valley Nisenan. The flood of miners to the area in search of gold brought diseases with them that decimated the Nisenan population.

Those who survived were subjected to violence and prejudice at the hands of the miners, and the Nisenan eventually were pushed out of their ancestral territory. Although this contact with settlers had a profound negative impact on the Nisenan population through disease and violent actions, the Nisenan people survive and maintain strong communities and action-oriented organizations.

4.4 History

The APE lies on the eastern edge of Sacramento County, which experienced its first influx of American settlers with the Gold Rush beginning in 1848. Mormon Island, a gravel bar set in the American River approximately 8 miles northeast of the APE, was a central gold-mining area in Northern California, and by 1853 was a busy center of commerce. Meanwhile, the Folsom area helped supply huge amounts of water for mining operations in the American River Mining District with a series of dams, ditches and sluice gates built mainly by the Natoma Water and Mining Company. Gold deposits in the area only held out for a few years, and by the late 1850s miners had moved to the other areas of the mother lode region. (Jones & Stokes 1991:12-7/8)

In 1856, the Sacramento Valley Railroad brought modernized transportation to Folsom with stage and freight lines. Ease of transport for both people and goods led to a period of marked growth. Despite the closure of the Sacramento Valley Railroad in 1869, mining continued in various forms through the 1940s, with placer and drift mining in the late nineteenth century, and later dredge mining. Dredge mining stopped only during World War II when the U.S. Government put a moratorium on the mining of nonessential metals. The Natomas Company continued dredge mining near Folsom until 1962 (Jones & Stokes 1991:12-7/8/9; Thompson and West 1880).

Parallel to the mining success of Sacramento County was its agricultural growth, with the region producing wine grapes as well as other orchard fruits and agricultural products, including wine. Following World War II, subdivisions, apartments, shopping centers, and industrial facilities took the place of agricultural land. This growth included the arrival of Aerojet, designer and producer of rockets, fuel, engines and motors, in 1953. Aerojet bought the land from the Natomas Company, whose dredge mining left huge furrows of earth from dredging; these dredge tailings were well-suited for rocket testing. (Allen 2007:8-11).

The 1960-61 build of U.S. 50 increased commercial and residential development in the Folsom corridor. The Sacramento Aerojet facility employed more than 20,000 people by 1963, providing important technologies and manufactured items for space exploration, military defense and a multitude of other purposes. In the 1970s and 1980s, Aerojet downsized considerably while merging, cooperating and renting its property to other companies. Today, Aerojet operates as Aerojet Rocketdyne out of multiple locations across the United States. (Allen 2007:8-11).

4.5 Archaeological Buried Site Potential

ICF performed additional research to address the sensitivity of the APE for buried archaeological sites and surface archaeological sites. The research and review of pertinent geologic,

geoarchaeological, and perennial stream alignment data for the APE and surroundings included the following.

- Sacramento Valley Geology, geological data (Helley and Harwood 1985).
- Geoarchaeological Assessment (Meyer and Rosenthal 2008).
- Bureau of Land Management Cultural Resource Forecast Model (Ingbar and Hall 2014).

Overall, the APE is located in areas that have undergone anthropogenic modification through construction of roads, historic mining operations, highways, railroads, and urban commercial and residential infrastructure.

4.5.1 Buried Site Potential

Surface geologic data was reviewed for the APE and used to establish landform age ranges within the APE. Identified landforms that predate earliest estimated periods for human occupation of the region are considered to have very low potential for buried archaeological sites. Conversely, identified landforms that postdate human occupation are considered to have a higher potential for buried archaeological sites. The degree of buried potential is directly correlated with the estimated formation date range of the landform. The more recent the landform, the more potential for buried sites. The archaeological record indicates that the earliest evidence for human occupation of California dates to the Late Pleistocene, which ends approximately 11,500 BP. Because of this date, it is easy to justify a very low potential for buried sites in landforms dating from the Late Pleistocene and earlier because these contexts are too old to harbor subsurface archaeological deposits. Conversely, if a landform dates to the Middle Holocene or later, there is an increased potential for subsurface archaeological deposits. Early Holocene landforms generally have a low to moderate sensitivity due to low population levels and an overall dearth of Early Holocene sites in the Central Valley. According to Meyer and Rosenthal's geoarchaeological overview of Caltrans District 3, the majority of the lands within and surrounding the APE are underlain by Older Pleistocene and Pre-Pleistocene deposits which have a very low potential for containing buried archaeological deposits (Meyer and Rosenthal 2008:115).

Chapter 5 Field Methods

On June 8, 2016, ICF archaeologist Stephen Pappas conducted an archaeological pedestrian survey of the portions of the APE for which access was obtained. The survey consisted of a combination of an intensive pedestrian survey—walking transects spaced at no more than 15 meters in areas that exhibited exposed ground surface without artificial fill or development—and a cursory inspection in areas that have been either built up with fill, paved, or development. Two areas were not accessible and were observed from a distance.

The complete 15-meter transect strategy was conducted in all portions of the APE within the Aerojet property as well as the areas of the U.S. 50/Hazel Avenue interchange north of U.S. 50. During the survey of the U.S. 50/Hazel Avenue interchange, it was observed that the entire ground surface had been built up from the original surface (Figure 1). Within the Aerojet property, portions of the landscape appeared to have been heavily disturbed due to grading associated with Aerojet operations. Areas with cut banks, exposed soils, or disturbance by rodents were closely inspected for cultural materials.



Figure 1. Overview within Hazel interchange corkscrew, view south, June 8, 2016

The portions of the APE where a cursory inspection was conducted consisted of the ROW south of U.S. 50 (Figure 2) and the parking lot of the Nimbus Winery. These areas were spot-checked at all accessible locations to confirm the areas were either landscaped, paved, or built-up with only exposed road base along the surface. No indications of original ground surface was present at any of these areas.



Figure 2. Overview of U.S. 50 eastbound ROW at east end of APE, view northeast, June 8, 2016

Two areas within the APE could not be accessed and were observed from afar. The non-accessible areas included the U.S. 50/Hazel Avenue interchange south of U.S. 50 (the area within and surrounding the Hazel Avenue eastbound off-ramp) and a wide portion of the Alder Creek channel south of U.S. 50 that was completely inundated marshlands. The area within the Hazel Avenue eastbound off-ramp was not accessed due to oncoming traffic safety concerns. It was observed that the off-ramp had been heavily modified and the surface at the highway level was heavily landscaped and/or consisted of a surface of cobbles with little to no soil. A portion of the Alder Creek channel was not accessible due to thick riparian vegetation immediately adjacent to the creek, and because portions of the actual creek channel were submerged.

A survey-grade submeter global positioning system unit was used to identify the APE and guide transect placement, as well as relocate any previously recorded resources within the APE. Digital photographs were taken to document ground conditions, and all observations were recorded in the field. A survey coverage map is presented in Figure 4 of Appendix A. This map indicates areas within the APE that were surveyed at 15-meter intervals, areas of cursory survey, or areas of no access.

Chapter 6 Study Findings and Conclusions

6.1 Archaeological Resources in the APE

As a result of the field survey, no archaeological resources were identified within the APE.

6.2 Conclusions

The majority of the APE has experienced intense ground disturbance from historic-period gold dredging and modern urban development activities, such as construction of roads and highways, commercial and industrial development, and landscaping activities. The APE maintains a low potential for buried archaeological sites overall, and a low potential for surficial prehistoric sites. Because the current survey consisted only of surface inspection, there remains the possibility that previously unrecorded buried archaeological resources are present within the APE; however, due to the intense ground disturbance carried out from dredge mining and development, the possibility is very low. In summary, this study concludes that no archaeological resources are present in the APE.

If previously unidentified cultural materials are unearthed during construction, it is Caltrans' policy that work be halted in that area until a qualified archaeologist can assess the significance of the find. Additional archaeological survey will be needed if project limits are extended beyond the present survey limits.

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Chapter 8 Preparer's Qualifications

Stephen Pappas, MA, RPA

Stephen Pappas is a seasoned archaeologist with more than 13 years of experience in cultural resource management who meets the Secretary of the Interior's Standards for Archeology and is a Registered Professional Archaeologist. His experience includes field director and archaeologist. He has worked throughout California, Nevada, Arizona, and New Mexico. Mr. Pappas holds a B.A. in Anthropology from California State University, Chico (2002) and an M.A. in Archaeology and Heritage from University of Leicester (2016). His project deliverables include reports and plans for survey, testing and evaluation, data recovery, treatment and monitoring; Memoranda of Agreement; and feasibility studies. Mr. Pappas' project experience includes compliance with NEPA, CEQA, and Sections 106 of the NHPA, and Sections 404 of the Clean Water Act.

Appendix A Figures

Figure 1. Project Vicinity Map

Figure 2. Project Location Map

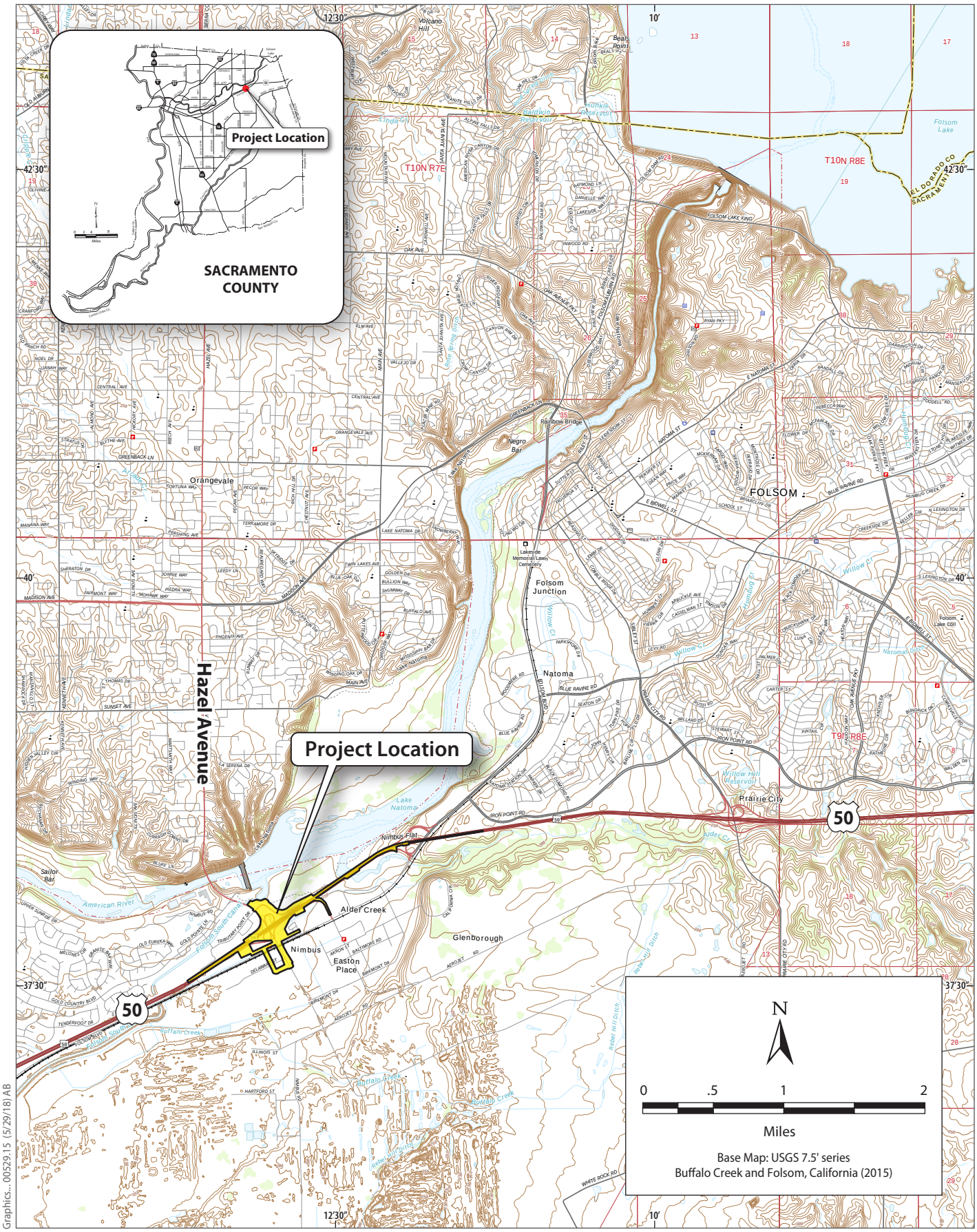
Figure 3. Areas of Potential Effects Map

Figure 4. Archaeological Survey Results Map

Figure 5. Alternative 1: L-9 Interchange with Viaduct Connector

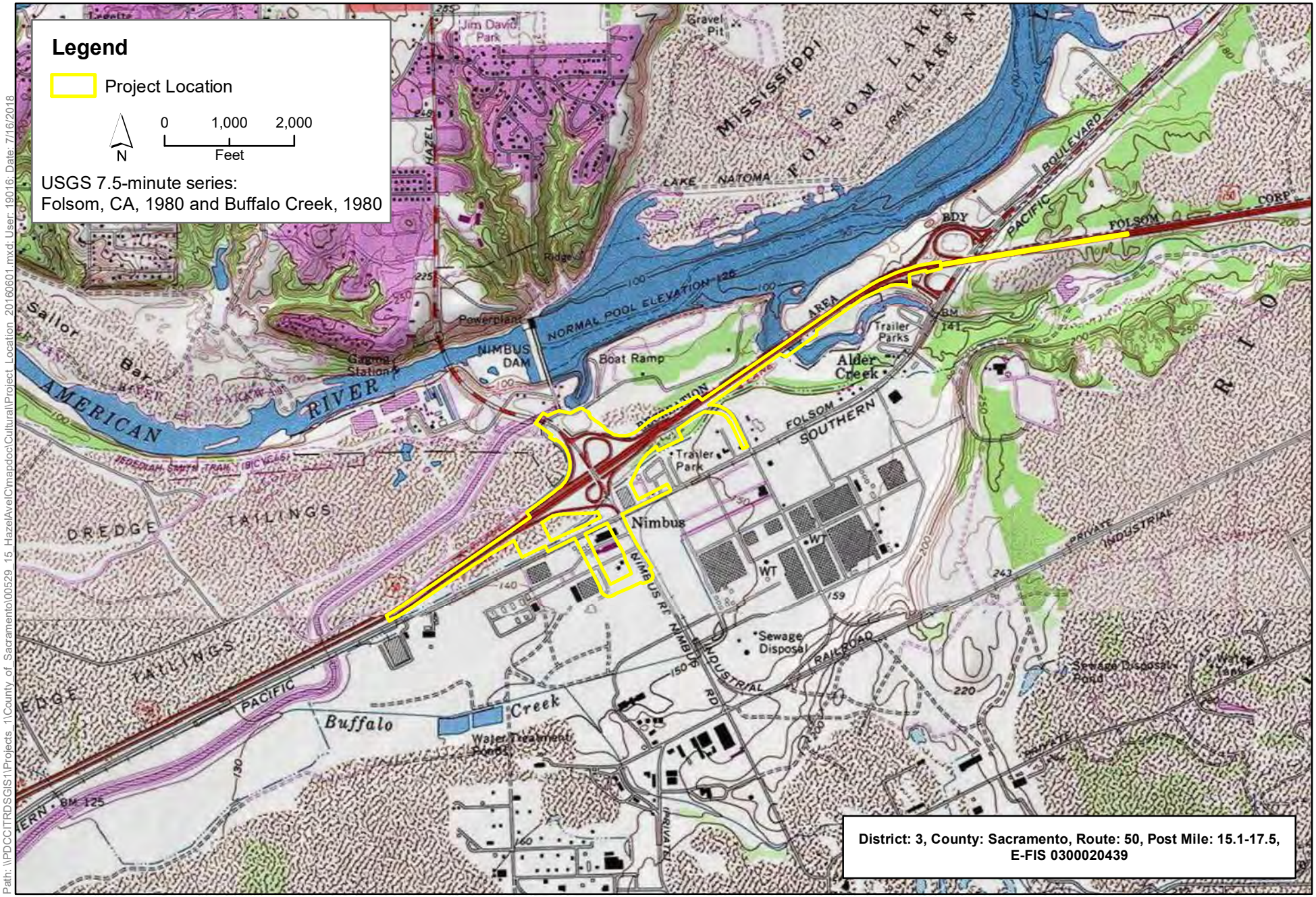
Figure 6. Alternative 1a: L-9 Interchange with Undercrossing Connector

Figure 7. Alternative 2: Direct Flyover to Hazel Avenue with Connector



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Figure 1
Project Vicinity



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Figure 2
Study Location
Hazel Avenue/U.S. 50 Interchange Project

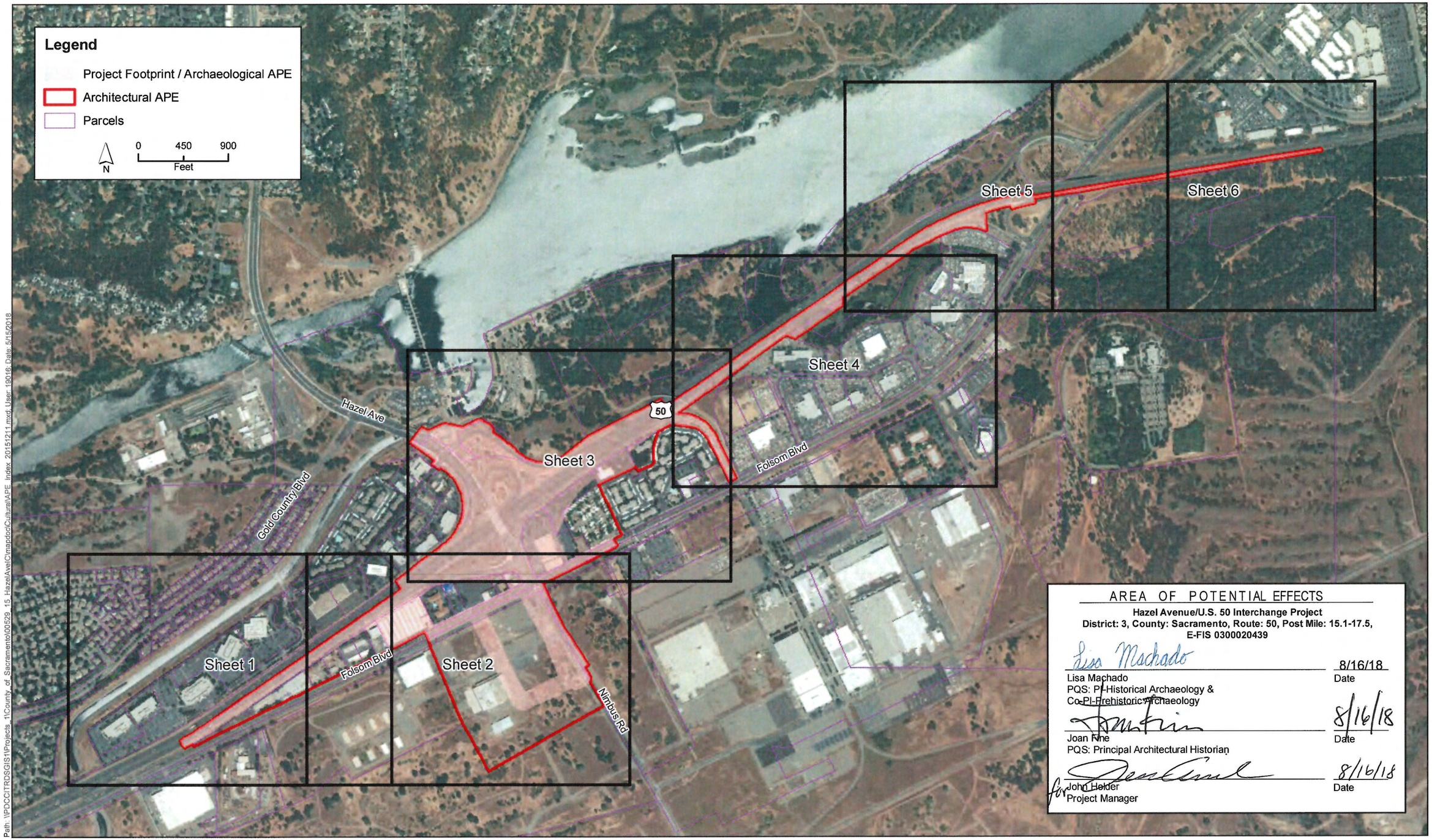
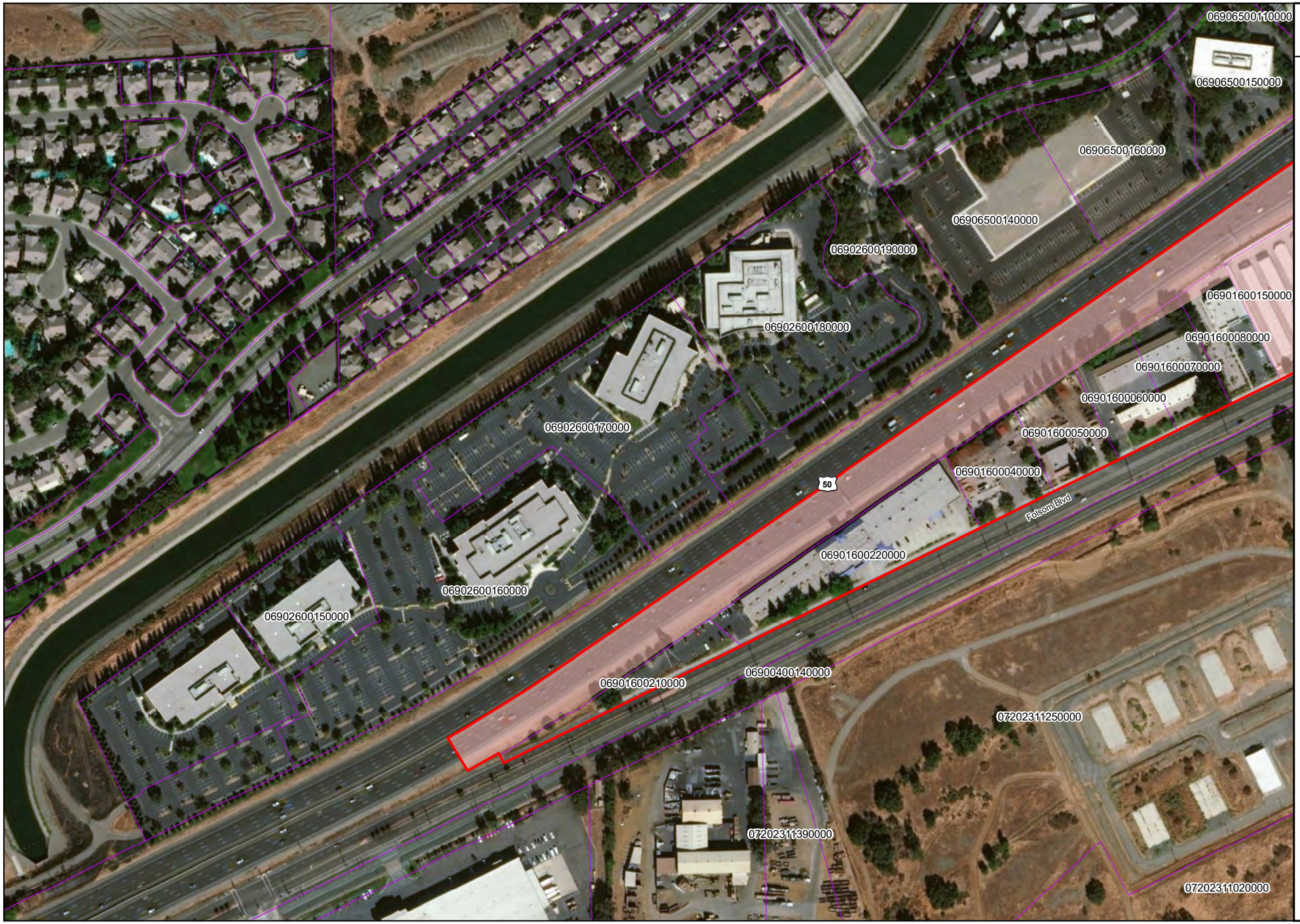


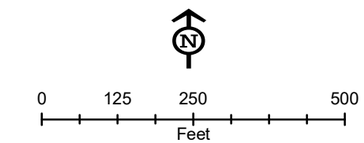
Figure 3
Area of Potential Effects – Map Index
Hazel Avenue/U.S. 50 Interchange Project

Hazel Avenue/U.S. 50 Interchange Project
Page 1 of 6

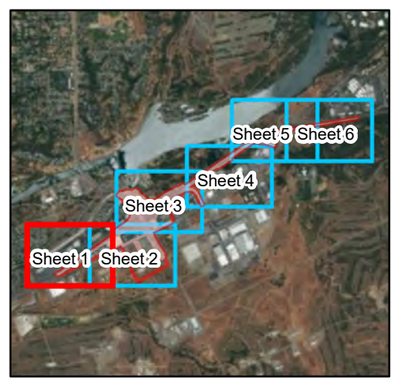
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- Architectural APE
- Parcels





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Figure 3
Area of Potential Effects
Hazel Avenue/U.S. 50 Interchange Project



Hazel Avenue/U.S. 50 Interchange Project
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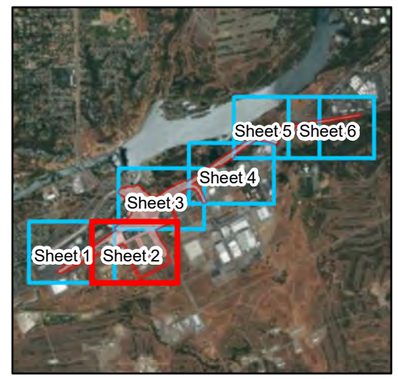
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Figure 3
Area of Potential Effects
Hazel Avenue/U.S. 50 Interchange Project

Hazel Avenue/U.S. 50 Interchange Project
Page 3 of 6

Legend

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Figure 3
Area of Potential Effects
Hazel Avenue/U.S. 50 Interchange Project



Hazel Avenue/U.S. 50 Interchange Project
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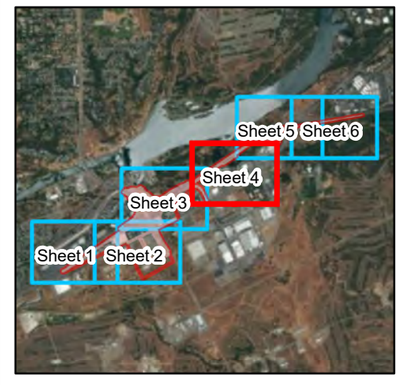
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Figure 3
Area of Potential Effects
Hazel Avenue/U.S. 50 Interchange Project



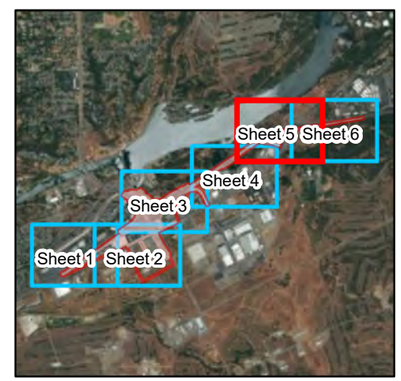
Hazel Avenue/U.S. 50 Interchange Project
Page 5 of 6

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- Architectural APE
- Parcels

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Figure 3
Area of Potential Effects
Hazel Avenue/U.S. 50 Interchange Project

Hazel Avenue/U.S. 50 Interchange Project
Page 6 of 6

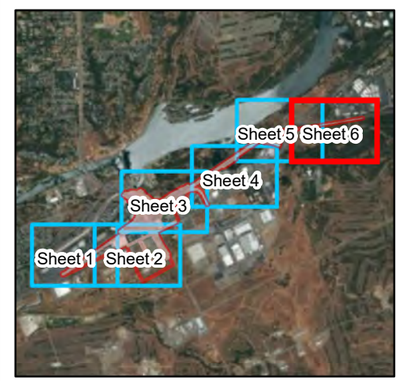
Legend

- Project Footprint / Archaeological APE
- Architectural APE
- Parcels

N

0 125 250 500
Feet

1 inch = 250 feet



Path: \\PDCCITRDSGIS1\Projects_1\County_of_Sacramento\00529_15_HazelAve\Cmapdoc\Cultural\APE_20151211.mxd; Author: ; Date: 4/26/2018

Figure 3
Area of Potential Effects
Hazel Avenue/U.S. 50 Interchange Project

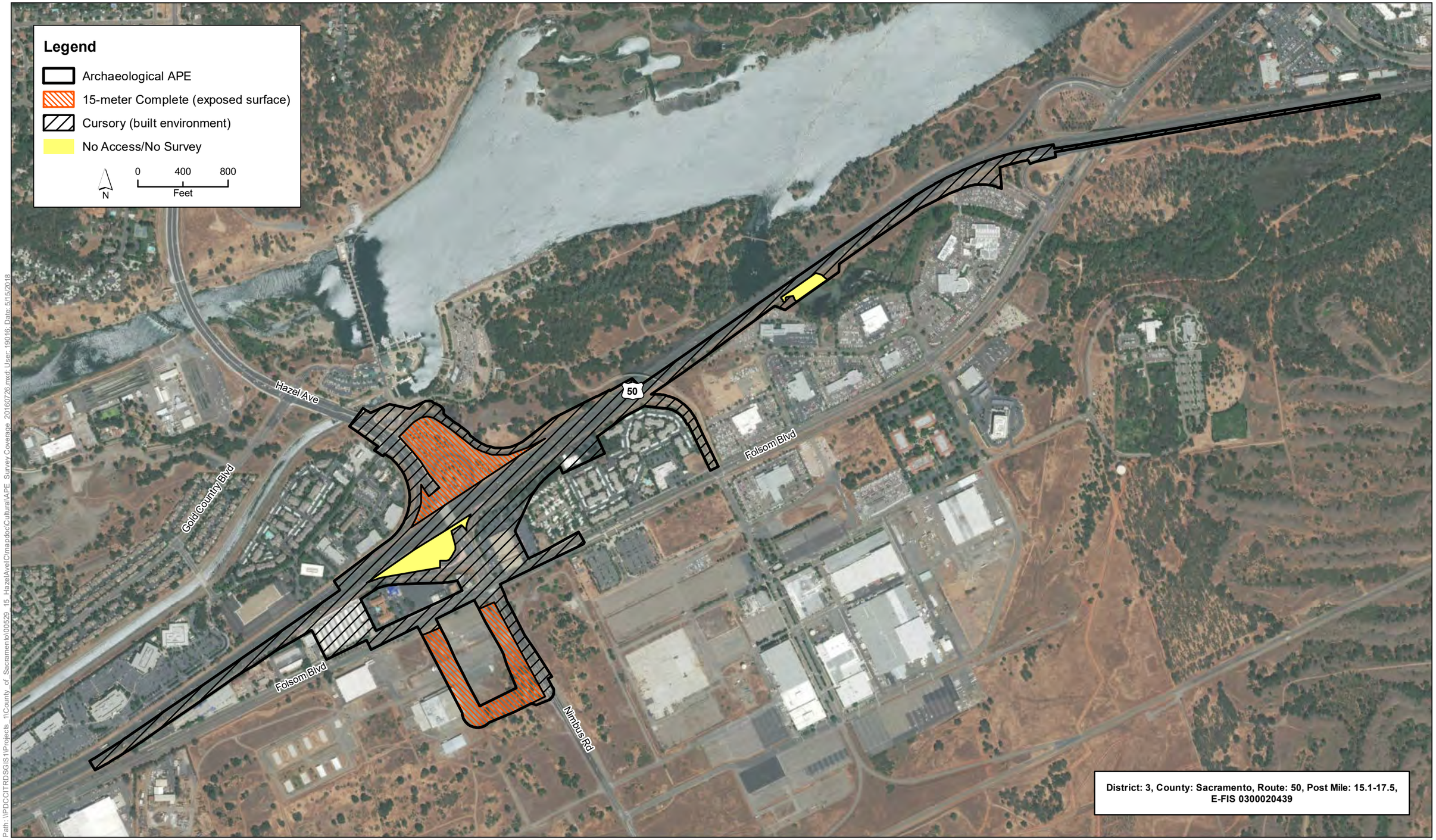


Figure 4
Survey Coverage Map
Hazel Avenue/U.S. 50 Interchange Project



Figure 5
Alternative 1: L-9 Interchange with Viaduct Connector
U.S. 50/Hazel Avenue Interchange Project



Path: K:\Projects_1\County of Sacramento\00529_15 HazelAve\CImapdoc\Alternative_1a_20160229.mxd; User: 19016; Date: 4/10/2017

Figure 6
Alternative 1a: L-9 Interchange with Undercrossing Connector
U.S. 50/Hazel Avenue Interchange Project

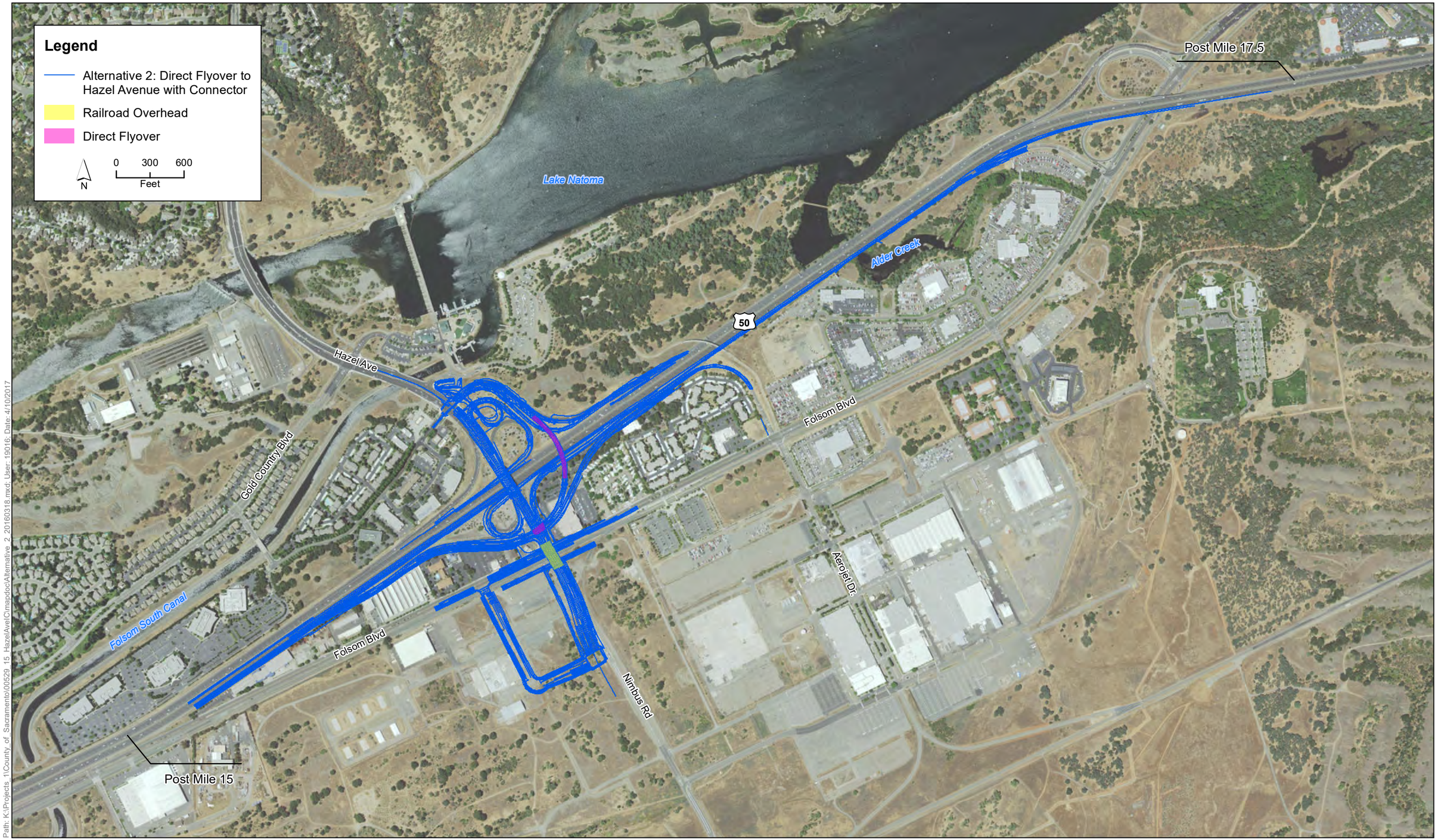


Figure 7
Alternative 2: Direct Flyover to Hazel Avenue with Connector
U.S. 50/Hazel Avenue Interchange Project

Appendix B NCIC Records Search

California Historical Resources Information System

NORTH CENTRAL INFORMATION CENTER

AMADOR
EL DORADO
NEVADA
PLACER
SACRAMENTO
YUBA

California State University, Sacramento
6000 J Street, Folsom Hall, Suite 2042
Sacramento, California 95819-6100
phone: (916) 278-6217
fax: (916) 278-5162
email: ncic@csus.edu

12/4/2015

NCIC File No.: SAC-15-191

Erik Allen
ICF International
700 K Street #630
Sacramento, CA 95814

Information Center Invoice for
529.15 002

Staff Processing:	? hours @ $150/hour		$ cost
In-House Research:	1 hours @ $100/hour		$ 100.00
Staff Assistance/Copies:	? hours @ $40/hour		$ cost
Mapped Spatial Features:	?		$ cost
Shapefiles:	77 shapes @ $12/shape		$ 924.00
Digital Database Record Fee:	? records @ $0.25/record		$ cost
Quads:	?		$ cost
Copy/Print/PDF:	888 pages @ $0.15/page		$ 133.20
PDF Flat Fee:	y/n		$ cost
		SUBTOTAL	$ 1157.20
Rapid response surcharge of 50% of subtotal:		**SURCHARGE**	$ cost
Emergency response surcharge of 100% of subtotal:		**SURCHARGE**	$ cost

Make check payable to: University Enterprises, Inc.

Mail to: North Central Information Center
6000 J Street, Folsom Hall, Suite 2042
Sacramento, California 95819-6100

Staff: Nathan Hallam Memo: SAC-15-191 **TOTAL** $ 1157.20

California Historical Resources Information System

NORTH CENTRAL INFORMATION CENTER

AMADOR
EL DORADO
NEVADA
PLACER
SACRAMENTO
YUBA

California State University, Sacramento
6000 J Street, Folsom Hall, Suite 2042
Sacramento, California 95819-6100
phone: (916) 278-6217
fax: (916) 278-5162
email: ncic@csus.edu

4/6/2016

NCIC File No.: copy request

Erik Allen
ICF International
630 K Street, Suite 400
Sacramento, CA 95814

Records Search Invoice for
Hazel Avenue/U.S. 50 Interchange Project

Staff Processing:	?	hours @ $150/hour	$ cost
In-House Research:	?	hours @ $100/hour	$ cost
Staff Assistance/Copies:	1	hours @ $40/hour	$ 40.00
Mapped Spatial Features:	?		$ cost
Shapefiles:	?	shapes @ $12/shape	$ cost
Digital Database Record Fee:	?	records @ $0.25/record	$ cost
Quad Maps:	?		$ cost
Copy/Print/PDF:	161	pages @ $0.15/page	$ 24.15
PDF Flat Fee:	y/n		$ cost
		Subtotal	$ 64.15
		Priority response: 50% surcharge	$ cost
		Emergency response: 100% surcharge	$ cost

Make check payable to:

University Enterprises, Inc.

Forward payment to:

North Central Information Center
6000 J Street, Folsom Hall, Suite 2042
Sacramento, CA 95819-6100

Staff: Nathan Hallam Memo: copy request **TOTAL** $ 64.15

Appendix C Native American Consultation

CONFIDENTIAL

NOT PUBLICLY AVAILABLE

Attachment B
Local Historical Society Letters

1. California Historical Society
2. Folsom Historical Society:

   823 Sutter Street, Folsom Ca 95630 (916) 985-2707, info@folsomhistoricalsociety.org

   Archives open Tues-Friday by appointment only:
   http://www.folsomhistoricalsociety.org/research/
3. Rancho Cordova Historical Society

   2729 Prospect Park Dr., Ste 117, Rancho Cordova, CA 95670, ranchocordovahistory.com
4. Sacramento County Historical Society

   P.O. Box 160065, Sacramento, Ca 95816 (916) 572-9858
5. Heritage Preservation League of Folsom (sent 8/29)

   P.O. Box 353
   Folsom, CA 95763-0353

March 25, 2016

The California Historical Society
678 Mission Street
San Francisco, CA 94105

t: Section 106 and CEQA review of the U.S. 50 / Hazel Avenue Interchange Improvements Project, in Sacramento County, California.

Dear California Historical Society:

ICF International is currently conducting a cultural resources study for the U.S. 50 / Hazel Avenue Interchange Improvement Project in Sacramento County (see attached Project Location Map). The County of Sacramento, in cooperation with Caltrans and the City of Rancho Cordova, proposes to modify the existing U.S. 50/Hazel Avenue interchange, and extend and grade-separate Hazel Avenue over Folsom Boulevard and the Sacramento Placerville Transportation Corridor Joint Powers Authority (SPTC-JPA) rail corridor. Hazel Avenue will be extended further south to a proposed intersection with the future Atlanta Street (a new roadway that will be constructed as part of the Easton Place development). The primary purpose of the project is to modify the existing U.S. 50/Hazel Avenue Interchange to reduce congestion, improve traffic operations, accommodate travel demand due to planned and approved developments, and improve safety of all modes of travel including bicycles and pedestrians. Two alternatives, with one sub-alternative, have been developed for the project.

Caltrans is the lead agency under the National Environmental Policy Act (NEPA) and, and Sacramento County is the lead agency under the California Environmental Quality Act (CEQA).

As part of our effort to identify cultural resources in the area of potential effects, we are consulting historical societies, museums, and archives, like yourself, to determine if you have any knowledge of, or information on, historical resources that may be affected by the proposed project. We are also interested in any historical information, including photographs, maps, and oral histories pertaining to the project area and vicinity, particularly any historical information you might have on the Nimbus Winery in Rancho Cordova.

We thank you in advance for your assistance with this. If you have any questions or comments regarding this project, please call me at (415) 677-7105, or email <afike@icfi.com>.

Sincerely,



Aisha Fike, MA
Architectural Historian

Enclosure: Project Location Map

March 25, 2016

Folsom Historical Society
823 Sutter Street
Folsom, CA 95630

t: Section 106 and CEQA review of the U.S. 50 / Hazel Avenue Interchange Improvements Project, in Sacramento County, California.

Dear Folsom Historical Society:

ICF International is currently conducting a cultural resources study for the U.S. 50 / Hazel Avenue Interchange Improvement Project in Sacramento County (see attached Project Location Map). The County of Sacramento, in cooperation with Caltrans and the City of Rancho Cordova, proposes to modify the existing U.S. 50/Hazel Avenue interchange, and extend and grade-separate Hazel Avenue over Folsom Boulevard and the Sacramento Placerville Transportation Corridor Joint Powers Authority (SPTC-JPA) rail corridor. Hazel Avenue will be extended further south to a proposed intersection with the future Atlanta Street (a new roadway that will be constructed as part of the Easton Place development). The primary purpose of the project is to modify the existing U.S. 50/Hazel Avenue Interchange to reduce congestion, improve traffic operations, accommodate travel demand due to planned and approved developments, and improve safety of all modes of travel including bicycles and pedestrians. Two alternatives, with one sub-alternative, have been developed for the project.

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We thank you in advance for your assistance with this. If you have any questions or comments regarding this project, please call me at (415) 677-7105, or email <afike@icfi.com>.

Sincerely,



Aisha Fike, MA
Architectural Historian

Enclosure: Project Location Map

March 25, 2016

Rancho Cordova Historical Society
2729 Prospect Park Drive
Ste. 117
Rancho Cordova, CA 95670

t: Section 106 and CEQA review of the U.S. 50 / Hazel Avenue Interchange Improvements Project, in Sacramento County, California.

Dear Rancho Cordova Historical Society:

ICF International is currently conducting a cultural resources study for the U.S. 50 / Hazel Avenue Interchange Improvement Project in Sacramento County (see attached Project Location Map). The County of Sacramento, in cooperation with Caltrans and the City of Rancho Cordova, proposes to modify the existing U.S. 50/Hazel Avenue interchange, and extend and grade-separate Hazel Avenue over Folsom Boulevard and the Sacramento Placerville Transportation Corridor Joint Powers Authority (SPTC-JPA) rail corridor. Hazel Avenue will be extended further south to a proposed intersection with the future Atlanta Street (a new roadway that will be constructed as part of the Easton Place development). The primary purpose of the project is to modify the existing U.S. 50/Hazel Avenue Interchange to reduce congestion, improve traffic operations, accommodate travel demand due to planned and approved developments, and improve safety of all modes of travel including bicycles and pedestrians. Two alternatives, with one sub-alternative, have been developed for the project.

Caltrans is the lead agency under the National Environmental Policy Act (NEPA) and, and Sacramento County is the lead agency under the California Environmental Quality Act (CEQA).

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We thank you in advance for your assistance with this. If you have any questions or comments regarding this project, please call me at (415) 677-7105, or email <afike@icfi.com>.

Sincerely,



Aisha Fike, MA
Architectural Historian

Enclosure: Project Location Map

March 25, 2016

Sacramento County Historical Society
P.O. Box 160065
Sacramento, CA 95816

t: Section 106 and CEQA review of the U.S. 50 / Hazel Avenue Interchange Improvements Project, in Sacramento County, California.

Dear Sacramento County Historical Society:

ICF International is currently conducting a cultural resources study for the U.S. 50 / Hazel Avenue Interchange Improvement Project in Sacramento County (see attached Project Location Map). The County of Sacramento, in cooperation with Caltrans and the City of Rancho Cordova, proposes to modify the existing U.S. 50/Hazel Avenue interchange, and extend and grade-separate Hazel Avenue over Folsom Boulevard and the Sacramento Placerville Transportation Corridor Joint Powers Authority (SPTC-JPA) rail corridor. Hazel Avenue will be extended further south to a proposed intersection with the future Atlanta Street (a new roadway that will be constructed as part of the Easton Place development). The primary purpose of the project is to modify the existing U.S. 50/Hazel Avenue Interchange to reduce congestion, improve traffic operations, accommodate travel demand due to planned and approved developments, and improve safety of all modes of travel including bicycles and pedestrians. Two alternatives, with one sub-alternative, have been developed for the project.

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We thank you in advance for your assistance with this. If you have any questions or comments regarding this project, please call me at (415) 677-7105, or email <afike@icfi.com>.

Sincerely,



Aisha Fike, MA
Architectural Historian

Enclosure: Project Location Map

August 29, 2016

Heritage Preservation League of Folsom
P.O. Box 353
Folsom, CA 95763-0353

t: Section 106 and CEQA review of the U.S. 50 / Hazel Avenue Interchange Improvements Project, in Sacramento County, California.

Dear Heritage Preservation League of Folsom:

ICF International is currently conducting a cultural resources study for the U.S. 50 / Hazel Avenue Interchange Improvement Project in Sacramento County (see attached Project Location Map). The County of Sacramento, in cooperation with Caltrans and the City of Rancho Cordova, proposes to modify the existing U.S. 50/Hazel Avenue interchange, and extend and grade-separate Hazel Avenue over Folsom Boulevard and the Sacramento Placerville Transportation Corridor Joint Powers Authority (SPTC-JPA) rail corridor. Hazel Avenue will be extended further south to a proposed intersection with the future Atlanta Street (a new roadway that will be constructed as part of the Easton Place development). The primary purpose of the project is to modify the existing U.S. 50/Hazel Avenue Interchange to reduce congestion, improve traffic operations, accommodate travel demand due to planned and approved developments, and improve safety of all modes of travel including bicycles and pedestrians. Two alternatives, with one sub-alternative, have been developed for the project.

Caltrans is the lead agency under the National Environmental Policy Act (NEPA) and, and Sacramento County is the lead agency under the California Environmental Quality Act (CEQA).

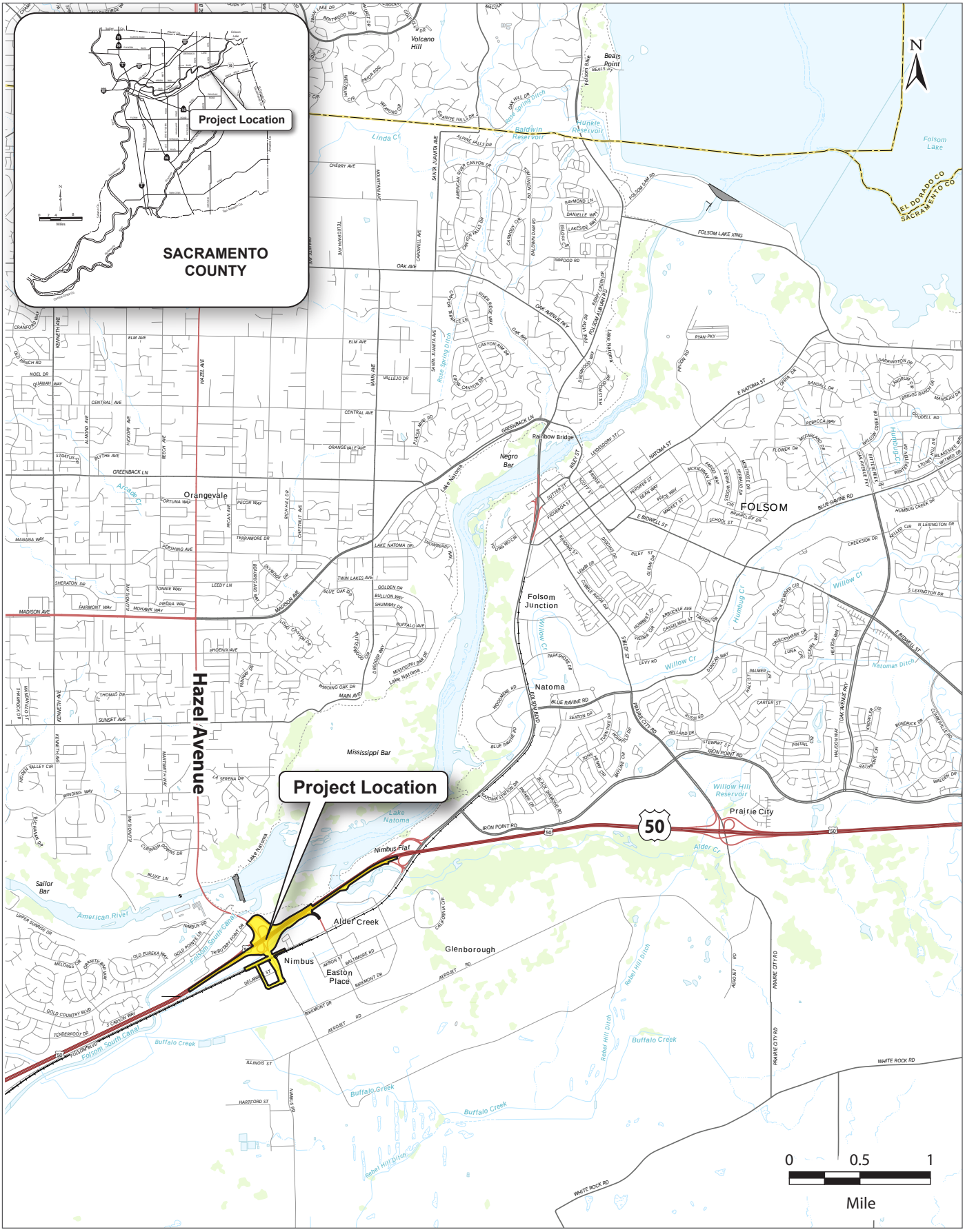
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We thank you in advance for your assistance with this. If you have any questions or comments regarding this project, please call me at (415) 677-7105, or email <afike@icfi.com>.

Sincerely,

Aisha Fike, MA
Architectural Historian

Enclosure: Project Location Map



00529.15 Task 003 (10-26-2015) SS

ICF INTERNATIONAL

Figure 1
Project Location

From:	Pappas, Steve
To:	Pappas, Steve
Subject:	FW: Heritage Preservation League response to CEQA review letter for U.S. 50 Hazel interchange
Date:	Friday, July 20, 2018 11:55:32 AM
Attachments:	image001.png

From: Fike, Aisha
Sent: Wednesday, November 16, 2016 9:38 AM
To: Lin, Sandy <Sandy.Lin@icf.com>
Cc: Zamora, Cherry <Cherry.Zamora@icf.com>; Pappas, Steve <Steve.Pappas@icf.com>
Subject: FW: Heritage Preservation League response to CEQA review letter for U.S. 50 Hazel interchange

Hello team, I just heard back from an interested party and have responded thanking them for reaching out. Have the reports been submitted yet? I would like to add a brief sentence that we heard back from the Heritage Preservation League, however, it can wait until the final round of submittals. No biggie.

Thank you all,

Aisha

From: Beth Kelly [mailto:bk@burlesonconsulting.com]
Sent: Wednesday, November 16, 2016 9:22 AM
To: Fike, Aisha <aisha.rahimi@icf.com>
Cc: Anne Rhea <annerhea@comcast.net>; Beth Kelly <bk@burlesonconsulting.com>; Dennis Stefani (d.stefani@sbcglobal.net) <d.stefani@sbcglobal.net>; karenpardieck@sbcglobal.net; Lisbet Gullone (lgullone@gmail.com) <lgullone@gmail.com>; Loretta <loretta@shaunv.com>; Marty Donahoo <mart@fedshra.org>
Subject: Heritage Preservation League response to CEQA review letter for U.S. 50 Hazel interchange

Hello Aisha,

Sorry for the delay in responding to your August 29 letter to the Heritage Preservation League asking for information related to the Nimbus Winery near the U.S.50 Hazel interchange project. The Heritage Preservation League is interested in preserving the Nimbus Wintery and former cannery, previously part of the Natomas Company. We don't have any photos or information in our files; however, the Folsom Historical Society History Museum in Folsom on Sutter Street would have those for your review. The best person to contact there is Rodi Lee.

Sincerely,

Heritage Preservation League
P.O. Box 353
Folsom, CA

Beth Kelly
Program Manager

Burleson Consulting Inc.
Woman-Owned Small Business
Environmental Puzzle Masters

Burleson Consulting, Inc.
950 Glenn Drive Suite 245
Folsom CA 95630
(916) 984-4651 ext. 114 office
(916) 605-6865 cell
bk@burlesonconsulting.com
www.burlesonconsulting.com

Attachment C
California Historic Bridge Inventory Sheet

Structure Maintenance & Investigations



Historical Significance - Local Agency Bridges

District 03

Sacramento County

Bridge Number	Bridge Name	Location	Historical Significance	Year Built	Year Wid/Ext
24C0150	WATT AVENUE POC	.05 MI N. OF POPLAR BLVD	5. Bridge not eligible for NRHP	1974	
24C0151	DRAINAGE DITCH	50' N LAMBERT RD	5. Bridge not eligible for NRHP	1925	1933
24C0152	DRAINAGE DITCH	1.8 MI N LAMBERT RD	5. Bridge not eligible for NRHP	1925	1933
24C0153	STONE LAKE DRAIN	3.2 MI N LAMBERT RD	5. Bridge not eligible for NRHP	1925	1933
24C0154	MOKELUMNE RIVER OVERFLOW	0.5 MI N SAN JOAQUIN CL	5. Bridge not eligible for NRHP	1988	
24C0155	MOKELUMNE RIVER OVERFLOW	1.8 MI N SAN JQUIN CO LIN	5. Bridge not eligible for NRHP	1930	
24C0156	DRAINAGE DITCH	0.4 MI N HOOD-FRANKLIN RD	5. Bridge not eligible for NRHP	1933	
24C0157	STONE LAKE DRAIN	0.8 MI N HOOD-FRANKLIN RD	5. Bridge not eligible for NRHP	1933	
24C0158	DRAINAGE DITCH (EHRHARDT CHANNEL)	0.2 MI S ELK GROVE BLVD	5. Bridge not eligible for NRHP	2003	
24C0160	COSUMNES RIVER	2.3 MI W CHRISTENSEN RD	5. Bridge not eligible for NRHP	1983	
24C0165	SOUTH FORK ELDER CREEK	0.1 MI N OF MACK RD	5. Bridge not eligible for NRHP	1987	
24C0166	COSUMNES RIVER OVERFLOW	2.3 MI W CHRISTENSEN RD	5. Bridge not eligible for NRHP	1983	
24C0167	DELTA CROSS CHANNEL	N EDGE WALNUT GRVE S LOCK	5. Bridge not eligible for NRHP	1951	
24C0168	GRIZZLEY SLOUGH	0.5 MI N SA JOQUN CO LINE	5. Bridge not eligible for NRHP	1931	
24C0170	SUITOR SLOUGH	2.8 MI NE SAN JOQ CO LINE	5. Bridge not eligible for NRHP	1947	
24C0171	ELDER CREEK	0.2 MI N OF GERBER RD	5. Bridge not eligible for NRHP	1950	
24C0172	MORRISON CREEK	0.6 MI N OF ELDER CREEK	5. Bridge not eligible for NRHP	1965	
24C0173	EQUIPMENT UC	0.3 MI S OF STATE RTE 16	5. Bridge not eligible for NRHP	1960	
24C0174	LA RIVIERA DRIVE UC	0.4 MI N OF S.R. 50	5. Bridge not eligible for NRHP	1960	2003
24C0175	STRONG RANCH SLOUGH	0.45 MI N ARDEN WAY	5. Bridge not eligible for NRHP	1965	
24C0176	CHICKEN RANCH SLOUGH	0.3 MI N MARCONI AVE	5. Bridge not eligible for NRHP	1938	1963
24C0177	ARCADE CREEK	0.3 MI N AUBURN BLVD	5. Bridge not eligible for NRHP	1945	1971
24C0178	NORTH CHANNEL DRY CREEK	0.3 MI E RIO LINDA BLVD	5. Bridge not eligible for NRHP	1960	2001
24C0179	CHANNEL DRY CREEK	.7KM E. OF RIO LINDA BLVD	5. Bridge not eligible for NRHP	2001	
24C0180	LAGUNA CREEK	2.1 MI W CHRISTENSEN RD	5. Bridge not eligible for NRHP	1983	
24C0181	FOLSOM SOUTH CANAL	0.1 MI W/O SUNRISE BLVD	5. Bridge not eligible for NRHP	1970	
24C0182	COSUMNES RIVER OVERFLOW	2.75 MI W CHRISTENSEN RD	5. Bridge not eligible for NRHP	1983	
24C0184	WEST SLOUGH	3.1 MI W CHRISTENSEN RD	5. Bridge not eligible for NRHP	1983	
24C0185	COSUMNES RIVER OVERFLOW	3.2 MI W CHRISTENSEN RD	5. Bridge not eligible for NRHP	1983	
24C0188	STONE LAKE CANAL	1.3 MI E OF HOOD	5. Bridge not eligible for NRHP	1956	
24C0189	FOLSOM SOUTH CANAL	0.2 MI N OF S.R. 50	5. Bridge not eligible for NRHP	1966	
24C0190	LINDA CREEK	0.1 MI N OF OAK AVE	5. Bridge not eligible for NRHP	1974	
24C0191	PASTURE CREEK	0.8 MI SW CLAY STA RD	5. Bridge not eligible for NRHP	1961	
24C0192	COSUMNES RIVER OVERFLOW	0.4 MI E OF SH 99	5. Bridge not eligible for NRHP	1973	
24C0193	ELK GROVE CREEK	0.5 MI EAST OF S.R. 99	5. Bridge not eligible for NRHP	1976	
24C0194	MORRISON CREEK	100' W OF EAST PKWY	5. Bridge not eligible for NRHP	1956	1971
24C0195	FLORIN CREEK	0.6 MI W FLORIN PERKIN RD	5. Bridge not eligible for NRHP	1960	
24C0196	ELDER CREEK	0.4 MI E OF HEDGE AVE	5. Bridge not eligible for NRHP	1963	
24C0198	STRONG RANCH SLOUGH	0.3 MI N OF NORTHRUP AVE	5. Bridge not eligible for NRHP	1945	1993
24C0199	CHICKEN RANCH SLOUGH	0.1 MI SOUTH ARDEN WAY	5. Bridge not eligible for NRHP	1965	1993
24C0203	ARCADE CREEK	0.35 MI S MADISON AVE	5. Bridge not eligible for NRHP	1968	
24C0204L	MORRISON CREEK	0.1 MI S OF LEMON HILL	5. Bridge not eligible for NRHP	1970	
24C0204R	MORRISON CREEK	0.1 MI S OF LEMON HILL	5. Bridge not eligible for NRHP	1974	

Structure Maintenance & Investigations

Historical Significance - State Agency Bridges



District 03

Sacramento County

Bridge Number	Bridge Name	Location	Historical Significance	Year Built	Year Wid/Ext
24 0001L	AMERICAN RIVER (160 WB)	03-SAC-160-R44.47-SAC	5. Bridge not eligible for NRHP	1915	1934
24 0001R	AMERICAN RIVER (160 EB)	03-SAC-160-R44.46-SAC	5. Bridge not eligible for NRHP	1968	
24 0003	AMERICAN RIVER (BUS 80)	03-SAC-051-2.61-SAC	5. Bridge not eligible for NRHP	1954	1966
24 0004L	SACRAMENTO RIVER VIADUCT	03-SAC-050-L0.01-SAC	5. Bridge not eligible for NRHP	1966	1971
24 0004R	SACRAMENTO RIVER VIADUCT	03-SAC-050-L0.01-SAC	5. Bridge not eligible for NRHP	1966	1971
24 0016	STRAWBERRY CREEK	03-SAC-099-16.35-SAC	5. Bridge not eligible for NRHP	1924	1955
24 0016K	STRAWBERRY CREEK	03-SAC-099-16.36-SAC	4. Historical Significance not determined	1995	
24 0017	WHITEHOUSE CREEK	03-SAC-099-14.63	5. Bridge not eligible for NRHP	1924	1956
24 0018	LAGUNA CREEK	03-SAC-099-14.32	4. Historical Significance not determined	1995	
24 0019	ELK GROVE CREEK	03-SAC-099-13.00	5. Bridge not eligible for NRHP	1956	
24 0020L	COSUMNES RIVER	03-SAC-099-8.40	5. Bridge not eligible for NRHP	1929	1958
24 0020R	COSUMNES RIVER	03-SAC-099-8.40	5. Bridge not eligible for NRHP	1958	1993
24 0021L	COSUMNES RIVER OVERFLOW	03-SAC-099-7.92	5. Bridge not eligible for NRHP	1958	
24 0021R	COSUMNES RIVER OVERFLOW	03-SAC-099-7.92	5. Bridge not eligible for NRHP	1958	1993
24 0022L	COSUMNES RIVER OVERFLOW	03-SAC-099-7.45	5. Bridge not eligible for NRHP	1958	1989
24 0022R	COSUMNES RIVER OVERFLOW	03-SAC-099-7.45	5. Bridge not eligible for NRHP	1958	1993
24 0023	B STREET UNDERPASS	03-SAC-051-1.73-SAC	4. Historical Significance not determined	1954	
24 0025	BADGER CREEK	03-SAC-099-6.96	4. Historical Significance not determined	1993	
24 0027L	NORTH LAGOON CREEK	03-SAC-099-5.06	5. Bridge not eligible for NRHP	1928	1958
24 0027R	NORTH LAGOON CREEK	03-SAC-099-5.06	5. Bridge not eligible for NRHP	1958	1993
24 0028L	SOUTH LAGOON CREEK	03-SAC-099-4.91	5. Bridge not eligible for NRHP	1928	1958
24 0028R	SOUTH LAGOON CREEK	03-SAC-099-4.91	5. Bridge not eligible for NRHP	1958	1993
24 0029	LOG CABIN CREEK	03-SAC-099-2.36	5. Bridge not eligible for NRHP	1958	
24 0030L	NORTH CHANNEL DRY CREEK	03-SAC-099-0.13-GAL	5. Bridge not eligible for NRHP	1938	1986
24 0030R	NORTH CHANNEL DRY CREEK	03-SAC-099-0.13-GAL	5. Bridge not eligible for NRHP	1955	1992
24 0031	ELVAS UP	03-SAC-051-2.43-SAC	4. Historical Significance not determined	1954	
24 0033	ALDER CREEK HWY 50 LAKE NATOMA	03-SAC-050-16.46	5. Bridge not eligible for NRHP	1948	1954
24 0034J	WATT AVE WB 50 OFF-RAMP	03-SAC-050-R5.33-SAC	5. Bridge not eligible for NRHP	2015	
24 0034K	WATT AVE WB 50 ON-RAMP	03-SAC-050-R5.34-SAC	5. Bridge not eligible for NRHP	2015	
24 0034L	WATT AVENUE OC	03-SAC-050-R5.33	5. Bridge not eligible for NRHP	1971	
24 0034R	WATT AVENUE OC	03-SAC-050-R5.34	5. Bridge not eligible for NRHP	1971	
24 0034T	WATT AVE EB 50 ON-RAMP	03-SAC-050-R5.40-SAC	5. Bridge not eligible for NRHP	2015	
24 0037	HADSELVILLE CREEK	03-SAC-104-13.92	5. Bridge not eligible for NRHP	1968	
24 0038	CLAY CREEK	03-SAC-104-9.94	5. Bridge not eligible for NRHP	1968	
24 0039	GRIFFITH CREEK	03-SAC-104-5.78	5. Bridge not eligible for NRHP	1918	1968
24 0040	WINDMILL DRAW	03-SAC-104-5.44	5. Bridge not eligible for NRHP	1918	1968
24 0041	ROLLING DRAW	03-SAC-104-5.18	5. Bridge not eligible for NRHP	1918	1968
24 0042	SKUNK CREEK	03-SAC-104-4.30	5. Bridge not eligible for NRHP	1918	1968
24 0045L	LAGOON CREEK	03-SAC-099-4.98	5. Bridge not eligible for NRHP	1928	1958
24 0045R	LAGOON CREEK	03-SAC-099-4.98	5. Bridge not eligible for NRHP	1958	1993
24 0046L	WILLOW SLOUGH	03-SAC-099-6.54	5. Bridge not eligible for NRHP	1927	1958
24 0046R	WILLOW SLOUGH	03-SAC-099-6.54	5. Bridge not eligible for NRHP	1958	1993

Structure Maintenance & Investigations



Historical Significance - State Agency Bridges

District 03

Sacramento County

Bridge Number	Bridge Name	Location	Historical Significance	Year Built	Year Wid/Ext
24 0130L	ROUTE 51/160 SEPARATION	03-SAC-051-3.63-SAC	5. Bridge not eligible for NRHP	1954	1996
24 0130R	ROUTE 51/160 SEPARATION	03-SAC-051-3.63-SAC	5. Bridge not eligible for NRHP	1954	1980
24 0131	A STREET OC	03-SAC-051-1.77-SAC	5. Bridge not eligible for NRHP	1954	
24 0132R	ARDEN WAY RAMP UC	03-SAC-051-4.14R-SAC	5. Bridge not eligible for NRHP	1954	1960
24 0133	CAL EXPO UC	03-SAC-051-3.14-SAC	5. Bridge not eligible for NRHP	1954	1968
24 0134K	STOCKTON BOULEVARD ON RAMP OC	03-SAC-099-17.24-SAC	5. Bridge not eligible for NRHP	1959	
24 0135	MACK ROAD OC	03-SAC-099-17.66-SAC	5. Bridge not eligible for NRHP	1959	1984
24 0138	SIMMERHORN ROAD OC	03-SAC-099-1.57-GAL	5. Bridge not eligible for NRHP	1958	
24 0139	AMADOR AVENUE OC	03-SAC-099-1.62-GAL	5. Bridge not eligible for NRHP	1958	
24 0143	MORRISON CREEK	03-SAC-099-20.03	5. Bridge not eligible for NRHP	1959	1991
24 0144	ROUTE 104/99 SEPARATION	03-SAC-104-0.01	5. Bridge not eligible for NRHP	1958	
24 0145	44TH AVENUE POC	03-SAC-099-21.10	5. Bridge not eligible for NRHP	1959	
24 0146	41ST AVENUE OC	03-SAC-099-21.27	5. Bridge not eligible for NRHP	1959	
24 0147	MARTIN LUTHER KING JR BLVD OC	03-SAC-099-21.57	5. Bridge not eligible for NRHP	1959	
24 0148	FRUITRIDGE ROAD OC	03-SAC-099-21.94-SAC	5. Bridge not eligible for NRHP	1959	1971
24 0149	ELDER CREEK	03-SAC-099-18.05-SAC	5. Bridge not eligible for NRHP	1959	1991
24 0150	FLORIN ROAD OC SOUTH	03-SAC-099-19.61	5. Bridge not eligible for NRHP	1959	1973
24 0151	ARNO ROAD OC	03-SAC-099-6.01	5. Bridge not eligible for NRHP	1958	
24 0152	47TH AVENUE OC	03-SAC-099-20.86	5. Bridge not eligible for NRHP	1959	
24 0153	27TH AVENUE POC	03-SAC-099-22.22-SAC	5. Bridge not eligible for NRHP	1959	
24 0154	21ST AVENUE UC	03-SAC-099-22.59-SAC	5. Bridge not eligible for NRHP	1959	1974
24 0156	5TH AVENUE OC	03-SAC-099-23.69-SAC	5. Bridge not eligible for NRHP	1959	
24 0157	2ND AVENUE UC	03-SAC-099-24.03-SAC	5. Bridge not eligible for NRHP	1959	1998
24 0157G	N99-E&W50 CONNECTOR OC	03-SAC-099-24.03-SAC	5. Bridge not eligible for NRHP	1968	
24 0158	BROADWAY UC	03-SAC-099-24.19-SAC	5. Bridge not eligible for NRHP	1961	1967
24 0161	12TH AVENUE OC	03-SAC-099-23.13-SAC	5. Bridge not eligible for NRHP	1959	
24 0162	8TH AVENUE POC	03-SAC-099-23.42-SAC	5. Bridge not eligible for NRHP	1959	
24 0163	DILLARD ROAD OC	03-SAC-099-7.36	5. Bridge not eligible for NRHP	1958	
24 0167	FLORIN ROAD OC NORTH	03-SAC-099-19.62	5. Bridge not eligible for NRHP	1959	1973
24 0168	HAZEL AVENUE OC	03-SAC-050-15.76	4. Historical Significance not determined	1994	
24 0169	TURNBRIDGE DRIVE POC	03-SAC-099-20.18	5. Bridge not eligible for NRHP	1961	
24 0170	SUNRISE BLVD OC	03-SAC-050-12.50-RACO	5. Bridge not eligible for NRHP	1962	
24 0171	FAIR OAKS PUC	03-SAC-050-12.85	5. Bridge not eligible for NRHP	1962	2000
24 0172	WEST CITRUS OVERHEAD	03-SAC-050-R11.87-RACO	5. Bridge not eligible for NRHP	1973	2012
24 0173	MAYHEW OH	03-SAC-050-R6.34	5. Bridge not eligible for NRHP	1973	
24 0174	MATHER SPUR UP	03-SAC-050-R9.36	5. Bridge not eligible for NRHP	1973	
24 0175	MATHER FIELD OC	03-SAC-050-R9.51-RACO	5. Bridge not eligible for NRHP	1973	
24 0179K	UNION HOUSE CREEK (FORMERLY BEACON CREEK)	03-SAC-099-17.32-SAC	5. Bridge not eligible for NRHP	1961	
24 0180	UNION HOUSE CREEK (FORMERLY BEACON CREEK)	03-SAC-099-17.33-SAC	5. Bridge not eligible for NRHP	1961	
24 0181	FLORIN CREEK	03-SAC-099-18.64	5. Bridge not eligible for NRHP	1961	
24 0183	ZINFANDEL DRIVE OC	03-SAC-050-R10.92-RACO	5. Bridge not eligible for NRHP	1973	1991
24 0186	HOWE AVENUE OC	03-SAC-050-R3.67-SAC	5. Bridge not eligible for NRHP	1969	

Structure Maintenance & Investigations

Historical Significance - State Agency Bridges



District 03

Sacramento County

Bridge Number	Bridge Name	Location	Historical Significance	Year Built	Year Wid/Ext
24 0313	39TH STREET UC	03-SAC-050-R0.85-SAC	5. Bridge not eligible for NRHP	1971	2004
24 0314	48TH STREET OC	03-SAC-050-R1.41-SAC	5. Bridge not eligible for NRHP	1971	
24 0315	51ST STREET OC	03-SAC-050-R1.63-SAC	5. Bridge not eligible for NRHP	1971	
24 0316S	59TH ST OFF-RAMP OC	03-SAC-050-R2.01-SAC	5. Bridge not eligible for NRHP	1971	
24 0317	59TH STREET OC	03-SAC-050-R2.13-SAC	5. Bridge not eligible for NRHP	1971	
24 0318	65TH STREET UC	03-SAC-050-R2.63-SAC	5. Bridge not eligible for NRHP	1971	2012
24 0319	EAST DRAINAGE CANAL	03-SAC-005-26.88-SAC	5. Bridge not eligible for NRHP	1968	
24 0320	DRAINAGE DITCH	03-SAC-005-30.78	5. Bridge not eligible for NRHP	1966	
24 0321	WESTERN DRAINAGE CANAL	03-SAC-005-33.61	5. Bridge not eligible for NRHP	1966	
24 0326	HOOD-FRANKLIN ROAD OC	03-SAC-005-8.49	5. Bridge not eligible for NRHP	1975	
24 0327L	STONE LAKE CREEK	03-SAC-005-8.11	5. Bridge not eligible for NRHP	1975	
24 0327R	STONE LAKE CREEK	03-SAC-005-8.11	5. Bridge not eligible for NRHP	1975	
24 0332	NATOMAS MAIN CANAL	03-SAC-080-M2.10	5. Bridge not eligible for NRHP	1970	
24 0335	FOLSOM SOUTH CANAL	03-SAC-104-7.75	5. Bridge not eligible for NRHP	1972	
24 0336	FOLSOM SOUTH CANAL	03-SAC-016-T11.35	5. Bridge not eligible for NRHP	1971	
24 0338	CANALSIDE EQUESTRIAN UC	03-SAC-050-14.78	5. Bridge not eligible for NRHP	1971	
24 0339	FOLSOM SOUTH CANAL	03-SAC-050-14.80	5. Bridge not eligible for NRHP	1971	
24 0341	ELKHORN BOULEVARD OC	03-SAC-099-33.36	5. Bridge not eligible for NRHP	1987	
24 0343	LAGUNA CREEK	03-SAC-016-R11.53	5. Bridge not eligible for NRHP	1979	
24 0344	SOUTH REACH STONE LAKE	03-SAC-005-6.43	5. Bridge not eligible for NRHP	1975	
24 0345	MIDDLE REACH STONE LAKE	03-SAC-005-8.83	5. Bridge not eligible for NRHP	1975	
24 0346	STONE LAKE	03-SAC-005-9.38	5. Bridge not eligible for NRHP	1975	
24 0347	SOUTH REACH BEACH LAKE	03-SAC-005-12.40	5. Bridge not eligible for NRHP	1975	
24 0350F	W80-N5 CONNECTOR OC	03-SAC-080-M2.64-SAC	5. Bridge not eligible for NRHP	1968	
24 0351J	I STREET SACRAMENTO RIVER BRIDGE APPROACH	03-SAC-005-23.80-SAC	5. Bridge not eligible for NRHP	1937	
24 0352K	PARKING GARAGE CONNECTOR UC	03-SAC-005-23.68-SAC	5. Bridge not eligible for NRHP	1982	
24 0353F	S5-N99 CONNECTOR SEPARATION	03-SAC-005-30.11-SAC	5. Bridge not eligible for NRHP	1987	
24 0354F	S5-N99 CONNECTOR SEPARATION	03-SAC-005-30.04-SAC	5. Bridge not eligible for NRHP	1987	
24 0357	ARENA BLVD OC	03-SAC-005-28.04-SAC	5. Bridge not eligible for NRHP	2004	
24 0358	LAGUNA BLVD OC	03-SAC-099-13.66	5. Bridge not eligible for NRHP	1990	
24 0359	LAGUNA BLVD OC	03-SAC-005-12.04	5. Bridge not eligible for NRHP	1992	
24 0360	CALVINE ROAD OC	03-SAC-099-15.80-SAC	5. Bridge not eligible for NRHP	1995	
24 0361	ELK GROVE BLVD OC	03-SAC-099-12.76	5. Bridge not eligible for NRHP	1997	
24 0362	TRUXEL ROAD OC	03-SAC-080-M3.63-SAC	5. Bridge not eligible for NRHP	1997	
24 0363	EAST BIDWELL ROAD OC	03-SAC-050-21.50	5. Bridge not eligible for NRHP	2000	
24 0364S	PRAIRIE CITY ROAD ON-RAMP SEPARATION	03-SAC-050-19.20-FOL	5. Bridge not eligible for NRHP	1998	
24 0365	PRAIRIE CITY ROAD OC	03-SAC-050-19.23-FOL	5. Bridge not eligible for NRHP	1998	
24 0366	HAZEL/FOLSOM POC	03-SAC-050-16.17	5. Bridge not eligible for NRHP	2000	
24 0367	GRANT LINE ROAD OC	03-SAC-099-10.07-ELKG	5. Bridge not eligible for NRHP	2008	
24 0370	WEST ELVERTA ROAD OC	03-SAC-099-35.37	5. Bridge not eligible for NRHP	2013	
24 0373	NATOMAS POC	03-SAC-080-M2.12	4. Historical Significance not determined	2012	
24 0374	SHELDON ROAD OC	03-SAC-099-14.87-ELKG	5. Bridge not eligible for NRHP	2010	
24 0375	MANLOVE POC	03-SAC-050-R5.76-RACO	5. Bridge not eligible for NRHP	2011	

Attachment D
Documentation on Previous Determinations (SHPO Concurrence Letters, OHP Historic Property Data File)

Each of the documents listed below is identified on the subsequent pages by a margin number.

1. APN-069-0160-011. Sacramento County Fire Station #63. 12395 Folsom Boulevard, Rancho Cordova, CA. HRI status code: 6J-Landmark or Points of Interest found ineligible for designation by the SHRC (1995). HRI Reference Number: DSA-34-SPS-3039
2. APN 069-0050-013. P-34-001667. Nimbus Winery. HRI status code: 6Y Determined ineligible for NRHP listing by consensus through Section 106 process. Evaluated in 2007 by Liu and Sikes HRI Reference Number: BUR920110A.
3. APN 072-0231-125. P-34-002183. Aerojet Building 49015. HRI status code: 6X- Evaluated and determined ineligible for the NRHP listing through the Section 106 process under the MOA for the Glenborough at Easton and Easton Place Project. (MOA Section II. C - see Attachment D)
4. P-34-000455. CA-Sac-000428. Sacramento Valley Railroad. HRI status code: 2S2-Determined eligible for NRHP listing by consensus through Section 106 process. Listed in the CRHR and evaluated in 1993.

PROPERTY-NUMBER	PRIMARY-#	STREET.ADDRESS.....	NAMES.....	CITY.NAME.....	OWN	YR-C	OHP-PROG..	PRG-REFERENCE-NUMBER	STAT-DAT	NRS	CRIT
184218			DOUGLAS MISSILE TEST FACILITY HD/	RANCHO CORDOVA	P	1956	PROJ.REVW.	COE110520A	07/29/11	2D2	AC
173787			INDUSTRIAL RAILROAD SPUR	RANCHO CORDOVA	P		PROJ.REVW.	FHWA071120A	12/21/07	6Y	
184217			DOUGLAS MISSILE TEST HD/ GAMMA TES	RANCHO CORDOVA	P	1964	PROJ.REVW.	COE110520A	07/29/11	2D2	AC
184216			DOUGLAS MISSILE TEST FACILITY HD/B	RANCHO CORDOVA	P	1963	PROJ.REVW.	COE110520A	07/29/11	2D2	AC
184220			DOUGLAS MISSILE TEST FACILITY/SOLI	RANCHO CORDOVA	P	1956	PROJ.REVW.	COE110520A	07/29/11	2D2	AC
155952		2305 CEMO DR		RANCHO CORDOVA	P		PROJ.REVW.	FCC051006C	10/14/05	6Y	
096125		10595 FOLSOM BLVD	FIRE STATION #61	RANCHO CORDOVA	C	1956	HIST.RES.	DSA-34-SPS-3040	05/04/95	6J	
096136		12395 FOLSOM BLVD	SACRAMENTO COUNTY-FIRE STATION #63	RANCHO CORDOVA	D	1961	HIST.RES.	DSA-34-SPS-3039	05/04/95	6J	1
074371		12401 FOLSOM BLVD	NIMBUS WINERY	RANCHO CORDOVA	U	1888	PROJ.REVW.	BUR920110A	02/03/92	6Y	
074372		12415 FOLSOM BLVD		RANCHO CORDOVA	U	1930	PROJ.REVW.	BUR920110A	02/03/92	6Y	2
186577		2500 FURMINT WAY		RANCHO CORDOVA	P		PROJ.REVW.	HUD100426D	05/25/10	6Y	
090686		HAZEL AVE	COLOMA ROAD - NIMBUS DAM	RANCHO CORDOVA	FS		HIST.RES.	SHL-0746-0000	07/05/60	7L	
101335		2720 KILGORE RD	AMERICAN RIVER GRANGE HALL #172	RANCHO CORDOVA	P	1882	HIST.RES.	NPS-96001079-0000	10/10/96	1S	A
							NAT.REG.	34-0049	10/10/96	3S	
							HIST.RES.	SPHI-SAC-020	05/15/96	7L	
							ST.PT.INT.	34-0047		7L	
182165		MATHER AFB	BUILDING 8560	RANCHO CORDOVA	M	1950	PROJ.REVW.	COE110318A	04/04/11	6Y	
107084		2909 MATHER FIELD RD		RANCHO CORDOVA	P	1940	HIST.RES.	DOE-34-97-0027-0000	03/03/97	6Y	
							PROJ.REVW.	FTA970129A	03/03/97	6Y	
107083		2919 MATHER FIELD RD		RANCHO CORDOVA	P	1940	HIST.RES.	DOE-34-97-0026-0000	03/03/97	6Y	
							PROJ.REVW.	FTA970129A	03/03/97	6Y	
107087		10298 MC CRACKEN DR		RANCHO CORDOVA	P	1920	HIST.RES.	DOE-34-97-0028-0000	03/03/97	6Y	
							PROJ.REVW.	FTA970129A	03/03/97	6Y	
181362		12525 QUICKSILVER DR		RANCHO CORDOVA	P	1956	PROJ.REVW.	FCC100817A	01/18/11	6Y	
046504	34-002474	SR 16	BRIDGE #24-62	RANCHO CORDOVA	S	0	HIST.SURV.	5670-0001-0000		7R	
090640		WHITE ROCK RD	FIFTEEN MILE HOUSE - CALIFORNIA OV	RANCHO CORDOVA	C	1857	HIST.RES.	SHL-0698-0000	09/11/59	7L	
183169			NORTH GRANLEES DAM	(VIC) RANCHO MURI		1921	PROJ.REVW.	COE100722A	08/16/10	6Y	
072973		0	FOLSOM PRISON POWERHOUSE	REPRESSA	U	1882	ST.HS.LDMK	34-0002		7W	
153000		6400 6TH ST		RIO LINDA		1940	PROJ.REVW.	FEMA040816A	08/31/04	6Y	
121004	34-000550	6444 6TH ST		RIO LINDA	P	1927	HIST.RES.	DOE-34-99-0001-0000	07/06/99	6Y	
							PROJ.REVW.	FEMA990621A	07/06/99	6Y	
152997		6541 CHERRY LANE		RIO LINDA		1954	PROJ.REVW.	FEMA040816A	08/31/04	6Y	
152996		6816 DRY CREEK RD		RIO LINDA	P	1920	PROJ.REVW.	FEMA040816A	08/31/04	6Y	
152999		9550 DRY CREEK RD		RIO LINDA	P	1964	PROJ.REVW.	FEMA040816A	08/31/04	6Y	
068244		325 ELKHORN BLVD		RIO LINDA	U		PROJ.REVW.	HUD871027A	12/09/87	6Y	
121006	34-000549	738 K ST		RIO LINDA	P	1940	HIST.RES.	DOE-34-99-0002-0000	07/06/99	6Y	
							PROJ.REVW.	FEMA990621B	07/06/99	6Y	
090989		RIO LINDA BLVD	THE ARCHWAY	RIO LINDA	U		HIST.RES.	SPHI-SAC-007	05/18/83	7L	
132139		2849 RIO LINDA BLVD		RIO LINDA	P	1939	HIST.RES.	DOE-34-01-0005-0000	11/21/01	6Y	
							PROJ.REVW.	FCC010619H	11/21/01	6Y	
080846		110 W E ST		RIO LINDA	U	1943	PROJ.REVW.	HUD930317E	04/22/93	6Y	
150995		G ST	HAYER DAM	(VIC) RIO LINDA	M	1929	HIST.RES.	DOE-34-04-0030-0000	07/06/04	6Y	
							PROJ.REVW.	COE040628A	07/06/04	6Y	
046519	34-002475	14340 OLD RIVER RD	THE RYDE HOTEL	RYDE	P	1926	TAX.(NPS)	012881CA820112	01/18/82	2D3	
							HIST.SURV.	5680-0001-0000		3S	
085720			BALLAST DECK-WOOD MP 108.56	SACRAMENTO	U	1929	HIST.RES.	DOE-34-93-0050-0000	12/21/93	6Y	
							PROJ.REVW.	ICC931025A	12/21/93	6Y	
067596			BLDG S41 - SHARPE ARMY DEPOT	SACRAMENTO	U		PROJ.REVW.	COE900102A	02/16/90	6Y	

MEMORANDUM OF AGREEMENT
BETWEEN
THE UNITED STATES ARMY CORPS OF ENGINEERS AND
THE CALIFORNIA STATE HISTORIC PRESERVATION OFFICER
REGARDING
THE GLENBOROUGH AT EASTON AND EASTON PLACE PROJECT
SACRAMENTO COUNTY, CALIFORNIA

WHEREAS, the United States Army Corps of Engineers, Sacramento District (Corps) proposes to issue a permit pursuant to Section 404 of the Clean Water Act (Undertaking) to Easton Development Company, LLC (Applicant) for the proposed Glenborough at Easton and Easton Place Project (Project), in Sacramento County, California; and

WHEREAS, the Project would involve the construction of a mixed-use development that will be implemented over a build-out of 20 years or more, which will be constructed in phases (Phase), and involve the discharge of fill materials into waters of the United States; and

WHEREAS, the Corps, in consultation with the California State Historic Preservation Officer (SHPO) and in accordance with 36 CFR § 800.4(a)(1), has established the Undertaking's Area of Potential Effects (APE) as including all areas to be developed as part of the Undertaking, including all temporary and permanent easements and construction staging areas, as depicted in Attachment 1 to this Memorandum of Agreement (MOA); and

WHEREAS, the Corps, in consultation with SHPO and in accordance with 36 CFR § 800.4(b) and § 800.4(c), has inventoried historic properties within the Undertaking's APE and has determined that historic archaeological site CA-SAC-1008-H, the Alder Creek Corridor Mining District (ACCMD), is eligible for listing in the National Register of Historic Places under Criteria A, C, and D; and

WHEREAS, the Corps, in consultation with SHPO and in accordance with 36 CFR § 800.5(a), has applied the criteria of adverse effect and determined that the Undertaking will have an adverse effect on the ACCMD;

WHEREAS, the Corps has considered alternatives to the Undertaking, has chosen to proceed with the Undertaking, and has determined to resolve adverse effects of the Undertaking on the ACCMD through the execution and implementation of this Memorandum of Agreement (MOA); and

WHEREAS, the Applicant has participated in the consultation and has been invited to concur in this MOA; and

WHEREAS, pursuant to 36 CFR § 800.6(a)(1), the Corps has notified the Advisory Council on Historic Preservation (Council) of its adverse effect determination with specified documentation and the Council has chosen not to participate in the consultation pursuant to 36 CFR § 800.6(a)(1)(iii); and

NOW, THEREFORE, the Corps and SHPO agree that the Undertaking shall be implemented in accordance with the following stipulations in order to take into account the effects of the Undertaking on historic properties, and further agree that these stipulations shall govern the Undertaking and all of its parts until this MOA expires or is terminated.

STIPULATIONS

The Corps will ensure the following stipulations are carried out in sequence and to its satisfaction by incorporating this MOA as a special condition of any Section 404 Permit related to the Project issued by the Corps to Applicant/Permittee or its transferees as successors to such Section 404 Permit.

I. TREATMENT OF ADVERSE EFFECTS OF HISTORIC PROPERTIES

A. The Corps shall ensure the Applicant implements the attached 25 July 2011 *Historic Properties Treatment Plan for Alder Creek Corridor Mining District (CA-SAC-1008-H), Sacramento County, California* (HPTP) (Attachment 2) prior to the start of construction activities for each Phase of the Project, as set forth in the attached HPTP and outlined below:

Phase 1

1. Low-level aerial photography, aircraft-mounted Light Detection and Ranging (LIDAR) image acquisition, and field verification for the entire ACCMD.
2. Ground-based documentation of precise boundary delineation for loci and features that are associated with Phase 1 of project construction and laser scanning, photography, and mapping of representative examples, as shown on the maps in Attachment A of the attached HPTP (Attachment 2 to this MOA).
3. Installation of temporary fencing with controlled access after completion of documentation for Phase 1.

Phase 2

1. Ground-based documentation of precise boundary delineation for the remainder of the loci and features within the APE and laser scanning, photography, and mapping of representative examples, as shown on the maps in Attachment A of the attached HPTP (Attachment 2 to this MOA).
2. Data recovery of Feature 4A.
3. Installation of public interpretive displays for the nature center and trailhead signs.
4. Removal of temporary fencing upon the Corps' determination that the resolution of adverse effect is complete.

B. Every two years from the date of the execution of this MOA, the Applicant shall submit to the Corps and SHPO a brief status report on the work performed in implementing the terms of the MOA and HPTP, as well as a general scope for the work to be performed

over the following 2 years. The Corps and SHPO shall have 30 days to review and provide comments on the progress of implementation. If no comments are received within the 30 day comment period, then the Applicant may assume that the Corps and/or SHPO have no comment, and can proceed with implementation of the MOA and HPTP, as described herein.

C. Any party to this MOA may propose an amendment to the HPTP. Such amendment will not require amendment of this MOA. Disputes regarding amendments proposed hereunder shall be resolved through consultation between the MOA parties. The time frames for such consultation shall be consistent with those established under Stipulation IV.C below. If the dispute is resolved within this time frame, the MOA parties shall proceed in accordance with the terms of that resolution. If the dispute is not resolved within this time frame, no amendment to the HPTP will occur.

II. REPORTING REQUIREMENTS AND RELATED REVIEWS

A. The Applicant shall notify the Corps and SHPO within ten (10) days of completion of fieldwork for each Phase of the Project, as required by Stipulation I of this MOA.

B. Within fifteen (15) days of notifying the Corps and SHPO of completion of all fieldwork for each Phase of the Project as required by Stipulation I of this MOA, the Applicant shall prepare a draft interim report that (1) discusses the scope of the study; (2) describes the field methods; (3) reports the preliminary findings; and (4) states any additional recommendations for site management. This report shall be distributed concurrently to the Corps and SHPO for review and comment, both in hard copy and electronically.

C. The Corps and SHPO shall review and provide any comments to the Applicant, and copy the other MOA parties regarding their comments, within thirty (30) days of receipt of the interim report. If no comments are received within the thirty (30) day comment period, the Applicant may assume the Corps and/or SHPO have no comment. The Applicant shall respond to any comments, and copy the other MOA parties, within fifteen (15) days or implement the Resolving Objections Stipulation of the MOA (Stipulation IV.C). After all comments are addressed, the Applicant shall provide a final interim report to the Corps and SHPO concurrently, both in hard copy and electronically.

D. Prior to the start of any grading or construction activity for each Phase of the Project, other than what is specifically allowed per the HPTP (fencing requirements, etc.), the applicant shall satisfy the fieldwork, mapping, and documentation requirements set forth in the HPTP for documenting and recording the ACCMD. The Applicant will distribute all technical reports generated as a result of requirements set forth in the HPTP in draft form concurrently to the Corps and SHPO for review and comment. The Corps and SHPO shall review and provide any comments to the Applicant, and copy the other MOA parties regarding their comments, within thirty (30) days of receipt of the draft reports. If no comments are received within the thirty (30) day comment period, the Applicant may assume the Corps and/or SHPO have no comment. The Applicant shall respond to any comments, and copy the other MOA parties, within thirty (30) days or implement the

Resolving Objections Stipulation of the MOA (Stipulation IV.C). After all comments are addressed, the Applicant shall provide a final report in accordance with Stipulation IV.B.

III. STANDARDS

A. PROFESSIONAL QUALIFICATIONS AND STANDARDS

1. Professional Qualifications.
All historic preservation activities implemented pursuant to this MOA shall be conducted by, or under the direct supervision of, a person or persons meeting, at a minimum, the Secretary of Interior's *Professional Qualifications Standards for Archaeology* (48 FR 44739) for historical archaeologist and who has had at least one year of full-time professional experience at a supervisory level in the study of archaeological resources of the historic period, with an emphasis on Gold Rush-era mining resources.

2. Historic Preservation Standards.
All historic preservation activities carried out pursuant to the MOA shall meet the Secretary of the Interior's Standards and Guidelines for Archeology and Historic Preservation (48 FR 44716-44740) as well as standards and guidelines for historic preservation activities established by the SHPO and National Park Service.

3. Curation and Curation Standards.
The Corps shall ensure that the materials and records resulting from the historic preservation work stipulated in this MOA are curated in accordance with 36 CFR Part 79, or at a Corps- and SHPO-approved curation facility.

4. Documentation Standards.
The Corps shall ensure that all written documentation prescribed by Stipulation I and II of this MOA shall conform to the *Secretary of the Interior's Standards and Guidelines for Archaeology and Historic Preservation* (48 FR 44716-44740), as well as to applicable standards and guidelines established by the SHPO.

IV. ADMINISTRATIVE STIPULATIONS

A. CONFIDENTIALITY

The parties to this MOA acknowledge that Historic Properties covered by this MOA are subject to the provisions of § 304 of the NHPA, relating to the disclosure of archaeological site information and, having so acknowledged, will ensure that all actions and documentation prescribed by this MOA are consistent with § 304 of the NHPA.

B. REPORT DISTRIBUTION

The Corps shall ensure that copies of all technical reports and studies prepared to satisfy the terms of this MOA are provided upon completion by the Applicant to all parties to this MOA and to the North Central Information Center (NCIC) of the California Historical Resources Information System (CHRIS), consistent with requirements of Stipulation IV.A., above.

C. RESOLVING OBJECTIONS

1. Should any party to this MOA object at any time in writing to the manner in which the terms of this MOA are implemented, to any action carried out or proposed with respect to the implementation of the MOA, or to any documentation prepared in accordance with and subject to the terms of this MOA, the Corps shall immediately notify the other parties to this MOA of the objection, and shall request their comments on the objection be provided within 15 days following receipt of the Corps' notification, and proceed to consult with the objecting party for no more than 30 days to resolve the objection. The Corps will honor the request of the other parties to participate in the consultation and will take any comments provided by those parties into account.

2. If the objection is resolved during the 30-day consultation period, the Corps may proceed with the disputed action in accordance with the terms of that resolution.

3. If after initiating such consultation, the Corps determines that the objection cannot be resolved through consultation, the Corps shall forward all documentation relevant to the objection, including the Corps' proposed response to the objection, to the Council, with the expectation that the Council will, within 30 days after receipt of such documentation, do one of the following:

a. advise the Corps that the Council concurs in the Corps' proposed response to the objection, whereupon the Corps will respond to the objection accordingly. The objection shall thereby be resolved; or

b. provide the Corps with recommendations, which the Corps will take into account in reaching a final decision regarding its response to the objection. The objection shall thereby be resolved; or

c. notify the Corps that the objection will be referred for comment, pursuant to 36 CFR § 800.7(c), and proceed to refer the objection and comment. The Corps shall take the resulting comment into account in accordance with 36 CFR § 800.7(c)(4) and § 110(1) of the NHPA. The objection shall thereby be resolved.

4. Should the Council not exercise one of the foregoing options within 30 days after receipt of all pertinent documentation, the Corps may assume the Council's concurrence in its proposed response to the objection and proceed with implementation of that response. The objection shall thereby be resolved.

5. The Corps shall take into account any Council recommendation or comment provided in accordance with Section IV.C.1 of this stipulation, with reference only to the subject of the objection. The Corps' responsibility to ensure all actions are carried out under this MOA that are not the subject of the objection shall remain unchanged.

6. At any time during the implementation of the terms of this MOA, should an objection pertaining to such implementation be raised by a member of the public, the Corps shall immediately notify the other parties to this MOA in writing of the objection and take the objection into consideration. The Corps shall consult with the objecting party and, if the objecting party so requests, with the other parties to this MOA, for no more than fifteen (15) days. Within ten (10) days following closure of this consultation period, the Corps will render a decision regarding the objection and notify all parties to this MOA of its decision in writing. In reaching its decision, the Corps will take into account any comments from the consulting parties regarding the objection, including the objecting party. The Corps' decision regarding the resolution will be final. The objection will thereby be resolved.

7. The Corps may authorize any action subject to objection under this stipulation to proceed after the objection has been resolved in accordance with the terms of this stipulation.

8. The Corps shall provide all parties to this MOA and the Council, when the Council has issued comments hereunder, and any parties that have objected pursuant to Section C.6 of this stipulation, with a copy of its final written decision regarding any objection addressed pursuant to this stipulation.

D. AMENDMENTS

1. Any party to this MOA may propose that this MOA be amended, whereupon all parties to this MOA will consult for no more than thirty (30) days to consider such amendment. The Corps may extend this consultation period. The amendment process shall comply with 36 CFR § 800.6(c)(1) and § 800.6(c)(7). This MOA may be amended only upon the written agreement of the signatory parties. If it is not amended, this MOA may be terminated by the Corps or the SHPO.

2. The HPTP may be amended through consultation as prescribed in Section C of Stipulation I without amending the MOA proper.

E. TERMINATION

1. Only the Corps or the SHPO may terminate this MOA. If this MOA is not amended as provided for in Section D of this stipulation, or if the Corps or the SHPO proposes termination of this MOA for other reasons, the signatory party proposing termination shall, in writing, notify the other parties to this MOA, explain the reasons for proposing termination, and consult with the other parties to this MOA for at least thirty (30) days to seek alternatives to termination. Should such consultation result in an agreement on an alternative to termination, then the parties shall proceed in accordance with the terms of that agreement. Such consultation shall not be required if the Corps proposes termination because the Undertaking no longer meets the definition set forth at 36 CFR § 800.16(y).

2. Should such consultation fail, the signatory party proposing termination may terminate this MOA by promptly notifying the other parties to this MOA in writing. Termination hereunder shall render this MOA without further force or effect.

3. If this MOA is terminated hereunder, and if the Corps determines that the undertaking will nonetheless proceed, then the Corps shall either consult in accordance with 36 CFR Part 800.6 to develop a new MOA, or request the comments of the Council, pursuant to 36 CFR Part 800.

F. DURATION OF THE MOA

1. Unless terminated pursuant to Section E of this stipulation, or unless it is superseded by an amended MOA, this MOA will be in effect following execution by the signatory parties until the Corps, in consultation with the other parties to this MOA, determines that all the terms of this MOA have been satisfactorily fulfilled. Upon a determination by the Corps that all of the terms of this MOA have been satisfactorily fulfilled, the Corps will

immediately notify the other parties to this MOA in writing of its determination that all terms of this MOA have been satisfactorily fulfilled and of the termination of the MOA. Following provision of such notice, this MOA will have no further force or effect.

2. The terms of this MOA shall be satisfactorily fulfilled within fifteen (15) years following the date of execution by the signatory parties. If the Corps determines that this requirement cannot be met, the parties to this MOA will consult to reconsider its terms. Reconsideration may include the continuation of the MOA as originally executed, amendment of the MOA, or termination. In the event of termination, the Corps will comply with Section E.3 of this stipulation, if it determines that the Undertaking will proceed notwithstanding termination of this MOA.

3. If the Undertaking (issuance of a permit) has not been implemented within five (5) years following execution of this MOA by the signatory parties, this MOA shall automatically terminate and have no further force or effect. In such event, the Corps shall notify the other MOA parties in writing and, if it chooses to continue with the Undertaking, shall reinitiate review of the Undertaking in accordance with 36 CFR Part 800.

G. EFFECTIVE DATE.

This MOA will take effect immediately upon full execution by the Corps and the SHPO.

EXECUTION of this MOA by the Corps and the SHPO, pursuant to 36 CFR § 800.6, including its transmittal by the Corps to the Council in accordance with 36 CFR § 800.6 (b)(1)(iv), and subsequent implementation of its terms, shall evidence that the Corps has afforded the Council an opportunity to comment on the Undertaking and its effects on Historic Properties, and that the Corps has taken into account the effects of this Undertaking on Historic Properties.

SIGNATORY PARTIES:

UNITED STATES ARMY CORPS OF ENGINEERS, SACRAMENTO DISTRICT

Name: _____ _____

Michael S. Jewell Date

Title: Chief, Regulatory Division

CALIFORNIA STATE HISTORIC PRESERVATION OFFICER

Name: _____ _____

Milford Wayne Donaldson, FAIA Date

Title: State Historic Preservation Officer

CONCURRING PARTIES:

EASTON DEVELOPMENT COMPANY, LLC

Name: _____ _____

David Hatch Date

Title: Chief Operation Officer

AEROJET GENERAL CORPORATION

Name: _____ _____

David Hatch Date

Title: Vice President

LIST OF ATTACHMENTS

Attachment 1 – Area of Potential Effects Map

Attachment 2 – Historic Property Treatment Plan for ACCMD

ATTACHMENT 1

Area of Potential Effects Map

ATTACHMENT 2

Historic Property Treatment Plan for ACCMD

U.S. 50 / Hazel Avenue Interchange Project
Sacramento County, California
03-SAC-50-PM 15.1/17.5
EA 03-3E380, Project ID 0300020439
County Control Number 2011-70062

Location Hydraulic Study Report



Prepared for:

Caltrans

SACRAMENTO COUNTY

June 2017

U.S. 50 / Hazel Avenue Interchange Project
Sacramento County, California
03-SAC-50-PM 15.1/17.5
EA 03-3E380, Project ID 0300020439
County Control Number 2011-70062

Location Hydraulic Study Report

Submitted to:
California Department of Transportation and
County of Sacramento

Prepared by:
WRECO

This report has been prepared by or under the supervision of the following Registered Engineer. The Registered Civil Engineer attests to the technical information contained herein and has judged the qualifications of any technical specialists providing engineering data upon which recommendations, conclusions, and decisions are based.

Han-Bin Liang, Ph.D., P.E.
Registered Civil Engineer

6/13/2017
Date



June 2017

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Executive Summary

The County of Sacramento (County), in cooperation with the California Department of Transportation (Caltrans) and the City of Rancho Cordova (City), proposes to modify the existing United States (U.S.) 50/Hazel Avenue interchange, and extend and grade-separate Hazel Avenue over Folsom Boulevard and the Sacramento Placerville Transportation Corridor Joint Powers Authority (SPTC-JPA) rail corridor (Project). Hazel Avenue will be extended further south to a proposed intersection with the future Atlanta Street (a new roadway that will be constructed as part of the Easton Place development). Two alternatives, with one sub-alternative, and a no-build alternative have been developed for the Project.

All Project alternatives involve an auxiliary lane bridge on pilings which are within the Federal Emergency Management Agency (FEMA) floodway for Alder Creek, just upstream of its intersection with Lake Natoma on the American River. The soffit elevation of the proposed auxiliary lane bridge deck is above the current effective FEMA base flood elevation, which is a static flood elevation for both Alder Creek and lower Lake Natoma due to the presence of Nimbus Dam. The impact associated with this floodplain encroachment is minimal because of the small area of the proposed widening relative to the large storage area of Alder Creek pond upstream of U.S. 50.

A Physical Map Revision hydraulic model of Alder Creek was also used to assess the potential floodplain impacts associated with the U.S. 50 auxiliary lane extension widening at the Alder Pond bridge crossing. Although the widening would result in added impervious areas and the piles for the auxiliary lane extension would result in fill within the floodplain, the hydraulic analysis indicated that the proposed Project improvements would not result in increases in water surface elevation along Alder Creek. Because the project will not result in increases in water surface elevation, additional measures to minimize floodplain impacts are not required.

There would be potential short-term adverse effects to the natural and beneficial floodplain values that could result during the construction activities. There would also be long-term adverse impacts to the natural and beneficial floodplain values that would result from the addition of the piles within the channel under the auxiliary lane widening. However, these impacts would be minor because of the small construction footprint. Minimization measures, such as best management practices, are proposed to address potential adverse effects to the natural and beneficial floodplain values.

Sacramento County Department of Public Works should coordinate with local, State, and Federal water resources and floodplain management agencies, as necessary. Regulatory permits and approvals would be required as the Project enters into the final design phase.

Acronyms

AASHTO	American Association of State Highway and Transportation Officials
ADT	average daily traffic
BFE	base flood elevation
BMP	best management practice
Caltrans	California Department of Transportation
CFR	Code of Federal Regulations
cfs	cubic feet per second
CIP	cast-in-place
City	City of Rancho Cordova
County	County of Sacramento
DOT	Department of Transportation
DWR	Department of Water Resources
FFRMS	Federal Flood Risk Management Standard
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
ft	feet/foot
HSA	hydrologic sub-area
HOV	high-occupancy vehicle
in.	inch
km	kilometers
LOMR	Letter of Map Revision
LOS	Level of Service
LRFD	Load and Resistance Factor Design
MSE	mechanically stabilized earth
MTP	Metropolitan Transportation Plan
NFIP	National Flood Insurance Program
NAVD 88	North American Vertical Datum of 1988
NGVD 29	National Geodetic Vertical Datum of 1929
NOAA	National Oceanic and Atmospheric Administration
PMR	Physical Map Revision
Project	United States 50/Hazel Avenue interchange, and extend and grade-separate Hazel Avenue over Folsom Boulevard and the Sacramento Placerville Transportation Corridor Joint Powers Authority rail corridor
RC	reinforced concrete
RCB	reinforced concrete box culvert
SACOG	Sacramento Area Council of Government's
SPTC-JPA	Sacramento Placerville Transportation Corridor Joint Powers Authority
SWMP	Stormwater Management Plan
UPRR	Union Pacific Railroad
U.S.	United States
USGS	United States Geological Survey
WMAP	Watershed Management Action Plan

LOCATION HYDRAULIC STUDY FORM

Dist. 03 Co. SAC Rte. 50 P.M. 15.1/17.5 EA: 03-3E380
Bridge No. 24 0033

Floodplain Description:
American River (including Lake Natoma) – Shaded Zone AE Floodway

1. Description of Proposal
Re-design of the U.S. 50/Hazel Avenue interchange in Rancho Cordova. Construction of an eastbound auxiliary lane over Alder Creek, which will utilize a bridge on piles to span the base flood width.

2. ADT: Current 115,000 (year 2009) Projected 195,000 (year 2030)

3. Hydraulic Data: Base Flood Q100= 180,000 CFS
WSE100= See the table below *The flood of record, if greater than Q100:*
Q= n/a CFS WSE= n/a
Overtopping flood Q= n/a CFS WSE= n/a

Source/Alternative	100-Year Water Surface Elevation (ft NAVD 88)
FEMA Effective FIRM/FIS	128.4
HEC-RAS Model for Existing Condition	135.2
HEC-RAS Model for Proposed Auxiliary Lane Extension	135.0

Are NFIP maps and studies available? NO ____ YES X

4. Is the highway location alternative within a regulatory floodway? NO ____ YES X

5. Attach map with flood limits outlined showing all buildings or other improvements within the base floodplain.

Potential Q100 backwater damages:

A. Residences? NO X YES ____
B. Other Bldgs? NO X YES ____
C. Crops? NO X YES ____
D. Natural and beneficial Floodplain values? NO X YES ____

"Natural and beneficial flood-plain values" shall include but are not limited to fish, wildlife, plants, open space, natural beauty, scientific study, outdoor recreation, agriculture, aquaculture, forestry, natural moderation of floods, water quality maintenance, and groundwater recharge.

6. Type of Traffic:

A. Emergency supply or evacuation route? NO ____ YES X
B. Emergency vehicle access? NO ____ YES X
C. Practicable detour available? NO ____ YES X
D. School bus or mail route? NO ____ YES X

7. Estimated duration of traffic interruption for 100-year event hours: n/a

LOCATION HYDRAULIC STUDY FORM cont.

Dist. 03 Co. SAC Rte. 50 P.M. 15.1/17.5 EA: 03-3E380
Bridge No. 24 0033

8. Estimated value of Q100 flood damages (if any) – moderate risk level.

A.	Roadway	$ n/a
B	Property	$ n/a
	Total	$ n/a

9. Assessment of Level of Risk

Low X
Moderate
High

For High Risk projects, during design phase, additional Design Study Risk Analysis may be necessary to determine design alternative.

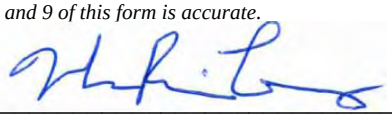
LOCATION HYDRAULIC STUDY FORM cont.

Dist. 03 Co. SAC Rte. 50 P.M. 15.1/17.5 EA: 03-3E380
Bridge No. 24 0033

PREPARED BY:

Signature:

I certify that I have conducted a Location Hydraulic Study consistent with 23 CFR 650 and that the information summarized in items numbers 3, 4, 5, 7, and 9 of this form is accurate.



_____ *Date* 6/13/2017

Local Agency/Consulting Hydraulic Engineer

Is there any longitudinal encroachment, significant encroachment, or any support of incompatible Floodplain development? NO X YES

If yes, provide evaluation and discussion of practicability of alternatives in accordance with 23 CFR 650.113

Information developed to comply with the Federal requirement for the Location Hydraulic Study shall be retained in the project files.

I certify that item numbers 1, 2, 6 and 8 of this Location Hydraulic Study Form are accurate and will ensure that Final PS&E reflects the information and recommendations of said report:

_____ *Date* _____

District Project Engineer

_____ *Date* _____

Local Agency Project Engineer

CONCURRED BY:

I have reviewed the quality and adequacy of the floodplain submittal consistent with the attached checklist, and concur that the submittal is adequate to meet the mandates of 23 CFR 650.

_____ *Date* _____

District Project Manager

_____ *Date* _____

District Hydraulic Branch *(for very complex projects or when required expertise is unavailable. Note: District Hydraulic Branch review of local assistance projects shall be based on reasonableness and concurrence with the information provided).*

I concur that the natural and beneficial floodplain values are consistent with the results of other studies prepared pursuant to 23 CFR 771, and that the NEPA document or determination includes environmental mitigation consistent with the Floodplain analysis.

_____ *Date* _____

District Senior Environmental Planner *(or Designee)*

Note: If a significant floodplain encroachment is identified as a result of floodplains studies, FHWA will need to approve the encroachment and concur in the Only Practicable Alternative Finding.

SUMMARY FLOODPLAIN ENCROACHMENT REPORT

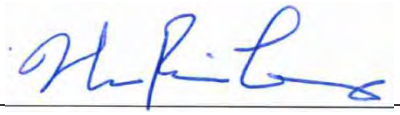
Dist. 03 Co. SAC Rte. 50 P.M. 15.1/17.5
Project No.: 03-3E380 Bridge No. 24 0033

Limits: Auxiliary lane bridge over Alder Creek on U.S. 50.

Floodplain Description: American River (including Lake Natoma) – Shaded Zone AE Floodway

		No	Yes
1.	Is the proposed action a longitudinal encroachment of the base floodplain?	X	
2.	Are the risks associated with the implementation of the proposed action significant?	X	___
3.	Will the proposed action support probable incompatible floodplain development?	X	___
4.	Are there any significant impacts on natural and beneficial floodplain values?	X	___
5.	Routine construction procedures are required to minimize impacts on the floodplain. Are there any special mitigation measures necessary to minimize impacts or restore and preserve natural and beneficial floodplain values? If yes, explain.	X	___
6.	Does the proposed action constitute a significant floodplain encroachment as defined in 23 CFR, Section 650.105(q).	X	___
7.	Are Location Hydraulic Studies that document the above answers on file? If not explain.	___	X

PREPARED BY:



_____ *Date* 6/13/2017

Local Agency/Consulting Hydraulic Engineer

CONCURRED BY:

_____ *Date* _____

District Project Manager

I concur that impacts to natural and beneficial floodplain values are consistent with the results of other studies prepared pursuant to 23 CFR 771, and that the NEPA document or determination includes environmental mitigation consistent with the Floodplain analysis.

_____ *Date* _____

District Senior Environmental Planner *(or Designee)*

Note: If a significant floodplain encroachment is identified as a result of floodplains studies, FHWA will need to approve the encroachment and concur in the Only Practicable Alternative Finding.

1 GENERAL DESCRIPTION

The County of Sacramento (County), in cooperation with the California Department of Transportation (Caltrans) and the City of Rancho Cordova (City), proposes to modify the existing United States (U.S.) 50/Hazel Avenue interchange, and extend and grade-separate Hazel Avenue over Folsom Boulevard and the Sacramento Placerville Transportation Corridor Joint Powers Authority (SPTC-JPA) rail corridor (Project). Hazel Avenue will be extended further south to a proposed intersection with the future Atlanta Street (a new roadway that will be constructed as part of the Easton Place development). The Project also includes:

- Construction of a portion of an eastbound transition auxiliary lane on U.S. 50 from Hazel Avenue through the Folsom Boulevard overcrossing, also known as the Natoma Overhead.
- The modification of the existing Aerojet Road off-ramp from U.S. 50.
- Reconstruction of the westbound loop on-ramp.
- Reconstruction of the eastbound diagonal off-ramp, and both eastbound on-ramps.
- Eastbound on- and off-ramp auxiliary lanes, from west of Hazel Avenue to the eastbound off-ramp, and from the loop on-ramp extending to the Folsom Boulevard interchange.
- Roadway improvements constructed along approximately 2,300 feet of Folsom Boulevard. Improvements include sidewalks, street lighting, and landscaping along the north side of Folsom Boulevard, and landscaping and lighting along the south.

The Project is located in the County of Sacramento at the interchange of Hazel Avenue and U.S. 50 (see Figure 1-1 and Figure 1-2). The Project area is bounded along Hazel Avenue by the Tributary Point/westbound off-ramp intersection to the north, and extends approximately 1,000 feet (ft) south of Folsom Boulevard to a future intersection within the proposed Easton Place development. The Project limits along U.S. 50 begin approximately 3,200 ft west of the existing Hazel Avenue overcrossing, and extend 2,500 ft east of the Natoma Overhead. Improvements along Folsom Boulevard will extend from approximately 1,200 ft west of the Hazel Avenue intersection to 900 ft to the east.

1.1 Project Purpose

The primary purpose of the Project is to modify the existing U.S. 50/Hazel Avenue Interchange to reduce congestion, improve traffic operations, accommodate travel demand due to planned and approved developments, and improve safety of all modes of travel including bicycles and pedestrians.

The following objectives will be met by the proposed alternatives:

- Improve operations by removing the close intersection spacing between the eastbound ramps and Folsom Boulevard, and minimizing conflict with heavy and light rail.
    - Proposed alternatives accomplish this by grade-separating Hazel Avenue over Folsom Boulevard.
- Provide sufficient capacity in the ramps and roadways for future traffic volumes.

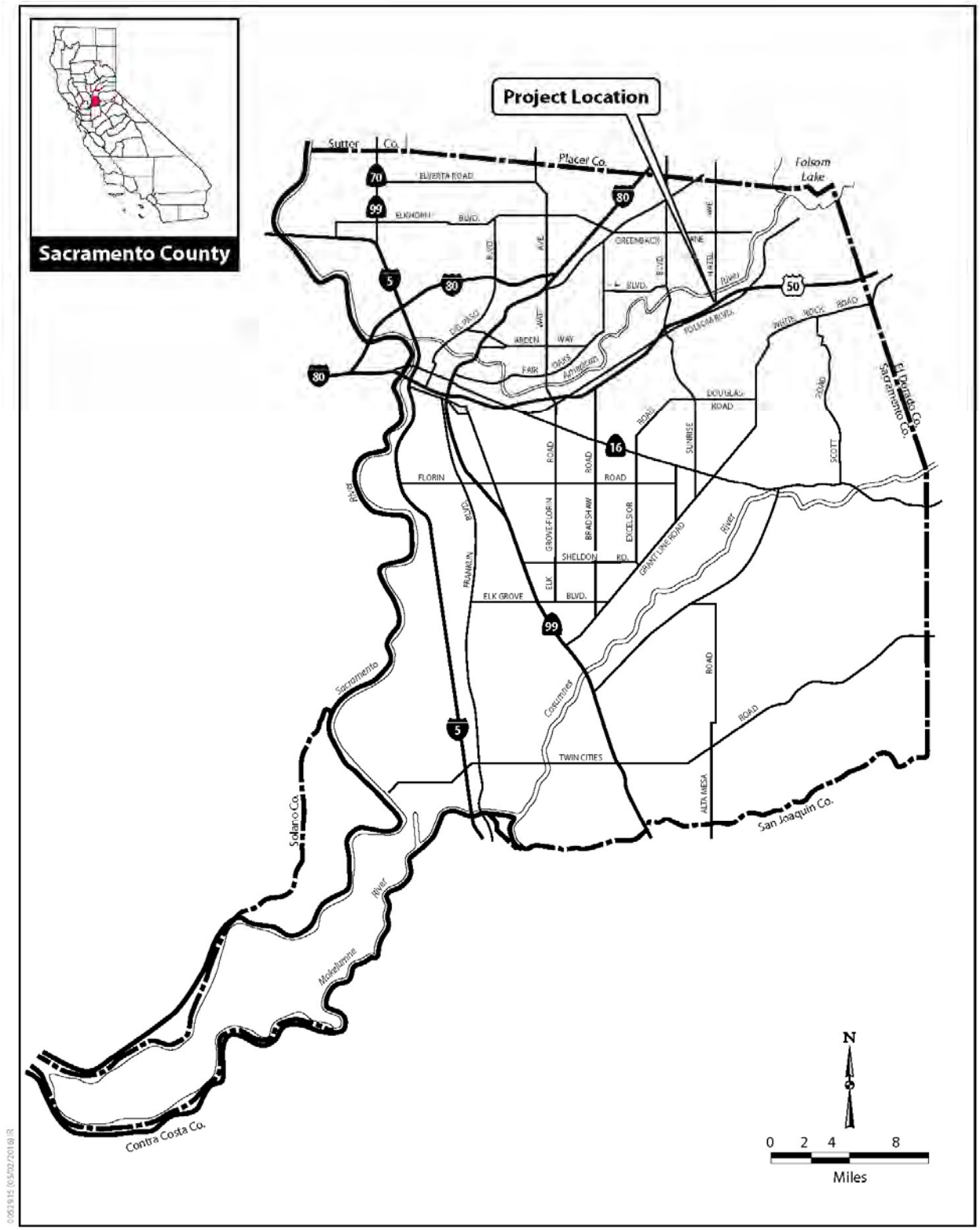


Figure 1-1. Project Vicinity Map

Source: ICF International

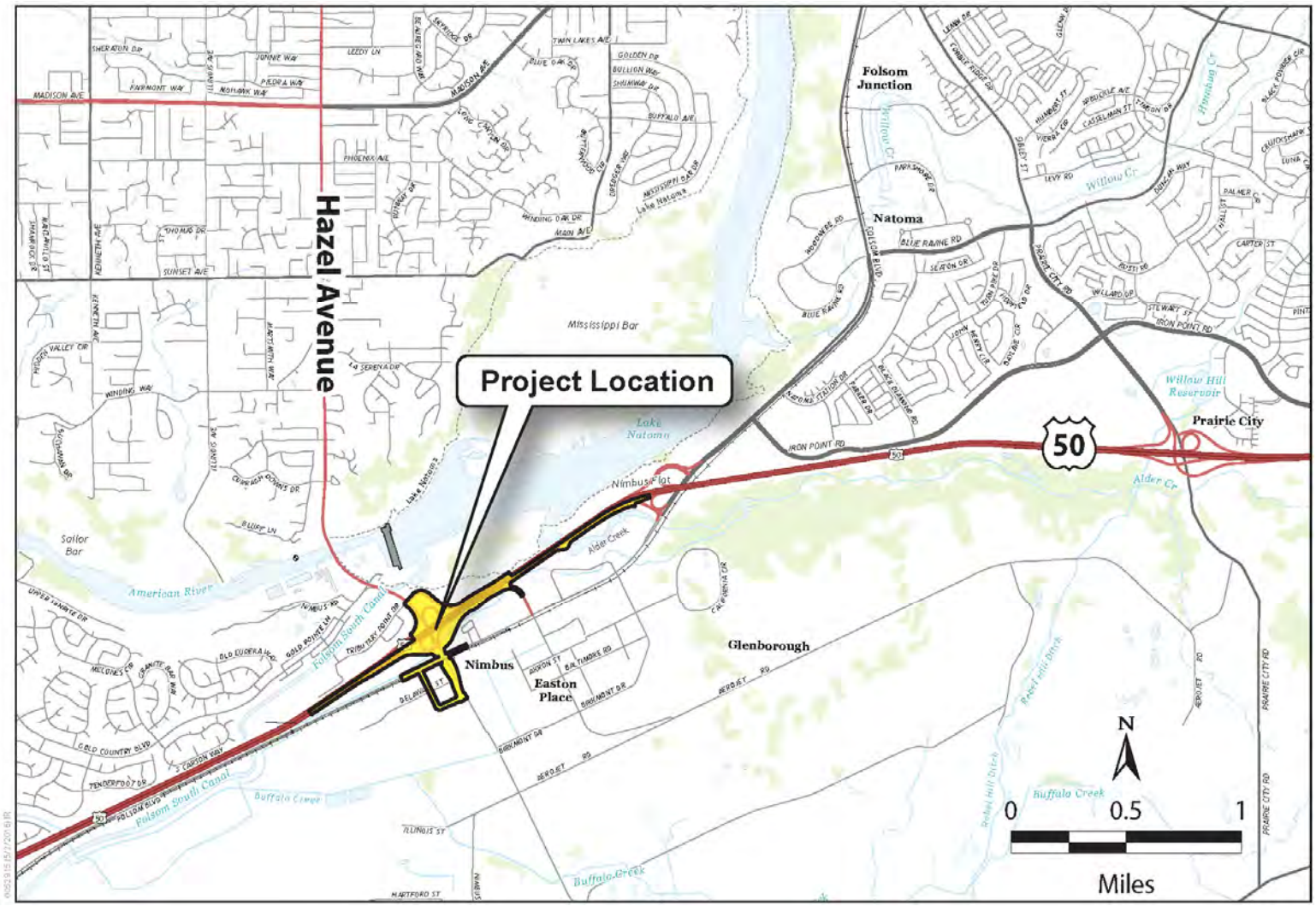


Figure 1-2. Project Location Map

Source: ICF International

- Proposed alternatives accomplish this by widening and/or lengthening the on/off-ramps and Hazel Avenue as required by their respective traffic analysis.

- Maintain the Aerojet Road off-ramp connection to the approved development while improving the mainline operations.
  - Proposed alternatives accomplish this by removing the Aerojet Road exit from U.S. 50 but still providing direct access to Aerojet Road through the eastbound Hazel Avenue off-ramp.

1.2 Project Need

The Project is needed to relieve existing congestion at the interchange and to accommodate planned and approved developments identified by the adopted Sacramento County General Plan and the Sacramento Area Council of Government's (SACOG) Regional Transportation Plan.

The approved developments within and near the Project area will increase traffic demand beyond what the existing interchange can accommodate. The close intersection spacing between Folsom Boulevard and the eastbound ramp intersections does not provide sufficient queuing for increased traffic volumes. Additionally, the County is currently widening Hazel Avenue from the interchange to Madison Avenue from four to six traffic lanes. This increase in roadway capacity is expected to deliver more traffic to the interchange during peak traffic periods.

Traffic demand forecasts for this Project were conducted using the SACOG 2035 Metropolitan Transportation Plan (MTP) projected to 2038 (20 years after anticipated opening day) and supplemented by anticipated levels of additional development currently in application or advanced planning stages. Based on these projections, it is anticipated the existing interchange will degrade to Level of Service (LOS) "F."

1.3 Project Description

The proposed Project would construct modifications to the existing interchange, and grade-separate and extend Hazel Avenue to the south to a future intersection with Atlanta Street, which will be built with the approved Easton Place development. Two alternatives, with one sub-alternative, have been developed for the Project.

The following is a description of elements and design components that are common to all alternatives:

1.3.1 Roadway Modifications

- Construction of a portion of an eastbound transition auxiliary lane on U.S. 50 from Hazel Avenue through the Folsom Boulevard overcrossing, also known as the Natoma Overhead.
- The modification of the existing Aerojet Road off-ramp from U.S. 50.
- The westbound loop on-ramp will be reconstructed, with the ramp intersection shifted north towards the westbound off-ramp terminus, increasing storage lengths. The ramp

will be metered with two lanes (one mixed use, and one high-occupancy vehicle [HOV] bypass), and a squared-up "pedestrian friendly entrance."

- Reconstruction of the eastbound diagonal off-ramp to conform with the new Hazel Avenue profile and accommodate the Aerojet Road ramp divergence.
- The eastbound diagonal on-ramp will be reconstructed to conform with the new Hazel Avenue profile, and will be metered with two lanes; one mixed flow, and one HOV bypass.
- The eastbound loop on-ramp will be reconstructed to conform with the new Hazel Avenue profile and will be metered with two lanes; one mixed flow, and one HOV bypass. A tie-back wall at the abutment of the overcrossing is proposed to maximize the opening through the structure. The loop ramp will develop an additional lane on U.S. 50 that will continue on to the Folsom Boulevard interchange.
- Construction of eastbound on- and off-ramp auxiliary lanes on U.S. 50, from west of Hazel Avenue to the eastbound off-ramp, and from the loop on-ramp extending to the Folsom Boulevard interchange.
- Traffic signals at the ramp intersections will be modified. Safety lighting will be installed. A new signalized intersection and at-grade railroad crossing will be constructed for the Jughandle.
- Pedestrian access will be maintained on the east side of Hazel Avenue with 6-foot (ft) sidewalks (however the existing sidewalk on the overcrossing will remain 5 ft wide). Bicyclists may utilize the County standard 7-ft shoulders. It is expected that pedestrians and bicyclists will continue to use the nearby Bikeway and Pedestrian Overcrossing as the primary means for crossing U.S. 50.
- Roadway improvements constructed along approximately 2,300 ft of Folsom Boulevard. Improvements include the removal of the existing signalized intersection with Hazel Avenue, and installation of sidewalks, street lighting, and landscaping along the north side of Folsom Boulevard, and landscaping and lighting along the south.

1.3.2 Transition Lane to U.S. 50/Folsom Boulevard Interchange

As indicated in Caltrans' 2009 Corridor System Management Plan, eastbound U.S. 50 is shown to have one HOV lane and three mixed-flow lanes to Hazel Avenue as the Concept Facility. Also, eastbound U.S. 50 is shown to have one HOV lane and three mixed-flow lanes across Folsom Boulevard as the Ultimate Facility. This Project will accommodate these future facility improvements, will conform to the approved Caltrans project at the U.S. 50/Folsom Boulevard interchange (a portion of which is to be constructed in 2016), and will then restripe the third mixed-flow lane through the U.S. 50/Folsom Boulevard interchange.

It has been determined in the traffic analysis for this Project, and in studies for adjacent projects that this Project is required to add the mixed-flow lane, because, that the additional eastbound lane on U.S. 50 extending through the Folsom Boulevard interchange is needed for operations.

Under all alternatives, accommodating this mixed-flow lane will require the eastbound loop on-ramp to extend its auxiliary lane to the U.S. 50/Folsom Boulevard eastbound off-ramp. This will require widening and a new structure over Alder Creek.

To widen U.S. 50 over Alder Creek, a new bridge will be required. Currently Alder Creek flows under U.S. 50 through a box culvert (Bridge No. 24-0033). A mechanically stabilized earth (MSE) wall (Bridge No. 24-0372) is above the culvert. The new bridge is necessary because there is insufficient lateral space to construct an adjacent MSE wall on top of the culvert and the creek maintains a high operating water level.

1.3.3 Railroad Overhead

Hazel Avenue will extend and be grade-separated over Folsom Boulevard and the SPTC-JPA rail corridor. Currently there is one light rail track located on the north side of the Union Pacific Railroad (UPRR) tracks. Sacramento Regional Transit plans to add another track at this location in the future. When the addition of that track occurs, the existing UPRR track will be relocated south to accommodate the second light rail track. The proposed design meets the requirements for all three tracks, with the clearances shown in Figure 1-3.

Temporary vertical clearances of 21-ft-6-in. and permanent vertical clearances of 24 ft have been accounted for in the layout of all three alternatives for the Hazel Avenue Overhead. The vertical clearance provided will accommodate the Overhead Catenary System for the light rail.

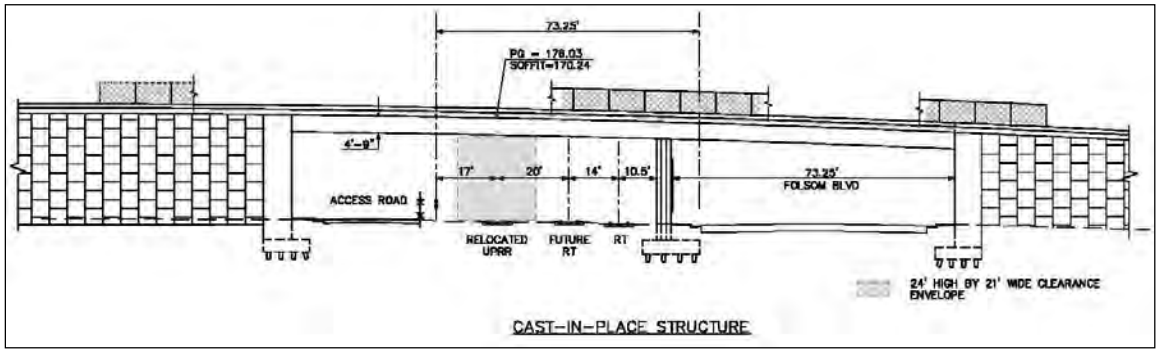


Figure 1-3. Railroad Overhead Schematic

Source: ICF International/Mark Thomas and Company

1.3.4 Build Alternative 1: L-9 Interchange with Viaduct Connector

Alternative 1 consists of a modified type L-9 interchange configuration. A Caltrans Type L-9 interchange indicates a ramp configuration that includes a diagonal off-ramp, a diagonal on-ramp, and a loop on-ramp, as shown in Figure 1-4. This alternative will provide a viaduct connection to Aerojet Road.

As with all alternatives, Hazel Avenue will grade-separate over Folsom Boulevard and the SPTC-JPA rail corridor and will extend further south to a proposed intersection with the future Atlanta Street (a new roadway as part of the Easton Place development). The existing at-grade intersection of Hazel Avenue and Folsom Boulevard will be removed, sidewalks will be extended across the former intersection, and the lanes will be re-striped to remove left turn lanes.

The location of the departure point of the existing Aerojet Road off-ramp from U.S. 50 will be moved to join with the eastbound Hazel Avenue off-ramp. The eastbound Hazel Avenue off-ramp will split and introduce a direct viaduct ramp over Hazel Avenue to carry eastbound off-

ramp traffic to Aerojet Road and Folsom Boulevard. The off-ramp diverge from U.S. 50 will be shifted approximately 830 ft to the east to provide decision sight distance before the Aerojet Road split. The two-lane off-ramp will widen to five lanes at the ramp terminal intersection, with three left turn lanes and two right turn lanes. Retaining walls and barriers placed at the proposed right-of-way will minimize acquisition. The eastbound off-ramp will also have an auxiliary lane prior to the exit.

The Aerojet Road viaduct will land adjacent to the eastbound diagonal on-ramp and then turn southerly to conform to Folsom Boulevard along its existing alignment. Retaining walls are proposed between the viaduct and the diagonal on-ramp to accommodate the grade difference, and to the outside of the ramp after the viaduct lands, to minimize right-of-way acquisitions. Retaining walls are also proposed along Aerojet Road as it approaches the horizontal curve towards Folsom Boulevard to accommodate the grade difference between the ramp and mainline and to minimize right-of-way acquisition.

The existing Hazel Avenue Overcrossing of U.S. 50 will be widened on the west side to accommodate eight lanes (three through-lanes and one freeway-only lane in both directions). The existing raised concrete median across the structure will be removed, and the roadway will be re-striped with a 6-ft striped median. The existing sidewalk and barrier on the east side of the structure will remain.

1.3.5 Alternative 1A: L-9 Interchange with Undercrossing Connector

Alternative 1A is the same as Alternative 1, with the following exceptions:

The eastbound off-ramp will split and introduce a direct tunnel ramp under Hazel Avenue to carry eastbound off-ramp traffic to Aerojet Road and Folsom Boulevard, as shown in Figure 1-5.

1.3.6 Alternative 2: Direct Flyover to Hazel Avenue with Connector

Alternative 2 consists of a modified type L-9 interchange configuration, with a flyover ramp carrying vehicles travelling from eastbound U.S. 50 to northbound Hazel Avenue over the freeway to join with the westbound off-ramp, as shown in Figure 1-6.

The existing Aerojet Road off-ramp from U.S. 50 will be removed. The eastbound off-ramp diverge from U.S. 50 will be shifted approximately 680 ft to the east to provide decision sight distance. An auxiliary lane will precede the off-ramp. A retaining wall is proposed adjacent to the off-ramp to minimize right-of-way acquisition.
The eastbound off-ramp will split and introduce northbound and southbound Hazel Avenue ramps. The northbound ramp will also carry traffic headed for Aerojet Road/Folsom Boulevard. An overhead sign will direct vehicles heading to southbound Hazel Avenue to the right lane, and vehicles destined for northbound Hazel Avenue, Aerojet Road or Folsom Boulevard to use either lane. Retaining walls are proposed for the ramp as it approaches the horizontal curve towards Folsom Boulevard to accommodate the grade difference between the ramp and mainline and to minimize right-of-way acquisition at an apartment complex.

The northbound Hazel Avenue movement will cross under Hazel Avenue at the interchange, cross over U.S. 50 on a two-lane flyover structure, and then merge with the westbound off-ramp and terminate at the Hazel Avenue/Tributary Point intersection. The westbound off-ramp will split so that the southbound and through movements align to the left of the ramp, and the northbound movements are to the right.

The southbound ramp will connect directly to Hazel Avenue. However, in Alternative 2 an intersection is not required at Hazel Avenue and the eastbound ramp. By eliminating an intersection at the eastbound ramp, and by removing the heavy eastbound-to-northbound movements from the Hazel Avenue overcrossing, the existing structure can remain without widening.

The two-lane westbound off-ramp will be reconstructed to provide decision sight distance between the divergence point from U.S. 50 and a new ramp split that accommodates the flyover. The westbound off-ramp will split on either side of the flyover ramp, with one lane to the right carrying northbound Hazel Avenue traffic and the other crossing underneath the flyover ramp to join up on the left side of the flyover for the southbound Hazel Avenue movements. The profiles of the three ramps have been coordinated to match grade quickly to minimize retaining wall limits and enhance driver visibility. Overhead signage will direct drivers into the appropriate lanes for northbound and southbound Hazel Avenue traffic.

1.3.7 No-Build Alternative

Alternative 3, the No-Build Alternative, would not modify the U.S. 50/Hazel Avenue interchange. The interchange would remain with the same existing configuration, ramps, and lanes. This alternative does not meet the purpose and need of the Project.



Figure 1-4. Alternative 1: L-9 Interchange with Viaduct Connector

Source: ICF International



Figure 1-5. Alternative 1a: L-9 Interchange with Undercrossing Connector

Source: ICF International



Figure 1-6. Alternative 2: Direct Flyover to Hazel Avenue with Connector

Source: ICF International

1.4 Regulatory Setting

1.4.1 Executive Order 11988 (Floodplain Management, 1977)

Executive Order 11988 (Floodplain Management) directs all federal agencies to avoid, to the extent possible, long- and short-term adverse impacts associated with the occupancy and modification of floodplains, and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. Requirements for compliance are outlined in Title 23, Code of Federal Regulations, Part 650, Subpart A (23 CFR 650A) titled "Location and Hydraulic Design of Encroachment on Floodplains."

If the preferred alternative involves significant encroachment onto the floodplain, the final environmental document (final environmental impact statement or finding of no significant impact) must include:

- The reasons why the proposed action must be located in the floodplain,
- The alternatives considered and why they were not practicable, and
- A statement indicating whether the action conforms to applicable state or local floodplain protection standards.

1.4.2 Executive Order 13690 (Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input)

The Federal Flood Risk Management Standard (FFRMS) is the national flood risk management standard established by Executive Order 13690 to be incorporated into existing processes used to implement Executive Order 11988. Executive Order 13690 amends "Executive Order 11988, Floodplain Management," and directs all federal agencies to avoid conducting, allowing, or supporting construction in the base floodplain. The executive order also directs federal agencies to take action to reduce the risk of flood loss, minimize the impact of floods on human safety, health, and welfare, and restore and preserve the natural and beneficial values served by the floodplain. The floodplain elevation and flood hazard area should be the result of using a climate-informed science approach.

The FFRMS requires all future federal investments in and affecting floodplains to meet the level of resilience as established by the Executive Order 13690. The vertical flood elevation and corresponding horizontal floodplain determined using the approaches in the FFRMS establish the level to which a structure or facility must be resilient. This may include using structural or nonstructural methods to reduce or prevent damage; elevating a structure; or, where appropriate, designing it to adapt to, withstand and rapidly recover from a flood event. The implementation of the Executive Order 13690 for floodplains gives agencies the flexibility to select one of the following approaches for establishing the flood elevation and hazard area used in siting, design, and construction:

- Use data and methods informed by best-available actionable hydrologic and hydraulic data and methods that integrate current and future changes in flooding based on climate-informed science;
- Build two feet above the 100-year (1%-annual-chance) flood elevation for standard non-critical projects, and three feet above the 100-year flood elevation for critical projects such as hospitals and evacuation centers;
- Build to the 500-year (0.2%-annual-chance) flood elevation; or
- Build to an elevation and flood hazard area that results from using any other method identified in an update to the FFRMS.

Executive Order 13690 is not a self-implementing requirement. Both the U.S. Department of Transportation (DOT) and the Federal Highway Administration (FHWA) have to take actions to update their procedures before they apply to FHWA projects. The U.S. DOT has been working on an implementation plan to comply with the Executive Order 13690. However, no FHWA programs should deviate from the existing requirements (23 CFR 650A) until promulgation of any new/revised regulation, policies, and guidance for compliance with the Executive Order 13690.

Therefore, the Project will continue to be compliant with FHWA regulations contained in 23 CFR 650A, Location and Hydraulic Design of Encroachments on Flood Plains. These regulations are FHWA's current method for implementing the Executive Order 11988, which relates to Floodplain Management.

1.4.3 California's National Flood Insurance Program

The Federal Emergency Management Agency (FEMA) is the nationwide administrator of the National Flood Insurance Program (NFIP), which is a program that was established by the National Flood Insurance Act of 1968 to protect lives and property, and to reduce the financial burden of providing disaster assistance. Under the NFIP, FEMA has the lead responsibility for flood hazard assessment and mitigation, and it offers federally backed flood insurance to homeowners, renters, and business owners in communities that choose to participate in the program. FEMA has adopted the 100-year floodplain as the base flood standard for the NFIP. FEMA is also concerned with construction that would be within a 500-year floodplain for proposed projects that are considered "critical actions," which are defined as any activities where even a slight chance of flooding is too great. FEMA issues the Flood Insurance Rate Maps (FIRMs) for communities that participate in the NFIP. These FIRMs present delineations of flood hazard zones.

In California, nearly all of the State's flood-prone communities participate in the NFIP, which is locally administered by the California Department of Water Resources' (DWR) Division of Flood Management. Under California's NFIP, communities have a mutual agreement with the State and Federal government to regulate floodplain development according to certain criteria and standards, which is further detailed in the NFIP.

1.4.4 Sacramento County Floodplain Data

The Sacramento County Flood Insurance Study (FIS), covering Sacramento County and incorporated areas, is used to locally develop FIRMs and base flood elevations (BFEs). The effective FIS for Sacramento County is dated June 16, 2015. The FIRM used to evaluate the Project impacts on the floodplain was Map Number 06067C0114H, which has an effective date of August 16, 2012. The FIRMs can be found in Appendix A and the FIS flood profiles, which show the BFEs, can be found in Appendix B.

1.5 Design Standards

1.5.1 FEMA Standards

FEMA standards are employed for design, construction, and regulation to reduce flood loss and to protect resources. Two types of standards are often employed: design criteria and performance standards.

A design criteria or specified standard dictates that a provision, practice, requirement, or limit be met; e.g., using the 1% annual chance flood (100-year recurrence interval) and establishing floodway boundaries so as not to cause more than a 1-ft increase in flood stages.

A performance standard dictates that a goal is to be achieved, leaving it to the individual application as to how to achieve the goal; e.g., providing protection to the regulatory flood, keeping post-development stormwater runoff the same as pre-development, or maintaining the present quantity and quality of water in a wetland.

The 1% annual chance flood and floodplain have been adopted as a common design and regulatory standard in the United States. The NFIP adopted it in the early 1970s, and it was adopted as a standard for use by all federal agencies with the issuance of Executive Order 11988. States or local agencies are free to impose a more stringent standard within their jurisdiction.

1.5.2 FHWA Standards

FHWA criterion refers to the California Amendments to American Association of State Highway and Transportation Officials (AASHTO) Load and Resistance Factor Design (LRFD) Bridge Design Specifications (2014), which indicates that the proposed bridge profile should provide adequate freeboard to pass anticipated drift for the 50-year design flood, to pass the 100-year base flood without freeboard, or the flood of record without freeboard, whichever is greater.

1.5.3 Caltrans Standards

The Caltrans criteria for the hydraulic design of bridges is that they be designed to pass the 2% probability of annual exceedance flow (50-year design discharge) or the flood of record, whichever is greater, with adequate freeboard to pass anticipated drift. Two (2) feet of freeboard for the 50-year flow is commonly used in bridge designs. The bridge should also be designed to pass the 1% probability of annual exceedance flow (100-year design discharge, or base flood). No freeboard is added to the base flood.

1.6 Creek, Stream, and River Crossings

Alder Creek is the only surface water to cross the Project; the creek crosses U.S. 50 at post mile 16.46 via a bridge structure (Bridge No. 24-0033).

Alder Creek and areas east of the Hazel Avenue interchange drain northerly towards Lake Natoma, which roughly parallels U.S. 50 from the eastern extent of the Project to the Nimbus Dam. The hydroelectric dam impounds the American River to create the Lake Natoma reservoir and discharges water into both the American River and Folsom South Canal. The canal roughly parallels U.S. 50 to the north. Surface runoff from the Project west of the Hazel Avenue interchange drains northerly towards the canal. The canal crosses U.S. 50 outside the limits of the Project at post mile 14.80.

1.7 Bridge Numbers

The culvert which conveys Alder Creek under U.S. 50 is Bridge No. 24-0033. The bridge that passes U.S. 50 over Folsom South Canal is Bridge No. 24-0339.

1.8 Traffic

The average daily traffic (ADT) through the Project area along U.S. 50 was estimated in 2009 as 105,000 vehicles, 6% of those being trucks. Caltrans predicts that the ADT will increase to 195,000 by the year 2030. The estimated detour length around the bridge is 5 kilometers (km) (Caltrans 2013). During a 100-year flood event on the American River, the detour length would increase to nearly 10 miles and motorists would need to take Folsom Boulevard north (to avoid the flooding on Folsom Boulevard south of U.S. 50) and eventually over Lake Natoma and then take Greenback Lane and Madison Avenue south to get back to Hazel Avenue (see Figure 1-7).

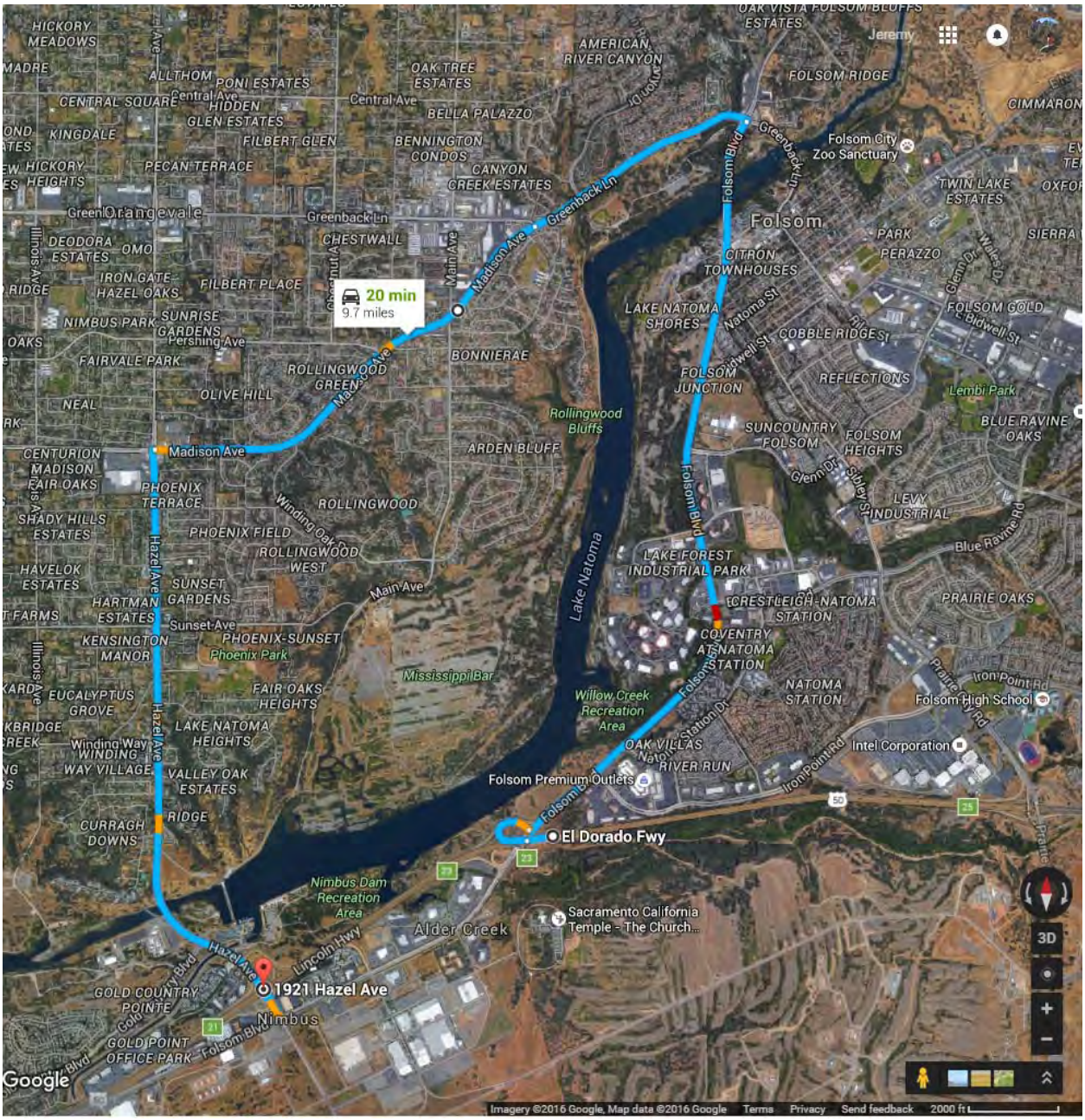


Figure 1-7. Detour Route for Base Flood at U.S. 50 and Lake Natoma

Source: Google Earth

1.9 Vertical Datum

The Project references the North American Vertical Datum of 1988 (NAVD 88). Elevations in this document reference the NAVD 88 datum unless otherwise specified.

2 AFFECTED ENVIRONMENT

2.1 Geographic Location

The Project is located within City of Rancho Cordova and unincorporated areas of Sacramento County. The area studied for this report includes the Project limits and nearby areas as appropriate, including the Hazel Avenue interchange, U.S. 50 at and surrounding the interchange, and local area streets that connect to Hazel Avenue where improvements are proposed to conform to the proposed Hazel Avenue (Figure 1-1 and Figure 1-2).

2.2 Watershed Description

The Alder Creek watershed is located at the eastern edge of the Sacramento Valley, before the Sierra Nevada Mountains, and generally slopes from east to west, roughly following the alignment of U.S. 50. The creek has a watershed area of approximately 11 square miles and flows into the American River just upstream of Nimbus Dam, see Figure 2-1.

As part of this Location Hydraulic Study, a review was performed of prior studies documenting the Alder Creek watershed, including the Alder Creek Watershed Management Action Plan (WMAP), which was completed in 2010 by AECOM for the City of Folsom with grant funding from the CALFED Bay-Delta Program. As part of the WMAP, the lower extent of Alder Creek was characterized by Northwest Hydraulic Consultants (NHC, 2009) as such:

> *The mouth of Alder Creek was inundated following the completion of Lake Natoma in 1955, forming Alder Creek pond (the pond). The pond is located at the downstream terminus of Alder Creek, between Folsom Blvd. and Highway 50. Alder Creek flows into the pond downstream of culverts beneath Folsom Blvd and to Lake Natoma through culverts beneath Highway 50. The pond ranges from about 5 to 10 acres in size, depending on water surface elevations in Lake Natoma, operated by the Bureau of Reclamation as an afterbay for Folsom Reservoir. (NHC, 2009)*

Additionally, there is an existing dam located on Alder Creek approximately 2,000 ft upstream of Folsom Boulevard, which is currently owned by the City of Folsom. The Alder Creek Miners Dam was built in about 1908-1910 as part of the gold-mining activities that historically occurred in the area (AMEC, 2011). Estimated to be about 25 ft high, based on a 1911 drawing, the dam also provides a base level control and creates a backwater area, Alder Reservoir, which extends upstream approximately 1,500 ft during base flow conditions (AECOM, 2010).

The Caltrans "Water Quality Planning Tool" identifies the Project area as being in the Calwater watershed of Lower American hydrologic sub-area (HSA #519.21) of the Valley-American hydrologic unit and Coon-American hydrologic area. The tool also identifies the Project area as being within the United States Geological Survey (USGS) Watershed Boundary Dataset of the Upper American River sub-watershed of the American River watershed.

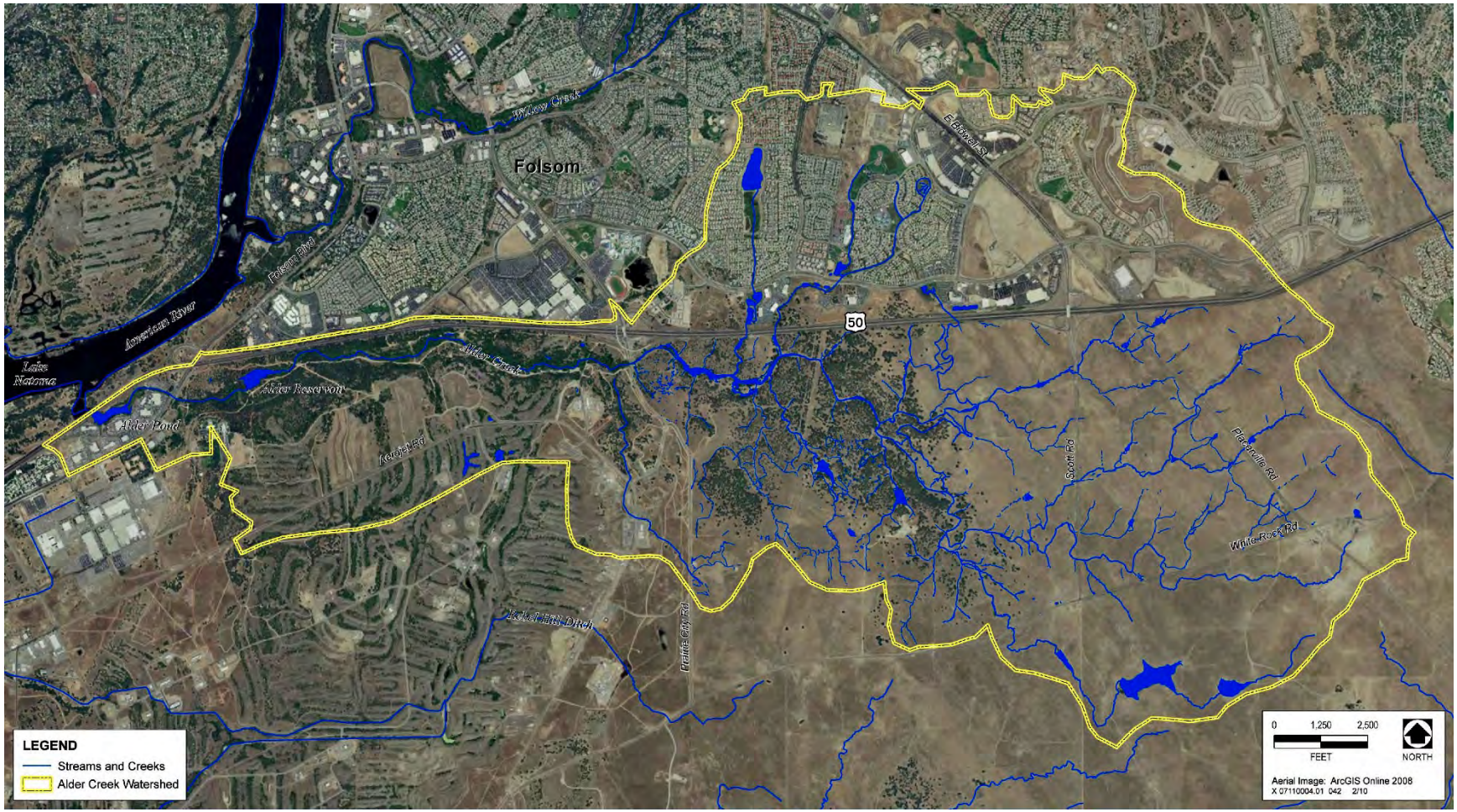


Figure 2-1. Alder Creek Watershed Boundary

Source: AECOM, 2010

2.3 Effective FEMA Floodplains

The Project extends through the FEMA FIRMs 06067C0113H and 06067C0114H. The FIRMs identify the northeastern portion of the westbound U.S. 50 off-ramp to Hazel Avenue as within a shaded Zone X area associated with Lake Natoma. The maps also identify U.S. 50 at and east of the Alder Creek crossing as within Zone AE and shaded Zone X areas associated with Alder Creek. The remainder of the Project is not located within a FEMA floodplain. The effective FIRMS are included in Appendix A.

Shaded Zone X areas are classified as areas of: 0.2% annual chance flood (500-year floodplain), 1% annual chance flood (100-year floodplain) with average depths of less than 1 ft or with drainage areas less than 1 square mile, and/or protected by levees from 1% annual chance flood. Zone AE areas are floodway areas subject to inundation by the 1% annual chance flood where BFEs have been determined. The base flood elevation for the Zone AE associated with Alder Creek is +128 ft NAVD 88.

The Project site is also within a regulatory floodway. According to Title 44, Section 60.3(d)(3) of the CFR, a community shall "prohibit encroachments, including fill, new construction, substantial improvements, and other development within the adopted regulatory floodway unless it has been demonstrated through hydrologic and hydraulic analyses performed in accordance with standard engineering practice that the proposed encroachment would not result in any increase in flood levels within the community during the occurrence of the base flood discharge."

2.4 Future FEMA Floodplains: Physical Map Revision

Flood hazard maps are revised by FEMA by one of two methods: Letter of Map Revision (LOMR) or Physical Map Revision (PMR). FEMA makes the determination to process a map revision as either a LOMR or PMR, which is generally determined based on the scope of revision.

A LOMR is an official letter issued to communities by FEMA that revises the effective data on the FIRM and/or FIS. A LOMR does not re-issue the FIRM panel or FIS because physical revisions on the map are not made. LOMRs are typically intended for small coverage areas. Published FIRMs, FIS, and any LOMRs establish the effective data for a community.

A PMR re-issues a FIRM or FIS. Revisions that affect more than a full FIRM panel are generally processed as a PMR. A PMR is used to change flood risk zones, floodplain and floodway delineations, and flood elevations. A PMR is generally a more involved process than a LOMR and includes a community comment period. FEMA issues a 316-PMR letter stating that a study, or revision, has been approved, and will be mapped at a future date.

A LOMR application (Case No. 14-09-2228P) was submitted September 15, 2015 for a portion of Alder Creek in Sacramento County, which affected FIRM Panels 06067C0114H, 06067C0118H, and 06067C0119H. The LOMR affected the communities of the City of Folsom and Sacramento County.

FEMA reviewed the LOMR application and determined that the map revision should be revised as a PMR. A 316-PMR letter was issued on February 19, 2016 by FEMA in response to the LOMR application. The 316-PMR letter indicated that the FEMA Region IX Office programmed funds as part of the Fiscal Year 2017 to process the PMR.

Supporting hydrologic and hydraulic data for the LOMR/PMR has been reviewed and approved by FEMA. This particular PMR is part of a two-phase study, and the second phase of the study is on-going and anticipated to be complete by the end of the 2016 calendar year. The physical revisions to the FIRMs and FIS will not be realized for at least two years after the inception of the PMR.

The Alder Creek LOMR study references the National Geodetic Vertical Datum of 1929 (NGVD 29) while the Project references the NAVD 88 vertical datum. Based on the latitude and longitude at the U.S. 50, the conversion from NGVD 29 to NAVD 88 is +2.51 ft (National Oceanic and Atmospheric Administration [NOAA] Vertcon 2013). The effective FIRM (dated August 16, 2012 for Panel 06067C0114H) shows a BFE of +128 ft NAVD 88 at the U.S. 50 crossing of Alder Creek, which is +125.5 ft NGVD 29.

WRECO obtained the supporting HEC-RAS model from the FEMA Data Library. The HEC-RAS model that was developed in support of the LOMR for Alder Creek shows a water surface elevation of +132.9 ft NGVD 29 (+135.4 ft NAVD 88) just upstream of the U.S. 50 crossing and +125.9 ft NGVD 29 (+128.4 ft NAVD 88) just downstream of the U.S. 50 crossing. The U.S. 50 crossing is modeled as a double 10-ft-by-10-ft reinforced concrete box (RCB) culvert. The modeling shows water surface elevations that are higher than the effective FIRM BFE: 7.4 ft higher upstream of U.S. 50 and no change downstream of U.S. 50 (the FIRM shows an elevation of +128 ft NAVD 88, and the FIS flood profile shows an elevation of +128.4 ft NAVD 88). The HEC-RAS model shows that U.S. 50 is overtopped during a 100-year storm event.

3 HYDROLOGY AND HYDRAULICS

The hydrologic and hydraulic assessment of the Project site as it pertains to the evaluation of the major source of flooding at the Project site was limited to a review of the FEMA FIS and FIRMs of the Project area, along with prior studies of the Alder Creek watershed. The creek flows into Lake Natoma, which is a federally operated reservoir created by Nimbus Dam. The backwater condition created by the dam is responsible for both Lake Natoma on the American River and the Alder Creek pond at the mouth of Alder Creek. This impoundment restricts flow and greatly reduces velocities in the FEMA floodway in Lake Natoma and along Alder Creek through the Project area. In addition to Nimbus Dam, the Alder Creek Miners Dam just upstream of Folsom Avenue also acts to control high flows on lower Alder Creek. Because of these hydraulic control structures, the FEMA BFE in Lake Natoma and Alder Creek pond represents a static backwater condition with relatively low velocities during flooding.

3.1 Hydrologic Assessment

FEMA performed a hydrologic assessment of the American River in the Project area by updating an existing peak-flow frequency curve to include 1986 flow data. The base flood was routed through Folsom Dam, resulting in a 1-percent annual chance peak flow, and based on dam operation rules for reservoir releases, the flow was estimated to be 180,000 cubic ft per second (cfs). The 1-percent annual peak flow for the Alder Creek watershed was estimated to be approximately 4,400 cfs (NHC 2009).

3.2 Hydraulic Assessment

3.2.1 Based on Effective FEMA Floodplains

FEMA also performed a hydraulic analysis of the American River for the 1% annual chance flood. Controlled releases from Nimbus Dam and flow over the dam spillway determined the BFEs in Lake Natoma. FEMA has estimated these as being +128.4 ft (normal flood stage pool elevation) extending from Nimbus Dam upstream past the Willow Creek confluence.

At the Project site, Alder Creek flows under U.S. 50 through a 228-ft-long double 10-ft-by-10-ft RCB culvert and into Lake Natoma (Caltrans 2013). The approximate invert elevation of the RCB inlet is +103 ft. The RCB elevation creates a submerged condition because the normal operational level of Lake Natoma is between +122.0 ft and +125.0 ft. The Alder Creek crossing at U.S. 50 was assessed as part of the WMAP by Northwest Hydraulic Consultants. The culvert condition was described as:

> *The twin box culverts (10'x10' barrels) underneath Folsom Boulevard do not appear to be affected by sediment deposition; however minor blockage by debris during high flow events may occur. Field inspections completed on this portion of the creek indicate no evidence of any significant scour or deposition of sediment in the vicinity of the culvert. (NHC, 2009)*

The +128.4-ft BFE of Lake Natoma extends into the Alder Creek waterway upstream of U.S. 50 to a foot bridge on the Folsom Automall property, just downstream of the Folsom Boulevard

crossing. A planning study detailing the Alder Pond Bridge for the auxiliary lane extension can be seen in Appendix C.

The proposed Alder Pond Bridge for the auxiliary lane extension will be a pile-supported structure. However, the existing box culverts on Alder Creek at U.S. 50 were widened by Caltrans in 1954 by 95 ft on the west side and 25 ft on the east side on the highway (Caltrans 2008), and the proposed Project will not alter or effect the existing box culverts. The Caltrans as-built details for the box culverts is included for reference in Appendix D. The soffit elevation of the slab of the auxiliary lane extension, elevation 128.9 ft, is 0.5 ft above the BFE of 128.4 ft. Therefore, the only change being proposed to the FEMA floodway for Alder Creek at U.S. 50 is the addition of the piles to support the new auxiliary lane bridge on the east side of the highway.

Due to the hydraulic control structures on both Alder Creek and the American River, with the FEMA BFE in Lake Natoma and Alder Creek pond representing a static backwater condition, it was evident that a hydraulic modeling approach to assessing the Project's potential effects on the floodplain would not be appropriate. Therefore, the approach of this study to assessing the proposed Project was to compare the relative volume of fill associated with the proposed pilings to the flood storage volume of Lake Natoma and Alder Creek pond. The surface area for the region of Lake Natoma and Alder Creek pond, which is shown on the FEMA FIRM as representing the BFE of +128 ft, was calculated to be 365 acres. The area of Alder Creek pond upstream of the U.S. 50 cross culvert, accounts for approximately 9.4 acres of the total area. The planning study details for the Alder Pond Bridge show the auxiliary lane extension as being supported by 10 piles with 18 in. diameters. The footprint of the auxiliary lane extension accounts for approximately 4,000 sq. ft of encroachment within the FEMA floodway/floodplain. This encroachment represents approximately 0.98% (less than 1%) into the existing area of the Alder Creek pond floodway/floodplain upstream of the U.S. 50 cross culvert. Therefore, the proposed fill associated with the piles was considered to represent no significant impact to the floodway/floodplain as a result of the Project.

3.2.2 Based on Future FEMA Floodplains: Physical Map Revision

A 316-PMR letter was issued by FEMA, which indicated that the FEMA Region IX Office programmed funds as part of the Fiscal Year 2017 to process the PMR. Supporting hydrologic and hydraulic data for the LOMR/PMR has been reviewed and approved by FEMA. This particular PMR is part of a two-phase study. The physical revisions to the FIRMs and FIS will not be realized for at least two years after the inception of the PMR. Although the physical revisions to the FIRMs and FIS have not yet been incorporated as effective data, the revisions will ultimately be incorporated. As such, potential impacts to the floodplains based on the LOMR/PMR HEC-RAS model were also assessed.

The planning study for the Alder Pond Bridge (included in Appendix C) shows a proposed pile-supported structure with the auxiliary lane extension along the upstream (east) side of the existing U.S. 50 bridge. The piles would support the cast-in-place/reinforced concrete (CIP/RC) slab superstructure, which would be 10 ft, 9 in. wide. With a 31° skew, the widening in the flow direction would be approximately 12.5 ft. The planning study details show that the widening

would be within the limits of the existing culvert on the upstream (east) side and the piles would flank the culvert on either side (towards the north and south). The existing culvert would remain.

The Caltrans as-built details for the existing box culverts under U.S. 50 (included in Appendix D) show that the existing culvert is longer than the existing roadway. The culvert projects from fill at a 2.5:1 (horizontal to vertical) slope with flared wingwalls.

In the LOMR/PMR HEC-RAS model, the existing U.S. 50 bridge is defined with the roadway length (in the flow direction) equivalent to the culvert length (in the flow direction). The significance of this modeling approach is that the roadway section and fill is represented to extend along the full length of the culvert (when in actuality, it does not). Because the proposed improvements would be within the limits of the existing culvert, the LOMR/PMR HEC-RAS model already accounts for the proposed fill that would result from the new piles and CIP/RC slab improvements associated with the auxiliary lane extension at the Alder Creek Pond. The Project improvements at the Alder Creek Pond bridge would therefore not result in any increases to the 100-year flood water surface elevation.

In the LOMR/PMR HEC-RAS model, the cross section at the location where the widening would occur is just upstream of the existing culvert. The cross section includes ineffective flow areas that extend left and right from the sides of the existing culvert. The proposed piles are within those ineffective flow areas. Therefore, the proposed piles would have no impact on the cross sectional area.

For both existing and proposed conditions, the eastbound portion of the U.S. 50 bridge over Alder Pond includes a concrete barrier at the edge of shoulder, which would obstruct the flood flow if it overtops on the upstream side of U.S. 50. The deck/roadway elevation at the upstream face of the U.S. 50 bridge in the LOMR/PMR HEC-RAS model was revised to use the top of concrete barrier as the input for the roadway elevation within the limits of the concrete barrier for both existing and proposed conditions. The Advanced Planning Study for the Auxiliary Lane Extension improvements shows that the cross slope of the widening matches the existing cross slope and the concrete barrier as having the same height as the existing concrete barrier.

Because the roadway widening on the eastbound lanes would lower the edge of shoulder elevation, the top of the concrete barrier elevation included in the proposed condition hydraulic model was set lower than the inputs for the existing condition hydraulic model. The top of the concrete barrier elevation included in the existing condition hydraulic ranged from 131.0 to 131.8 ft NGVD 29 (133.5 to 134.4 ft NAVD 88) in the revised LOMR/PMR HEC-RAS model. The top of the concrete barrier elevation included in the proposed condition hydraulic model ranged from 130.5 to 131.3 ft NGVD 29 (133.0 to 133.8 ft NAVD 88). The existing culvert and the proposed widening improvements are depicted in a schematic in Appendix E. Thrie beam barrier is used as the median barrier and edge of shoulder barrier on the westbound portion of the U.S. 50 bridge over Alder Pond. The configuration of the thrie beam barrier with the openings between the wooden posts would have less obstruction for the flood flows crossing the U.S. 50 travel lanes. WRECO did not revise the roadway elevation at the downstream face of the U.S. 50 bridge assigned in the LOMR/PMR HEC-RAS model for both existing and proposed conditions because improvements are not proposed in the westbound portion of the bridge.

The 100-year water surface elevation of Alder Creek at the upstream face of the U.S. 50 crossing from the LOMR/PMR HEC-RAS model was 132.87 ft NGVD 29 (135.38 ft NAVD 88) and would be overtopped during a 100-year storm event. The 100-year water surface elevation of Alder Creek at the upstream face of the U.S. 50 crossing in the existing condition revised hydraulic model was 132.70 ft NGVD 29 (135.21 ft NAVD 88). The 100-year water surface elevation of Alder Creek at the upstream face of the U.S. 50 crossing in the proposed condition hydraulic model was 132.45 ft NGVD 29 (134.96 ft NAVD 88), which is 0.25 ft lower than the revised existing condition 100-year water surface elevation.

The HEC-RAS model shows that U.S. 50 is overtopped during a 100-year storm event for both existing and proposed conditions. The water surface profiles along Alder Creek in the vicinity of the Project, and the cross sections at the U.S. 50 crossing are included in Appendix F.

4 PROJECT EVALUATION

Executive Order 11988 requires federal agencies to avoid to the maximum extent possible the long- and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. This section analyzes the impacts associated with this Project.

4.1 Risk Associated with the Proposed Action

As defined by the 23 CFR 650A, risk shall mean the consequences associated with the probability of flooding attributable to an encroachment. It shall include the potential for property loss and hazard to life during the service life of the bridge and roadway.

The potential risk associated with the implementation of the proposed action includes but is not limited to: 1) change in land use, 2) change in impervious surface area, 3) fill inside the floodplain, or 4) change in the 100-year water surface elevation. The measures to minimize the potential floodplain impacts associated with the action are summarized in Section 5.

4.1.1 Change in Land Use

No change in land use in the floodplain shall occur as a result of the Project.

4.1.2 Change in Impervious Surface Area

The total impervious surface area would increase by 3.3 acres as a result of the Project in the scenario Alternative 2 with the flyover connector to Hazel Avenue. Alternative 2 represents the largest increase in impervious area of the alternative designs. Construction resulting in an increase in impervious surface area is subject to the Caltrans Stormwater Management Plan (SWMP). According to the SWMP, measures would need to be taken to ensure treatment, detention, and infiltration of the increased quantity of runoff from the added impervious area.

4.1.3 Fill Inside the Floodplain

4.1.3.1 Effective FEMA Floodplains

The displacement of volume in the floodway can be attributed to the piles proposed to support the auxiliary lane extension for the Alder Pond Bridge (see Appendix C). The soffit of the slab of the auxiliary lane extension, elevation 128.9 ft, is 0.5 ft above the BFE of 128.4 ft. The proposed widening of the U.S. 50 travel lanes and shoulders will displace an area of approximately 4,000 sq. ft in the floodway from an open space land use designation to transportation corridor. Analysis of the topographic survey data indicates that the extent of floodplain of Alder Creek on the southern side of U.S. 50 is equal to the distance between the toes of the abutments. This indicates that the Alder Pond Bridge carrying the U.S. 50 auxiliary lane extension would not encroach upon the floodplain. Considering the relatively large storage volume of Alder Creek pond upstream of U.S. 50, the Project will have a negligible impact on the height of the water surface elevation during the base flood.

4.1.3.2 Future Physical Map Revision

The HEC-RAS model that was developed in support of the LOMR/PMR for Alder Creek shows a water surface elevation of 132.9 ft NGVD 29 (135.4 ft NAVD 88) just upstream of the U.S. 50 crossing and 125.9 ft NGVD 29 (128.4 ft NAVD 88) just downstream of the U.S. 50 crossing. The modeling shows water surface elevations that are higher than the effective FIRM BFE: 7.4 ft higher upstream of U.S. 50 and no change downstream of U.S. 50. With the soffit of the slab of the auxiliary lane extension at elevation 128.9 ft, the Alder Pond Bridge would be overtopped by the base flood. WRECO updated the bridge deck/roadway elevation of U.S. 50 in the LOMR/PMR hydraulic model to account for the flood flow obstructions caused by the concrete barrier. The resulting 100-year water surface elevation from the existing and proposed condition hydraulic analysis was 132.7 ft NGVD 29 (135.2 ft NAVD 88) for the existing condition and 132.5 ft NGVD 29 (135.0 ft NAVD 88) for the proposed condition. The results of the analysis indicated that the proposed Project would not result in increases in water surface elevation along Alder Creek (see Section 3.2.2, which discusses the modeling assumptions).

Because the proposed improvements would be within the limits of the existing culvert, the LOMR/PMR HEC-RAS model already accounts for the proposed fill that would result from the new piles and CIP/RC slab improvements associated with the auxiliary lane extension at the Alder Creek Pond. In addition, the cross section at the location where the widening would occur is just upstream of the existing culvert. The cross section includes ineffective flow areas that extend left and right from the sides of the existing culvert. Because the proposed piles are within those ineffective flow areas, they would have no impact on the cross sectional area.

4.1.4 Change in the 100-Year Water Surface Elevation

Section 4.1.3.1 provides analysis showing no anticipated change in the 100-year water surface elevation as a result of the Project based on an evaluation of the effective FEMA floodplain data. Section 4.1.3.2 provides analysis showing no increases in the 100-year water surface elevation as a result of the Project based on an evaluation of the modified LOMR/PMR HEC-RAS model.

4.2 Summary of Potential Encroachments

The 23 CFR 650A defines a significant encroachment as a highway encroachment, and any direct support of likely base floodplain development, that would involve one or more of the following construction or flood-related impacts: 1) significant potential for interruption or termination of a transportation facility that is needed for emergency vehicles or provides a community's only evacuation route, 2) a significant risk, or 3) a significant adverse impact on the natural and beneficial floodplain values (2011). The following sections discuss the potential impacts to the floodplain that may result from the proposed action. The risk associated with implementation of the action is discussed in Section 4.1.

4.2.1 Potential Traffic Interruptions for the Base Flood

There will be lane closures during Project construction; appropriate traffic measures as well as construction scheduling will be planned to minimize the impact to traffic in the construction corridor. After completion of the Project, traffic conditions are expected to improve in the Project area.

Based on the published FIRM BFEs, it is not anticipated that U.S. 50 will be inundated in the Project area. It is not anticipated that the proposed Project would change the extent of flooding and water depth around the Project site.

4.2.2 Potential Impacts on Natural and Beneficial Floodplain Values

As defined by the 23 CFR 650A, natural and beneficial floodplain values include, but are not limited to: fish, wildlife, plants, open space, natural beauty, scientific study, outdoor recreation, agriculture, aquaculture, forestry, natural moderation of floods, water quality maintenance, and groundwater recharge.

Potential short-term adverse effects during construction of the Alder Pond Bridge to natural and beneficial floodplain values include: 1) loss of vegetation during construction activity, and 2) temporary disturbance of wildlife habitat along Lake Natoma and Alder Creek. Long-term adverse impacts due to the Project are caused by the displacement of habitat along the south side of U.S. 50. These impacts would be minor because of the low habitat value and the relatively small construction footprint.

4.2.3 Support of Probable Incompatible Floodplain Development

As defined by the 23 CFR 650A, the support of incompatible base floodplain development will encourage, allow, serve, or otherwise facilitate incompatible base floodplain development, such as commercial development or urban growth.

The Project design would not create new access to the floodplain or the surrounding areas and therefore would not support or promote incompatible development within in the floodplain.

4.2.4 Longitudinal Encroachments

As defined by the Caltrans Standard Environmental Reference, a longitudinal encroachment is an action within the limits of the base floodplain that is longitudinal to the normal direction of the floodplain.

The Project proposes the auxiliary lane extension, which is perpendicular to the direction of flow of Alder Creek, and therefore is not a longitudinal encroachment.

5 AVOIDANCE, MINIMIZATION, AND/OR MITIGATION MEASURES

The Project would have negligible adverse impacts in and on the floodplain.

5.1 Minimize Floodplain Impacts

The Project would not change the overall land use within the watershed basin. Although the Project would place a small amount of fill in the floodplain and increase the impervious area, the effect of the proposed design to the existing floodplain would be minimal. Additional minimization measures are not proposed for the Project.

5.2 Restore and Preserve Natural and Beneficial Floodplain Values

Temporary environmental impacts from construction activities for the proposed Project can be minimized with standard measures such as revegetation, best management practices (BMPs), and other activities that meet the requirements that are part of the Project permit conditions.

With the implementation of these minimization measures, impacts to natural and beneficial floodplain values would be minimal and additional measures to restore and preserve the natural and beneficial values were not considered.

5.3 Alternatives to Significant Encroachments

The Alder Pond Bridge pilings would be a relatively small and insignificant encroachment on the existing floodplain on the south side of U.S. 50. This portion of the floodplain is a backwater of Lake Natoma and therefore does not pose the threat of impeding flood flows or causing backwater conditions upstream. Because of the negligible impact and the limited alternative options to adding an auxiliary lane, an alternative to this encroachment was not analyzed.

5.4 Alternatives to Longitudinal Encroachments

The proposed Project construction would not be classified as a longitudinal encroachment. Therefore, alternatives to longitudinal encroachments were not analyzed.

5.5 Coordination with Local, State, and Federal Water Resources and Floodplain Management Agencies

Sacramento County Department of Public Works will coordinate with local, State, and Federal water resources and floodplain management agencies as necessary during all aspects of the proposed Project. Regulatory permits and approvals would be required as the Project enters into the final design phase. A 1602 Streambed Alteration Agreement with the California Department of Fish and Wildlife, 404 Nationwide Permit with the USACE, and 401 Water Quality Certification with the Regional Water Quality Control Board are expected to be required for the Project.

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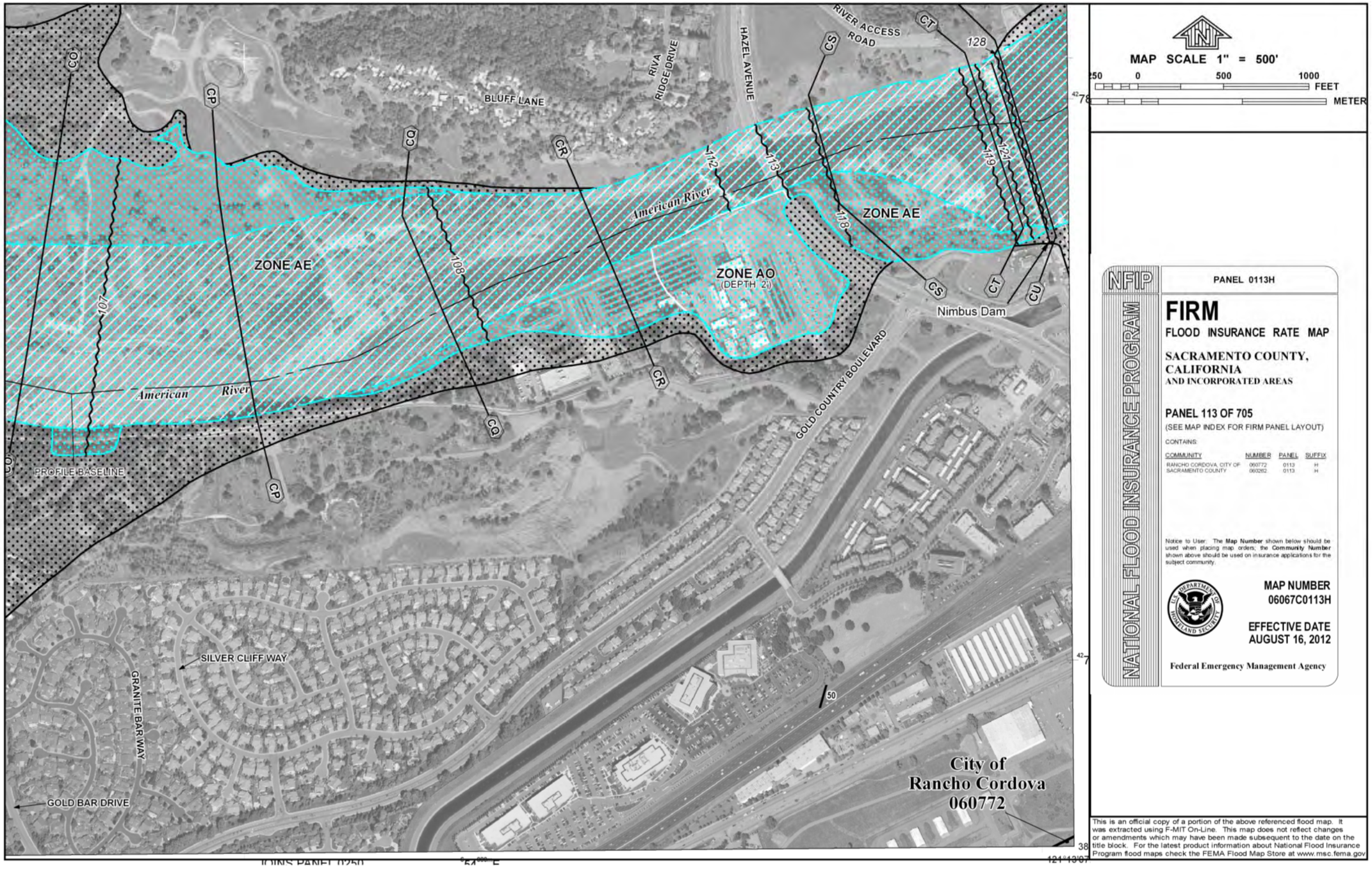
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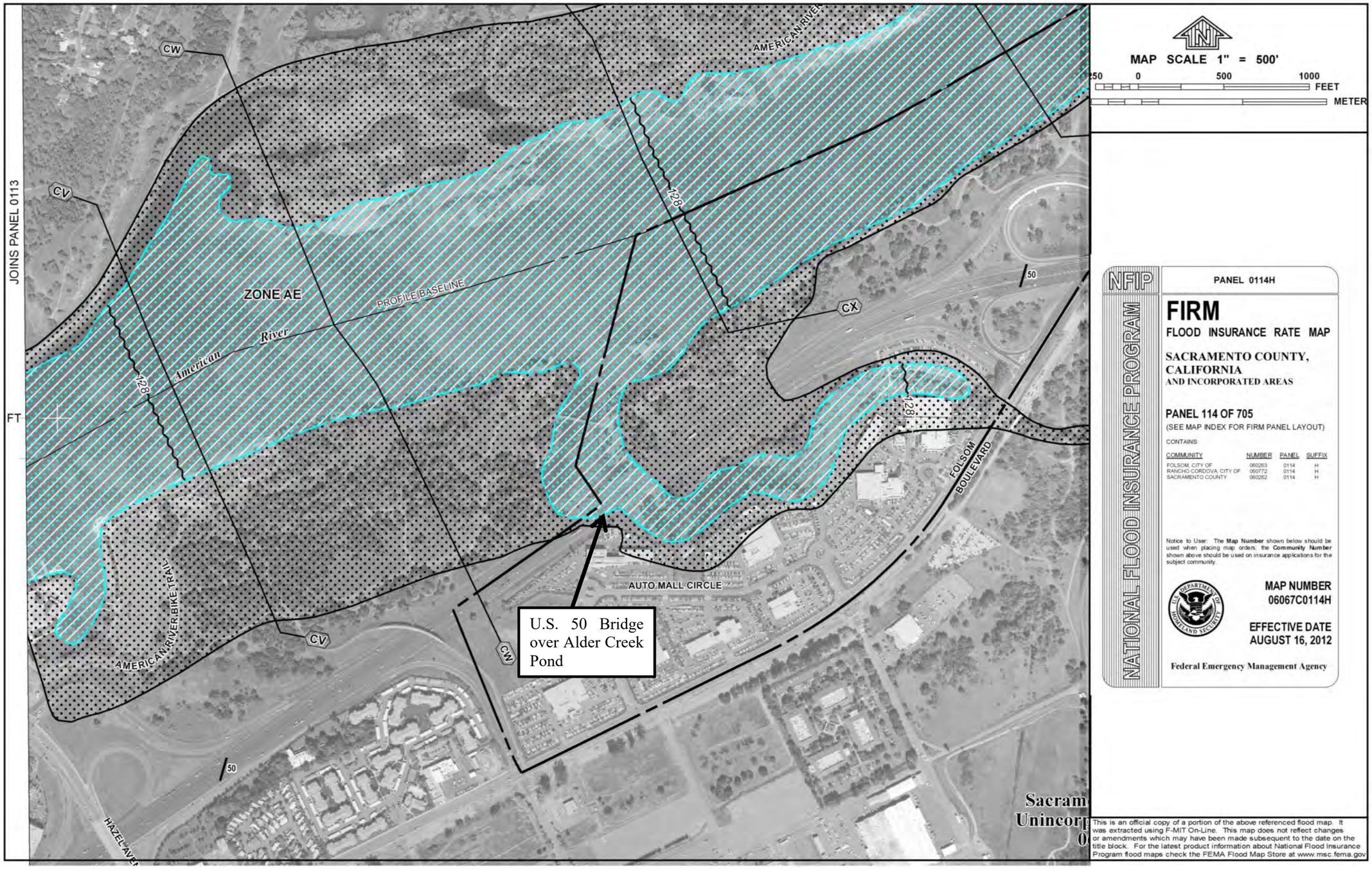
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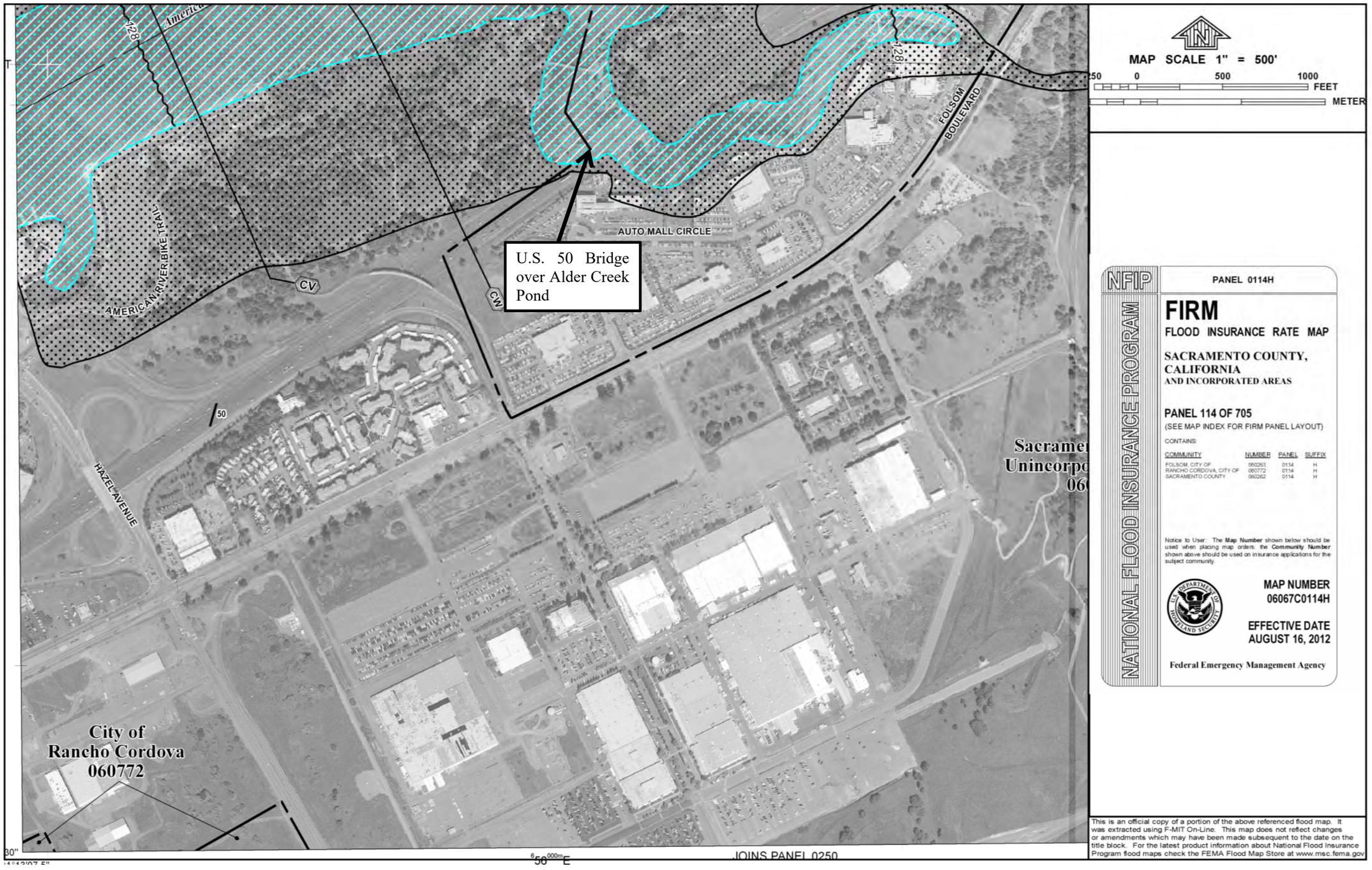
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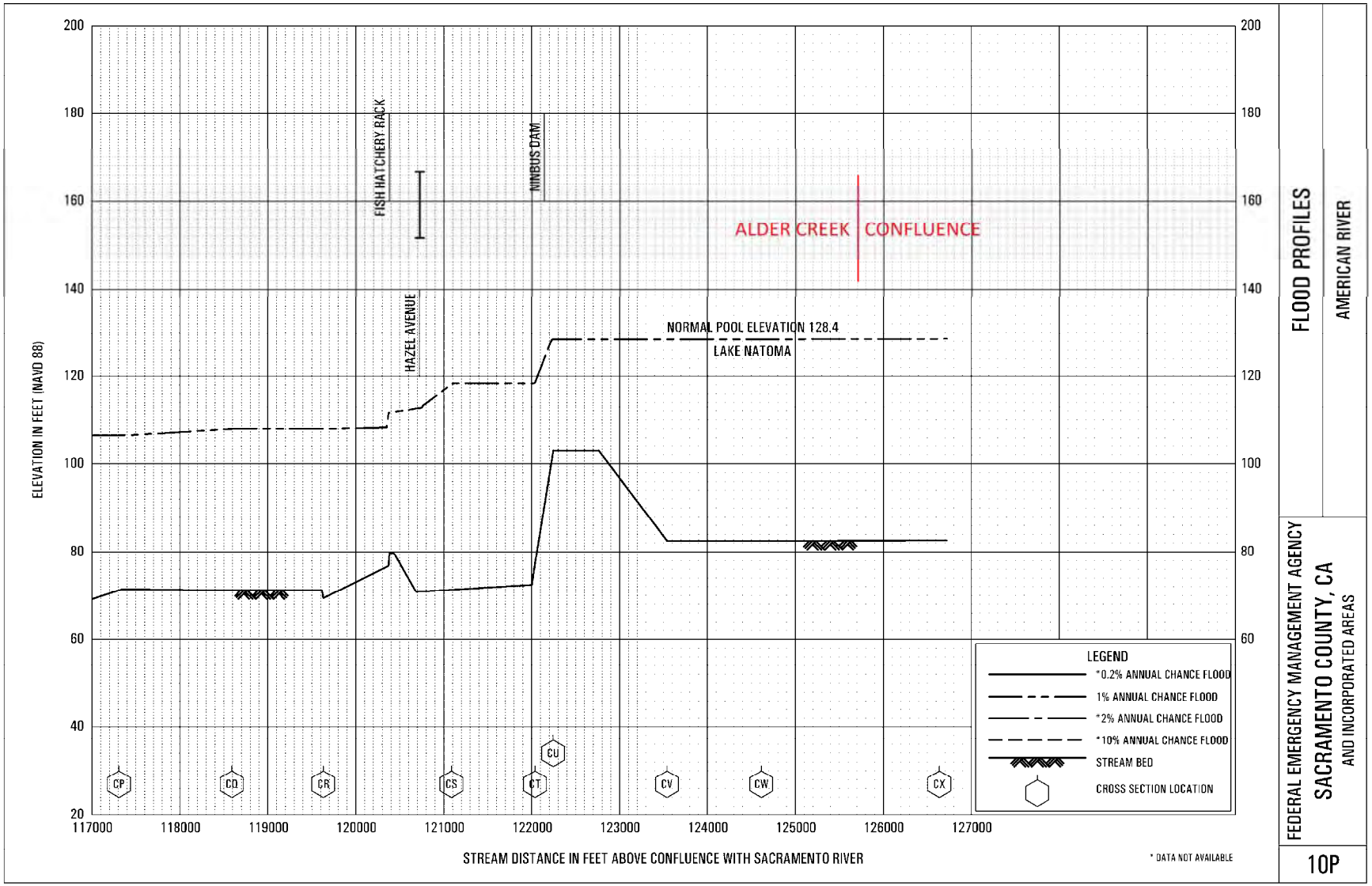
Appendix A Federal Emergency Management Agency Flood Insurance Rate Maps

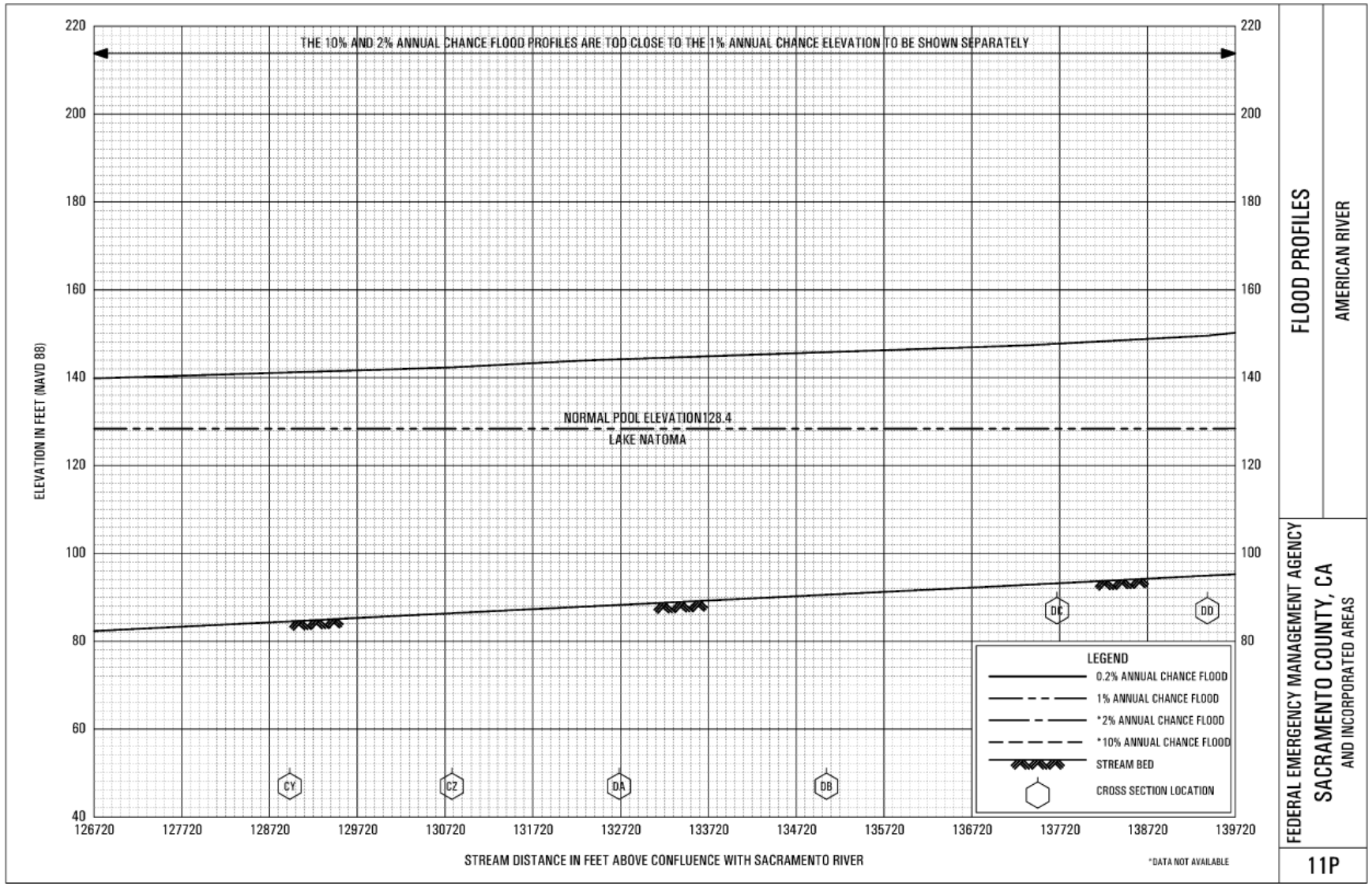

ZONE AE
ZONE AO
(DEPTH 2)
ZONE AE
American River
American River
BLUFF LANE
RIVA RIDGE DRIVE
HAZEL AVENUE
RIVER ACCESS ROAD
GOLD COUNTRY BOULEVARD
Nimbus Dam
PROFILE BASELINE
SILVER CLIFF WAY
GRANITE BAR WAY
GOLD BAR DRIVE
City of
Rancho Cordova
060772
CO
CP
CQ
CR
CS
CT
CU
107
108
112
113
118
119
121
128
50
MAP SCALE 1" = 500'
250 0 500 1000
FEET
METER
NFIP
NATIONAL FLOOD INSURANCE PROGRAM
PANEL 0113H
FIRM
FLOOD INSURANCE RATE MAP
SACRAMENTO COUNTY, CALIFORNIA
AND INCORPORATED AREAS
PANEL 113 OF 705
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)
CONTAINS:
COMMUNITY NUMBER PANEL SUFFIX
RANCHO CORDOVA, CITY OF 060772 0113 H
SACRAMENTO COUNTY 060262 0113 H
Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.
MAP NUMBER
06067C0113H
EFFECTIVE DATE
AUGUST 16, 2012
Federal Emergency Management Agency
This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov


MAP SCALE 1" = 500'
0
500
1000
FEET
METER
PANEL 0114H
NFIP
NATIONAL FLOOD INSURANCE PROGRAM
FIRM
FLOOD INSURANCE RATE MAP
SACRAMENTO COUNTY, CALIFORNIA
AND INCORPORATED AREAS
PANEL 114 OF 705
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)
CONTAINS:
COMMUNITY NUMBER PANEL SUFFIX
FOLSOM, CITY OF 060263 0114 H
RANCHO CORDOVA, CITY OF 060772 0114 H
SACRAMENTO COUNTY 060262 0114 H
Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.
MAP NUMBER
06067C0114H
EFFECTIVE DATE
AUGUST 16, 2012
Federal Emergency Management Agency
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JOINS PANEL 0113
FT
CW
CV
CX
ZONE AE
PROFILE BASELINE
American River
AMERICAN RIVER
128
50
FOLSOM BOULEVARD
AUTO MALL CIRCLE
AMERICAN RIVER BIKE TRAIL
HAZEL AVE
U.S. 50 Bridge over Alder Creek Pond


U.S. 50 Bridge over Alder Creek Pond
AUTO MALL CIRCLE
FOLSOM BOULEVARD
AMERICAN RIVER BIKE TRAIL
HAZEL AVENUE
CV
CW
50
City of Rancho Cordova 060772
MAP SCALE 1" = 500'
0
500
1000
FEET
METER
NFIP
PANEL 0114H
FIRM
FLOOD INSURANCE RATE MAP
SACRAMENTO COUNTY, CALIFORNIA
AND INCORPORATED AREAS
PANEL 114 OF 705
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)
CONTAINS:
COMMUNITY NUMBER PANEL SUFFIX
FOLSOM, CITY OF 060263 0114 H
RANCHO CORDOVA, CITY OF 060772 0114 H
SACRAMENTO COUNTY 060262 0114 H
Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.
MAP NUMBER
06067C0114H
EFFECTIVE DATE
AUGUST 16, 2012
Federal Emergency Management Agency
NATIONAL FLOOD INSURANCE PROGRAM
This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov
JOINS PANEL 0250

Appendix B Federal Emergency Management Agency Flood Profiles


FISH HATCHERY RACK
NIMBUS DAM
ALDER CREEK
CONFLUENCE
HAZEL AVENUE
NORMAL POOL ELEVATION 128.4
LAKE NATOMA
ELEVATION IN FEET (NAVD 88)
STREAM DISTANCE IN FEET ABOVE CONFLUENCE WITH SACRAMENTO RIVER
* DATA NOT AVAILABLE
LEGEND
*0.2% ANNUAL CHANCE FLOOD
1% ANNUAL CHANCE FLOOD
*2% ANNUAL CHANCE FLOOD
*10% ANNUAL CHANCE FLOOD
STREAM BED
CROSS SECTION LOCATION
CP
CQ
CR
CS
CT
CU
CV
CW
CX
FLOOD PROFILES
AMERICAN RIVER
FEDERAL EMERGENCY MANAGEMENT AGENCY
SACRAMENTO COUNTY, CA
AND INCORPORATED AREAS
10P


THE 10% AND 2% ANNUAL CHANCE FLOOD PROFILES ARE TOO CLOSE TO THE 1% ANNUAL CHANCE ELEVATION TO BE SHOWN SEPARATELY
NORMAL POOL ELEVATION 128.4
LAKE NATOMA
ELEVATION IN FEET (NAVD 88)
220
200
180
160
140
120
100
80
60
40
126720
127720
128720
129720
130720
131720
132720
133720
134720
135720
136720
137720
138720
139720
CY
CZ
DA
DB
DC
DD
LEGEND
0.2% ANNUAL CHANCE FLOOD
1% ANNUAL CHANCE FLOOD
*2% ANNUAL CHANCE FLOOD
*10% ANNUAL CHANCE FLOOD
STREAM BED
CROSS SECTION LOCATION
STREAM DISTANCE IN FEET ABOVE CONFLUENCE WITH SACRAMENTO RIVER
*DATA NOT AVAILABLE
FLOOD PROFILES
AMERICAN RIVER
FEDERAL EMERGENCY MANAGEMENT AGENCY
SACRAMENTO COUNTY, CA
AND INCORPORATED AREAS
11P

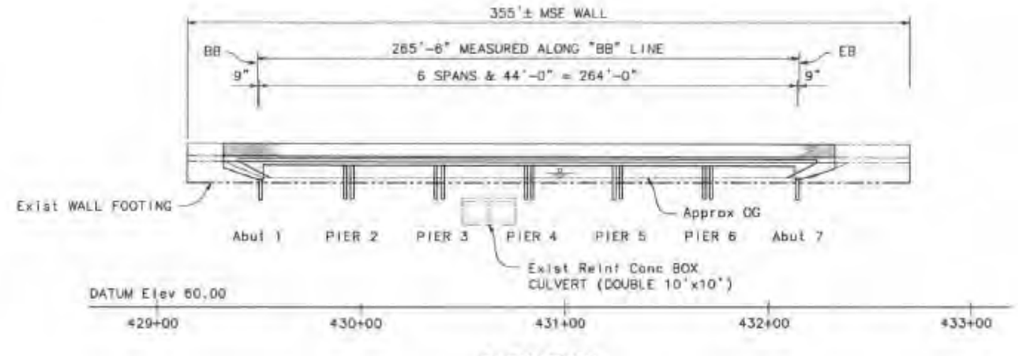
Appendix C Planning Study – Alder Pond Bridge

PREPARED FOR THE STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

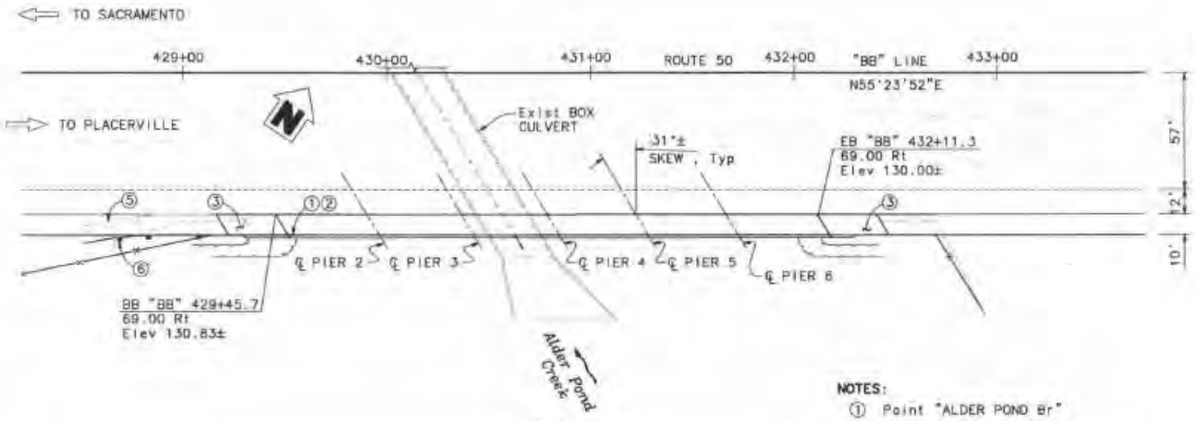
DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT
03	SAC	50	15.4/16.9

COUNTY OF SACRAMENTO
906 G STREET, SUITE 510
SACRAMENTO, CA 95814

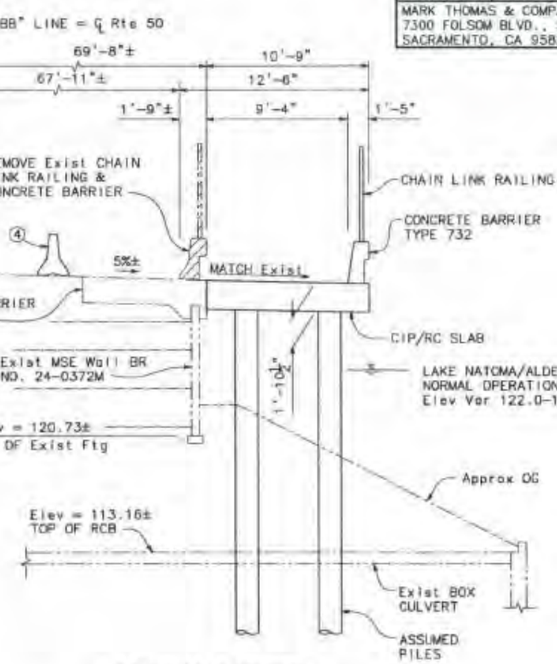
MARK THOMAS & COMPANY, INC.
7300 FOLSOM BLVD., SUITE 203
SACRAMENTO, CA 95826



ELEVATION
SCALE: 1" = 30'



PLAN
SCALE: 1" = 30'



TYPICAL SECTION
1/4" = 1'-0"

NOTES:
① Point "ALDER POND Br"
② Point "BR NO. 24-NEW
③ Structure Approach Type N(300)
④ Temporary Railing (Type K)
⑤ Remove MBGR, see "ROAD PLANS"
⑥ MBGR, see "ROAD PLANS"

LEGEND:
Indicates Existing Structure
Indicates Bridge Removal (Portion)

DATE OF ESTIMATE	FEBRUARY 2013
STRUCTURE DEPTH	= 1'-10 1/2"
LENGTH	= 265'-6"
WIDTH	= 10'-9"
AREA OF WORK	= 3,031 FT²
COST / FT² INCLUDING 10% MOBILIZATION & 25% CONTINGENCY	= $335/FT²
BRIDGE COST	= $1,015,000

X Eric Fredrickson
DESIGN OVERSIGHT
X 4-10-14
SIGN OFF DATE

DESIGNED BY	J. HICKEY	DATE	04-04-14
DRAWN BY	G. BOYKO	DATE	04-04-14
CHECKED BY	J. PASSALACQUA	DATE	04-04-14
APPROVED		DATE	

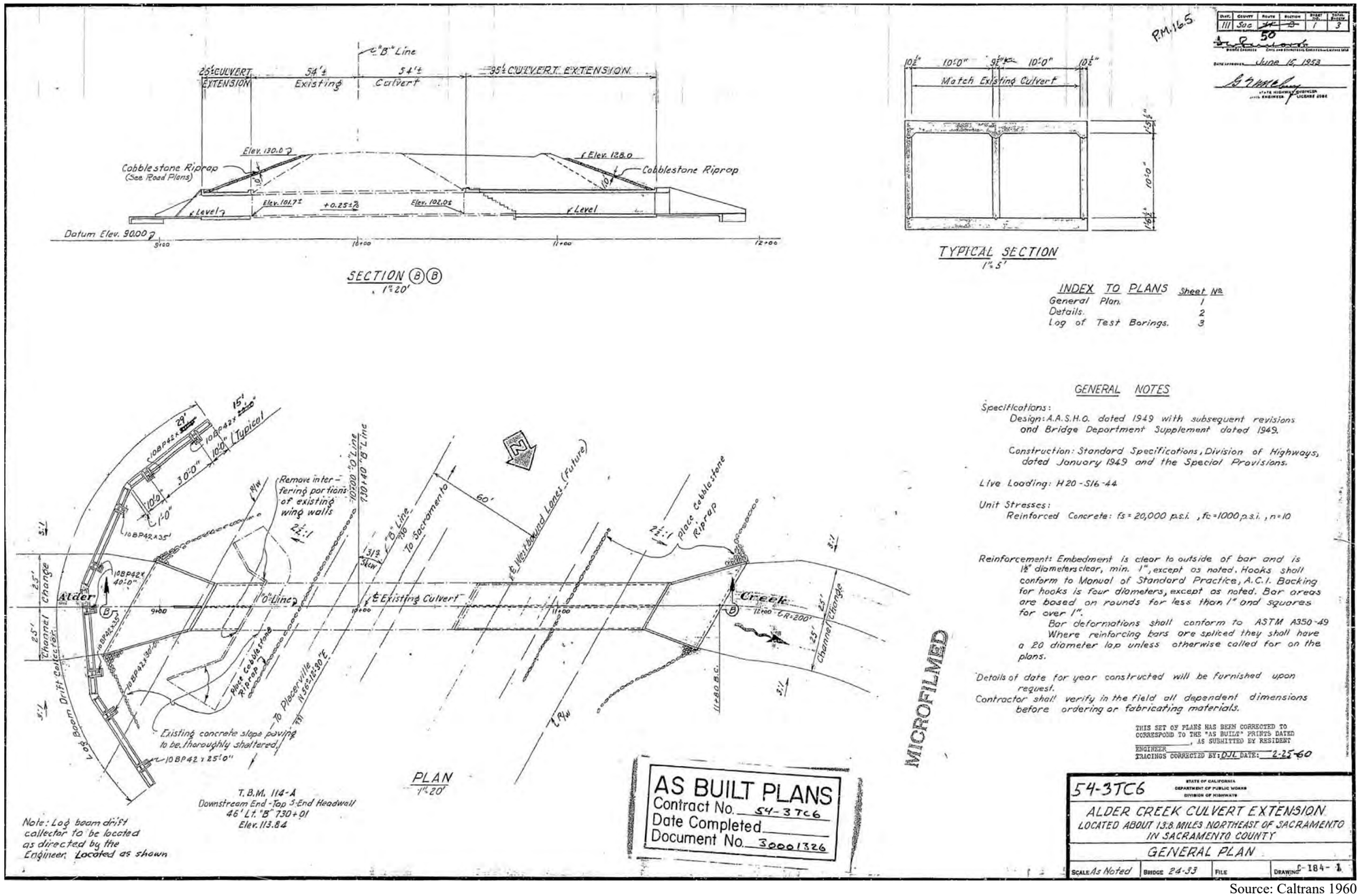
J. PASSALACQUA
PROJECT ENGINEER

AUXILIARY LANE EXTENSION
PLANNING STUDY
ALDER POND BRIDGE

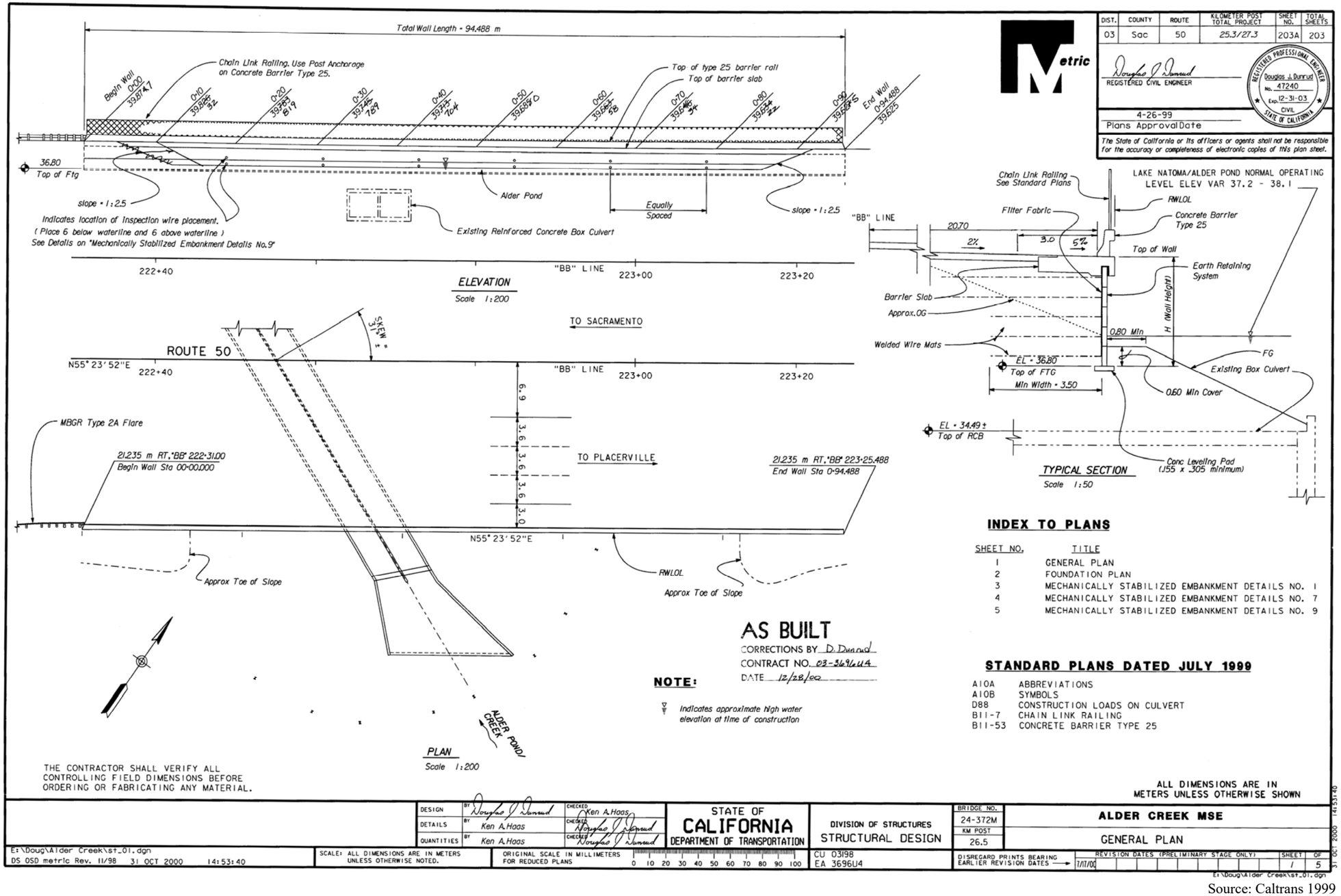
BRIDGE NO. 24-NEW	UNIT:
SCALE: AS SHOWN	PROJECT NUMBER & PHASE: 03-3E380K
CONTRACT NO.: X	PROJECT ID: 0300020439

ADVANCE PLANNING STUDY SHEET (ENGLISH) (REV. 7/18/13)
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DATE PLOTTED => $DATE
TIME PLOTTED => $TIME
USERNAME => $USER

Appendix D Caltrans As-Built for Box Culverts

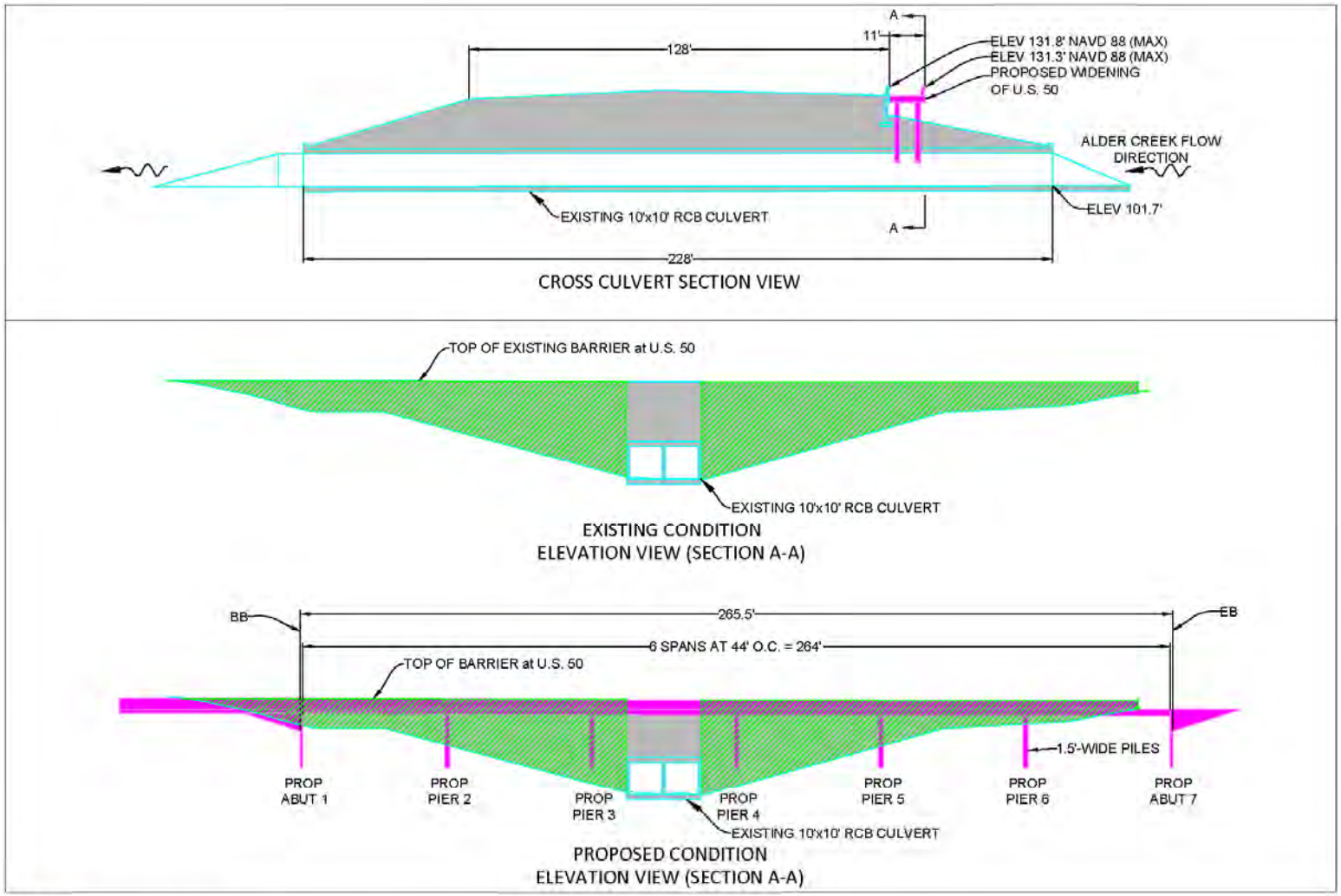


Source: Caltrans 1960



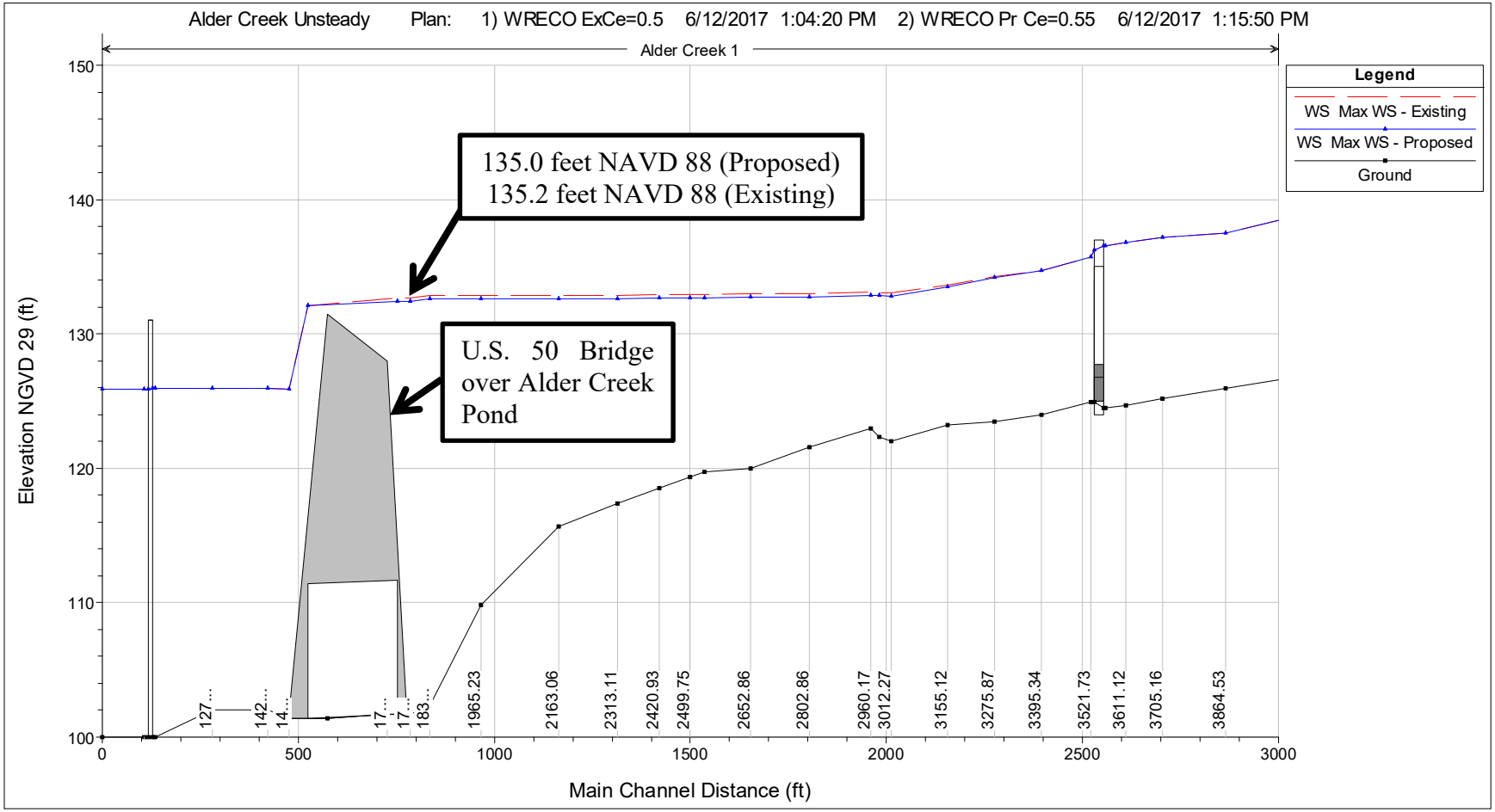
Source: Caltrans 1999

Appendix E Existing Culvert and Widening Schematic

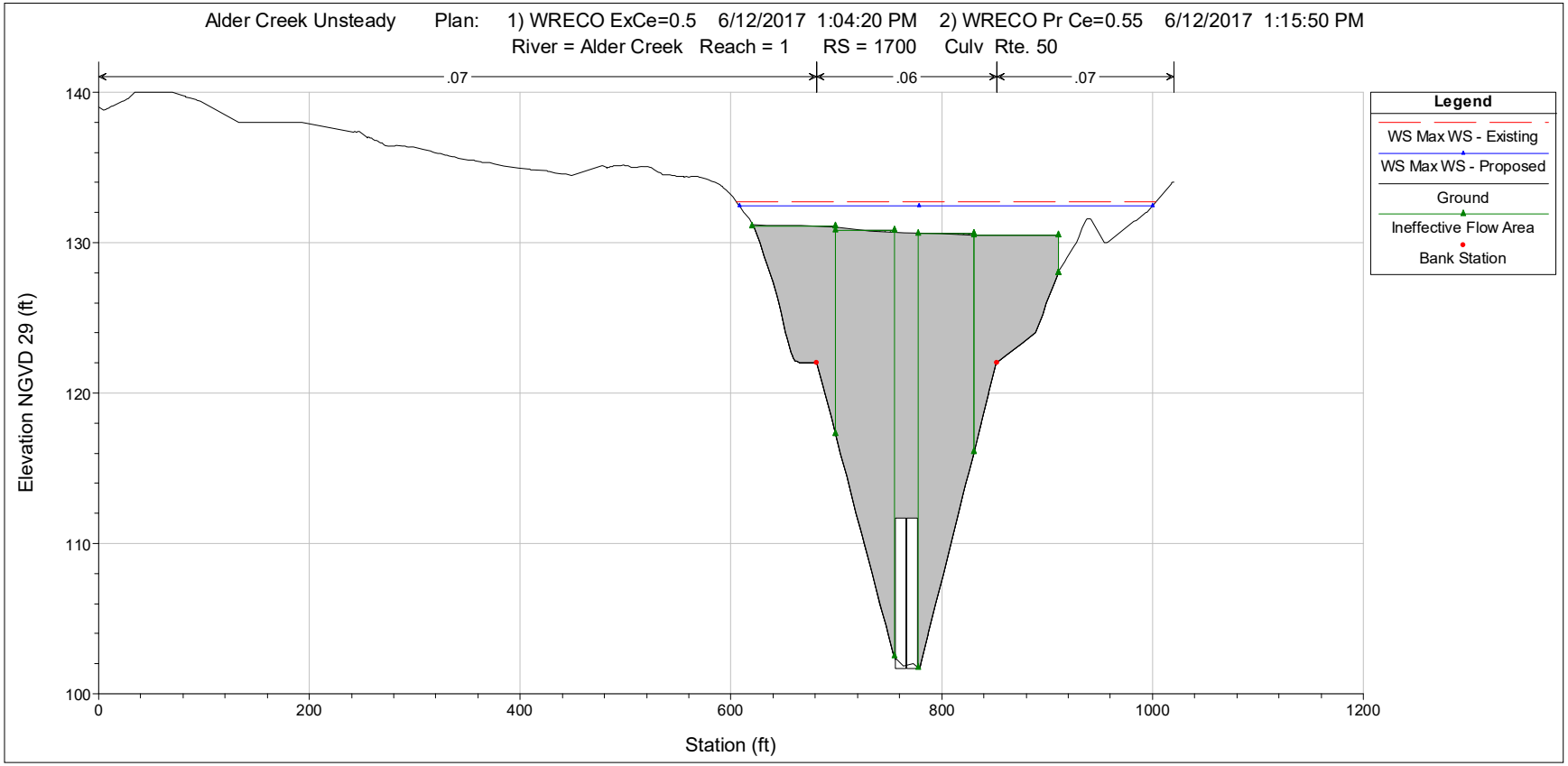


EXISTING CULVERT AND WIDENING SCHEMATIC | AUXILIARY LANE EXTENSION AT ALDER POND BRIDGE

Appendix F HEC-RAS Model Output



Water Surface Profile Along Alder Creek in the Vicinity of the U.S. 50 Bridge



Cross Section of U.S. 50 Bridge

Water Quality Assessment Report

Hazel Avenue/ U.S. Route 50 Interchange Project



City of Rancho Cordova, Sacramento County, California
03-SAC-50-PM 15.1/17.5
Project ID 0300020439
EA 03-3E380
County Control Number 2011-70062

August 2016

Caltrans

Water Quality Assessment Report

Hazel Avenue/U.S. Route 50 Interchange Project
City of Rancho Cordova, Sacramento County, California
03-SAC-50-PM 15.1/17.5
Project ID 0300020439
EA 03-3E380
County Control Number 2011-70062

August 2016

STATE OF CALIFORNIA
Department of Transportation

Prepared By: Han-Bin Liang, Ph.D., P.E.
(925) 941-0017
1243 Alpine Road, Suite 108, Walnut Creek, CA 94596
WRECO

The environmental review, consultation, and any other action required in accordance with applicable Federal laws for this project is being, or has been, carried-out by Caltrans under its assumption of responsibility pursuant to 23 USC 326.

Executive Summary

The County of Sacramento (County), in cooperation with the California Department of Transportation (Caltrans) and the City of Rancho Cordova (City), proposes to modify the existing United States (U.S.) 50/Hazel Avenue interchange, and extend and grade-separate Hazel Avenue over Folsom Boulevard and the Sacramento Placerville Transportation Corridor Joint Powers Authority (SPTC-JPA) rail corridor. Hazel Avenue will be extended further south to a proposed intersection with the future Atlanta Street (a new roadway that will be constructed as part of the Easton Place development). Two alternatives, with one sub-alternative, and a no-build alternative have been developed for the Project.

The purpose of this Water Quality Assessment Report is to summarize the proposed Project impacts, the physical setting within the Project limits, and the regulatory laws which apply to this Project. This report discusses the water resources within the Project limits, the quality of these waters, describes water quality impairments and beneficial uses, identifies potential water quality impacts/benefits associated with the proposed Project, and recommends avoidance and/or minimization measures for potentially adverse impacts. This report fulfills requirements of the National Environmental Policy Act and California Environmental Quality Act to provide information about the proposed Project's potential impacts to water quality. It also provides information, to the extent possible, for National Pollutant Discharge Elimination System (NPDES) permitting.

Alder Creek crosses U.S. 50 at post mile 16.46 via a bridge structure (Bridge No. 24 003). In addition to directly discharging to the creek, the Project directly and indirectly discharges to Lake Natoma and the Folsom South Canal. Alder Creek terminates at its confluence at Lake Natoma, and the lake discharges to the American River and canal via a dam structure.

The following environmental permits and approvals are likely required for the proposed Project to allow for work within the bed, bank, or channel of the Alder Creek:

- Clean Water Act (CWA) Section 404 Permit from the United States Army Corps of Engineers
- CWA Section 401 Certification from the Regional Water Quality Control Board
- 1602 Streambed Alteration Agreement from the California Department of Fish and Wildlife

Coordination with regulatory agencies pertaining to water quality has not occurred as of the date shown on this report.

The Project will disturb an acre or more of soil; therefore, a Storm Water Pollution Prevention Plan (SWPPP) will be required for the Project. A component of the SWPPP includes performing a risk level determination in compliance with the Statewide Construction General Permit. The permit separates projects into Risk Levels 1, 2, or 3. Risk levels are calculated by determining the Project's sediment and receiving water risks. All risk levels are subject to temporary construction site best management practice implementation and visual monitoring requirements.

Risk Level 2 and 3 projects require stormwater sampling at all discharge locations, with the samples subject to numeric action levels for pH and turbidity. Risk Level 3 projects are subject to receiving water monitoring triggers for pH, turbidity, and suspended sediment concentrations. The proposed Project is expected to be classified as Risk Level 2, thus meaning stormwater sampling will be necessary.

Possible impacts of this Project include temporary impacts to the beneficial uses of receiving waters and aquatic resources during construction, and permanent impacts to water quality from sediment and pollutants in runoff. An increase in stormwater velocity and volume could also result due to the increase in impervious area. The existing and new impervious surface and disturbed soil area for each alternative can be found in the table below.

Alternative	Impervious Area (acre)		Disturbed Soil Area (acre)
	Existing	New	
1	26.6	8.4	44.7
1A		8.6	45.2
2		9.6	54.6

The Project's overall design goal will be to avoid and minimize impacts to water resources to the maximum extent practicable, promote infiltration of stormwater runoff, maximize treatment of stormwater runoff, and reduce erosion by metering or detaining post-Project runoff.

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Acronyms

BMP	Best management practices
Caltrans	California Department of Transportation
CGP	Construction General Permit
City	City of Rancho Cordova
County	County of Sacramento
CWA	Clean Water Act
DSA	Disturbed Soil Area
EPA	Environmental Protection Act
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
HOV	High Occupancy Vehicle
HSA	Hydrologic Sub-Area
HSG	Hydrologic Soil Group
K	Soil erodibility factor
LS	Length-slope factor
MS4	Municipal Separate Storm Sewer System
MSE	Mechanically Stabilized Earth
No.	Number
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
R	Rainfall runoff erosivity factor
RWQCB	Regional Water Quality Control Board
SACOG	Sacramento Area Council of Government's
SPTC-JPA	Sacramento Placerville Transportation Corridor Joint Powers Authority
SWMP	Storm Water Management Plan
SWPPP	Storm Water Pollution Prevention Plan
SWRCB	State Water Resources Control Board
TMDL	total maximum daily load
UPRR	Union Pacific Railroad
U.S.	United States
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
WDR	Waste Discharge Requirement
WQAR	Water Quality Assessment Report

1 INTRODUCTION

The County of Sacramento (County), in cooperation with the California Department of Transportation (Caltrans) and the City of Rancho Cordova (City), proposes to modify the existing United States (U.S.) 50/Hazel Avenue interchange, and extend and grade-separate Hazel Avenue over Folsom Boulevard and the Sacramento Placerville Transportation Corridor Joint Powers Authority (SPTC-JPA) rail corridor. Hazel Avenue will be extended further south to a proposed intersection with the future Atlanta Street (a new roadway that will be constructed as part of the Easton Place development). The Project also includes:

- Construction of a portion of an eastbound transition auxiliary lane on U.S. 50 from Hazel Avenue through the Folsom Boulevard Overcrossing, also known as the Natoma Overhead.
- The modification of the existing Aerojet Road off-ramp from U.S. 50.
- Reconstruction of the westbound loop on-ramp.
- Reconstruction of the eastbound diagonal off-ramp, and both eastbound on-ramps.
- Eastbound on- and off-ramp auxiliary lanes, from west of the Hazel Avenue to the eastbound off-ramp, and from the loop on-ramp extending to the Folsom Boulevard interchange.
- Roadway improvements constructed along approximately 2,300 feet of Folsom Boulevard. Improvements include sidewalks, street lighting, and landscaping along the north side of Folsom Boulevard, and landscaping and lighting along the south.

The Project is located in the County of Sacramento at the interchange of Hazel Avenue and U.S. 50 (see Figure 1 and Figure 2). The Project area is bounded along Hazel Avenue by the Tributary Point/westbound off-ramp intersection to the north, and extends approximately 1,000 feet south of Folsom Boulevard to a future intersection within the proposed Easton Place development. The Project limits along U.S. 50 begin approximately 3,200 feet west of the existing Hazel Avenue Overcrossing, and extend 2,500 feet east of the Natoma Overhead. Improvements along Folsom Boulevard will extend from approximately 1,200 feet west of the Hazel Avenue intersection to 900 feet to the east.

1.1 Project Purpose

The primary purpose of the Project is to modify the existing U.S. 50/Hazel Avenue Interchange to reduce congestion, improve traffic operations, accommodate travel demand due to planned and approved developments, and improve safety of all modes of travel including bicycles and pedestrians.

The following objectives will be met by the proposed alternatives:

- Improve operations by removing the close intersection spacing between the eastbound ramps and Folsom Boulevard, and minimizing conflict with heavy and light rail.

  - Proposed alternatives accomplish this by grade-separating Hazel Avenue over Folsom Boulevard.

- Provide sufficient capacity in the ramps and roadways for future traffic volumes.

  - Proposed alternatives accomplish this by widening and/or lengthening the on/off-ramps and Hazel Avenue as required by their respective traffic analysis.

- Maintain the Aerojet Road off-ramp connection to the approved development while improving the mainline operations.

  - Proposed alternatives accomplish this by removing the Aerojet Road exit from U.S. 50 but still providing direct access to Aerojet Road through the eastbound Hazel Avenue off-ramp.

1.2 Project Need

The Project is needed to relieve existing congestion at the interchange and to accommodate planned and approved developments identified by the adopted Sacramento County General Plan and the Sacramento Area Council of Government's (SACOG) Regional Transportation Plan.

The approved developments within and near the Project area will increase traffic demand beyond what the existing interchange can accommodate. The close intersection spacing between the Folsom Boulevard and eastbound ramp intersections does not provide sufficient queuing for increased traffic volumes. Additionally, the County of Sacramento is currently widening Hazel Avenue from the interchange to Madison Avenue from four to six traffic lanes. This increase in roadway capacity is expected to deliver more traffic to the interchange during peak traffic periods.

Traffic demand forecasts for this Project were conducted using the SACOG 2035 Metropolitan Transportation Plan projected to 2038 (20 years after anticipated opening day) and supplemented by anticipated levels of additional development currently in application or advanced planning stages. Based on these projections, it is anticipated the existing interchange will degrade to Level of Service "F".

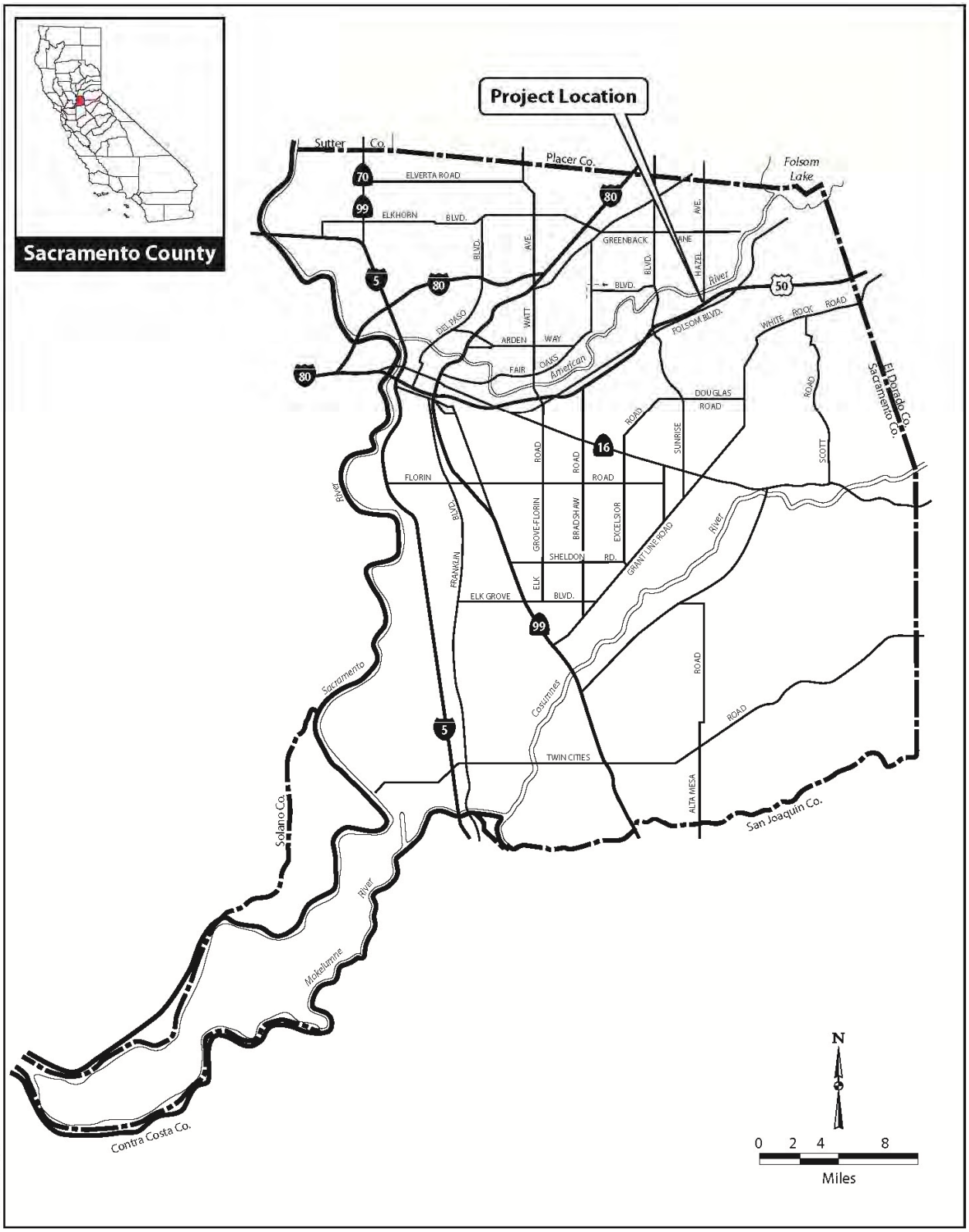


Figure 1. Vicinity Map



Figure 2. Location Map

1.3 Project Description

The proposed Project would construct modifications to the existing interchange, and grade-separate and extend Hazel Avenue to the south to a future intersection with Atlanta Street, which will be built with the approved Easton Place development. Two alternatives, with one sub-alternative, have been developed for the Project.

The following is a description of elements and design components that are common to all alternatives:

1.3.1 Roadway Modifications

- Construction of a portion of an eastbound transition auxiliary lane on U.S. 50 from Hazel Avenue through the Folsom Boulevard Overcrossing, also known as the Natoma Overhead.
- The modification of the existing Aerojet Road off-ramp from U.S. 50.
- The westbound loop on-ramp will be reconstructed, with the ramp intersection shifted north towards the westbound off-ramp terminus, increasing storage lengths. The ramp will be metered with two lanes (one mixed use, and one high occupancy vehicle [HOV] bypass), and a squared-up "pedestrian friendly entrance".
- Reconstruction of the eastbound diagonal off-ramp to conform with the new Hazel Avenue profile and accommodate the Aerojet Road ramp divergence.
- The eastbound diagonal on-ramp will be reconstructed to conform with the new Hazel Avenue profile, and will be metered with two lanes; one mixed flow, and one HOV bypass.
- The eastbound loop on-ramp will be reconstructed to conform with the new Hazel Avenue profile, and will be metered with two lanes; one mixed flow, and one HOV bypass. A tie-back wall at the abutment of the overcrossing is proposed to maximize the opening through the structure. The loop ramp will develop an additional lane on U.S. 50 that will continue on to the Folsom Boulevard interchange.
- Construction of eastbound on- and off-ramp auxiliary lanes on U.S. 50, from west of the Hazel Avenue to the eastbound off-ramp, and from the loop on-ramp extending to the Folsom Boulevard interchange.
- Traffic signals at the ramp intersections will be modified. Safety lighting will be installed. A new signalized intersection and at-grade railroad crossing will be constructed for the Jughandle.
- Pedestrian access will be maintained on the east side of Hazel Avenue with 6-foot sidewalks (however the existing sidewalk on the overcrossing will remain 5 feet wide). Bicyclists may utilize the County standard 7-foot shoulders. It is expected that pedestrians and bicyclists will continue to use the nearby Bikeway and Pedestrian Overcrossing as the primary means for crossing U.S. 50.
- Roadway improvements constructed along approximately 2,300 feet of Folsom Boulevard. Improvements include the removal of the existing signalized intersection with Hazel Avenue, and installation of sidewalks, street lighting, and landscaping along the north side of Folsom Boulevard, and landscaping and lighting along the south.

1.3.2 Transition Lane to U.S. 50/Folsom Boulevard Interchange

As indicated in Caltrans' 2009 Corridor System Management Plan, eastbound U.S. 50 is shown to have 1 HOV lane and 3 mixed flow lanes to Hazel Avenue as the Concept Facility. Also, eastbound U.S. 50 is shown to have 1 HOV lane and 3 mixed flow lanes across Folsom Boulevard as the Ultimate Facility. This Project will accommodate these future facility improvements, will conform to the approved Caltrans project at U.S. 50/Folsom Boulevard interchange that is constructing a portion of those improvements in 2016, and will then restripe the third mixed flow lane through the U.S. 50/Folsom Boulevard interchange.

This Project is required to add the mixed flow lane because it has been determined in the traffic analysis for this Project, and in studies for adjacent projects, that the additional eastbound lane on U.S. 50 extending through the Folsom Boulevard interchange is needed for operations. Under all alternatives, accommodating this mixed flow lane will require the eastbound loop on-ramp to extend its auxiliary lane to the U.S. 50/Folsom Boulevard eastbound off-ramp. This will require widening and a new structure over Alder Creek.

Currently Alder Creek flows under U.S. 50 through a box culvert (Bridge No. 24-0033). A mechanically stabilized earth (MSE) wall (Bridge No. 24-0372) is above the culvert. To widen U.S. 50 over Alder Creek, a new bridge will be required. The new bridge is necessary because there is insufficient lateral space to construct an adjacent MSE wall on top of the culvert and the creek maintains a high operating water level.

1.3.3 Railroad Overhead

Hazel Avenue will extend and be grade-separated over Folsom Boulevard and the SPTC-JPA rail corridor. Currently there is one light rail track located on the north side of the Union Pacific Railroad (UPRR) tracks. Sacramento Regional Transit plans to add another track at this location in the future. When the addition of that track occurs, the existing UPRR track will be relocated south to accommodate the second light rail track. The proposed design meets the requirements for all three tracks, with the clearances shown in the figure below. Temporary vertical clearances of 21-foot-6-inches and permanent vertical clearances of 24 feet have been accounted for in the layout of all three alternatives for the Hazel Avenue Overhead. The vertical clearance provided will accommodate the Overhead Catenary System for the light rail.

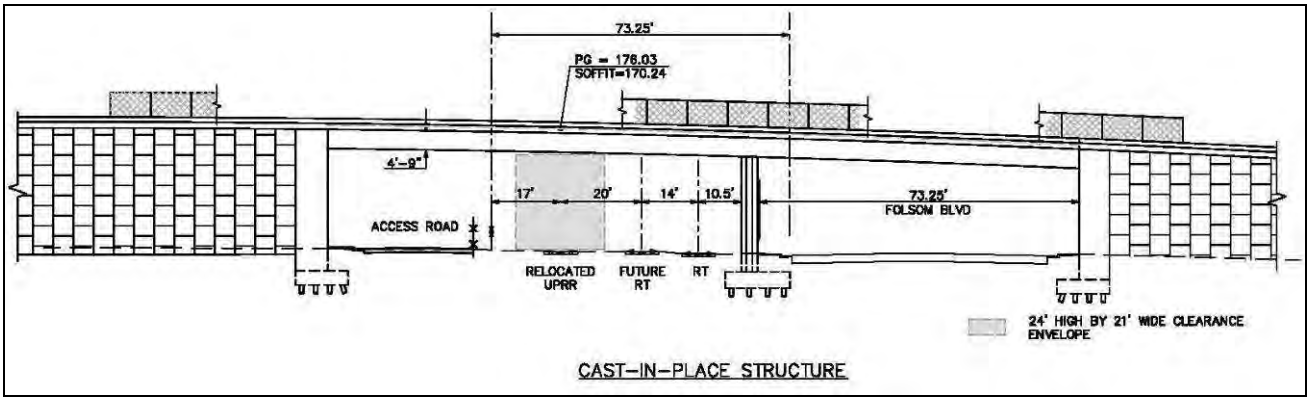


Figure 3. Railroad Overhead Schematic

1.3.4 Build Alternative 1: L-9 Interchange with Viaduct Connector

Alternative 1 consists of a modified type L-9 interchange configuration. A Caltrans Type L-9 interchange indicates a ramp configuration that includes a diagonal off-ramp, a diagonal on-ramp and a loop on-ramp. This alternative will provide a viaduct connection to Aerojet Road (see Figure 4).

As with all alternatives, Hazel Avenue will grade-separate over Folsom Boulevard and the SPTC-JPA rail corridor and will extend further south to a proposed intersection with the future Atlanta Street (a new roadway as part of the Easton Place development). The existing at-grade intersection of Hazel Avenue and Folsom Boulevard will be removed, sidewalks will be extended across the former intersection, and the lanes will be re-striped to remove left turn lanes.

The location of the departure point of the existing Aerojet Road off-ramp from U.S. 50 will be moved to join with the eastbound Hazel Avenue off-ramp. The eastbound Hazel Avenue off-ramp will split and introduce a direct viaduct ramp over Hazel Avenue to carry eastbound off-ramp traffic to Aerojet Road and Folsom Boulevard. The off-ramp diverge from U.S. 50 will be shifted approximately 830 feet to the east to provide decision sight distance before the Aerojet Road split. The two-lane off-ramp will widen to five lanes at the ramp terminal intersection, with three left turn lanes and two right turn lanes. Retaining walls and barriers placed at the proposed right-of-way will minimize acquisition. The eastbound off-ramp will also have an auxiliary lane prior to the exit.

The Aerojet Road viaduct will land adjacent to the eastbound diagonal on-ramp and then turn southerly to conform to Folsom Boulevard along its existing alignment. Retaining walls are proposed between the viaduct and the diagonal on-ramp to accommodate the grade difference, and to the outside of the ramp after the viaduct lands, to minimize right-of-way acquisitions. Retaining walls are also proposed along Aerojet Road as it approaches the horizontal curve towards Folsom Boulevard to accommodate the grade difference between the ramp and mainline and to minimize right-of-way acquisition.

The existing Hazel Avenue Overcrossing of U.S. 50 will be widened on the west side to accommodate eight lanes (3 through lanes and 1 freeway-only lane in both directions). The existing raised concrete median across the structure will be removed, and the roadway will be re-striped with a 6-foot striped median. The existing sidewalk and barrier on the east side of the structure will remain.

1.3.5 Alternative 1A: L-9 Interchange with Undercrossing Connector

Alternative 1A is the same as Alternative 1, with the following exceptions:

The eastbound off-ramp will split and introduce a direct tunnel ramp under Hazel Avenue to carry eastbound off-ramp traffic to Aerojet Road and Folsom Boulevard (see Figure 5).

1.3.6 Alternative 2: Direct Flyover to Hazel Avenue With Connector

Alternative 2 consists of a modified type L-9 interchange configuration, with a flyover ramp carrying vehicles travelling from eastbound U.S. 50 to northbound Hazel Avenue over the freeway to join with the westbound off-ramp (see Figure 6).

The existing Aerojet Road off-ramp from U.S. 50 will be removed.

The eastbound off-ramp diverge from U.S. 50 will be shifted approximately 680 feet to the east to provide decision sight distance. An auxiliary lane will precede the off-ramp. A retaining wall is proposed adjacent to the off-ramp to minimize right-of-way acquisition.

The eastbound off-ramp will split and introduce northbound and southbound Hazel Avenue ramps. The northbound ramp will also carry traffic headed for Aerojet Road/Folsom Boulevard. An overhead sign will direct vehicles heading to southbound Hazel Avenue to the right lane, and vehicles destined for northbound Hazel Avenue or Aerojet Road or Folsom Boulevard to use either lane. Retaining walls are proposed for the ramp as it approaches the horizontal curve towards Folsom Boulevard to accommodate the grade difference between the ramp and mainline and to minimize right-of-way acquisition at an apartment complex.

The northbound Hazel Avenue movement will cross under Hazel Avenue at the interchange, cross over U.S. 50 on a two-lane flyover structure, and then merge with the westbound off-ramp and terminate at the Hazel Avenue/Tributary Point intersection. The westbound off-ramp will split so that the southbound and through movements align to the left of the ramp, and the northbound movements are to the right.

The southbound ramp will connect directly to Hazel Avenue. However, in Alternative 2 an intersection is not required at Hazel Avenue and the eastbound ramp. By eliminating an intersection at the eastbound ramp, and by removing the heavy eastbound-to-northbound movements from the Hazel Avenue overcrossing, the existing structure can remain without widening.

The two-lane westbound off-ramp will be reconstructed to provide decision sight distance between the divergence point from U.S. 50 and a new ramp split that accommodates the flyover. The westbound off-ramp will split on either side of the flyover ramp, with one lane to the right carrying northbound Hazel Avenue traffic and the other crossing underneath the flyover ramp to join up on the left side of the flyover for the southbound Hazel Avenue movements. The profiles of the three ramps have been coordinated to match grade quickly to minimize retaining wall limits and enhance driver visibility. Overhead signage will direct drivers into the appropriate lanes for northbound and southbound Hazel Avenue traffic.

1.3.7 No-Build Alternative

Alternative 3, the No Build Alternative, would not modify the U.S. 50/Hazel Avenue Interchange. The interchange would remain with the same existing configuration, ramps, and lanes. This alternative does not meet the purpose and need of the Project.



Figure 4. Alternative 1: L-9 Interchange with Viaduct Connector



Figure 5. Alternative 1a: L-9 Interchange with Undercrossing Connector



Figure 6. Alternative 2: Direct Flyover to Hazel Avenue with Connector

1.3.8 Impervious and Disturbed Soil Areas

The estimated existing and new impervious surface and disturbed soil areas (DSA) are shown in Table 1. These impervious and DSA values will be further refined during the design phase once the limits of grading, construction staging locations, and Project geometry have been developed.

Table 1. Impervious and Disturbed Soil Areas

Alternative	Impervious Area (acre)		DSA (acre)
	Existing	New	
1	26.6	8.4	44.7
1A		8.6	45.2
2		9.6	54.6

1.4 Risk Level Assessment

The proposed build alternatives would disturb an area or more of soil. As a result, in accordance with the Statewide Construction General Permit (CGP), a risk assessment of this Project is required; the CGP is discussed further in Section 2.2.3 of this Water Quality Assessment Report (WQAR). The Project Risk Level is determined from the sediment risk and receiving water risk. The sediment risk factor is determined from the product of the rainfall runoff erosivity factor (R), the soil erodibility factor (K), and the length-slope factor (LS). The R factor was determined from the U.S. Environmental Protection Agency (EPA) "Stormwater Phase II Final Rule Construction Rainfall Erosivity Waiver" (Revised March 2012). The estimated construction schedule is currently not planned, so the R factor is based on an estimated two-year construction period. The K values presented in this section are based on general soil classification from the Natural Resources Conservation Service (NRCS) "Web Soil Survey" along the Project site. The Project LS factor was determined using the Caltrans "Water Quality Planning Tool." The factors used to determine the sediment risk are summarized in Table 2 and included in Appendix A.

Table 2. Sediment Risk Factors

R	K	LS	R*K*LS	Sediment Risk
100	0.32	0.74	23.68	Medium

Based on the available information at this phase, the Project has medium sediment risk because the product of the R, K, and LS factor is between 15 and 75. For the Project to be classified as having a high sediment risk, the construction duration would have to be greater than six and a half years. As previously noted, the construction schedule is not currently planned; the sediment risk factor would be updated once this schedule has been refined.

The Project is classified as having a high receiving water risk because the Project is located within a hydrologic sub-area (HSA) where the surface water bodies have the combined existing

beneficial uses of cold freshwater habitat, fish migration, and fish spawning. The HSA was determined using the Caltrans "Water Quality Planning Tool," and the beneficial uses are listed in the Central Valley Regional Water Quality Control Board's (RWQCB) Basin Plan (2015).

The combined medium sediment risk and high receiving water risk results in the Project being classified as Risk Level 2. Risk Level 2 project requirements include preparation of Rain Event Action Plans prior to an anticipated rain event, and stormwater sampling at all discharge locations, with the samples subject to numeric action levels for pH and turbidity.

1.5 Approach to Water Quality Assessment

The purpose of the WQAR is to fulfill the requirements of the National Environmental Policy Act and the California Environmental Quality Act, and to provide information, to the extent possible, for National Pollutant Discharge Elimination System (NPDES) permitting. The document includes a discussion of the proposed Project, the physical setting of the Project area, and the regulatory framework with respect to water quality. It also provides data on surface water and groundwater resources within the Project area and the water quality of these waters, describes water quality impairments and beneficial uses, identifies potential water quality impacts/benefits associated with the proposed Project, and recommends avoidance and/or minimization measures for potentially adverse impacts.

2 REGULATORY SETTING

2.1 Federal Laws and Requirements

2.1.1 Clean Water Act

In 1972 Congress amended the Federal Water Pollution Control Act, making the addition of pollutants to the waters of the U.S. from any point source unlawful unless the discharge is in compliance with an NPDES permit. Known today as the Clean Water Act (CWA), Congress has amended it several times. In the 1987 amendments, Congress directed dischargers of stormwater from municipal and industrial/construction point sources to comply with the NPDES permit scheme. Important CWA sections are:

- Sections 303 and 304 require states to promulgate water quality standards, criteria, and guidelines.
- Section 401 requires that an applicant for a federal license or permit for any activity potentially resulting in a discharge to waters of the U.S. must obtain certification from the State that the discharge will comply with other provisions of the act. (Most frequently required in tandem with a Section 404 permit request. See below).
- Section 402 establishes the NPDES, a permitting system for the discharges (except for dredge or fill material) of any pollutant into waters of the U.S. The RWQCB administer this permitting program in California. Section 402(p) requires permits for discharges of stormwater from industrial/construction and Municipal Separate Storm Sewer Systems (MS4s).
- Section 404 establishes a permit program for the discharge of dredge or fill material into waters of the U.S. This permit program is administered by the U.S. Army Corps of Engineers (USACE).

The objective of the CWA is "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters."

USACE issues two types of 404 permits: Standard and General permits. For General permits, there are two types: Regional permits and Nationwide permits. Regional permits are issued for a general category of activities when they are similar in nature and cause minimal environmental effect. Nationwide permits are issued to authorize a variety of minor project activities with no more than minimal effects.

There are also two types of Standard permits: Individual permits and Letters of Permission. Ordinarily, projects that do not meet the criteria for a Nationwide Permit may be permitted under one of USACE's Standard permits. For Standard permits, the USACE's decision to approve is based on compliance with the U.S. EPA's Section 404 (b)(1) Guidelines (U.S. EPA CFR 40 Part 230) and whether permit approval is in the public interest. The 404(b)(1) Guidelines were developed by the U.S. EPA in conjunction with the USACE, and allow the discharge of dredged

or fill material into the aquatic system (waters of the U.S.) only if there is no practicable alternative that would have less adverse effects. The 404(b)(1) Guidelines state that USACE may not issue a permit if there is a least environmentally damaging practicable alternative to the proposed discharge that would have fewer effects on waters of the U.S. and not have any other significant adverse environmental consequences. Per the 404(b)(1) Guidelines, documentation is needed that a sequence of avoidance, minimization, and compensation measures have been followed, in that order. The 404(b)(1) Guidelines also restrict permitting activities that violate water quality or toxic effluent standards, jeopardize the continued existence of listed species, violate marine sanctuary protections, or cause "significant degradation" to waters of the U.S. In addition, every permit from the USACE, even if not subject to the 404(b)(1) Guidelines, must meet general requirements; see 33 CFR 320.4.

2.2 State Laws and Requirements

2.2.1 Porter-Cologne Water Quality Control Act

California's Porter-Cologne Act, enacted in 1969, provides the legal basis for water quality regulation within California. This Act requires a "Report of Waste Discharge" for any discharge of waste (liquid, solid, or gaseous) to land or surface waters that may impair beneficial uses for surface and/or groundwater of the State. It predates the CWA and regulates discharges to waters of the State. Waters of the State include more than just waters of the U.S., like groundwater and surface waters not considered waters of the U.S. Additionally, it prohibits discharges of "waste" as defined and this definition is broader than the CWA definition of "pollutant." Discharges under the Porter-Cologne Act are permitted by Waste Discharge Requirements (WDRs) and may be required even when the discharge is already permitted or exempt under the CWA.

The State Water Resources Control Board (SWRCB) and RWQCBs are responsible for establishing the water quality standards (objectives and beneficial uses) required by the CWA, and regulating discharges to ensure compliance with the water quality standards. Details regarding water quality standards in a project area are contained in the applicable RWQCB Basin Plan. In California, Regional Boards designate beneficial uses for all water body segments in their jurisdictions, and then set criteria necessary to protect these uses. Consequently, the water quality standards developed for particular water segments are based on the designated use and vary depending on such use. In addition, the SWRCB identifies waters failing to meet standards for specific pollutants, which are then state-listed in accordance with CWA Section 303(d). If a state determines that waters are impaired for one or more constituents, and the standards cannot be met through point source or non-source point controls (NPDES permits or Waste Discharge Requirements), the CWA requires the establishment of Total Maximum Daily Loads (TMDLs). TMDLs specify allowable pollutant loads from all sources (point, non-point, and natural) for a given watershed.

2.2.2 State Water Resources Control Board and Regional Water Quality Control Boards

The SWRCB adjudicates water rights, sets water pollution control policy, issues water board orders on matters of statewide application, and oversees water quality functions throughout the state by approving Basin Plans, TMDLs, and NPDES permits. RWQCBs are responsible for

protecting beneficial uses of water resources within their regional jurisdiction using planning, permitting, and enforcement authorities to meet this responsibility.

2.2.3 National Pollutant Discharge Elimination System Program

Municipal Separate Storm Sewer Systems (MS4)

Section 402(p) of the CWA requires the issuance of NPDES permits for five categories of stormwater dischargers, including MS4s. The U.S. EPA defines an MS4 as "any conveyance or system of conveyances (roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, human-made channels, and storm drains) owned or operated by a state, city, town, county, or other public body having jurisdiction over stormwater, that are designed or used for collecting or conveying storm water." The SWRCB has identified Caltrans as an owner/operator of an MS4 pursuant to federal regulations. Caltrans' MS4 Permit (Order No. 2012-0011-DWQ) only covers properties, facilities, and activities within the State's right-of-way. The SWRCB or the RWQCB issues NPDES permits for five years, and permit requirements remain active until a new permit has been adopted. The Caltrans MS4 permit has been amended by Order 2014-0006-EXEC, Order 2014-0077-DWQ, and Order 2015-0036-EXEC.

Caltrans' MS4 Permit contains three basic requirements:

- Compliance with the requirements of the CGP (see below);
- Implementation of a year-round program in all parts of the State to effectively control stormwater and non-storm water discharges; and
- Stormwater discharges must meet water quality standards through implementation of permanent and temporary (construction) best management practices (BMPs) to the maximum extent practicable, and other measures as the SWRCB determines to be necessary to meet the water quality standards.

To comply with the permit, Caltrans developed the Statewide Storm Water Management Plan (SWMP) to address stormwater pollution controls related to highway planning, design, construction, and maintenance activities throughout California. The SWMP assigns responsibilities within Caltrans for implementing stormwater management procedures and practices as well as training, public education and participation, monitoring and research, program evaluation, and reporting activities. The SWMP describes the minimum procedures and practices that Caltrans uses to reduce pollutants in stormwater and non-storm water discharges. It outlines procedures and responsibilities for protecting water quality, including the selection and implementation of BMPs. The proposed Project will be programmed to follow the guidelines and procedures outlined in the latest SWMP to address stormwater runoff.

Construction General Permit

The CGP (Order No. 2009-009-DWQ, as amended by 2010-0014-DWG and 2012-0006-DWQ), adopted on November 16, 2010, became effective on February 14, 2011. The permit regulates stormwater discharges from construction sites that result in land disturbance of one acre or greater, and/or are smaller sites that are part of a larger common plan of development. For all projects subject to the CGP, applicants are required to develop and implement an effective Storm

Water Pollution Prevention Plan (SWPPP). In accordance with Caltrans' Standard Specifications, a Water Pollution Control Plan is necessary for projects with a DSA of less than one acre.

By law, all stormwater discharges associated with construction activity where clearing, grading, and excavation results in soil disturbance of at least one acre must comply with the provisions of the CGP. Construction activity that results in soil disturbances of less than one acre is subject to this CGP if there is potential for significant water quality impairment resulting from the activity as determined by the RWQCB. Operators of regulated construction sites are required to develop SWPPPs; implement sediment, erosion, and pollution prevention control measures; and obtain coverage under the CGP.

The CGP separates projects into Risk Levels 1, 2, or 3. Risk levels are determined during the planning and design phases and are based on potential erosion and transport to receiving waters. Requirements apply according to the Risk Level determined. For example, a Risk Level 3 (highest risk) project would require compulsory stormwater runoff pH and turbidity monitoring, and pre- and post-construction aquatic biological assessments during specified seasonal windows.

Section 401 Permitting
Under Section 401 of the CWA, any project requiring a federal license or permit that may result in a discharge to a water of the United States must obtain a 401 Certification, which certifies that the project will be in compliance with State water quality standards. The most common federal permit triggering 401 Certification is a CWA Section 404 permit, issued by the USACE. The 401 permit certifications are obtained from the appropriate RWQCB, dependent on the project location, and are required before USACE issues a 404 permit.

In some cases, the RWQCB may have specific concerns with discharges associated with a project. As a result, the RWQCB may issue a set of requirements known as WDRs under the State Water Code (Porter-Cologne Act) that define activities, such as the inclusion of specific features, effluent limitations, monitoring, and plan submittals that are to be implemented for protecting or benefiting water quality. WDRs can be issued to address both permanent and temporary discharges of a project.

2.3 Regional and Local Requirements

2.3.1 RWQCB Basin Plan

The County and City are within the limits of the Central Valley RWQCB. The Central Valley RWQCB developed the Water Quality Control Plan for the Sacramento and San Joaquin River Basins (Basin Plan), which designates the beneficial uses of waters within the region, establishing water quality objectives, and containing plans and policies for all waters within the basin. The fourth edition of the Basin Plan was revised June 2015, which incorporates the approved amendments to date.

2.3.2 MS4

The Project proposes work within Caltrans, County, and the City's right-of-way. The portion of the Project within the State's right-of-way will be subject to Caltrans' Storm Water Management Plan, including Caltrans' MS4 Permit (Order No. 2012-0011-DWQ),which is discussed in Section 2.2.3 of this WQAR.

The Project limits within the City and County are covered under the Sacramento County Region-Wide General Permit for Discharges from MS4S, Permit R5-2016-0040, NPDES No. CAS0085324, adopted on MS4 Permit Order No. R5-2015-0023, NPDES Permit No. CAS082597, adopted on June 23, 2016. The current MS4 Permit requirements for development and redevelopment projects, and the applicable measures to comply with these requirements are outlined in the *Stormwater Quality Design Manual* (May 2014) developed by the Sacramento Stormwater Quality Partnership.

3 AFFECTED ENVIRONMENT/EXISTING CONDITIONS

3.1 Introduction

The area studied for this WQAR includes the Project limits and nearby areas as appropriate, including the Hazel Avenue interchange, U.S. 50 at and surrounding the interchange, and local area streets that connect to Hazel Avenue where improvements are proposed to conform to the proposed Hazel Avenue (Figure 2).

The methods and procedures considered for the development of this WQAR were the federal, state, and local water quality laws and regulations relevant to the Project study area. These laws and regulations include the Clean Water Act, California's Porter-Cologne Water Quality Control Act, and Caltrans regulations.

As part of this WQAR, existing topographic data from the U.S. Geological Survey (USGS), erosion and general soil data from the U.S. Department of Agriculture NRCS *Web Soil Survey*, and hydrology and surface stream information from the Federal Emergency Management Agency (FEMA) were utilized. General information regarding channel geomorphology, existing groundwater, and biotic and aquatic groups specific to the study area were considered in order to evaluate the impacts that would result from the construction of the Project.

3.2 General Setting

3.2.1 Population and Land Use

The City's website identifies the total 2016 population as 72,203 with an expected 2020 population of 77,239 (Rancho Cordova 2016). The areas west and south of the Hazel Avenue interchange consist of commercial and light industrial land uses. The Nimbus Flat area of the Folsom Lake State Recreation Area is located east of the northeastern quadrant of the interchange. This recreational area extends north of U.S. 50 to the eastern extent of the Project.

3.2.2 Topography

The topography generally trends northwesterly towards the Folsom South Canal and the base of the Nimbus Dam. The area is flat except at the existing overpass and on- and off- ramps where the grade climbs for an approximately 30 feet.

3.2.3 Hydrology

3.2.3.1 Regional Hydrology

The Caltrans "Water Quality Planning Tool" identifies the Project area as being in the Calwater watershed of the Lower American HSA (#519.21) of the Valley-American hydrologic unit and Coon-American hydrologic area. The tool also identifies the Project area as being within the USGS Watershed Boundary Dataset of the Upper American River sub-watershed of the American River watershed.

3.2.3.2 Local Hydrology

Precipitation and Climate

Winters within the region are mild and wet with precipitation expected to be predominantly between October 15 and April 15. The area has an average annual precipitation of 22.21 inches. Summers within the region are dry with rare occurrences of precipitation. The average temperature is 63.3 degrees with a high average of 93.8 degrees Fahrenheit in July and a low average of 40.4 degrees Fahrenheit in December (Caltrans 2014).

Surface Streams

Alder Creek is the only surface water to cross the Project; the creek crosses U.S. 50 at post mile 16.46 via a bridge structure (Bridge No. 24 003) (Caltrans 2016).

Alder Creek and areas east of the Hazel Avenue interchange drain northerly towards Lake Natoma, which roughly parallels U.S. 50 from the eastern extent of the Project to the Nimbus Dam. The dam discharges water into the American River and Folsom South Canal. The canal roughly parallels U.S. 50 to the north. Runoff from Project west of the Hazel Avenue interchange drains northerly towards the canal. The canal crosses U.S. 50 outside the limits of the Project at post mile 14.80 via a reinforced concrete box (Bridge No. 24 0339).

Floodplains

The Project extends through FEMA Flood Insurance Rate Maps (FIRMs) 06067C0113H (2012a) and 06067C0114H (2012b). The FIRMs identify the northeastern portion of the westbound U.S. 50 off-ramp to Hazel Avenue as being within a shaded Zone X area associated with Lake Natoma. The maps also identify U.S. 50 at and east of the Alder Creek crossing as being within Zone AE and shaded Zone X areas; these areas are associated with Alder Creek. The remainder of the Project is not located within a FEMA floodplain. The FIRMS are included in Appendix B.

Shaded Zone X areas are classified as areas of: 0.2% annual chance flood (500-year floodplain), 1% annual chance flood (100-year floodplain) with average depths of less than 1 foot or with drainage areas less than 1 square mile, and/or protected by levees from 1% annual chance flood. Zone AE areas are floodway areas subject to inundation by the 1% annual chance flood where base flood elevations have been determined. The base flood elevation for the Zone AE associated with Alder Creek is 128 feet referenced to the North American Vertical Datum of 1988.

Municipal Supply

The Caltrans District 3 Work Plan (2015) does not identify any drinking water reservoirs or recharge facilities near U.S. 50 in Sacramento County. While the Work Plan does not identify any municipal supply sources, the Folsom South Canal is used for municipal water supply.

3.2.3.3 Groundwater Hydrology

The *Preliminary Geotechnical Report* (Parikh 2013) found that based on as-built log of test borings from 1990 to 1996, the measured groundwater was found approximately 17.7 to 25.3 feet below existing groundline.

3.2.4 Geology/Soils

The NRCS Web Soil Survey identifies the soils within the Project area as comprising Natomas loam, Natomas-Xerorthents, urban land, and Xerorthents; a map of the survey area used for this Project is included in Appendix A.1 Natomas loam is classified as being within hydrologic soil group (HSG) C, and Xerorthents are classified as being within HSG A; the remainder of the soils are not classified as being within any HSG. Soils within HSG A have high infiltration rates, while soils within HSG C have slow infiltration rates.

3.2.4.1 Soil Erosion Potential

The Web Soil Survey provides limited soil erosion K factor information for the Project area because much of the area consists of urban land or dredge trailings. K factor information is available for the areas east of the Hazel Avenue interchange; these areas have a K factor of 0.32. K factors range from 0.02 to 0.69, so a value of 0.32 suggests that the soils have a moderate potential for soil erosion.

The Caltrans District 3 Work Plan does not identify slopes prone to erosion within the County.

3.2.5 Biological Communities

The *Natural Environment Study* (ICFI 2016) discusses in detail the various biological communities present within the Project area. This section summarizes information from the study.

3.2.5.1 Special-Status Species

The study determined that there is potential habitat for special-species plant species within the biological study area; however, the study area has a low likelihood of supporting special-status plants because the natural communities have substantially altered from historical conditions. Furthermore, botanical surveys did not observe special-status plants within the study area.

The study determined that 11 special-status animal species may occur in the study or be affected by the proposed Project. These species are: vernal pool fairy shrimp, midvalley fairy shrimp, valley elderberry longhorn beetle, western pond turtle, Swainson's hawk, white-tailed kite, yellow-breasted chat, tricolored blackbird, song sparrow (Modesto population), Pallid bat, and western red bat. Focused surveys for each of these species have not been conducted. Due to the potential habitat for these species, the study evaluates the potential direct, indirect, and cumulative impacts, and recommends appropriate avoidance and minimization efforts, and compensatory mitigation for each species.

3.2.5.2 Stream/Riparian Habitats

Alder Creek crosses U.S. 50 within the Project limits. The study determined that valley foothill riparian woodland occurs on the banks of Alder Creek above the ordinary high water mark. The riparian woodland provides high-value habitat for wildlife by providing food, water, and migration and dispersal corridors, as well as escape, nesting, and thermal cover for many wildlife species.

3.2.5.3 Wetland

Emergent wetland occurs at the edges of open water in Alder Creek below valley foothill riparian woodland vegetation and below the ordinary high water mark of the creek. The wetland provides food, cover, and water for a variety of amphibians, reptiles, birds, and mammals. Seasonal wetlands within the study area consist of created features that occur within the existing cloverleaf loops of the U.S. 50/Hazel Avenue interchange and several small inclusions of seasonal wetland vegetation in depressions. The seasonal wetlands and pools provide unique habitat for a variety of aquatic invertebrates and are used for breeding and feeding by amphibians. Both the emergent and seasonal wetlands are potential waters of the U.S. and are waters of the State.

3.2.5.4 Fish Passage

The Central Valley RWQCB Basin Plan identifies the surface water bodies within HSA #519.21 as having the beneficial uses of fish migration for both warm and cold freshwater fish species.

3.3 Water Quality Objectives/Standards and Beneficial Uses

3.3.1 Surface Water Quality Objectives/Standards and Beneficial Uses

The Central Valley RWQCB Basin Plan identifies narrative and numerical water quality objectives for the region. The general water quality objectives established within the Central Valley region include bacteria, biostimulatory substances, chemical constituents, color, dissolved oxygen, floating material, oil and grease, pesticides, pH, radioactivity, salinity, sediment, settleable material, suspended material, tastes and odors, temperature, toxicity, and turbidity. Excerpts from the Basin Plan detailing the water quality objectives for surface waters are included in Appendix C.1 of this WQAR.

Beneficial uses are critical to water quality management in California. According to State law, the beneficial uses of California's water that may be protected against quality degradation include, but are not limited to, "domestic, municipal, agricultural and industrial supply, power generation, recreation, aesthetic enjoyment, navigation, and preservation and enhancement of fish, wildlife, and other aquatic resources or preserves" (Water Code Section 13050). Descriptions of these beneficial uses are included in Appendix D of this WQAR. Protection and enhancement of existing and potential beneficial uses are primary goals of water quality planning.

The CVRWQCB Basin Plan lists the following beneficial uses for surface waters within HSA #519.21:

- Municipal and domestic supply
- Agricultural irrigation
- Industrial service supply and power
- Contact, canoeing, and rafting recreation
- Other noncontact recreation
- Warm and cold freshwater fish habitat

- Warm and cold fish migration
- Warm and cold fish spawning
- Wildlife habitat

3.3.2 Groundwater Quality Objectives/Standards and Beneficial Uses

The Central Valley RWQCB Basin Plan identifies narrative and numerical groundwater objectives for the region. The general water quality objectives established within the Central Valley region include bacteria, chemical constituents, radioactivity, tastes and odors, and toxicity. The Basin Plan identifies narrative and numerical groundwater objectives for the region, stating, "Unless otherwise designated by the Regional Water Board, all ground waters in the Region are considered as suitable or potentially suitable, at a minimum, for municipal and domestic water supply, agricultural supply, industrial service supply, and industrial process supply." Excerpts from the Basin Plan detailing the water quality objectives for ground waters are included in Appendix C.2 of this WQAR.

3.4 Existing Water Quality

Surface water and groundwater quality information in the Project area was obtained from the Central Valley RWQCB Basin Plan and SWRCB website.

3.4.1 Regional Water Quality

Water quality concerns, such as impairments of beneficial uses or degradations of water quality, may arise. At any given time, water quality problems generally reflect the intensity of activities of key discharge sources and the volume, quality, and uses of the receiving waters affected by the discharges. Historic and ongoing point and nonpoint source discharges impact surface waters. Substantial portions of major rivers are impaired, to some degree, by discharges from agriculture, mines, urban areas, and industries. A variety of historic and ongoing point and non-point industrial, urban, and agricultural activities degrade the quality of groundwater. Discharges to groundwater associated with these activities include industrial and agricultural chemical use and spills; underground and above ground tank and sump leaks; landfill leachate and gas releases; septic tank failures; improper animal waste management; and chemical seepage via shallow drainage wells and abandoned wells.

3.4.2 List of Impaired Waters

The American River and Lake Natoma are listed on the 2012 Clean Water Act 303(d) list of impaired water bodies; the Project discharges to the segment of the American River identified as "Lower American River (Nimbus Dam to confluence with Sacramento River)." Table 3 lists the pollutants for which water quality standards are not met and a TMDL is required. Alder Creek and Folsom South Canal are not listed on the 303(d) list.

The 303(d) list states that the source of the listed pollutants is unknown. Although the TMDL completion date for mercury within the American River was scheduled for 2010, as of the date of this WQAR, the TMDL has not been completed or approved.

Table 3. Pollutants of the Project Receiving Waters

Water Body	Pollutant	Scheduled TMDL Date
Lower American River (Nimbus Dam to confluence with Sacramento River)	Mercury	2010
	Polychlorinated Biphenyls (PCBs)	2021
	Unknown Toxicity	2021
Lake Natoma	Mercury	2019

Source: SWRCB

3.4.3 Areas of Special Biological Significance

There are no areas of special biological significance located within or near the Project.

4 ENVIRONMENTAL CONSEQUENCES

The following sections present the potential temporary and permanent water quality impacts from the proposed Project activities.

During construction, potential water quality impacts include sediment-laden discharge from DSAs and pollutant-laden discharge from storage or work areas. Temporary impacts can also result from construction near water resources. Permanent impacts to water quality result from the addition and replacement of impervious area; the impervious area prevents runoff from naturally dispersing and infiltrating into the ground, resulting in increased concentrated flow.

4.1 Introduction

In the current condition, runoff from the roadway either sheet flows off the roadway over vegetated surfaces and into roadside ditches or is collected by drainage inlets within the median, runoff from the ramps sheet flow off the roadway onto vegetated surfaces, and runoff along Hazel Avenue is collected by a network of drainage inlets and culverts. There are no existing permanent stormwater treatment measures or low impact development practices used to minimize or prevent sediment or pollutant-laden flows from entering Alder Creek, American River, Lake Natoma, or the Folsom South Canal. The proposed roadway improvements will modify, remove and replace, and/or propose new drainage facilities. It is also likely that the widening and roadway modifications will necessitate the need for dikes, curbs, and barriers that would inhibit existing areas of sheet flow, resulting in more inlets and culverts to convey concentrated runoff flows. Where feasible, the proposed drainage improvements will connect to existing outfalls, but it is anticipated that modified or new outfalls would be necessary.

To address the increases in flow, loss of existing sheet flow areas, and potential increases in pollutant laden runoff, the proposed roadway and drainage design will incorporate low impact development concepts that promote infiltration and protect water quality, and implement post-construction stormwater treatment BMPs. These avoidance and minimization measures are discussed further in Section 5 of this WQAR.

4.2 Potential Impacts to Water Quality

4.2.1 Anticipated Changes to the Physical/Chemical Characteristics of the Aquatic Environment

This Project results in an increase of impervious areas and therefore could potentially increase the volume and velocity of stormwater flow to downstream receiving water bodies. In addition, pollutant loading can also be increased. The newly created impervious area is directly related to the potential permanent water quality impacts. Stormwater runoff from the Project corridor both directly and indirectly drains into receiving waters that could be potentially impacted by the increases in volume, velocity, and pollutant loading.

4.2.1.1 Substrate

The Project proposes work within waterway crossings to replace or modify existing bridges. The modification and/or replacement of the bridge can result in changes to creek characteristics at the crossing and upstream and downstream of the crossing depending on the geometry of the proposed bridge.

4.2.1.2 Currents, Circulation, or Drainage Patterns

The goal of the Project drainage design will be to maintain existing drainage patterns. To the extent practicable, drainage facilities will be designed to connect to existing outfalls and not divert flows from the Project area to discharge to a differing water bodies; e.g. areas that currently drain to Alder Creek will not be collected and conveyed to directly discharge to the American River or Folsom South Canal. However, while the watershed to each receiving water will not change, the proposed interchange replacement and widening, improvements to the ramps, and modifications to U.S. 50 will result in the removal and replacement of local drainage facilities and installation of new drainage facilities, which will impact local drainage patterns. The additional impervious area created by the Project may result in impacts to the existing hydrograph, including increases in low flow and peak flow velocity and volume to Project water bodies.

The Project proposes work within Alder Creek to modify the existing bridges. The bridge improvements have the potential to result in changes to creek characteristics at the crossing and upstream and downstream of the crossing depending on the geometry of the proposed bridge.

4.2.1.3 Suspended Particulates (Turbidity)

In-water work for the new bridge structure and supports would require excavation, mobilization, and grading within the creek and banks. This work could result in disturbed and excavated soils entering the waterway and increasing the turbidity locally and within the lake and river downstream of the Project. These impacts would be minimized by working within allowable construction periods directed by Caltrans and the regulatory agencies. Proper implementation of temporary diversion systems and dewatering operations, as appropriate, would also be used to minimize these short-term impacts.

This Project will result in additional impervious area, which increases the amount of runoff not infiltrating into the ground. This non-infiltrated and concentrated runoff results in the direct discharge of sediment-laden flow from the roadway to receiving water bodies. Any stormwater impacts would be minimized through proper implementation of permanent design pollution prevention and post-construction stormwater treatment BMPs.

4.2.1.4 Oil, Grease, and Chemical Pollutants

Heavy metals associated with vehicle tire and brake wear, oil and grease, and exhaust emissions are the primary pollutants associated with transportation corridors. Generally, highway stormwater runoff has the following pollutants: total suspended solids, nitrate nitrogen, total Kjeldahl nitrogen, phosphorus, ortho-phosphate, copper, lead, and zinc. The pollutants are dispersed from tree leaves, combustion products from fossil fuels, and the wearing of brake pads and tires. The build alternatives may have potential permanent water quality impacts due to

increasing congestion, i.e., more types of vehicles being able to drive along the interchange and U.S. 50, leading to a greater deposition of particulates from exhaust and heavy metals from braking.

4.2.1.5 Temperature, Oxygen, Depletion, and Other Parameters

The Project is not expected to impact temperature, oxygen, depletion impacts.

4.2.1.6 Flood Control Functions

The goal of the Project is to avoid and minimize any effects to the existing floodplain. The Project proposes a new bridge over Alder Creek. The new bridge would likely include new piers being placed inside the creek and within the limits of the Alder Creek floodplain. These obstructions, new fill, and increased impervious area within the floodplain could result in increases to the base flood elevation and floodplain characteristics. The Project *Location Hydraulic Study* (2016) provides a detailed analysis of the Project effects to the existing floodplain and measures considered to avoid, minimize, and mitigate these impacts.

4.2.1.7 Storm, Wave and Erosion Buffers

There are no known storm, wave, or erosion buffers within the Project area, so no impacts to these features are expected.

4.2.1.8 Erosion and Accretion Patterns

The increase in impervious area can result in the modification of existing receiving water body hydrographs by increasing the flow volumes and rates and peak durations from the loss of unpaved overland flow and native infiltration (hydromodification). These hydromodification impacts can cause increased bed and bank erosion, loss of habitat, increased sediment transport and deposition, and increased flooding. This Project will be required to comply with the hydromodification requirements of the Caltrans MS4 permit that include assessing potential hydromodification impacts and providing measures to address these impacts.

4.2.1.9 Aquifer Recharge/Groundwater

The proposed Project will result in an increase in impervious area, which would decrease the area available for runoff to infiltrate the soil. This has the potential to decrease the volume of water that previously recharged local aquifers and reduce groundwater volumes. The impact on the aquifers and groundwater volumes may consequently impact the beneficial uses of the groundwater basins.

4.2.1.10 Baseflow

There are no expected baseflow impacts to the Project receiving waters. Water within Lake Natoma, Folsom South Canal, and Alder Creek are predominantly controlled by the Nimbus Dam. While the increase in impervious area would increase the amount of runoff from the Project, compared to the overall watershed that drains to the lake and is controlled by the dam, there would be no impacts to the baseflow characteristics.

4.2.2 Anticipated Changes to the Biological Characteristics of the Aquatic Environment

The *Natural Environment Study* provides a detailed discussion of the anticipated changes to the biological characteristics of the aquatic environment, including special aquatic sites, endangered or threatened species, and invasive species. The following discussion of potential changes is based on information related to the RWQCB Basin Plan.

4.2.2.1 Habitat for Fish and Other Aquatic Organisms

The surface waters within HSA #519.21 are identified as having the combined beneficial uses of freshwater fish habitat, migration, and spawning. Work within or near the Alder Creek may impact these beneficial uses. DSA created from grading, equipment mobilization, and other construction activities can result in increases in sediment and pollutant load, damaging the habitat and impacting the species present within the creek, river, or lake. The permanent increase in impervious area may result in a permanent increase in pollutant loading, plus hydromodification impacts can result in localized or downstream alterations to water body characteristics including erosion and loss of habitat due to increased velocities and volumes.

4.2.2.2 Wildlife Habitat

The surface waters within HSA #519.21 are identified as having the existing beneficial use of wildlife habitat. Potential impacts to wildlife habitat may occur during construction due to clearing and grubbing activities, blockages of migration or wildlife passages, or from general soil disturbance and movement of construction material. Permanent impacts to wildlife habitat are not expected because the Project area is currently and will remain a transportation corridor and appropriate wildlife habitat protection measures or mitigation would be implemented based on the permits obtained for the Project.

4.2.3 Anticipated Changes to the Human Use Characteristics of the Aquatic Environment

The surface waters within HSA #519.21 are identified as having the existing beneficial uses of both contact and noncontact recreation. These beneficial uses may potentially be impacted during construction, but no long-term impacts are anticipated.

4.2.3.1 Existing and Potential Water Supplies; Water Conservation

Folsom South Canal is used for municipal water; additionally, the American River is used as drinking water source. Runoff in the pre- and post-Project conditions discharges directly and indirectly to these waterways. Short-term impacts to the Project receiving waters during construction are discussed in Section 4.2.4.1 of this WQAR. Permanent impacts could include increases of pollutants and sediment due to the increase of impervious area, which were discussed in Section 4.2.1 of this WQAR.

The Project would need to consider water conservation efforts in accordance with local standards plus the current Caltrans “Model Water Efficient Landscape Ordinance” guidance. Therefore, water conservation impacts are not expected.

4.2.3.2 Recreational or Commercial Fisheries

Recreational fishing is allowed within Lake Natoma and the American River, and is likely allowed within Alder Creek at its confluence with the lake; fishing within the canal is likely not permitted. There are no identified commercial fisheries within the vicinity of the Project. The proposed improvements are not expected to have any impact to fishing with Lake Natoma or the American River. There is the potential for minimal impacts to fishing within Alder Creek during construction of the improvements to the U.S. 50 crossing over the creek. The Project is not expected to result in any impact to the creek that would affect fishing within Alder Creek.

4.2.3.3 Other Water Related Recreation

The waters within the HSA have the existing beneficial uses of contact and noncontact recreation. There are no anticipated permanent changes to these beneficial uses resulting from this Project.

4.2.3.4 Aesthetics of the Aquatic Ecosystem

There are no expected changes to the aesthetics of the aquatic ecosystem. Any work areas within Alder Creek for the proposed crossing improvements would be restored to or better than the existing conditions, as required by the permits obtained for the Project.

4.2.3.5 Parks, National and Historic Monuments, National Seashores, Wild and Scenic Rivers, Wilderness Areas, etc.

The Nimbus Flat area of the Folsom Lake State Recreation Area lies in the area east of Hazel Avenue and north of U.S. 50. Improvements to and within the area of the existing westbound off-ramp to Hazel Avenue may impact areas within the State Recreation Area. Further investigation into the right-of-way constraints and temporary and/or permanent easements would be necessary to determine the impacts to the Nimbus Flat area.

4.2.3.6 Traffic/Transportation Patterns

The proposed Project would improve traffic and transportation patterns along Hazel Avenue and U.S. 50. The Project receiving waters are not used for transportation purposes, so changes to traffic or transportation patterns are not anticipated. Local boating may occur, but these activities are generally for recreational purposes.

4.2.3.7 Energy Consumption or Generation

There would be no anticipated changes to energy consumption or generation due to this Project.

4.2.3.8 Navigation

None of the waters within HSA #519.21 are identified as having navigable beneficial uses. While local boating is allowed, shipping, travel, or private, military, or commercial vessels do not traverse the Project receiving waters. Therefore, the Project is not anticipated to result in changes to navigation characteristics.

4.2.3.9 Safety

The proposed Project will improve safety along U.S. 50 and Hazel Avenue. There are no anticipated changes to safety within the receiving waters due to the Project.

4.2.4 Short-Term Impacts During Construction

4.2.4.1 Physical/Chemical Characteristics of the Aquatic Environment

Earth moving and other construction activities could cause minor erosion and runoff of soil into the drainage systems along the Project corridor during construction, which could temporarily affect water quality in the receiving waters. Sediment-laden flow from runoff flowing over DSAs can increase turbidity and decrease the clarity and impact beneficial uses of the receiving water body. Additional sources of sediment that could result in increases in turbidity include uncovered or improperly covered active and non-active stockpiles, unstabilized slopes and construction staging areas, and construction equipment not properly maintained or cleaned. Generally, as the DSAs increase, the potential for temporary water quality impacts also increases; the estimated DSA for each alternative is listed in Table 1.

Fueling or maintenance of construction vehicles would occur within the Project site during construction, so there would be a risk of accidental spills or releases of fuels, oils, or other potentially toxic materials. An accidental release of these materials could pose a threat to water quality if contaminants enter storm drains, open channels, or surface water receiving bodies. The magnitude of the impact from an accidental release depends on the amount and type of material spilled.

4.2.4.2 Biological Characteristics of the Aquatic Environment

The biological studies prepared for the Project will discuss short-term impacts and the potential measures to address these impacts. It is anticipated that compliance with general and Project-specific permits would address short-term impacts to the biological characteristics of the aquatic environment. Short-term impacts would likely result from fill or removal of jurisdictional wetlands or aquatic features, sediment and construction debris entering biological sensitive areas, and impacts to other identified environmentally sensitive areas form construction activities.

4.2.4.3 Human Use Characteristics of the Aquatic Environment

Construction of the new bridge over Alder Creek would likely require construction of a temporary creek diversion system and local dewatering of the creek within the work area. Appropriate measures would have to also be implemented to ensure that access to the area for purposes other than construction is limited or prohibited. These activities could impact local boating, fishing, or other contact and non-contact uses of the aquatic environment. Beyond work at the Alder Creek crossing, no other short-term impacts to human use characteristics of the aquatic environment are anticipated.

4.2.5 Long-Term Impacts During Operation and Maintenance

4.2.5.1 Physical/Chemical Characteristics of the Aquatic Environment

Long-term impacts to the physical and chemical characteristics of the aquatic environment would most likely occur due to potential increases in runoff containing sediment or roadway pollutants and hydromodification impacts. The increase of impervious area reduces infiltration and has the potential for sediment-laden or flows containing roadway pollutants to enter receiving waters. If permanent design pollution prevention or post-construction treatment BMPs are not implemented, the sediment and contaminants can negatively impact the quality of water. This can be a detrimental impact because water from the Project both directly and indirectly discharges to the Folsom South Canal.

This Project would be required to assess hydromodification impacts in accordance with the *Caltrans Hydromodification Requirements Guidance* (2015) because the Project: includes stream crossings that are waters of the U.S. and has a new impervious surface of one acre or more. The assessment of potential hydromodification impacts would be done as a separate study.

4.2.5.2 Biological Characteristics of the Aquatic Environment

The biological studies prepared for the Project will discuss permanent and long-term impacts and the potential measures to address these impacts. It is anticipated that compliance with general and Project-specific permits would result in minimal long-term impacts to the biological characteristics of the aquatic environment.

4.2.5.3 Human Use Characteristics of the Aquatic Environment

No long-term impacts to the human use characteristics of the aquatic environment are expected. While the existing crossing over Alder Creek will be replaced with the widened structure, the creek will have the same beneficial uses.

4.3 Impact Assessment Methodology

The proposed alternatives would generally have similar construction (short-term) and operations/maintenance (long-term) impacts. As discussed in Section 1.3.2, all the alternatives propose widening and a new structure over Alder Creek. This in-water work would likely require dewatering and/or temporary diversion systems, plus trigger the need for environmental permits (401 Certification, 404 Permit, and 1602 Agreement). As shown in Table 1, during construction, all the alternatives would disturb more than an acre of soil, and would therefore be subject to the CGP, where Alternative 2 has the greatest DSA and alternatives 1 and 1A result in a similar amount of DSA. Typically, as DSA increases, the potential for short-term impacts to water quality increases, including the potential for erosion of disturbed slopes and turbidity in stormwater runoff.

Long-term water quality impacts result from increases in impervious area, where impervious area inhibits infiltration and increases the amount of runoff that discharges directly into the river. The new impervious surface resulting from each build alternatives are similar, with Alternative 2 having the greatest amount of new impervious surface. The potential impacts related to the

increase in impervious area would be similar for all the build alternatives because the impacts can be addressed using similar BMPs or low impact development concepts.

4.4 Alternative-Specific Impact Analysis

There are fundamentally no differences among alternatives that would necessitate alternative-specific impact analysis of environmental consequences.

4.5 Cumulative Impacts

There are currently no known current or future development or redevelopment projects within the watershed that would result in cumulative impacts to water quality. However, should a project or improvement be programmed or planned, each project would be subject to NPDES requirements and have their own BMPs that would be required to avoid and minimize water quality and prevent cumulative impacts.

5 AVOIDANCE AND MINIMIZATION MEASURES

5.1 Avoidance and/or Minimization Measures for Water Resources

Temporary construction site BMPs would be implemented during construction to prevent any construction materials or debris from entering surface waters or channels within the Project vicinity. Design pollution prevention and erosion control BMPs would be implemented prior to, during, and after construction to prevent silt and sediment from entering surface waters. Permanent stormwater treatment BMPs would be implemented to promote infiltration and retention of runoff, and to reduce the potential for downstream water bodies from being impacted by sediment and pollutants from roadway runoff.

5.2 Avoidance and/or Minimization Measures for Stormwater and Groundwater

The temporary and permanent measures to address water quality impacts are a condition of the Caltrans' MS4 Permit, CGP, and local County and City MS4 Permit. Details and calculations for these design feature or BMPs would be developed and incorporated into the Project's design, operations, and maintenance phases. Temporary construction-related water quality impacts and permanent water quality impacts would be avoided or minimized through proper implementation of these design features or BMPs. Additional coordination between Caltrans, the County, and the City will be necessary during the design and implementation of permanent design features. This may include concurrence and an agreement to address the future maintenance of permanent stormwater treatment devises placed within the State's right-of-way.

5.2.1 Storm Water Pollution Prevention Plan

In accordance with the CGP, a risk assessment of this Project is required; see Section 1.4 of this WQAR for the risk assessment.

Caltrans requires the Project's contractors to implement a SWPPP to comply with the conditions of the CGP. The SWPPP would be submitted by the contractor and must be approved by Caltrans prior to the start of construction. The SWPPP is intended to address construction-phase impacts, and include, at minimum, the following elements:

- Project Description – The Project description includes a discussion of the proposed project, maps and other information related to construction activities and potential sources of pollutants.
- Minimum Construction Control Measures – These measures may include limiting construction access routes, stabilization of areas denuded by construction, and using sediment controls and filtration.
- Erosion and Sediment Control – The SWPPP is required to contain a description of soil stabilization practices, control measures to prevent a net increase in sediment load in

stormwater, controls to reduce tracking sediment onto roads, and controls to reduce wind erosion.

- Non-Stormwater Management – The SWPPP includes provisions to reduce and control discharges other than stormwater.
- Post-Construction Stormwater Management – The SWPPP includes a list of stormwater control measures that provide ongoing (permanent) protection for water resources.
- Waste Management and Disposal – The SWPPP includes a waste management section including equipment maintenance waste, used oil, batteries, etc. All waste must be disposed of as required by state and federal law.
- Maintenance, Inspection, and Repair – The SWPPP requires an ongoing program to ensure that all controls are in place and operating as designed.
- Monitoring – This provision requires documented inspections of the control measures.
- Reports – The contractor would prepare an annual report on the construction project and submit this report on July 15 each year. This report would be submitted on the Storm Water Multiple Application and Report Tracking System website to the SWRCB.
- Training – The SWPPP provides documentation on the training and qualifications of the designated Qualified SWPPP Developer and Qualified SWPPP Practitioner. Trained personnel must do inspections, maintenance, and repair of construction site BMPs.
- Construction Site Monitoring Program – The SWPPP includes a Construction Site Monitoring Program detailing the procedures and methods related to the visual monitoring and sampling and analysis plans for non-visible pollutants, sediment and turbidity, pH, and bioassessment.

Because the Project must comply with the CGP, a Notice of Intent (NOI) would need to be filed with the SWRCB's Storm Water Multiple Application and Report Tracking System. Earth disturbing activities should not occur until NOI is approved and a Waste Discharger Identification number is assigned to the Project. In compliance with the CGP dischargers must also electronically file to the Storm Water Multiple Application and Report Tracking System: permit registration documents, changes of information, sampling and monitoring information, annual reporting, a Notice of Termination once construction is completed, and other required compliance documents.

5.2.2 Temporary Construction Site BMPs

Caltrans is required to reduce pollutants in stormwater discharges to the maximum extent practicable. For discharges from a construction site, pollutants must be reduced using the best available technology economically achievable, and conventional pollutants (i.e. total suspended solids and pH) must be reduced using best conventional technology. Potential temporary impacts to water quality can be avoided or minimized by implementing temporary construction site BMPs. Table 4 lists typical BMPs used to address construction water quality impacts. The selected BMPs are consistent with the minimum practices required under the CGP and Caltrans standards. Proper use of these temporary construction site BMPs would minimize or avoid potential construction-related water quality impacts.

Table 4. Temporary BMPs

Temporary BMP	Purpose
Soil Stabilization	
Move-In/Move-Out	Mobilization locations where permanent erosion control or revegetation to sustain slopes is required within the Project.
Temporary Cover	Plastic covers for stockpiles.
Temporary Fence (Type ESA)	High visibility fence to designate areas off-limits to the contractor.
Sediment Control	
Temporary Fiber Rolls	Degradable fibers rolled tightly and placed on the toe and face of slopes to intercept runoff.
Temporary Silt Fence	Linear, permeable fabric barriers to intercept sediment-laden sheet flow. Placed downslope of exposed soil areas, along channels and project perimeter.
Temporary Gravel Bag Berm	Single row of gravel bags installed end to end to form a barrier across a slope to intercept runoff. Can be used to divert or detain moderately concentrated flows.
Temporary Check Dams	Small constructed device of rock or other product placed across a channel or ditch to reduce flow velocity.
Temporary Drainage Inlet Protection	Runoff detainment devices used at storm drain inlets that are subject to runoff from construction activities.
Tracking Control	
Temporary Construction Entrances/Exits	Points of entrance/exit to a construction site that are stabilized to reduce the tracking of mud and dirt onto public roads.
Street Sweeping	Removal of tracked sediment to prevent entrance to a storm drain or watercourse.
Non-Stormwater Management	
Material and Equipment Use Over Water	Use, storage, and disposal of materials and equipment on barges, boats, temporary construction pads, other platforms or similar locations that minimize or eliminate the discharge of potential pollutants to a watercourse.
Temporary Creek Diversion	To protect water quality and allow for construction activities to take place in the creek, along the banks or beneath the active creek.
All other anticipated non-stormwater management measures are covered under Job Site Management.	
Waste Management and Materials Pollution Control	
Temporary Concrete Washout Facilities	Specified vehicle washing areas to contain concrete waste materials.
All other anticipated waste management and materials pollution control measures are covered under Job Site Management.	
Job Site Management	
General measures covered under job site management include: • Spill prevention and control • Materials management • Stockpile management • Waste management • Hazardous waste management • Contaminated soil • Concrete waste • Sanitary and septic waste and liquid waste Miscellaneous job site management includes: • Training of employees and subcontractors • Proper selection, deployment, and repair of construction site BMPs	Non-stormwater management consists of: • Water control and conservation • Illegal connection and discharge detection and reporting • Vehicle and equipment cleaning • Vehicle and equipment fueling and maintenance • Material and equipment used over water • Structure removal over or adjacent to water • Paving, sealing, saw cutting and grinding operations • Thermoplastic striping and pavement markers • Concrete curing and concrete finishing

A temporary creek diversion system is expected to be necessary for the proposed bridge work at Alder Creek. Prior to installation, approval of the temporary creek diversion system will be required from Caltrans, the Central Valley RWQCB, and any the other agencies with jurisdiction of the creek. Scheduling is also a BMP that should be considered. Work proposed in waters of the U.S. or waters of the State would need to be scheduled according to the appropriate regulatory agency requirements.

Dewatering operations may also be needed for excavations near the creek and because of the Project's close proximity to the American River and Lake Natoma. The contract documents would address any necessary permits for dewatering. There is a SWRCB Permit and RWQCB Waiver that covers low threat discharges to land. Both regulatory documents have certain compliance conditions, criteria, and restrictions for use by the Contractor.

A spill on the roadway would trigger immediate response actions to report, contain, and mitigate the incident. The California Office of Emergency Services has developed a Hazardous Materials Incident Contingency Plan, which provides a program for response to spills involving hazardous materials. The plan designates a chain of command for notification, evacuation, response, and cleanup of spills. Caltrans also has spill contingency procedures and response crews.

5.2.3 Permanent Pollution Prevention Design Measures

5.2.3.1 Permanent Soil Stabilization

Erosion control measures would be applied to all exposed areas once soil disturbance work is completed to achieve final soil stabilization. These measures contribute to reducing the potential for loose sediment from impacting the roadway and receiving waters, and are used to achieve the necessary vegetation establishment and coverage to terminate coverage under the CGP once construction is completed. Erosion control measures used to achieve permanent soil stabilization can include a fiber rolls, rolled erosion control products, and a mixture of hydroseed, hydromulch, straw, and compost. Compost not only improves erosion resistance and vegetation establishment, but can also be used to promote stormwater treatment of runoff by increasing the infiltration potential of the soil and immobilizing heavy metals that are common along highways.

5.2.3.2 Post Construction Stormwater Treatment

The Caltrans MS4 permit requires that highway facility projects that create and/or replace one acre or more of impervious surface implement permanent post-construction stormwater treatment controls. This Project is expected to surpass this threshold. Additionally, because this Project proposes to reconstruct and extend the existing Hazel Avenue interchange, plus modify the existing ramps and mainline U.S. 50, there is the potential for the Project to result in an increase in impervious area that is greater than 50 percent of the total post-project impervious area within Project limits. When this threshold is met or exceeded, the Caltrans MS4 permit requires that the numeric sizing criteria apply to the entire project; therefore, the Project may be required to treat the existing, new, and replaced impervious surfaces within the Project limits. The impervious surface values for the Project would be evaluated in detail during the design phase, and the appropriate BMPs implemented to meet this required treatment.

The Caltrans MS4 permit states that treatment must be designed according to the following priorities, in the following order of preference:

i. Infiltrate, harvest and re-use, and/or evapotranspire the stormwater runoff;
ii. Capture and treat the stormwater runoff.

The Caltrans *Project Planning and Design Guide* (2016) provides guidance on determining which method of treatment is both site and design feasible for a Project. Based on the available soil data presented in Section 3.2.4 of this WQAR, infiltration based devices are feasible west of the Hazel Avenue interchange where the soils are within HSG A. At and east of the interchange the soils are not favorable for infiltration, so conventional treatment BMPs that capture and treat the stormwater runoff are likely more feasible. Evaluating the proposed geometry and available right-of-way, placement of stormwater treatment BMPs would likely be limited to the interchange area and sheet flow onto vegetated side slopes. The drainage and stormwater treatment design would be developed during the design phase to identify the proposed and existing drainage facilities used to collect and route stormwater to treatment BMPs.

All permanent design features and elements proposed within the State's right-of-way require Caltrans' Maintenance and Storm Water functional unit involvement to review, comment on, and approve these features. A separate maintenance agreement, between all stakeholders, may be necessary and should be discussed in future programmatic documents and/or reports.

5.2.3.3 Hydromodification Management

The Project is required to consider impacts because the Project adds more than one acre of new impervious surface. A rapid stability assessment to determine the potential hydromodification impacts is required because the Project includes a stream crossing identified as a Water of the U.S. (i.e. Alder Creek), adds more than one acre of impervious surface, and is within a threshold drainage area.

Typically design pollution prevention and post-construction stormwater treatment controls can be used to hydromodification management. However, if the rapid stability assessment determines that the Project will result in Alder Creek not being laterally and vertically stable and poses a risk to the existing or proposed highway structure, then more engineered measures would be necessary for hydromodification management. Options presented in the Caltrans MS4 permit to address these higher risk hydromodification impacts include, in-stream and floodplain enhancement/restoration, fish barrier removal, regional flow control, and off-site BMPs. The appropriate measures to provide hydromodification management will be determined once the rapid stability assessment is completed during the design phase.

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6.1 Preparer(s) Qualifications

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Appendix A Risk Level Assessment

Appendix A.1 Sediment Risk

R Factor

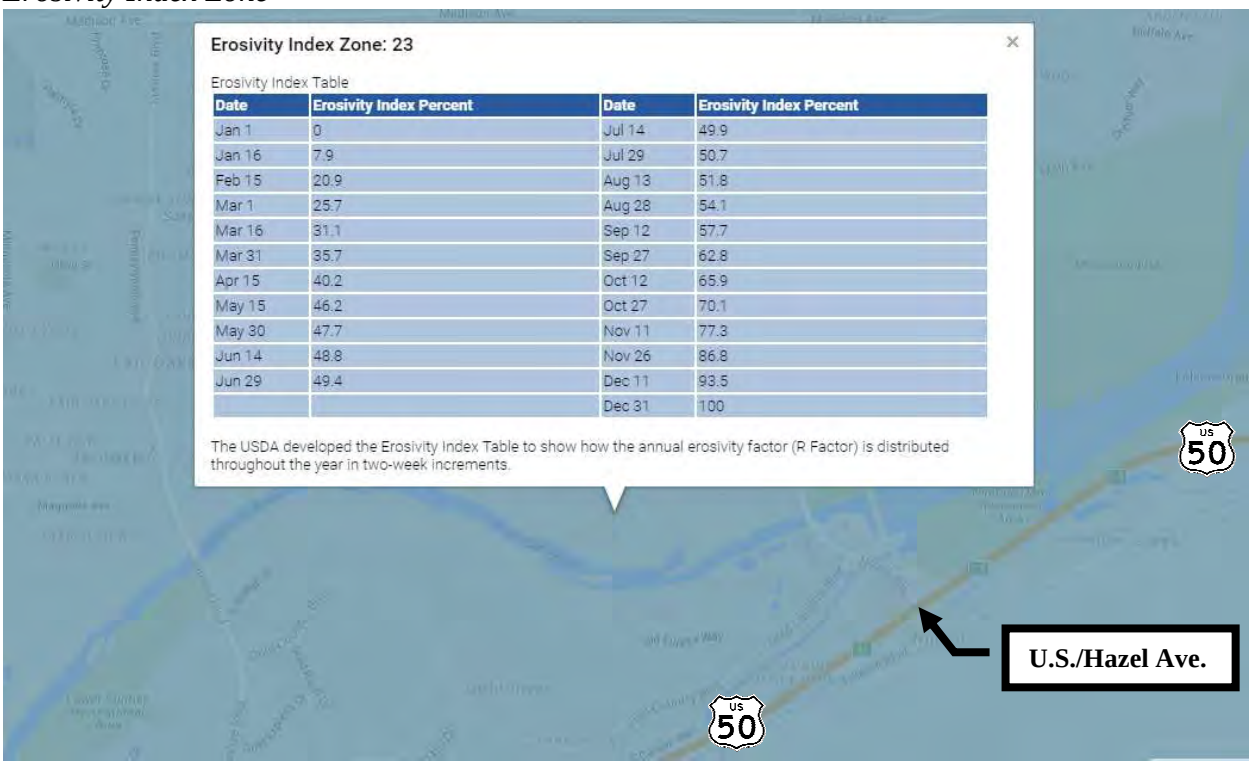
Annual R Factor



Source: Caltrans

Project is approximately equidistant to 40 and 60, so annual R for Project is **50**

Erosivity Index Zone

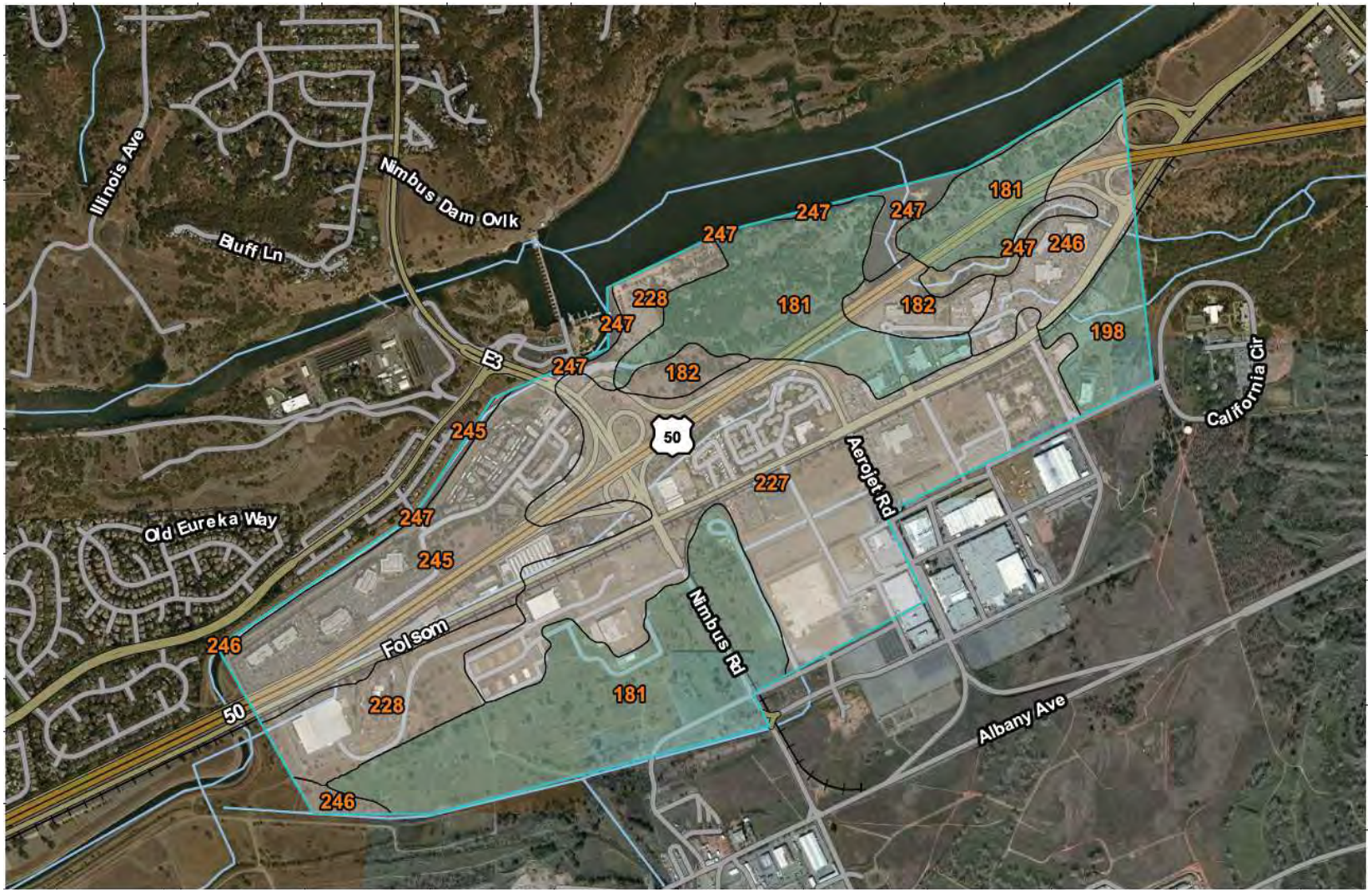


Date	Erosivity Index Percent	Date	Erosivity Index Percent
Jan 1	0	Jul 14	49.9
Jan 16	7.9	Jul 29	50.7
Feb 15	20.9	Aug 13	51.8
Mar 1	25.7	Aug 28	54.1
Mar 16	31.1	Sep 12	57.7
Mar 31	35.7	Sep 27	62.8
Apr 15	40.2	Oct 12	65.9
May 15	46.2	Oct 27	70.1
May 30	47.7	Nov 11	77.3
Jun 14	48.8	Nov 26	86.8
Jun 29	49.4	Dec 11	93.5
		Dec 31	100

Source: Caltrans

Assuming 2-year construction period, Total Project R = 50 x 100% x 2 years = **100**

K Factor

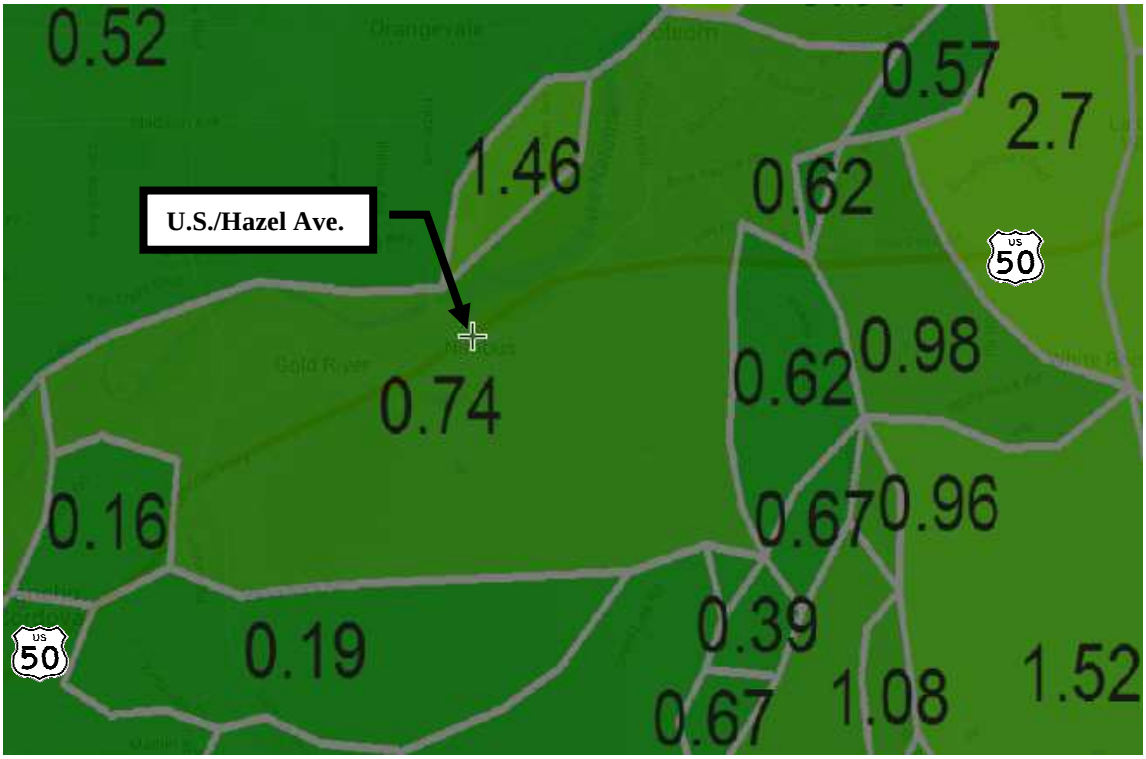


Source: NRCS

K Factor, Rock Free— Summary by Map Unit — Sacramento County, California (CA067)				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
181	Natomas loam, 0 to 2 percent slopes	.32	252.8	30.4%
182	Natomas-Xerorthents, dredge tailings complex, 0 to 50 percent slopes		28.8	3.5%
198	Redding gravelly loam, 0 to 8 percent slopes	.32	29.2	3.5%
227	Urban land		261.8	31.5%
228	Urban land-Natomas complex, 0 to 2 percent slopes		62.6	7.5%
245	Xerorthents, dredge tailings, 2 to 50 percent slopes		124.8	15.0%
246	Xerorthents, dredge tailings-Urban land complex, 0 to 2 percent slopes		43.3	5.2%
247	Water		29.0	3.5%
Totals for Area of Interest			**832.3**	**100.0%**

Source: NRCS

LS Factor



Source: Caltrans

LS = **0.74**

Appendix A.2 Receiving Water Risk

Beneficial Uses of Surface Water Bodies

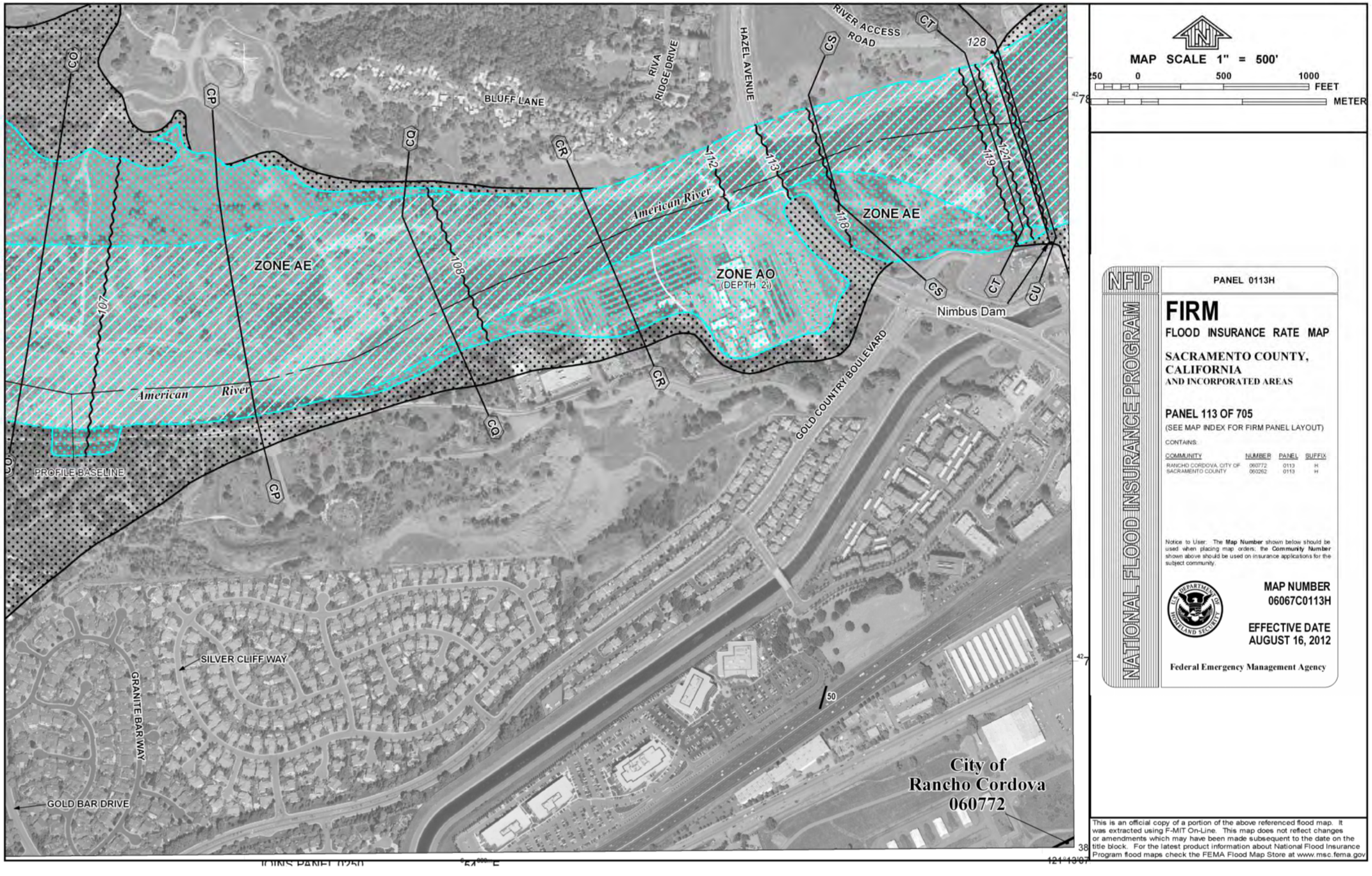
	SURFACE WATER BODIES	HYDRO UNIT NUMBER	MUN	AGRI-CULTURE		INDUSTRY			RECREATION			FRESHWATER HABITAT (2)		MIGRATION		SPAWNING		WILD	NAV
			MUNICIPAL AND DOMESTIC SUPPLY	IRRIGATION	STOCK WATERING	PROCESS	SERVICE SUPPLY	POWER	CONTACT	CANOEING (1) AND RAFTING	OTHER NONCONTACT	WARM	COLD	WARM (3)	COLD (4)	WARM (3)	COLD (4)	WILDLIFE HABITAT	NAVIGATION
30	COLUSA BASIN DRAIN TO EYE ["I"] STREET BRIDGE	520.00	E	E					E	E	E	E	E	E	E	E	E	E	E
31	SUTTER BYPASS	520.3		E					E			E			E		E	E	
	FEATHER RIVER																		
32	LAKE ALMANOR	518.41						E	E			E	E			E		E	
33	NORTH FORK, FEATHER RIVER	518.4	E					E	E	E	E		E				E	E	
	MIDDLE FORK, FEATHER RIVER	518.3																	
34	SOURCE TO LITTLE LAST CHANCE CREEK	518.35		E	E				E	E	E	E	E				E	E	
35	FRENCHMAN RESERVOIR	518.36							E		E	P	E				E	E	
36	LITTLE LAST CHANCE CREEK TO LAKE OROVILLE	518.3	E						E	E	E	E	E				E	E	
37	LAKE DAVIS	518.34							E		E	P	E				E	E	
38	LAKES BASIN LAKES	518.5							E		E		E				E	E	
39	LAKE OROVILLE	518.12	E	E				E	E		E	E	E			E	E	E	
40	FISH BARRIER DAM TO SACRAMENTO RIVER	515.	E	E					E	E	E	E	E	E	E	E	E	E	
	YUBA RIVER																		
41	SOURCES TO ENGLEBRIGHT RESERVOIR	517.	E	E	E			E	E	E	E		E				E	E	
42	ENGLEBRIGHT DAM TO FEATHER RIVER	515.3		E	E			E	E	E	E	E	E	E	E	E	E	E	
43	BEAR RIVER	515.1	E	E	E			E	E	E	E	E	E	P	P	P	P	E	
	AMERICAN RIVER																		
44	NORTH FORK, SOURCE TO FOLSOM LAKE	514.5	E	E					E	E	E	P	E				E	E	
45	MIDDLE FORK, SOURCE TO FOLSOM LAKE	514.4	E	E	E			E	E	E	E	P	E				E	E	
46	DESOLATION VALLEY LAKES	514.4							E		E		E				E	E	
	SOUTH FORK	514.3																	
48	SOURCE TO PLACERVILLE	514.3	E					E	E	E	E	P	E				E	E	
49	PLACERVILLE TO FOLSOM LAKE	514.32	E	E				E	E	E	E	E	E					E	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	E		E	
51	FOLSOM DAM TO SACRAMENTO RIVER	519.21	E	E			E	E	E	E	E	E	E	E	E	E	E	E	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	CACHE CREEK																		
53	CLEAR LAKE (a)	513.52	E	E	E				E		E	E	P			E		E	
54	CLEAR LAKE TO YOLO BYPASS (d)	511/513	E	E	E	E	E		E	E	E	E	P			E	E	E	

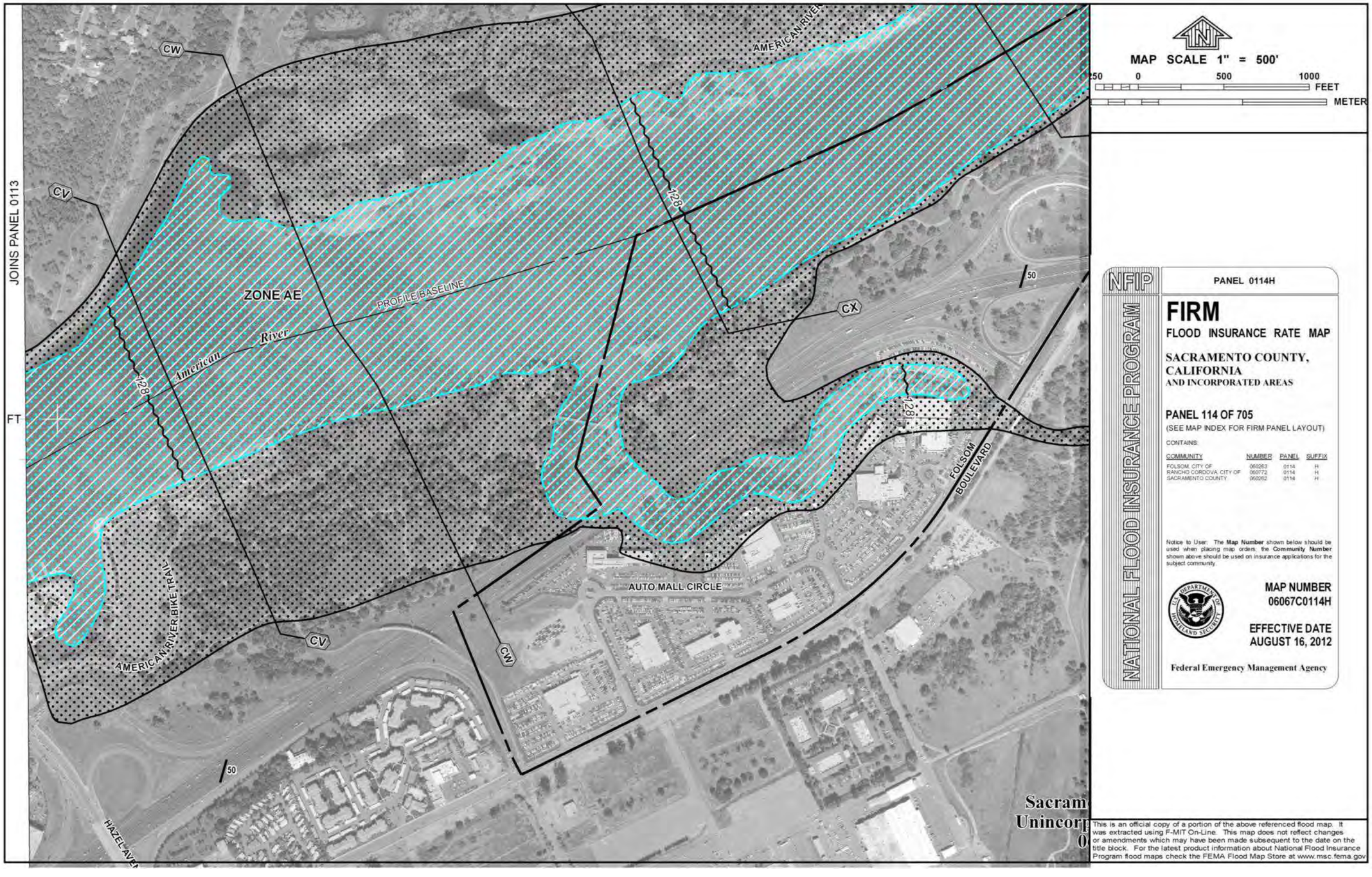
(1) Shown for streams and rivers only with the implication that certain flows are required for this beneficial use.
(2) Resident does not include anadromous. Any Segments with both COLD and WARM beneficial use designations will be considered COLD water bodies for the application of water quality objectives.
(3) Striped bass, sturgeon, and shad.
(4) Salmon and steelhead
~~(5) As a primary beneficial use.~~
(6) The indicated beneficial uses are to be protected for all waters except in specific cases where evidence indicates the appropriateness of additional or alternative beneficial use designations.
(7) Sport fishing is the only recreation activity permitted.
(8) Beneficial uses vary throughout the Delta and will be evaluated on a case-by-case basis. COMM is a designated beneficial use for the Sacramento San Joaquin Delta and Yolo Bypass waterways listed in Appendix 43 and not any tributaries to the listed waterways or portions of the listed waterways outside of the legal Delta boundary unless specifically designated.
(9) Per State Water Board Resolution No. 90-28, Marsh Creek and Marsh Creek Reservoir in Contra Costa County are assigned the following beneficial uses: REC1 and REC2 (potential uses), WARM, WILD and RARE. COMM is a designated beneficial use for Marsh Creek and its tributaries listed in Appendix 43 within the legal Delta boundary.

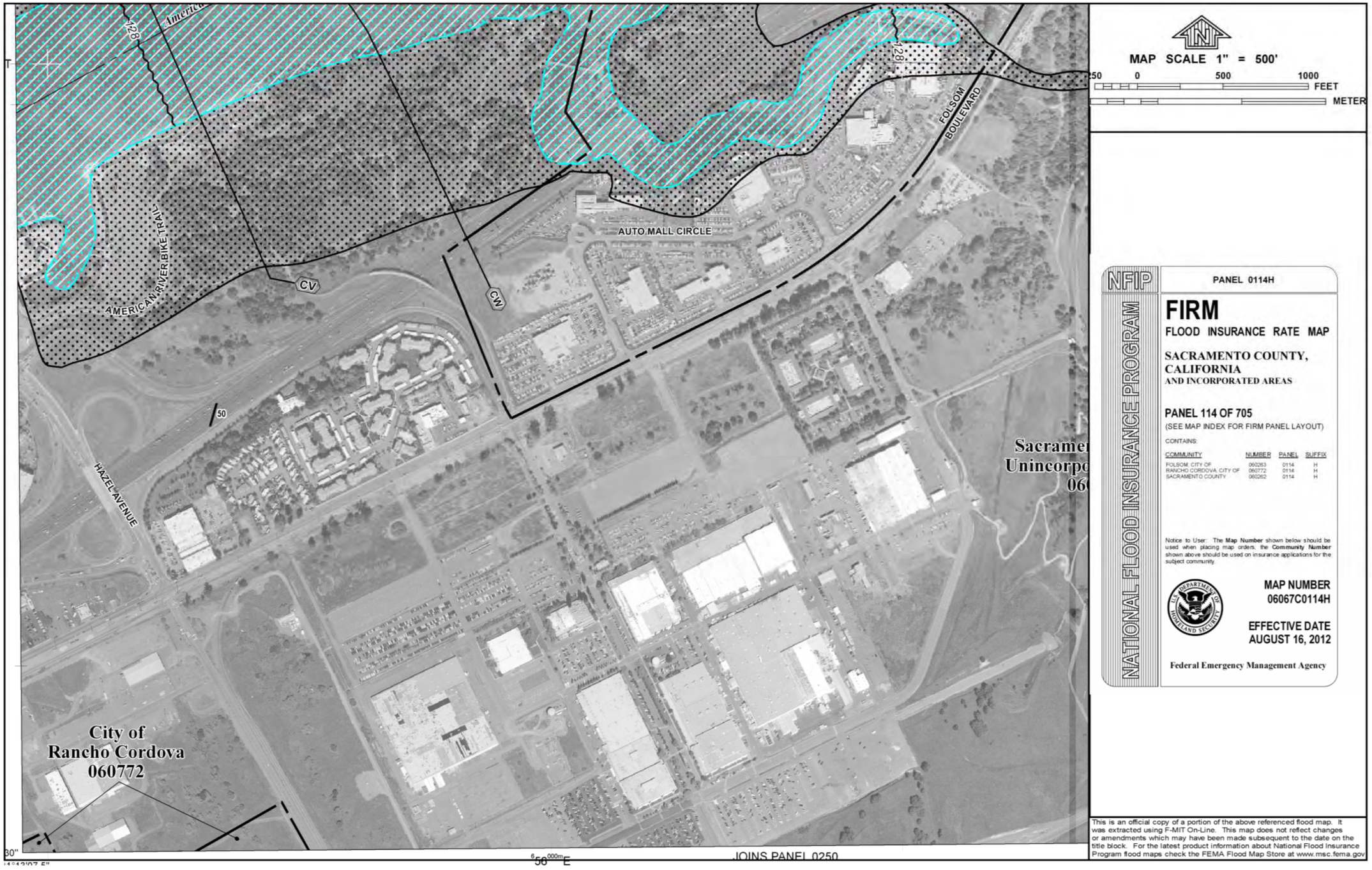
A/ Hidden Reservoir = Hensley Lake
B/ Buchanan Reservoir = Eastman Lake

Source: Central Valley RWQCB

Appendix B Federal Emergency Management Agency - Flood Insurance Rate Maps


ZONE AE
ZONE AO
(DEPTH 2)
ZONE AE
American River
American River
BLUFF LANE
RIVA RIDGE DRIVE
HAZEL AVENUE
RIVER ACCESS ROAD
GOLD COUNTRY BOULEVARD
Nimbus Dam
PROFILE BASELINE
SILVER CLIFF WAY
GRANITE BAR WAY
GOLD BAR DRIVE
City of
Rancho Cordova
060772
CO
CP
CQ
CR
CS
CT
CU
107
108
112
113
118
119
121
128
50
MAP SCALE 1" = 500'
250 0 500 1000
FEET
METER
NFIP
NATIONAL FLOOD INSURANCE PROGRAM
PANEL 0113H
FIRM
FLOOD INSURANCE RATE MAP
SACRAMENTO COUNTY, CALIFORNIA
AND INCORPORATED AREAS
PANEL 113 OF 705
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)
CONTAINS:
COMMUNITY NUMBER PANEL SUFFIX
RANCHO CORDOVA, CITY OF 060772 0113 H
SACRAMENTO COUNTY 060262 0113 H
Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.
MAP NUMBER
06067C0113H
EFFECTIVE DATE
AUGUST 16, 2012
Federal Emergency Management Agency
This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov


MAP SCALE 1" = 500'
0
500
1000
FEET
METER
JOINS PANEL 0113
FT
ZONE AE
PROFILE BASELINE
American River
AMERICAN RIVER
CW
CV
CX
128
50
FOLSOM BOULEVARD
AUTO MALL CIRCLE
AMERICAN RIVER BIKE TRAIL
HAZEL AVE
NFIP
NATIONAL FLOOD INSURANCE PROGRAM
PANEL 0114H
FIRM
FLOOD INSURANCE RATE MAP
SACRAMENTO COUNTY, CALIFORNIA
AND INCORPORATED AREAS
PANEL 114 OF 705
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)
CONTAINS:
COMMUNITY NUMBER PANEL SUFFIX
FOLSOM, CITY OF 060263 0114 H
RANCHO CORDOVA, CITY OF 060772 0114 H
SACRAMENTO COUNTY 060262 0114 H
Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.
MAP NUMBER
06067C0114H
EFFECTIVE DATE
AUGUST 16, 2012
Federal Emergency Management Agency
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MAP SCALE 1" = 500'
250 0 500 1000
FEET
METER
NFIP
PANEL 0114H
FIRM
FLOOD INSURANCE RATE MAP
SACRAMENTO COUNTY, CALIFORNIA
AND INCORPORATED AREAS
PANEL 114 OF 705
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)
CONTAINS:
COMMUNITY NUMBER PANEL SUFFIX
FOLSOM, CITY OF 060263 0114 H
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NATIONAL FLOOD INSURANCE PROGRAM
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AUTO MALL CIRCLE
FOLSOM BOULEVARD
AMERICAN RIVER BIKE TRAIL
HAZEL AVENUE
CV
CW
50
City of
Rancho Cordova
060772
JOINS PANEL 0250

Appendix C Water Quality Objectives

Appendix C.1 Objectives for All Inland Surface Waters

III. WATER QUALITY OBJECTIVES

The Porter-Cologne Water Quality Control Act defines water quality objectives as "...the limits or levels of water quality constituents or characteristics which are established for the reasonable protection of beneficial uses of water or the prevention of nuisance within a specific area" [Water Code Section 13050(h)]. It also requires the Regional Water Board to establish water quality objectives, while acknowledging that it is possible for water quality to be changed to some degree without unreasonably affecting beneficial uses. In establishing water quality objectives, the Regional Water Board must consider, among other things, the following factors:

- Past, present, and probable future beneficial uses;
- Environmental characteristics of the hydrographic unit under consideration, including the quality of water available thereto;
- Water quality conditions that could reasonably be achieved through the coordinated control of all factors which affect water quality in the area;
- Economic considerations;
- The need for developing housing within the region;
- The need to develop and use recycled water. (Water Code Section 13241)

The Federal Clean Water Act requires a state to submit for approval of the Administrator of the U.S. Environmental Protection Agency *(USEPA)* all new or revised water quality standards which are established for surface and ocean waters. As noted earlier, California water quality standards consist of both beneficial uses (identified in Chapter II) and the water quality objectives based on those uses.

There are **seven important points** that apply to water quality objectives.

The **first point** is that water quality objectives can be revised through the basin plan amendment process. Objectives may apply region-wide or be specific to individual water bodies or parts of water bodies. Site-specific objectives may be developed whenever the Regional Water Board believes they are appropriate. As indicated previously, federal regulations call for each state to review its water quality standards at least every three years. These Triennial Reviews provide one opportunity to evaluate changing water quality objectives, because they begin with an identification of potential and actual water quality problems, i.e., beneficial use impairments. Since impairments may be associated with water quality objectives being exceeded, the Regional Water Board uses the results of the Triennial Review to implement actions to assess, remedy, monitor, or otherwise address the impairments, as appropriate, in order to achieve objectives and protect beneficial uses. If a problem is found to occur because, for example, a water quality objective is too weak to protect beneficial uses, the Basin Plan should be amended to make the objective more stringent. (Better enforcement of the water quality objectives or adoption of certain policies or redirection of staff and resources may also be proper responses to water quality problems. See the Implementation chapter for further discussion.)

Changes to the objectives can also occur because of new scientific information on the effects of specific constituents. A major source of information is the USEPA which develops data on the effects of chemical and other constituent concentrations on particular aquatic species and human health. Other information sources for data on protection of beneficial uses include the National Academy of Science which has published data on bioaccumulation and the Federal Food and Drug Administration which has issued criteria for unacceptable levels of chemicals in fish and shellfish used for human consumption. The Regional Water Board may make use of those and other state or federal agency information sources in assessing the need for new water quality objectives.

The **second point** is that achievement of the objectives depends on applying them to controllable water quality factors. *Controllable water quality factors* are those actions, conditions, or circumstances resulting from human activities that may influence the quality of the waters of the State, that are subject to the authority of the State Water Board or the Regional Water Board, and that may be reasonably controlled. Controllable factors are not allowed to cause further degradation of water quality in instances where uncontrollable factors have

already resulted in water quality objectives being exceeded. The Regional Water Board recognizes that man made changes that alter flow regimes can affect water quality and impact beneficial uses.

The **third point** is that objectives are to be achieved primarily through the adoption of waste discharge requirements (including permits) and cleanup and abatement orders. When adopting requirements and ordering actions, the Regional Water Board considers the potential impact on beneficial uses within the area of influence of the discharge, the existing quality of receiving waters, and the appropriate water quality objectives. It can then make a finding as to the beneficial uses to be protected within the area of influence of the discharge and establish waste discharge requirements to protect those uses and to meet water quality objectives. The objectives contained in this plan, and any State or Federally promulgated objectives applicable to the basins covered by the plan, are intended to govern the levels of constituents and characteristics in the main water mass unless otherwise designated. They may not apply at or in the immediate vicinity of effluent discharges, but at the edge of the *mixing zone* if areas of dilution or criteria for diffusion or dispersion are defined in the waste discharge specifications.

The **fourth point** is that the Regional Water Board recognizes that immediate compliance with water quality objectives adopted by the Regional Water Board or the State Water Board, or with water quality criteria adopted by the USEPA, may not be feasible in all circumstances. Where the Regional Water Board determines it is infeasible for a discharger to comply immediately with such objectives or criteria, compliance shall be achieved in the shortest practicable period of time (determined by the Regional Water Board), not to exceed ten years after the adoption of applicable objectives or criteria. This policy shall apply to water quality objectives and water quality criteria adopted after the effective date of this amendment to the Basin Plan [25 September 1995]. The Regional Water Board will establish compliance schedules in NPDES permits consistent with the provisions of the State Water Board's Compliance Schedule Policy (Resolution 2008-0025). Time schedules in waste discharge requirements are established consistent with Water Code Section 13263.

The **fifth point** is that in cases where water quality objectives are formulated to preserve historic conditions, there may be insufficient data to determine completely the temporal and hydrologic variability representative of historic water quality. When violations of such objectives occur, the Regional Water Board judges the reasonableness of achieving those objectives through regulation of the controllable factors in the areas of concern.

The **sixth point** is that the State Water Board adopts policies and plans for water quality control which can specify water quality objectives or affect their implementation. Chief among the State Water Board's policies for water quality control is State Water Board Resolution No. 68-16 (Statement of Policy with Respect to Maintaining High Quality of Waters in California). It requires that wherever the existing quality of surface or ground waters is better than the objectives established for those waters in a basin plan, the existing quality will be maintained unless as otherwise provided by Resolution No. 68-16 or any revisions thereto. This policy and others establish general objectives. The State Water Board's water quality control plans applicable to the Sacramento and San Joaquin River Basins are the Thermal Plan and Water Quality Control Plan for Salinity. The Thermal Plan and its water quality objectives are in the Appendix. The Water Quality Control Plan for Salinity water quality objectives are listed as Table III-5. The State Water Board's plans and policies that the Basin Plan must conform to are addressed in Chapter IV, Implementation.

The **seventh point** is that water quality objectives may be in numerical or narrative form. The enumerated milligram-per-liter (mg/l) limit for copper is an example of a numerical objective; the objective for color is an example of a narrative form.

Information on the application of water quality objectives is contained in the section, *Policy for Application of Water Quality Objectives*, in Chapter IV.

WATER QUALITY OBJECTIVES FOR INLAND SURFACE WATERS

The objectives below are presented by categories which, like the Beneficial Uses of Chapter II, were standardized for uniformity among the Regional Water Boards. The water quality objectives apply to all surface waters in the Sacramento and San Joaquin River Basins, including the Delta, or as noted. *(The legal boundary of the Delta is contained in Section 12220 of the Water Code and identified in Figure III-1.)* The numbers in parentheses following specific water bodies are keyed to Figure II-1.

Bacteria

In waters designated for contact recreation (REC-1), the fecal coliform concentration based on a minimum of not less than five samples for any 30-day period shall not exceed a geometric mean of 200/100 ml, nor shall more than ten percent of the total number of samples taken during any 30-day period exceed 400/100 ml.

For Folsom Lake (50), the fecal coliform concentration based on a minimum of not less than five samples for any 30-day period, shall not exceed a geometric mean of 100/100 ml, nor shall more than ten percent of the total number of samples taken during any 30-day period exceed 200/100 ml.

Biostimulatory Substances

Water shall not contain biostimulatory substances which promote aquatic growths in concentrations that cause nuisance or adversely affect beneficial uses.

Chemical Constituents

Waters shall not contain chemical constituents in concentrations that adversely affect beneficial uses.*

The chemical constituent objectives in Tables III-1 and III-1A apply to the water bodies specified. Metal objectives in the table are dissolved concentrations.

Selenium, molybdenum, and boron objectives are total concentrations. Water quality objectives are also contained in the Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta, adopted by the State Water Board in May 1995 and revised in 2006.

At a minimum, water designated for use as domestic or municipal supply (MUN) shall not contain concentrations of chemical constituents in excess of the maximum contaminant levels (MCLs) specified in the following provisions of Title 22 of the California Code of Regulations, which are incorporated by reference into this plan: Tables 64431-A (Inorganic Chemicals) and 64431-B (Fluoride) of Section 64431, Table 64444-A (Organic Chemicals) of Section 64444, and Tables 64449-A (Secondary Maximum Contaminant Levels-Consumer Acceptance Limits) and 64449-B (Secondary Maximum Contaminant Levels-Ranges) of Section 64449. This incorporation-by-reference is prospective, including future changes to the incorporated provisions as the changes take effect. At a minimum, water designated for use as domestic or

*This includes drinking water chemical constituents of concern, such as organic carbon.

TABLE III-1
TRACE ELEMENT WATER QUALITY OBJECTIVES

CONSTITUENT	MAXIMUM CONCENTRATION [a] (mg/l)	APPLICABLE WATER BODIES
Arsenic	0.01	Sacramento River from Keswick Dam to the I Street Bridge at City of Sacramento (13, 30); American River from Folsom Dam to the Sacramento River (51); Folsom Lake (50); and the Sacramento-San Joaquin Delta.
Barium	0.1	As noted above for Arsenic.
Boron	2.0 (15 March through 15 September) 0.8 (monthly mean, 15 March through 15 September)	San Joaquin River, mouth of the Merced River to Vernalis
	2.6 (16 September through 14 March) 1.0 (monthly mean, 16 September through 14 March)	
	1.3 (monthly mean, critical year[b])	
	5.8 2.0 (monthly mean, 15 March through 15 September)	Salt Slough, Mud Slough (north), San Joaquin River from Sack Dam to the mouth of Merced River
Cadmium	0.00022 [c]	Sacramento River and its tributaries above State Hwy 32 bridge at Hamilton City

TABLE III-1 TRACE ELEMENT
WATER QUALITY OBJECTIVES (Continued)

CONSTITUENT	MAXIMUM CONCENTRATION [a] (mg/l)	APPLICABLE WATER BODIES
Copper	0.0056 [c]	As noted above for Cadmium
	0.01 [d]	As noted above for Arsenic. [d]
Cyanide	0.01	As noted above for Arsenic
Iron	0.3	As noted above for Arsenic
Manganese	0.05	As noted above for Arsenic
Molybdenum	0.015 0.010 (monthly mean)	San Joaquin River, mouth of the Merced River to Vernalis
	0.050 0.019 (monthly mean)	Salt Slough, Mud Slough (north), San Joaquin River from Sack Dam to the mouth of Merced River
Selenium	0.012 0.005 (4-day average)	San Joaquin River, mouth of the Merced River to Vernalis
	0.020 0.005 (4-day average)	Mud Slough (north), and the San Joaquin River from Sack Dam to the mouth of Merced River
	0.020 0.002 (monthly mean)	Salt Slough and constructed and re-constructed water supply channels in the Grassland watershed listed in Appendix 40.
Silver	0.01	As noted above for Arsenic.
Zinc	0.1 [d]	As noted above for Arsenic. [d]
	0.016 [c]	As noted above for Cadmium

a Metal objectives in this table are dissolved concentrations. Selenium, molybdenum, and boron objectives are total concentrations.

b See Table IV-3.

c The effects of these concentrations were measured by exposing test organisms to dissolved aqueous solutions of 40 mg/l hardness that had been filtered through a 0.45 micron membrane filter. Where deviations from 40 mg/l of water hardness occur, the objectives, in mg/l, shall be determined using the following formulas:

$$Cu = e^{(0.905)(\ln \text{hardness}) - 1.612} \times 10^{-3}$$

$$Zn = e^{(0.830)(\ln \text{hardness}) - 0.289} \times 10^{-3}$$

$$Cd = e^{(1.160)(\ln \text{hardness}) - 5.777} \times 10^{-3}$$

d Does not apply to Sacramento River above State Hwy. 32 bridge at Hamilton City. See relevant objectives (c) above.

WATER QUALITY OBJECTIVES III-4.00 27 March 2014

TABLE III-1A
ORGANIC CHEMICAL WATER QUALITY OBJECTIVES

CONSTITUENT	MAXIMUM CONCENTRATION (µg/l)	APPLICABLE WATER BODIES
Chlorodibromomethane (DBCM)	4.9	New Alamo Creek, from Old Alamo Creek to Ulatis Creek; Ulatis Creek, from New Alamo Creek to Cache Slough
Dichlorobromomethane (DCBM)	16	New Alamo Creek, from Old Alamo Creek to Ulatis Creek; Ulatis Creek, from New Alamo Creek to Cache Slough
Chloroform	46	New Alamo Creek, from Old Alamo Creek to Ulatis Creek; Ulatis Creek, from New Alamo Creek to Cache Slough

municipal supply (MUN) shall not contain lead in excess of 0.015 mg/l. The Regional Water Board acknowledges that specific treatment requirements are imposed by state and federal drinking water regulations on the consumption of surface waters under specific circumstances. To protect all beneficial uses the Regional Water Board may apply limits more stringent than MCLs.

Cryptosporidium and *Giardia*

Waters shall not contain *Cryptosporidium* and *Giardia* in concentrations that adversely affect the public water system component[1] of the MUN beneficial use. This narrative water quality objective for *Cryptosporidium* and *Giardia* shall be applied within the Sacramento-San Joaquin Delta and its tributaries below the first major dams (shown in Figure A44-1) and should be implemented as specified in Section IV of the Basin Plan. Compliance with this objective will be assessed at existing and new public water system intakes.

[1] Public water system as defined in Health and Safety Code, section 116275, subdivision (h).

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Color

Water shall be free of discoloration that causes nuisance or adversely affects beneficial uses.

Dissolved Oxygen

Within the legal boundaries of the Delta, the dissolved oxygen concentration shall not be reduced below:

7.0 mg/l in the Sacramento River (below the I Street Bridge) and in all Delta waters west of the Antioch Bridge; 6.0 mg/l in the San Joaquin River (between Turner Cut and Stockton, 1 September through 30 November); and 5.0 mg/l in all other Delta waters except for those bodies of water which are constructed for special purposes and from which fish have been excluded or where the fishery is not important as a beneficial use.

For surface water bodies outside the legal boundaries of the Delta, the monthly median of the mean daily dissolved oxygen *(DO)* concentration shall not fall below 85 percent of saturation in the main water mass, and the 95 percentile concentration shall not fall below 75 percent of saturation. The dissolved oxygen concentrations shall not be reduced below the following minimum levels at any time:

Waters designated WARM 5.0 mg/l
Waters designated COLD 7.0 mg/l
Waters designated SPWN 7.0 mg/l

The more stringent objectives in Table III-2 apply to specific water bodies in the Sacramento and San Joaquin River Basins:

TABLE III-2
SPECIFIC DISSOLVED OXYGEN WATER QUALITY OBJECTIVES

AMOUNT	TIME	PLACE
9.0 mg/l *	1 June to 31 August	Sacramento River from Keswick Dam to Hamilton City (13)
8.0 mg/l	1 September to 31 May	Feather River from Fish Barrier Dam at Oroville to Honcut Creek (40)
8.0 mg/l	all year	Merced River from Cressy to New Exchequer Dam (78)
8.0 mg/l	15 October to 15 June	Tuolumne River from Waterford to La Grange (86)

* When natural conditions lower dissolved oxygen below this level, the concentrations shall be maintained at or above 95 percent of saturation.

Floating Material

Water shall not contain floating material in amounts that cause nuisance or adversely affect beneficial uses.

Mercury

For Sulphur Creek (Colusa County), waters shall be maintained free of mercury from anthropogenic sources such that beneficial uses are not adversely affected. During low flow conditions, defined as flows less than 3 cfs, the instantaneous maximum total mercury concentration shall not exceed 1,800 ng/l. During high flow conditions, defined as flows greater than 3 cfs, the instantaneous maximum ratio of mercury to total suspended solids shall not exceed 35 mg/kg. Both objectives apply at the mouth of Sulphur Creek.

Methylmercury

For Clear Lake (53), the methylmercury concentration in fish tissue shall not exceed 0.09 and 0.19 mg methylmercury/kg wet weight of tissue in trophic level 3 and 4 fish, respectively.

For Cache Creek (Clear Lake to Yolo Bypass) (54), North Fork Cache Creek, and Bear Creek (tributary to Cache Creek), the average methylmercury concentration shall not exceed 0.12 and 0.23 mg methylmercury/ kg wet weight of muscle tissue in trophic level 3 and 4 fish, respectively. For Harley Gulch (tributary to Cache Creek), the average methylmercury concentration shall not exceed 0.05 mg methylmercury/ kg wet weight in whole, trophic level 2 and 3 fish.

For the Sacramento-San Joaquin Delta and Yolo Bypass waterways listed in Appendix 43, the average methylmercury concentrations shall not exceed 0.08 and 0.24 mg methylmercury/kg, wet weight, in muscle tissue of trophic level 3 and 4 fish, respectively (150-500 mm total length). The average methylmercury concentrations shall not exceed 0.03 mg methylmercury/kg, wet weight, in whole fish less than 50 mm in length.

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Compliance with the methylmercury fish tissue objectives shall be determined by analysis of fish tissue as described in Chapter V, Surveillance and Monitoring.

Oil and Grease

Waters shall not contain oils, greases, waxes, or other materials in concentrations that cause nuisance, result in a visible film or coating on the surface of the water or on objects in the water, or otherwise adversely affect beneficial uses.

pH

The pH shall not be depressed below 6.5 nor raised above 8.5.

The following site-specific objectives replace the general pH objective, above, in its entirety for the listed water bodies.

For Goose Lake (2), pH shall be less than 9.5 and greater than 7.5 at all times.

Pesticides

- No individual pesticide or combination of pesticides shall be present in concentrations that adversely affect beneficial uses.
- Discharges shall not result in pesticide concentrations in bottom sediments or aquatic life that adversely affect beneficial uses.
- Total identifiable persistent chlorinated hydrocarbon pesticides shall not be present in the water column at concentrations detectable within the accuracy of analytical methods approved by the Environmental Protection Agency or the Executive Officer.
- Pesticide concentrations shall not exceed those allowable by applicable antidegradation policies (see State Water Resources Control Board Resolution No. 68-16 and 40 C.F.R. Section 131.12.).
- Pesticide concentrations shall not exceed the lowest levels technically and economically achievable.
- Waters designated for use as domestic or municipal supply (MUN) shall not contain concentrations of pesticides in excess of the Maximum Contaminant Levels set forth in California Code of Regulations, Title 22, Division 4, Chapter 15.
- Waters designated for use as domestic or municipal supply (MUN) shall not contain concentrations of thiobencarb in excess of 1.0 µg/l.

Pesticide concentrations shall not exceed the levels identified in Table III-2A. Where more than one objective may be applicable, the most stringent objective applies.

For the purposes of this objective, the term pesticide shall include: (1) any substance, or mixture of substances which is intended to be used for defoliating plants, regulating plant growth, or for preventing, destroying, repelling, or mitigating any pest, which may infest or be detrimental to vegetation, man, animals, or households, or be present in any agricultural or nonagricultural environment whatsoever, or (2) any spray adjuvant.

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TABLE III-2A

SPECIFIC PESTICIDE OBJECTIVES

PESTICIDE	MAXIMUM CONCENTRATION AND AVERAGING PERIOD	APPLICABLE WATER BODIES
Chlorpyrifos	0.025 µ g/L ; 1-hour average (acute) 0.015 µ g/L ; 4-day average (chronic) Not to be exceeded more than once in a three year period.	San Joaquin River from Mendota Dam to Vernalis (Reaches include Mendota Dam to Sack Dam (70), Sack Dam to Mouth of Merced River (71), Mouth of Merced River to Vernalis (83)), Delta Waterways listed in Appendix 42. Sacramento River from Shasta Dam to Colusa Basin Drain (13) and the Sacramento River from the Colusa Basin Drain to I Street Bridge (30). Feather River from Fish Barrier Dam to Sacramento River (40).
Diazinon	0.16 µ g/L ; 1-hour average (acute) 0.10 µ g/L ; 4-day average (chronic) Not to be exceeded more than once in a three year period.	San Joaquin River from Mendota Dam to Vernalis (Reaches include Mendota Dam to Sack Dam (70), Sack Dam to Mouth of Merced River (71), Mouth of Merced River to Vernalis (83)), Delta Waterways listed in Appendix 42, Sacramento River from Shasta Dam to Colusa Basin Drain (13) and the Sacramento River from the Colusa Basin Drain to I Street Bridge (30). Feather River from Fish Barrier Dam to Sacramento River (40).

or (3) any breakdown products of these materials that threaten beneficial uses. Note that discharges of "inert" ingredients included in pesticide formulations must comply with all applicable water quality objectives.

Radioactivity

Radionuclides shall not be present in concentrations that are harmful to human, plant, animal or aquatic life nor that result in the accumulation of radionuclides in the food web to an extent that presents a hazard to human, plant, animal or aquatic life.

At a minimum, waters designated for use as domestic or municipal supply (MUN) shall not contain concentrations of radionuclides in excess of the maximum contaminant levels (MCLs) specified in Table 64442 of Section 64442 and Table 64443 of Section 64443 of Title 22 of the California Code of Regulations, which are incorporated by reference into this plan. This incorporation-by-reference is prospective, including future changes to the incorporated provisions as the changes take effect.

Salinity

Electrical Conductivity and Total Dissolved Solids–Special Cases in the Sacramento and San Joaquin River Basins Other Than the Delta

The objectives for electrical conductivity and total dissolved solids in Table III-3 apply to the water bodies specified. To the extent of any conflict with the general Chemical Constituents water quality objectives, the more stringent shall apply.

Electrical Conductivity, Total Dissolved Solids, and Chloride–Delta Waters

See the Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary, 2006, for salinity objectives applicable in the Delta.

Table III-3

ELECTRICAL CONDUCTIVITY AND TOTAL DISSOLVED SOLIDS

PARAMETER	WATER QUALITY OBJECTIVES	APPLICABLE WATER BODIES
Electrical Conductivity (at 25°C)	Shall not exceed 230 micromhos/cm (50 percentile) or 235 micromhos/cm (90 percentile) at Knights Landing above Colusa Basin Drain; or 240 micromhos/cm (50 percentile) or 340 micromhos/cm (90 percentile) at I Street Bridge, based upon previous 10 years of record.	Sacramento River (13, 30)
	Shall not exceed 150 micromhos/cm (90 percentile) in well-mixed waters of the Feather River.	North Fork of the Feather River (33); Middle Fork of the Feather River from Little Last Chance Creek to Lake Oroville (36); Feather River from the Fish Barrier Dam at Oroville to Sacramento River (40)
	Shall not exceed 150 micromhos/cm from Friant Dam to Gravelly Ford (90 percentile).	San Joaquin River, Friant Dam to Mendota Pool (69)
Total Dissolved Solids	Shall not exceed 125 mg/l (90 percentile)	North Fork of the American River from the source to Folsom Lake (44); Middle Fork of the American River from the source to Folsom Lake (45); South Fork of the American River from the source to Folsom Lake (48, 49); American River from Folsom Dam to Sacramento River (51)
	Shall not exceed 100 mg/l (90 percentile)	Folsom Lake (50)
	Shall not exceed 1,300,000 tons	Goose Lake (2)

Sediment

The suspended sediment load and suspended sediment discharge rate of surface waters shall not be altered in such a manner as to cause nuisance or adversely affect beneficial uses.

Settleable Material

Waters shall not contain substances in concentrations that result in the deposition of material that causes nuisance or adversely affects beneficial uses.

Suspended Material

Waters shall not contain suspended material in concentrations that cause nuisance or adversely affect beneficial uses.

Tastes and Odors

Water shall not contain taste- or odor-producing substances in concentrations that impart undesirable tastes or odors to domestic or municipal water supplies or to fish flesh or other edible products of aquatic origin, or that cause nuisance, or otherwise adversely affect beneficial uses.

1 September 1998 III-7.00 WATER QUALITY OBJECTIVES

Temperature

The natural receiving water temperature of intrastate waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Water Board that such alteration in temperature does not adversely affect beneficial uses.

Temperature objectives for COLD interstate waters, WARM interstate waters, and Enclosed Bays and Estuaries are as specified in the *Water Quality Control Plan for Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays of California* including any revisions. There are also temperature objectives for the Delta in the State Water Board's *2006 Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary*.

At no time or place shall the temperature of COLD or WARM intrastate waters be increased more than 5°F above natural receiving water temperature. Temperature changes due to controllable factors shall be limited for the water bodies specified as described in Table III-4. To the extent of any conflict with the above, the more stringent objective applies.

In determining compliance with the water quality objectives for temperature, appropriate averaging periods may be applied provided that beneficial uses will be fully protected.

TABLE III-4
SPECIFIC TEMPERATURE OBJECTIVES

DATES	APPLICABLE WATER BODY
From 1 December to 15 March, the maximum temperature shall be 55°F.	Sacramento River from its source to Box Canyon Reservoir (9); Sacramento River from Box Canyon Dam to Shasta Lake (11)
From 16 March to 15 April, the maximum temperature shall be 60°F.	
From 16 April to 15 May, the maximum temperature shall be 65°F.	
From 16 May to 15 October, the maximum temperature shall be 70°F.	
From 16 October to 15 November, the maximum temperature shall be 65°F.	
From 16 November to 30 November, the maximum temperature shall be 60°F.	
The temperature in the epilimnion shall be less than or equal to 75°F or mean daily ambient air temperature, whichever is greater.	Lake Siskiyou (10)
The temperature shall not be elevated above 56°F in the reach from Keswick Dam to Hamilton City nor above 68°F in the reach from Hamilton City to the I Street Bridge during periods when temperature increases will be detrimental to the fishery.	Sacramento River from Shasta Dam to I Street Bridge (13, 30)

The following site-specific objective replaces the general temperature objective, above, in its entirety for the listed water body:

For Deer Creek, source to Cosumnes River, temperature changes due to controllable factors shall not cause creek temperatures to exceed the objectives specified in Table III-4A.

TABLE III-4A
DEER CREEK TEMPERATURE OBJECTIVES

Date	Daily Maximum (°F)[a]	Monthly Average (°F)[b]
January and February	63	58
March	65	60
April	71	64
May	77	68
June	81	74
July through Sept.	81	77
October	77	72
November	73	65
December	65	58

a Maximum not to be exceeded.
b Defined as a calendar month average.

Toxicity

All waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life. This objective applies regardless of whether the toxicity is caused by a single substance or the interactive effect of multiple substances. Compliance with this objective will be determined by analyses of indicator organisms, species diversity, population density, growth anomalies, and biotoxicity tests of appropriate duration or other methods as specified by the Regional Water Board.

The Regional Water Board will also consider all material and relevant information submitted by the discharger and other interested parties and numerical criteria and guidelines for toxic substances developed by the State Water Board, the California Office of Environmental Health Hazard Assessment, the State Water Board Division of Drinking Water Programs, the U.S. Food and Drug Administration, the National Academy of Sciences, the U.S. Environmental Protection Agency, and other appropriate

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organizations to evaluate compliance with this objective.

The survival of aquatic life in surface waters subjected to a waste discharge or other controllable water quality factors shall not be less than that for the same water body in areas unaffected by the waste discharge, or, when necessary, for other control water that is consistent with the requirements for "experimental water" as described in *Standard Methods for the Examination of Water and Wastewater*, latest edition. As a minimum, compliance with this objective as stated in the previous sentence shall be evaluated with a 96-hour bioassay.

In addition, effluent limits based upon acute biotoxicity tests of effluents will be prescribed where appropriate; additional numerical receiving water quality objectives for specific toxicants will be established as sufficient data become available; and source control of toxic substances will be encouraged.

Turbidity

Waters shall be free of changes in turbidity that cause nuisance or adversely affect beneficial uses. Increases in turbidity attributable to controllable water quality factors shall not exceed the following limits:

- Where natural turbidity is less than 1 Nephelometric Turbidity Unit (NTU), controllable factors shall not cause downstream turbidity to exceed 2
- Where natural turbidity is between 1 and 5 NTUs, increases shall not exceed 1 NTU.
- Where natural turbidity is between 5 and 50 NTUs, increases shall not exceed 20 percent.
- Where natural turbidity is between 50 and 100 NTUs, increases shall not exceed 10 NTUs.
- Where natural turbidity is greater than 100 NTUs, increases shall not exceed 10 percent.

In determining compliance with the above limits, appropriate averaging periods may be applied provided that beneficial uses will be fully protected.

Exceptions to the above limits will be considered when a dredging operation can cause an increase in turbidity. In those cases, an allowable zone of dilution within which turbidity in excess of the limits may be tolerated will be defined for the operation and prescribed in a discharge permit.

For Folsom Lake (50) and American River (Folsom Dam to Sacramento River) (51), except for periods of storm runoff, the turbidity shall be less than or equal 10 NTUs. To the extent of any conflict with the general turbidity objective, the more stringent applies.

For Delta waters, the general objectives for turbidity apply subject to the following: except for periods of storm runoff, the turbidity of Delta waters shall not exceed 50 NTUs in the waters of the Central Delta and 150 NTUs in other Delta waters. Exceptions to the Delta specific objectives will be considered when a dredging operation can cause an increase in turbidity. In this case, an allowable zone of dilution within which turbidity in excess of limits can be tolerated will be defined for the operation and prescribed in a discharge permit.

For Deer Creek, source to Cosumnes River:

- When the dilution ratio for discharges is less than 20:1 and where natural turbidity is less that 1 Nephelometric Turbidity Unit (NTU), discharges shall not cause the receiving water daily average turbidity to exceed 2 NTUs or daily maximum turbidity to exceed 5 NTUs. Where natural turbidity is between 1 and 5 NTUs, dischargers shall not cause receiving water daily average turbidity to increase more than 1 NTU or daily maximum turbidity to exceed 5 NTUs
- Where discharge dilution ratio is 20:1 or greater, or where natural turbidity is greater than 5 NTUs, the general turbidity objectives shall apply.

Appendix C.2 Objectives for Ground Water

WATER QUALITY OBJECTIVES FOR GROUND WATERS

The following objectives apply to all ground waters of the Sacramento and San Joaquin River Basins, as the objectives are relevant to the protection of designated beneficial uses. These objectives do not require improvement over naturally occurring background concentrations. The ground water objectives contained in this plan are not required by the federal Clean Water Act.

Bacteria

In ground waters used for domestic or municipal supply (MUN) the most probable number of coliform organisms over any seven-day period shall be less than 2.2/100 ml.

Chemical Constituents

Ground waters shall not contain chemical constituents in concentrations that adversely affect beneficial uses.

At a minimum, ground waters designated for use as domestic or municipal supply (MUN) shall not contain concentrations of chemical constituents in excess of the maximum contaminant levels (MCLs) specified in the following provisions of Title 22 of the California Code of Regulations, which are incorporated by reference into this plan: Tables 64431-A (Inorganic Chemicals) and 64431-B (Fluoride) of Section 64431, Table 64444-A (Organic Chemicals) of Section 64444, and Tables 64449-A (Secondary Maximum Contaminant Levels-Consumer Acceptance Limits) and 64449-B (Secondary Maximum Contaminant Levels-Ranges) of Section 64449. This incorporation-by-reference is prospective, including future changes to the incorporated provisions as the changes take effect. At a minimum, water designated for use as domestic or municipal supply (MUN) shall not contain lead in excess of 0.015 mg/l. To protect all beneficial uses, the Regional Water Board may apply limits more stringent than MCLs.

Radioactivity

At a minimum, ground waters designated for use as domestic or municipal supply (MUN) shall not contain concentrations of radionuclides in excess of the maximum contaminant levels (MCLs) specified in Table 4 (MCL Radioactivity) of Section 64443 of Title 22 of the California Code of Regulations, which are incorporated by reference into this plan. This incorporation-by-reference is prospective, including future changes to the incorporated provisions as the changes take effect.

Tastes and Odors

Ground waters shall not contain taste- or odor-producing substances in concentrations that cause nuisance or adversely affect beneficial uses.

Toxicity

Ground waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life associated with designated beneficial use(s). This objective applies regardless of whether the toxicity is caused by a single substance or the interactive effect of multiple substances.

Appendix D Descriptions of Beneficial Uses

II. EXISTING AND POTENTIAL BENEFICIAL USES

Beneficial uses are critical to water quality management in California. State law defines beneficial uses of California's waters that may be protected against quality degradation to include (and not be limited to) "...domestic; municipal; agricultural and industrial supply; power generation; recreation; aesthetic enjoyment; navigation; and preservation and enhancement of fish, wildlife, and other aquatic resources or preserves" (Water Code Section 13050(f)). Protection and enhancement of existing and potential beneficial uses are primary goals of water quality planning.

Significant points concerning the concept of beneficial uses are:

1. All water quality problems can be stated in terms of whether there is water of sufficient quantity or quality to protect or enhance beneficial uses.

2. Beneficial uses do not include all of the reasonable uses of water. For example, disposal of wastewaters is not included as a beneficial use. This is not to say that disposal of wastewaters is a prohibited use of waters of the State; it is merely a use which cannot be satisfied to the detriment of beneficial uses. Similarly, the use of water for the dilution of salts is not a beneficial use although it may, in some cases, be a reasonable and desirable use of water.

3. The protection and enhancement of beneficial uses require that certain quality and quantity objectives be met for surface and ground waters.

4. Fish, plants, and other wildlife, as well as humans, use water beneficially.

Beneficial use designation (and water quality objectives, see Chapter III) must be reviewed at least once during each three-year period for the purpose of modification as appropriate (40 CFR 131.20).

The beneficial uses, and abbreviations, listed below are standard basin plan designations.

Municipal and Domestic Supply (MUN) - Uses of water for community, military, or individual water supply systems including, but not limited to, drinking water supply.

Agricultural Supply (AGR) - Uses of water for farming, horticulture, or ranching including, but not limited to, irrigation (including leaching of salts), stock watering, or support of vegetation for range grazing.

Industrial Service Supply (IND) - Uses of water for industrial activities that do not depend primarily on water quality including, but not limited to, mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, or oil well repressurization.

Industrial Process Supply (PRO) - Uses of water for industrial activities that depend primarily on water quality.

Ground Water Recharge (GWR) - Uses of water for natural or artificial recharge of ground water for purposes of future extraction, maintenance of water quality, or halting of saltwater intrusion into freshwater aquifers.

Freshwater Replenishment (FRSH) - Uses of water for natural or artificial maintenance of surface water quantity or quality.

Navigation (NAV) - Uses of water for shipping, travel, or other transportation by private, military, or commercial vessels.

Hydropower Generation (POW) - Uses of water for hydropower generation.

Water Contact Recreation (REC-1) - Uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, white water activities, fishing, or use of natural hot springs.

Non-contact Water Recreation (REC-2) - Uses of water for recreational activities involving proximity to water, but where there is generally no body contact with water, nor any likelihood of ingestion of water. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing,

or aesthetic enjoyment in conjunction with the above activities.

Commercial and Sport Fishing (COMM) - Uses of water for commercial or recreational collection of fish, shellfish, or other organisms including, but not limited to, uses involving organisms intended for human consumption or bait purposes.

Aquaculture (AQUA) - Uses of water for aquaculture or mariculture operations including, but not limited to, propagation, cultivation, maintenance, or harvesting of aquatic plants and animals for human consumption or bait purposes.

Warm Freshwater Habitat (WARM) - Uses of water that support warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.

Cold Freshwater Habitat (COLD) - Uses of water that support cold water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.

Estuarine Habitat (EST) - Uses of water that support estuarine ecosystems including, but not limited to, preservation or enhancement of estuarine habitats, vegetation, fish, shellfish, or wildlife (e.g., estuarine mammals, waterfowl, shorebirds).

Wildlife Habitat (WILD) - Uses of water that support terrestrial or wetland ecosystems including, but not limited to, preservation and enhancement of terrestrial habitats or wetlands, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.

Preservation of Biological Habitats of Special Significance (BIOL) - Uses of water that support designated areas or habitats, such as established refuges, parks, sanctuaries, ecological reserves, or Areas of Special Biological Significance (ASBS), where the preservation or enhancement of natural resources requires special protection.

Rare, Threatened, or Endangered Species (RARE) - Uses of water that support aquatic habitats necessary, at least in part, for the survival and successful maintenance of plant or animal species established under state or federal law as rare, threatened or endangered.

Migration of Aquatic Organisms (MIGR) - Uses of water that support habitats necessary for migration or other temporary activities by aquatic organisms, such as anadromous fish.

Spawning, Reproduction, and/or Early Development (SPWN) - Uses of water that support high quality aquatic habitats suitable for reproduction and early development of fish.

Shellfish Harvesting (SHELL) - Uses of water that support habitats suitable for the collection of filter-feeding shellfish (e.g., clams, oysters, and mussels) for human consumption, commercial, or sports purposes.

Surface Waters

Existing and potential beneficial uses which currently apply to surface waters of the basins are presented in Figure II-1 and Table II-1. The beneficial uses of any specifically identified water body generally apply to its tributary streams, except as provided below:

- MUN, COLD, MIGR and SPWN do not apply to Old Alamo Creek (Solano County) from its headwaters to the confluence with New Alamo Creek
- MUN and the human consumption of aquatic organisms do not apply to Sulphur Creek (Colusa County) from Schoolhouse Canyon to the confluence with Bear Creek

In some cases a beneficial use may not be applicable to the entire body of water. In these cases the Regional Water Board's judgment will be applied.

It should be noted that it is impractical to list every surface water body in the Region. For unidentified water bodies, the beneficial uses will be evaluated on a case-by-case basis.

Hazel Avenue/U.S. Route 50 Interchange Project



Paleontological Evaluation Report and Preliminary Paleontological Mitigation Plan

Hazel Avenue/U.S. Route 50 Interchange Project

City of Rancho Cordova, Sacramento County

03-SAC-50/PM 15.1-17.5

Federal Project No.: EA 03-3E380/E-FIS 0300020439

February 2017

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Paleontological Evaluation Report and Preliminary Paleontological Mitigation Plan

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February 2017

STATE OF CALIFORNIA
Department of Transportation
District 3

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Summary

Project Description

The County of Sacramento, in cooperation with California Department of Transportation (Caltrans) and the City of Rancho Cordova, is proposing the Hazel Avenue/U.S. Route (US 50) Interchange Project (proposed project) to modify the existing interchange, and extend and grade-separate Hazel Avenue over Folsom Boulevard and the Sacramento Placerville Transportation Corridor Joint Powers Authority (SPTC-JPA) rail corridor. The primary purpose of the project is to reduce congestion, improve traffic operations, accommodate travel demand due to planned and approved developments, and improve safety of all modes of travel including bicycles and pedestrians. Caltrans is considering three build alternatives and a no-build alternative. Alternative 1 consists of a modified type L-9 interchange configuration. Alternative 1A is identical to Alternative 1 except that the eastbound off-ramp will split and introduce a direct tunnel ramp under Hazel Avenue to carry eastbound off-ramp traffic to Aerojet Road and Folsom Boulevard. Alternative 2 consists of a modified type L-9 interchange configuration, with a flyover ramp carrying vehicles travelling from eastbound U.S. 50 to northbound Hazel Avenue over the freeway to join with the westbound off-ramp. Under the No Build Alternative, the interchange would retain the existing configuration, ramps, and lanes.

The proposed project is subject to state and federal environmental review requirements because the use of federal funds from the Federal Highway Administration (FHWA) is proposed. Accordingly, project documentation is being prepared in compliance with both the National Environmental Policy Act (NEPA) and the California Environmental Quality Act (CEQA). Caltrans is the lead agency under NEPA and the County of Sacramento, in cooperation with the City of Rancho Cordova, is the lead agency under CEQA. The interchange is included in several planning efforts: the Easton Place Development, Aerojet Special Planning Area, 2030 Sacramento County General Plan, SACOG Metropolitan Transportation Improvement Plan, and Hazel Station Special Planning Area. This Paleontological Evaluation Report (PER) and Preliminary Paleontological Mitigation Plan (PMP) outlines measures and methods for paleontological resources protection designed to meet the needs and requirements of the NEPA and CEQA regarding impacts on paleontological resources. Those measures and methods will ensure NEPA and CEQA compliance if they are implemented during construction of the project. This PER/PMP was prepared in order to ensure compliance and meet the requirements of NEPA (42 United States Code [USC] 4321), CEQA (Chapter 1, Section 21002), the California Public Resources Code (Chapter 1.7, Section 5097.5), the Federal-Aid Highway Act of 1935 (20 USC 78), the Antiquities

Act of 1906 (16 USC 431-433), and its amendment, Archeological and Paleontological Salvage (23 USC 305).

Proposed monitoring and mitigation methods outlined herein are in part derived from the Society of Vertebrate Paleontology (SVP) standard guidelines (2010) and the Caltrans Standard Environmental Reference (SER) Environmental Handbook, Volume 1, Chapter 8, Paleontology. These measures and methods have been widely used in California and have proven to be successful in protecting and preserving significant paleontological resources while allowing for the timely completion of construction work.

The study purpose, methods, goals, and mitigation measures for this PER/PMP are first and foremost to reduce any negative impacts of construction on significant, non-renewable paleontological resources preserved in the geologic formations to an acceptable level. Measures to reduce these potential negative impacts are detailed in this plan. This PER/PMP documents that the planned construction excavations and ground disturbance for the project will encounter and impact geologic formations known to contain significant paleontological resources. This PER/PMP provides a summary of fossils from geologic formations/deposits found in the limits of the project and shows these geologic units are regarded as high potential to contain additional significant paleontological resources.

Based on this report's findings, the geologic formations present in the project area are known to contain significant fossils, including mammoth, bison, camel, horse, ground sloth, dire wolf, rodents, moles, birds, and bony fish (University of California Museum of Paleontology 2016a, 2016b, and 2016c), are the Pleistocene Riverbank Formation and Modesto Formation.

Affected Environment

Given that paleontological resources are preserved in the Riverbank and Modesto Formations based on fossil localities outside the project area, and that construction-related excavations into these geologic formations can lead to destruction of paleontological resources should they be present, it is critical to a successful PER/PMP to understand the nature and location of proposed excavation activities. For the project, these construction-related excavations may include excavations for road widening and realignment, excavation for bridge footings, trenching for the tunnel ramp under Hazel Avenue, construction of the transition lane to the US 50/Folsom Boulevard interchange, and other ground-disturbing activities in the project area. Geologic formations known to contain sensitive, non-renewable paleontological resources mapped in the area are the Pleistocene Riverbank Formation and the Pleistocene Modesto Formation.

Environmental Consequences and Required Mitigation

Potential impacts are expected on the Riverbank Formation and Modesto Formation, which underlie the project area. The Riverbank Formation and Modesto Formation are regarded as having a high potential to contain significant fossils due to their recorded fossiliferous nature from known localities throughout the Sacramento and San Joaquin Valleys. The measures outlined in this PER/PMP to salvage significant fossil resources found during construction activities would serve as a method to reduce potential effects on paleontological resources to a level that would not be adverse under NEPA and would be less than significant under CEQA.

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List of Abbreviated Terms

Caltrans	California Department of Transportation
CEQA	California Environmental Quality Act
FHWA	Federal Highway Administration
HOV	high occupancy vehicle
LOS	Level of Service
MSE	Mechanically Stabilized Earth
MTP	Metropolitan Transportation Plan
NEPA	National Environmental Policy Act
PEAR	preliminary environmental analysis report
PER	Paleontological Evaluation Report
PL	Public Law
PMP	Paleontological Mitigation Plan
proposed project	Hazel Avenue/U.S. Highway Interchange Project
ROW	right-of-way
SACOG	Sacramento Area Council of Government
SER	Standard Environmental Reference
SPTC-JPA	Sacramento Placerville Transportation Corridor Joint Powers Authority
SVP	Society of Vertebrate Paleontology
UMCP	University of California Museum of Paleontology
UPRR	Union Pacific Railroad
US 50	U.S. Route
USC	United States Code
USTs	underground storage tanks

Chapter 1 Introduction

The County of Sacramento, in cooperation with Caltrans and the City of Rancho Cordova, proposes to modify the existing Hazel Avenue/US 50 interchange, and extend and grade-separate Hazel Avenue over Folsom Boulevard and the Sacramento Placerville Transportation Corridor Joint Powers Authority (SPTC-JPA) rail corridor (Figure 1 and Figure 2). Hazel Avenue will be extended further south to a proposed intersection with the future Atlanta Street (a new roadway that will be constructed as part of the Easton Place development).

1.1 Goals of Study

The preliminary environmental analysis report (PEAR) prepared for this project indicated that the proposed project was situated in highly sensitive units known to contain significant, non-renewable paleontological resources. Because of this, the PEAR indicated that a PER and potentially a PMP must be prepared.

The goals for this combined Paleontological Evaluation Report (PER) and Paleontological Mitigation Plan (PMP) are to evaluate and document the significance of the resources that could be affected and reduce the impacts from project construction on paleontological resources to an acceptable level. Complete avoidance of resources may not be possible because excavation would be required regardless of the selected alternative. The mitigation measures and methods outlined herein meet the requirements of the National Environmental Policy Act (NEPA) and the California Environmental Quality Act (CEQA), and as outlined in the Caltrans Standard Environmental Reference (SER). Mitigation measures are identified to serve as a method to ensure that effects to paleontological resources would not be adverse under NEPA and would be less than significant under CEQA. These mitigation measures have been widely used in California and have proven to be successful in protecting and preserving significant paleontological resources while allowing for the timely completion of construction work.

This PER/PMP conforms to the procedures and format as set forth in the Caltrans Environmental Handbook, Volume 1, Chapter 8, Paleontology. This report is needed to provide methods for paleontological resource recovery operations, scope of work, decision thresholds regarding paleontological fieldwork, scheduling, a cost estimate, and permitting for the proposed project. This report documents the results of the PER and the PMP prepared for this project.

1.2 Construction-Related Impacts

The proposed project includes ground-disturbing activities and excavation of soil below depths of 5 feet. The deepest excavation would occur for construction of abutments and new bridge, retaining

walls, and ramps below undercrossings. The depth of excavation required for the gas station removal is to be determined, but is anticipated to take place in previously disturbed soils. The formations and sediments that may be affected by excavation and other construction-related activities and how those activities could affect paleontological resources are discussed in this section.

1.2.1 Formations and Sediments That May Be Affected

The central portion of the project area is immediately underlain by highly sensitive formations. These formations are the Pleistocene Riverbank Formation and Modesto Formation.

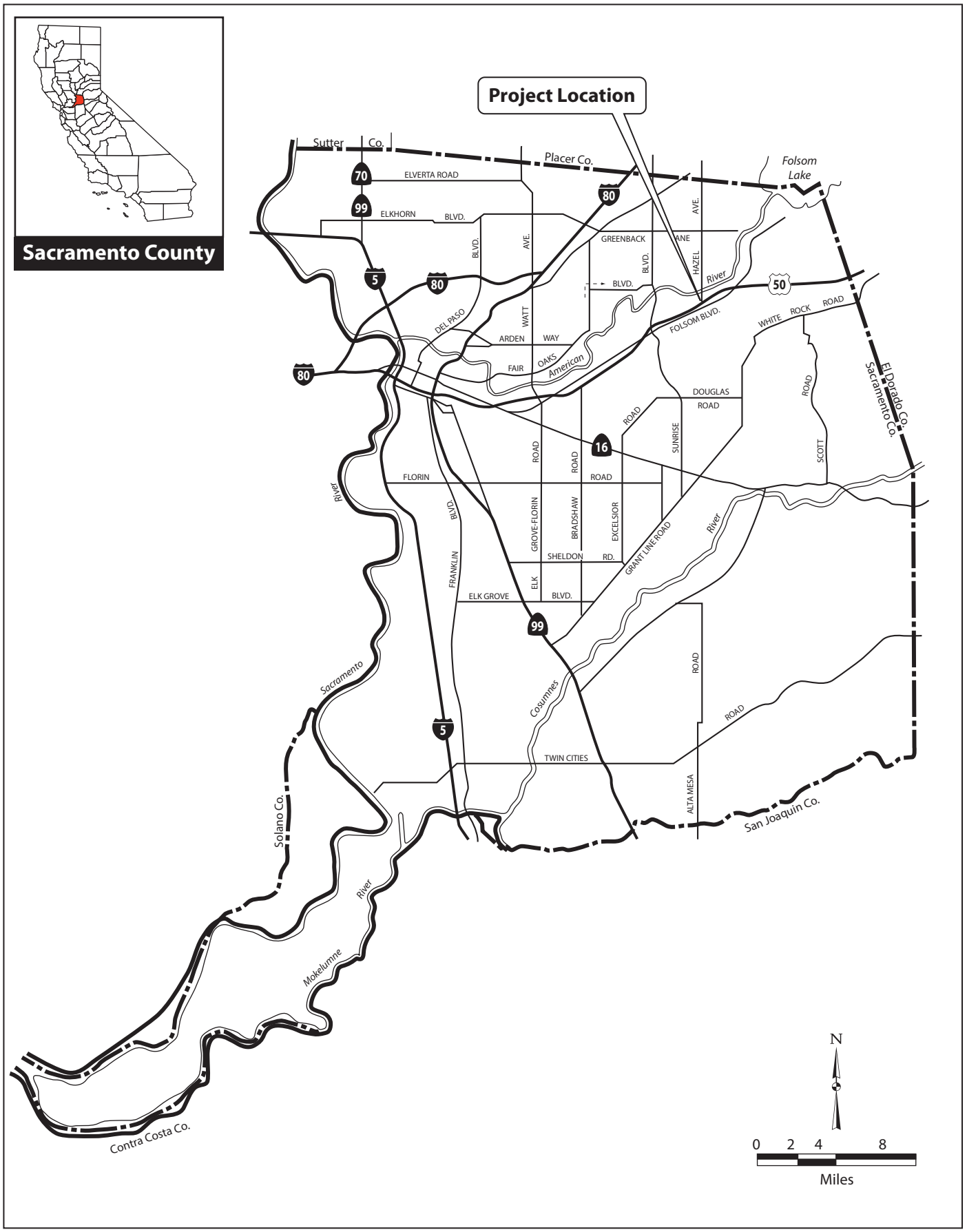
Although the remainder of the project area is immediately underlain by dredge tailings, which are highly disturbed and unlikely to contain paleontological resources, these tailing are underlain by the Riverbank Formation. Therefore, excavation that exceeds the depth of the dredge tailings would affect Riverbank Formation.

1.2.2 Project-Related Work That May Affect Paleontological Resources

The primary mechanism for impacts on paleontological resources would be ground disturbance during construction.

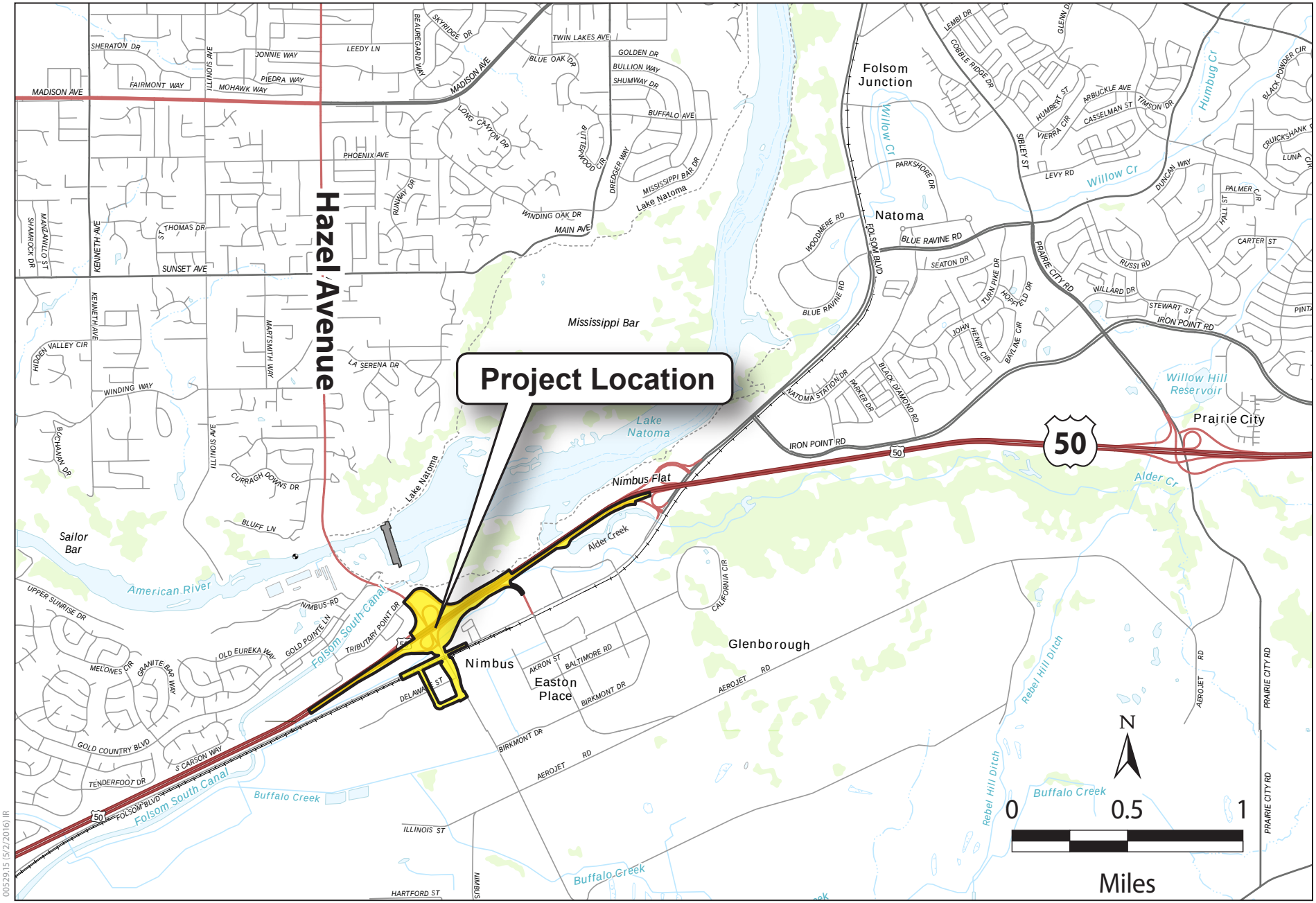
There is a potential for impact on paleontological resources mainly in the central portion of the project area, where highly sensitive formations occur at or near the surface. A portion of the project area not sensitive for paleontological resources is the eastbound auxiliary lane and transition lane through the Hazel Avenue overcrossing where artificial fill used for road base and disturbed soil is present at the surface and project construction involves mainly fill and grading for road widening. In addition, the jughandle area is underlain by dredge tailings, which are also not considered sensitive for paleontological resources. Construction of the proposed project would require disturbance of large areas of soil and excavation to depths greater than 5 feet, depending on the element of the project being constructed (e.g., trenching for the tunnel ramp under Hazel Avenue and construction of the transition lane to the US 50/Folsom Boulevard interchange). Grading and excavation for the proposed build alternatives would most likely encroach into the known fossiliferous Riverbank and Modesto Formations. More detail about the proposed project is included in Chapter 3, Project Description. Depth of excavation and the geologic units affected are provided in Section 5.4, Construction-Related Effects.

In the Central Valley, scientifically significant paleontological vertebrate fossil resources of Pleistocene age have been recovered from deposits similar to those deposits underlying the proposed project. Non-marine Pleistocene deposits are regionally extensive and are considered sensitive throughout their extent. These units have a high potential to contain important



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Figure 1-1
Project Vicinity



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Figure 2

Project Location

paleontological vertebrate fossil resources. If such resources are present at the project site, construction activities could cause adverse impacts under NEPA and significant impacts under CEQA, such as destruction and loss of possible scientifically significant paleontological vertebrate fossil resources.

1.2.3 Cumulative Effects on Paleontological Resources

No significant cumulative impact on paleontological resources has been identified for the project region. However, available evidence indicates that the area's Pleistocene strata in particular preserve a rich vertebrate fauna and, with progressive development in coming decades, ongoing earthwork could foreseeably result in damage to fossil resources that rises to the level of a significant cumulative impact.

Caltrans constructs highway structures in many locations throughout the Central Valley that require excavation in Pleistocene-age sediments similar to those found in the project area. While individually many of these construction projects involve smaller amounts of excavation resulting in a lower intensity of impact, the total extent of all excavation for these projects could result in the loss of a large number of important fossils. The loss of even a few scientifically important fossil specimens would mean the inability to piece together important parts of the earth's history and the evolution of species.

The salvage of fossil specimens during construction excavation for these projects would ensure that adverse effects under NEPA would not occur and would result in the reduction of this impact to less than significant under CEQA. After implementation of this approach, cumulative impacts are not anticipated related to the proposed project.

1.3 Required Mitigation

Documented vertebrate fossil content from the Riverbank and Modesto Formations indicate that these units should be considered highly sensitive for paleontological resources. As a result, these units are classified following Caltrans standards as "High Potential" rock units. These units, based on previous studies, contain or are likely to contain significant vertebrate, invertebrate, or plant fossils.

Mitigation is required to reduce potential effects on paleontological resources to a level that would not be adverse under NEPA and would be less than significant under CEQA. Measures have been identified in this PER/PMP to ensure that adverse effects under NEPA and significant impacts under CEQA would not occur.

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Chapter 2 Background

2.1 Project Need

The proposed project is needed to relieve congestion at the existing interchange and to accommodate planned and approved developments identified by the adopted Sacramento County General Plan and the Sacramento Area Council of Government's (SACOG's) Regional Transportation Plan.

The approved developments within and near the project area will increase traffic demand beyond what the existing interchange can accommodate. The close spacing between the Folsom Boulevard intersection and the eastbound off-ramp intersection does not provide sufficient queuing for increased traffic volumes. Additionally, the County of Sacramento is currently widening Hazel Avenue from four to six traffic lanes between the existing interchange and Madison Avenue. This increase in roadway capacity is expected to deliver more traffic to the Hazel Avenue/US 50 interchange during peak traffic periods.

Traffic demand forecasts for the proposed project were conducted using the SACOG 2035 Metropolitan Transportation Plan (MTP) projected to 2038 (20 years after anticipated opening day) and supplemented by anticipated levels of additional development currently in application or advanced planning stages. Based on these projections, it is anticipated the existing interchange will degrade to Level of Service (LOS) "F".

2.2 Project Purpose

The primary purpose of the proposed project is to modify the existing interchange to reduce congestion, improve traffic operations, accommodate travel demand due to planned and approved developments, and improve safety of all modes of travel, including bicycles and pedestrians.

The build alternatives for the proposed project would meet the following objectives.

- Improve operations by removing the close intersection spacing between the eastbound ramps and Folsom Boulevard, and minimizing conflict with heavy and light rail.
  - Proposed alternatives accomplish this by grade-separating Hazel Avenue over Folsom Boulevard.
- Provide sufficient capacity in the ramps and roadways for future traffic volumes.
  - Proposed alternatives accomplish this by widening and/or lengthening the on/off-ramps and Hazel Avenue as required by their respective traffic analysis.

- Maintain the Aerojet Road off-ramp connection to the approved development while improving the mainline operations.
  - Proposed alternatives accomplish this by removing the Aerojet Road exit from U.S. 50 but still providing direct access to Aerojet Road through the eastbound Hazel Avenue off-ramp.

Chapter 3 Project Description

3.1 Project Location

The project is located in the City of Rancho Cordova and unincorporated County of Sacramento at the interchange of Hazel Avenue and US 50. The project area is bounded along Hazel Avenue by the Tributary Point/westbound off-ramp intersection to the north, and extends approximately 1,000 feet south of Folsom Boulevard to a future intersection within the proposed Easton Place development. The project limits along US 50 begin approximately 3,200 feet west of the existing Hazel Avenue Overcrossing, and extend 2,500 feet east of the Natoma Overhead. Improvements along Folsom Boulevard would extend from approximately 1,200 feet west of the Hazel Avenue intersection to 900 feet to the east.

3.2 Alternatives

3.2.1 Proposed Project

This section describes the proposed project and the design alternatives that were developed to meet the identified need through accomplishing the defined purpose while avoiding or minimizing environmental impacts. Three proposed build alternatives are being considered for this project.

- Alternative 1: This alternative consists of a modified type L-9 interchange configuration and will provide a viaduct connection to Aerojet Road.
- Alternative 1a: This alternative is the same as Alternative 1 except that the eastbound off-ramp will split and introduce a direct tunnel ramp under Hazel Avenue to carry eastbound off-ramp traffic to Aerojet Road and Folsom Boulevard.
- Alternative 3: This alternative consists of a modified type L-9 interchange configuration, with a flyover ramp carrying vehicles travelling from eastbound US 50 to northbound Hazel Avenue over the freeway to join with the westbound off-ramp.

These alternatives are described in more detail in sections 3.2.3 to 3.2.5.

3.2.2 Project Alternatives

The proposed project would construct modifications to the existing interchange, and grade-separate and extend Hazel Avenue to the south to a future intersection with Atlanta Street, which will be built with the approved Easton Place development. Two alternatives, with one sub-alternative, have been developed for the project.

3.2.2.1 Common Design Features of the Build Alternatives

The following is a description of elements and design components that are common to all alternatives.

Roadway Modifications

- Construction of a portion of an eastbound transition auxiliary lane on US 50 from Hazel Avenue through the Folsom Boulevard Overcrossing, also known as the Natoma Overhead.
- Modification of the existing Aerojet Road off-ramp from US 50.
- Reconstruction of the westbound loop on-ramp, with the ramp intersection shifted north towards the westbound off-ramp terminus, increasing storage lengths. The ramp would be metered with two lanes (one mixed use, and one high occupancy vehicle [HOV]) bypass), and a squared-up, pedestrian-friendly entrance.
- Reconstruction of the eastbound diagonal off-ramp to conform with the new Hazel Avenue profile and accommodate the Aerojet Road ramp divergence.
- Reconstruction of the eastbound diagonal on-ramp to conform with the new Hazel Avenue profile. The ramp would be metered with two lanes; one mixed flow, and one HOV bypass.
- Reconstruction of the eastbound loop on-ramp to conform with the new Hazel Avenue profile. The ramp would be metered with two lanes; one mixed flow, and one HOV bypass. A tie-back wall at the abutment of the overcrossing is proposed to maximize the opening through the structure. The loop ramp would develop an additional lane on US 50 that will continue on to the Folsom Boulevard interchange.
- Construction of eastbound on- and off-ramp auxiliary lanes on US 50, from west of the Hazel Avenue interchange to the eastbound off-ramp, and from the loop on-ramp extending to the Folsom Boulevard interchange.
- Modification of traffic signals and installation of safety lighting at the ramp intersections. A new signalized intersection and at-grade railroad crossing would be constructed for the jughandle.
- Maintenance of pedestrian access on the east side of Hazel Avenue with 6-feet sidewalks; however, the existing sidewalk on the overcrossing will remain 5 feet wide. Bicyclists may utilize the County standard 7-feet shoulders. It is expected that pedestrians and bicyclists would continue to use the nearby Bikeway and Pedestrian Overcrossing as the primary means for crossing US 50.

- Construction of roadway improvements along approximately 2,300 feet of Folsom Boulevard. Improvements include the removal of the existing signalized intersection with Hazel Avenue, and installation of sidewalks, street lighting, and landscaping along the north side of Folsom Boulevard, and landscaping and lighting along the south.

Transition Lane to Folsom Boulevard/US 50 Interchange

As indicated in Caltrans' 2009 Corridor System Management Plan, eastbound US 50 is shown to have one HOV lane and three mixed flow lanes to Hazel Avenue as the Concept Facility. Additionally, eastbound US 50 is shown to have one HOV lane and three mixed flow lanes across Folsom Boulevard as the Ultimate Facility. The proposed project would accommodate these future facility improvements; conform to the approved Caltrans improvements at the Folsom Boulevard/US 50 interchange, some of which will occur in 2016; and would restripe the third mixed flow lane through the Folsom Boulevard/US 50 interchange.

The proposed project is required to add the mixed flow lane because it has been determined in the traffic analysis for this project, and in studies for adjacent projects, that the additional eastbound lane on US 50 extending through the Folsom Boulevard interchange is needed for operations.

Under all proposed project alternatives, accommodating this mixed flow lane will require the eastbound loop on-ramp to extend its auxiliary lane to the Folsom Boulevard/US 50 eastbound off-ramp. This would require widening and a new structure over Alder Creek.

Alder Creek currently flows under US 50 through a box culvert (Br. No. 24-0033). A Mechanically Stabilized Earth (MSE) wall (Br. No. 24-0372) is above the culvert. A new bridge would be required to widen US 50 over Alder Creek. The new bridge is necessary because there is insufficient lateral space to construct an adjacent MSE wall on top of the culvert and because the creek maintains a high operating water level.

Railroad Overhead

Hazel Avenue would extend and be grade-separated over Folsom Boulevard and the SPTC-JPA rail corridor. There is currently one light rail track on the north side of the Union Pacific Railroad (UPRR) tracks. Sacramento Regional Transit plans to add another track at this location; when the addition occurs, the existing UPRR track will be relocated south to accommodate the second light rail track. The proposed project design meets the requirements for all three tracks, with the clearances shown in Figure 3 below.

Temporary vertical clearances of 21 feet, 6 inches and permanent vertical clearances of 24 feet have been accounted for in the layout of all three alternatives for the Hazel Avenue Railroad

Overhead. The vertical clearance provided would accommodate the Overhead Catenary System for the light rail.

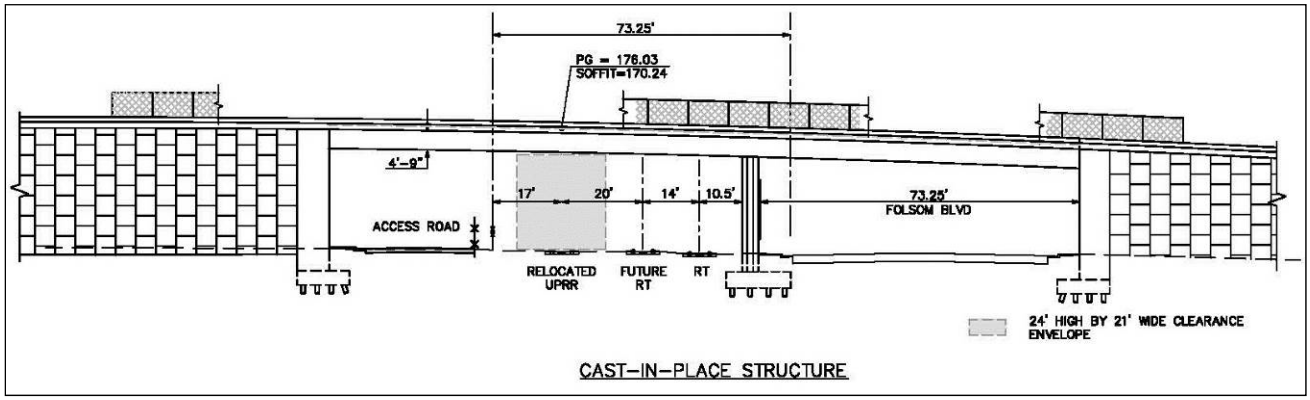


Figure 3. Cast-in-Place Structure

Construction Information

The section describes the major construction activities anticipated with the project.

Clearing and Grubbing

The existing ground would be cleared and grubbed to accommodate the new roadway, embankments and structures. This work would remove above ground material including all vegetation, non-salvageable trees and debris.

Construction of Roadway

This work would involve the obliteration of existing roadway, where applicable, and placement of new embankment, aggregate base, hot mix asphalt pavement, and curb, gutter and sidewalk.

Construction of Undercrossing Connector Ramp (Alt 1A)

Along with the elements noted for the "Construction of Roadway", this work is anticipated to be built using "top-down" construction methods. First, soldier piles would be installed to stabilize the slope. These will be steel beams set into vertical holes filled with concrete and temporary lagging spanning between the beams. The area between the abutments would be excavated down to the final roadway surface. Dewatering may be required. Abutments would be supported by the steel piling in the soldier pile wall. Precast superstructures would be utilized to minimize construction duration and impacts to traffic.

Construction of Hazel Ave Overcrossing, Aerojet Ramp Viaduct, Hazel Ave Overhead, Hazel Avenue Ramp Overcrossing

The new bridges are anticipated to be cast-in-place concrete box girder bridges. These structures would be built on deep foundations. Due to the presence of cobbles, steel piles with driving shoes are anticipated. Bridge superstructures would be constructed on temporary falsework. An alternative to the cast-in-place superstructure is a precast bridge where the primary superstructure is fabricated off-site. After fabrication, the bridge members would be shipped to the site and erected with cranes.

Construction of Bridge over Alder Creek

Because dewatering is not feasible at Alder Creek, the widening of US 50 would be accommodated with a bridge constructed over the waterway. Driven concrete pile extensions would be utilized for the columns. Piles would be driven using temporary or permanent casings. The concrete piles/columns would be cast. The superstructure would be cast-in-place and would be temporarily supported by falsework.

Construction of Sub-Horizontal Ground Anchor Wall

The ground anchor wall would be constructed in lifts using "top-down" construction methods and tiebacks. Tieback anchors would be drilled below the existing Hazel Ave Overcrossing abutments, which are founded on deep foundations. Shotcrete facing would be installed to stabilize the slope while subsequent lifts are constructed. Finally, a cast-in-place facing would be applied to the wall, providing long-term durability and an aesthetically pleasing texture.

Building Removal

The removal of the Cattleman's restaurant or the Nimbus Winery building will be require for the project. The Chevron station at the northwest corner of Hazel Avenue and Folsom Boulevard has underground storage tanks (USTs) that also would need to be removed.

Vertical Area of Potential Effects

The vertical Area of Potential Effects for the project is expected to include the following:

- Clearing and grubbing: 1 foot below ground surface
- Construction of abutments/new bridge: 5–15 feet below ground surface
- Construction of retaining walls: 15 feet below ground surface
- Removal of existing retaining wall: 3 feet below ground surface

- Tree removal: 2 feet below ground surface
- Building removal: 5 feet below ground surface
- Gas station removal: unknown (to be determined)
- Existing signal removal: 3 feet below ground surface
- Pile driving for structures: 50–80 feet below ground surface
- Construction of ramps below undercrossings:
  - Alt 1A: 17–20 feet below ground surface near ramps, 15 feet for retaining walls.
  - Alt 2: 5 feet below ground surface

3.2.2.2 Alternative 1

Alternative 1 consists of a modified type L-9 interchange configuration (Figure 4). A Caltrans Type L-9 interchange indicates a ramp configuration that includes a diagonal off-ramp, a diagonal on-ramp and a loop on-ramp. This alternative will provide a viaduct connection to Aerojet Road.

As with all alternatives, Hazel Avenue would grade-separate over Folsom Boulevard and the SPTC-JPA rail corridor and would extend south to a proposed intersection with the future Atlanta Street. The existing at-grade intersection of Hazel Avenue and Folsom Boulevard would be removed, sidewalks would be extended across the former intersection, and the lanes would be restriped to remove left-turn lanes.

The location of the departure point of the existing Aerojet Road off-ramp from US 50 would be moved to join with the eastbound Hazel Avenue off-ramp. The eastbound Hazel Avenue off-ramp would split and introduce a direct viaduct ramp over Hazel Avenue to carry eastbound off-ramp traffic to Aerojet Road and Folsom Boulevard. The off-ramp diverge from US 50 would be shifted approximately 830 feet to the east in order to provide decision sight distance before the Aerojet Road split. The two-lane off-ramp would widen to five lanes at the ramp terminal intersection, with three left-turn lanes and two right-turn lanes. Retaining walls and barriers placed at the proposed right-of-way (ROW) would minimize acquisition. The eastbound off-ramp would also have an auxiliary lane prior to the exit.

The Aerojet Road viaduct would land adjacent to the eastbound diagonal on-ramp and then turn southerly to conform to Folsom Boulevard along its existing alignment. Retaining walls are proposed between the viaduct and the diagonal on-ramp to accommodate the grade difference, and to the outside of the ramp after the viaduct lands, to minimize ROW acquisitions. Retaining walls are also proposed along Aerojet Road as it approaches the horizontal curve towards Folsom



Figure 4
Alternative 1: L-9 Interchange with Viaduct Connector
Hazel Avenue/U.S. 50 Interchange Project

Boulevard to accommodate the grade difference between the ramp and mainline and to minimize ROW acquisition.

The existing Hazel Avenue Overcrossing of US 50 would be widened on the west side to accommodate eight lanes (three through lanes and one freeway-only lane in both directions). The existing raised concrete median across the structure would be removed, and the roadway would be restriped with a 6-feet striped median. The existing sidewalk and barrier on the east side of the structure would remain.

3.2.2.3 Alternative 1A: L-9 Interchange with Undercrossing Connector

Alternative 1A is the same as Alternative 1, except that the eastbound off-ramp would split and introduce a direct tunnel ramp under Hazel Avenue to carry eastbound off-ramp traffic to Aerojet Road and Folsom Boulevard (Figure 5).

3.2.2.4 Alternative 2: Direct Flyover to Hazel Avenue With Connector

Alternative 2 consists of a modified type L-9 interchange configuration, with a flyover ramp carrying vehicles travelling from eastbound U.S. 50 to northbound Hazel Avenue over the freeway to join with the westbound off-ramp (Figure 6).

The existing Aerojet Road off-ramp from US 50 would be removed. The eastbound off-ramp divergence point from US 50 would be shifted approximately 680 feet to the east to provide decision sight distance. An auxiliary lane would precede the off-ramp. A retaining wall is proposed adjacent to the off-ramp to minimize ROW acquisition.

The eastbound off-ramp would split and introduce northbound and southbound Hazel Avenue ramps. The northbound ramp would also carry traffic headed for Aerojet Road/Folsom Boulevard. An overhead sign would direct vehicles heading to southbound Hazel Avenue into the right lane and direct vehicles destined for northbound Hazel Avenue or Aerojet Road or Folsom Boulevard to use either lane. Retaining walls are proposed for the ramp as it approaches the horizontal curve towards Folsom Boulevard to accommodate the grade difference between the ramp and mainline and to minimize ROW acquisition at an apartment complex.

The northbound Hazel Avenue movement would cross under Hazel Avenue at the interchange, cross over US 50 on a two-lane flyover structure, and then merge with the westbound off-ramp and terminate at the Hazel Avenue/Tributary Point intersection. The westbound off-ramp would split so that the southbound and through movements align to the left of the ramp, and the northbound movements are to the right.

The southbound ramp would connect directly to Hazel Avenue; however, for Alternative 2 an intersection is not required at Hazel Avenue and the eastbound ramp. By eliminating an intersection at the eastbound ramp, and by removing the heavy eastbound-to-northbound movements from the Hazel Avenue overcrossing, the existing structure could remain without widening.

The two-lane westbound off-ramp would be reconstructed to provide decision sight distance between the divergence point from US 50 and a new ramp split that accommodates the flyover. The westbound off-ramp would split on either side of the flyover ramp, with one lane to the right carrying northbound Hazel Avenue traffic and the other crossing underneath the flyover ramp to join up on the left side of the flyover for the southbound Hazel Avenue movements. The profiles of the three ramps have been coordinated to match grade quickly in order to minimize retaining wall limits and enhance driver visibility. Overhead signage would direct drivers into the appropriate lanes for northbound and southbound Hazel Avenue traffic.

Right of Way and Utilities

For Alternative 1, ROW acquisition is anticipated from parcels in the southwest quadrant of the interchange. It is anticipated that 12 parcels would be affected by the improvements, including full acquisition and demolition of structures at the Chevron gas station (APN 069-0160-012) and Cattleman's restaurant (APN 069-0060-085). The viaduct structure is proposed to cross over the northern portion of the Nimbus Winery parking lot (APN 069-0050-013) on an aerial easement, to allow parking below the structure and minimize project effects on the business.

The ROW take at the Nimbus Winery property (APN 069-0050-013) would be larger in Alternative 1A because acquisition would be required instead of using an aerial easement.

For Alternative 2, ROW acquisition is anticipated from parcels in the southwest quadrant of the interchange. It is anticipated that 13 parcels would be affected by the improvements, including full acquisition and demolition of structures at the Chevron gas station (APN 069-0160-012), Cattleman's restaurant (APN 069-0060-085) and the Nimbus Winery property (APN 069-0050-013).

These acquisition needs described above are preliminary and would be finalized during the ROW acquisition process and Final Design of the project

The proposed project would require the relocation of utilities for all build alternatives, and it is anticipated that this would include: gas lines, overhead electric lines, underground electric lines,



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Figure 5
Alternative 1a: L-9 Interchange with Undercrossing Connector
Hazel Avenue/U.S. 50 Interchange Project



Figure 6
Alternative 2: Direct Flyover to Hazel Avenue with Connector
Hazel Avenue/U.S. 50 Interchange Project

fiber optic cables, water lines, sewer lines, and storm drain lines. There is also potential for project effects on other unknown utilities.

3.2.2.5 Alternative 3: No Build Alternative

Alternative 3, the No Build Alternative, would not modify the existing interchange, would retain the same existing configuration, ramps, and lanes. The No Build Alternative does not meet the purpose and need of the proposed project.

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Chapter 4 Regulatory Setting

This section describes the regulatory setting for paleontological resources that may be affected by the proposed project. Paleontological resources are understood to include fossilized remains of vertebrates, invertebrates, and plants, as well as fossil tracks and trackways. The applicable federal and state regulations that protect paleontological resources are discussed below. Additionally, Sacramento County and the City of Rancho Cordova have policies to protect paleontological resources by requiring that discretionary development projects identify and avoid or protect paleontological resources; these local policies are also described below.

4.1 Regulatory Overview

Paleontology is the study of life in past geologic time based on fossil plants and animals. Fossils furnish information about the kinds of plants and animals that existed, when they appeared and vanished, where and how they lived, and the type of environments they preferred. Fossils help us to learn how species evolved, how some descended from others, and how groups of organisms are related (California Geological Survey 2002a).

Caltrans protects and enhances the environment and quality of life in accordance with the environmental, economic, and social goals of California (California Department of Transportation 1992). Caltrans evaluates the environmental benefits and consequences of its activities and implements practices that minimize environmental impacts. As part of the project development and delivery process, Caltrans conducts paleontological studies in response to federal, state, and local laws, regulations, and ordinances (California Department of Transportation 2014). Although not required to do so, whenever feasible, Caltrans complies with local laws and ordinances concerning paleontological resources (California Department of Transportation 2014).

Construction of this project would be funded in part with state and federal funds. The Federal-Aid Highway Act of 1956 (PL 84-627) and 1958 (PL 85-767) specifically extends the Antiquities Act of 1906 (PL 59-209) to apply to paleontological resources on highway projects funded by the Highway Act and authorizes the use of Highway Act funds for paleontological salvage to the extent approved as necessary by Caltrans (PL 85-767, Aug. 27, 1958, 72 Stat. 913; PL 86-657, Section 8(e), July 14, 1960, 74 Stat. 525. See also 23 USC 305).

The Antiquities Act requires that any investigations be carried out by properly qualified institutions and experts. Typical federal requirements for paleontological resource management for compliance with the Antiquities Act are outlined in the Bureau of Land Management Manual Section 8270 (Bureau of Land Management 1998).

Under California law, paleontological resources are protected by CEQA, the California Code of Regulations, Title 14, Section 4306 et seq., and Public Resources Code Section 5097.5. CEQA requires that public agencies not approve projects as proposed if there are feasible alternatives or feasible mitigation measures available that would substantially lessen the significant environmental effects of such projects (Chapter 1, Section 21002). California Public Resources Code Section 5097 protects vertebrate paleontological sites:

> A person shall not knowingly and willfully excavate upon, or remove, destroy, injure, or deface, any historic or prehistoric ruins, burial grounds, archaeological or vertebrate paleontological site, including fossilized footprints, inscriptions made by human agency, rock art, or any other archaeological, paleontological or historical feature, situated on public lands, except with the express permission of the public agency having jurisdiction over the lands.

Typical California requirements for paleontological studies and mitigation are outlined in Title 20, California Code of Regulations, Section 2012 et seq., and Caltrans' SER, Environmental Handbook, Volume 1, Chapter 8, Paleontology (California Department of Transportation 2014).

4.2 Federal Antiquities Act

The Federal Antiquities Act of 1906 (Public Law [PL] 59-209, 16 United States Code [USC] 431–433) was enacted with the primary goal of protecting cultural resources in the United States. As such, it prohibits appropriation, excavation, injury, or destruction of "any historic or prehistoric ruin or monument, or any object of antiquity" located on lands owned or controlled by the federal government, without permission of the secretary of the federal department with jurisdiction. It also establishes criminal penalties, including fines or imprisonment, for these acts, and sets forth a permit requirement for collection of antiquities on federally owned lands.

Neither the Antiquities Act itself nor its implementing regulations (43 Code of Federal Regulations 3) specifically mentions paleontological resources. However, several federal agencies—including the National Park Service, U.S. Bureau of Land Management, and U.S. Forest Service—have interpreted "objects of antiquity" to include fossils. Consequently, the Antiquities Act represents an early cornerstone for efforts to protect the nation's paleontological resources.

4.3 Archaeological and Paleontological Salvage Statute and Federal-Aid Highway Act

The Archaeological and Paleontological Salvage Statute (23 USC 305) amended the Antiquities Act of 1906 with the following text.

> Funds authorized to be appropriated to carry out this title to the extent approved as necessary, by the highway department of any State, may be used for archaeological and paleontological salvage in that state in compliance with the Act entitled "An Act for the preservation of American

> Antiquities," approved June 8, 1906 (PL 59-209; 16 USC 431-433), and State laws where applicable.

The Federal-Aid Highway Act of 1935 (20 USC 78) gives specific authority to use federal funds for salvage of paleontological sites impacted by highway projects.

Together, the Archaeological and Paleontological Salvage Statute and Federal-Aid Highway Act permit paleontological resources salvage to be carried out under federal highway project funding, as long as the excavated materials and any information recovered from them are used for public purposes and not for private gain.

4.4 National Environmental Policy Act

NEPA does not provide specific guidance regarding paleontological resources, but the NEPA requirement that federal agencies take all practicable measures to "preserve important historic, cultural, and natural aspects of our national heritage" (NEPA Section 101[b][4]) is interpreted as applying to paleontological materials. Under NEPA, paleontological resources are typically treated in a manner similar to that used for cultural resources.

4.5 California Codes

Several sections of the California Public Resources Code protect paleontological resources. Section 5097.5 prohibits "knowing and willful" excavation, removal, destruction, injury, and defacement of any paleontologic feature on public lands (lands under state, county, city, district, or public authority jurisdiction, or the jurisdiction of a public corporation), except where the agency with jurisdiction has granted express permission. Section 30244 requires reasonable mitigation for impacts on paleontological resources that occur as a result of development on public lands.

The sections of the California Code of Regulations relating to the State Division of Beaches and Parks afford protection to geologic features and "paleontological materials" but grant the director of the state park system authority to issue permits for specific activities that may result in damage to such resources, if the activities are in the interest of the state park system and for state park purposes (Title 14 California Code of Regulations Sections 4307–4309).

CEQA includes in its definition of historical resources "any object [or] site … that has yielded or may be likely to yield information important in prehistory" (CEQA Guidelines Section 15064.5[3]), which is typically interpreted as including fossil materials and other paleontological resources. More specifically, destruction of a "unique paleontological resource or site or unique geologic feature" could be a significant impact under CEQA (CEQA Guidelines Appendix G

[CEQA Checklist]). Treatment of paleontological resources under CEQA is generally similar to treatment of cultural resources, requiring evaluation of resources in a project's area of potential effect, assessment of potential impacts on significant or unique resources, and development of mitigation measures for potentially significant impacts, which may include monitoring combined with data recovery and/or avoidance.

4.6 Sacramento County General Plan

The Sacramento County General Plan contains the following goals, objectives, and policies regarding paleontological resources.

GOAL: Promote the inventory, protection and interpretation of the cultural heritage of Sacramento County, including historical and archaeological settings, sites, buildings, features, artifacts and/or areas of ethnic historical, religious or socio-economical importance.

Archeological Site Protection During Development

Objective: Attention and care during project review and construction to ensure that cultural resource sites, either previously known or discovered on the project site, are properly protected with sensitivity to cultural and ethnic values of all affected.

Policies:

CO-160. County Planning staff shall take historical and cultural resources into consideration when conducting planning studies and documents in preparation of, including but not limited to, areas plans, corridor plans, community plans, and specific plans.

CO-161. As a condition of approval for discretionary projects, require appropriate mitigation to reduce potential impacts where development could adversely affect paleontological resources.

CO-162. Projects located within areas known to be sensitive for paleontological resources, should be monitored to ensure proper treatment of resources and to ensure crews follow proper reporting, safeguards and procedures.

CO-163. Require that a certified geologist or paleo resources consultant determine appropriate protection measures when resources are discovered during the course of development and land altering activities.

Implementation Measures:

C. Establish procedures to:

- Conduct periodic training programs for County Municipal Services Agency and County Airports construction and maintenance personnel to facilitate their awareness of archeological site indicators and proper procedures. (DERA)
- Utilize mitigation monitoring and reporting programs to provide for on-site monitoring during construction adjacent to known sites. (DERA)

County of Sacramento General Plan 80 Conservation Element
Amended November 9, 2011

E. Create a new section in the Conservation Element on Paleontological Resources that includes background on paleontology in general and also specific to Sacramento County.

4.7 Rancho Cordova General Plan

The Rancho Cordova General Plan contains the following goal and policy regarding paleontological resources.

Goal CHR.1: Identify and preserve the history of Rancho Cordova for future generations.

Policy CHR.1.2 – Establish and promote programs that identify, maintain, and protect buildings, sites, or other features of the landscape possessing historic or cultural significance.

Action CHR.1.2.1 – Develop and regularly update a comprehensive historic resources inventory, coordinating with other agencies as necessary. The inventory will contain a list of all locally historically significant properties, as well as historic archaeological and paleontological resources in the Planning Area and a map depicting their locations.

Policy CHR.1.3 – Establish review procedures for development projects that recognize the history of the area in conjunction with State and federal laws.

Action CHR.1.3.1 – Require historic resources and paleontological studies (e.g., archaeological and historical investigations) for all applicable discretionary projects, in accordance with CEQA regulations. The studies should identify paleontological, historic, or cultural resources in the project area, determine their eligibility for inclusion in the California Register of Historical Resources, and provide mitigation measures for any resources in the project area that cannot be avoided.

Action CHR.1.3.2 – Incorporate the following two conditions in applicable permits for all discretionary projects.

Cross reference:

OSPT.2.4

The Planning Department shall be notified immediately if any cultural resources (e.g., prehistoric or historic artifacts) or paleontological resources (e.g., fossils) are uncovered during construction. All construction must stop in vicinity of the find and an archaeologist that meets the Secretary of the Interior's Professional Qualifications Standards in prehistoric or historical archaeology or a paleontologist shall be retained to evaluate the finds and recommend appropriate action.

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Chapter 5 Description of the Resource, Impacts, and Required Mitigation

5.1 Types of Rock Units and Fossils under Study

The study area for paleontological resources is the area within the ROW and construction disturbance limits for the proposed project (Figure 2). The project area is located in the Folsom U.S. Geological Survey 7.5-minute quadrangle in Township 9 north, Range 7 east. The project is located between 38°36'48" N and 38°38'57" N and 121°15'1" W and 121°10' 48" W.

The geologic formations in the limits of the proposed project are the Pleistocene Riverbank and Modesto Formations (Figure 7). These formations would be affected by project-related excavation and are known to contain significant paleontological resources, which could be encountered during excavations for this project. As discussed in Section 5.3.2 below, significant fossils recovered from these formations include mammoth, bison, camel, horse, ground sloth, dire wolf, rodents, moles, birds, and bony fish (University of California Museum of Paleontology 2016a, 2016b, 2016c) (Appendix A).

5.2 Regional Geology

The project area is located in the Sacramento Valley, which forms the northern portion of California's Great Valley geomorphic province (Norris and Webb 1990:412; California Geological Survey 2002b).

The Great Valley, also called the Central Valley, is a nearly flat alluvial plain that lies between the Sierra Nevada on the east and the Coast Ranges on the west. Its south end is defined by the Tehachapi Mountains north of Los Angeles, and its north end is defined by the Klamath Mountains. Subdivided into the Sacramento Valley to the north and the San Joaquin Valley to the south, the valley has an average width of about 50 miles and is about 400 miles long overall (Norris and Webb 1990:412–417; Bartow 1991:1).

The Great Valley is floored by a thick sequence of sedimentary deposits that range in age from Jurassic through Quaternary. Under the eastern and central portions of the valley, the base of the sequence likely rests on Mesozoic crystalline rock allied to the plutons of the Sierra Nevada; to the west, basement rocks are believed to be Franciscan metasediments and/or mélange similar to exposures in the Coast Ranges. Mesozoic sedimentary rocks now in the subsurface record marine deposition. These sedimentary rocks are overlain by Tertiary strata reflecting marine, estuarine,

and terrestrial conditions, which are in turn overlain by Quaternary fluvial and alluvial strata, recording uplift and erosion of the Sierra Nevada and Coast Ranges to approximately their present shape (Norris and Webb 1990:412–419; Bartow 1991:1).

The Sierra Nevada geomorphic province is just east of the project area. The Sierra Nevada geomorphic province is a linear, tilted fault block almost 400 miles long that extends from northern Butte County to the Mojave Desert. Its western slope is gentle (approximately 2°), in contrast to its steep eastern slope. This western slope is deeply incised by rivers and disappears beneath the sediments of the Great Valley. Massive granites make up the upper elevation Sierra, which has been shaped by glaciation, such as is seen in Yosemite. Lower in the Sierra is the northwest-trending Mother Lode, which is made up of metamorphic rock containing gold-bearing veins. The Sierra Nevada disappears to the north beneath the Cenozoic volcanic rock of the Cascade Range (California Geological Survey 2002b).

5.3 Study Area

5.3.1 Local Geology

The project area is part of a stepped braided floodplain that formed during the Pleistocene to Holocene migration of the American River. During the Pleistocene, as the ancestral American River flowed down from the Sierra Nevada and past what is now the city of Folsom, it formed a complex of alluvial fan and channel deposits and created river terraces. During this time, as the river migrated north, it created several channels and formed the distinct channel deposits present in the project area today (Shlemon 1972). The two Pleistocene alluvial deposits underlying the project area are the Riverbank and Modesto Formations.

The area on the south side of the American River from the city of Folsom south to Mather was dredge mined for gold from the 1880s to the 1950s by several companies that eventually merged to become the Natomas Company (Clark 1998).This mining left behind dredge tailings, which are mounds of gravel and cobble with fine sediments between the mounds.

Geologic mapping by the California Geological Survey (2011) shows that most of the interchange, which is located in the southcentral portion of the project area, is underlain by the Riverbank Formation, as is the eastern end of the Aerojet Road connector. The eastbound approach to the off-ramp is underlain by the Pleistocene Modesto Formation (Figure 7). The jughandle and western approach to the interchange are underlain by dredge tailings.

Much of the area, however, is developed and the surface is disturbed by road and building construction. In addition, artificial fill has been placed for road base and to elevate on-ramps and off-ramps.

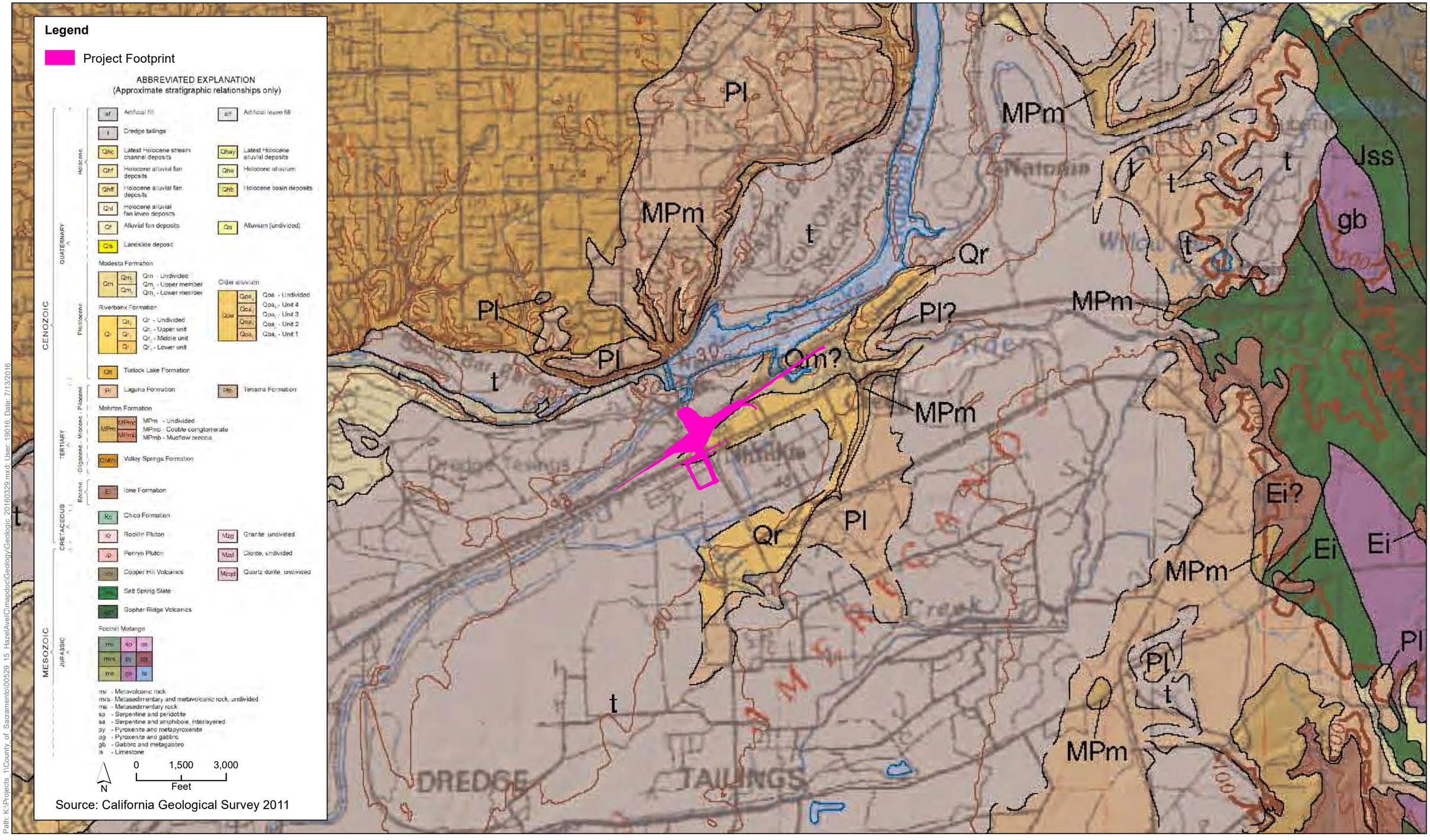


Figure 7
Geologic Map

5.3.1.1 Dredge or Mine Tailings

Dredge tailings occur in the western portion of the project area and underlie the jughandle and the approach to the interchange (California Geological Survey 2011). These areas of gravel and cobble appear to be less than 5 feet thick (Appendix A in Parikh Consultants 2013) and are highly disturbed.

5.3.1.2 Riverbank Formation

The central portion of the interchange is underlain by the Pleistocene Riverbank Formation. The Riverbank Formation is an alluvial deposit made up of weathered arkosic gravels, sand, silt, and clay. The unit forms alluvial terraces and dissected alluvial fans on the southeast side of the Sacramento Valley. It is divided into two informal members in the Sacramento Valley, the upper and lower members, based largely on the more eroded character of the lower member by comparison with exposures of the upper member (California Geological Survey 2011; Helley and Harwood 1985).

5.3.1.3 Modesto Formation

Like the Riverbank Formation, the Modesto Formation is an alluvial deposit. The two formations are lithologically very similar because both units were deposited by streams originating in the same rock of the Sierra Nevada and because both units were deposited in similar alluvial fan environments. The primary differences between the Modesto and Riverbank Formations are age-related; they include the degree of consolidation/cementation, the amount of deformation (tilting and/or folding), and soil development. Where Modesto alluvium overlies the Riverbank Formation, the contact between the two units is frequently marked by a deeply developed paleosol with a pronounced clay horizon (Atwater 1982).

5.3.2 Description of Resource: Fossils

The University of California Museum of Paleontology (UMCP) database contains 126 records of vertebrate fossils in Sacramento County (University of California Museum of Paleontology 2016a) (Appendix A). Of these, 120 records are from a unit found in the project area, as described below.

5.3.2.1 Dredge or Mine Tailings

The dredge or mine tailings have low potential to contain fossils because they are primarily reworked gravels and cobbles.

5.3.2.2 Riverbank Formation

California's Pleistocene sedimentary units—especially those that, like the Riverbank and Modesto Formations, record deposition in continental settings—are typically considered highly sensitive for paleontological resources because of the large number of recorded fossil finds in such units throughout the state. The Pleistocene age of the Riverbank Formation is well represented by important fossils recovered from excavations at the Arco Arena site in 1989 (Hilton et al. 2000) and other localities. Fossil finds in the Riverbank Formation include mammoth, bison, camel, horse, ground sloth, dire wolf, rodents, moles, birds, and bony fish (University of California Museum of Paleontology 2016b) (Appendix A).

The University of California Museum of Paleontology (UCMP) database contains 120 records of vertebrate fossils from the Riverbank Formation in Sacramento County. Most of these fossils were found in the Teichert gravel pit near Perkins, approximately 10 miles west of the project area. A significant number of small vertebrate fossils were excavated at this site, including Pleistocene ground squirrels, voles, pocket gophers, packrats, shrews, and a bird (University of California Museum of Paleontology 2016b).

Because of its vertebrate content, the Riverbank Formation is considered highly sensitive for paleontological resources.

5.3.2.3 Modesto Formation

As described for the Riverbank Formation, Pleistocene sedimentary units are typically considered highly sensitive for paleontological resources. Although there are no records of fossils in this unit in Sacramento County, the UCMP database contains numerous records of vertebrate fossils in this unit. These records include mammoth, ground sloth, camel, and bison (University of California Museum of Paleontology 2016c) (Appendix A).

Because of its vertebrate content, the Modesto Formation is considered highly sensitive for paleontological resources.

5.3.2.4 Project Area

Although there are no known fossil localities in the project area boundaries, most of the project area is underlain by geologic units with the potential to contain significant paleontological resources. These units therefore have a high potential to contain significant paleontological resources should they be disturbed by work associated with the proposed project.

5.4 Construction-Related Effects on Paleontological Resources

The primary mechanism for impacts on paleontological resources would be ground disturbance during construction of the interchange (Table 5-1). The potential for impact is greatest in the central portion of the project area because deep excavation would occur there and it is directly underlain by geologic units with potential to contain fossils and (Figure 7).

- The greatest amount of excavation would occur at the interchange for all alternatives and would result from the trenching for the tunnel ramp under Hazel Avenue.
- Depending on its location, ground disturbance for the construction of ancillary facilities, including supporting facilities, temporary construction offices, and construction staging areas, could also disturb native materials and potentially result in impacts on paleontological resources.

The severity of impacts would depend on the location and depth of construction activities and could be substantial. As shown in Table 5-1, the tunnel ramp and construction of transition lane to the US 50/Folsom Boulevard interchange would require excavation from 5 to 20 feet below ground surface, which could damage paleontological resources. Construction of the retaining walls would require excavation from 15 feet below ground surface, which could damage paleontological resources. With implementation of the mitigation measures described in this report (Chapter 8, Scope of Work), these effects will be reduced.

Table 5-1. Depth of Excavation for Major Construction Activities

Area	Construction Activity	Depth of Excavation (feet below ground surface)	Unit Affected	Monitoring Recommend?
Actions Common to All Alternatives				
Construction of east bound transition auxiliary lane on US 50 from Hazel Avenue through the Folsom Boulevard Overcrossing	Fill placement and grading for majority; see below for construction of bridge over Alder Creek	Less than 3	Artificial fill and previously disturbed soil	No
Reconstruction of westbound loop on-ramp	Grading	Less than 3	Artificial fill and previously disturbed soil	No
Reconstruction of the eastbound diagonal off-ramp	Grading	Less than 3	Artificial fill and previously disturbed soil	No
Reconstruction of the eastbound diagonal on-ramp	Grading	Less than 3	Artificial fill and previously disturbed soil	No

Area	Construction Activity	Depth of Excavation (feet below ground surface)	Unit Affected	Monitoring Recommend?
Construction of eastbound on- and off-ramp auxiliary lanes on US 50	Grading	Less than 3	Artificial fill and previously disturbed soil	No
Construction of transition lane to US 50/Folsom Boulevard interchange	Widening of the road and construction of a bridge over Alder Creek	5 to 15	Possibly the Modesto or Riverbank Formation	Yes
Construction of railroad overhead	Excavation to extend Hazel Avenue and grade-separate over Folsom Boulevard and the SPTC-JPA rail corridor	10 to 30 for construction of abutments/new bridge and retaining wall	Riverbank Formation	Yes
Along US 50 eastbound off-ramp and northbound Hazel to eastbound on-ramp and Aerojet Road.	Construction of retaining walls	15	Modesto and Riverbank Formations	Yes
Gas station	Demolition and underground storage tank removal	Unknown	Riverbank Formation	Only if excavation beyond the original extent for installation is necessary.
Alternative 1				
Viaduct connection to Aerojet Road	Excavation to place footings for viaduct structure	10 to 30	Possibly the Modesto or Riverbank Formation	Yes
Alternative 1a				
Direct tunnel ramp under Hazel Avenue to Aerojet Road	Excavation for tunnel ramp	17 to 20 near ramps; 15 for retaining walls	Modesto and Riverbank Formations	Yes
Alternative 2				
Flyover ramp from eastbound US 50 to northbound Hazel Avenue over the freeway to join with the westbound off-ramp	Excavation to place footings for flyover ramp	5 to 15	Modesto and Riverbank Formations	Yes
Undercrossings	Construction of ramps	5	Possibly Modesto Formation and Riverbank Formation	No unless otherwise determined by the principal paleontologist during final design

5.5 Comparison of Alternatives

The primary difference between the alternatives with regard to potential effects on paleontological resources is the amount of excavation required for implementation. Alternative 1A would result in the greatest effect on paleontological resources because of the amount of excavation required for the tunnel ramp under Hazel Avenue. This excavation would be in the Modesto and Riverbank Formations, which are sensitive for paleontological resources.

5.6 Conclusions

It is strongly recommended herein that, based on the high potential of the geologic units in the project area to contain fossils, this PER/PMP be implemented for structuring a mitigation and monitoring program once constructions begins.

5.7 Cumulative Effects on Paleontological Resources

No significant cumulative impacts on paleontological resources have been identified for the project region. However, available evidence indicates that the area's Pleistocene strata preserve a rich vertebrate fauna and, with progressive development in coming decades, ongoing earthwork could foreseeably result in greater impacts on fossil resources to rise to the level of a significant cumulative impact.

Caltrans constructs highway structures in many locations throughout the Central Valley that require excavation in Pleistocene-age sediments similar to those found in the project area. Although these individual construction projects involve smaller amounts of excavation resulting in impacts of a lower intensity, the combined extent of excavation for these projects could result in the loss of a large number of important fossils. The loss of even a few scientifically important fossil specimens would mean the inability to piece together important parts of the earth's history and the evolution of species.

Implementation of the mitigation measures described in this report will ensure that adverse effects under NEPA would not occur and will result in the reduction of this impact to less-than-significant levels under CEQA. With implementation of this approach, cumulative impacts are not anticipated related to the proposed project.

5.8 Required Mitigation

Excavation and earthmoving activities in areas shown to be sensitive for paleontological resources will be monitored by a qualified professional under the supervision of a California licensed Professional Geologist. If paleontological resources are discovered during construction activities,

specific steps to evaluate and salvage fossil specimens, document their scientific value, and store specimens in a recognized repository institution, as appropriate, will be taken. Details of the implementation of this mitigation are provided in Chapter 8.

Chapter 6 Paleontological Significance and Goals for Recovery

Pleistocene deposits cover a vast area in the Sacramento Valley, including the proposed project area. These deposits have potential to reveal additional important fossils that can contribute to our understanding of the geologic history of the Central Valley.

6.1 Paleontological Significance Criteria

The Caltrans SER paleontology guidelines are used herein to classify the significance of the geologic units present within the proposed project alignment. Descriptions of the guidelines are provided below.

6.2 Methods

6.2.1 Literature Search

No literature searches were conducted. Instead, local experts were contacted for information on fossil localities in the area. The Sierra College collection does not include specimens from the Riverbank or Modesto Formation in the immediate area of the project (Hilton pers. comm.).

6.2.2 Paleontological Records Search

Online paleontological databases were reviewed along with a detailed literature search and study. Review of the online records of the UCMP (2016b, 2016c) indicates that the Riverbank and Modesto Formations have yielded significant fossils. These finds are described in Section 5.3.2. The results of this search indicate the formations that would be impacted by the proposed project have yielded both standard and significant fossils in the past and therefore have high potential to contain additional significant fossils. These fossils have the potential of being uncovered during ground-disturbing work during construction of the proposed project.

The basis for assessments of paleontological sensitivity (i.e., potential to contain scientifically important paleontological resources) followed standard Caltrans criteria (California Department of Transportation 2014). Caltrans criteria use three categories to describe the likelihood that a geologic unit contains significant fossil materials—high potential, low potential, and no potential, defined in Table 6-1.

Table 6-1. California Department of Transportation Paleontological Sensitivity Terminology

Caltrans Sensitivity Designation	Characteristics of Geologic Units in This Category
High Potential (High Sensitivity) Riverbank Formation Modesto Formation	This category consists of rock units known to contain important vertebrate, invertebrate, or plant fossils anywhere within their geographic extent, including sedimentary rock units that are suitable for the preservation of fossils, as well as some volcanic and low-grade metamorphic rock units. This category includes rock units with the potential to contain • abundant vertebrate fossils • a few significant fossils (large or small vertebrate, invertebrate, or plant fossils) that may provide new and significant taxonomic, phylogenetic, ecologic, and/or stratigraphic data • areas that may contain datable organic remains older than Recent, including Neotoma (sp.) middens • areas that may contain unique new vertebrate deposits, traces, and/or trackways Fossiliferous deposits with very limited geographic extent or an uncommon origin (e.g., tar pits and caves) are given special consideration and ranked as highly sensitive.
Low Potential (Low Sensitivity) Dredge or mining tailings	This category includes sedimentary rock units that • are potentially fossiliferous, but have not yielded significant fossils in the past • have not yet yielded fossils, but have the potential to contain fossil remains • contain common and/or widespread invertebrate fossils of species whose taxonomy, phylogeny, and ecology are well understood *Note that sedimentary rocks expected to contain vertebrate fossils are considered highly sensitive, because vertebrates are generally rare and found in more localized strata.*
No Potential (No Sensitivity)	This category includes rock units and deposits either too young to contain fossils or are of intrusive igneous origin, most extrusive igneous rocks, and moderate- to high-grade metamorphic rocks.
Source: California Department of Transportation 2014.	

6.3 Significance of the Resource

The geologic units in the proposed project's boundaries have a high potential to contain important, nonrenewable paleontological resources and, following the guidelines set by the Caltrans SER, are assigned high potential to contain paleontological remains of scientific importance. The fossils found in these units are described in Section 5.3.2.

6.4 Goals for Recovery

The primary proposed goal is to recover fossils uncovered during construction and excavation work, while working with the construction and engineering teams to ensure construction continues

in a timely manner while fossils, if exposed, are safely recovered, collected, preserved, and transported to a qualified museum repository. Additional goals include recording detailed notes, which include Global Positioning System locality data, lithologic descriptions of fossiliferous units, interpretation of relative age by soil rubification characteristics, and laboratory work studying the fossil remains for taxonomic and assemblage purposes. Cross sections, formation designation, and Quaternary geologic mapping, as well as stratigraphic sections produced from the data accumulated during mitigation in the field, will be used for correlations across the Sacramento Valley for future studies.

Construction-related impacts on these fossils that may occur in the deposits could represent a tremendous loss of important geological, paleontological, and biological information.

Paleontological resources preserved in sedimentary rocks of the Riverbank and Modesto Formations have the potential to provide the following geological, paleontological, and biological information.

- Paleoecologic structure of Pleistocene invertebrate and vertebrate assemblages of northern California.
- Pleistocene terrestrial paleoenvironments and paleoclimate of northern California.
- Pleistocene biodiversity and biogeography of northern California.
- Pleistocene microfossil (pollen, ostracodes) biochronology and biostratigraphy.
- Pleistocene microfossil evolution and systematics.
- Pleistocene evolution and systematics.
- Correlation of Pleistocene sedimentary rocks/deposits of the greater San Joaquin-Sacramento Valley.

6.5 Limitations

The geological and paleontological information and recommendations contained in this report are based on the geological and paleontological resources available at the time this report was prepared. If the project design should change, then this report should be updated to reflect the revised project condition/design. The findings, recommendations, specifications, or professional advice contained herein have been made in accordance with accepted professional paleontological practices in the local area at the time. No other warranties are implied or expressed.

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Chapter 7 Decision Thresholds

The goal of this study and mitigation is to prevent destruction of paleontological resources while working in a safe and timely manner to avoid construction delays. To achieve this goal, paleontological monitoring will take place when earth-moving or excavations occur during project construction. If significant paleontological resources are recovered, additional fieldwork may be required, which would include additional field staff and would take additional time. Fieldwork will cease when all excavation work has been completed and when significant fossils, if any, are properly recovered and treated for transport to a museum repository.

In terms of required sample size if fossils are found, approximately five sample specimens (e.g., botanical, significant trace fossils such as diagnostic internal molds and external casts, marine/non-marine invertebrates) per cubic meter will provide enough data for sedimentary strata composed of thick accumulations of paleobotanical deposits, invertebrate (gastropod/pelecypod) beds, and coquinas (i.e., abundantly fossiliferous units consisting of one or two species). In the event strata are excavated to reveal abundant, well-preserved, and significant paleobotanical, micropaleo, invertebrate, or vertebrate fauna, construction will be redirected until a qualified paleontologist, as defined by the Caltrans SER, assesses the find by evaluating the material and the potential need for additional crew and resources.

According to the project consultant engineer, the proposed project would result in grading and excavation throughout the project footprint. Therefore, to address mitigation issues and to prevent adverse effects under NEPA and significant impacts under CEQA on paleontological resources, full-time paleontological monitoring will occur during ground-disturbing and excavation activities (Table 5-1). Once a construction sequencing plan has been prepared for the proposed project that identifies a more detailed excavation schedule, the qualified principal paleontologist may reduce the time allotted for full-time monitoring.

Associated fragments recovered from the site will be placed in an approved institutional repository (Society of Vertebrate Paleontology 2010).

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Chapter 8 Scope of Work

This chapter presents the scope of work for measures intended to reduce or eliminate potential adverse effects on paleontological resources. These measures will be implemented to avoid destruction of, and mitigate other potential effects on, significant paleontological resources that may be present in Pleistocene-age to Pliocene-age deposits in the subsurface at the proposed project.

Effort associated with the preparation of this PER/PMP included identifying permitting issues, preliminary identification of a qualified museum repository that would agree to curate fossils for this project should they be exposed (Appendix B), identifying additional project specifics with respect to construction schedules provided, proposed facilities and proposed infrastructure, identifying field work and laboratory efforts, and identifying requirements for monitoring, sample collecting, and sample preparation work.

The following scope of work for mitigation measures is intended to be implemented prior to, during, and/or after construction of the proposed project. It includes both the standard special provision for paleontology and a nonstandard special provision for paleontology.

1. As part of the standard special provision for paleontology, the construction contractor will:

    - Submit a schedule of subsurface-disturbing activities at least 15 days before starting construction activities and submit an updated schedule at least 3 business days before implementing any changes.
    - Attend a preconstruction meeting with the paleontological resources mitigation team and the resident engineer to establish procedures for coordination, cooperation, and worker safety during mitigation activities.
    - Request paleontological resource awareness training at least 10 days before the start of construction activities. All construction personnel and subcontractors involved in subsurface-disturbing activities must complete 1 hour of training provided by the paleontological resources mitigation team before working at the site.
    - Not perform subsurface-disturbing activities unless authorized.
    - Notify the resident engineer 15 days before starting subsurface-disturbing activities.

    The resident engineer may order construction personnel to:

    - Divert or stop construction activities in the vicinity of fossils.

- Avoid disturbing an area pending the removal of fossils.
- Perform additional excavation.
- Modify and excavation to facilitate in-place stabilization of fossils by the paleontological mitigation team.

2. A non-standard special provision for paleontology mitigation will be included in the construction contract special provisions section to advise the construction contractor of the requirement to cooperate with paleontological salvage. The following items will be part of the provisions:

    - A qualified principal paleontologist, as defined by the Caltrans SER, will be retained to prepare and implement a final PMP prior to construction. If the qualified paleontologist is also not a licensed professional geologist in the state of California, then a licensed professional geologist will also be retained to review and approve the PMP prior to construction.
    - The final PMP will list the proposed staff and professional qualifications (Appendix C).
    - The qualified principal paleontologist will attend a task order meeting and conduct a site visit to review task order requirements; review plans, maps, initial site reports, and mitigation requirements; review site geology and paleontological sensitivity; prepare a mitigation work plan; and prepare a Code of Safe Practices in accordance with the California Division of Occupational Safety and Health Title 8 (California Division of Occupational Safety and Health). The Code of Safe Practices will include any hazard waste issues, including those related to removal of the Cattleman's restaurant, Nimbus Winery, or Chevron station.
    - The qualified principal paleontologist will perform schedule coordination and supervision for paleontological monitors for any salvage work (including bulk screening) and will perform sediment preparation and identification, which includes rigorous cleaning (e.g., high air pressure, brushing, scraping) of specimens (including hiring of paleontological specialists). Monthly progress reports will be prepared for lead agency review and comment.

3. The qualified principal paleontologist may designate a paleontological monitor to be present during earth-moving activities. According to the preliminary engineering that has been prepared, excavations could occur throughout the proposed project area; therefore, paleontological monitoring is recommended during any earth-moving activities/excavations. One onsite paleontological monitor should be sufficient to handle the construction observation until additional paleontological monitors are needed. The need for additional monitors could

be due to the occurrence of simultaneous excavations and/or the discovery of significant fossil resources. Specific timing of these excavations throughout the project site is unknown at this time. Exact timing of excavation schedules may be known closer to the proposed project start date; therefore, paleontological monitoring may be reduced to on-call, or part-time, via communication and coordination between the resident engineer and the qualified principal paleontologist.

The paleontological monitor will have a college degree in paleontology or geology and at least 2 years paleontological monitoring experience or other qualifications described by the SVP (2010). The monitor is required to be present during all project grading. The monitor will assess all project bulk samples, review geological and paleontological reports on the local area to gain better understanding of the types of lithologies and fossils that may be present, log stratigraphy during excavation, prepare field maps, prepare daily monitoring forms, and keep daily field notes in a logbook. Copies of the field reports and monitoring forms will be kept by the field monitor and delivered to the qualified principal paleontologist for final report writing. The field monitor will take daily photographs of construction work and excavations.

4. The qualified principal paleontologist and paleontological monitor will be notified by the resident engineer or lead agency in advance of starting construction activity and should attend any safety training programs for the proposed project. Paleontological monitoring should be full-time during excavation for undercrossings, in-ground structural elements such as bridge substructures and culverts, and any other project elements requiring deep excavation. If, after 50 percent of the grading/excavation is completed at a particular location for the proposed project, it can be demonstrated that the level of monitoring should be reduced for that site, the qualified principal paleontologist will amend the mitigation program (Society of Vertebrate Paleontology 2010). If pieces of heavy equipment are in use simultaneously at different locations, each location may be individually monitored.

   The qualified principal paleontologist will meet with the resident engineer and construction contractor at a preconstruction conference to develop an agreed-upon communication plan and to discuss provisions for worker safety. All project personnel will receive paleontological awareness training prior to commencement of work by the qualified principal paleontologist. Before construction begins, construction personnel involved with earthmoving activities will be informed of the possibility of encountering fossils, the appearance and types of fossils likely to be seen during construction, and the proper notification techniques should fossils be encountered. Worker training may be included with construction worker education or during environmental training.

5. If paleontological resources are discovered during earth-moving activities, the construction crew will immediately cease work within a 60-foot radius of the find and notify the resident engineer. In the event paleontological resources are discovered, fossil specimens will be properly collected and sufficiently documented to be of scientific value. Exposed fossils left in situ are subject to weathering that damages the fossil; therefore, documentation and recovery of the fossil is necessary soon after the fossil is exposed. Non-fossil sediment samples will also be collected with each recorded locality for lithologic and pedalogic reasons. Depending on the nature of the fossil material, samples will be collected in buckets, cloth sample bags, or plaster field jackets.

6. The following actions will occur during the grading and construction process and after recovery of specimens if fossils are found.

    - For sediments containing microfossils (e.g., pollen, freshwater ostracodes), the monitor will take bulk samples for offsite processing at a later time to recover fossils. According to the SVP recommendations, an adequate sample comprises 6,000 pounds (or 2,500 kilograms) of each site horizon or paleosol, as determined by the supervisory [qualified principal] paleontologist (Society of Vertebrate Paleontology 2010). It is recommended that the supervisory or project [qualified principal] paleontologist understand the project's goals and budgetary limits and retain representative bulk samples at his or her discretion. Horizons or paleosols most likely to contain microfossils are fine-grained sedimentary horizons. These sediments are typically recovered through a process of bulk matrix sampling followed by screen washing through 20 or 30 mesh screens (Society of Vertebrate Paleontology 2010).
    - Macro fossils (i.e., large enough to view with the naked eye) could include tusks and other vertebrate remains. Some of these resources may be fragile and require hardening before moving as well as encasing in plaster for later preparation and conservation in a laboratory. A full skeleton may require moving either whole or in blocks for eventual preparation. The paleontological monitor, in coordination with the resident engineer, may temporarily halt or redirect the excavation equipment away from the fossils to be salvaged.
    - Oriented samples must be preserved for paleomagnetic analysis. Samples of fine matrices should be obtained and stored for pollen analysis. Other matrix samples may be retained with the samples for later analysis.
    - Recovered specimens will be recovered for identification (not exhibition) and stabilized. Sedimentary matrix with microfossils is screened, washed, and sorted to identify the contained fossils. Removal of excess matrix during preparation reduces storage space.

- Specimens will be identified by competent qualified individuals to a point of maximum specificity. Ideally, identification is of individual specimens to element, genus, and species. Batch identification and batch numbering will be avoided.
- Where appropriate, specimens will be analyzed by stratigraphic occurrence and by size, taxa, or taphonomic conditions. The results will be presented in a faunal list, a distribution of taxa, or evolutionary, ecological, or depositional deductions. Cross sections may also be prepared.
- Adequate storage in a recognized repository institution for recovered specimens is a goal of the program. Adequate storage includes curation of specimens into the collection of a recognized non-profit paleontological specimen repository with a permanent curator, such as a museum or university. Specimens will be catalogued and a complete list will be prepared of fossils that are introduced into the repository by the curator of the museum or university. A complete set of field notes, geologic maps, and stratigraphic sections must accompany the fossil collections.
- A report will be prepared by the qualified principal paleontologist to include a summary of the field and laboratory methods, site geology and stratigraphy, faunal list, and a brief statement of significance and relationship of the site to similar fossil localities. This report may include preliminary drafts and a final paleontological mitigation report. A complete set of field notes, geological maps, stratigraphic sections, and a list of identified specimens will accompany the report. The report will be finalized only after all aspects of the program are completed. The final report together with its accompanying documents constitutes the goals of a mitigation project. Full copies of the final report will be deposited with the lead agency (Caltrans), and the repository institution.

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Chapter 9 Schedule

The precise construction and excavation schedule for the project has not yet been established; however, it would be prepared closer to the time project construction would begin. Prior to construction and when the final schedule is provided, this chapter will be updated by the qualified principal paleontologist as part of the final PMP. Laboratory processing will take place during and following project construction at the paleontological consultant's workplace or onsite in the field. Paleontological monitoring can later be reevaluated based on potential changes to construction schedules, nature of exposed geologic units, occurrence of thick, unknown artificial fill, etc. The contractor will provide the resident engineer with a schedule of excavation or ground-disturbing activities to be conducted for the proposed project in advance of the proposed project start date. Pending the size and amount of construction grading areas, the qualified principal paleontologist will be empowered to determine the number of monitors to use onsite.

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Chapter 10 Justification of Cost Estimate

A precise construction excavation schedule for the project is not yet available. The labor estimates presented in Tables 10-1 and 10-2 are based on an estimated monitoring schedule of 35 days. Once a more detailed construction and excavation schedule is prepared, a more accurate paleontological labor estimate may be developed (Appendix D). The labor estimate assumes there will be a qualified principal paleontologist managing one full-time paleontological monitor. The paleontological monitor will be onsite full-time during construction auguring and excavation within high paleontological resource sensitivity units.

Time allotted for paleontological project management assumes teleconferences with paleontological personnel, the lead agency, and the resident engineer. In addition, this time includes detailed filing of paperwork, including daily field reports and photographs, review of daily field reports, and unforeseeable problem solving. The bulk of the qualified principal paleontologist's time and work budget is for task order meetings, meetings with the resident engineer and construction contractor during pre-construction paleontological resources awareness training, site visits, review of construction plans, maps, and previous assessment reports with respect to the site and region, review of site geology and paleontology, paleontological sensitivity analysis, preparation of mitigation plan prior to construction which includes possible changes in the scope and work plan since this report was written, and preparation of Code of Safety Practices in accordance with Title 8 "Construction Safety Orders" (http://www.dir.ca.gov/title8/sub4.html). In addition, the qualified principal paleontologist is tasked to schedule, coordinate, supervise, and help the paleontological monitor salvage significant paleontological resources should they be encountered. Teleconferences, monthly progress reports and invoicing are also included.

Time is also included for general administrative and project management staff to provide technical editing and report reviews.

In the event that significant fossils are discovered that require additional workers and specialized tools for proper removal, the labor estimate may be subject to change.

Table 10-1. Standard Labor Estimate – No Fossils Found

Labor Category			Hours Per Week	Total Hours (35 days or 7 weeks)
Field time				
	Monitoring			
		(1) Paleontological Monitor	40	280
	Field Supervision			
		(1) Principal Paleontologist	6	42
Progress Report Preparation				
	Report Preparation			
		(1) Project Manager	4	28
		(1) Principal Paleontologist	4	28
		(1) Paleontological Monitor	4	28
Project Management				
	Meetings			
		(1) Principal Paleontologist	4	28
	Project Management			
		(1) Project Manager	6	42
Total			68	476

Table 10-2. Contingency Labor Estimate – Significant Fossils Found

Labor Category			Hours Per Week	Total Hours (35 days or 7 weeks)
Field time				
	Second Monitor			
		(1) Paleontological Monitor	40	280
	Salvage			
		(1) Paleontological Monitor	40	280
Preparation and Curation				
	Screenwashing	(1) Assistant	40	280
	Fossil Preparation	(1) Preparator	40	280
	Fossil Curation			
		(1) Curator	40	280
Final Report Preparation				
	Report Preparation			
		(1) Project Manager	40	280
		(1) Principal Paleontologist	40	280
		(1) Paleontological Monitor	40	280
Total			320	2,240

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11.1 Personal Communications

Hilton, Richard. Faculty. Department of Earth Sciences, Sierra College, Rocklin, CA. April 13, 2016—email.

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Chapter 12 Permits

If paleontological specimens are collected from private property, written permission is required from the landowner. In the instance of mitigation during the construction phase of a State transportation project, Caltrans typically is the fee-simple landowner. In the case of easements across federally-administered lands, the Federal land-managing agency generally retains ownership of the paleontological specimens and permits may be required from that agency. The proposed project would be in Caltrans ROW, therefore no permit requirements are anticipated.

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Appendix A
University of California Museum of Paleontology Database Results

UCMP Records for Sacramento County

UCMP Records for Riverbank Formation in Sacramento County

UCMP Records for Riverbank Formation

UCMP Records for Modesto Formation

UCMP Records for Sacramento County

spec_id	class	genus	species	period	epoch	county_std
V77734	Mammalia	Equus		Quaternary	Pleistocene	Sacramento County
V77945	Mammalia	Camelops		Quaternary	Pleistocene	Sacramento County
V80703	Mammalia	Mammuthus	columbi	Quaternary	Pleistocene	Sacramento County
V81276	Mammalia	Camelops	hesternus	Quaternary	Pleistocene	Sacramento County
V81277	Mammalia	Glossotherium	harlani	Quaternary	Pleistocene	Sacramento County
V81771	Mammalia	Equus		Quaternary	Pleistocene	Sacramento County
V81772	Mammalia	Equus		Quaternary	Pleistocene	Sacramento County
V85158	Mammalia			Quaternary	Pleistocene	Sacramento County
V85338	Mammalia			Quaternary	Pleistocene	Sacramento County
V85339	Mammalia			Quaternary	Pleistocene	Sacramento County
V85340	Mammalia	Equus		Quaternary	Pleistocene	Sacramento County
V85348	Mammalia	Equus		Quaternary	Pleistocene	Sacramento County
V85349	Mammalia	Equus		Quaternary	Pleistocene	Sacramento County
V85378	Mammalia	Canis	latrans	Quaternary	Pleistocene	Sacramento County
V85379	Mammalia	Canis	latrans	Quaternary	Pleistocene	Sacramento County
V85380	Mammalia	Canis	dirus	Quaternary	Pleistocene	Sacramento County
V85381	Mammalia	Bison		Quaternary	Pleistocene	Sacramento County
V85382	Mammalia	Thomomys		Quaternary	Pleistocene	Sacramento County
V85383	Aves			Quaternary	Pleistocene	Sacramento County
V86103	Mammalia	Camelops	hesternus	Quaternary	Pleistocene	Sacramento County
V96294	Osteichthyes	Orthodon		Quaternary	Pleistocene	Sacramento County
V119253	Mammalia	Scapanus	latimanus	Quaternary	Pleistocene	Sacramento County
V119254	Mammalia	Scapanus	latimanus	Quaternary	Pleistocene	Sacramento County
V119255	Mammalia	Scapanus	latimanus	Quaternary	Pleistocene	Sacramento County
V119256	Mammalia	Scapanus	latimanus	Quaternary	Pleistocene	Sacramento County
V124843	Mammalia	Neotoma		Quaternary	Pleistocene	Sacramento County
V124844	Mammalia	Neotoma		Quaternary	Pleistocene	Sacramento County
V124845	Mammalia	Neotoma		Quaternary	Pleistocene	Sacramento County
V124846	Mammalia	Neotoma		Quaternary	Pleistocene	Sacramento County
V124847	Mammalia	Neotoma		Quaternary	Pleistocene	Sacramento County
V124848	Mammalia	Neotoma		Quaternary	Pleistocene	Sacramento County
V124849	Mammalia	Neotoma		Quaternary	Pleistocene	Sacramento County
V124850	Mammalia	Neotoma		Quaternary	Pleistocene	Sacramento County
V124851	Mammalia	Neotoma		Quaternary	Pleistocene	Sacramento County
V124852	Mammalia	Neotoma		Quaternary	Pleistocene	Sacramento County
V124853	Mammalia	Neotoma		Quaternary	Pleistocene	Sacramento County
V124854	Mammalia	Neotoma		Quaternary	Pleistocene	Sacramento County
V124855	Mammalia	Neotoma		Quaternary	Pleistocene	Sacramento County
V124856	Mammalia	Neotoma		Quaternary	Pleistocene	Sacramento County
V124857	Mammalia	Neotoma		Quaternary	Pleistocene	Sacramento County
V125883	Mammalia	Mammuthus	columbi	Quaternary	Pleistocene	Sacramento County
V131332	Reptilia	Thamnophis		Quaternary	Pleistocene	Sacramento County
V131333	Reptilia	Thamnophis		Quaternary	Pleistocene	Sacramento County
V140225	Mammalia	Mammuthus		Quaternary	Pleistocene	Sacramento County

UCMP Records for Sacramento County

spec_id	class	genus	species	period	epoch	county_std
V173836	Mammalia	Mammuthus	columbi	Quaternary	Pleistocene	Sacramento County
V197815	Mammalia	Mammuthus		Quaternary	Pleistocene	Sacramento County
V228178	Mammalia	Thomomys		Quaternary	Pleistocene	Sacramento County
V228179	Mammalia	Thomomys		Quaternary	Pleistocene	Sacramento County
V228180	Mammalia	Thomomys		Quaternary	Pleistocene	Sacramento County
V228181	Mammalia	Thomomys		Quaternary	Pleistocene	Sacramento County
V228182	Mammalia	Thomomys		Quaternary	Pleistocene	Sacramento County
V228183	Mammalia	Thomomys		Quaternary	Pleistocene	Sacramento County
V228184	Mammalia	Thomomys		Quaternary	Pleistocene	Sacramento County
V228185	Mammalia	Thomomys		Quaternary	Pleistocene	Sacramento County
V228186	Mammalia	Thomomys		Quaternary	Pleistocene	Sacramento County
V228187	Mammalia	Thomomys		Quaternary	Pleistocene	Sacramento County
V228188	Mammalia	Thomomys		Quaternary	Pleistocene	Sacramento County
V228189	Mammalia	Thomomys		Quaternary	Pleistocene	Sacramento County
V228190	Mammalia	Thomomys		Quaternary	Pleistocene	Sacramento County
V228191	Mammalia	Thomomys		Quaternary	Pleistocene	Sacramento County
V228192	Mammalia	Thomomys		Quaternary	Pleistocene	Sacramento County
V228193	Mammalia	Thomomys		Quaternary	Pleistocene	Sacramento County
V228194	Mammalia	Thomomys		Quaternary	Pleistocene	Sacramento County
V228195	Mammalia	Thomomys		Quaternary	Pleistocene	Sacramento County
V228196	Mammalia	Thomomys		Quaternary	Pleistocene	Sacramento County
V228197	Mammalia	Thomomys		Quaternary	Pleistocene	Sacramento County
V228198	Mammalia	Thomomys		Quaternary	Pleistocene	Sacramento County
V228199	Mammalia	Thomomys		Quaternary	Pleistocene	Sacramento County
V228200	Mammalia	Thomomys		Quaternary	Pleistocene	Sacramento County
V228201	Mammalia	Thomomys		Quaternary	Pleistocene	Sacramento County
V228202	Mammalia	Microtus		Quaternary	Pleistocene	Sacramento County
V228203	Mammalia	Microtus		Quaternary	Pleistocene	Sacramento County
V228204	Mammalia	Microtus		Quaternary	Pleistocene	Sacramento County
V228205	Mammalia	Microtus		Quaternary	Pleistocene	Sacramento County
V228206	Mammalia	Microtus		Quaternary	Pleistocene	Sacramento County
V228207	Mammalia	Microtus		Quaternary	Pleistocene	Sacramento County
V228208	Mammalia	Microtus		Quaternary	Pleistocene	Sacramento County
V228209	Mammalia	Microtus		Quaternary	Pleistocene	Sacramento County
V228210	Mammalia	Microtus		Quaternary	Pleistocene	Sacramento County
V228211	Mammalia	Microtus		Quaternary	Pleistocene	Sacramento County
V228212	Mammalia	Microtus		Quaternary	Pleistocene	Sacramento County
V228213	Mammalia	Microtus		Quaternary	Pleistocene	Sacramento County
V228214	Mammalia	Spermophilus		Quaternary	Pleistocene	Sacramento County
V228215	Mammalia	Spermophilus		Quaternary	Pleistocene	Sacramento County
V228216	Mammalia	Spermophilus		Quaternary	Pleistocene	Sacramento County
V228217	Mammalia	Spermophilus		Quaternary	Pleistocene	Sacramento County
V228218	Mammalia	Spermophilus		Quaternary	Pleistocene	Sacramento County
V228219	Mammalia	Spermophilus		Quaternary	Pleistocene	Sacramento County
V228220	Mammalia	Spermophilus		Quaternary	Pleistocene	Sacramento County

UCMP Records for Sacramento County

spec_id	class	genus	species	period	epoch	county_std
V228221	Mammalia	Spermophilus		Quaternary	Pleistocene	Sacramento County
V228222	Mammalia	Spermophilus		Quaternary	Pleistocene	Sacramento County
V228223	Mammalia	Reithrodontomys		Quaternary	Pleistocene	Sacramento County
V228224	Mammalia	Reithrodontomys		Quaternary	Pleistocene	Sacramento County
V228225	Mammalia	Reithrodontomys		Quaternary	Pleistocene	Sacramento County
V228226	Mammalia	Reithrodontomys		Quaternary	Pleistocene	Sacramento County
V228227	Mammalia	Reithrodontomys		Quaternary	Pleistocene	Sacramento County
V228228	Mammalia	Reithrodontomys		Quaternary	Pleistocene	Sacramento County
V228229	Mammalia	Reithrodontomys		Quaternary	Pleistocene	Sacramento County
V228230	Mammalia	Reithrodontomys		Quaternary	Pleistocene	Sacramento County
V228231	Mammalia	Reithrodontomys		Quaternary	Pleistocene	Sacramento County
V228232	Mammalia	Reithrodontomys		Quaternary	Pleistocene	Sacramento County
V228233	Mammalia	Reithrodontomys		Quaternary	Pleistocene	Sacramento County
V228234	Mammalia	Reithrodontomys		Quaternary	Pleistocene	Sacramento County
V228235	Mammalia	Reithrodontomys		Quaternary	Pleistocene	Sacramento County
V228236	Mammalia	Reithrodontomys		Quaternary	Pleistocene	Sacramento County
V228237	Mammalia	Reithrodontomys		Quaternary	Pleistocene	Sacramento County
V228238	Mammalia	Reithrodontomys		Quaternary	Pleistocene	Sacramento County
V228239	Mammalia	Reithrodontomys		Quaternary	Pleistocene	Sacramento County
V228240	Mammalia	Reithrodontomys		Quaternary	Pleistocene	Sacramento County
V228241	Mammalia	Reithrodontomys		Quaternary	Pleistocene	Sacramento County
V228242	Mammalia	Reithrodontomys		Quaternary	Pleistocene	Sacramento County
V228243	Mammalia	Sylvilagus		Quaternary	Pleistocene	Sacramento County
V228244	Mammalia	Sylvilagus		Quaternary	Pleistocene	Sacramento County
V228245	Amphibia			Quaternary	Pleistocene	Sacramento County
V228246	Amphibia			Quaternary	Pleistocene	Sacramento County
V228247	Amphibia	Rana		Quaternary	Pleistocene	Sacramento County
V228248	Mammalia	Sorex		Quaternary	Pleistocene	Sacramento County
V228249	Mammalia	Sorex		Quaternary	Pleistocene	Sacramento County
V228250	Mammalia	Sorex		Quaternary	Pleistocene	Sacramento County
V228251	Aves			Quaternary	Pleistocene	Sacramento County
V228252	Aves			Quaternary	Pleistocene	Sacramento County
V228253	Amphibia	Scaphiopus		Quaternary	Pleistocene	Sacramento County
V228254	Amphibia	Scaphiopus		Quaternary	Pleistocene	Sacramento County
V228255	Osteichthyes	Archoplites		Quaternary	Pleistocene	Sacramento County
V228256	Osteichthyes			Quaternary	Pleistocene	Sacramento County

UCMP Records for Riverbank Formation in Sacramento County

spec_id	class	genus	species	epoch	period	county_std
V80703	Mammalia	Mammuthus	columbi	Pleistocene	Quaternary	Sacramento County
V81276	Mammalia	Camelops	hesternus	Pleistocene	Quaternary	Sacramento County
V81277	Mammalia	Glossotherium	harlani	Pleistocene	Quaternary	Sacramento County
V81771	Mammalia	Equus		Pleistocene	Quaternary	Sacramento County
V81772	Mammalia	Equus		Pleistocene	Quaternary	Sacramento County
V85338	Mammalia			Pleistocene	Quaternary	Sacramento County
V85339	Mammalia			Pleistocene	Quaternary	Sacramento County
V85340	Mammalia	Equus		Pleistocene	Quaternary	Sacramento County
V85378	Mammalia	Canis	latrans	Pleistocene	Quaternary	Sacramento County
V85379	Mammalia	Canis	latrans	Pleistocene	Quaternary	Sacramento County
V85380	Mammalia	Canis	dirus	Pleistocene	Quaternary	Sacramento County
V85381	Mammalia	Bison		Pleistocene	Quaternary	Sacramento County
V85382	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V85383	Aves			Pleistocene	Quaternary	Sacramento County
V96294	Osteichthyes	Orthodon		Pleistocene	Quaternary	Sacramento County
V119253	Mammalia	Scapanus	latimanus	Pleistocene	Quaternary	Sacramento County
V119254	Mammalia	Scapanus	latimanus	Pleistocene	Quaternary	Sacramento County
V119255	Mammalia	Scapanus	latimanus	Pleistocene	Quaternary	Sacramento County
V119256	Mammalia	Scapanus	latimanus	Pleistocene	Quaternary	Sacramento County
V124843	Mammalia	Neotoma		Pleistocene	Quaternary	Sacramento County
V124844	Mammalia	Neotoma		Pleistocene	Quaternary	Sacramento County
V124845	Mammalia	Neotoma		Pleistocene	Quaternary	Sacramento County
V124846	Mammalia	Neotoma		Pleistocene	Quaternary	Sacramento County
V124847	Mammalia	Neotoma		Pleistocene	Quaternary	Sacramento County
V124848	Mammalia	Neotoma		Pleistocene	Quaternary	Sacramento County
V124849	Mammalia	Neotoma		Pleistocene	Quaternary	Sacramento County
V124850	Mammalia	Neotoma		Pleistocene	Quaternary	Sacramento County
V124851	Mammalia	Neotoma		Pleistocene	Quaternary	Sacramento County
V124852	Mammalia	Neotoma		Pleistocene	Quaternary	Sacramento County
V124853	Mammalia	Neotoma		Pleistocene	Quaternary	Sacramento County
V124854	Mammalia	Neotoma		Pleistocene	Quaternary	Sacramento County
V124855	Mammalia	Neotoma		Pleistocene	Quaternary	Sacramento County
V124856	Mammalia	Neotoma		Pleistocene	Quaternary	Sacramento County
V124857	Mammalia	Neotoma		Pleistocene	Quaternary	Sacramento County
V125883	Mammalia	Mammuthus	columbi	Pleistocene	Quaternary	Sacramento County
V131332	Reptilia	Thamnophis		Pleistocene	Quaternary	Sacramento County
V131333	Reptilia	Thamnophis		Pleistocene	Quaternary	Sacramento County
V140225	Mammalia	Mammuthus		Pleistocene	Quaternary	Sacramento County
V151912	Mammalia			Pleistocene	Quaternary	Sacramento County
V173836	Mammalia	Mammuthus	columbi	Pleistocene	Quaternary	Sacramento County
V197815	Mammalia	Mammuthus		Pleistocene	Quaternary	Sacramento County
V228178	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V228179	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V228180	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County

UCMP Records for Riverbank Formation in Sacramento County

spec_id	class	genus	species	epoch	period	county_std
V228181	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V228182	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V228183	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V228184	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V228185	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V228186	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V228187	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V228188	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V228189	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V228190	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V228191	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V228192	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V228193	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V228194	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V228195	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V228196	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V228197	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V228198	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V228199	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V228200	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V228201	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V228202	Mammalia	Microtus		Pleistocene	Quaternary	Sacramento County
V228203	Mammalia	Microtus		Pleistocene	Quaternary	Sacramento County
V228204	Mammalia	Microtus		Pleistocene	Quaternary	Sacramento County
V228205	Mammalia	Microtus		Pleistocene	Quaternary	Sacramento County
V228206	Mammalia	Microtus		Pleistocene	Quaternary	Sacramento County
V228207	Mammalia	Microtus		Pleistocene	Quaternary	Sacramento County
V228208	Mammalia	Microtus		Pleistocene	Quaternary	Sacramento County
V228209	Mammalia	Microtus		Pleistocene	Quaternary	Sacramento County
V228210	Mammalia	Microtus		Pleistocene	Quaternary	Sacramento County
V228211	Mammalia	Microtus		Pleistocene	Quaternary	Sacramento County
V228212	Mammalia	Microtus		Pleistocene	Quaternary	Sacramento County
V228213	Mammalia	Microtus		Pleistocene	Quaternary	Sacramento County
V228214	Mammalia	Spermophilus		Pleistocene	Quaternary	Sacramento County
V228215	Mammalia	Spermophilus		Pleistocene	Quaternary	Sacramento County
V228216	Mammalia	Spermophilus		Pleistocene	Quaternary	Sacramento County
V228217	Mammalia	Spermophilus		Pleistocene	Quaternary	Sacramento County
V228218	Mammalia	Spermophilus		Pleistocene	Quaternary	Sacramento County
V228219	Mammalia	Spermophilus		Pleistocene	Quaternary	Sacramento County
V228220	Mammalia	Spermophilus		Pleistocene	Quaternary	Sacramento County
V228221	Mammalia	Spermophilus		Pleistocene	Quaternary	Sacramento County
V228222	Mammalia	Spermophilus		Pleistocene	Quaternary	Sacramento County
V228223	Mammalia	Reithrodontomys		Pleistocene	Quaternary	Sacramento County
V228224	Mammalia	Reithrodontomys		Pleistocene	Quaternary	Sacramento County
V228225	Mammalia	Reithrodontomys		Pleistocene	Quaternary	Sacramento County

UCMP Records for Riverbank Formation in Sacramento County

spec_id	class	genus	species	epoch	period	county_std
V228226	Mammalia	Reithrodontomys		Pleistocene	Quaternary	Sacramento County
V228227	Mammalia	Reithrodontomys		Pleistocene	Quaternary	Sacramento County
V228228	Mammalia	Reithrodontomys		Pleistocene	Quaternary	Sacramento County
V228229	Mammalia	Reithrodontomys		Pleistocene	Quaternary	Sacramento County
V228230	Mammalia	Reithrodontomys		Pleistocene	Quaternary	Sacramento County
V228231	Mammalia	Reithrodontomys		Pleistocene	Quaternary	Sacramento County
V228232	Mammalia	Reithrodontomys		Pleistocene	Quaternary	Sacramento County
V228233	Mammalia	Reithrodontomys		Pleistocene	Quaternary	Sacramento County
V228234	Mammalia	Reithrodontomys		Pleistocene	Quaternary	Sacramento County
V228235	Mammalia	Reithrodontomys		Pleistocene	Quaternary	Sacramento County
V228236	Mammalia	Reithrodontomys		Pleistocene	Quaternary	Sacramento County
V228237	Mammalia	Reithrodontomys		Pleistocene	Quaternary	Sacramento County
V228238	Mammalia	Reithrodontomys		Pleistocene	Quaternary	Sacramento County
V228239	Mammalia	Reithrodontomys		Pleistocene	Quaternary	Sacramento County
V228240	Mammalia	Reithrodontomys		Pleistocene	Quaternary	Sacramento County
V228241	Mammalia	Reithrodontomys		Pleistocene	Quaternary	Sacramento County
V228242	Mammalia	Reithrodontomys		Pleistocene	Quaternary	Sacramento County
V228243	Mammalia	Sylvilagus		Pleistocene	Quaternary	Sacramento County
V228244	Mammalia	Sylvilagus		Pleistocene	Quaternary	Sacramento County
V228245	Amphibia			Pleistocene	Quaternary	Sacramento County
V228246	Amphibia			Pleistocene	Quaternary	Sacramento County
V228247	Amphibia	Rana		Pleistocene	Quaternary	Sacramento County
V228248	Mammalia	Sorex		Pleistocene	Quaternary	Sacramento County
V228249	Mammalia	Sorex		Pleistocene	Quaternary	Sacramento County
V228250	Mammalia	Sorex		Pleistocene	Quaternary	Sacramento County
V228251	Aves			Pleistocene	Quaternary	Sacramento County
V228252	Aves			Pleistocene	Quaternary	Sacramento County
V228253	Amphibia	Scaphiopus		Pleistocene	Quaternary	Sacramento County
V228254	Amphibia	Scaphiopus		Pleistocene	Quaternary	Sacramento County
V228255	Osteichthyes	Archoplites		Pleistocene	Quaternary	Sacramento County
V228256	Osteichthyes			Pleistocene	Quaternary	Sacramento County

UCMP Records for Riverbank Formation

spec_id	class	genus	species	epoch	period	county_std
V80703	Mammalia	Mammuthus	columbi	Pleistocene	Quaternary	Sacramento County
V81276	Mammalia	Camelops	hesternus	Pleistocene	Quaternary	Sacramento County
V81277	Mammalia	Glossotherium	harlani	Pleistocene	Quaternary	Sacramento County
V81771	Mammalia	Equus		Pleistocene	Quaternary	Sacramento County
V81772	Mammalia	Equus		Pleistocene	Quaternary	Sacramento County
V85338	Mammalia			Pleistocene	Quaternary	Sacramento County
V85339	Mammalia			Pleistocene	Quaternary	Sacramento County
V85340	Mammalia	Equus		Pleistocene	Quaternary	Sacramento County
V85378	Mammalia	Canis	latrans	Pleistocene	Quaternary	Sacramento County
V85379	Mammalia	Canis	latrans	Pleistocene	Quaternary	Sacramento County
V85380	Mammalia	Canis	dirus	Pleistocene	Quaternary	Sacramento County
V85381	Mammalia	Bison		Pleistocene	Quaternary	Sacramento County
V85382	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V85383	Aves			Pleistocene	Quaternary	Sacramento County
V96294	Osteichthyes	Orthodon		Pleistocene	Quaternary	Sacramento County
V97557	Mammalia	Glossotherium	harlani	Pleistocene	Quaternary	Stanislaus County
V119253	Mammalia	Scapanus	latimanus	Pleistocene	Quaternary	Sacramento County
V119254	Mammalia	Scapanus	latimanus	Pleistocene	Quaternary	Sacramento County
V119255	Mammalia	Scapanus	latimanus	Pleistocene	Quaternary	Sacramento County
V119256	Mammalia	Scapanus	latimanus	Pleistocene	Quaternary	Sacramento County
V124843	Mammalia	Neotoma		Pleistocene	Quaternary	Sacramento County
V124844	Mammalia	Neotoma		Pleistocene	Quaternary	Sacramento County
V124845	Mammalia	Neotoma		Pleistocene	Quaternary	Sacramento County
V124846	Mammalia	Neotoma		Pleistocene	Quaternary	Sacramento County
V124847	Mammalia	Neotoma		Pleistocene	Quaternary	Sacramento County
V124848	Mammalia	Neotoma		Pleistocene	Quaternary	Sacramento County
V124849	Mammalia	Neotoma		Pleistocene	Quaternary	Sacramento County
V124850	Mammalia	Neotoma		Pleistocene	Quaternary	Sacramento County
V124851	Mammalia	Neotoma		Pleistocene	Quaternary	Sacramento County
V124852	Mammalia	Neotoma		Pleistocene	Quaternary	Sacramento County
V124853	Mammalia	Neotoma		Pleistocene	Quaternary	Sacramento County
V124854	Mammalia	Neotoma		Pleistocene	Quaternary	Sacramento County
V124855	Mammalia	Neotoma		Pleistocene	Quaternary	Sacramento County
V124856	Mammalia	Neotoma		Pleistocene	Quaternary	Sacramento County
V124857	Mammalia	Neotoma		Pleistocene	Quaternary	Sacramento County
V125542	Mammalia	Equus		Pleistocene	Quaternary	Fresno County
V125883	Mammalia	Mammuthus	columbi	Pleistocene	Quaternary	Sacramento County
V131332	Reptilia	Thamnophis		Pleistocene	Quaternary	Sacramento County
V131333	Reptilia	Thamnophis		Pleistocene	Quaternary	Sacramento County
V140225	Mammalia	Mammuthus		Pleistocene	Quaternary	Sacramento County
V140260	Mammalia	Nothrotheriops	shastensis	Pleistocene	Quaternary	Madera County
V140261	Mammalia	Nothrotheriops	shastensis	Pleistocene	Quaternary	Madera County
V140262	Mammalia	Megalonyx	wheatleyi	Pleistocene	Quaternary	Madera County
V140263	Mammalia	Paramylodon	harlani	Pleistocene	Quaternary	Madera County
V140264	Mammalia	Smilodon	fatalis	Pleistocene	Quaternary	Madera County

UCMP Records for Riverbank Formation

spec_id	class	genus	species	epoch	period	county_std
V140265	Mammalia	Canis	armbrusteri	Pleistocene	Quaternary	Madera County
V140390	Mammalia	Homotherium	serum	Pleistocene	Quaternary	Madera County
V140391	Mammalia	Homotherium	serum	Pleistocene	Quaternary	Madera County
V140392	Mammalia	Paramylodon	harlani	Pleistocene	Quaternary	Madera County
V140393	Mammalia	Megalonyx	wheatleyi	Pleistocene	Quaternary	Madera County
V140394	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V140395	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V140396	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V140397	Mammalia	Hemiauchenia		Pleistocene	Quaternary	Madera County
V140398	Mammalia	Tetrameryx	irvingtonensis	Pleistocene	Quaternary	Madera County
V140399	Mammalia	Odocoileus		Pleistocene	Quaternary	Madera County
V140400	Mammalia	Camelops		Pleistocene	Quaternary	Madera County
V140401	Mammalia	Camelops		Pleistocene	Quaternary	Madera County
V140402	Mammalia	Mammuthus	columbi	Pleistocene	Quaternary	Madera County
V140404	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V140405	Mammalia	Mammuthus	columbi	Pleistocene	Quaternary	Madera County
V140406	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V140407	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V140408	Mammalia	Thomomys		Pleistocene	Quaternary	Madera County
V140409	Mammalia	Capromeryx		Pleistocene	Quaternary	Madera County
V140410	Mammalia	Tetrameryx	irvingtonensis	Pleistocene	Quaternary	Madera County
V140411	Mammalia	Tertameryx	irvingtonensis	Pleistocene	Quaternary	Madera County
V140412	Mammalia	Hemiauchenia		Pleistocene	Quaternary	Madera County
V140413	Mammalia	Canis	latrans	Pleistocene	Quaternary	Madera County
V140414	Aves			Pleistocene	Quaternary	Madera County
V140415	Mammalia	Mammuthus	columbi	Pleistocene	Quaternary	Madera County
V140426	Mammalia	Smilodon		Pleistocene	Quaternary	Madera County
V140618	Mammalia	Miracinonyx	trumani	Pleistocene	Quaternary	Madera County
V140625	Reptilia	Clemmys	marmorata	Pleistocene	Quaternary	Madera County
V140626	Mammalia	Lepus		Pleistocene	Quaternary	Madera County
V140627	Mammalia	Dipodomys		Pleistocene	Quaternary	Madera County
V140645	Mammalia	Notiosorex		Pleistocene	Quaternary	Madera County
V141402	Mammalia	Mammuthus	columbi	Pleistocene	Quaternary	Madera County
V141403	Aves			Pleistocene	Quaternary	Madera County
V141407	Mammalia	Mammuthus	columbi	Pleistocene	Quaternary	Madera County
V149170	Reptilia	Xerobates	agassizi	Pleistocene	Quaternary	Madera County
V151912	Mammalia			Pleistocene	Quaternary	Sacramento County
V152555	Amphibia			Pleistocene	Quaternary	Madera County
V152920	Mammalia			Pleistocene	Quaternary	Madera County
V156047	Mammalia	Canis	armbrusteri	Pleistocene	Quaternary	Madera County
V156048	Mammalia	Canis	armbrusteri	Pleistocene	Quaternary	Madera County
V156954	Mammalia			Pleistocene	Quaternary	Madera County
V170180	Mammalia	Vulpes		Pleistocene	Quaternary	Madera County
V170181	Mammalia	Vulpes		Pleistocene	Quaternary	Madera County
V171130	Mammalia			Pleistocene	Quaternary	Madera County
V171131	Mammalia			Pleistocene	Quaternary	Madera County

UCMP Records for Riverbank Formation

spec_id	class	genus	species	epoch	period	county_std
V171132	Mammalia			Pleistocene	Quaternary	Madera County
V171133	Mammalia			Pleistocene	Quaternary	Madera County
V171134	Mammalia			Pleistocene	Quaternary	Madera County
V171135	Mammalia			Pleistocene	Quaternary	Madera County
V171607	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171608	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171609	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171610	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171611	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171612	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171613	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171614	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171615	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171616	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171617	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171618	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171619	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171620	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171621	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171622	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171623	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171624	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171625	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171626	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171627	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171628	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171629	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171630	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171631	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171908	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171909	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171910	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171911	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171912	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171913	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171914	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171915	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171916	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171917	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171918	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171919	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171920	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171921	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171922	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171923	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171924	Mammalia	Equus		Pleistocene	Quaternary	Madera County

UCMP Records for Riverbank Formation

spec_id	class	genus	species	epoch	period	county_std
V171925	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171926	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171927	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171928	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171929	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171930	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171931	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171932	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171933	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171934	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171935	Mammalia			Pleistocene	Quaternary	Madera County
V171936	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171937	Mammalia			Pleistocene	Quaternary	Madera County
V171938	Mammalia	Camelops		Pleistocene	Quaternary	Madera County
V171939	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171940	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171941	Mammalia			Pleistocene	Quaternary	Madera County
V171942	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171943	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171944	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171945	Mammalia			Pleistocene	Quaternary	Madera County
V171946	Reptilia	Clemmys		Pleistocene	Quaternary	Madera County
V171947	Mammalia			Pleistocene	Quaternary	Madera County
V171948	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171949	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171950	Reptilia	Clemmys		Pleistocene	Quaternary	Madera County
V171951	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171952	Mammalia			Pleistocene	Quaternary	Madera County
V171953	Reptilia	Clemmys		Pleistocene	Quaternary	Madera County
V171954	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171955	Reptilia	Clemmys		Pleistocene	Quaternary	Madera County
V171956	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171957	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171958	Mammalia	Camelops		Pleistocene	Quaternary	Madera County
V171959	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171960	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171961	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171962	Mammalia			Pleistocene	Quaternary	Madera County
V171963	Mammalia			Pleistocene	Quaternary	Madera County
V171964	Mammalia			Pleistocene	Quaternary	Madera County
V171965	Mammalia			Pleistocene	Quaternary	Madera County
V171966	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171967	Mammalia			Pleistocene	Quaternary	Madera County
V171968	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171969	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171970	Mammalia			Pleistocene	Quaternary	Madera County

UCMP Records for Riverbank Formation

spec_id	class	genus	species	epoch	period	county_std
V171971	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171972	Mammalia			Pleistocene	Quaternary	Madera County
V171973	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171974	Mammalia			Pleistocene	Quaternary	Madera County
V171975	Mammalia			Pleistocene	Quaternary	Madera County
V171976	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171977	Mammalia			Pleistocene	Quaternary	Madera County
V171978	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171979	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171980	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171981	Mammalia			Pleistocene	Quaternary	Madera County
V171982	Mammalia			Pleistocene	Quaternary	Madera County
V171983	Mammalia			Pleistocene	Quaternary	Madera County
V171984	Mammalia			Pleistocene	Quaternary	Madera County
V171985	Mammalia			Pleistocene	Quaternary	Madera County
V171986	Mammalia			Pleistocene	Quaternary	Madera County
V171987	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171988	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171989	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171990	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171991	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171992	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171993	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171994	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171995	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171996	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V171997	Mammalia			Pleistocene	Quaternary	Madera County
V171998	Mammalia			Pleistocene	Quaternary	Madera County
V171999	Mammalia			Pleistocene	Quaternary	Madera County
V172000	Mammalia			Pleistocene	Quaternary	Madera County
V172001	Mammalia			Pleistocene	Quaternary	Madera County
V172002	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V172003	Mammalia			Pleistocene	Quaternary	Madera County
V172004	Mammalia	Camelops		Pleistocene	Quaternary	Madera County
V172005	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V172006	Mammalia			Pleistocene	Quaternary	Madera County
V172007	Mammalia			Pleistocene	Quaternary	Madera County
V172008	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V172009	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V172010	Mammalia	Camelops		Pleistocene	Quaternary	Madera County
V172011	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V172012	Mammalia			Pleistocene	Quaternary	Madera County
V172013	Mammalia			Pleistocene	Quaternary	Madera County
V172014	Mammalia			Pleistocene	Quaternary	Madera County
V172015	Mammalia			Pleistocene	Quaternary	Madera County
V172016	Mammalia	Camelops		Pleistocene	Quaternary	Madera County

UCMP Records for Riverbank Formation

spec_id	class	genus	species	epoch	period	county_std
V172017	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V172018	Mammalia			Pleistocene	Quaternary	Madera County
V172019	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V173836	Mammalia	Mammuthus	columbi	Pleistocene	Quaternary	Sacramento County
V175275	Mammalia			Pleistocene	Quaternary	Madera County
V175276	Mammalia	Nothriotheriops	shastensis	Pleistocene	Quaternary	Madera County
V192651	Mammalia			Pleistocene	Quaternary	Madera County
V194432	Aves			Pleistocene	Quaternary	Madera County
V194433	Aves			Pleistocene	Quaternary	Madera County
V194840	Mammalia	Megalonyx	wheatleyi	Pleistocene	Quaternary	Madera County
V194900	Mammalia			Pleistocene	Quaternary	Madera County
V197566	Mammalia			Pleistocene	Quaternary	Madera County
V197567	Mammalia	Tetrameryx	irvingtonensis	Pleistocene	Quaternary	Madera County
V197569	Mammalia			Pleistocene	Quaternary	Madera County
V197815	Mammalia	Mammuthus		Pleistocene	Quaternary	Sacramento County
V197877	Mammalia	Paramylodon		Pleistocene	Quaternary	Madera County
V197881	Mammalia			Pleistocene	Quaternary	Madera County
V197883	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V197884	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V197885	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V197886	Mammalia	Camelops		Pleistocene	Quaternary	Madera County
V197887	Mammalia	Camelops		Pleistocene	Quaternary	Madera County
V197888	Mammalia	Camelops		Pleistocene	Quaternary	Madera County
V197889	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V197890	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V197899	Mammalia	Mammuthus		Pleistocene	Quaternary	Madera County
V212864	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V212865	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V212866	Mammalia	Camelops		Pleistocene	Quaternary	Madera County
V212867	Mammalia	Camelops		Pleistocene	Quaternary	Madera County
V212868	Mammalia	Camelops		Pleistocene	Quaternary	Madera County
V218734	Mammalia	Microtus		Pleistocene	Quaternary	Madera County
V218735	Mammalia	Microtus		Pleistocene	Quaternary	Madera County
V218736	Mammalia	Microtus		Pleistocene	Quaternary	Madera County
V218737	Mammalia	Microtus		Pleistocene	Quaternary	Madera County
V223370	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V223371	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V223372	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V223373	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V223374	Mammalia	Equus		Pleistocene	Quaternary	Madera County
V228178	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V228179	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V228180	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V228181	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V228182	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V228183	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County

UCMP Records for Riverbank Formation

spec_id	class	genus	species	epoch	period	county_std
V228184	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V228185	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V228186	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V228187	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V228188	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V228189	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V228190	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V228191	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V228192	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V228193	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V228194	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V228195	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V228196	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V228197	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V228198	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V228199	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V228200	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V228201	Mammalia	Thomomys		Pleistocene	Quaternary	Sacramento County
V228202	Mammalia	Microtus		Pleistocene	Quaternary	Sacramento County
V228203	Mammalia	Microtus		Pleistocene	Quaternary	Sacramento County
V228204	Mammalia	Microtus		Pleistocene	Quaternary	Sacramento County
V228205	Mammalia	Microtus		Pleistocene	Quaternary	Sacramento County
V228206	Mammalia	Microtus		Pleistocene	Quaternary	Sacramento County
V228207	Mammalia	Microtus		Pleistocene	Quaternary	Sacramento County
V228208	Mammalia	Microtus		Pleistocene	Quaternary	Sacramento County
V228209	Mammalia	Microtus		Pleistocene	Quaternary	Sacramento County
V228210	Mammalia	Microtus		Pleistocene	Quaternary	Sacramento County
V228211	Mammalia	Microtus		Pleistocene	Quaternary	Sacramento County
V228212	Mammalia	Microtus		Pleistocene	Quaternary	Sacramento County
V228213	Mammalia	Microtus		Pleistocene	Quaternary	Sacramento County
V228214	Mammalia	Spermophilus		Pleistocene	Quaternary	Sacramento County
V228215	Mammalia	Spermophilus		Pleistocene	Quaternary	Sacramento County
V228216	Mammalia	Spermophilus		Pleistocene	Quaternary	Sacramento County
V228217	Mammalia	Spermophilus		Pleistocene	Quaternary	Sacramento County
V228218	Mammalia	Spermophilus		Pleistocene	Quaternary	Sacramento County
V228219	Mammalia	Spermophilus		Pleistocene	Quaternary	Sacramento County
V228220	Mammalia	Spermophilus		Pleistocene	Quaternary	Sacramento County
V228221	Mammalia	Spermophilus		Pleistocene	Quaternary	Sacramento County
V228222	Mammalia	Spermophilus		Pleistocene	Quaternary	Sacramento County
V228223	Mammalia	Reithrodontomys		Pleistocene	Quaternary	Sacramento County
V228224	Mammalia	Reithrodontomys		Pleistocene	Quaternary	Sacramento County
V228225	Mammalia	Reithrodontomys		Pleistocene	Quaternary	Sacramento County
V228226	Mammalia	Reithrodontomys		Pleistocene	Quaternary	Sacramento County
V228227	Mammalia	Reithrodontomys		Pleistocene	Quaternary	Sacramento County
V228228	Mammalia	Reithrodontomys		Pleistocene	Quaternary	Sacramento County
V228229	Mammalia	Reithrodontomys		Pleistocene	Quaternary	Sacramento County

UCMP Records for Riverbank Formation

spec_id	class	genus	species	epoch	period	county_std
V228230	Mammalia	Reithrodontomys		Pleistocene	Quaternary	Sacramento County
V228231	Mammalia	Reithrodontomys		Pleistocene	Quaternary	Sacramento County
V228232	Mammalia	Reithrodontomys		Pleistocene	Quaternary	Sacramento County
V228233	Mammalia	Reithrodontomys		Pleistocene	Quaternary	Sacramento County
V228234	Mammalia	Reithrodontomys		Pleistocene	Quaternary	Sacramento County
V228235	Mammalia	Reithrodontomys		Pleistocene	Quaternary	Sacramento County
V228236	Mammalia	Reithrodontomys		Pleistocene	Quaternary	Sacramento County
V228237	Mammalia	Reithrodontomys		Pleistocene	Quaternary	Sacramento County
V228238	Mammalia	Reithrodontomys		Pleistocene	Quaternary	Sacramento County
V228239	Mammalia	Reithrodontomys		Pleistocene	Quaternary	Sacramento County
V228240	Mammalia	Reithrodontomys		Pleistocene	Quaternary	Sacramento County
V228241	Mammalia	Reithrodontomys		Pleistocene	Quaternary	Sacramento County
V228242	Mammalia	Reithrodontomys		Pleistocene	Quaternary	Sacramento County
V228243	Mammalia	Sylvilagus		Pleistocene	Quaternary	Sacramento County
V228244	Mammalia	Sylvilagus		Pleistocene	Quaternary	Sacramento County
V228245	Amphibia			Pleistocene	Quaternary	Sacramento County
V228246	Amphibia			Pleistocene	Quaternary	Sacramento County
V228247	Amphibia	Rana		Pleistocene	Quaternary	Sacramento County
V228248	Mammalia	Sorex		Pleistocene	Quaternary	Sacramento County
V228249	Mammalia	Sorex		Pleistocene	Quaternary	Sacramento County
V228250	Mammalia	Sorex		Pleistocene	Quaternary	Sacramento County
V228251	Aves			Pleistocene	Quaternary	Sacramento County
V228252	Aves			Pleistocene	Quaternary	Sacramento County
V228253	Amphibia	Scaphiopus		Pleistocene	Quaternary	Sacramento County
V228254	Amphibia	Scaphiopus		Pleistocene	Quaternary	Sacramento County
V228255	Osteichthyes	Archoplites		Pleistocene	Quaternary	Sacramento County
V228256	Osteichthyes			Pleistocene	Quaternary	Sacramento County
V235854	Mammalia			Pleistocene	Quaternary	Madera County
V235855	Mammalia			Pleistocene	Quaternary	Madera County

UCMP Records for Modesto Formation

spec_id	class	genus	species	epoch	period	loc_ID_nur	county_std
V97554	Mammalia	Megalonyx	jeffersoni	Pleistocene	Quaternary	V72007	Stanislaus County
V97555	Mammalia	Megalonyx	jeffersoni	Pleistocene	Quaternary	V72007	Stanislaus County
V97556	Mammalia	Mammuthus	columbi	Pleistocene	Quaternary	V72007	Stanislaus County
V102675	Mammalia	Bison	latifrons	Pleistocene	Quaternary	V72186	Stanislaus County
V142212	Mammalia			Pleistocene	Quaternary	V96015	Yolo County
V142213	Mammalia			Pleistocene	Quaternary	V96015	Yolo County
V142214	Mammalia			Pleistocene	Quaternary	V96015	Yolo County
V142215	Mammalia			Pleistocene	Quaternary	V96015	Yolo County
V142216	Mammalia			Pleistocene	Quaternary	V96015	Yolo County
V142217	Reptilia			Pleistocene	Quaternary	V96015	Yolo County
V142218	Mammalia			Pleistocene	Quaternary	V96015	Yolo County
V142219	Mammalia			Pleistocene	Quaternary	V96015	Yolo County
V153054	Mammalia	Camelops		Pleistocene	Quaternary	V99464	Stanislaus County
V153055	Mammalia	Camelops		Pleistocene	Quaternary	V99464	Stanislaus County
V153056	Mammalia	Camelops		Pleistocene	Quaternary	V99464	Stanislaus County
V153057	Mammalia	Camelops		Pleistocene	Quaternary	V99464	Stanislaus County
V153058	Mammalia	Camelops		Pleistocene	Quaternary	V99464	Stanislaus County
V153059	Mammalia	Bison		Pleistocene	Quaternary	V99464	Stanislaus County
V197603	Mammalia	Mammuthus		Pleistocene	Quaternary	V99830	Fresno County
V197604	Mammalia	Mammuthus		Pleistocene	Quaternary	V99830	Fresno County
V197605	Mammalia	Mammuthus		Pleistocene	Quaternary	V99830	Fresno County
V197606	Mammalia	Mammuthus		Pleistocene	Quaternary	V99830	Fresno County
V197607	Mammalia	Mammuthus		Pleistocene	Quaternary	V99830	Fresno County
V197608	Mammalia			Pleistocene	Quaternary	V99829	Fresno County
V197609	Mammalia			Pleistocene	Quaternary	V99829	Fresno County
V197610	Mammalia	Mammuthus		Pleistocene	Quaternary	V99830	Fresno County
V197611	Mammalia	Mammuthus		Pleistocene	Quaternary	V99830	Fresno County

Appendix B
Draft Curation Agreement

Date: December 5, 2016
Re: Curation and Storage of fossils/specimens from excavation at Hazel Avenue and Highway 50

To Whom It May Concern;

Fossils and/or specimens obtained by a third party through mitigation contract activities being performed in accordance with the California Environmental Quality Act (CEQA) for the County of Sacramento and the California Department of Transportation (Caltrans), may be accepted the Center for Sacramento History (CSH) only upon prior approval in writing by the CSH Director. Upon approval, and meeting the following requirements: minimum standards for specimen preparation and associated data; payment of accession fee; payment for curatorial supplies such as, but not limited to, trays, vials, foam, boxes and museum quality cabinets and drawers as required, shall CSH care for and house the items following standard museum protocols.

Minimum Standards:

1.) All specimens must be cleaned, labeled, and cataloged, before they are transferred.
2.) The collection must be in standard museum quality, acid-free boxes which will be packed and labeled in accordance with CSH standards.
3.) An inventory must be prepared for each box and a copy must be included inside each box.
4.) A copy of the final report, accompanied documentation including: artifact catalog, a complete set of GPS data, copies of field notes and grid maps, photographs, locality forms and stratigraphic sections, a list of individuals who participated in the project, notes on mending or cleaning of artifacts with processes and chemicals used are identified, artifact analysis reports, box inventory lists and a list of identified specimens must accompany the collections. These documents will be deposited in the Museum archives concurrent with the acceptance of the collection.
5.) All computer generated data bases and material shall be stored on CDs. All data base software shall be Microsoft Access and all word processing software shall be Microsoft Word. All CDs will be marked with the version of the software used and the subject matter.

The County shall not transfer, and the City and CSH will not accept any artifacts that are “Cultural Items” as defined in the Native American Graves Protection and Repatriation Act, (“NAGPRA”), artifacts requiring special handling, or material or artifacts that have been treated with pesticides or other potentially dangerous chemicals.

CSH curation conditions will be in conformance with the Society of Vertebrate Paleontology (SVP) standards, as documented in SVP’s 2010 *Standard Procedures for the Assessment and Mitigation of Adverse Impacts to Paleontological Resources*.

CSH will make the collections and data available to land managers, government officials, and qualified researchers upon request.

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A Sacramento City/County Agency

City of Sacramento Representative:

Marcia Eymann
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551 Sequoia Pacific Blvd.
Sacramento, CA 95814-0229
Email: meymann@cityofsacramento.org
Office: (916) 808-5960

Marcia Eymann: *Marcia Eymann* Date: December 5, 2016

Appendix C
Resumes for Principal Paleontologist, Monitors, and Key Staff

To be provided during Plans, Specifications. & Estimates (PS&E) phase, as applicable.

Appendix D
Cost Estimate

To be provided during Plans, Specifications. & Estimates (PS&E) phase, as applicable.

PHASE I INITIAL SITE ASSESSMENT

HAZEL AVENUE/U.S. 50 INTERCHANGE PROJECT
CITY OF RANCHO CORDOVA, SACRAMENTO COUNTY
03-SAC-50/PM 15.1-17.5
FEDERAL PROJECT NO.: EA 03-3E380/E-FIS 0300020439

COUNTY CONTROL NUMBER 2011-70062

For

ICF INTERNATIONAL
630 K Street, Sacramento, CA 95818

PARIKH CONSULTANTS, INC.

2360 Qume Drive, San
Jose, CA. 95131

October 25, 2017 Job No. 2011-135-ICF

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PHASE I INITIAL SITE ASSESSMENT
HAZEL AVENUE/U.S. 50 INTERCHANGE PROJECT
CITY OF RANCHO CORDOVA, SACRAMENTO COUNTY, CALIFORNIA

SUMMARY OF CONCLUSIONS

This Phase I Initial Site Assessment (ISA) was performed by PARIKH Consultants, Inc. to evaluate whether potential sources or indications of hazardous substance contamination are present in the proposed right-of-way for the Hazel Avenue/U.S. Route 50 (U.S. 50) Interchange Project in the City of Rancho Cordova and unincorporated Sacramento County, California. The proposed project involves three build alternatives for improvement of the Hazel Avenue Interchange with U.S. 50 and crossing with Folsom Blvd and grade separation of Hazel Avenue south of Folsom Blvd.

Hazel Avenue will be extended further south to a proposed intersection with the future Atlanta Street (a new roadway that will be constructed as part of the Easton Place Development). The project also includes:

- Construction of a portion of an eastbound transition auxiliary lane on Highway 50 from Hazel Avenue through the Folsom Boulevard Overcrossing, also known as the Natoma Overhead
- The modification of the existing Aerojet Road off-ramp from U.S. 50
- Reconstruction of the westbound loop on-ramp
- Reconstruction of the eastbound diagonal off-ramp, and both eastbound on-ramps
- Eastbound on- and off-ramp auxiliary lanes, from west of Hazel Avenue to the eastbound off-ramp, and from the loop on-ramp extending to the Folsom Boulevard Interchange
- Roadway improvements constructed along approximately 2,300 feet of Folsom Boulevard. Improvements include sidewalks, street lighting, and landscaping along the north side of Folsom Boulevard, and landscaping and lighting along the south.

The study included a field inspection of the project area, and a review of listings of Federal and State regulatory agencies that are responsible for recording incidents of spills, and soil and ground water contamination and transfer, store, or disposal facilities that handle hazardous materials.

Previous land uses at the project area were primarily limited to agricultural, commercial and industrial uses.

A site reconnaissance of the project area was conducted to identify nearby sites or land uses that might adversely affect the corridor due to environmental hazards.

1. A review of previous land use and the site reconnaissance indicates that the nearby roadways have supported vehicular activity since the new interchange was built in the 1960s. It is highly likely that the surface soils along these roadways are affected by deposition of aerial lead. Therefore it is recommended that surface samples of soil be collected and analyzed for total lead. The pavement markings consist of yellow paint and possibly thermoplastic stripes that contain lead. These will have to be addressed for disposal.

2. The project would involve acquisition of the Lakha Properties at the northeast intersection of Folsom Blvd and Hazel Avenue. The Lakha Properties contain several old buildings including a restaurant and the eastern end near the ROW. Due to the age of these buildings, they should be tested for asbestos containing materials (ACM) and lead based paint (LBP) prior to purchase. In the event the project involves renovation or demolition of the bridge structure, it would have to be surveyed for ACM and LBP prior to start of work. An ACM investigation should be performed by an inspector certified by Asbestos Hazardous Emergency Response Act (AHERA) under Toxic Substance Control Act (TSCA) Title II and certified by Cal OSHA under State of California rules and regulations (California Code of Regulations, Section 1529). This work should be performed during the design phase.

3. Active railroad tracks are present to the south of Folsom Blvd. south of the intersection of Hazel Avenue with Folsom Blvd. Historical USGS maps and aerial photos have shown the tracks to be present since early 20th century. The soil within the railroad right-of-way may be impacted with heavy metals, total petroleum hydrocarbons as diesel, and polynuclear aromatic hydrocarbons (PNAs). In that regards, soil samples should be collected within the railroad right-of-way and the project area, and analyzed for the above constituents.

4. Review of Geotracker files indicate that a 30,000 gallon heating oil underground storage tank (UST) was removed from the Lakha Properties under the project name of Nimbus Winery at 12401 Folsom Blvd. The UST was removed in 2000 and the site was issued closure letter in 2009. Reviews of reports indicate that the residual soil and groundwater impacts were left behind. Groundwater was impacted with TPH G and volatile organic compounds below the action levels designated by the Regional Water Quality Control Board (RWQCB). Soil was impacted with total petroleum hydrocarbons as diesel, and motor oil at levels as high as 15,000 ppm at 25 feet. In the event project involves excavations in this area or installation of foundations (piles) in this area, soils and groundwater should be tested and a risk management plan should be developed describing management of contaminated soils encountered during construction.

5. Folsom Street Chevron is located on the northwest corner of Folsom Blvd and Hazel Avenue. This service station would be acquired as portion of the right of way. There are no groundwater monitoring reports available for the property. There are USTs on this facility that need to be removed as part of the closure. There is potential of leaks associated with the USTs or the fuel dispenser areas. These areas should be investigated prior to acquisition of the property.

6. Groundwater within the project area is impacted with chlorinated solvents as a result of historical operations at the Aerojet Facility. If construction requires drilled piles they could be 50-80 feet below surface and will encounter groundwater. Due to the known contamination, drilling should be performed by OSHA (CFR 1910.120) trained personnel

with appropriate license. Soil cuttings shall be characterized for possible presence of chlorinated solvents and disposed of appropriately. The extracted groundwater, generated due to dewatering of the piles should be stored in tanks and characterized for chlorinated solvents, and either sent offsite for recycling or directed to the existing groundwater treatment system at the Aerojet Facilities for treatment.

Other than noted above during the project area site reconnaissance, environmental areas of concern were not readily identified or apparent based on the scope of work performed in this project.

This conclusion, and any and all conclusions, recommendations and information included in this report are based upon the information that was readily available to PARIKH Consultants, Inc. at the time of the site visit, and on PARIKH Consultants, Inc.'s professional judgment and reviews using accepted environmental site assessment practices pursuant to the scope of work.

1.0 INTRODUCTION

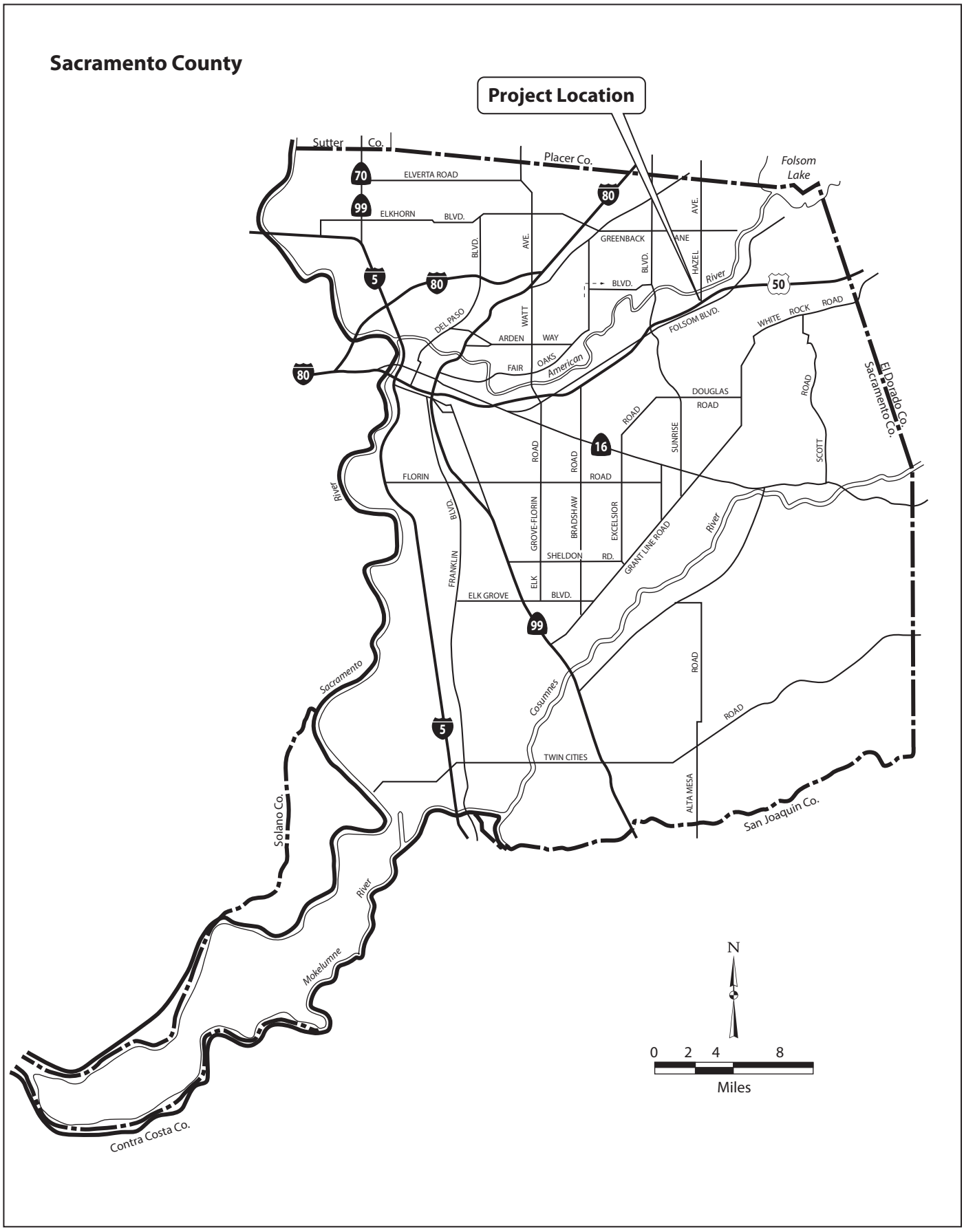
This Phase I Initial Site Assessment (ISA) was performed to identify potential environmental impacts to the Hazel Avenue/U.S. 50 Interchange Project in the City of Rancho Cordova and unincorporated Sacramento County, California. The project vicinity map, project location map and the three build alternatives that are being considered for the project are provided in Figures 1-5. The permanent and temporary project impacts are depicted in Figures 6A and 6B.

The County of Sacramento, in cooperation with Caltrans and the City of Rancho Cordova, proposes to modify the existing U.S. 50/Hazel Avenue interchange, and extend and grade-separate Hazel Avenue over Folsom Boulevard and the Sacramento Placerville Transportation Corridor Joint Powers Authority (SPTC-JPA) rail corridor. Hazel Avenue will be extended further south to a proposed intersection with the future Atlanta Street (a new roadway that will be constructed as part of the Easton Place Development). The project also includes:

- Construction of a portion of an eastbound transition auxiliary lane on Highway 50 from Hazel Avenue through the Folsom Boulevard Overcrossing, also known as the Natoma Overhead
- The modification of the existing Aerojet Road off-ramp from U.S. 50
- Reconstruction of the westbound loop on-ramp
- Reconstruction of the eastbound diagonal off-ramp, and both eastbound on-ramps
- Eastbound on- and off-ramp auxiliary lanes, from west of the Hazel Avenue to the eastbound off-ramp, and from the loop on-ramp extending to the Folsom Boulevard interchange
- Roadway improvements constructed along approximately 2,300 feet of Folsom Boulevard. Improvements include sidewalks, street lighting, and landscaping along the north side of Folsom Boulevard, and landscaping and lighting along the south.

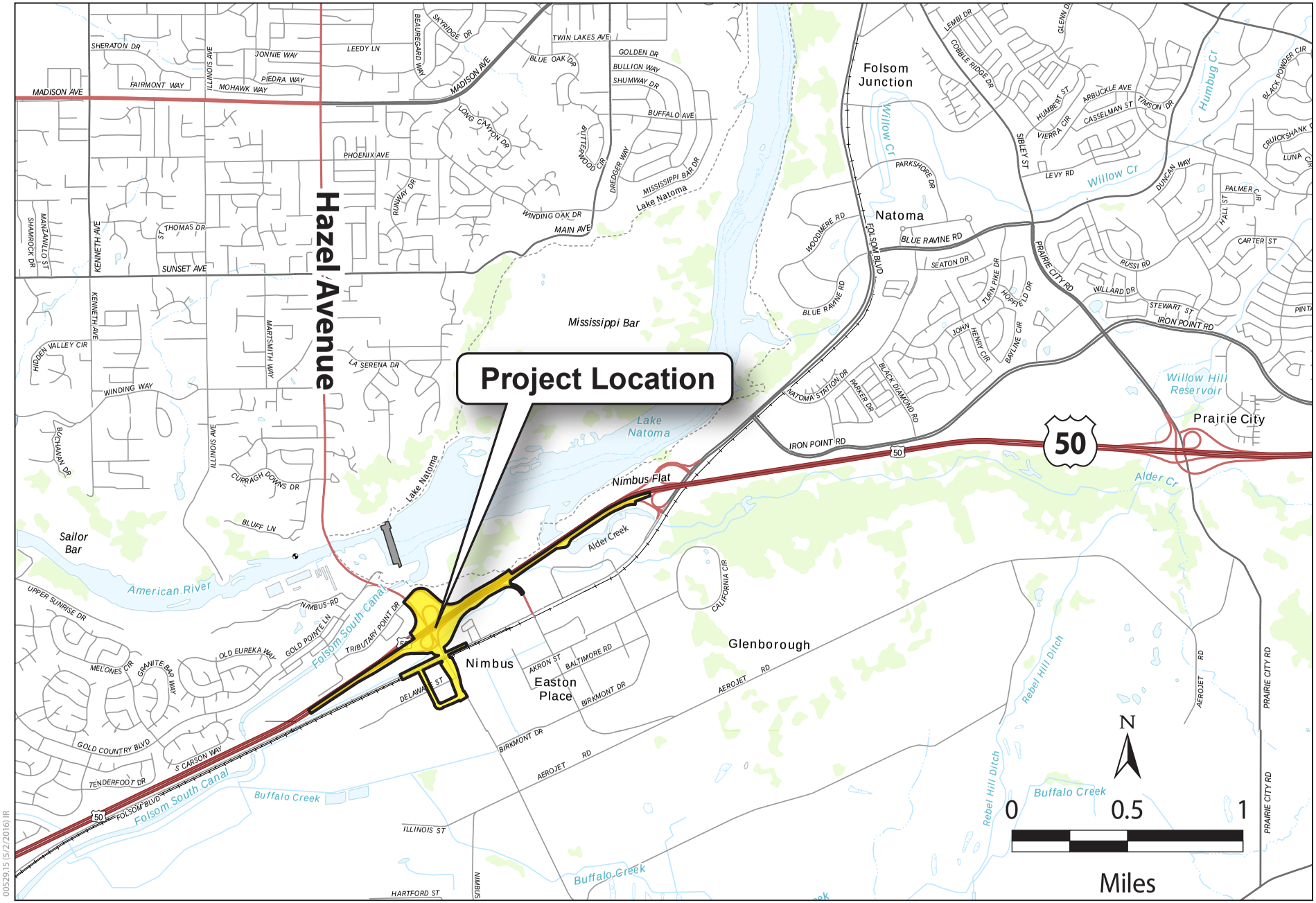
The project is located in the County of Sacramento at the interchange of Hazel Avenue and U.S. 50. The project area is bounded along Hazel Avenue by the Tributary Point/westbound off-ramp intersection to the north, and extends approximately 1000’ south of Folsom Boulevard to a future intersection within the proposed Easton Place development. The project limits along U.S. 50 begin approximately 3200’ west of the existing Hazel Avenue Overcrossing, and extend 2500’ east of the Natoma Overhead. Improvements along Folsom Boulevard will extend from approximately 1200’ west of the Hazel Avenue intersection to 900’ to the east.

The purpose of this investigation was to identify and evaluate potential hazardous waste sites and update the evaluation of environmental factors that may have affected the soil and groundwater quality in the project vicinity due to past and present environmental and commercial activities. This report was prepared by PARIKH Consultants, Inc.



00529.15 (05/02/2016) IR

Figure 1
Project Vicinity



00529.15 (5/2/2016) IR

Figure 2
Project Location



Figure 3
Alternative 1: L-9 Interchange with Viaduct Connector
U.S. 50/Hazel Avenue Interchange Project



Figure 4
Alternative 1a: L-9 Interchange with Undercrossing Connector
U.S. 50/Hazel Avenue Interchange Project

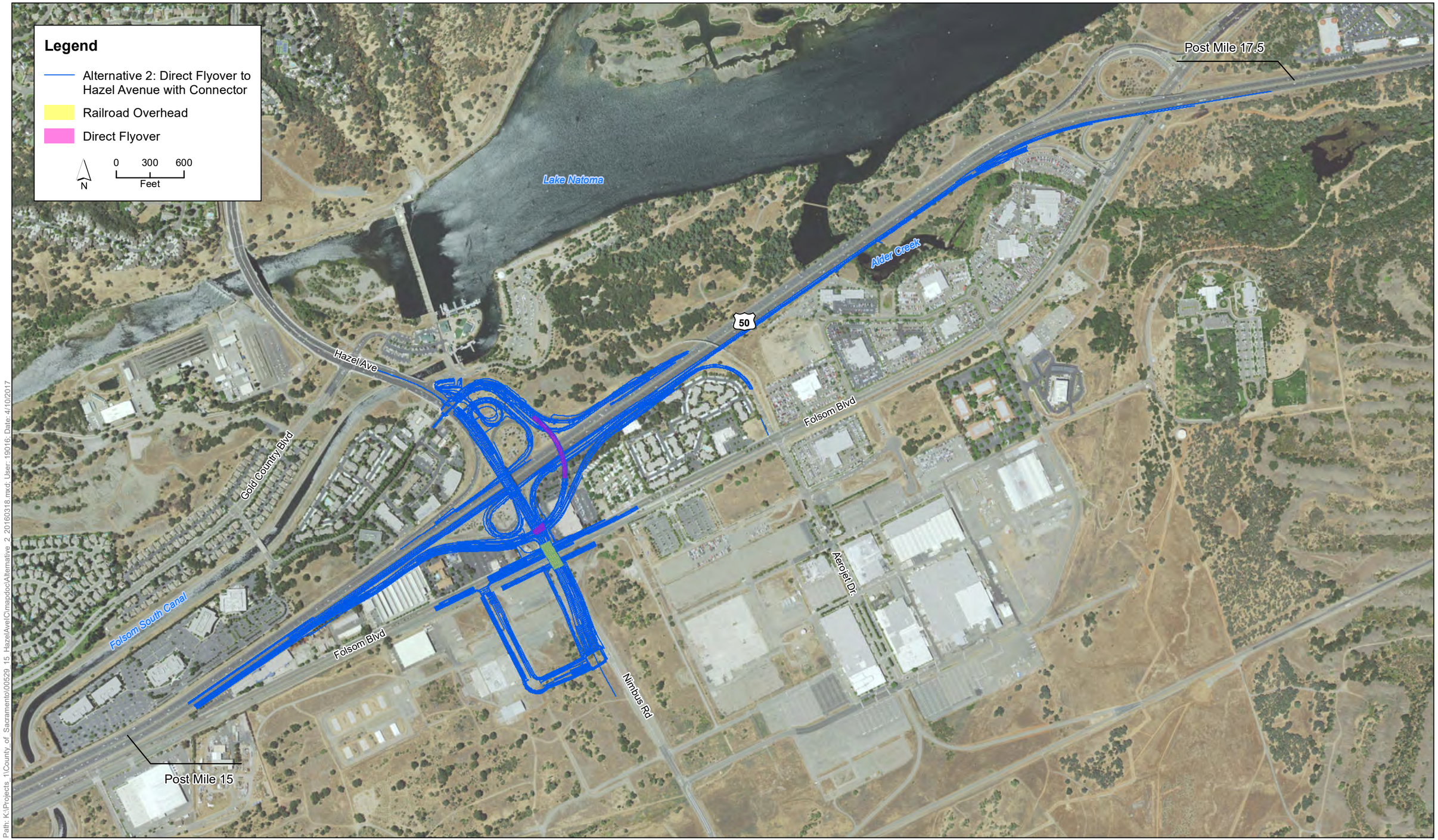


Figure 5
Alternative 2: Direct Flyover to Hazel Avenue with Connector
U.S. 50/Hazel Avenue Interchange Project

The ISA studies were performed between March 20 and April 28, 2016 and included the following scope of work:

- Site visit and visual inspection of exterior of the project vicinity
- Review of Previous Environmental Reports in the project vicinity
- Review of computer database government record search of hazardous waste sites within 1-mile of the project
- Review of area hydrogeology
- Review of available agency records for the project vicinity
- Preparation of a written report summarizing the results.

The following sections present the details and findings of the Phase I Initial Site Assessment:

- Section 2.0 - Project Description and Historic Information
- Section 3.0 - Physical Site Inspection
- Section 4.0 - Regulatory Review
- Section 5.0 - Conclusions and Recommendations
- Section 6.0 - Limitations

2.0 PROJECT DESCRIPTION AND HISTORIC INFORMATION

2.1 PROJECT DESCRIPTION

Project Need and Purpose

The Hazel Avenue/U.S. 50 Interchange Improvement Project is needed to relieve existing congestion at the interchange and to accommodate planned and approved developments identified by the adopted Sacramento County General Plan and the Sacramento Area Council of Government's (SACOG) Regional Transportation Plan.

The approved developments within and near the project area will increase traffic demand beyond what the existing interchange can accommodate. The close intersection spacing between the Folsom Boulevard and eastbound ramp intersections does not provide sufficient queuing for increased traffic volumes. Additionally, the County of Sacramento is currently widening Hazel Avenue from the interchange to Madison Avenue from four to six traffic lanes. This increase in roadway capacity is expected to deliver more traffic to the interchange during peak traffic periods.

Traffic demand forecasts for this project were conducted using the SACOG 2035 Metropolitan Transportation Plan (MTP) projected to 2038 (20 years after anticipated opening day) and

supplemented by anticipated levels of additional development currently in application or advanced planning stages. Based on these projections, it is anticipated the existing interchange will degrade to Level of Service (LOS) "F".

The primary purpose of the project is to modify the existing U.S. 50/Hazel Avenue Interchange to reduce congestion, improve traffic operations, accommodate travel demand due to planned and approved developments, and improve safety of all modes of travel including bicycles and pedestrians.

The following objectives will be met by the proposed alternatives:

- Improve operations by removing the close intersection spacing between the eastbound ramps and Folsom Boulevard, and minimizing conflict with heavy and light rail.
    - Proposed alternatives accomplish this by grade-separating Hazel Avenue over Folsom Boulevard.
- Provide sufficient capacity in the ramps and roadways for future traffic volumes.
    - Proposed alternatives accomplish this by widening and/or lengthening the on/off-ramps and Hazel Avenue as required by their respective traffic analysis.
- Maintain the Aerojet Road off-ramp connection to the approved development while improving the mainline operations.
    - Proposed alternatives accomplish this by removing the Aerojet Road exit from U.S. 50 but still providing direct access to Aerojet Road through the eastbound Hazel Avenue off-ramp.

Proposed Project

The proposed project would construct modifications to the existing interchange, and grade-separate and extend Hazel Avenue to the south to a future intersection with Atlanta Street, which will be built with the approved Easton Place development. Two alternatives, with one sub-alternative, have been developed for the project.

The following is a description of elements and design components that are common to all alternatives:

Roadway Modifications

- Construction of a portion of an eastbound transition auxiliary lane on Highway 50 from Hazel Avenue through the Folsom Boulevard Overcrossing, also known as the Natoma Overhead.
- The modification of the existing Aerojet Road off-ramp from U.S. 50.

- The westbound loop on-ramp will be reconstructed, with the ramp intersection shifted north towards the westbound off-ramp terminus, increasing storage lengths. The ramp will be metered with two lanes (one mixed use, and one HOV bypass), and a squared-up "pedestrian friendly entrance".
- Reconstruction of the eastbound diagonal off-ramp to conform to the new Hazel Avenue profile and accommodate the Aerojet Road ramp divergence.
- The eastbound diagonal on-ramp will be reconstructed to conform to the new Hazel Avenue profile, and will be metered with two lanes; one mixed flow, and one HOV bypass.
- The eastbound loop on-ramp will be reconstructed to conform to the new Hazel Avenue profile, and will be metered with two lanes; one mixed flow, and one HOV bypass. A tie-back wall at the abutment of the overcrossing is proposed to maximize the opening through the structure. The loop ramp will develop an additional lane on U.S. 50 that will continue on to the Folsom Boulevard interchange.
- Construction of eastbound on- and off-ramp auxiliary lanes on U.S. 50, from west of the Hazel Avenue to the eastbound off-ramp, and from the loop on-ramp extending to the Folsom Boulevard interchange.
- Traffic signals at the ramp intersections will be modified. Safety lighting will be installed. A new signalized intersection and at-grade railroad crossing will be constructed for the Jughandle.
- Pedestrian access will be maintained on the east side of Hazel Avenue with 6-foot sidewalks (however the existing sidewalk on the overcrossing will remain 5 feet wide). Bicyclists may utilize the County standard 7-foot shoulders. It is expected that pedestrians and bicyclists will continue to use the nearby Bikeway and Pedestrian Overcrossing as the primary means for crossing U.S. 50.
- Roadway improvements constructed along approximately 2,300 feet of Folsom Boulevard. Improvements include the removal of the existing signalized intersection with Hazel Avenue, and installation of sidewalks, street lighting, and landscaping along the north side of Folsom Boulevard, and landscaping and lighting along the south.

Transition Lane to U.S. 50/Folsom Boulevard Interchange

As indicated in Caltrans' 2009 Corridor System Management Plan, eastbound U.S. 50 is shown to have 1 HOV lane and 3 mixed flow lanes to Hazel Avenue as the Concept Facility. Also, eastbound U.S. 50 is shown to have 1 HOV lane and 3 mixed flow lanes across Folsom Boulevard as the Ultimate Facility. This project will accommodate these future facility improvements, will conform to the approved Caltrans project at U.S. 50/Folsom Boulevard interchange that is constructing a portion of those improvements in 2016, and will then restripe the third mixed flow lane through the U.S. 50/Folsom Boulevard interchange.

This project is required to add the mixed flow lane because it has been determined in the traffic analysis for this project, and in studies for adjacent projects, that the additional eastbound lane on U.S. 50 extending through the Folsom Boulevard interchange is needed for operations.

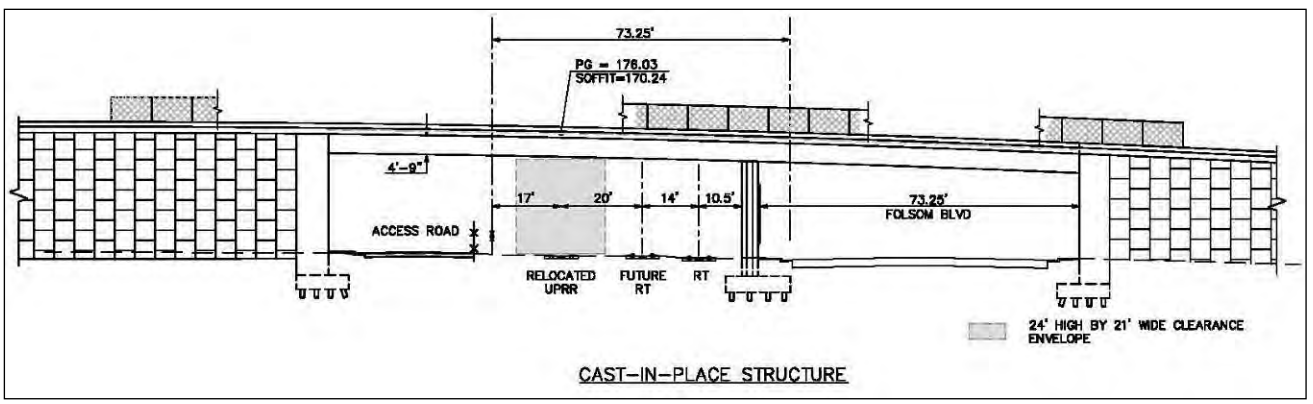
Under all alternatives, accommodating this mixed flow lane will require the eastbound loop on-ramp to extend its auxiliary lane to the U.S. 50/Folsom Boulevard eastbound off-ramp. This will require widening and a new structure over Alder Creek.

Currently Alder Creek flows under U.S. 50 through a box culvert (Br. No. 24-0033). A Mechanically Stabilized Earth (MSE) wall (Br. No. 24-0372) is above the culvert. To widen U.S. 50 over Alder Creek, a new bridge will be required. The new bridge is necessary because there is insufficient lateral space to construct an adjacent MSE wall on top of the culvert and the creek maintains a high operating water level.

Railroad Overhead

Hazel Avenue will extend and be grade-separated over Folsom Boulevard and the SPTC-JPA rail corridor. Currently there is one light rail track located on the north side of the UPRR tracks. Sacramento Regional Transit plans to add another track at this location in the future. When the addition of that track occurs, the existing UPRR track will be relocated south to accommodate the second light rail track. The proposed design meets the requirements for all three tracks, with the clearances shown in the figure below.

Temporary vertical clearances of 21'-6" and permanent vertical clearances of 24'-0" have been accounted for in the layout of all three alternatives for the Hazel Avenue Overhead. The vertical clearance provided will accommodate the Overhead Catenary System for the light rail.



Alternative 1: L-9 Interchange with Viaduct Connector

Alternative 1 consists of a modified Type L-9 interchange configuration. A Caltrans Type L-9

interchange indicates a ramp configuration that includes a diagonal off-ramp, a diagonal on-ramp and a loop on-ramp. This alternative will provide a viaduct connection to Aerojet Road.

As with all alternatives, Hazel Avenue will grade-separate over Folsom Boulevard and the SPTC-JPA rail corridor and will extend further south to a proposed intersection with the future Atlanta Street (a new roadway as part of the Easton Place development). The existing at-grade intersection of Hazel Avenue and Folsom Boulevard will be removed, sidewalks will be extended across the former intersection, and the lanes will be re-striped to remove left turn lanes. The location of the departure point of the existing Aerojet Road off-ramp from U.S. 50 will be moved to join with the eastbound Hazel Avenue off-ramp. The eastbound Hazel Avenue off-ramp will split and introduce a direct viaduct ramp over Hazel Avenue to carry eastbound off-ramp traffic to Aerojet Road and Folsom Boulevard. The off-ramp diverge from U.S. 50 will be shifted approximately 830 feet to the east to provide decision sight distance before the Aerojet Road split. The two-lane off-ramp will widen to five lanes at the ramp terminal intersection, with three left turn lanes and two right turn lanes. Retaining walls and barriers placed at the proposed right-of-way will minimize acquisition. The eastbound off-ramp will also have an auxiliary lane prior to the exit.

The Aerojet Road viaduct will land adjacent to the eastbound diagonal on-ramp and then turn southerly to conform to Folsom Boulevard along its existing alignment. Retaining walls are proposed between the viaduct and the diagonal on-ramp to accommodate the grade difference and to the outside of the ramp after the viaduct lands, to minimize right-of-way acquisitions. Retaining walls are also proposed along Aerojet Road as it approaches the horizontal curve towards Folsom Boulevard to accommodate the grade difference between the ramp and mainline and to minimize right-of-way acquisition.

The existing Hazel Avenue Overcrossing of U.S. 50 will be widened on the west side to accommodate eight lanes (3 through lanes and 1 freeway-only lane in both directions). The existing raised concrete median across the structure will be removed, and the roadway will be re-striped with a 6-foot striped median. The existing sidewalk and barrier on the east side of the structure will remain.

Alternative 1A: L-9 Interchange with Undercrossing Connector

Alternative 1A is the same as Alternative 1, with the following exceptions:

The eastbound off-ramp will split and introduce a direct tunnel ramp under Hazel Avenue to carry eastbound off-ramp traffic to Aerojet Road and Folsom Boulevard.

Alternative 2: Direct Flyover to Hazel Avenue With Connector

Alternative 2 consists of a modified type L-9 interchange configuration, with a flyover ramp carrying vehicles travelling from eastbound U.S. 50 to northbound Hazel Avenue over the freeway to join with the westbound off-ramp.

The existing Aerojet Road off-ramp from U.S. 50 will be removed.

The eastbound off-ramp diverge from U.S. 50 will be shifted approximately 680 feet to the east to provide decision sight distance. An auxiliary lane will precede the off-ramp. A retaining wall is proposed adjacent to the off-ramp to minimize right-of-way acquisition.

The eastbound off-ramp will split and introduce northbound and southbound Hazel Avenue ramps. The northbound ramp will also carry traffic headed for Aerojet Road/Folsom Boulevard. An overhead sign will direct vehicles heading to southbound Hazel Avenue to the right lane, and vehicles destined for northbound Hazel Avenue or Aerojet Road or Folsom Boulevard to use either lane. Retaining walls are proposed for the ramp as it approaches the horizontal curve towards Folsom Boulevard to accommodate the grade difference between the ramp and mainline and to minimize right-of-way acquisition at an apartment complex.

The northbound Hazel Avenue movement will cross under Hazel Avenue at the interchange, cross over U.S. 50 on a two-lane flyover structure, and then merge with the westbound off-ramp and terminate at the Hazel Avenue/Tributary Point intersection. The westbound off-ramp will split so that the southbound and through movements align to the left of the ramp, and the northbound movements are to the right.

The southbound ramp will connect directly to Hazel Avenue. However, in Alternative 2 an intersection is not required at Hazel Avenue and the eastbound ramp. By eliminating an intersection at the eastbound ramp, and by removing the heavy eastbound-to-northbound movements from the Hazel Avenue overcrossing, the existing structure can remain without widening.

The two-lane westbound off-ramp will be reconstructed to provide decision sight distance between the divergence point from U.S. 50 and a new ramp split that accommodates the flyover. The westbound off-ramp will split on either side of the flyover ramp, with one lane to the right carrying northbound Hazel Avenue traffic and the other crossing underneath the flyover ramp to join up on the left side of the flyover for the southbound Hazel Avenue movements. The profiles of the three ramps have been coordinated to match grade quickly to minimize retaining wall limits and enhance driver visibility. Overhead signage will direct drivers into the appropriate lanes for northbound and southbound Hazel Avenue traffic.

Right of Way and Utilities

For Alternative 1, right of way is anticipated from parcels in the southwest quadrant of the interchange. It is anticipated that 12 parcels will be affected by the improvements, including full acquisition and demolition of structures at the Chevron gas station (APN 069-0160-012) and Cattleman's restaurant (APN 069-0060-085). The viaduct structure is proposed to cross over the northern portion of the Nimbus Winery parking lot (APN 069-0050-013) on an aerial easement, to allow parking below the structure and minimize impacts to the business.

The right-of-way take at the Nimbus Winery property (APN 069-0050-013) will be larger in Alternative 1A, as acquisition is required as opposed to an aerial easement.

For Alternative 2, right of way is anticipated from parcels in the southwest quadrant of the interchange. It is anticipated that 13 parcels will be affected by the improvements, including full acquisition and demolition of structures at the Chevron gas station (APN 069-0160-012), Cattleman's restaurant (APN 069-0060-085) and the Nimbus Winery property (APN 069-0050-013).

These acquisition needs described above are preliminary and would be finalized during the right of way process and Final Design of the project.

For all alternatives, the project will require the relocation of utilities, and it is anticipated that this will include: gas lines, overhead electric lines, underground electric lines, fiber optic cables, water lines, sewer lines, and storm drain lines. The potential for impacts to other unknown utilities also exists.

2.2 HISTORICAL AERIAL PHOTOGRAPH REVIEW

To examine the historical use of the area, a review of aerial photographs, obtained through Environmental Data Resources, Inc., from 1937, 1952, 1961, 1971, 1981, 1993, 1998, 2005 and 2006 was performed. Aerial photographs are enclosed in Appendix A. A summary description of the photographs reviewed is presented below.

The 1937 photo shows presence of Folsom Blvd and buildings in the current location of the shopping center at the northeast corner of Folsom Blvd and Hazel Avenue. Mounds of dredge cuttings are visible in the aerial photographs to the north and northwest of Folsom Blvd. Hazel Avenue and U.S. 50 are not present. Land use north of Folsom Blvd east of Hazel Avenue is agricultural, while rest of the area is unused land. The 1952 photo shows presence of U.S. 50 and buildings on south west corner of Folsom Blvd and Hazel Avenue, however Hazel Avenue itself is not present. The 1961 photo shows the current outline of the Hazel Avenue interchange. A few buildings are present in the southwest corner of the intersection of Folsom Blvd and Hazel

Avenue, in addition to the buildings observed in the earlier photographs. Also, Aerojet facilities to the south east of the Hazel Avenue Folsom Blvd interchange are visible. The 1971 through 2006 aerial photos show gradual development of the project area with following observations.

The 1971 aerial photo shows addition of a mobile home park north of the shopping center on Folsom Blvd. 1981 and 1993 photos show expansion of the commercial properties on the west side of Folsom Blvd south of Hazel Avenue intersection between Folsom Blvd and Route 50. The 2005 and 2006 aerial photos show development of residential properties between Folsom Blvd and U.S. 50 east of the mobile home park, and development of commercial properties north west of the Hazel Avenue Interchange with U.S. 50.

The 2005 aerial photo shows a vacant lot at the northwest corner of Hazel Avenue and Folsom Blvd, where the Chevron service station is located. The 2006 aerial photo shows presence of the service station.

2.3 HISTORICAL USGS MAP REVIEW

USGS maps from 1893 (SACRAMENTO) 1944, 1967, 1975, 1980 (FOLSOM) and 1916, 1967 and 1975 (BUFFALO CREEK) obtained through Environmental Data Resources, Inc., were reviewed. These USGS maps are included in Appendix B. Elevation of the site is at approximately 140 feet above mean sea level and site slopes towards north/northwest. The American River is present to the north while Southern Pacific Railroad line is visible along the southern side of Folsom Blvd. Areas north and northwest of Folsom Blvd are shown to be covered with dredge tailings in the USGS maps. The tailings are from dredging of the American River. Nimbus Dam on the American River is visible in the 1967 USGS map. A road extending from Nimbus Dam to the south is named Nimbus Road and crosses Folsom Blvd in the current location of Hazel Avenue and traverses to the south. The road is later changed to Hazel Avenue. In the 1980 USGS map, the areas west of Hazel Avenue and north of Folsom Blvd are shown as repositories for the dredge tailings from the American River.

2.4 HISTORICAL SANBORN MAP REVIEW

Historical Sanborn maps were not available for the project area as outlined in Appendix C.

3.0 PHYSICAL SITE INSPECTION

Observations made during the site inspection walk/drive-through of the project vicinity are described in the following paragraphs. The site inspection was performed on Saturday April 9, 2016.

3.1 SITE VISIT

The site visit consisted of walk/drive-through of the area of study and observation of problem sites or visual contamination.

Intersection of Hazel Avenue and Folsom Blvd is bordered to the northwest by a Chevron service station at 12399 Folsom Blvd. Groundwater monitoring wells, or remediation systems which are evidence of potential environmental impacts were not observed on this property or adjacent lots. This property is within the right of way. Even though groundwater monitoring wells were not observed, impacts from accidental spills are likely in the dispenser areas. Also as part of the purchase of the ROW, the USTs are to be removed and closed. Residual contamination is often encountered during UST closure activities and should be accounted for. Further west is a Sacramento Fire District building, and a restaurant "Rudy's Lobster House & Bar" followed by a Comfort Inn Motel, several materials storage facilities and commercial buildings. These properties were bordered to the north by Route 50 or the Hazel Avenue off- ramp.

To the northeast of the intersection of Hazel Avenue and Folsom Blvd is the Nimbus Village Shopping Center containing a number of restaurants and retail shops. Further to the east are a mobile home park and a single family residential complex. North of the mobile home park immediately south of Route 50 is Cattlemen's Restaurant. The restaurant is accessed through a driveway from the Nimbus Village.

South side of the interchange is occupied by Aerojet facility. Hazel Avenue turns into Nimbus Avenue as it enters the Aerojet facility. To the southeast a groundwater treatment system is visible while to the southwest are several warehouses. Railroad tracks travel parallel and to the south side of Folsom Blvd.

North of Route 50, Hazel Avenue intersects Tributary Point Drive. Another Chevron service station is located on the northwest side of Tributary Point Drive intersection with Hazel Avenue. To the south across the street is an AM/PM Mini Mart and a service station followed by several commercial establishments such as restaurants and retail establishments. Groundwater monitoring wells or remediation systems which are evidence of potential environmental impacts were not observed on either of the properties or the adjacent lots or streets.

3.2 AERIAL LEAD DEPOSITION

The Hazel Avenue and Folsom Blvd. right-of-way areas have been a traffic bearing road since 1960s. It is likely that the surface soils along these roads are impacted with lead as a result of past operations. It is highly likely that the surface soils along the project area are impacted with aerially deposited lead (ADL) and should be investigated. A workplan for investigation of surface soils along the proposed right-of-way should be prepared to determine which of the surface soils may have been impacted with hazardous levels of ADL.

3.3 ASBESTOS CONTAINING MATERIALS AND LEAD BASED PAINT

Cattlemen's Restaurant and the buildings on the northeast corner of the Folsom Blvd and Hazel Avenue are registered as the Lakha Properties. Due to their age, these are the only buildings likely to be included within the proposed right-of-way that may contain asbestos containing materials (ACM) and lead based paint (LBP). The building at the Chevron service station was built in 2005-2006 time frame and is relatively new.

The structures could contain asbestos-containing materials (ACM) and lead-based paint (LBP) in their construction materials. These structures should be surveyed for ACM and LBP prior to demolition or renovation. An asbestos survey of the bridge should be conducted by a Cal-OSHA certified asbestos inspector. The ACM survey should include sampling and testing of the concrete to meet the California Air Resources Control Board requirements.

Lead based paint and ACM should be abated by using contractors certified to perform such work, and in accordance with State and Federal regulations.

3.4 IMPACTS FROM RAILROAD OPERATIONS

The site visit showed presence of UPRR railroad tracks and Sacramento Regional Transit tracks formerly occupied by Southern Pacific and Sacramento Placerville Railroad. Soils adjacent to railroad tracks have typically been impacted with heavy metals, TPH as diesel, fuel oil, and PCBs. Soils along railroad tracks may be impacted from locomotives (TPH as diesel, i.e. TPH- D), railroad ties (polynuclear aromatics) or slag ballast used to set the ties (heavy metals). It is therefore recommended that the surface soils in the areas adjacent to the former tracks be sampled and analyzed for TPH-D, heavy metals, and polynuclear aromatic hydrocarbons. A workplan should be prepared and sampling and analytical program should be developed prior to initiation of the work.

3.5 IMPACTS DUE TO DEMOLITION OF SERVICE STATION

Both alternatives involve removal of the Chevron service station at the northwest corner of Hazel Avenue and Folsom Blvd. Removal of the service station will involve removal of the underground storage tanks and possible contamination associated with the surface soils and the USTs. Even though the station is relatively new and the tanks were constructed according to the new EPA guidelines, there is potential for discovery of soil and groundwater contamination at the site due to usual vehicular usage. It is recommended that soil and groundwater in the service station area be tested for gasoline and diesel fuel constituents to assess potential impacts to the U.S. 50 and Hazel Avenue Interchange Project

4.0 REGULATORY REVIEW

4.1 DATABASE AND REGULATORY REVIEWS

A search of environmental regulatory databases was conducted for the project area. The database search was conducted by Environmental Data Resources, Inc. (EDR) to determine whether documentation exists related to environmental incidents at the site or surrounding properties. The databases searched and respective search distances from the site location (project limits) as specified by ASTM guidelines are as follows:

- Federal Databases
    - National Priority List (NPL)
    - Proposed National Priority List (Proposed NPL)
    - Comprehensive Environmental Response Compensation, and Liability Information System (CERCLIS)
    - CERCLIS No Further Remedial Action Planned (CERCLIS – NFRAP)
    - Corrective Action Report (CORRACTS)
    - Resource Conservation and Recovery Information System Treatment, Storage Disposal facility (RCRIS-TSD)
    - Resource Conservation and Recovery Information Systems large quantity generator
    - Resource Conservation and Recovery Information Systems small quantity generator
    - Emergency Response Notification System (ERNS) – Target Property
    - Superfund (CERCLA) Consent Decrees (CONSENT)
    - Records of Decision (ROD)
    - Delisted NPL
    - Facility Index System/Facility Identification Initiative Program Summary Report (FINDS) – Target Property
    - Hazardous Material Reporting System (HMIRS) – Target Property
    - Material Licensing Tracking System (MLTS) – Target Property
    - Mines Master Index file (MINES)
    - Federal Superfund liens (NPL liens) – Target Property
    - PCB Activity Database System (PADS) – Target Property
    - RCRA Administration Action Tracking System
    - Toxic Chemical Release Inventory System (TRIS) – Target Property
    - Toxic Substance Control Act (TSCA) – Target Property
    - Section 7 Tracking System (SSTS) – Target Property
    - FIFRA/TSCA Tracking System (FTTS) – Target Property
- State of California, Regional, and County Databases
    - Annual Work plan Sites (AWP)

- Cal Sites Databases (CAL-SITES)
- California Hazardous Material Incident Report System (CHMIRS)
- "Cortese" Hazardous Waste and Substance Sites List (CORTESE)
- Proposition 65 Records (NOTIFY 65)
- Toxic Pits Cleanup Act Sites (TOXIC PITS)
- State Landfill
- Waste Management Unit Database (WMUDS/SWAT)
- Leaking Underground Storage Tank Information System (LUST)
- Bond Expenditure Plan (CA BOND EXP. PLAN)
- Active UST Facilities (UST)
- Facility Inventory Database (CA FID UST)
- Hazardous Substance Storage Container Database HIST UST)
- Aboveground Petroleum Storage Tank Facilities (AST) – Target Property
- Cleaner Facilities (CLEANERS)
- Waste Discharge System (CA WDS) – Target Property
- List of Deed Restrictions (DEED) – Target Property
- Spills, Leaks, Investigation and Cleanup Cost Recovery Listing (CAL SLIC)
- Hazardous Waste Information System (HAZNET)

The results of the EDR database search and descriptions of the environmental databases are provided in Appendix D. In addition, appropriate databases such as Geotracker related to the California Regional Water Quality Control Board and the Envirostor related to the California Department of Toxic Substances Control, were reviewed. Individual sites on the databases were tracked for whether they were open cases or closed and the data was compared to the findings of the EDR report.

Review of the EDR database and regulatory records indicate that majority of the sites are identified as HAZNET sites. Several LUST and SLIC sites were identified within the vicinity of the project area but they have all been identified as closed with no further action status. The status of these sites was verified by checking the Geotracker and the Envirostor databases.

Review of Geotracker files indicate that a 30,000 gallon (heating oil) underground storage tank (UST) was removed on the Lakha Properties under the project name of Nimbus Winery at 12401 Folsom Blvd. The UST was removed in 2000 and the site was issued closure letter in 2009. Review of site investigation reports (enclosed as Appendix E) indicate that the residual soil and groundwater impacts were left behind. Groundwater was impacted with TPH G and volatile organic compounds below the action levels designated by the RWQCB. Soil was impacted with total petroleum hydrocarbons as diesel, and motor oil at levels as high as 15,000 ppm at 25 feet. In the event project involves excavations in this area or installation of foundations (piles) in this

area, soils and groundwater should be tested and a risk management plan needs to be developed describing management of contaminated soils encountered during construction.

The Geotracker files did not include any files for the Chevron service station.

Aerojet Facility located on the south side of Folsom Blvd is identified on several databases including NPL, CERCUS, RCRA TSDF, and CORRACTS. The site is an 8,500 acre superfund site undergoing cleanup. Based on review of several public notification flyers and the Record of Decision, the site is a former gold mining area that was converted to a manufacturing facility in 1953. Soil and groundwater have been contaminated by past operating and disposal practices from industrial chemical manufacturing, pesticide manufacturing, and testing operations. Although numerous types of chemicals have been used at the Aerojet site, tricholorethene (TCE), tetrachloroethene (PCE), perchlorate and N-nitrosodimethylamine (NDMA) are most commonly encountered in the groundwater. (Appendix E) the site is undergoing groundwater treatment for a variety of chlorinated solvents and the groundwater appears to have impacted the project area.

As a consequence of the historical mining and dredging activities, the Aerojet site has become a significant groundwater recharge zone for the underlying groundwater bearing zones. Six individual layers (A-F) have been defined beneath the Aerojet site with Layer A being the shallowest and Layer F being the deepest. Depth to groundwater for the project area is approximately 15-55 feet for Layer A, and 45-120 feet for Layer B. Based on review the 2015 groundwater contour maps, the groundwater in layers B-F below the Project Area are impacted with TCE and perchlorate. The maps also show some sporadic areas with TCE impacts in Layer A that falls on the south western portion of the intersection of Folsom Blvd. and Hazel Avenue on the Aerojet property. For this project if construction requires drilled piles they could be 50-80 feet below surface (or deeper) and will encounter groundwater. Due to the known contamination, drilling should be performed by OSHA (CFR 1910.120) trained personnel with appropriate license. Soil cuttings shall be characterized for possible presence of chlorinated solvents and disposed of appropriately. Also, groundwater is likely to be extracted as part of the dewatering of the piles. The extracted groundwater is to be stored in tanks, and characterized for chlorinated solvents, and either sent offsite for recycling or directed to the existing groundwater treatment system at the Aerojet facilities for treatment. Portions of the project right of way will be within the Aerojet facility. We recommend additional characterization of the soils within the proposed right of way to address potential impacts from the historical use of the Aerojet Facility.

5.0 CONCLUSIONS AND RECOMMENDATIONS

1. A review of previous land use and the site reconnaissance indicates that the nearby roadways have supported vehicular activity since the 1960s. It is highly likely that the surface soils along these roadways are affected by deposition of aerial lead. Therefore it

is recommended that surface samples of soil be collected and analyzed for total lead. The pavement markings consist of yellow paint and possibly thermoplastic stripes that contain lead. These will have to be addressed for disposal.

2. The project would involve acquisition of the properties, Lakha Properties, at the northeast intersection of Folsom Blvd and Hazel Avenue. The Lakha Properties contain several old buildings including a restaurant and a mini golf facility located at the eastern end near the ROW. Due to the age of these buildings, they should be tested for asbestos containing materials (ACM) and lead based paint (LBP) prior to purchase. In the event the project involves renovation or demolition of the bridge structure, it would have to be surveyed for ACM and LBP prior to start of work. An ACM investigation should be performed by an inspector certified by Asbestos Hazardous Emergency Response Act (AHERA) under Toxic Substance Control Act (TSCA) Title II and certified by Cal OSHA under State of California rules and regulations (California Code of Regulations, Section 1529). This work should be performed during the design phase

3. Active railroad tracks are present to the south of Folsom Blvd. south of the intersection of Hazel Avenue with Folsom Blvd. Historical USGS maps and aerial photos have shown the tracks to be present since early 20th century. The soil within the railroad right-of-way may be impacted with heavy metals, total petroleum hydrocarbons as diesel, and polynuclear aromatic hydrocarbons (PNAs). In that regards, soil samples should be collected within the railroad right-of-way and the project area, and analyzed for the above constituents.

4. Review of Geotracker files indicate that a 30,000 gallon heating oil underground storage tank (UST) was removed on the Lakha Properties under the project name of Nimbus Winery at 12401 Folsom Blvd. The UST was removed in 2000 and the site was issued closure letter in 2009. Review of reports indicates that the residual soil and groundwater impacts were left behind. Groundwater was impacted with TPH G and volatile organic compounds below the action levels designated by the RWQCB. Soil was impacted with total petroleum hydrocarbons as diesel, and motor oil at levels as high as 15,000 ppm at 25 feet. In the event project involves excavations in this area or installation of foundations (piles) in this area, soils and groundwater should be tested and a risk management plan needs to be developed describing management of contaminated soils encountered during construction.

5. Folsom Street Chevron is located on the northwest corner of Folsom Blvd and Hazel Avenue. This services station is to be acquired as portion of the right of way. There are no groundwater monitoring reports available for the property. There are USTs on this facility that need to be removed as part of the closure. There is potential of leaks associated with

the USTs or the fuel dispenser areas. These areas should be investigated prior to acquisition of the property. Prior to acquisition of any contaminated right-of-way, complete characterization of the associated contamination, regulatory indemnification, and formal authorization is required. Accordingly, the project will comply with Project Delivery Directive No. 02, Contaminated Property Acquisition (PD-02). A Hazardous Materials Disclosure Document (HMDD) – Acquisition form will be completed, as required by Caltrans to acquire contaminated right-of-way.

6. Groundwater within the project area is impacted with chlorinated solvents as a result of historical operations at the Aerojet Facility. If construction requires drilled piles they could be 50-80 feet below surface and will encounter groundwater. Due to the known contamination, drilling should be performed by OSHA (CFR 1910.120) trained personnel with appropriate license. Soil cuttings shall be characterized for possible presence of chlorinated solvents and disposed off appropriately. The extracted groundwater, generated due to dewatering of the piles should be stored in tanks and characterized for chlorinated solvents, and either sent offsite for recycling or directed to the existing groundwater treatment system at the Aerojet Facilities for treatment.

7. The project will include right-of-way from the McDonnel Douglas/Aerojet Federal and State Superfund site. The right-of-way within the McDonnel Douglas/Aerojet Federal and State Superfund site would be under County right-of-way.

8. Any structure acquired will require a structural survey to determine if any lead or asbestos are present in the structure(s) and the appropriate working protection, material handling, and material disposal requirements are.

Other than noted above during the site reconnaissance of the project area, environmental areas of concern were not readily identified or apparent based on the scope of work performed in this project. Based on PARIKH Consultants, Inc.'s Phase I Environmental Site Assessment findings, environmental conditions or issues of concerns, other than noted above, were not identified or indicated.

6.0 LIMITATIONS

The operations, facility conditions and information obtained and utilized in the preparation of this report have been obtained in part from the client, and their employees or agents, and various government officials and are assumed by PARIKH Consultants, Inc. to be complete and correct. It should be noted that this information is subject to professional interpretation, which leads to conclusions, which may differ, based upon opinions specific to individuals.

This report has been presented in accordance with generally accepted environmental assessment

practices, based upon the information set forth within the report narrative, for specific application to the proposed Hazel Avenue and U.S. 50 right-of-way improvements in Rancho Cordova and Sacramento County, California. No warranty, expressed or implied, is made.

The conclusions in this report are qualitative opinions based on limited quantitative information. Soil and groundwater sampling and analysis were not a part of this scope of work. The scope of work was limited to observation of the surface at a specific time, a limited aerial survey review, and environmental database research. This assessment is not designed to predict future site or off-site conditions. Also, site conditions can differ at locations other than those observed along the project corridor. Subsurface conditions can differ from those observed on the surface.

This investigation is not a risk assessment and is not intended to provide information needed for public health risk assessment purposes. The consultant has endeavored to determine as much as practical about the site conditions given what we consider to be a reasonable amount of analysis and research time. Additional investigation or sampling and analysis could result in information that would lead to revised conclusions. Additional search can usually turn up more information but frequently with a diminishing rate of information return for the effort spent. The degree of certainty of an environmental assessment is proportional to the time and effort spent. However, the degree of certainty cannot be 100% even with highly detailed exploratory drilling and testing work well beyond the scope of this study.

Respectfully submitted,
PARIKH CONSULTANTS, INC.





Gary Parikh, P.E.; G.E #666
Project Manager

FIGURE 6A



LEGEND

SA	POTENTIAL STAGING AREA
	BUILDING/STRUCTURE TO BE REMOVED
	TEMPORARY IMPACTS
	PERMANENT IMPACTS
	EXISTING FEATURES
	COUNTY ROW

HAZEL AVE/US-50 INTERCHANGE
LIMITS OF PERMANENT AND TEMPORARY IMPACTS

03-SAC-50 PM 15.1/17.5

0 100 200 400
Graphic Scale

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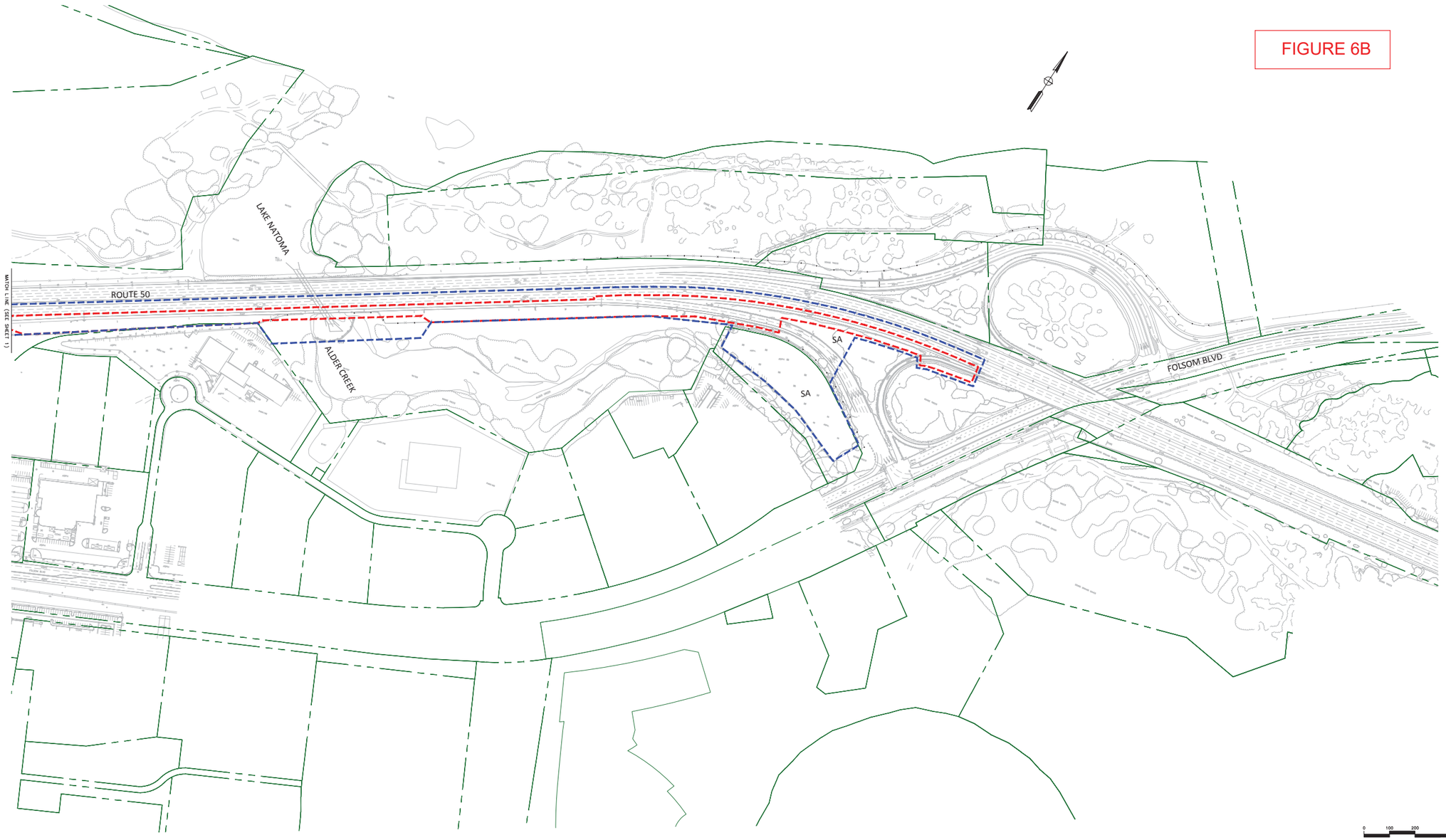
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CHK'D BY ____ DATE 10/16/18
SCALE 1"=200'

APPROVED ON ____
BY ____
RCE NO. ____

JOB NO. 20-0105
FILE NO. ____

SHEET NO. 1 OF 2

FIGURE 6B



LEGEND

SA	POTENTIAL STAGING AREA
	BUILDING/STRUCTURE TO BE REMOVED
	TEMPORARY IMPACTS
	PERMANENT IMPACTS
	EXISTING FEATURES
	COUNTY ROW

HAZEL AVE/US-50 INTERCHANGE
LIMITS OF PERMANENT AND TEMPORARY IMPACTS
TRANSITION LANE PM 15.1/17.5

03-SAC-50

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SCALE	1"=400'		

JOB NO. 3616002
FILE NO.

SHEET NO. 2 OF 2

AERIALLY DEPOSITED LEAD ASSESSMENT

US-50 / Hazel Avenue Interchange
Sacramento County, California

Prepared by:

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October 2016

Prepared for:

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File No. 2843.X
October 17, 2016

Ms. Cherry Zamora
ICF International
630 K Street, Suite 400
Sacramento, CA 95814

Subject: **Aerially Deposited Lead Assessment**
US-50 / Hazel Avenue Interchange
Sacramento County, California

Dear Ms. Zamora,

Blackburn Consulting (BCI) completed this Aerially Deposited Lead (ADL) Assessment report for the US-50 / Hazel Avenue Interchange Project, located in Sacramento County, California.

This report includes a brief description of the project, the scope of our ADL investigation, analytical methods, findings, conclusions, and recommendations regarding the occurrence of ADL within the project area.

BCI appreciates this opportunity to be on your team. Please call if you have questions or require additional information.

Sincerely,

BLACKBURN CONSULTING

Laura Long
Environmental Engineer

Nicole Hart, P.E.
Senior Project Manager

AERIALLY DEPOSITED LEAD ASSESSMENT
US-50 / HAZEL AVENUE INTERCHANGE
Sacramento County, California

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FIGURES

Figure 1 - Vicinity Map
Figure 2 - Sampling Locations

APPENDIX A - ADL Analytical Laboratory Results and Chain of Custody

APPENDIX B - Statistical Analysis

1. INTRODUCTION

Blackburn Consulting (BCI) prepared this Aerially Deposited Lead (ADL) Assessment for the US-50 / Hazel Avenue Interchange Project located in Sacramento County, California. BCI assessed the presence of ADL in surface and shallow subsurface soil within areas of the project corridor anticipated to be disturbed by the planned improvements. The Assessment evaluates whether impacts due to ADL will require mitigation recommendations for construction and/or additional testing.

BCI prepared this report for ICF International (ICF) to use during planning and construction. Do not use or rely on this report for different locations or improvements without the written consent of BCI.

2. PROJECT LOCATION AND DESCRIPTION

The project is located along US-50 from approximately 2,000 feet west of the Hazel Avenue overpass to approximately 5,100 feet east of the overpass in Sacramento County, California. The project area includes on- and off-ramps at the US-50 / Hazel Avenue Interchange, the northbound shoulder of Folsom Boulevard, and the off-ramp from US-50 to Aerojet. Figure 1 presents the Vicinity Map.

Two alternative plans and one sub-alternative plan are proposed for the US-50 / Hazel Avenue interchange improvements. Plans include construction of additional structures, lanes, modifications to roadway alignments, improvements to existing roadways and sidewalks, and acquisition and demolition of existing structures.

2.1 Potential for ADL in Soil

Soil testing along roads heavily traveled prior to1987 indicates that ADL may be present in the surface soil of the unpaved shoulders. The lead is generally attributed to emissions from vehicles previously powered by internal-combustion, leaded-gasoline engines. Along roads where the shoulder subgrade has not been disturbed, the presence of ADL is generally limited to the upper twenty-four inches. Lead concentrations typically drop rapidly with increased depth below the ground surface. The US-50 / Hazel Avenue Interchange was constructed prior to 1987; therefore, the potential for ADL exists.

3. SCOPE OF WORK

To prepare this assessment, BCI completed the following tasks:

- Prepared a Sampling Workplan and site specific Health and Safety Plan.
- Prepared a map of the proposed ADL sample locations based on the project limits provided by ICF (Figure 2).

- Sampled thirty (30) locations along the unpaved shoulders of the proposed alignments; this includes on- and off-ramps at the US-50 / Hazel Avenue Interchange, the northbound shoulder of Folsom Boulevard, and the off-ramp from US-50 to Aerojet.
- Collected sixty-one (61) soil samples from thirty (30) locations within the project limits.
- Submitted sixty-one (61) soil samples for laboratory analysis of total lead, soluble lead and/or pH.
- Reviewed analytical results.
- Performed statistical analysis of the analytical data set.
- Prepared this report.

4. SAMPLE SUMMARY

BCI obtained samples from thirty (30) hand auger boring locations along the unpaved shoulders of the proposed alignments; this includes on- and off-ramps at the US-50 / Hazel Avenue Interchange, the northbound shoulder of Folsom Boulevard, and the off-ramp from US-50 to Aerojet. Boring locations were within five to ten lateral feet of the existing pavement edge, and within areas anticipated to be disturbed by the planned construction activities. Two deviations to the Sampling Workplan occurred:

1) BCI proposed to collect ninety (90) soil samples; however, BCI encountered boulders and/or gravel during sampling and therefore only obtained sixty-one (61) soil samples. The sample distribution consisted of:
   - Thirty (30) samples from zero to six (0-6”) inches below ground surface (bgs)
   - Twenty-two (22) samples from twelve to eighteen (12-18”) inches bgs
   - Nine (9) samples from twenty-four to thirty (24-30”) inches bgs.

2) Aerojet denied site access for two proposed sample locations (ADL-26 and ALD-27).

We summarize below sample collection, subsurface soil conditions, and laboratory analysis. Figure 2 shows the approximate sample locations.

4.1 Sample Collection

BCI collected and prepared samples for analysis. BCI attempted to collect soil samples from thirty (30) hand auger boring locations at three (3) depth intervals: zero to six (0-6”) inches, twelve to eighteen (12-18”) inches and twenty-four to thirty (24-30”) inches bgs. However, at several locations, BCI encountered refusal from boulders and/or gravel below the first depth interval. Specifically, BCI:

- Collected soil samples within all thirty (30) hand auger borings from zero to six (0-6”) inches.
- Collected soil samples within twenty-two (22) hand auger borings from twelve to eighteen (12-18”) inches. BCI encountered refusal at approximately six to eight (6-8”) inches bgs at eight (8) locations (ADL-11, -13, -16, -22, -25, -28, -29 and -32).

- Collected soil samples within nine (9) hand auger borings from twenty-four to thirty (24-30") inches. BCI encountered refusal at approximately eighteen (18") inches bgs at twenty-one (21) locations (ADL-2, -4, -5, -7, -8, -9, -11, -13, -14, -16, -17, -18, -20, -21, -22, -23, -25, -28, -29, -31 and -32).
- Transferred samples into glass jars, labeled with the sample time, date, location, depth, and the sampler's initials.
- Cleaned sampling equipment between each sample by washing with an Alconox solution followed by rinsing with distilled water.
- Placed sample containers in a cooled ice chest, and delivered to SunStar Laboratories, a California certified analytical laboratory, under continuous chain-of-custody documentation.
- Backfilled borings with excess cuttings and discharged wash and rinse water to the ground surface at the boring locations.

4.2 Sample Analysis

BCI submitted sixty-one (61) soil samples to SunStar Laboratories, Inc. for the following analysis:

- Sixty-one (61) samples were analyzed for total lead using EPA Test Method 6010B. Eleven (11) samples exhibited total lead concentrations exceeding 50 milligrams per kilograms (mg/kg) and were therefore selected for further testing. The 50 mg/kg threshold indicates a sample has the potential to exceed the Soluble Threshold Limit Concentration (STLC)[1] of 5 milligrams per liter (mg/l).
- Eleven (11) samples selected for further testing were analyzed for soluble lead using the Waste Extraction Test (WET) procedure and EPA Test Method 6010B.
- Three (3) samples were analyzed for solubility using a variation of the WET procedure that uses distilled water as the extractant (WET-DI). This additional solubility test is conducted to further determine soil management parameters when WET soluble lead results are in excess of 5 mg/l. An insufficient amount of sample material remained for WET-DI analysis following WET solubility testing, therefore, samples selected for WET-DI testing were obtained from a different depth interval at the same hand auger location.
- Two (2) samples were further analyzed for solubility using the Toxicity Characteristic Leaching Procedure (TCLP) by EPA Method 1311.
- Nine (9) randomly selected samples were analyzed for pH using EPA Method 9045.

The laboratory performed Quality Assurance/Quality Control (QA/QC) procedures for each method of analysis. Laboratory QA/QC procedures include: 1) Method Blanks, 2) Duplicate Samples, and 3) Spiked Samples. A copy of the laboratory reports and chain-of-custody document is included in Appendix A.

[1] STLC is a regulatory limit defining hazardous waste in California

5. ANALYTICAL RESULTS

We summarize the analytical test results in Table 1:

TABLE 1:
Summary of Analytical Results

Sample #		Soil Depth Interval (inches)	Metals (EPA 6010B)	STLC Waste Extraction Test (Citric Method)	STLC Waste Extraction Test (DI Method)	TCLP Leaching Test
			Lead (mg/kg)	Lead (mg/l)	Lead (mg/l)	Lead (mg/l)
ADL-1	A	0-6	88.9	5.03		
ADL-1	B	12-18	79.5	6.74		0.118
ADL-1	C	24-30	118	18.9		
ADL-2	A	0-6	51.1	3.64		
ADL-2	B	12-18	284	29.5		
ADL-3	A	0-6	43.9	--		
ADL-3	B	12-18	59.8	5.74		
ADL-3	C	24-30	49.0	--		
ADL-4	A	0-6	ND	--		
ADL-4	B	12-18	14.6	--		
ADL-5	A	0-6	49.2	--	ND	
ADL-5	B	12-18	452	44.9		1.55
ADL-6	A	0-6	39.2	--		
ADL-6	B	12-18	31.9	--		
ADL-6	C	24-30	ND	--		
ADL-7	A	0-6	15.5	--		
ADL-7	B	12-18	25.5	--		
ADL-8	A	0-6	13.1	--		
ADL-8	B	12-18	ND	--		
ADL-9	A	0-6	53.2	2.61		
ADL-9	B	12-18	33.4	--		
ADL-10	A	0-6	20.0	--		
ADL-10	B	12-18	ND	--		
ADL-10	C	24-30	ND	--		
ADL-11	A	0-6	12.9	--		
ADL-12	A	0-6	ND	--		
ADL-12	B	12-18	ND	--		
ADL-12	C	24-30	ND	--		
ADL-13	A	0-6	ND	--		
ADL-14	A	0-6	ND	--		
ADL-14	B	12-18	ND	--		

TABLE 1: Summary of Analytical Results						
Sample #		**Soil Depth Interval (inches)**	**Metals (EPA 6010B)**	**STLC Waste Extraction Test (Citric Method)**	**STLC Waste Extraction Test (DI Method)**	**TCLP Leaching Test**
			Lead (mg/kg)	**Lead (mg/l)**	**Lead (mg/l)**	**Lead (mg/l)**
ADL-15	A	0-6	ND	--		
ADL-15	B	12-18	ND	--		
ADL-15	C	24-30	ND	--		
ADL-16	A	0-6	ND	--		
ADL-17	A	0-6	ND	--		
ADL-17	B	12-18	21.0	--		
ADL-18	A	0-6	59.8	3.62		
ADL-18	B	12-18	54.6	3.02		
ADL-19	A	0-6	22.2	--	ND	
ADL-19	B	2-18	64.9	6.92		
ADL-19	C	24-30	46.0	--	ND	
ADL-20	A	0-6	39.0	--		
ADL-20	B	12-18	36.5	--		
ADL-21	A	0-6	ND	--		
ADL-21	B	12-18	ND	--		
ADL-22	A	0-6	25.0	--		
ADL-23	A	0-6	19.6	--		
ADL-23	B	12-18	ND	--		
ADL-24	A	0-6	33.1	--		
ADL-24	B	12-18	ND	--		
ADL-24	C	24-30	ND	--		
ADL-25	A	0-6	ND	--		
ADL-28	A	0-6	30.7	--		
ADL-29	A	0-6	ND	--		
ADL-30	A	0-6	15.1	--		
ADL-30	B	12-18	ND	--		
ADL-30	C	24-30	ND	--		
ADL-31	A	0-6	ND	--		
ADL-31	B	12-18	ND	--		
ADL-32	A	0-6	ND	--		

ND = Not Detected at a reporting limit of 3.0 mg/kg (total lead) and 0.100 mg/l (soluble lead by WET-DI)

Test results indicate the following:

- Total lead concentrations range from below the detection limit of 3.0 mg/kg to 452 mg/kg with an average detected concentration of 26.54 mg/kg.
- No samples exceed the TTLC of 1,000 mg/kg.
- Eleven (11) samples exhibited total lead in excess of 50 mg/kg (i.e. ten times higher than the STLC of 5.0 mg/l) and were further tested for soluble lead by the WET method. Soluble lead concentrations (WET) range from 2.61 mg/l to 44.9 mg/l. Seven (7) samples exceed the STLC (WET) of 5.0 mg/l.
- Three (3) samples within the same hand auger as samples which exhibited greater than 5.0 mg/l by the WET method were tested for soluble lead by the WET-DI method. Soluble lead concentrations by the WET-DI method were all below the level of detection of 0.100 mg/l.
- Soluble lead results by the TCLP test were 0.118 mg/l and 1.55 mg/l, which are both below the federal hazardous waste threshold of 5.0 mg/l for lead.
- Results of the nine (9) pH tests range from 5.5 to 8.0 with an average pH of 6.42 (close to neutral).

Figure 2 presents the total lead concentrations within each hand auger.

6. STATISTICAL ANALYSIS

BCI performed statistical analysis of the ADL sample data using ProUCL 5.0 software to calculate the sample mean (average) as well as the 95% Upper Confidence Limit (UCL) on the mean. Much of the ADL data is skewed to lower concentrations and does not fit a standard distribution pattern; therefore, BCI calculated UCLs using non-parametric and lognormal techniques that do not require data to have a specific distribution. Appendix B presents statistical analysis calculations performed by ProUCL 5.0.

6.1 Total Lead

We analyzed groups of data based on sample depth. Table 2 summarizes the total lead results for each sample depth interval, as well as the combined intervals (0-30”) and (12-30”). Data sets for the (12-18”) and (24-30”) depth intervals were combined into (12-30”) to provide statistically relevant data, due to the lack of detectable concentrations obtained from the (24-30”) interval. The combined interval (0-30”) provides information on the sample population as a whole. Sample ADL-5B, with a total lead concentration of 452 mg/kg, was identified as a statistical outlier and removed from the data set to provide a more representative statistical analysis.

The tested concentration of total lead is distributed consistently throughout all of the sample depths at sample locations with detected concentrations of lead. Samples located along the US-50 corridor generally exhibiting elevated lead concentrations, while tested samples at Hazel Avenue and Folsom Boulevard exhibited either non-detect or low lead levels.

Due to the presence of lead delineation along US-50 versus along Hazel Avenue and Folsom Boulevard, BCI conducted statistical analyses for two alternative soil management options; one analysis for all sample locations within the project limits, and a second analysis only for samples located along the US-50 Corridor. Data is also presented for the sample population not within the US-50 Corridor; however, a valid statistical evaluation could not be performed due to the low number of detected concentrations. Figure 2 differentiates the sample locations based on the sample groups.

TABLE 2:
Total Lead Statistical Summary by Depth Interval
All Sample Locations and US-50 Corridor

Soil Depth Interval (inches bgs)	Detection Range* (mg/kg)	All Sample Locations Mean (mg/kg)	All Sample Locations 95% UCL (mg/kg)	US-50 Corridor Mean (mg/kg)	US-50 Corridor 95% UCL (mg/kg)	Samples not within US-50 Corridor (Estimated*** Mean/UCL)
0 - 6	ND to 88.9	21.65	28.8	32.02	41.71	8.55/22.38
12 - 18	ND to 284**	34.32	81.45	57.31	146.1	4.29/16.43
12 - 30	ND to 284*	31.42	61.48	45.41	89.78	No data
0 - 30	ND to 284*	26.54	38.83	37.78	55.74	6.46/15.45

* ND = Not detected at a reporting limit of 3.0 mg/kg
** Outlier ADL-5B removed from data set.
*** Statistical analysis not valid due to number of data points and ND values.

Based on the mean and 95% UCL values shown in Table 2, the majority of lead impact is located along the US-50 Corridor below the 0-6" sample interval. However, the total lead concentrations and the 95% UCL for both groups at each sample depth interval are well below the 1,000 mg/kg TTLC for lead.

6.2 Soluble Lead

Soluble lead testing was performed on eleven samples by the WET method, three samples by the WET-DI method, and two samples by the TCLP test. We used statistical modeling to analyze the WET and TCLP data. We did not use statistical modeling for the WET-DI method as all results were Non-Detect.

Lead solubility (WET) testing was limited to the eleven samples with total lead concentrations that exceeded 50 mg/kg. This tends to introduce an upward bias in solubility results. We therefore performed a linear regression analysis to predict the 95% UCL for WET solubility and reduce the effect of the biased sample populations. For the regression analysis, we consider ten

data points (as discussed above, ADL-5B was determined to be an outlier and removed from the sample population) and define the intercept to occur at the origin. The calculated multiple "r" correlation coefficient is 0.87 which indicates that the correlation between the total and soluble lead data sets is acceptable.

We also performed a linear regression analysis to predict the 95% UCL for TCLP test solubility and to reduce the effect of the biased sample populations. For the regression analysis we considered the two data points and defined the intercept to occur at the origin. The calculated multiple "r" correlation coefficient is 1.0 which indicates that the correlation between the total and soluble lead data sets is acceptable.

The WET data regression equation is calculated to be:

$y = 0.1016(x)$ for all sample locations

The TCLP data regression equation is calculated to be:

$y = 0.0025(x)$

Where:

y = soluble lead concentrations in mg/l

x = total lead concentrations in mg/kg

We used the 95% UCL values for total lead in the regression formulas to calculate the predicted WET and TCLP solubility for the various soil depth intervals shown in Table 3.

TABLE 3:
Predicted Lead Solubility

Soil Depth Interval (inches bgs)	95% UCL Total Lead All Locations (mg/kg)	95% UCL WET-Soluble Lead All Locations (mg/l)	95% UCL Total Lead US-50 Corridor (mg/kg)	95% UCL WET-Soluble Lead US-50 Corridor (mg/l)	95% UCL TCLP Lead All Locations/ US-50 Corridor (mg/l)
0-6"	28.8	2.93	41.71	4.24	0.072/0.104
12-18"	81.45	8.28	146.1	14.84	0.204/0.365
Combined Interval 12-30	61.48	6.25	89.78	9.12	0.154/0.225
Combined Interval 0-30"	38.83	3.95	55.74	5.66	0.097/0.139

The predicted 95% UCL for the samples tested using the WET test are below the STLC of 5.0 mg/l, for the 0-6" and 0-30" depth intervals for All Locations. The predicted 95% UCL for samples tested using the WET test exceed the STLC regulatory threshold of 5.0 mg/l for the 12-18" and 12-30" soil depth intervals in the statistical analysis for All Locations.

The predicted 95% UCL for samples tested using the WET test exceed the STLC regulatory threshold of 5.0 mg/l for each of the soil depth intervals except the 0-6" depth interval for the US-50 Corridor sample locations.

The predicted 95% UCL WET-Soluble Lead for samples located outside the US-50 Corridor was not calculated. A valid statistical evaluation could not be performed due to the low number of detected concentrations. No tested concentrations of total lead in excess of 50 mg/kg (i.e. ten times higher than the STLC of 5.0 mg/l) were observed.

The predicted 95% UCL for TCLP solubility for all sample populations is well below the federal hazardous waste threshold limit of 5.0 mg/l. Soluble lead concentrations (WET-DI) were all below the level of detection of 0.100 mg/l.

7. CONCLUSIONS

The near-surface soil zero to thirty (0-30") inches bgs within the project limits generally exhibit low levels of ADL. The results indicate higher concentrations of ADL are associated with the samples obtained from the shoulders of US-50, while lower concentrations and/or non-detect results are associated with Hazel Avenue, Folsom Boulevard, and the on- and off-ramp connections to US-50.

All detected concentrations are well below the total TTLC of 1,000 mg/kg that defines the lower limit for hazardous waste. Based on the mean and 95% UCL values shown in Table 2, the total lead concentrations in all intervals and sample locations are below the 1,000 mg/kg TTLC for lead based on the individual analytical test results.

Soluble lead by the WET method results range from 2.61 mg/l to 44.9 mg/l, with 7 samples exceeding the individual STLC for lead of 5 mg/l. The regression analysis to predict soluble lead levels (WET) of unbiased sample populations indicates the 95% UCL for soluble lead levels is below the STLC of 5.0 mg/l, for the 0-6" and 0-30" depth intervals when considering All Locations. The 95% UCL for soluble lead levels exceeds the STLC of 5.0 mg/l for all sample depths and locations with the exception of the (0-6") depth interval when considering the US-50 Corridor.

The predicted 95% UCL WET-Soluble Lead for samples located outside the US-50 Corridor was not calculated because no tested concentrations of total lead exceeded 50 mg/kg (i.e. ten times higher than the STLC of 5.0 mg/l). These results indicate that the estimated mean and 95% UCL for total lead are well below the screening concentration of 50 mg/kg (i.e. ten times higher than the STLC of 5.0 mg/l) for all soil depth intervals outside the US-50 Corridor.

The predicted 95% UCL for TCLP solubility for all sample populations is below the federal hazardous waste threshold limit of 5.0 mg/l.

The project soil pH averages 6.42 (close to neutral) and ranges from slightly acidic to slightly basic, conditions that do not enhance lead leaching potential. The pH conditions do not impose any special soil management requirements.

7.1 Waste Disposal/Soil Reuse

Regulatory criteria to classify a waste as "California Hazardous" for handling and disposal purposes are contained in the California Code of Regulations (CCR), Title 22, Division 4.5, Chapter 11, Article 3, subsection 66261.24. Federal criteria to classify a waste as "Resource Conservation and Recovery Act (RCRA) Hazardous Waste" are contained in Title 40 of the Code of Federal Regulations (40 CFR), Part 261. For a waste containing lead, the waste is classified as California Hazardous when: 1) the total lead content exceeds the TTLC (1,000 mg/kg); or 2) the soluble lead content exceeds the STLC (5.0 mg/l) based on the standard Waste Extraction Test (WET).

Management of lead-impacted soil on projects within Caltrans Right of Way (ROW) is governed by the statewide variance for reuse of lead-contaminated soil issued by the State Department of Toxic Substances Control (DTSC). A summary of the variance is provided in Table 4. Based on our review and analysis of the test data, and the results of the statistical analyses, we conclude that the Caltrans Variance may be invoked, as determined by Caltrans, for this project.

Preliminary comparison of the test results with the soil classifications in the Caltrans Variance indicates that excavated soil will be characterized as either Soil Type "Y-1" or "X – Non–hazardous Waste". Soil Type "Y-1" will be managed in accordance with the variance. Handling and disposition of Soil Type X with elevated lead will not be subject to management under the conditions of the Variance, but it will require contractor notification and preparation of a lead compliance plan for worker safety.

To prepare a soil management plan, Caltrans requires additional testing to better define the volumes of each classification and to segregate the soil based on depth and/or location. Additional testing includes soluble lead analysis using the WET-DI method for sample populations exceeding the TTLC or STLC for lead. All soluble lead results analyzed by WET-DI method were "Non-Detect", therefore, the least stringent Soil Type "Y-1" classification is applicable.

For the project corridor, the following classifications are recommended:

- US-50 Corridor: Based on the 95% UCL WET soluble lead levels, the entire depth interval (0-30") of the US-50 Corridor will be considered Soil Type "Y-1" if considered independently from Hazel Avenue, Folsom Boulevard, and the on- and off-ramps connecting to US-50 sample locations.

- Hazel Avenue, Folsom Boulevard, and the on- and off-ramps connecting to US-50: Based on the estimated mean and 95% UCL total lead levels, the entire depth interval (0-30") at these locations will be considered Soil Type "X".
- All Locations (Combined US-50 Corridor and Hazel Avenue, Folsom Boulevard and all on- and off-ramps connecting to US-50): Based on Total Lead and 95% UCL WET soluble lead levels, the entire depth interval throughout the project limits will be considered Soil Type "X" if managed as a whole.

Any excess soil not placed within the project limits shall be disposed of at an approved landfill facility. Prior to transport to the facility, the contractor should consult with the landfill operator to determine specific waste acceptance and testing criteria. The Contractor should conduct his fieldwork in compliance with Title 8 CCR, Section 5192, which includes an appropriate project-specific worker Health & Safety Plan (HASP).

TABLE 4: Caltrans Variance for Aerially Deposited Lead Soil Management

Soluble Lead (mg/1)	Total Lead (mg/kg)	Soil Type	Handling
CALIFORNIA TESTING			
STLC (WET) <5.0	**TTLC** <1,000	**X**	**Non-hazardous Waste.** Notify and require Lead Compliance Plan for worker safety.
	1,000 — 1,411 and DI WET < 1.5 mg/l	Y1	**Hazardous Waste. Variance applies** — cover with minimum 1 foot of clean soil.*
	1,411 — 3,397 and DI WET < 150 mg/l	Y2	**Hazardous Waste. Variance applies —** cover with pavement structure. *
	1,000 — 3,397 but Surplus	Z2	**Hazardous Waste -** Surplus. Dispose at Class 1 disposal site.
	> 3,397 or 1,000 — 3,397 & DI WET > 150 mg/l	Z2	**Hazardous Waste —** not reusable under Variance. Dispose at Class 1 disposal site.
CALIFORNIA TESTING			
STLC (WET) >5.0	**TTLC < 1411 and DI** WET < 1.5 mg/l	**Y1**	**Hazardous Waste. Variance applies —** cover with minimum of 1 foot of clean soil.*
	1,411 — 3,397 and DI WET < 150 mg/l	Y2	**Hazardous Waste. Variance applies —** cover with pavement structure.*
	< 3,397 and DI WET < 150 mg/l but Surplus	Z2	**Hazardous Waste -** Surplus. Dispose at Class I disposal site.
	> 3,397 or DI **WET >** 150 mg/l	Z2	**Hazardous Waste —** not reusable under Variance. Dispose at Class 1 disposal site.
FEDERAL TESTING			
TCLP > 5.0 mg/1	N/A	Z3	**RCRA Hazardous Waste** Dispose at Class 1 disposal site as a RCRA waste regardless of TTLC and STLC results.

*Note: For hazardous waste levels of lead – if pH is less than 5.5 soil must be placed under a pavement structure. If pH is less than 5.0, the variance cannot be used and the soil must be disposed as Z2 material.

8. RISK TO HUMAN HEALTH

Based on the current and proposed land use for the project and surrounding areas, it is appropriate to compare the total lead values to the California Human Health Screening Levels (CHHSL) limits for lead in soil. Total lead concentrations above the CHHSL do not automatically trigger a response action or suggest that a significant risk to human health exists. If the CHHSL is exceeded, it may be appropriate to evaluate potential risks posed by site contaminants.

The CHHSL for total lead is 320 mg/kg for a commercial/industrial exposure scenario. Only one of the sixty-one ADL samples exceed the CHHSL for lead. The average values and the 95% UCLs for the various soil depth intervals are all significantly less than the CHHSL. Based on the results of our ADL assessment, we conclude that lead impacted soil within the project limits do not pose a significant health risk to site workers.

9. HEALTH AND SAFETY REQUIREMENTS

The contractor shall conduct all grading operations with the awareness that lead impacted soils are present on the site and conduct all operations in accordance with a specialized soil management plan and applicable Cal/OSHA requirements including a project specific worker Health & Safety Plan (HASP) and Lead Compliance Plan.

10. LIMITATIONS

The accompanying report summarizes the findings and opinions of BCI in accordance with generally accepted environmental engineering principles and practices currently used in Northern California.

Our scope does not include evaluation of other hazardous materials or a determination of their potential presence on the site.

The accompanying report summarizes the findings and opinions of BCI and was prepared for the specific use of our client and applies only to the subject area.

We base the findings and conclusions presented in this report on limited soil sampling and laboratory analyses, and judgment and experience. We are not responsible for interpretations by others of data presented in this report. This report does not represent a legal opinion. No warranty is expressed or implied.

AERIALLY DEPOSITED LEAD ASSESSMENT
US-50 / Hazel Avenue Interchange
Sacramento County, California

FIGURES

Figure 1 – Vicinity Map

Figure 2– Sampling Locations



N

NO SCALE

blackburn consulting

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VICINITY MAP

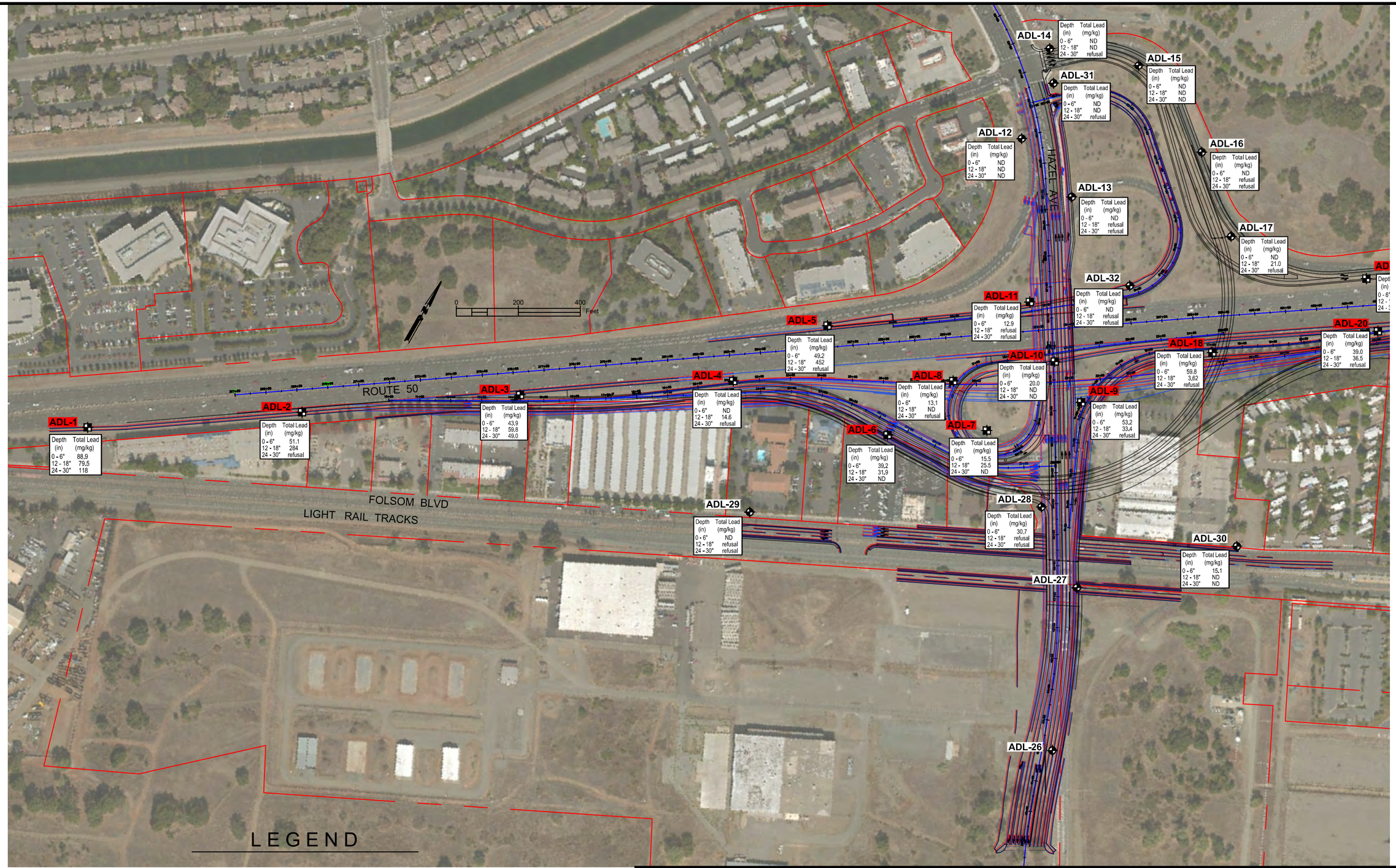
Hazel Ave/US-50 Interchange
Rancho Cordova, CA

File No. 2843.x

October 2016

Figure 1

10/11/2016 2843.x Vicinity Map - Figure 1.dwg



LEGEND

Alternative 1

Alternative 1A

Alternative 2

ADL-1 **Approximate Sampling Locations Outside The US-50 Corridor**

ADL-2 **US-50 Corridor Sampling Locations**

ND = Not detected at or above reporting limit

Source: Preliminary project geometrics provided by Mark Thomas & Company, Inc., March 2016.

blackburn consulting

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SAMPLING LOCATIONS

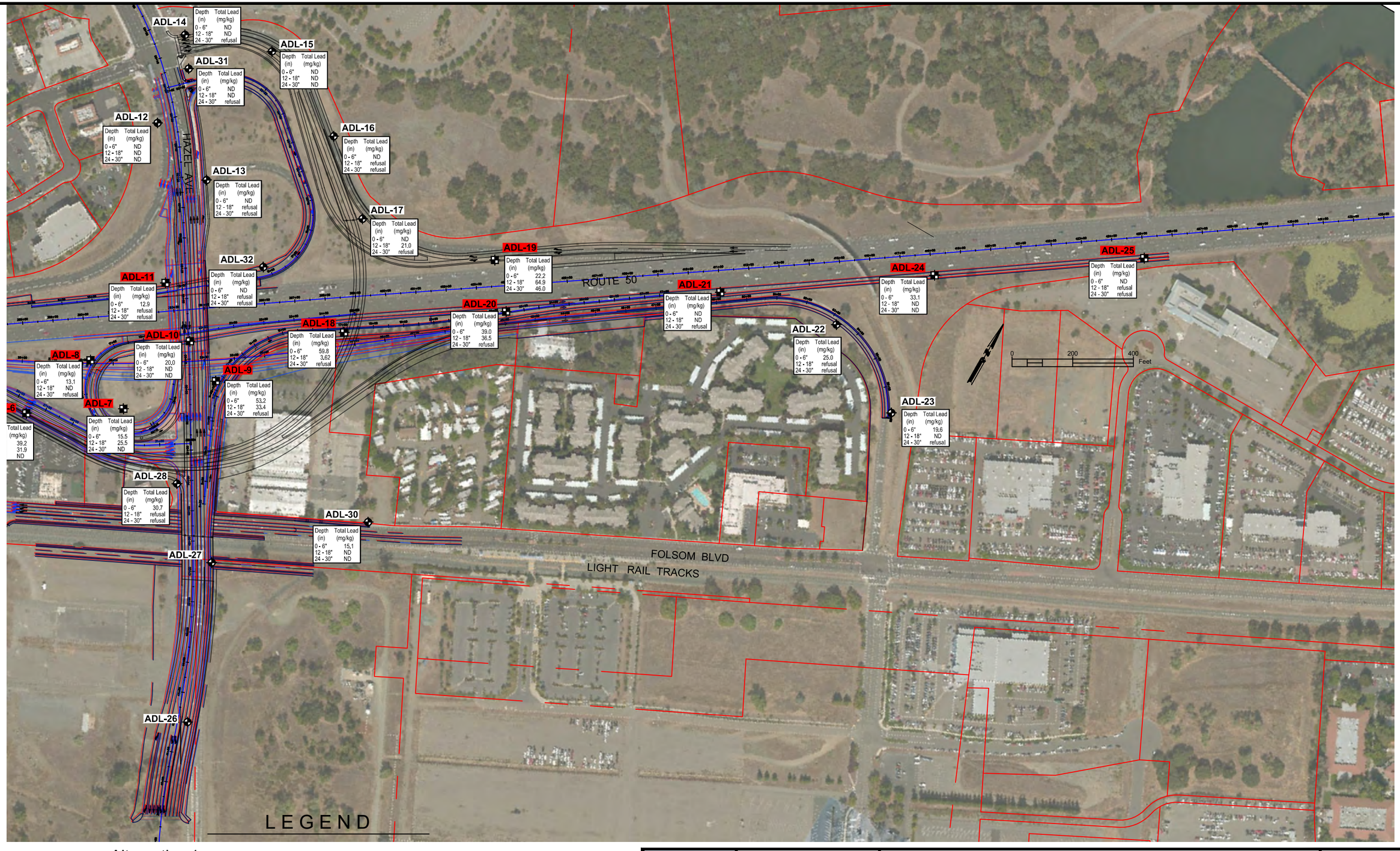
Hazel Ave/US-50 Interchange
All Alternatives
Rancho Cordova, California

File No. 2843.x

October 2016

Figure 2a

10/11/16 2843.x figx hazel ave_us-50 interchange-all.dwg



10/11/16 2843.x figx hazel ave_us-50 interchange-all.dwg

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SAMPLING LOCATIONS
Hazel Ave/US-50 Interchange
All Alternatives
Rancho Cordova, California

File No. 2843.x

October 2016

Figure 2b

AERIALLY DEPOSITED LEAD ASSESSMENT
US-50 / Hazel Avenue Interchange
Sacramento County, California

APPENDIX A

ADL Analytical Laboratory Results and

Chain of Custody

SunStar Laboratories, Inc.
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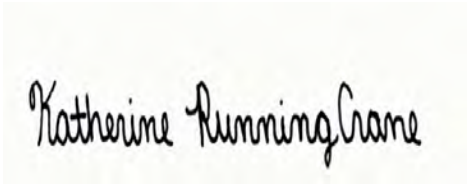
01 September 2016

Kristy Chapman
Blackburn Consulting-West Sac.
2491 Boatman Ave.
West Sacramento, CA -

RE: US-50 and Hazel Ave Interchange

Enclosed are the results of analyses for samples received by the laboratory on 07/30/16 10:00. If you have any questions concerning this report, please feel free to contact me.

Sincerely,



Katherine RunningCrane
Project Manager

SunStar Laboratories, Inc.
PROVIDING QUALITY ANALYTICAL SERVICES NATIONWIDE

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Blackburn Consulting-West Sac.	Project: US-50 and Hazel Ave Interchange	
2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
ADL-9-A	T161774-01	Soil	07/27/16 10:20	07/30/16 10:00
ADL-9-B	T161774-02	Soil	07/27/16 10:40	07/30/16 10:00
ADL-18-A	T161774-03	Soil	07/27/16 10:50	07/30/16 10:00
ADL-18-B	T161774-04	Soil	07/27/16 11:15	07/30/16 10:00
ADL-20-A	T161774-05	Soil	07/27/16 11:30	07/30/16 10:00
ADL-20-B	T161774-06	Soil	07/27/16 11:35	07/30/16 10:00
ADL-21-A	T161774-07	Soil	07/27/16 11:50	07/30/16 10:00
ADL-21-B	T161774-08	Soil	07/27/16 11:55	07/30/16 10:00
ADL-22-A	T161774-09	Soil	07/27/16 12:20	07/30/16 10:00
ADL-23-A	T161774-10	Soil	07/27/16 13:00	07/30/16 10:00
ADL-23-B	T161774-11	Soil	07/27/16 13:15	07/30/16 10:00
ADL-24-A	T161774-12	Soil	07/27/16 12:00	07/30/16 10:00
ADL-24-B	T161774-13	Soil	07/27/16 12:04	07/30/16 10:00
ADL-24-C	T161774-14	Soil	07/27/16 12:06	07/30/16 10:00
ADL-25-A	T161774-15	Soil	07/27/16 12:20	07/30/16 10:00
ADL-28-A	T161774-16	Soil	07/27/16 10:22	07/30/16 10:00
ADL-29-A	T161774-17	Soil	07/27/16 10:08	07/30/16 10:00
ADL-30-A	T161774-18	Soil	07/27/16 10:40	07/30/16 10:00
ADL-30-B	T161774-19	Soil	07/27/16 10:43	07/30/16 10:00
ADL-30-C	T161774-20	Soil	07/27/16 10:49	07/30/16 10:00
ADL-1-A	T161774-21	Soil	07/28/16 09:45	07/30/16 10:00
ADL-1-B	T161774-22	Soil	07/28/16 09:50	07/30/16 10:00
ADL-1-C	T161774-23	Soil	07/28/16 10:00	07/30/16 10:00
ADL-2-A	T161774-24	Soil	07/28/16 10:20	07/30/16 10:00
ADL-2-B	T161774-25	Soil	07/28/16 10:25	07/30/16 10:00
ADL-3-A	T161774-26	Soil	07/28/16 10:40	07/30/16 10:00

SunStar Laboratories, Inc.



Katherine RunningCrane, Project Manager

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West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
ADL-3-B	T161774-27	Soil	07/28/16 10:45	07/30/16 10:00
ADL-3-C	T161774-28	Soil	07/28/16 11:00	07/30/16 10:00
ADL-4-A	T161774-29	Soil	07/28/16 11:30	07/30/16 10:00
ADL-4-B	T161774-30	Soil	07/28/16 11:40	07/30/16 10:00
ADL-5-A	T161774-31	Soil	07/28/16 12:00	07/30/16 10:00
ADL-5-B	T161774-32	Soil	07/28/16 12:12	07/30/16 10:00
ADL-6-A	T161774-33	Soil	07/28/16 12:00	07/30/16 10:00
ADL-6-B	T161774-34	Soil	07/28/16 12:15	07/30/16 10:00
ADL-6-C	T161774-35	Soil	07/28/16 12:40	07/30/16 10:00
ADL-11-A	T161774-36	Soil	07/28/16 10:20	07/30/16 10:00
ADL-12-A	T161774-37	Soil	07/28/16 11:02	07/30/16 10:00
ADL-12-B	T161774-38	Soil	07/28/16 11:20	07/30/16 10:00
ADL-12-C	T161774-39	Soil	07/28/16 11:38	07/30/16 10:00
ADL-13-A	T161774-40	Soil	07/28/16 10:04	07/30/16 10:00
ADL-32-A	T161774-41	Soil	07/28/16 10:13	07/30/16 10:00
ADL-7-A	T161774-42	Soil	07/29/16 09:53	07/30/16 10:00
ADL-7-B	T161774-43	Soil	07/29/16 09:50	07/30/16 10:00
ADL-8-A	T161774-44	Soil	07/29/16 10:13	07/30/16 10:00
ADL-8-B	T161774-45	Soil	07/29/16 10:25	07/30/16 10:00
ADL-10-A	T161774-46	Soil	07/29/16 10:40	07/30/16 10:00
ADL-10-B	T161774-47	Soil	07/29/16 10:45	07/30/16 10:00
ADL-10-C	T161774-48	Soil	07/29/16 10:52	07/30/16 10:00
ADL-14-A	T161774-49	Soil	07/29/16 11:15	07/30/16 10:00
ADL-14-B	T161774-50	Soil	07/29/16 11:20	07/30/16 10:00
ADL-15-A	T161774-51	Soil	07/29/16 12:00	07/30/16 10:00
ADL-15-B	T161774-52	Soil	07/29/16 12:05	07/30/16 10:00

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Katherine RunningCrane

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ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
ADL-15-C	T161774-53	Soil	07/29/16 12:15	07/30/16 10:00
ADL-16-A	T161774-54	Soil	07/29/16 12:30	07/30/16 10:00
ADL-17-A	T161774-55	Soil	07/29/16 11:15	07/30/16 10:00
ADL-17-B	T161774-56	Soil	07/29/16 11:30	07/30/16 10:00
ADL-19-A	T161774-57	Soil	07/29/16 10:00	07/30/16 10:00
ADL-19-B	T161774-58	Soil	07/29/16 10:30	07/30/16 10:00
ADL-19-C	T161774-59	Soil	07/29/16 10:45	07/30/16 10:00
ADL-31-A	T161774-60	Soil	07/29/16 12:06	07/30/16 10:00
ADL-31-B	T161774-61	Soil	07/29/16 12:15	07/30/16 10:00

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2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

DETECTIONS SUMMARY

Sample ID: ADL-9-A **Laboratory ID:** T161774-01

Analyte	Result	Reporting Limit	Units	Method	Notes
Lead	**53.2**	3.00	mg/kg	EPA 6010B	
Lead	**2.61**	0.100	mg/l	STLC Waste Extraction T	

Sample ID: ADL-9-B **Laboratory ID:** T161774-02

Analyte	Result	Reporting Limit	Units	Method	Notes
Lead	**33.4**	3.00	mg/kg	EPA 6010B	

Sample ID: ADL-18-A **Laboratory ID:** T161774-03

Analyte	Result	Reporting Limit	Units	Method	Notes
Lead	**59.8**	3.00	mg/kg	EPA 6010B	
Lead	**3.62**	0.100	mg/l	STLC Waste Extraction T	

Sample ID: ADL-18-B **Laboratory ID:** T161774-04

Analyte	Result	Reporting Limit	Units	Method	Notes
Lead	**54.6**	3.00	mg/kg	EPA 6010B	
Lead	**3.02**	0.100	mg/l	STLC Waste Extraction T	

Sample ID: ADL-20-A **Laboratory ID:** T161774-05

Analyte	Result	Reporting Limit	Units	Method	Notes
Lead	**39.0**	3.00	mg/kg	EPA 6010B	
pH	**6.6**	0.1	pH Units	EPA 9045B	O-04

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Sample ID: ADL-20-B **Laboratory ID:** T161774-06

Analyte	Result	Reporting Limit	Units	Method	Notes
Lead	**36.5**	3.00	mg/kg	EPA 6010B	

Sample ID: ADL-21-A **Laboratory ID:** T161774-07

No Results Detected

Sample ID: ADL-21-B **Laboratory ID:** T161774-08

No Results Detected

Sample ID: ADL-22-A **Laboratory ID:** T161774-09

Analyte	Result	Reporting Limit	Units	Method	Notes
Lead	**25.0**	3.00	mg/kg	EPA 6010B	

Sample ID: ADL-23-A **Laboratory ID:** T161774-10

Analyte	Result	Reporting Limit	Units	Method	Notes
Lead	**19.6**	3.00	mg/kg	EPA 6010B	

Sample ID: ADL-23-B **Laboratory ID:** T161774-11

Analyte	Result	Reporting Limit	Units	Method	Notes
pH	**5.8**	0.1	pH Units	EPA 9045B	O-04

Sample ID: ADL-24-A **Laboratory ID:** T161774-12

Analyte	Result	Reporting Limit	Units	Method	Notes
Lead	**33.1**	3.00	mg/kg	EPA 6010B	

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Sample ID: ADL-24-B **Laboratory ID:** T161774-13

No Results Detected

Sample ID: ADL-24-C **Laboratory ID:** T161774-14

Analyte	Result	Reporting Limit	Units	Method	Notes
pH	**5.6**	0.1	pH Units	EPA 9045B	O-04

Sample ID: ADL-25-A **Laboratory ID:** T161774-15

No Results Detected

Sample ID: ADL-28-A **Laboratory ID:** T161774-16

Analyte	Result	Reporting Limit	Units	Method	Notes
Lead	**30.7**	3.00	mg/kg	EPA 6010B	

Sample ID: ADL-29-A **Laboratory ID:** T161774-17

No Results Detected

Sample ID: ADL-30-A **Laboratory ID:** T161774-18

Analyte	Result	Reporting Limit	Units	Method	Notes
Lead	**15.1**	3.00	mg/kg	EPA 6010B	

Sample ID: ADL-30-B **Laboratory ID:** T161774-19

Analyte	Result	Reporting Limit	Units	Method	Notes
pH	**6.6**	0.1	pH Units	EPA 9045B	O-04

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Sample ID: ADL-30-C **Laboratory ID:** T161774-20

No Results Detected

Sample ID: ADL-1-A **Laboratory ID:** T161774-21

Analyte	Result	Reporting Limit	Units	Method	Notes
Lead	**88.9**	3.00	mg/kg	EPA 6010B	
Lead	**5.03**	0.100	mg/l	STLC Waste Extraction T	

Sample ID: ADL-1-B **Laboratory ID:** T161774-22

Analyte	Result	Reporting Limit	Units	Method	Notes
Lead	**79.5**	3.00	mg/kg	EPA 6010B	
Lead	**0.118**	0.100	mg/l	EPA 1311	
Lead	**6.74**	0.100	mg/l	STLC Waste Extraction T	

Sample ID: ADL-1-C **Laboratory ID:** T161774-23

Analyte	Result	Reporting Limit	Units	Method	Notes
Lead	**118**	3.00	mg/kg	EPA 6010B	
Lead	**18.9**	0.100	mg/l	STLC Waste Extraction T	

Sample ID: ADL-2-A **Laboratory ID:** T161774-24

Analyte	Result	Reporting Limit	Units	Method	Notes
Lead	**51.1**	3.00	mg/kg	EPA 6010B	
Lead	**3.64**	0.100	mg/l	STLC Waste Extraction T	
pH	**5.5**	0.1	pH Units	EPA 9045B	O-04

Sample ID: ADL-2-B **Laboratory ID:** T161774-25

Analyte	Result	Reporting Limit	Units	Method	Notes
Lead	**284**	3.00	mg/kg	EPA 6010B	

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Sample ID: ADL-2-B **Laboratory ID:** T161774-25

Analyte	Result	Reporting Limit	Units	Method	Notes
Lead	**29.5**	0.100	mg/l	STLC Waste Extraction T	

Sample ID: ADL-3-A **Laboratory ID:** T161774-26

Analyte	Result	Reporting Limit	Units	Method	Notes
Lead	**43.9**	3.00	mg/kg	EPA 6010B	

Sample ID: ADL-3-B **Laboratory ID:** T161774-27

Analyte	Result	Reporting Limit	Units	Method	Notes
Lead	**59.8**	3.00	mg/kg	EPA 6010B	
Lead	**5.74**	0.100	mg/l	STLC Waste Extraction T	

Sample ID: ADL-3-C **Laboratory ID:** T161774-28

Analyte	Result	Reporting Limit	Units	Method	Notes
Lead	**49.0**	3.00	mg/kg	EPA 6010B	

Sample ID: ADL-4-A **Laboratory ID:** T161774-29

No Results Detected

Sample ID: ADL-4-B **Laboratory ID:** T161774-30

Analyte	Result	Reporting Limit	Units	Method	Notes
Lead	**14.6**	3.00	mg/kg	EPA 6010B	

Sample ID: ADL-5-A **Laboratory ID:** T161774-31

Analyte	Result	Reporting Limit	Units	Method	Notes

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Sample ID: ADL-5-A **Laboratory ID:** T161774-31

Analyte	Result	Reporting Limit	Units	Method	Notes
Lead	**49.2**	3.00	mg/kg	EPA 6010B	

Sample ID: ADL-5-B **Laboratory ID:** T161774-32

Analyte	Result	Reporting Limit	Units	Method	Notes
Lead	**452**	3.00	mg/kg	EPA 6010B	
Lead	**1.55**	0.100	mg/l	EPA 1311	
Lead	**44.9**	0.100	mg/l	STLC Waste Extraction T	
pH	**5.6**	0.1	pH Units	EPA 9045B	O-04

Sample ID: ADL-6-A **Laboratory ID:** T161774-33

Analyte	Result	Reporting Limit	Units	Method	Notes
Lead	**39.2**	3.00	mg/kg	EPA 6010B	

Sample ID: ADL-6-B **Laboratory ID:** T161774-34

Analyte	Result	Reporting Limit	Units	Method	Notes
Lead	**31.9**	3.00	mg/kg	EPA 6010B	

Sample ID: ADL-6-C **Laboratory ID:** T161774-35

No Results Detected

Sample ID: ADL-11-A **Laboratory ID:** T161774-36

Analyte	Result	Reporting Limit	Units	Method	Notes
Lead	**12.9**	3.00	mg/kg	EPA 6010B	

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Sample ID: ADL-12-A **Laboratory ID:** T161774-37

No Results Detected

Sample ID: ADL-12-B **Laboratory ID:** T161774-38

No Results Detected

Sample ID: ADL-12-C **Laboratory ID:** T161774-39

Analyte	Result	Reporting Limit	Units	Method	Notes
pH	**6.9**	0.1	pH Units	EPA 9045B	O-04

Sample ID: ADL-13-A **Laboratory ID:** T161774-40

No Results Detected

Sample ID: ADL-32-A **Laboratory ID:** T161774-41

No Results Detected

Sample ID: ADL-7-A **Laboratory ID:** T161774-42

Analyte	Result	Reporting Limit	Units	Method	Notes
Lead	**15.5**	3.00	mg/kg	EPA 6010B	

Sample ID: ADL-7-B **Laboratory ID:** T161774-43

Analyte	Result	Reporting Limit	Units	Method	Notes
Lead	**25.5**	3.00	mg/kg	EPA 6010B	

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Sample ID: ADL-8-A **Laboratory ID:** T161774-44

Analyte	Result	Reporting Limit	Units	Method	Notes
Lead	**13.1**	3.00	mg/kg	EPA 6010B	

Sample ID: ADL-8-B **Laboratory ID:** T161774-45

No Results Detected

Sample ID: ADL-10-A **Laboratory ID:** T161774-46

Analyte	Result	Reporting Limit	Units	Method	Notes
Lead	**20.0**	3.00	mg/kg	EPA 6010B	

Sample ID: ADL-10-B **Laboratory ID:** T161774-47

No Results Detected

Sample ID: ADL-10-C **Laboratory ID:** T161774-48

Analyte	Result	Reporting Limit	Units	Method	Notes
pH	**8.0**	0.1	pH Units	EPA 9045B	O-04

Sample ID: ADL-14-A **Laboratory ID:** T161774-49

No Results Detected

Sample ID: ADL-14-B **Laboratory ID:** T161774-50

No Results Detected

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Sample ID: ADL-15-A **Laboratory ID:** T161774-51

No Results Detected

Sample ID: ADL-15-B **Laboratory ID:** T161774-52

No Results Detected

Sample ID: ADL-15-C **Laboratory ID:** T161774-53

No Results Detected

Sample ID: ADL-16-A **Laboratory ID:** T161774-54

No Results Detected

Sample ID: ADL-17-A **Laboratory ID:** T161774-55

No Results Detected

Sample ID: ADL-17-B **Laboratory ID:** T161774-56

Analyte	Result	Reporting Limit	Units	Method	Notes
Lead	**21.0**	3.00	mg/kg	EPA 6010B	

Sample ID: ADL-19-A **Laboratory ID:** T161774-57

Analyte	Result	Reporting Limit	Units	Method	Notes
Lead	**22.2**	3.00	mg/kg	EPA 6010B	

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Sample ID: ADL-19-A **Laboratory ID:** T161774-57

Analyte	Result	Reporting Limit	Units	Method	Notes
pH	**7.2**	0.1	pH Units	EPA 9045B	O-04

Sample ID: ADL-19-B **Laboratory ID:** T161774-58

Analyte	Result	Reporting Limit	Units	Method	Notes
Lead	**64.9**	3.00	mg/kg	EPA 6010B	
Lead	**6.92**	0.100	mg/l	STLC Waste Extraction T	

Sample ID: ADL-19-C **Laboratory ID:** T161774-59

Analyte	Result	Reporting Limit	Units	Method	Notes
Lead	**46.0**	3.00	mg/kg	EPA 6010B	

Sample ID: ADL-31-A **Laboratory ID:** T161774-60

No Results Detected

Sample ID: ADL-31-B **Laboratory ID:** T161774-61

No Results Detected

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ADL-9-A

T161774-01 (Soil)

SunStar Laboratories, Inc.

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Metals by EPA 6010B									
Lead	**53.2**	3.00	mg/kg	1	6080112	08/01/16	08/02/16	EPA 6010B	
STLC Metals by 6000/7000 Series Methods									
Lead	**2.61**	0.100	mg/l	1	6081220	08/12/16	08/15/16	STLC Waste Extraction Test	

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ADL-9-B

T161774-02 (Soil)

SunStar Laboratories, Inc.

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Metals by EPA 6010B									
Lead	**33.4**	3.00	mg/kg	1	6080227	08/02/16	08/04/16	EPA 6010B	

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ADL-18-A

T161774-03 (Soil)

SunStar Laboratories, Inc.

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Metals by EPA 6010B									
Lead	**59.8**	3.00	mg/kg	1	6080227	08/02/16	08/04/16	EPA 6010B	
STLC Metals by 6000/7000 Series Methods									
Lead	**3.62**	0.100	mg/l	1	6081220	08/12/16	08/15/16	STLC Waste Extraction Test	

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ADL-18-B

T161774-04 (Soil)

SunStar Laboratories, Inc.

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Metals by EPA 6010B									
Lead	**54.6**	3.00	mg/kg	1	6080227	08/02/16	08/04/16	EPA 6010B	
STLC Metals by 6000/7000 Series Methods									
Lead	**3.02**	0.100	mg/l	1	6081220	08/12/16	08/15/16	STLC Waste Extraction Test	

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ADL-20-A

T161774-05 (Soil)

SunStar Laboratories, Inc.

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Metals by EPA 6010B									
Lead	**39.0**	3.00	mg/kg	1	6080227	08/02/16	08/04/16	EPA 6010B	
Conventional Chemistry Parameters by APHA/EPA/ASTM Methods									
pH	**6.6**	0.1	pH Units	1	6081222	08/12/16	08/12/16	EPA 9045B	O-04

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ADL-20-B

T161774-06 (Soil)

SunStar Laboratories, Inc.

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Metals by EPA 6010B									
Lead	**36.5**	3.00	mg/kg	1	6080227	08/02/16	08/04/16	EPA 6010B	

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ADL-21-A

T161774-07 (Soil)

SunStar Laboratories, Inc.

Metals by EPA 6010B

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Lead	ND	3.00	mg/kg	1	6080227	08/02/16	08/04/16	EPA 6010B	

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ADL-21-B

T161774-08 (Soil)

SunStar Laboratories, Inc.

Metals by EPA 6010B

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Lead	ND	3.00	mg/kg	1	6080227	08/02/16	08/04/16	EPA 6010B	

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ADL-22-A

T161774-09 (Soil)

SunStar Laboratories, Inc.

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Metals by EPA 6010B									
Lead	**25.0**	3.00	mg/kg	1	6080227	08/02/16	08/04/16	EPA 6010B	

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ADL-23-A

T161774-10 (Soil)

SunStar Laboratories, Inc.

Metals by EPA 6010B

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Lead	**19.6**	3.00	mg/kg	1	6080227	08/02/16	08/04/16	EPA 6010B	

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Blackburn Consulting-West Sac.	Project: US-50 and Hazel Ave Interchange	
2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

ADL-23-B

T161774-11 (Soil)

SunStar Laboratories, Inc.

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Metals by EPA 6010B									
Lead	ND	3.00	mg/kg	1	6080227	08/02/16	08/04/16	EPA 6010B	
Conventional Chemistry Parameters by APHA/EPA/ASTM Methods									
pH	**5.8**	0.1	pH Units	1	6081222	08/12/16	08/12/16	EPA 9045B	O-04

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Blackburn Consulting-West Sac.	Project: US-50 and Hazel Ave Interchange	
2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

ADL-24-A

T161774-12 (Soil)

SunStar Laboratories, Inc.

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Metals by EPA 6010B									
Lead	**33.1**	3.00	mg/kg	1	6080227	08/02/16	08/04/16	EPA 6010B	

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Blackburn Consulting-West Sac.	Project: US-50 and Hazel Ave Interchange	
2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

ADL-24-B

T161774-13 (Soil)

SunStar Laboratories, Inc.

Metals by EPA 6010B

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Lead	ND	3.00	mg/kg	1	6080227	08/02/16	08/04/16	EPA 6010B	

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Blackburn Consulting-West Sac.	Project: US-50 and Hazel Ave Interchange	
2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

ADL-24-C

T161774-14 (Soil)

SunStar Laboratories, Inc.

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Metals by EPA 6010B									
Lead	ND	3.00	mg/kg	1	6080227	08/02/16	08/04/16	EPA 6010B	
Conventional Chemistry Parameters by APHA/EPA/ASTM Methods									
pH	**5.6**	0.1	pH Units	1	6081222	08/12/16	08/12/16	EPA 9045B	O-04

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2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

ADL-25-A

T161774-15 (Soil)

SunStar Laboratories, Inc.

Metals by EPA 6010B

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Lead	ND	3.00	mg/kg	1	6080227	08/02/16	08/04/16	EPA 6010B	

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2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

ADL-28-A

T161774-16 (Soil)

SunStar Laboratories, Inc.

Metals by EPA 6010B

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Lead	**30.7**	3.00	mg/kg	1	6080227	08/02/16	08/04/16	EPA 6010B	

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2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

ADL-29-A

T161774-17 (Soil)

SunStar Laboratories, Inc.

Metals by EPA 6010B

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Lead	ND	3.00	mg/kg	1	6080227	08/02/16	08/04/16	EPA 6010B	

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2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

ADL-30-A

T161774-18 (Soil)

SunStar Laboratories, Inc.

Metals by EPA 6010B

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Lead	**15.1**	3.00	mg/kg	1	6080227	08/02/16	08/04/16	EPA 6010B	

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2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

ADL-30-B

T161774-19 (Soil)

SunStar Laboratories, Inc.

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Metals by EPA 6010B									
Lead	ND	3.00	mg/kg	1	6080227	08/02/16	08/04/16	EPA 6010B	
Conventional Chemistry Parameters by APHA/EPA/ASTM Methods									
pH	**6.6**	0.1	pH Units	1	6081222	08/12/16	08/12/16	EPA 9045B	O-04

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Katherine RunningCrane, Project Manager

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2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
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ADL-30-C

T161774-20 (Soil)

SunStar Laboratories, Inc.

Metals by EPA 6010B

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Lead	ND	3.00	mg/kg	1	6080227	08/02/16	08/04/16	EPA 6010B	

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2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
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ADL-1-A

T161774-21 (Soil)

SunStar Laboratories, Inc.

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Metals by EPA 6010B									
Lead	**88.9**	3.00	mg/kg	1	6080227	08/02/16	08/04/16	EPA 6010B	
STLC Metals by 6000/7000 Series Methods									
Lead	**5.03**	0.100	mg/l	1	6081220	08/12/16	08/15/16	STLC Waste Extraction Test	

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ADL-1-B

T161774-22 (Soil)

SunStar Laboratories, Inc.

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Metals by EPA 6010B									
Lead	**79.5**	3.00	mg/kg	1	6080228	08/02/16	08/04/16	EPA 6010B	
TCLP Metals by 6000/7000 Series Methods									
Lead	**0.118**	0.100	mg/l	1	6082614	08/26/16	09/01/16	EPA 1311	
STLC Metals by 6000/7000 Series Methods									
Lead	**6.74**	0.100	mg/l	1	6081220	08/12/16	08/15/16	STLC Waste Extraction Test	

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Katherine RunningCrane, Project Manager

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ADL-1-C

T161774-23 (Soil)

SunStar Laboratories, Inc.

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Metals by EPA 6010B									
Lead	**118**	3.00	mg/kg	1	6080228	08/02/16	08/04/16	EPA 6010B	
STLC Metals by 6000/7000 Series Methods									
Lead	**18.9**	0.100	mg/l	1	6081220	08/12/16	08/15/16	STLC Waste Extraction Test	

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ADL-2-A

T161774-24 (Soil)

SunStar Laboratories, Inc.

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Metals by EPA 6010B									
Lead	**51.1**	3.00	mg/kg	1	6080228	08/02/16	08/04/16	EPA 6010B	
STLC Metals by 6000/7000 Series Methods									
Lead	**3.64**	0.100	mg/l	1	6081220	08/12/16	08/15/16	STLC Waste Extraction Test	
Conventional Chemistry Parameters by APHA/EPA/ASTM Methods									
pH	**5.5**	0.1	pH Units	1	6081222	08/12/16	08/12/16	EPA 9045B	O-04

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2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
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ADL-2-B

T161774-25 (Soil)

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
SunStar Laboratories, Inc.									
Metals by EPA 6010B									
Lead	**284**	3.00	mg/kg	1	6080228	08/02/16	08/04/16	EPA 6010B	
STLC Metals by 6000/7000 Series Methods									
Lead	**29.5**	0.100	mg/l	1	6081220	08/12/16	08/15/16	STLC Waste Extraction Test	

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2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

ADL-3-A

T161774-26 (Soil)

SunStar Laboratories, Inc.

Metals by EPA 6010B

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Lead	**43.9**	3.00	mg/kg	1	6080228	08/02/16	08/04/16	EPA 6010B	

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2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

ADL-3-B

T161774-27 (Soil)

SunStar Laboratories, Inc.

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Metals by EPA 6010B									
Lead	**59.8**	3.00	mg/kg	1	6080228	08/02/16	08/04/16	EPA 6010B	
STLC Metals by 6000/7000 Series Methods									
Lead	**5.74**	0.100	mg/l	1	6081220	08/12/16	08/15/16	STLC Waste Extraction Test	

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2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

ADL-3-C

T161774-28 (Soil)

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
SunStar Laboratories, Inc.									
Metals by EPA 6010B									
Lead	**49.0**	3.00	mg/kg	1	6080228	08/02/16	08/04/16	EPA 6010B	

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2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

ADL-4-A

T161774-29 (Soil)

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
SunStar Laboratories, Inc.									
Metals by EPA 6010B									
Lead	ND	3.00	mg/kg	1	6080228	08/02/16	08/04/16	EPA 6010B	

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2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
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ADL-4-B

T161774-30 (Soil)

SunStar Laboratories, Inc.

Metals by EPA 6010B

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Lead	**14.6**	3.00	mg/kg	1	6080228	08/02/16	08/04/16	EPA 6010B	

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2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

ADL-5-A

T161774-31 (Soil)

SunStar Laboratories, Inc.

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Metals by EPA 6010B									
Lead	**49.2**	3.00	mg/kg	1	6080228	08/02/16	08/04/16	EPA 6010B	
STLC Metals by 6000/7000 Series Methods									
Lead	ND	0.100	mg/l	1	6082617	08/26/16	08/29/16	STLC Waste Extraction Test	DI-WET

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2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

ADL-5-B

T161774-32 (Soil)

SunStar Laboratories, Inc.

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Metals by EPA 6010B									
Lead	**452**	3.00	mg/kg	1	6080228	08/02/16	08/04/16	EPA 6010B	
TCLP Metals by 6000/7000 Series Methods									
Lead	**1.55**	0.100	mg/l	1	6082614	08/26/16	09/01/16	EPA 1311	
STLC Metals by 6000/7000 Series Methods									
Lead	**44.9**	0.100	mg/l	1	6081220	08/12/16	08/15/16	STLC Waste Extraction Test	
Conventional Chemistry Parameters by APHA/EPA/ASTM Methods									
pH	**5.6**	0.1	pH Units	1	6081222	08/12/16	08/12/16	EPA 9045B	O-04

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Katherine RunningCrane, Project Manager

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2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

ADL-6-A

T161774-33 (Soil)

SunStar Laboratories, Inc.

Metals by EPA 6010B

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Lead	**39.2**	3.00	mg/kg	1	6080228	08/02/16	08/04/16	EPA 6010B	

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2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

ADL-6-B

T161774-34 (Soil)

SunStar Laboratories, Inc.

Metals by EPA 6010B

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Lead	**31.9**	3.00	mg/kg	1	6080228	08/02/16	08/04/16	EPA 6010B	

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2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

ADL-6-C

T161774-35 (Soil)

SunStar Laboratories, Inc.

Metals by EPA 6010B

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Lead	ND	3.00	mg/kg	1	6080228	08/02/16	08/04/16	EPA 6010B	

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2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

ADL-11-A

T161774-36 (Soil)

SunStar Laboratories, Inc.

Metals by EPA 6010B

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Lead	**12.9**	3.00	mg/kg	1	6080228	08/02/16	08/04/16	EPA 6010B	

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2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

ADL-12-A

T161774-37 (Soil)

SunStar Laboratories, Inc.

Metals by EPA 6010B

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Lead	ND	3.00	mg/kg	1	6080228	08/02/16	08/04/16	EPA 6010B	

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2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

ADL-12-B

T161774-38 (Soil)

SunStar Laboratories, Inc.

Metals by EPA 6010B

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Lead	ND	3.00	mg/kg	1	6080228	08/02/16	08/04/16	EPA 6010B	

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2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

ADL-12-C

T161774-39 (Soil)

SunStar Laboratories, Inc.

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Metals by EPA 6010B									
Lead	ND	3.00	mg/kg	1	6080228	08/02/16	08/04/16	EPA 6010B	
Conventional Chemistry Parameters by APHA/EPA/ASTM Methods									
pH	**6.9**	0.1	pH Units	1	6081222	08/12/16	08/12/16	EPA 9045B	O-04

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Blackburn Consulting-West Sac.	Project: US-50 and Hazel Ave Interchange	
2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

ADL-13-A

T161774-40 (Soil)

SunStar Laboratories, Inc.

Metals by EPA 6010B

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Lead	ND	3.00	mg/kg	1	6080228	08/02/16	08/04/16	EPA 6010B	

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Blackburn Consulting-West Sac.	Project: US-50 and Hazel Ave Interchange	
2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

ADL-32-A

T161774-41 (Soil)

SunStar Laboratories, Inc.

Metals by EPA 6010B

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Lead	ND	3.00	mg/kg	1	6080228	08/02/16	08/04/16	EPA 6010B	

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Blackburn Consulting-West Sac.	Project: US-50 and Hazel Ave Interchange	
2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

ADL-7-A

T161774-42 (Soil)

SunStar Laboratories, Inc.

Metals by EPA 6010B

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Lead	**15.5**	3.00	mg/kg	1	6080229	08/02/16	08/04/16	EPA 6010B	

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Blackburn Consulting-West Sac.	Project: US-50 and Hazel Ave Interchange	
2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

ADL-7-B

T161774-43 (Soil)

SunStar Laboratories, Inc.

Metals by EPA 6010B

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Lead	**25.5**	3.00	mg/kg	1	6080229	08/02/16	08/04/16	EPA 6010B	

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Blackburn Consulting-West Sac.	Project: US-50 and Hazel Ave Interchange	
2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

ADL-8-A

T161774-44 (Soil)

SunStar Laboratories, Inc.

Metals by EPA 6010B

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Lead	**13.1**	3.00	mg/kg	1	6080229	08/02/16	08/04/16	EPA 6010B	

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2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

ADL-8-B

T161774-45 (Soil)

SunStar Laboratories, Inc.

Metals by EPA 6010B

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Lead	ND	3.00	mg/kg	1	6080229	08/02/16	08/04/16	EPA 6010B	

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2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

ADL-10-A

T161774-46 (Soil)

SunStar Laboratories, Inc.

Metals by EPA 6010B

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Lead	**20.0**	3.00	mg/kg	1	6080229	08/02/16	08/04/16	EPA 6010B	

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2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

ADL-10-B

T161774-47 (Soil)

SunStar Laboratories, Inc.

Metals by EPA 6010B

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Lead	ND	3.00	mg/kg	1	6080229	08/02/16	08/04/16	EPA 6010B	

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2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

ADL-10-C

T161774-48 (Soil)

SunStar Laboratories, Inc.

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Metals by EPA 6010B									
Lead	ND	3.00	mg/kg	1	6080229	08/02/16	08/04/16	EPA 6010B	
Conventional Chemistry Parameters by APHA/EPA/ASTM Methods									
pH	**8.0**	0.1	pH Units	1	6081222	08/12/16	08/12/16	EPA 9045B	O-04

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2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

ADL-14-A

T161774-49 (Soil)

SunStar Laboratories, Inc.

Metals by EPA 6010B

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Lead	ND	3.00	mg/kg	1	6080229	08/02/16	08/04/16	EPA 6010B	

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2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

ADL-14-B

T161774-50 (Soil)

SunStar Laboratories, Inc.

Metals by EPA 6010B

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Lead	ND	3.00	mg/kg	1	6080229	08/02/16	08/04/16	EPA 6010B	

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2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
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ADL-15-A

T161774-51 (Soil)

SunStar Laboratories, Inc.

Metals by EPA 6010B

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Lead	ND	3.00	mg/kg	1	6080229	08/02/16	08/04/16	EPA 6010B	

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2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
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ADL-15-B

T161774-52 (Soil)

SunStar Laboratories, Inc.

Metals by EPA 6010B

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Lead	ND	3.00	mg/kg	1	6080229	08/02/16	08/04/16	EPA 6010B	

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2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
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ADL-15-C

T161774-53 (Soil)

SunStar Laboratories, Inc.

Metals by EPA 6010B

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Lead	ND	3.00	mg/kg	1	6080229	08/02/16	08/04/16	EPA 6010B	

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2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

ADL-16-A

T161774-54 (Soil)

SunStar Laboratories, Inc.

Metals by EPA 6010B

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Lead	ND	3.00	mg/kg	1	6080229	08/02/16	08/04/16	EPA 6010B	

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2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

ADL-17-A

T161774-55 (Soil)

SunStar Laboratories, Inc.

Metals by EPA 6010B

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Lead	ND	3.00	mg/kg	1	6080229	08/02/16	08/04/16	EPA 6010B	

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2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

ADL-17-B

T161774-56 (Soil)

SunStar Laboratories, Inc.

Metals by EPA 6010B

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Lead	**21.0**	3.00	mg/kg	1	6080229	08/02/16	08/04/16	EPA 6010B	

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2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

ADL-19-A

T161774-57 (Soil)

SunStar Laboratories, Inc.

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Metals by EPA 6010B									
Lead	**22.2**	3.00	mg/kg	1	6080229	08/02/16	08/04/16	EPA 6010B	
STLC Metals by 6000/7000 Series Methods									
Lead	ND	0.100	mg/l	1	6082617	08/26/16	08/29/16	STLC Waste Extraction Test	DI-WET
Conventional Chemistry Parameters by APHA/EPA/ASTM Methods									
pH	**7.2**	0.1	pH Units	1	6081222	08/12/16	08/12/16	EPA 9045B	O-04

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Katherine RunningCrane

Katherine RunningCrane, Project Manager

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2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

ADL-19-B

T161774-58 (Soil)

SunStar Laboratories, Inc.

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Metals by EPA 6010B									
Lead	**64.9**	3.00	mg/kg	1	6080229	08/02/16	08/04/16	EPA 6010B	
STLC Metals by 6000/7000 Series Methods									
Lead	**6.92**	0.100	mg/l	1	6081220	08/12/16	08/15/16	STLC Waste Extraction Test	

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Katherine RunningCrane

Katherine RunningCrane, Project Manager

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2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

ADL-19-C

T161774-59 (Soil)

SunStar Laboratories, Inc.

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Metals by EPA 6010B									
Lead	**46.0**	3.00	mg/kg	1	6080229	08/02/16	08/04/16	EPA 6010B	
STLC Metals by 6000/7000 Series Methods									
Lead	ND	0.100	mg/l	1	6082617	08/26/16	08/29/16	STLC Waste Extraction Test	DI-WET

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Katherine RunningCrane

Katherine RunningCrane, Project Manager

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ADL-31-A

T161774-60 (Soil)

SunStar Laboratories, Inc.

Metals by EPA 6010B

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Lead	ND	3.00	mg/kg	1	6080229	08/02/16	08/04/16	EPA 6010B	

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2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

ADL-31-B

T161774-61 (Soil)

SunStar Laboratories, Inc.

Metals by EPA 6010B

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Lead	ND	3.00	mg/kg	1	6080229	08/02/16	08/04/16	EPA 6010B	

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2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

Metals by EPA 6010B - Quality Control

SunStar Laboratories, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 6080112 - EPA 3051										
Blank (6080112-BLK1)				Prepared: 08/01/16 Analyzed: 08/02/16						
Lead	ND	3.00	mg/kg							
LCS (6080112-BS1)				Prepared: 08/01/16 Analyzed: 08/02/16						
Lead	84.4	3.00	mg/kg	100		84.4	75-125			
Matrix Spike (6080112-MS1)	**Source: T161769-01**			Prepared: 08/01/16 Analyzed: 08/02/16						
Lead	86.2	3.00	mg/kg	100	3.43	82.8	75-125			
Matrix Spike Dup (6080112-MSD1)	**Source: T161769-01**			Prepared: 08/01/16 Analyzed: 08/02/16						
Lead	85.4	3.00	mg/kg	99.0	3.43	82.8	75-125	0.877	20	
Batch 6080227 - EPA 3051										
Blank (6080227-BLK1)				Prepared: 08/02/16 Analyzed: 08/04/16						
Lead	ND	3.00	mg/kg							
LCS (6080227-BS1)				Prepared: 08/02/16 Analyzed: 08/04/16						
Lead	100	3.00	mg/kg	100		100	75-125			
Matrix Spike (6080227-MS1)	**Source: T161774-02**			Prepared: 08/02/16 Analyzed: 08/04/16						
Lead	129	3.00	mg/kg	95.2	33.4	100	75-125			
Matrix Spike Dup (6080227-MSD1)	**Source: T161774-02**			Prepared: 08/02/16 Analyzed: 08/04/16						
Lead	127	3.00	mg/kg	98.0	33.4	95.8	75-125	1.38	20	
Batch 6080228 - EPA 3051										
Blank (6080228-BLK1)				Prepared: 08/02/16 Analyzed: 08/04/16						
Lead	ND	3.00	mg/kg							

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Katherine RunningCrane

Katherine RunningCrane, Project Manager

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Metals by EPA 6010B - Quality Control

SunStar Laboratories, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 6080228 - EPA 3051										
LCS (6080228-BS1)				Prepared: 08/02/16 Analyzed: 08/04/16						
Lead	79.0	3.00	mg/kg	100		79.0	75-125			
Matrix Spike (6080228-MS1)		**Source: T161774-22**		Prepared: 08/02/16 Analyzed: 08/04/16						
Lead	123	3.00	mg/kg	98.0	79.5	44.3	75-125			QM-07
Matrix Spike Dup (6080228-MSD1)		**Source: T161774-22**		Prepared: 08/02/16 Analyzed: 08/04/16						
Lead	96.8	3.00	mg/kg	97.1	79.5	17.8	75-125	23.8	20	QM-07
Batch 6080229 - EPA 3051										
Blank (6080229-BLK1)				Prepared: 08/02/16 Analyzed: 08/04/16						
Lead	ND	3.00	mg/kg							
LCS (6080229-BS1)				Prepared: 08/02/16 Analyzed: 08/04/16						
Lead	99.5	3.00	mg/kg	100		99.5	75-125			
Matrix Spike (6080229-MS1)		**Source: T161774-42**		Prepared: 08/02/16 Analyzed: 08/04/16						
Lead	86.3	3.00	mg/kg	98.0	15.5	72.2	75-125			QR-04
Matrix Spike Dup (6080229-MSD1)		**Source: T161774-42**		Prepared: 08/02/16 Analyzed: 08/04/16						
Lead	90.8	3.00	mg/kg	95.2	15.5	79.0	75-125	5.01	20	

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2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

TCLP Metals by 6000/7000 Series Methods - Quality Control

SunStar Laboratories, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 6082614 - TCLP Metals										
Blank (6082614-BLK1)				Prepared: 08/26/16 Analyzed: 09/01/16						
Lead	ND	0.100	mg/l							
LCS (6082614-BS1)				Prepared: 08/26/16 Analyzed: 09/01/16						
Lead	0.442	0.100	mg/l	0.500		88.4	75-125			
Matrix Spike (6082614-MS1)	**Source: T161774-22**			Prepared: 08/26/16 Analyzed: 09/01/16						
Lead	0.555	0.100	mg/l	0.500	0.118	87.5	75-125			
Matrix Spike Dup (6082614-MSD1)	**Source: T161774-22**			Prepared: 08/26/16 Analyzed: 09/01/16						
Lead	0.559	0.100	mg/l	0.500	0.118	88.3	75-125	0.740	30	

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Katherine RunningCrane

Katherine RunningCrane, Project Manager

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Blackburn Consulting-West Sac.	Project: US-50 and Hazel Ave Interchange	
2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

STLC Metals by 6000/7000 Series Methods - Quality Control

SunStar Laboratories, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 6081220 - STLC Metals										
Blank (6081220-BLK1)				Prepared: 08/12/16 Analyzed: 08/15/16						
Lead	ND	0.100	mg/l							
LCS (6081220-BS1)				Prepared: 08/12/16 Analyzed: 08/15/16						
Lead	10.4	0.100	mg/l	10.0		104	75-125			
Matrix Spike (6081220-MS1)	**Source: T161774-01**			Prepared: 08/12/16 Analyzed: 08/15/16						
Lead	12.4	0.100	mg/l	10.0	2.61	98.3	75-125			
Matrix Spike Dup (6081220-MSD1)	**Source: T161774-01**			Prepared: 08/12/16 Analyzed: 08/15/16						
Lead	12.0	0.100	mg/l	10.0	2.61	93.9	75-125	3.64	30	
Batch 6082617 - STLC Metals										
Blank (6082617-BLK1)				Prepared: 08/26/16 Analyzed: 08/29/16						
Lead	ND	0.100	mg/l							DI-WET
LCS (6082617-BS1)				Prepared: 08/26/16 Analyzed: 08/29/16						
Lead	10.8	0.100	mg/l	10.0		108	75-125			DI-WET
Matrix Spike (6082617-MS1)	**Source: T161774-31**			Prepared: 08/26/16 Analyzed: 08/29/16						
Lead	9.71	0.100	mg/l	10.0	ND	97.1	75-125			DI-WET
Matrix Spike Dup (6082617-MSD1)	**Source: T161774-31**			Prepared: 08/26/16 Analyzed: 08/29/16						
Lead	9.72	0.100	mg/l	10.0	ND	97.2	75-125	0.178	30	DI-WET

SunStar Laboratories, Inc.

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Katherine RunningCrane

Katherine RunningCrane, Project Manager

SunStar Laboratories, Inc.
PROVIDING QUALITY ANALYTICAL SERVICES NATIONWIDE

25712 Commercentre Drive
Lake Forest, California 92630
949.297.5020 Phone
949.297.5027 Fax

Blackburn Consulting-West Sac.	Project: US-50 and Hazel Ave Interchange	
2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

Conventional Chemistry Parameters by APHA/EPA/ASTM Methods - Quality Control

SunStar Laboratories, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 6081222 - General Preparation										
Duplicate (6081222-DUP1)		**Source: T161742-01**		Prepared & Analyzed: 08/12/16						
pH	8.23	0.1	pH Units		8.20			0.365	20	

SunStar Laboratories, Inc.
PROVIDING QUALITY ANALYTICAL SERVICES NATIONWIDE

25712 Commercentre Drive
Lake Forest, California 92630
949.297.5020 Phone
949.297.5027 Fax

Blackburn Consulting-West Sac.	Project: US-50 and Hazel Ave Interchange	
2491 Boatman Ave.	Project Number: 2843.X	**Reported:**
West Sacramento CA, -	Project Manager: Kristy Chapman	09/01/16 17:45

Notes and Definitions

QR-04	The pecent recovery and/or RPD was outside acceptance criteria. Results accepted based upon percent recovery results in duplicate QC sample and the CCV and CCB results.
QM-07	The spike recovery and or RPD was outside acceptance limits for the MS and/or MSD. The batch was accepted based on acceptable LCS recovery.
O-04	This sample was received and analyzed outside the EPA recommended holding time.
DI-WET	Sample was extracted using DI water in place of extraction fluid for Waste Extraction Test.
DET	Analyte DETECTED
ND	Analyte NOT DETECTED at or above the reporting limit
NR	Not Reported
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference

SunStar Laboratories, Inc.

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Katherine RunningCrane

Katherine RunningCrane, Project Manager

SunStar Laboratories, Inc.

PROVIDING QUALITY ANALYTICAL SERVICES NATIONWIDE

25712 Commercentre Drive, Lake Forest, CA 92630
949-297-5020

Chain of Custody Record

PO # 10703

Client: Blackburn Consulting
Address: 2491 Boatman Ave, West Sac
Phone: Fax:
Project Manager: Kristy Chapman (KAC)

Date: 7/27/16 Page: 1 Of 5
Project Name: US-50 and Hazel Ave Interchange
Collector: Client Project #: 28435.A
Batch #: ~~T161775~~ T161774 EDF #:

Sample ID	Date Sampled	Time	Sample Type	Container Type	8260	8260 + OXY	8260 BTEX, OXY only	8270	8021 BTEX	8015M (gasoline)	8015M (diesel)	8015M Ext./Carbon Chain	6010/7000 Title 22 Metals	6020 ICP-MS Metals	6010B - Lead			Laboratory ID #	Comments/Preservative	Total # of containers
ADL-9-A	7/27	10:20	Soil	4oz Jar											X			01		
" -9-B		10:40																02		
" -18-A		10:50																03		
" -18-B		11:15																04		
" -20-A		11:30																05		
" -20-B		11:35																06		
" -21-A		11:50																07		
" -21-B		11:55																08		
" -22-A		12:20																09		
" -23-A		13:00																10		
" -23-B		13:15																11		
" -24-A		12:00																12		
" -24-B		12:04																13		
" -24-C		12:06																14		
" -25-A	X	12:20	X	X											X			15		

Relinquished by: (signature)	Date / Time	Received by: (signature)	Date / Time
	7/29/16 1615	EQ Stevens	7/29/16 1615
Relinquished by: (signature)	Date / Time	Received by: (signature)	Date / Time
GSO 7:30:16	10:00		7:30:16 10:00
Relinquished by: (signature)	Date / Time	Received by: (signature)	Date / Time

Total # of containers: 15
Chain of Custody seals Y/N/NA: (N)
Seals intact? Y/N/NA:
Received good condition/cold: 3.0

Turn around time: Std

Notes

Sample disposal Instructions: Disposal @ $2.00 each ____ Return to client ____ Pickup ____

COC 150813

SunStar Laboratories, Inc.

PROVIDING QUALITY ANALYTICAL SERVICES NATIONWIDE

25712 Commercentre Drive, Lake Forest, CA 92630
949-297-5020

Chain of Custody Record

PO #10703

Client: Blackburn Consulting

Address:

Phone: Fax:

Project Manager: KAC

Date: 7/27 and 7/28 Page: 2 Of 5

Project Name: US-50 and Hazel Ave Interchange

Collector: Client Project #: 2843.X

Batch #: 7161774 EDF #:

Sample ID	Date Sampled	Time	Sample Type	Container Type	8260	8260 + OXY	8260 BTEX, OXY only	8270	8021 BTEX	8015M (gasoline)	8015M (diesel)	8015M Ext./Carbon Chain	6010/7000 Title 22 Metals	6020 ICP-MS Metals	✓ 6010B - Lead			Laboratory ID #	Comments/Preservative	Total # of containers
ADL-28-A	7/27	10:22	Soil	4oz Jar											X			16		
" -29-A		10:08																17		
-30-A		10:40																18		
-30-B		10:43																19		
-30-C	X	10:49	X	X											X			20		
ADL-1-A	7/28	9:45	Soil	4oz Jar											X			21		
" -1-B		9:50																22		
-1-C		10:00																23		
-2-A		10:20																24		
-2-B		10:25																25		
-3-A		10:40																26		
-3-B		10:45																27		
-3-C		11:00																28		
-4-A	X	11:30	X	X											X			29		

Relinquished by: (signature)	Date / Time	Received by: (signature)	Date / Time
	7/29/16 16:15	Ed Stevens	7/29/16 1615
Relinquished by: (signature)	Date / Time	Received by: (signature)	Date / Time
GSO 7-30-16	10:00		7-30-16 10:00
Relinquished by: (signature)	Date / Time	Received by: (signature)	Date / Time

Total # of containers: 14

Chain of Custody seals Y/N/NA

Seals intact? Y/N/NA

Received good condition/cold: 3.0

Turn around time: Std

Notes

Sample disposal Instructions: Disposal @ $2.00 each ____ Return to client ____ Pickup ____

COC 141594

SunStar Laboratories, Inc.

PROVIDING QUALITY ANALYTICAL SERVICES NATIONWIDE

25712 Commercentre Drive, Lake Forest, CA 92630
949-297-5020

Chain of Custody Record

PO #10703

Client: Blackburn Consulting
Address: 2491 Boatman Ave, West Sacramento
Phone: _____ Fax: _____
Project Manager: Kristy Chapman

Date: 7/28/16 Page: 3 Of 5
Project Name: US-50 and Hazel Ave Interchange
Collector: _____ Client Project #: 2843.X
Batch #: T161774 EDF #: _____

Sample ID	Date Sampled	Time	Sample Type	Container Type	8260	8260 + OXY	8260 BTEX, OXY only	8270	8021 BTEX	8015M (gasoline)	8015M (diesel)	8015M Ext./Carbon Chain	6010/7000 Title 22 Metals	6020 ICP-MS Metals	6010B - Lead			Laboratory ID #	Comments/Preservative	Total # of containers
ADL-4-B	7/28	11:40	Soil	4oz Jar											X			30		
-5-A		12:00																31		
-5-B		12:12																32		
-6-A		12:00																33		
-6-B		12:15																34		
-6-C		12:40																35		
-11-A		10:20																36		
-12-A		11:02																37		
-12-B		11:20																38		
-12-C		11:38																39		
-13-A		10:04																40		
-32-A	X	10:13													X			41		

Relinquished by: (signature)	Date / Time	Received by: (signature)	Date / Time
[signature]	7/29/16 16:15	[signature]	7/29/16 1615
[signature] GSO	7.30.16 10:00	[signature]	7.30.16 10:00
Relinquished by: (signature)	Date / Time	Received by: (signature)	Date / Time

Total # of containers: 12
Chain of Custody seals Y/N/NA:
Seals intact? Y/N/NA:
Received good condition/cold: 3.0

Turn around time: STD

Notes

Sample disposal Instructions: Disposal @ $2.00 each ____ Return to client ____ Pickup ____

COC 150787

SunStar Laboratories, Inc.

PROVIDING QUALITY ANALYTICAL SERVICES NATIONWIDE

25712 Commercentre Drive, Lake Forest, CA 92630
949-297-5020

Chain of Custody Record

PO # 10703

Client: Blackburn Consulting
Address: 2491 Boatman Ave, West Sacramento
Phone: ____ Fax: ____
Project Manager: Kristy Chapman

Date: 7/29/16 Page: 4 Of 5
Project Name: US-50 and Hazel Ave Interchange
Collector: ____ Client Project #: 2843.X
Batch #: T161774 EDF #: ____

Sample ID	Date Sampled	Time	Sample Type	Container Type	8260	8260 + OXY	8260 BTEX, OXY only	8270	8021 BTEX	8015M (gasoline)	8015M (diesel)	8015M Ext./Carbon Chain	6010/7000 Title 22 Metals	6020 ICP-MS Metals	6010B - Lead			Laboratory ID #	Comments/Preservative	Total # of containers
ADL-7-A	7/29	9:53	Soil	4oz Jar											X			42		
-7-B		9:50																43		
-8-A		10:13																44		
-8-B		10:25																45		
-10-A		10:40																46		
-10-B		10:45																47		
-10-C		10:52																48		
-14-A		11:15																49		
-14-B		11:20																50		
-15-A		12:00																51		
-15-B		12:05																52		
-15-C		12:15																53		
-16-A		12:30																54		
~~MW6~~ -17-A		11:15																55		
-17-B	X	11:30	X	X											X			56		

Relinquished by: (signature)	Date / Time	Received by: (signature)	Date / Time
[signature]	7/29/16 16:15	[signature]	7/29/16 1615
[signature] G50	7-30-16 10:00	[signature]	7-30-16 10:00

Total # of containers: 15
Chain of Custody seals Y/N/NA:
Seals intact? Y/N/NA:
Received good condition/cold: 3.0

Turn around time: STD

Notes

Sample disposal Instructions: Disposal @ $2.00 each ____ Return to client ____ Pickup ____

MG

COC 150788

SunStar Laboratories, Inc.

PROVIDING QUALITY ANALYTICAL SERVICES NATIONWIDE

25712 Commercentre Drive, Lake Forest, CA 92630
949-297-5020

Chain of Custody Record

PO # 10703

Client: Blackborn Consulting
Address: 2491 Boatman Ave, West Sacramento
Phone: Fax:
Project Manager: Kristy Chapman

Date: 7/29/16 Page: 5 Of 5
Project Name: US-50 and Hazel Ave Interchange
Collector:
Client Project #: 2543.X
Batch #: 7161774 EDF #:

Sample ID	Date Sampled	Time	Sample Type	Container Type	8260	8260 + OXY	8260 BTEX, OXY only	8270	8021 BTEX	8015M (gasoline)	8015M (diesel)	8015M Ext./Carbon Chain	6010/7000 Title 22 Metals	6020 ICP-MS Metals	6010B - Lead			Laboratory ID #	Comments/Preservative	Total # of containers
ADL-19-A	7/29	10:00	Soil	4oz Jar											X			57		
-19-B	"	10:30	"	"											"			58		
-19-C	"	10:45	"	"											"			59		
-31-A	"	12:06	"	"											"			60		
-31-B	X	12:15	X	X											X			61		

Relinquished by: (signature)	Date / Time	Received by: (signature)	Date / Time
	7/29/16 16:15		7-29-16 1615
Relinquished by: (signature)	Date / Time	Received by: (signature)	Date / Time
GSO	7-30-16 10:00		7-30-16 10:00
Relinquished by: (signature)	Date / Time	Received by: (signature)	Date / Time

Total # of containers: 5
Chain of Custody seals Y/N/NA: (N)
Seals intact? Y/N/NA: (N)
Received good condition/cold: 3.0

Turn around time: Std

Notes

Sample disposal Instructions: Disposal @ $2.00 each ____ Return to client ____ Pickup ____

COC 150789

SunStar Laboratories, Inc.
PROVIDING QUALITY ANALYTICAL SERVICES NATIONWIDE

SAMPLE RECEIVING REVIEW SHEET

Batch/Work Order #: T161774

Client Name: BLACKBURN CON. Project: US-50 AND HAZEL AVE INTERCHANG

Delivered by: ☐ Client ☐ SunStar Courier ☒ GSO ☐ FedEx ☐ Other

If Courier, Received by: _____ Date/Time Courier Received: _____

Lab Received by: SUNNY Date/Time Lab Received: 7-30-16 / 10:00

Total number of coolers received: 1

Temperature:	Cooler #1 3.2	°C +/- the CF (- 0.2°C) = 3.0	°C corrected temperature
Temperature:	Cooler #2	°C +/- the CF (- 0.2°C) =	°C corrected temperature
Temperature:	Cooler #3	°C +/- the CF (- 0.2°C) =	°C corrected temperature

Temperature criteria = ≤ 6°C (no frozen containers)	Within criteria?	☒ **Yes** ☐ **No**
If NO:		
Samples received on ice?	☐ Yes	☐ **No → Complete Non-Conformance Sheet**
If on ice, samples received same day collected?	☐ Yes → Acceptable	☐ **No → Complete Non-Conformance Sheet**

Custody seals intact on cooler/sample	☒ Yes	☐ No*	☐ N/A
Sample containers intact	☒ Yes	☐ No*	
Sample labels match Chain of Custody IDs	☒ Yes	☐ No*	
Total number of containers received match COC	☒ Yes	☐ No*	
Proper containers received for analyses requested on COC	☒ Yes	☐ No*	
Proper preservative indicated on COC/containers for analyses requested	☐ Yes	☐ No*	☒ N/A
Complete shipment received in good condition with correct temperatures, containers, labels, volumes preservatives and within method specified holding times	☒ **Yes**	☐ **No***	

* Complete Non-Conformance Receiving Sheet if checked

Cooler/Sample Review - Initials and date: SL 7.30.16

Comments:

(949) 297-5020 ■ www.sunstarlabs.com ■ 25712 Commercentre Drive ■ Lake Forest, CA 92630

SunStar Laboratories, Inc.
PROVIDING QUALITY ANALYTICAL SERVICES NATIONWIDE

WORK ORDER

T161774

Client:	**Blackburn Consulting-West Sac.**	**Project Manager:**	**Katherine RunningCrane**
Project:	**US-50 and Hazel Ave Interchange**	**Project Number:**	**2843.X**

Report To:

Blackburn Consulting-West Sac.
Kristy Chapman
2491 Boatman Ave.
West Sacramento, CA -

Date Due:	08/08/16 17:00 (5 day TAT)		
Received By:	Sunny Lounethone	Date Received:	07/30/16 10:00
Logged In By:	Sunny Lounethone	Date Logged In:	07/30/16 11:50

Samples Received at:	**3°C**		
Custody Seals	Yes	Received On Ice	Yes
Containers Intact	Yes		
COC/Labels Agree	Yes		
Preservation Confirme	No		

Analysis	Due	TAT	Expires	Comments
T161774-01 ADL-9-A [Soil] Sampled 07/27/16 10:20 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/23/17 10:20	
T161774-02 ADL-9-B [Soil] Sampled 07/27/16 10:40 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/23/17 10:40	
T161774-03 ADL-18-A [Soil] Sampled 07/27/16 10:50 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/23/17 10:50	
T161774-04 ADL-18-B [Soil] Sampled 07/27/16 11:15 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/23/17 11:15	
T161774-05 ADL-20-A [Soil] Sampled 07/27/16 11:30 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/23/17 11:30	
T161774-06 ADL-20-B [Soil] Sampled 07/27/16 11:35 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/23/17 11:35	
T161774-07 ADL-21-A [Soil] Sampled 07/27/16 11:50 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/23/17 11:50	

SunStar Laboratories, Inc.
PROVIDING QUALITY ANALYTICAL SERVICES NATIONWIDE

WORK ORDER

T161774

Client:	**Blackburn Consulting-West Sac.**	**Project Manager:**	**Katherine RunningCrane**
Project:	**US-50 and Hazel Ave Interchange**	**Project Number:**	**2843.X**

Analysis	Due	TAT	Expires	Comments
T161774-08 ADL-21-B [Soil] Sampled 07/27/16 11:55 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/23/17 11:55	
T161774-09 ADL-22-A [Soil] Sampled 07/27/16 12:20 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/23/17 12:20	
T161774-10 ADL-23-A [Soil] Sampled 07/27/16 13:00 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/23/17 13:00	
T161774-11 ADL-23-B [Soil] Sampled 07/27/16 13:15 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/23/17 13:15	
T161774-12 ADL-24-A [Soil] Sampled 07/27/16 12:00 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/23/17 12:00	
T161774-13 ADL-24-B [Soil] Sampled 07/27/16 12:04 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/23/17 12:04	
T161774-14 ADL-24-C [Soil] Sampled 07/27/16 12:06 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/23/17 12:06	
T161774-15 ADL-25-A [Soil] Sampled 07/27/16 12:20 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/23/17 12:20	
T161774-16 ADL-28-A [Soil] Sampled 07/27/16 10:22 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/23/17 10:22	
T161774-17 ADL-29-A [Soil] Sampled 07/27/16 10:08 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/23/17 10:08	
T161774-18 ADL-30-A [Soil] Sampled 07/27/16 10:40 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/23/17 10:40	

SunStar Laboratories, Inc.
PROVIDING QUALITY ANALYTICAL SERVICES NATIONWIDE

WORK ORDER

T161774

Client:	**Blackburn Consulting-West Sac.**	**Project Manager:**	**Katherine RunningCrane**
Project:	**US-50 and Hazel Ave Interchange**	**Project Number:**	**2843.X**

Analysis	Due	TAT	Expires	Comments
T161774-19 ADL-30-B [Soil] Sampled 07/27/16 10:43 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/23/17 10:43	
T161774-20 ADL-30-C [Soil] Sampled 07/27/16 10:49 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/23/17 10:49	
T161774-21 ADL-1-A [Soil] Sampled 07/28/16 09:45 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/24/17 09:45	
T161774-22 ADL-1-B [Soil] Sampled 07/28/16 09:50 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/24/17 09:50	
T161774-23 ADL-1-C [Soil] Sampled 07/28/16 10:00 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/24/17 10:00	
T161774-24 ADL-2-A [Soil] Sampled 07/28/16 10:20 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/24/17 10:20	
T161774-25 ADL-2-B [Soil] Sampled 07/28/16 10:25 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/24/17 10:25	
T161774-26 ADL-3-A [Soil] Sampled 07/28/16 10:40 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/24/17 10:40	
T161774-27 ADL-3-B [Soil] Sampled 07/28/16 10:45 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/24/17 10:45	
T161774-28 ADL-3-C [Soil] Sampled 07/28/16 11:00 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/24/17 11:00	
T161774-29 ADL-4-A [Soil] Sampled 07/28/16 11:30 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/24/17 11:30	

SunStar Laboratories, Inc.
PROVIDING QUALITY ANALYTICAL SERVICES NATIONWIDE

WORK ORDER

T161774

Client:	**Blackburn Consulting-West Sac.**	**Project Manager:**	**Katherine RunningCrane**
Project:	**US-50 and Hazel Ave Interchange**	**Project Number:**	**2843.X**

Analysis	Due	TAT	Expires	Comments
T161774-30 ADL-4-B [Soil] Sampled 07/28/16 11:40 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/24/17 11:40	
T161774-31 ADL-5-A [Soil] Sampled 07/28/16 12:00 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/24/17 12:00	
T161774-32 ADL-5-B [Soil] Sampled 07/28/16 12:12 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/24/17 12:12	
T161774-33 ADL-6-A [Soil] Sampled 07/28/16 12:00 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/24/17 12:00	
T161774-34 ADL-6-B [Soil] Sampled 07/28/16 12:15 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/24/17 12:15	
T161774-35 ADL-6-C [Soil] Sampled 07/28/16 12:40 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/24/17 12:40	
T161774-36 ADL-11-A [Soil] Sampled 07/28/16 10:20 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/24/17 10:20	
T161774-37 ADL-12-A [Soil] Sampled 07/28/16 11:02 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/24/17 11:02	
T161774-38 ADL-12-B [Soil] Sampled 07/28/16 11:20 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/24/17 11:20	
T161774-39 ADL-12-C [Soil] Sampled 07/28/16 11:38 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/24/17 11:38	
T161774-40 ADL-13-A [Soil] Sampled 07/28/16 10:04 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/24/17 10:04	

SunStar Laboratories, Inc.
PROVIDING QUALITY ANALYTICAL SERVICES NATIONWIDE

WORK ORDER

T161774

Client:	**Blackburn Consulting-West Sac.**	**Project Manager:**	**Katherine RunningCrane**
Project:	**US-50 and Hazel Ave Interchange**	**Project Number:**	**2843.X**

Analysis	Due	TAT	Expires	Comments
T161774-41 ADL-32-A [Soil] Sampled 07/28/16 10:13 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/24/17 10:13	
T161774-42 ADL-7-A [Soil] Sampled 07/29/16 09:53 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/25/17 09:53	
T161774-43 ADL-7-B [Soil] Sampled 07/29/16 09:50 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/25/17 09:50	
T161774-44 ADL-8-A [Soil] Sampled 07/29/16 10:13 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/25/17 10:13	
T161774-45 ADL-8-B [Soil] Sampled 07/29/16 10:25 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/25/17 10:25	
T161774-46 ADL-10-A [Soil] Sampled 07/29/16 10:40 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/25/17 10:40	
T161774-47 ADL-10-B [Soil] Sampled 07/29/16 10:45 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/25/17 10:45	
T161774-48 ADL-10-C [Soil] Sampled 07/29/16 10:52 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/25/17 10:52	
T161774-49 ADL-14-A [Soil] Sampled 07/29/16 11:15 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/25/17 11:15	
T161774-50 ADL-14-B [Soil] Sampled 07/29/16 11:20 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/25/17 11:20	
T161774-51 ADL-15-A [Soil] Sampled 07/29/16 12:00 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/25/17 12:00	

SunStar Laboratories, Inc.
PROVIDING QUALITY ANALYTICAL SERVICES NATIONWIDE

WORK ORDER

T161774

Client:	**Blackburn Consulting-West Sac.**	**Project Manager:**	**Katherine RunningCrane**
Project:	**US-50 and Hazel Ave Interchange**	**Project Number:**	**2843.X**

Analysis	Due	TAT	Expires	Comments
T161774-52 ADL-15-B [Soil] Sampled 07/29/16 12:05 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/25/17 12:05	
T161774-53 ADL-15-C [Soil] Sampled 07/29/16 12:15 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/25/17 12:15	
T161774-54 ADL-16-A [Soil] Sampled 07/29/16 12:30 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/25/17 12:30	
T161774-55 ADL-17-A [Soil] Sampled 07/29/16 11:15 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/25/17 11:15	
T161774-56 ADL-17-B [Soil] Sampled 07/29/16 11:30 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/25/17 11:30	
T161774-57 ADL-19-A [Soil] Sampled 07/29/16 10:00 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/25/17 10:00	
T161774-58 ADL-19-B [Soil] Sampled 07/29/16 10:30 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/25/17 10:30	
T161774-59 ADL-19-C [Soil] Sampled 07/29/16 10:45 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/25/17 10:45	
T161774-60 ADL-31-A [Soil] Sampled 07/29/16 12:06 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/25/17 12:06	
T161774-61 ADL-31-B [Soil] Sampled 07/29/16 12:15 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/25/17 12:15	

Reviewed By

Date

SunStar Laboratories, Inc.
PROVIDING QUALITY ANALYTICAL SERVICES NATIONWIDE

WORK ORDER

T161774

Client:	**Blackburn Consulting-West Sac.**	**Project Manager:**	**Katherine RunningCrane**
Project:	**US-50 and Hazel Ave Interchange**	**Project Number:**	**2843.X**

Report To:

Blackburn Consulting-West Sac.
Kristy Chapman
2491 Boatman Ave.
West Sacramento, CA -

Date Due:	08/08/16 17:00 (5 day TAT)		
Received By:	Sunny Lounethone	Date Received:	07/30/16 10:00
Logged In By:	Sunny Lounethone	Date Logged In:	07/30/16 11:50

Samples Received at:	**3°C**		
Custody Seals	Yes	Received On Ice	Yes
Containers Intact	Yes		
COC/Labels Agree	Yes		
Preservation Confirme	No		

Analysis	Due	TAT	Expires	Comments
T161774-01 ADL-9-A [Soil] Sampled 07/27/16 10:20 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/23/17 10:20	
STLC Pb	08/16/16 15:00	5	01/23/17 10:20	
STLC Leaching Procedure Metals	08/16/16 15:00	5	08/10/16 10:20	
T161774-02 ADL-9-B [Soil] Sampled 07/27/16 10:40 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/23/17 10:40	
T161774-03 ADL-18-A [Soil] Sampled 07/27/16 10:50 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/23/17 10:50	
STLC Pb	08/16/16 15:00	5	01/23/17 10:50	
STLC Leaching Procedure Metals	08/16/16 15:00	5	08/10/16 10:50	
T161774-04 ADL-18-B [Soil] Sampled 07/27/16 11:15 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/23/17 11:15	
STLC Pb	08/16/16 15:00	5	01/23/17 11:15	
STLC Leaching Procedure Metals	08/16/16 15:00	5	08/10/16 11:15	
T161774-05 ADL-20-A [Soil] Sampled 07/27/16 11:30 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/23/17 11:30	
pH soil 9045	08/16/16 15:00	5	08/03/16 11:30	

SunStar Laboratories, Inc.
PROVIDING QUALITY ANALYTICAL SERVICES NATIONWIDE

WORK ORDER

T161774

Client:	**Blackburn Consulting-West Sac.**	**Project Manager:**	**Katherine RunningCrane**
Project:	**US-50 and Hazel Ave Interchange**	**Project Number:**	**2843.X**

Analysis	Due	TAT	Expires	Comments
T161774-06 ADL-20-B [Soil] Sampled 07/27/16 11:35 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/23/17 11:35	
T161774-07 ADL-21-A [Soil] Sampled 07/27/16 11:50 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/23/17 11:50	
T161774-08 ADL-21-B [Soil] Sampled 07/27/16 11:55 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/23/17 11:55	
T161774-09 ADL-22-A [Soil] Sampled 07/27/16 12:20 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/23/17 12:20	
T161774-10 ADL-23-A [Soil] Sampled 07/27/16 13:00 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/23/17 13:00	
T161774-11 ADL-23-B [Soil] Sampled 07/27/16 13:15 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/23/17 13:15	
pH soil 9045	08/16/16 15:00	5	08/03/16 13:15	
T161774-12 ADL-24-A [Soil] Sampled 07/27/16 12:00 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/23/17 12:00	
T161774-13 ADL-24-B [Soil] Sampled 07/27/16 12:04 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/23/17 12:04	
T161774-14 ADL-24-C [Soil] Sampled 07/27/16 12:06 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/23/17 12:06	
pH soil 9045	08/16/16 15:00	5	08/03/16 12:06	
T161774-15 ADL-25-A [Soil] Sampled 07/27/16 12:20 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/23/17 12:20	

SunStar Laboratories, Inc.
PROVIDING QUALITY ANALYTICAL SERVICES NATIONWIDE

WORK ORDER

T161774

Client:	**Blackburn Consulting-West Sac.**	**Project Manager:**	**Katherine RunningCrane**
Project:	**US-50 and Hazel Ave Interchange**	**Project Number:**	**2843.X**

Analysis	Due	TAT	Expires	Comments
T161774-16 ADL-28-A [Soil] Sampled 07/27/16 10:22 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/23/17 10:22	
T161774-17 ADL-29-A [Soil] Sampled 07/27/16 10:08 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/23/17 10:08	
T161774-18 ADL-30-A [Soil] Sampled 07/27/16 10:40 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/23/17 10:40	
T161774-19 ADL-30-B [Soil] Sampled 07/27/16 10:43 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/23/17 10:43	
pH soil 9045	08/16/16 15:00	5	08/03/16 10:43	
T161774-20 ADL-30-C [Soil] Sampled 07/27/16 10:49 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/23/17 10:49	
T161774-21 ADL-1-A [Soil] Sampled 07/28/16 09:45 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/24/17 09:45	
STLC Pb	08/16/16 15:00	5	01/24/17 09:45	
STLC Leaching Procedure Metals	08/16/16 15:00	5	08/11/16 09:45	
T161774-22 ADL-1-B [Soil] Sampled 07/28/16 09:50 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/24/17 09:50	
STLC Pb	08/16/16 15:00	5	01/24/17 09:50	
STLC Leaching Procedure Metals	08/16/16 15:00	5	08/11/16 09:50	
T161774-23 ADL-1-C [Soil] Sampled 07/28/16 10:00 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/24/17 10:00	
STLC Pb	08/16/16 15:00	5	01/24/17 10:00	
STLC Leaching Procedure Metals	08/16/16 15:00	5	08/11/16 10:00	

SunStar Laboratories, Inc.
PROVIDING QUALITY ANALYTICAL SERVICES NATIONWIDE

WORK ORDER

T161774

Client:	**Blackburn Consulting-West Sac.**	**Project Manager:**	**Katherine RunningCrane**
Project:	**US-50 and Hazel Ave Interchange**	**Project Number:**	**2843.X**

Analysis	Due	TAT	Expires	Comments
T161774-24 ADL-2-A [Soil] Sampled 07/28/16 10:20 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/24/17 10:20	
pH soil 9045	08/16/16 15:00	5	08/04/16 10:20	
STLC Pb	08/16/16 15:00	5	01/24/17 10:20	
STLC Leaching Procedure Metals	08/16/16 15:00	5	08/11/16 10:20	
T161774-25 ADL-2-B [Soil] Sampled 07/28/16 10:25 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/24/17 10:25	
STLC Pb	08/16/16 15:00	5	01/24/17 10:25	
STLC Leaching Procedure Metals	08/16/16 15:00	5	08/11/16 10:25	
T161774-26 ADL-3-A [Soil] Sampled 07/28/16 10:40 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/24/17 10:40	
T161774-27 ADL-3-B [Soil] Sampled 07/28/16 10:45 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/24/17 10:45	
STLC Pb	08/16/16 15:00	5	01/24/17 10:45	
STLC Leaching Procedure Metals	08/16/16 15:00	5	08/11/16 10:45	
T161774-28 ADL-3-C [Soil] Sampled 07/28/16 11:00 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/24/17 11:00	
T161774-29 ADL-4-A [Soil] Sampled 07/28/16 11:30 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/24/17 11:30	
T161774-30 ADL-4-B [Soil] Sampled 07/28/16 11:40 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/24/17 11:40	
T161774-31 ADL-5-A [Soil] Sampled 07/28/16 12:00 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/24/17 12:00	

SunStar Laboratories, Inc.
PROVIDING QUALITY ANALYTICAL SERVICES NATIONWIDE

WORK ORDER

T161774

Client:	**Blackburn Consulting-West Sac.**	**Project Manager:**	**Katherine RunningCrane**
Project:	**US-50 and Hazel Ave Interchange**	**Project Number:**	**2843.X**

Analysis	Due	TAT	Expires	Comments
T161774-32 ADL-5-B [Soil] Sampled 07/28/16 12:12 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/24/17 12:12	
pH soil 9045	08/16/16 15:00	5	08/04/16 12:12	
STLC Pb	08/16/16 15:00	5	01/24/17 12:12	
STLC Leaching Procedure Metals	08/16/16 15:00	5	08/11/16 12:12	
T161774-33 ADL-6-A [Soil] Sampled 07/28/16 12:00 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/24/17 12:00	
T161774-34 ADL-6-B [Soil] Sampled 07/28/16 12:15 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/24/17 12:15	
T161774-35 ADL-6-C [Soil] Sampled 07/28/16 12:40 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/24/17 12:40	
T161774-36 ADL-11-A [Soil] Sampled 07/28/16 10:20 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/24/17 10:20	
T161774-37 ADL-12-A [Soil] Sampled 07/28/16 11:02 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/24/17 11:02	
T161774-38 ADL-12-B [Soil] Sampled 07/28/16 11:20 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/24/17 11:20	
T161774-39 ADL-12-C [Soil] Sampled 07/28/16 11:38 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/24/17 11:38	
pH soil 9045	08/16/16 15:00	5	08/04/16 11:38	
T161774-40 ADL-13-A [Soil] Sampled 07/28/16 10:04 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/24/17 10:04	
T161774-41 ADL-32-A [Soil] Sampled 07/28/16 10:13 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/24/17 10:13	

SunStar Laboratories, Inc.
PROVIDING QUALITY ANALYTICAL SERVICES NATIONWIDE

WORK ORDER

T161774

Client:	**Blackburn Consulting-West Sac.**	**Project Manager:**	**Katherine RunningCrane**
Project:	**US-50 and Hazel Ave Interchange**	**Project Number:**	**2843.X**

Analysis	Due	TAT	Expires	Comments
T161774-42 ADL-7-A [Soil] Sampled 07/29/16 09:53 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/25/17 09:53	
T161774-43 ADL-7-B [Soil] Sampled 07/29/16 09:50 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/25/17 09:50	
T161774-44 ADL-8-A [Soil] Sampled 07/29/16 10:13 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/25/17 10:13	
T161774-45 ADL-8-B [Soil] Sampled 07/29/16 10:25 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/25/17 10:25	
T161774-46 ADL-10-A [Soil] Sampled 07/29/16 10:40 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/25/17 10:40	
T161774-47 ADL-10-B [Soil] Sampled 07/29/16 10:45 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/25/17 10:45	
T161774-48 ADL-10-C [Soil] Sampled 07/29/16 10:52 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/25/17 10:52	
pH soil 9045	08/16/16 15:00	5	08/05/16 10:52	
T161774-49 ADL-14-A [Soil] Sampled 07/29/16 11:15 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/25/17 11:15	
T161774-50 ADL-14-B [Soil] Sampled 07/29/16 11:20 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/25/17 11:20	
T161774-51 ADL-15-A [Soil] Sampled 07/29/16 12:00 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/25/17 12:00	

SunStar Laboratories, Inc.
PROVIDING QUALITY ANALYTICAL SERVICES NATIONWIDE

WORK ORDER

T161774

Client:	**Blackburn Consulting-West Sac.**	**Project Manager:**	**Katherine RunningCrane**
Project:	**US-50 and Hazel Ave Interchange**	**Project Number:**	**2843.X**

Analysis	Due	TAT	Expires	Comments
T161774-52 ADL-15-B [Soil] Sampled 07/29/16 12:05 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/25/17 12:05	
T161774-53 ADL-15-C [Soil] Sampled 07/29/16 12:15 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/25/17 12:15	
T161774-54 ADL-16-A [Soil] Sampled 07/29/16 12:30 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/25/17 12:30	
T161774-55 ADL-17-A [Soil] Sampled 07/29/16 11:15 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/25/17 11:15	
T161774-56 ADL-17-B [Soil] Sampled 07/29/16 11:30 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/25/17 11:30	
T161774-57 ADL-19-A [Soil] Sampled 07/29/16 10:00 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/25/17 10:00	
pH soil 9045	08/16/16 15:00	5	08/05/16 10:00	
T161774-58 ADL-19-B [Soil] Sampled 07/29/16 10:30 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/25/17 10:30	
STLC Pb	08/16/16 15:00	5	01/25/17 10:30	
STLC Leaching Procedure Metals	08/16/16 15:00	5	08/12/16 10:30	
T161774-59 ADL-19-C [Soil] Sampled 07/29/16 10:45 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/25/17 10:45	
T161774-60 ADL-31-A [Soil] Sampled 07/29/16 12:06 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/25/17 12:06	
T161774-61 ADL-31-B [Soil] Sampled 07/29/16 12:15 (GMT-08:00) Pacific Time (US &				
6010 Pb	08/08/16 15:00	5	01/25/17 12:15	

Reviewed By

Date

SunStar Laboratories, Inc.
PROVIDING QUALITY ANALYTICAL SERVICES NATIONWIDE

WORK ORDER

T161774

Client:	**Blackburn Consulting-West Sac.**	**Project Manager:**	**Katherine RunningCrane**
Project:	**US-50 and Hazel Ave Interchange**	**Project Number:**	**2843.X**

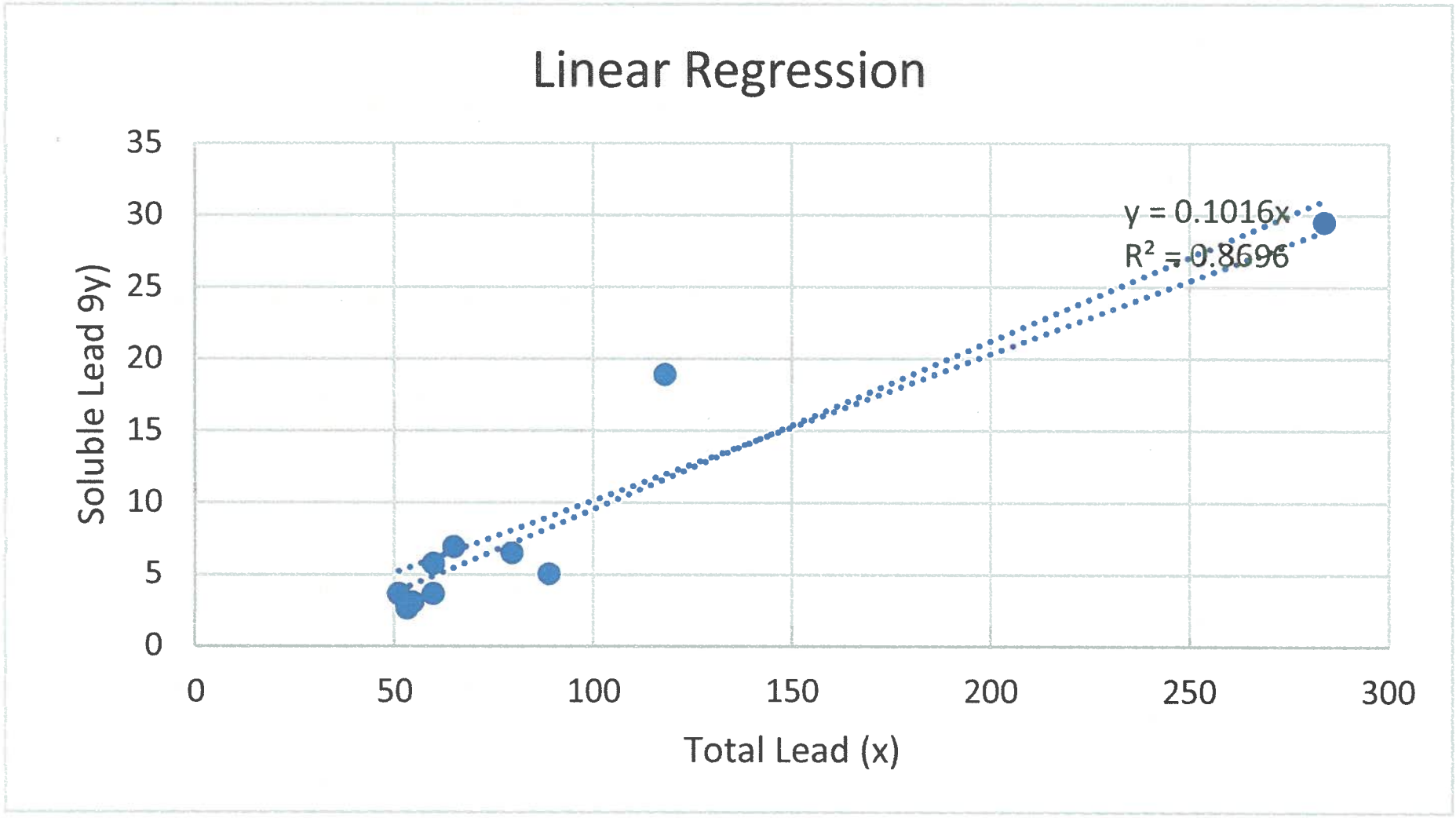
Reviewed By

Date

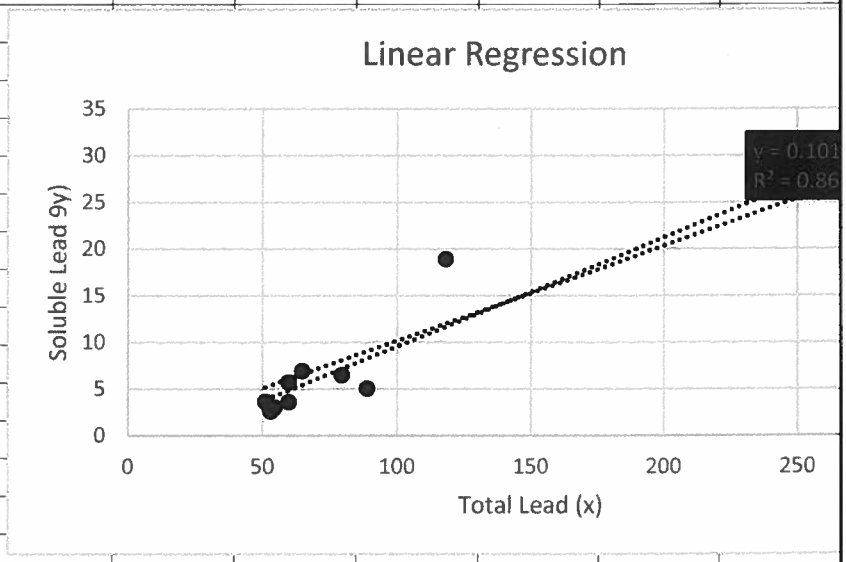
AERIALLY DEPOSITED LEAD ASSESSMENT
US-50 / Hazel Avenue Interchange
Sacramento County, California

APPENDIX B

Statistical Analysis


Linear Regression
Soluble Lead 9y)
Total Lead (x)
y = 0.1016x
R² = 0.8696
0
5
10
15
20
25
30
35
0
50
100
150
200
250
300

	A	B	C	D	E	F	G	H	I	J	K	L
1	ADL Combi	ADL 0-6	ADL 12-18	ADL 24-30	ADL 12-24 Combo		Total Lead X	Soluble Y	Total Lead	TCLP		
2	88.9	88.9	79.5	118	79.5		88.9	5.03	79.5	0.118		
3	79.5	51.1	284	49	284		79.5	6.47	452	1.55		
4	118	43.9	59.8	1.5	59.8		118	18.9				
5	51.1	1.5	14.6	1.5	14.6		51.1	3.64				
6	284	49.2	31.9	1.5	31.9		284	29.5				
7	43.9	39.2	25.5	1.5	25.5		59.8	5.74				
8	59.8	15.5	1.5	46	1.5		53.2	2.61				
9	49	13.1	33.4	1.5	33.4		59.8	3.62				
10	1.5	53.2	1.5	1.5	1.5		54.6	3.02				
11	14.6	20	1.5		1.5		64.9	6.92				
12	49.2	12.9	1.5		1.5							
13	39.2	1.5	1.5		1.5							
14	31.9	1.5	21		21							
15	1.5	1.5	54.6		54.6							
16	15.5	1.5	64.9		64.9							
17	25.5	1.5	36.5		36.5							
18	13.1	1.5	1.5		1.5							
19	1.5	59.8	1.5		1.5							
20	53.2	22.2	1.5		1.5							
21	33.4	39	1.5		1.5							
22	20	1.5	1.5		1.5							
23	1.5	25			118							
24	1.5	19.6			49							
25	12.9	33.1			1.5							
26	1.5	1.5			1.5							
27	1.5	30.7			1.5							
28	1.5	1.5			1.5							
29	1.5	15.1			46							
30	1.5	1.5			1.5							
31	1.5	1.5			1.5							
32	1.5											
33	1.5											
34	1.5											
35	1.5											
36	1.5											
37	21											
38	59.8											
39	54.6											
40	22.2											
41	64.9											
42	46											
43	39											
44	36.5											
45	1.5											
46	1.5											
47	25											
48	19.6											
49	1.5											
50	33.1											
51	1.5											
52	1.5											
53	1.5											



	A	B	C	D	E	F	G	H	I	J	K	L
54	30.7											
55	1.5											
56	15.1											
57	1.5											
58	1.5											
59	1.5											
60	1.5											
61	1.5											

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/14/2016 11:51:34 AM
From File	One Outlier Removed All Data.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lead ALL DEPTHS

General Statistics

Total Number of Observations	60	Number of Distinct Observations	32
Number of Detects	32	Number of Non-Detects	28
Number of Distinct Detects	31	Number of Distinct Non-Detects	1
Minimum Detect	12.9	Minimum Non-Detect	1.5
Maximum Detect	284	Maximum Non-Detect	1.5
Variance Detects	2417	Percent Non-Detects	46.67%
Mean Detects	48.44	SD Detects	49.16
Median Detects	37.75	CV Detects	1.015
Skewness Detects	3.816	Kurtosis Detects	17.57
Mean of Logged Detects	3.613	SD of Logged Detects	0.686

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.6	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.93	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.252	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.154	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	26.54	KM Standard Error of Mean	5.561
KM SD	42.4	95% KM (BCA) UCL	37.04
95% KM (t) UCL	35.83	95% KM (Percentile Bootstrap) UCL	36.46
95% KM (z) UCL	35.68	95% KM Bootstrap t UCL	41.11
90% KM Chebyshev UCL	43.22	95% KM Chebyshev UCL	50.78
97.5% KM Chebyshev UCL	61.26	99% KM Chebyshev UCL	81.87

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.805	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.759	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.137	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.158	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.019	k star (bias corrected MLE)	1.85
Theta hat (MLE)	23.99	Theta star (bias corrected MLE)	26.18
nu hat (MLE)	129.2	nu star (bias corrected)	118.4
Mean (detects)	48.44		

Gamma ROS Statistics using Imputed Non-Detects

53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58					Minimum	0.01				Mean	25.84	
59					Maximum	284				Median	13.85	
60					SD	43.17				CV	1.671	
61					k hat (MLE)	0.21				k star (bias corrected MLE)	0.211	
62					Theta hat (MLE)	122.9				Theta star (bias corrected MLE)	122.6	
63					nu hat (MLE)	25.22				nu star (bias corrected)	25.29	
64					Adjusted Level of Significance (β)	0.046						
65					Approximate Chi Square Value (25.29, α)	14.84				Adjusted Chi Square Value (25.29, β)	14.64	
66					95% Gamma Approximate UCL (use when n>=50)	44.05				95% Gamma Adjusted UCL (use when n<50)	44.65	
67												
68	Estimates of Gamma Parameters using KM Estimates											
69					Mean (KM)	26.54				SD (KM)	42.4	
70					Variance (KM)	1797				SE of Mean (KM)	5.561	
71					k hat (KM)	0.392				k star (KM)	0.383	
72					nu hat (KM)	47.02				nu star (KM)	46	
73					theta hat (KM)	67.73				theta star (KM)	69.23	
74					80% gamma percentile (KM)	42.6				90% gamma percentile (KM)	75.51	
75					95% gamma percentile (KM)	111.9				99% gamma percentile (KM)	203.8	
76												
77	Gamma Kaplan-Meier (KM) Statistics											
78					Approximate Chi Square Value (46.00, α)	31.44				Adjusted Chi Square Value (46.00, β)	31.14	
79					95% Gamma Approximate KM-UCL (use when n>=50)	38.83				95% Gamma Adjusted KM-UCL (use when n<50)	39.2	
80												
81	Lognormal GOF Test on Detected Observations Only											
82					Shapiro Wilk Test Statistic	0.957				Shapiro Wilk GOF Test		
83					5% Shapiro Wilk Critical Value	0.93				Detected Data appear Lognormal at 5% Significance Level		
84					Lilliefors Test Statistic	0.0868				Lilliefors GOF Test		
85					5% Lilliefors Critical Value	0.154				Detected Data appear Lognormal at 5% Significance Level		
86	Detected Data appear Lognormal at 5% Significance Level											
87												
88	Lognormal ROS Statistics Using Imputed Non-Detects											
89					Mean in Original Scale	29.12				Mean in Log Scale	2.761	
90					SD in Original Scale	41.35				SD in Log Scale	1.129	
91					95% t UCL (assumes normality of ROS data)	38.04				95% Percentile Bootstrap UCL	38.19	
92					95% BCA Bootstrap UCL	41.83				95% Bootstrap t UCL	43.81	
93					95% H-UCL (Log ROS)	43.65						
94												
95	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
96					KM Mean (logged)	2.116				KM Geo Mean	8.298	
97					KM SD (logged)	1.674				95% Critical H Value (KM-Log)	3.429	
98					KM Standard Error of Mean (logged)	0.22				95% H-UCL (KM -Log)	71.2	
99					KM SD (logged)	1.674				95% Critical H Value (KM-Log)	3.429	
100					KM Standard Error of Mean (logged)	0.22						
101												
102	DL/2 Statistics											
103	DL/2 Normal									DL/2 Log-Transformed		
104					Mean in Original Scale	26.19				Mean in Log Scale	1.793	

	A	B	C	D	E	F	G	H	I	J	K	L
105					SD in Original Scale	42.96					SD in Log Scale	2.024
106					95% t UCL (Assumes normality)	35.46					95% H-Stat UCL	131.3
107	DL/2 is not a recommended method, provided for comparisons and historical reasons											
108												
109	Nonparametric Distribution Free UCL Statistics											
110	Detected Data appear Approximate Gamma Distributed at 5% Significance Level											
111												
112	Suggested UCL to Use											
113					95% KM Approximate Gamma UCL	38.83					95% GROS Approximate Gamma UCL	44.05
114												
115	When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test											
116	When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL											
117												
118	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
119	Recommendations are based upon data size, data distribution, and skewness.											
120	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
121	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
122												

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/14/2016 11:57:07 AM
From File	One Outlier Removed All Data.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

ADLS

General Statistics

Total Number of Observations	30	Number of Distinct Observations	19
Number of Detects	18	Number of Non-Detects	12
Number of Distinct Detects	18	Number of Distinct Non-Detects	1
Minimum Detect	12.9	Minimum Non-Detect	1.5
Maximum Detect	88.9	Maximum Non-Detect	1.5
Variance Detects	406.9	Percent Non-Detects	40%
Mean Detects	35.08	SD Detects	20.17
Median Detects	31.9	CV Detects	0.575
Skewness Detects	1.106	Kurtosis Detects	1.405
Mean of Logged Detects	3.405	SD of Logged Detects	0.573

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.902	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.897	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.136	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.202	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	21.65	KM Standard Error of Mean	4.206
KM SD	22.39	95% KM (BCA) UCL	28.55
95% KM (t) UCL	28.8	95% KM (Percentile Bootstrap) UCL	28.93
95% KM (z) UCL	28.57	95% KM Bootstrap t UCL	29.83
90% KM Chebyshev UCL	34.27	95% KM Chebyshev UCL	39.98
97.5% KM Chebyshev UCL	47.92	99% KM Chebyshev UCL	63.5

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.304	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.744	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.115	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.205	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	3.438	k star (bias corrected MLE)	2.902
Theta hat (MLE)	10.2	Theta star (bias corrected MLE)	12.09
nu hat (MLE)	123.8	nu star (bias corrected)	104.5
Mean (detects)	35.08		

Gamma ROS Statistics using Imputed Non-Detects

53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58					Minimum	0.01				Mean	21.66	
59					Maximum	88.9				Median	15.3	
60					SD	22.82				CV	1.054	
61					k hat (MLE)	0.327				k star (bias corrected MLE)	0.317	
62					Theta hat (MLE)	66.14				Theta star (bias corrected MLE)	68.33	
63					nu hat (MLE)	19.65				nu star (bias corrected)	19.02	
64					Adjusted Level of Significance (β)	0.041						
65					Approximate Chi Square Value (19.02, α)	10.13				Adjusted Chi Square Value (19.02, β)	9.755	
66					95% Gamma Approximate UCL (use when n>=50)	40.66				95% Gamma Adjusted UCL (use when n<50)	42.22	
67												
68	**Estimates of Gamma Parameters using KM Estimates**											
69					Mean (KM)	21.65				SD (KM)	22.39	
70					Variance (KM)	501.3				SE of Mean (KM)	4.206	
71					k hat (KM)	0.935				k star (KM)	0.864	
72					nu hat (KM)	56.1				nu star (KM)	51.83	
73					theta hat (KM)	23.15				theta star (KM)	25.06	
74					80% gamma percentile (KM)	35.22				90% gamma percentile (KM)	51.67	
75					95% gamma percentile (KM)	68.33				99% gamma percentile (KM)	107.4	
76												
77	**Gamma Kaplan-Meier (KM) Statistics**											
78					Approximate Chi Square Value (51.83, α)	36.29				Adjusted Chi Square Value (51.83, β)	35.54	
79					95% Gamma Approximate KM-UCL (use when n>=50)	30.92				95% Gamma Adjusted KM-UCL (use when n<50)	31.57	
80												
81	**Lognormal GOF Test on Detected Observations Only**											
82					Shapiro Wilk Test Statistic	0.957				**Shapiro Wilk GOF Test**		
83					5% Shapiro Wilk Critical Value	0.897				Detected Data appear Lognormal at 5% Significance Level		
84					Lilliefors Test Statistic	0.118				**Lilliefors GOF Test**		
85					5% Lilliefors Critical Value	0.202				Detected Data appear Lognormal at 5% Significance Level		
86	Detected Data appear Lognormal at 5% Significance Level											
87												
88	**Lognormal ROS Statistics Using Imputed Non-Detects**											
89					Mean in Original Scale	24.02				Mean in Log Scale	2.811	
90					SD in Original Scale	20.78				SD in Log Scale	0.906	
91					95% t UCL (assumes normality of ROS data)	30.47				95% Percentile Bootstrap UCL	30.34	
92					95% BCA Bootstrap UCL	31.5				95% Bootstrap t UCL	31.73	
93					95% H-UCL (Log ROS)	37.27						
94												
95	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**											
96					KM Mean (logged)	2.205				KM Geo Mean	9.074	
97					KM SD (logged)	1.532				95% Critical H Value (KM-Log)	3.212	
98					KM Standard Error of Mean (logged)	0.288				95% H-UCL (KM -Log)	73.11	
99					KM SD (logged)	1.532				95% Critical H Value (KM-Log)	3.212	
100					KM Standard Error of Mean (logged)	0.288						
101												
102	**DL/2 Statistics**											
103	**DL/2 Normal**									**DL/2 Log-Transformed**		
104					Mean in Original Scale	21.35				Mean in Log Scale	1.928	

	A	B	C	D	E	F	G	H	I	J	K	L
105					SD in Original Scale	23.05				SD in Log Scale		1.892
106					95% t UCL (Assumes normality)	28.5				95% H-Stat UCL		154.4
107	DL/2 is not a recommended method, provided for comparisons and historical reasons											
108												
109	Nonparametric Distribution Free UCL Statistics											
110	Detected Data appear Normal Distributed at 5% Significance Level											
111												
112	Suggested UCL to Use											
113					95% KM (t) UCL	28.8						
114												
115	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
116	Recommendations are based upon data size, data distribution, and skewness.											
117	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
118	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
119												

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/14/2016 11:57:53 AM
From File	One Outlier Removed All Data.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

ADLM

General Statistics

Total Number of Observations	21	Number of Distinct Observations	12
Number of Detects	11	Number of Non-Detects	10
Number of Distinct Detects	11	Number of Distinct Non-Detects	1
Minimum Detect	14.6	Minimum Non-Detect	1.5
Maximum Detect	284	Maximum Non-Detect	1.5
Variance Detects	5724	Percent Non-Detects	47.62%
Mean Detects	64.15	SD Detects	75.66
Median Detects	36.5	CV Detects	1.179
Skewness Detects	2.903	Kurtosis Detects	8.984
Mean of Logged Detects	3.802	SD of Logged Detects	0.799

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.596	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.85	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.329	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.251	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	34.32	KM Standard Error of Mean	13.93
KM SD	60.87	95% KM (BCA) UCL	59.14
95% KM (t) UCL	58.35	95% KM (Percentile Bootstrap) UCL	59.31
95% KM (z) UCL	57.23	95% KM Bootstrap t UCL	88.47
90% KM Chebyshev UCL	76.11	95% KM Chebyshev UCL	95.04
97.5% KM Chebyshev UCL	121.3	99% KM Chebyshev UCL	172.9

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.73	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.742	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.206	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.26	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.537	k star (bias corrected MLE)	1.178
Theta hat (MLE)	41.75	Theta star (bias corrected MLE)	54.45
nu hat (MLE)	33.81	nu star (bias corrected)	25.92
Mean (detects)	64.15		

Gamma ROS Statistics using Imputed Non-Detects

53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58					Minimum	0.01				Mean		33.61
59					Maximum	284				Median		14.6
60					SD	62.77				CV		1.868
61					k hat (MLE)	0.198				k star (bias corrected MLE)		0.202
62					Theta hat (MLE)	169.5				Theta star (bias corrected MLE)		166.6
63					nu hat (MLE)	8.328				nu star (bias corrected)		8.472
64					Adjusted Level of Significance (β)	0.0383						
65					Approximate Chi Square Value (8.47, α)	3.011				Adjusted Chi Square Value (8.47, β)		2.766
66					95% Gamma Approximate UCL (use when n>=50)	94.56				95% Gamma Adjusted UCL (use when n<50)		102.9
67												
68	Estimates of Gamma Parameters using KM Estimates											
69					Mean (KM)	34.32				SD (KM)		60.87
70					Variance (KM)	3705				SE of Mean (KM)		13.93
71					k hat (KM)	0.318				k star (KM)		0.304
72					nu hat (KM)	13.35				nu star (KM)		12.78
73					theta hat (KM)	108				theta star (KM)		112.8
74					80% gamma percentile (KM)	52.81				90% gamma percentile (KM)		101
75					95% gamma percentile (KM)	156.3				99% gamma percentile (KM)		299.6
76												
77	Gamma Kaplan-Meier (KM) Statistics											
78					Approximate Chi Square Value (12.78, α)	5.744				Adjusted Chi Square Value (12.78, β)		5.384
79					95% Gamma Approximate KM-UCL (use when n>=50)	76.35				95% Gamma Adjusted KM-UCL (use when n<50)		81.45
80												
81	Lognormal GOF Test on Detected Observations Only											
82					Shapiro Wilk Test Statistic	0.93				Shapiro Wilk GOF Test		
83					5% Shapiro Wilk Critical Value	0.85				Detected Data appear Lognormal at 5% Significance Level		
84					Lilliefors Test Statistic	0.146				Lilliefors GOF Test		
85					5% Lilliefors Critical Value	0.251				Detected Data appear Lognormal at 5% Significance Level		
86	Detected Data appear Lognormal at 5% Significance Level											
87												
88	Lognormal ROS Statistics Using Imputed Non-Detects											
89					Mean in Original Scale	36.4				Mean in Log Scale		2.734
90					SD in Original Scale	61.3				SD in Log Scale		1.371
91					95% t UCL (assumes normality of ROS data)	59.47				95% Percentile Bootstrap UCL		59.57
92					95% BCA Bootstrap UCL	71.41				95% Bootstrap t UCL		90.49
93					95% H-UCL (Log ROS)	102.2						
94												
95	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
96					KM Mean (logged)	2.185				KM Geo Mean		8.887
97					KM SD (logged)	1.784				95% Critical H Value (KM-Log)		3.775
98					KM Standard Error of Mean (logged)	0.408				95% H-UCL (KM -Log)		196.6
99					KM SD (logged)	1.784				95% Critical H Value (KM-Log)		3.775
100					KM Standard Error of Mean (logged)	0.408						
101												
102	DL/2 Statistics											
103	DL/2 Normal									DL/2 Log-Transformed		
104					Mean in Original Scale	33.96				Mean in Log Scale		1.854

	A	B	C	D	E	F	G	H	I	J	K	L
105					SD in Original Scale	62.57				SD in Log Scale		2.168
106					95% t UCL (Assumes normality)	57.51				95% H-Stat UCL		573.5
107	DL/2 is not a recommended method, provided for comparisons and historical reasons											
108												
109	Nonparametric Distribution Free UCL Statistics											
110	Detected Data appear Gamma Distributed at 5% Significance Level											
111												
112	Suggested UCL to Use											
113					95% KM Adjusted Gamma UCL	81.45				95% GROS Adjusted Gamma UCL		102.9
114												
115	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
116	Recommendations are based upon data size, data distribution, and skewness.											
117	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
118	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
119												

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/14/2016 11:58:34 AM
From File	One Outlier Removed All Data.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

ADLD

General Statistics

Total Number of Observations	30	Number of Distinct Observations	15
Number of Detects	14	Number of Non-Detects	16
Number of Distinct Detects	14	Number of Distinct Non-Detects	1
Minimum Detect	14.6	Minimum Non-Detect	1.5
Maximum Detect	284	Maximum Non-Detect	1.5
Variance Detects	4667	Percent Non-Detects	53.33%
Mean Detects	65.62	SD Detects	68.31
Median Detects	47.5	CV Detects	1.041
Skewness Detects	2.861	Kurtosis Detects	9.074
Mean of Logged Detects	3.879	SD of Logged Detects	0.747

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.643	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.874	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.29	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.226	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	31.42	KM Standard Error of Mean	10.46
KM SD	55.19	95% KM (BCA) UCL	51.23
95% KM (t) UCL	49.19	95% KM (Percentile Bootstrap) UCL	49.17
95% KM (z) UCL	48.62	95% KM Bootstrap t UCL	64.41
90% KM Chebyshev UCL	62.79	95% KM Chebyshev UCL	77
97.5% KM Chebyshev UCL	96.72	99% KM Chebyshev UCL	135.5

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.616	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.748	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.192	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.232	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.791	k star (bias corrected MLE)	1.455
Theta hat (MLE)	36.64	Theta star (bias corrected MLE)	45.11
nu hat (MLE)	50.15	nu star (bias corrected)	40.73
Mean (detects)	65.62		

Gamma ROS Statistics using Imputed Non-Detects

53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58					Minimum	0.01				Mean	30.63	
59					Maximum	284				Median	0.01	
60					SD	56.57				CV	1.847	
61					k hat (MLE)	0.183				k star (bias corrected MLE)	0.187	
62					Theta hat (MLE)	167				Theta star (bias corrected MLE)	163.6	
63					nu hat (MLE)	11				nu star (bias corrected)	11.24	
64					Adjusted Level of Significance (β)	0.041						
65					Approximate Chi Square Value (11.24, α)	4.728				Adjusted Chi Square Value (11.24, β)	4.486	
66					95% Gamma Approximate UCL (use when n>=50)	72.79				95% Gamma Adjusted UCL (use when n<50)	76.72	
67												
68	Estimates of Gamma Parameters using KM Estimates											
69					Mean (KM)	31.42				SD (KM)	55.19	
70					Variance (KM)	3046				SE of Mean (KM)	10.46	
71					k hat (KM)	0.324				k star (KM)	0.314	
72					nu hat (KM)	19.45				nu star (KM)	18.84	
73					theta hat (KM)	96.92				theta star (KM)	100.1	
74					80% gamma percentile (KM)	48.71				90% gamma percentile (KM)	92.15	
75					95% gamma percentile (KM)	141.6				99% gamma percentile (KM)	269.5	
76												
77	Gamma Kaplan-Meier (KM) Statistics											
78					Approximate Chi Square Value (18.84, α)	10				Adjusted Chi Square Value (18.84, β)	9.63	
79					95% Gamma Approximate KM-UCL (use when n>=50)	59.2				95% Gamma Adjusted KM-UCL (use when n<50)	61.48	
80												
81	Lognormal GOF Test on Detected Observations Only											
82					Shapiro Wilk Test Statistic	0.962				Shapiro Wilk GOF Test		
83					5% Shapiro Wilk Critical Value	0.874				Detected Data appear Lognormal at 5% Significance Level		
84					Lilliefors Test Statistic	0.133				Lilliefors GOF Test		
85					5% Lilliefors Critical Value	0.226				Detected Data appear Lognormal at 5% Significance Level		
86	Detected Data appear Lognormal at 5% Significance Level											
87												
88	Lognormal ROS Statistics Using Imputed Non-Detects											
89					Mean in Original Scale	34.29				Mean in Log Scale	2.709	
90					SD in Original Scale	54.69				SD in Log Scale	1.343	
91					95% t UCL (assumes normality of ROS data)	51.25				95% Percentile Bootstrap UCL	52.13	
92					95% BCA Bootstrap UCL	59.32				95% Bootstrap t UCL	71.23	
93					95% H-UCL (Log ROS)	77.07						
94												
95	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
96					KM Mean (logged)	2.027				KM Geo Mean	7.589	
97					KM SD (logged)	1.802				95% Critical H Value (KM-Log)	3.623	
98					KM Standard Error of Mean (logged)	0.341				95% H-UCL (KM -Log)	129.2	
99					KM SD (logged)	1.802				95% Critical H Value (KM-Log)	3.623	
100					KM Standard Error of Mean (logged)	0.341						
101												
102	DL/2 Statistics											
103	DL/2 Normal									DL/2 Log-Transformed		
104					Mean in Original Scale	31.02				Mean in Log Scale	1.657	

	A	B	C	D	E	F	G	H	I	J	K	L
105					SD in Original Scale	56.35				SD in Log Scale		2.173
106					95% t UCL (Assumes normality)	48.5				95% H-Stat UCL		303.9
107	DL/2 is not a recommended method, provided for comparisons and historical reasons											
108												
109	Nonparametric Distribution Free UCL Statistics											
110	Detected Data appear Gamma Distributed at 5% Significance Level											
111												
112	Suggested UCL to Use											
113					95% KM Adjusted Gamma UCL	61.48				95% GROS Adjusted Gamma UCL		76.72
114												
115	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
116	Recommendations are based upon data size, data distribution, and skewness.											
117	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
118	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
119												

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/14/2016 12:35:48 PM
From File	US50 Corridor One Outlier.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

US50S

General Statistics

Total Number of Observations	18	Number of Distinct Observations	16
Number of Detects	15	Number of Non-Detects	3
Number of Distinct Detects	15	Number of Distinct Non-Detects	1
Minimum Detect	12.9	Minimum Non-Detect	1.5
Maximum Detect	88.9	Maximum Non-Detect	1.5
Variance Detects	431.3	Percent Non-Detects	16.67%
Mean Detects	38.12	SD Detects	20.77
Median Detects	39	CV Detects	0.545
Skewness Detects	0.87	Kurtosis Detects	1.075
Mean of Logged Detects	3.492	SD of Logged Detects	0.584

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.929	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.881	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.112	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.22	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	32.02	KM Standard Error of Mean	5.573
KM SD	22.84	95% KM (BCA) UCL	40.43
95% KM (t) UCL	41.71	95% KM (Percentile Bootstrap) UCL	41.49
95% KM (z) UCL	41.18	95% KM Bootstrap t UCL	42.72
90% KM Chebyshev UCL	48.73	95% KM Chebyshev UCL	56.31
97.5% KM Chebyshev UCL	66.82	99% KM Chebyshev UCL	87.46

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.273	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.742	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.121	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.223	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	3.53	k star (bias corrected MLE)	2.868
Theta hat (MLE)	10.8	Theta star (bias corrected MLE)	13.29
nu hat (MLE)	105.9	nu star (bias corrected)	86.05
Mean (detects)	38.12		

Gamma ROS Statistics using Imputed Non-Detects

53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58					Minimum	0.01				Mean	32.23	
59					Maximum	88.9				Median	31.9	
60					SD	23.24				CV	0.721	
61					k hat (MLE)	0.876				k star (bias corrected MLE)	0.767	
62					Theta hat (MLE)	36.8				Theta star (bias corrected MLE)	42.02	
63					nu hat (MLE)	31.53				nu star (bias corrected)	27.61	
64					Adjusted Level of Significance (β)	0.0357						
65					Approximate Chi Square Value (27.61, α)	16.62				Adjusted Chi Square Value (27.61, β)	15.81	
66					95% Gamma Approximate UCL (use when n>=50)	53.53				95% Gamma Adjusted UCL (use when n<50)	56.29	
67												
68	**Estimates of Gamma Parameters using KM Estimates**											
69					Mean (KM)	32.02				SD (KM)	22.84	
70					Variance (KM)	521.7				SE of Mean (KM)	5.573	
71					k hat (KM)	1.965				k star (KM)	1.674	
72					nu hat (KM)	70.73				nu star (KM)	60.28	
73					theta hat (KM)	16.3				theta star (KM)	19.12	
74					80% gamma percentile (KM)	48.93				90% gamma percentile (KM)	64.96	
75					95% gamma percentile (KM)	80.42				99% gamma percentile (KM)	115.1	
76												
77	**Gamma Kaplan-Meier (KM) Statistics**											
78					Approximate Chi Square Value (60.28, α)	43.42				Adjusted Chi Square Value (60.28, β)	42.05	
79					95% Gamma Approximate KM-UCL (use when n>=50)	44.44				95% Gamma Adjusted KM-UCL (use when n<50)	45.89	
80												
81	**Lognormal GOF Test on Detected Observations Only**											
82					Shapiro Wilk Test Statistic	0.947				**Shapiro Wilk GOF Test**		
83					5% Shapiro Wilk Critical Value	0.881				Detected Data appear Lognormal at 5% Significance Level		
84					Lilliefors Test Statistic	0.149				**Lilliefors GOF Test**		
85					5% Lilliefors Critical Value	0.22				Detected Data appear Lognormal at 5% Significance Level		
86	Detected Data appear Lognormal at 5% Significance Level											
87												
88	**Lognormal ROS Statistics Using Imputed Non-Detects**											
89					Mean in Original Scale	33.2				Mean in Log Scale	3.266	
90					SD in Original Scale	22				SD in Log Scale	0.748	
91					95% t UCL (assumes normality of ROS data)	42.22				95% Percentile Bootstrap UCL	41.97	
92					95% BCA Bootstrap UCL	42.19				95% Bootstrap t UCL	43.54	
93					95% H-UCL (Log ROS)	52.56						
94												
95	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**											
96					KM Mean (logged)	2.978				KM Geo Mean	19.65	
97					KM SD (logged)	1.26				95% Critical H Value (KM-Log)	3.038	
98					KM Standard Error of Mean (logged)	0.308				95% H-UCL (KM -Log)	110	
99					KM SD (logged)	1.26				95% Critical H Value (KM-Log)	3.038	
100					KM Standard Error of Mean (logged)	0.308						
101												
102	**DL/2 Statistics**											
103	**DL/2 Normal**									**DL/2 Log-Transformed**		
104					Mean in Original Scale	31.89				Mean in Log Scale	2.862	

	A	B	C	D	E	F	G	H	I	J	K	L
105					SD in Original Scale	23.68				SD in Log Scale		1.543
106					95% t UCL (Assumes normality)	41.6				95% H-Stat UCL		214.1
107	DL/2 is not a recommended method, provided for comparisons and historical reasons											
108												
109	Nonparametric Distribution Free UCL Statistics											
110	Detected Data appear Normal Distributed at 5% Significance Level											
111												
112	Suggested UCL to Use											
113					95% KM (t) UCL	41.71						
114												
115	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
116	Recommendations are based upon data size, data distribution, and skewness.											
117	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
118	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
119												

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/14/2016 12:36:36 PM
From File	US50 Corridor One Outlier.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

US50M

General Statistics

Total Number of Observations	12	Number of Distinct Observations	11
Number of Detects	10	Number of Non-Detects	2
Number of Distinct Detects	10	Number of Distinct Non-Detects	1
Minimum Detect	14.6	Minimum Non-Detect	1.5
Maximum Detect	284	Maximum Non-Detect	1.5
Variance Detects	6133	Percent Non-Detects	16.67%
Mean Detects	68.47	SD Detects	78.31
Median Detects	45.55	CV Detects	1.144
Skewness Detects	2.791	Kurtosis Detects	8.278
Mean of Logged Detects	3.878	SD of Logged Detects	0.8

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.609	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.842	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.344	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.262	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	57.31	KM Standard Error of Mean	21.99
KM SD	72.27	95% KM (BCA) UCL	99.54
95% KM (t) UCL	96.8	95% KM (Percentile Bootstrap) UCL	99.21
95% KM (z) UCL	93.48	95% KM Bootstrap t UCL	149.3
90% KM Chebyshev UCL	123.3	95% KM Chebyshev UCL	153.2
97.5% KM Chebyshev UCL	194.6	99% KM Chebyshev UCL	276.1

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.704	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.739	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.224	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.271	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.58	k star (bias corrected MLE)	1.173
Theta hat (MLE)	43.34	Theta star (bias corrected MLE)	58.39
nu hat (MLE)	31.6	nu star (bias corrected)	23.45
Mean (detects)	68.47		

Gamma ROS Statistics using Imputed Non-Detects

53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58					Minimum	0.01				Mean		57.06
59					Maximum	284				Median		34.95
60					SD	75.68				CV		1.326
61					k hat (MLE)	0.414				k star (bias corrected MLE)		0.366
62					Theta hat (MLE)	137.8				Theta star (bias corrected MLE)		155.8
63					nu hat (MLE)	9.939				nu star (bias corrected)		8.787
64					Adjusted Level of Significance (β)	0.029						
65					Approximate Chi Square Value (8.79, α)	3.199				Adjusted Chi Square Value (8.79, β)		2.706
66					95% Gamma Approximate UCL (use when n>=50)	156.7				95% Gamma Adjusted UCL (use when n<50)		185.3
67												
68	Estimates of Gamma Parameters using KM Estimates											
69					Mean (KM)	57.31				SD (KM)		72.27
70					Variance (KM)	5222				SE of Mean (KM)		21.99
71					k hat (KM)	0.629				k star (KM)		0.527
72					nu hat (KM)	15.09				nu star (KM)		12.65
73					theta hat (KM)	91.13				theta star (KM)		108.7
74					80% gamma percentile (KM)	94.3				90% gamma percentile (KM)		153.3
75					95% gamma percentile (KM)	216				99% gamma percentile (KM)		369.4
76												
77	Gamma Kaplan-Meier (KM) Statistics											
78					Approximate Chi Square Value (12.65, α)	5.66				Adjusted Chi Square Value (12.65, β)		4.965
79					95% Gamma Approximate KM-UCL (use when n>=50)	128.1				95% Gamma Adjusted KM-UCL (use when n<50)		146.1
80												
81	Lognormal GOF Test on Detected Observations Only											
82					Shapiro Wilk Test Statistic	0.932				Shapiro Wilk GOF Test		
83					5% Shapiro Wilk Critical Value	0.842				Detected Data appear Lognormal at 5% Significance Level		
84					Lilliefors Test Statistic	0.167				Lilliefors GOF Test		
85					5% Lilliefors Critical Value	0.262				Detected Data appear Lognormal at 5% Significance Level		
86	Detected Data appear Lognormal at 5% Significance Level											
87												
88	Lognormal ROS Statistics Using Imputed Non-Detects											
89					Mean in Original Scale	58.31				Mean in Log Scale		3.564
90					SD in Original Scale	74.7				SD in Log Scale		1.033
91					95% t UCL (assumes normality of ROS data)	97.04				95% Percentile Bootstrap UCL		99.07
92					95% BCA Bootstrap UCL	116.9				95% Bootstrap t UCL		159
93					95% H-UCL (Log ROS)	152.1						
94												
95	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
96					KM Mean (logged)	3.299				KM Geo Mean		27.08
97					KM SD (logged)	1.468				95% Critical H Value (KM-Log)		3.829
98					KM Standard Error of Mean (logged)	0.447				95% H-UCL (KM -Log)		433
99					KM SD (logged)	1.468				95% Critical H Value (KM-Log)		3.829
100					KM Standard Error of Mean (logged)	0.447						
101												
102	DL/2 Statistics											
103	DL/2 Normal									DL/2 Log-Transformed		
104					Mean in Original Scale	57.18				Mean in Log Scale		3.183

	A	B	C	D	E	F	G	H	I	J	K	L
105					SD in Original Scale	75.58				SD in Log Scale		1.776
106					95% t UCL (Assumes normality)	96.37				95% H-Stat UCL		1282
107	DL/2 is not a recommended method, provided for comparisons and historical reasons											
108												
109	Nonparametric Distribution Free UCL Statistics											
110	Detected Data appear Gamma Distributed at 5% Significance Level											
111												
112	Suggested UCL to Use											
113					95% KM Adjusted Gamma UCL	146.1				95% GROS Adjusted Gamma UCL		185.3
114												
115	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
116	Recommendations are based upon data size, data distribution, and skewness.											
117	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
118	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
119												

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/14/2016 12:37:19 PM
From File	US50 Corridor One Outlier.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

US50D

General Statistics

Total Number of Observations	20	Number of Distinct Observations	14
Number of Detects	13	Number of Non-Detects	7
Number of Distinct Detects	13	Number of Distinct Non-Detects	1
Minimum Detect	14.6	Minimum Non-Detect	1.5
Maximum Detect	284	Maximum Non-Detect	1.5
Variance Detects	4877	Percent Non-Detects	35%
Mean Detects	69.05	SD Detects	69.84
Median Detects	49	CV Detects	1.011
Skewness Detects	2.79	Kurtosis Detects	8.581
Mean of Logged Detects	3.944	SD of Logged Detects	0.736

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.65	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.866	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.293	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.234	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	45.41	KM Standard Error of Mean	14.65
KM SD	62.96	95% KM (BCA) UCL	74.08
95% KM (t) UCL	70.75	95% KM (Percentile Bootstrap) UCL	71.26
95% KM (z) UCL	69.51	95% KM Bootstrap t UCL	95
90% KM Chebyshev UCL	89.37	95% KM Chebyshev UCL	109.3
97.5% KM Chebyshev UCL	136.9	99% KM Chebyshev UCL	191.2

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.632	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.745	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.204	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.24	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.866	k star (bias corrected MLE)	1.487
Theta hat (MLE)	37	Theta star (bias corrected MLE)	46.44
nu hat (MLE)	48.53	nu star (bias corrected)	38.66
Mean (detects)	69.05		

Gamma ROS Statistics using Imputed Non-Detects

53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58					Minimum	0.01				Mean		44.89
59					Maximum	284				Median		32.65
60					SD	64.98				CV		1.447
61					k hat (MLE)	0.249				k star (bias corrected MLE)		0.245
62					Theta hat (MLE)	180.2				Theta star (bias corrected MLE)		183.1
63					nu hat (MLE)	9.965				nu star (bias corrected)		9.804
64					Adjusted Level of Significance (β)	0.038						
65					Approximate Chi Square Value (9.80, α)	3.82				Adjusted Chi Square Value (9.80, β)		3.529
66					95% Gamma Approximate UCL (use when n>=50)	115.2				95% Gamma Adjusted UCL (use when n<50)		124.7
67												
68	Estimates of Gamma Parameters using KM Estimates											
69					Mean (KM)	45.41				SD (KM)		62.96
70					Variance (KM)	3964				SE of Mean (KM)		14.65
71					k hat (KM)	0.52				k star (KM)		0.475
72					nu hat (KM)	20.81				nu star (KM)		19.02
73					theta hat (KM)	87.3				theta star (KM)		95.51
74					80% gamma percentile (KM)	74.39				90% gamma percentile (KM)		124.1
75					95% gamma percentile (KM)	177.6				99% gamma percentile (KM)		309.7
76												
77	Gamma Kaplan-Meier (KM) Statistics											
78					Approximate Chi Square Value (19.02, α)	10.13				Adjusted Chi Square Value (19.02, β)		9.619
79					95% Gamma Approximate KM-UCL (use when n>=50)	85.25				95% Gamma Adjusted KM-UCL (use when n<50)		89.78
80												
81	Lognormal GOF Test on Detected Observations Only											
82					Shapiro Wilk Test Statistic	0.959				Shapiro Wilk GOF Test		
83					5% Shapiro Wilk Critical Value	0.866				Detected Data appear Lognormal at 5% Significance Level		
84					Lilliefors Test Statistic	0.147				Lilliefors GOF Test		
85					5% Lilliefors Critical Value	0.234				Detected Data appear Lognormal at 5% Significance Level		
86	Detected Data appear Lognormal at 5% Significance Level											
87												
88	Lognormal ROS Statistics Using Imputed Non-Detects											
89					Mean in Original Scale	47.99				Mean in Log Scale		3.292
90					SD in Original Scale	62.87				SD in Log Scale		1.121
91					95% t UCL (assumes normality of ROS data)	72.3				95% Percentile Bootstrap UCL		72.51
92					95% BCA Bootstrap UCL	83.38				95% Bootstrap t UCL		99.96
93					95% H-UCL (Log ROS)	103.9						
94												
95	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
96					KM Mean (logged)	2.705				KM Geo Mean		14.96
97					KM SD (logged)	1.781				95% Critical H Value (KM-Log)		3.914
98					KM Standard Error of Mean (logged)	0.415				95% H-UCL (KM -Log)		361.9
99					KM SD (logged)	1.781				95% Critical H Value (KM-Log)		3.914
100					KM Standard Error of Mean (logged)	0.415						
101												
102	DL/2 Statistics											
103	DL/2 Normal									DL/2 Log-Transformed		
104					Mean in Original Scale	45.15				Mean in Log Scale		2.463

	A	B	C	D	E	F	G	H	I	J	K	L
105					SD in Original Scale	64.79				SD in Log Scale		2.152
106				95% t UCL (Assumes normality)		70.2				95% H-Stat UCL		1140
107	DL/2 is not a recommended method, provided for comparisons and historical reasons											
108												
109	Nonparametric Distribution Free UCL Statistics											
110	Detected Data appear Gamma Distributed at 5% Significance Level											
111												
112	Suggested UCL to Use											
113				95% KM Adjusted Gamma UCL		89.78				95% GROS Adjusted Gamma UCL		124.7
114												
115	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
116	Recommendations are based upon data size, data distribution, and skewness.											
117	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
118	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
119												

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/14/2016 12:38:12 PM
From File	US50 Corridor One Outlier.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

US50All

General Statistics

Total Number of Observations	40	Number of Distinct Observations	29
Number of Detects	29	Number of Non-Detects	11
Number of Distinct Detects	28	Number of Distinct Non-Detects	1
Minimum Detect	12.9	Minimum Non-Detect	1.5
Maximum Detect	284	Maximum Non-Detect	1.5
Variance Detects	2570	Percent Non-Detects	27.5%
Mean Detects	51.53	SD Detects	50.69
Median Detects	39.2	CV Detects	0.984
Skewness Detects	3.708	Kurtosis Detects	16.45
Mean of Logged Detects	3.685	SD of Logged Detects	0.679

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.605	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.926	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.263	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.161	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	37.78	KM Standard Error of Mean	7.714
KM SD	47.94	95% KM (BCA) UCL	50.61
95% KM (t) UCL	50.77	95% KM (Percentile Bootstrap) UCL	50.76
95% KM (z) UCL	50.46	95% KM Bootstrap t UCL	58.3
90% KM Chebyshev UCL	60.92	95% KM Chebyshev UCL	71.4
97.5% KM Chebyshev UCL	85.95	99% KM Chebyshev UCL	114.5

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.763	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.757	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.154	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.165	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.097	k star (bias corrected MLE)	1.903
Theta hat (MLE)	24.57	Theta star (bias corrected MLE)	27.08
nu hat (MLE)	121.6	nu star (bias corrected)	110.4
Mean (detects)	51.53		

Gamma ROS Statistics using Imputed Non-Detects

53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs											
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)											
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs											
56	This is especially true when the sample size is small.											
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates											
58					Minimum	0.01				Mean		37.37
59					Maximum	284				Median		31.3
60					SD	48.87				CV		1.308
61					k hat (MLE)	0.31				k star (bias corrected MLE)		0.303
62					Theta hat (MLE)	120.7				Theta star (bias corrected MLE)		123.3
63					nu hat (MLE)	24.77				nu star (bias corrected)		24.25
64					Adjusted Level of Significance (β)	0.044						
65					Approximate Chi Square Value (24.25, α)	14.04				Adjusted Chi Square Value (24.25, β)		13.75
66					95% Gamma Approximate UCL (use when n>=50)	64.54				95% Gamma Adjusted UCL (use when n<50)		65.91
67												
68	Estimates of Gamma Parameters using KM Estimates											
69					Mean (KM)	37.78				SD (KM)		47.94
70					Variance (KM)	2298				SE of Mean (KM)		7.714
71					k hat (KM)	0.621				k star (KM)		0.591
72					nu hat (KM)	49.67				nu star (KM)		47.28
73					theta hat (KM)	60.84				theta star (KM)		63.91
74					80% gamma percentile (KM)	62.27				90% gamma percentile (KM)		98.58
75					95% gamma percentile (KM)	136.7				99% gamma percentile (KM)		228.9
76												
77	Gamma Kaplan-Meier (KM) Statistics											
78					Approximate Chi Square Value (47.28, α)	32.5				Adjusted Chi Square Value (47.28, β)		32.04
79					95% Gamma Approximate KM-UCL (use when n>=50)	54.95				95% Gamma Adjusted KM-UCL (use when n<50)		55.74
80												
81	Lognormal GOF Test on Detected Observations Only											
82					Shapiro Wilk Test Statistic	0.96				Shapiro Wilk GOF Test		
83					5% Shapiro Wilk Critical Value	0.926				Detected Data appear Lognormal at 5% Significance Level		
84					Lilliefors Test Statistic	0.103				Lilliefors GOF Test		
85					5% Lilliefors Critical Value	0.161				Detected Data appear Lognormal at 5% Significance Level		
86	Detected Data appear Lognormal at 5% Significance Level											
87												
88	Lognormal ROS Statistics Using Imputed Non-Detects											
89					Mean in Original Scale	39.74				Mean in Log Scale		3.245
90					SD in Original Scale	47.16				SD in Log Scale		0.948
91					95% t UCL (assumes normality of ROS data)	52.3				95% Percentile Bootstrap UCL		52.27
92					95% BCA Bootstrap UCL	58.45				95% Bootstrap t UCL		62.02
93					95% H-UCL (Log ROS)	57.47						
94												
95	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
96					KM Mean (logged)	2.783				KM Geo Mean		16.17
97					KM SD (logged)	1.571				95% Critical H Value (KM-Log)		3.148
98					KM Standard Error of Mean (logged)	0.253				95% H-UCL (KM -Log)		122.6
99					KM SD (logged)	1.571				95% Critical H Value (KM-Log)		3.148
100					KM Standard Error of Mean (logged)	0.253						
101												
102	DL/2 Statistics											
103	DL/2 Normal									DL/2 Log-Transformed		
104					Mean in Original Scale	37.57				Mean in Log Scale		2.593

	A	B	C	D	E	F	G	H	I	J	K	L
105					SD in Original Scale	48.71				SD in Log Scale		1.887
106					95% t UCL (Assumes normality)	50.54				95% H-Stat UCL		235.4
107	DL/2 is not a recommended method, provided for comparisons and historical reasons											
108												
109	Nonparametric Distribution Free UCL Statistics											
110	Detected Data appear Approximate Gamma Distributed at 5% Significance Level											
111												
112	Suggested UCL to Use											
113					95% KM Adjusted Gamma UCL	55.74				95% GROS Adjusted Gamma UCL		65.91
114												
115	When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test											
116	When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL											
117												
118	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
119	Recommendations are based upon data size, data distribution, and skewness.											
120	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
121	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
122												

U.S. 50 / Hazel Avenue Interchange Project

AQSR



Air Quality Study Report

Hazel Avenue State Route 50 Interchange Project

Sacramento County

03-SAC-50/PM 15.1-17.4

Federal Project No.: EA 03-3E380/E-FIS 0300020439

July 2017

Caltrans

CALIFORNIA DEPARTMENT OF TRANSPORTATION

Air Quality Study Report

U.S. 50 / Hazel Avenue Interchange Project

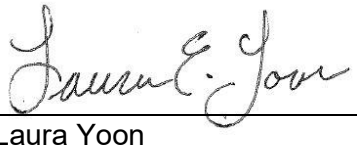
Sacramento County

03-SAC-50/PM 15.1-17.4

Federal Project No.: EA 03-3E380/E-FIS 0300020439

July 2017

STATE OF CALIFORNIA
Department of Transportation
District 3

Prepared By:  Date: July 18, 2017

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Acronyms and Abbreviations

$\mu g/m^3$	micrograms per cubic meter
AADT	annual average daily traffic
AEP	Association of Environmental Professionals
ARB	California Air Resources Board
BAU	business-as-usual
CAAQS	California Ambient Air Quality Standards
California CAA	California Clean Air Act
Caltrans	California Department of Transportation
CEQA	California Environmental Quality Act
CEQA Handbook	CEQA Air Quality Handbook
CFR	Code of Federal Regulations
CH_4	methane
Clean Air Plan	air quality attainment plan
CO	carbon monoxide
CO_2	carbon dioxide
DOT	U.S. Department of Transportation
DPM	diesel particulate matter
EPA	U.S. Environmental Protection Agency
ETW	edge of travel way
FCAA	federal Clean Air Act
FEIR	Final Environmental Impact Report
FHWA	Federal Highway Administration
FTIPs	Federal Transportation Improvement Programs
GHG	greenhouse gas
HDM	Caltrans Highway Design Manual
LCFS	low carbon fuel standard
LOS	level of service
MOVES	Motor Vehicle Emissions Simulator
MSAT	Mobile Source Air Toxics

MTP	Metropolitan Transportation Plan
MTP/SCS	Metropolitan Transportation Plan/Sustainable Communities Strategy
N_2O	nitrous oxide
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NO_2	nitrogen dioxide
NOA	Naturally occurring asbestos
NO_X	nitrogen oxides
O_3	ozone
PM	particulate matter
PM10	particles of 10 micrometers and smaller
PM2.5	particles of 2.5 micrometers and smaller
POAQC	project of air quality concern
ppm	parts per million
proposed project	U.S. 50/Hazel Avenue Interchange Project
RCB	reinforced concrete box
RCEM	Road Construction Emissions Model
ROG	reactive organic gases
RTP	regional transportation plan
SB	Senate Bill
SCS	Sustainable Communities Strategy
SIP	State Implementation Plan
SO_2	sulfur dioxide
SR	State Route
SVAB	Sacramento Valley Air Basin
TAC	toxic air contaminant
VMT	vehicle miles travelled

Chapter 1 Introduction

1.1 Purpose of the Air Quality Study Report

This report was prepared for the U.S. 50/Hazel Avenue Interchange Project (proposed project). The County of Sacramento, in cooperation with the California Department of Transportation (Caltrans) and the City of Rancho Cordova, proposes to modify the existing U.S. 50/Hazel Avenue interchange and extend and grade-separate Hazel Avenue over Folsom Boulevard and the Sacramento Placerville Transportation Corridor Joint Powers Authority (SPTC-JPA) rail corridor. Hazel Avenue will be extended further south to a proposed intersection with the future Atlanta Street (a new roadway that will be constructed as part of the Easton Place development). The project is located in the County of Sacramento at the interchange of Hazel Avenue and U.S. 50 (see Figure 1).

This report is intended to support the preparation of National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA) documentation for Caltrans. Caltrans is the lead agency under NEPA assigned by the Federal Highway Administration (FHWA) and the County of Sacramento is the lead agency under CEQA. This report also supports efforts to obtain agreements, permits, and concurrence needed to construct the proposed project. This report evaluates the effects of the project on air quality resources and climate change, based on system-wide measures of effectiveness and intersection traffic volumes under existing (2015), opening (2022), and design (2042) year conditions as reported in the traffic analysis report for this project (DKS 2016).

Three alternatives, including one sub-alternative and the No Build Alternative, are analyzed in this document. The two proposed Build Alternatives would construct modifications to the existing U.S. 50/Hazel Avenue interchange and extend Hazel Avenue to the south. The No Build Alternative would not make any improvements to the interchange. However, other local improvements throughout the U.S. 50 corridor and Sacramento County separately proposed and identified in the Sacramento Council of Government's (SACOG) Metropolitan Transportation Plan/Sustainable Communities Strategy (MTP/SCS) would be implemented according to their proposed schedules.

1.2 Scope and Content of the Report

This report describes the proposed project's regulatory and environmental setting, the environmental consequences of the project, and measures to avoid, minimize, or mitigate adverse impacts of the project on air quality resources. This report is organized as described here.

- Chapter 1, *Introduction*, introduces the report and describes the purpose, scope, and content of the report, as well as provides a summary of the project impacts; avoidance, minimization, and/or mitigation measures; and significance conclusions that are discussed later in the report.
- Chapter 2, *Project Description*, describes the project's characteristics, including location, purpose, need, and the alternatives associated with the project.
- Chapter 3, *Affected Environment, Environmental Consequences, and Avoidance, Minimization, and/or Mitigation Measures*, describes the regulatory and physical setting, discloses the environmental effects of the alternatives and the methods used to evaluate them, and identifies measures to avoid, minimize, or mitigate adverse effects associated with the alternatives.
- Chapter 4, *Air Quality Impacts under CEQA*, discloses the environmental impacts of the alternatives based on Appendix G of the State CEQA Guidelines to support the project-level CEQA document.
- Chapter 5, *References Cited*, describes the printed references and personal communications used to prepare this report.

1.3 Summary

Table 1 provides a summary of the impacts, significance conclusions, and avoidance, minimization, or mitigation measures discussed in this report.

Table 1. Summary of Impacts, Conclusions, and Avoidance, Minimization, or Mitigation Measures Associated with the Project

Impact	Conclusions	Avoidance, Minimization, or Mitigation Measures
AQ-1: Conformity of the Regional Transportation Plan with the State Implementation Plan	The proposed project (SAC24255) is listed in SACOG's 2016 MTP/SCS, 2017/20 MTIP, and corresponding Air Quality Conformity analysis.	None Required
AQ-2: Potential Violations of CO NAAQS or CAAQS	CO concentrations under the Build Alternatives are not expected to exceed the 1- or 8- hour NAAQS and CAAQS.	None Required
AQ-3: Potential Violations of PM10 or PM2.5 NAAQS or CAAQS	Sacramento County is currently classified as a nonattainment area with regard to the PM2.5 NAAQS and a maintenance area with regard to the PM10 NAAQS. However, due to virtually no change in AADT or truck volumes between the No Build and Build Alternatives, the project is determined not be a POAQC. SACOG's PLCG issued concurrence that the project is not a POAQC on June 19, 2017.	None Required
AQ-4: Potential for Generation of MSAT	The project would result in decreases in all MSAT emissions between existing (2015) and opening	None Required

Impact	Conclusions	Avoidance, Minimization, or Mitigation Measures
Emissions	(2022) year conditions Under design (2042) year conditions, the Build Alternatives would result in minor increases of Benzene and DPM, and decreases of all other MSATs. The predicted increase in Benzene and DPM under the Build Alternatives would be minor.	
AQ-5: Generation of Operation-Related Emissions of O_3 Precursors, CO, and Particulate Matter	The project would result in decreases in ROG, NOx, and CO, and minor increases in PM10 and PM2.5 between existing (2015) and design (2042) year conditions. Emissions increases are a result of background growth in VMT between 2015 and 2042. Minor increases in all criteria pollutants except NO_X are also expected between the Build and No Build Alternatives under design (2042) year conditions as a result of increasing VMT and changes in vehicle speeds.	None Required
AQ-6: Potential Temporary Increase in O_3 Precursors (ROG and NO_X), CO, and Particulate Matter Emissions during Grading and Construction Activities	The project would result in temporary increases in O_3 precursors, CO, PM10, and PM2.5 during construction.	Addressed by construction-related PM10 emission minimization measures in Caltrans Standard Specifications Section 14
AQ-7: Potential for Generation of GHG Contaminant Emissions	The project would result in minor increases in GHG emissions during construction and long-term operation. Operational emissions increases over existing conditions are a result of background growth in VMT between 2015 and 2042. Increases between Build and No Build Alternatives under design (2042) year conditions as a result of increasing VMT and changes in vehicle speeds.	None Required

AADT = annual average daily traffic
CAAQS = California Ambient Air Quality Standards
Caltrans = California Department of Transportation
CO = carbon monoxide
FTIP = Federal Transportation Improvement Program
GHG = greenhouse gas
MSAT = Mobile Source Air Toxics
MTP = Metropolitan Transportation Plan
NAAQS = National Ambient Air Quality Standards
NO_X = nitrogen oxides
O_3 = Ozone
PM10 = particles of 10 micrometers or smaller
PM2.5 = particles of 2.5 micrometers and smaller
POAQC = Project of Air Quality Concern
ROG = reactive organic gases
RTP = regional transportation plan
SCS = Sustainable Communities Strategy
VMT = vehicle miles travelled

Chapter 2 Project Description

2.1 Project Location

The project is located in the County of Sacramento at the interchange of Hazel Avenue and U.S. 50. The project area is bounded along Hazel Avenue by the Tributary Point/westbound off-ramp intersection to the north, and extends approximately 1000 feet south of Folsom Boulevard to a future intersection within the proposed Easton Place development. The project limits along U.S. 50 begin approximately 3200 feet west of the existing Hazel Avenue Overcrossing, and extend 2500 feet east of the Natoma Overhead. Improvements along Folsom Boulevard will extend from approximately 1200' west of the Hazel Avenue intersection to 900 feet to the east. The project vicinity can be seen in Figure 1 and project location in Figure 2.

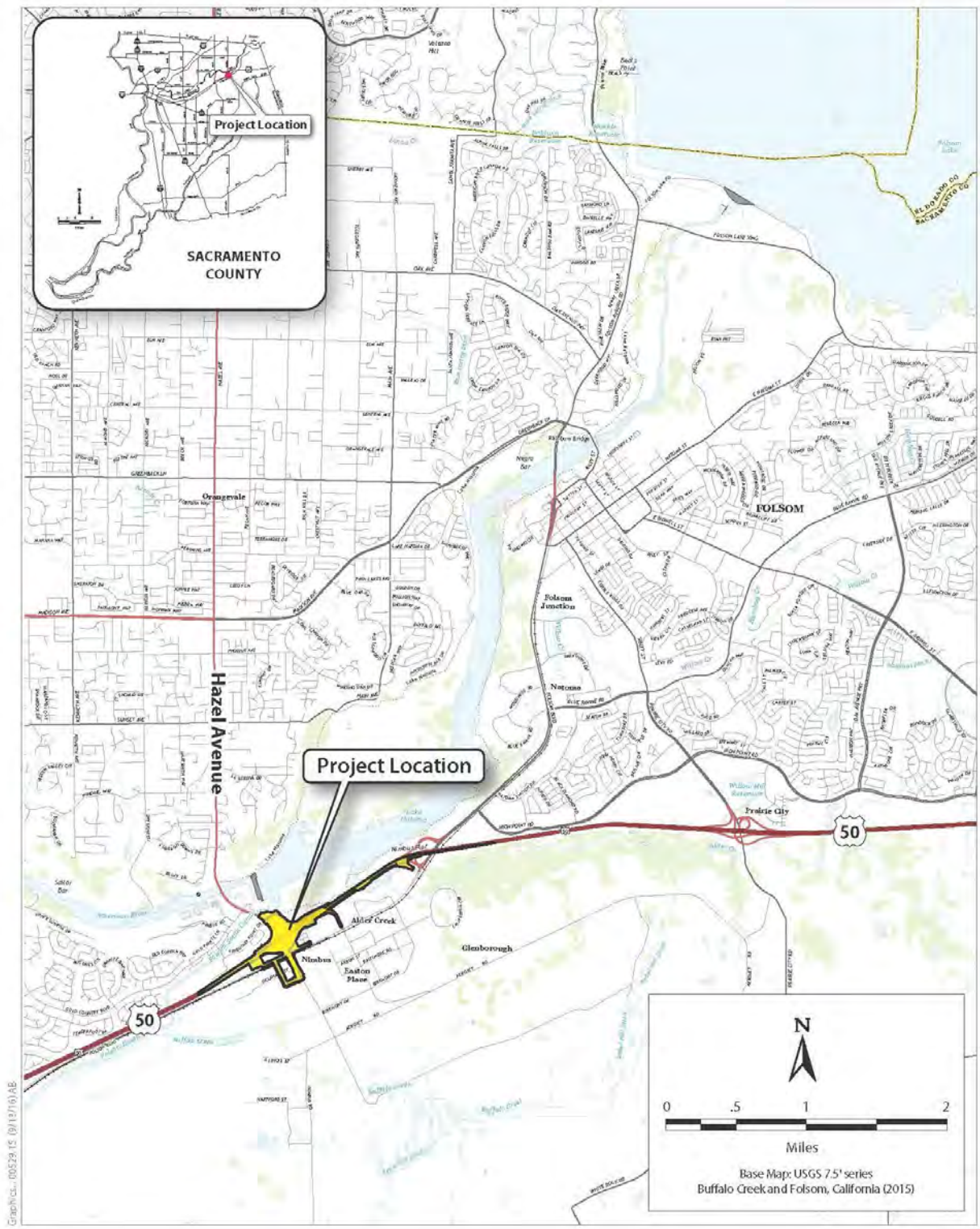


Figure 1
Project Vicinity

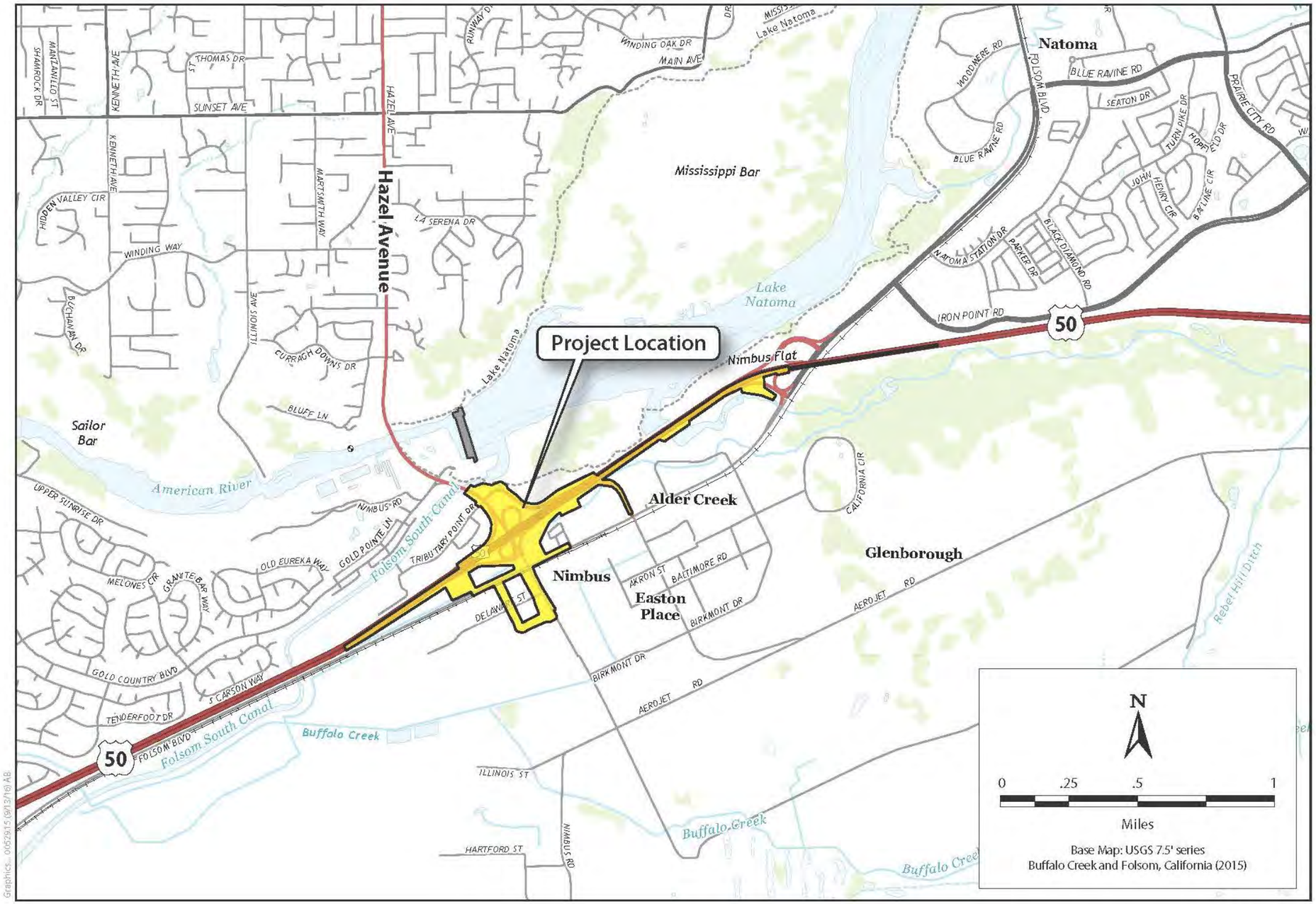


Figure 2
Project Location

2.2 Purpose and Need

2.2.1 Project Purpose

The primary purpose of the project is to modify the existing U.S. 50/Hazel Avenue Interchange to reduce congestion, improve traffic operations, accommodate travel demand due to planned and approved developments, and improve safety of all modes of travel including bicycles and pedestrians. The following objectives will be met by the Build Alternatives:

- Improve operations by removing the close intersection spacing between the eastbound ramps and Folsom Boulevard, and minimizing conflict with heavy and light rail.
- Provide sufficient capacity in the ramps and roadways for future traffic volumes.
- Maintain the Aerojet Road off-ramp connection to the approved development while improving the mainline operations.

2.2.2 Project Need

The U.S. 50 / Hazel Avenue Interchange Improvement Project is needed to relieve existing congestion at the interchange and to accommodate planned and approved developments identified by the adopted Sacramento County General Plan and SACOG's MTP/SCS.

The approved developments within and near the project area will increase traffic demand beyond what the existing interchange can accommodate. The close intersection spacing between the Folsom Boulevard and eastbound ramp intersections does not provide sufficient queuing for increased traffic volumes. Additionally, the County of Sacramento is currently widening Hazel Avenue from the interchange to Madison Avenue from four to six traffic lanes. This increase in roadway capacity is expected to deliver more traffic to the interchange during peak traffic periods.

Traffic demand forecasts for this project were conducted using SACOG's MTP/SCS projected to 2042 (20 years after anticipated opening day) and supplemented by anticipated levels of additional development currently in application or advanced planning stages. Based on these projections, it is anticipated the existing interchange will degrade to Level of Service (LOS) "F".

2.3 Alternatives

This section describes the proposed project and the design alternatives that were developed to meet the identified need through accomplishing the defined purpose while avoiding or minimizing environmental impacts.

2.3.1 Build Alternatives

The proposed project would construct modifications to the existing interchange, and grade-separate and extend Hazel Avenue to the south to a future intersection with Atlanta Street, which will be built with the approved Easton Place development. Two alternatives, with one sub-alternative, have been developed for the project.

Common Design Features of the Build Alternatives

The following is a description of elements and design components that are common to all alternatives.

Roadway Modifications

- Construction of a portion of an eastbound transition auxiliary lane on Highway 50 from Hazel Avenue through the Folsom Boulevard Overcrossing, also known as the Natoma Overhead.

- The modification of the existing Aerojet Road off-ramp from U.S. 50.

- The westbound loop on-ramp will be reconstructed, with the ramp intersection shifted north towards the westbound off-ramp terminus, increasing storage lengths. The ramp will be metered with two lanes (one mixed use, and one HOV bypass), and a squared-up "pedestrian friendly entrance".

- Reconstruction of the eastbound diagonal off-ramp to conform with the new Hazel Avenue profile and accommodate the Aerojet Road ramp divergence.

- The eastbound diagonal on-ramp will be reconstructed to conform with the new Hazel Avenue profile, and will be metered with two lanes; one mixed flow, and one HOV bypass.

- The eastbound loop on-ramp will be reconstructed to conform with the new Hazel Avenue profile, and will be metered with two lanes; one mixed flow, and one HOV bypass. A tie-back wall at the abutment of the overcrossing is proposed to maximize the

opening through the structure. The loop ramp will develop an additional lane on U.S. 50 that will continue on to the Folsom Boulevard interchange.

- Construction of eastbound on- and off-ramp auxiliary lanes on U.S. 50, from west of the Hazel Avenue to the eastbound off-ramp, and from the loop on-ramp extending to the Folsom Boulevard interchange.

- Traffic signals at the ramp intersections will be modified. Safety lighting will be installed. A new signalized intersection and at-grade railroad crossing will be constructed for the Jughandle.

- Pedestrian access will be maintained on the east side of Hazel Avenue with 6-foot sidewalks (however the existing sidewalk on the overcrossing will remain 5 feet wide). Bicyclists may utilize the County standard 7-foot shoulders. It is expected that pedestrians and bicyclists will continue to use the nearby Bikeway and Pedestrian Overcrossing as the primary means for crossing U.S. 50.

- Roadway improvements constructed along approximately 2,300 feet of Folsom Boulevard. Improvements include the removal of the existing signalized intersection with Hazel Avenue, and installation of sidewalks, street lighting, and landscaping along the north side of Folsom Boulevard, and landscaping and lighting along the south.

Transition Lane to U.S. 50/Folsom Boulevard Interchange

As indicated in Caltrans' 2009 Corridor System Management Plan, eastbound U.S. 50 is shown to have 1 HOV lane and 3 mixed flow lanes to Hazel Avenue as the Concept Facility. Also, eastbound U.S. 50 is shown to have 1 HOV lane and 3 mixed flow lanes across Folsom Boulevard as the Ultimate Facility. This project will accommodate these future facility improvements, will conform to the approved Caltrans project at U.S. 50/Folsom Boulevard interchange that is constructing a portion of those improvements in 2016, and will then restripe the third mixed flow lane through the U.S. 50/Folsom Boulevard interchange.

This project is required to add the mixed flow lane because it has been determined in the traffic analysis for this project, and in studies for adjacent projects, that the additional eastbound lane on U.S. 50 extending through the Folsom Boulevard interchange is needed for operations.

Under all alternatives, accommodating this mixed flow lane will require the eastbound loop on-ramp to extend its auxiliary lane to the U.S. 50/Folsom Boulevard eastbound off-ramp. This will require widening and a new structure over Alder Creek.

Currently Alder Creek flows under U.S. 50 through a box culvert (Br. No. 24-0033). A Mechanically Stabilized Earth (MSE) wall (Br. No. 24-0372) is above the culvert. To widen U.S. 50 over Alder Creek, a new bridge will be required. The new bridge is necessary because there is insufficient lateral space to construct an adjacent MSE wall on top of the culvert and the creek maintains a high operating water level.

Railroad Overhead

Hazel Avenue will extend and be grade-separated over Folsom Boulevard and the SPTC-JPA rail corridor. Currently there is one light rail track located on the north side of the UPRR tracks. Sacramento Regional Transit plans to add another track at this location in the future. When the addition of that track occurs, the existing UPRR track will be relocated south to accommodate the second light rail track. The proposed design meets the requirements for all three tracks, with the clearances shown in the figure below.

Temporary vertical clearances of 21'-6" and permanent vertical clearances of 24'-0" have been accounted for in the layout of all three alternatives for the Hazel Avenue Overhead. The vertical clearance provided will accommodate the Overhead Catenary System for the light rail.

Right of Way and Utilities

For Alternative 1, right of way is anticipated from parcels in the southwest quadrant of the interchange. It is anticipated that 12 parcels will be affected by the improvements, including full acquisition and demolition of structures at the Chevron gas station (APN 069-0160-012) and Cattleman's restaurant (APN 069-0060-085). The viaduct structure is proposed to cross over the northern portion of the Nimbus Winery parking lot (APN 069-0050-013) on an aerial easement, to allow parking below the structure and minimize impacts to the business.

The right-of-way take at the Nimbus Winery property (APN 069-0050-013) will be larger in Alternative 1A, as acquisition is required as opposed to an aerial easement.

For Alternative 2, right of way is anticipated from parcels in the southwest quadrant of the interchange. It is anticipated that 13 parcels will be affected by the improvements, including full acquisition and demolition of structures at the Chevron gas station (APN 069-0160-012), Cattleman's restaurant (APN 069-0060-085) and the Nimbus Winery property (APN 069-0050-013).

These acquisition needs described above are preliminary and would be finalized during the right of way process and Final Design of the project

For all alternatives, the project will require the relocation of utilities, and it is anticipated that this will include: gas lines, overhead electric lines, underground electric lines, fiber optic cables, water lines, sewer lines, and storm drain lines. The potential for impacts to other unknown utilities also exists.

2.3.2 Unique Features of the Build Alternatives

Alternative 1: L-9 Interchange with Viaduct Connector

Alternative 1 consists of a modified type L-9 interchange configuration (see Figure 3). A Caltrans Type L-9 interchange indicates a ramp configuration that includes a diagonal off-ramp, a diagonal on-ramp and a loop on-ramp. This alternative will provide a viaduct connection to Aerojet Road.

As with all alternatives, Hazel Avenue will grade-separate over Folsom Boulevard and the SPTC-JPA rail corridor and will extend further south to a proposed intersection with the future Atlanta Street (a new roadway as part of the Easton Place development). The existing at-grade intersection of Hazel Avenue and Folsom Boulevard will be removed, sidewalks will be extended across the former intersection, and the lanes will be re-striped to remove left turn lanes.

The location of the departure point of the existing Aerojet Road off-ramp from U.S. 50 will be moved to join with the eastbound Hazel Avenue off-ramp. The eastbound Hazel Avenue off-ramp will split and introduce a direct viaduct ramp over Hazel Avenue to carry eastbound off-ramp traffic to Aerojet Road and Folsom Boulevard. The off-ramp diverge from U.S. 50 will be shifted approximately 830 feet to the east to provide decision sight distance before the Aerojet Road split. The two-lane off-ramp will widen to five lanes at the ramp terminal intersection, with three left turn lanes and two right turn lanes. Retaining walls and barriers placed at the proposed right-of-way will minimize acquisition. The eastbound off-ramp will also have an auxiliary lane prior to the exit.

The Aerojet Road viaduct will land adjacent to the eastbound diagonal on-ramp and then turn southerly to conform to Folsom Boulevard along its existing alignment. Retaining walls are proposed between the viaduct and the diagonal on-ramp to accommodate the grade difference, and to the outside of the ramp after the viaduct lands, to minimize right-of-way acquisitions. Retaining walls are also proposed along Aerojet Road as it approaches the horizontal curve towards Folsom Boulevard to accommodate the grade difference between the ramp and mainline and to minimize right-of-way acquisition.

The existing Hazel Avenue Overcrossing of U.S. 50 will be widened on the west side to accommodate eight lanes (3 through lanes and 1 freeway-only lane in both directions). The existing raised concrete median across the structure will be removed, and the roadway will be re-striped with a 6-foot striped median. The existing sidewalk and barrier on the east side of the structure will remain.



Figure 3
Alternative 1: L-9 Interchange with Viaduct Connector
U.S. 50/Hazel Avenue Interchange Project

Alternative 1A: L-9 Interchange with Undercrossing Connector

Alternative 1A is the same as Alternative 1, except that the eastbound off-ramp will split and introduce a direct tunnel ramp under Hazel Avenue to carry eastbound off-ramp traffic to Aerojet Road and Folsom Boulevard (see Figure 4).



Figure 4
Alternative 1a: L-9 Interchange with Undercrossing Connector
U.S. 50/Hazel Avenue Interchange Project

Alternative 2: Direct Flyover to Hazel Avenue with Connector

Alternative 2 consists of a modified type L-9 interchange configuration, with a flyover ramp carrying vehicles travelling from eastbound U.S. 50 to northbound Hazel Avenue over the freeway to join with the westbound off-ramp (see Figure 5).



Figure 5
Alternative 2: Direct Flyover to Hazel Avenue with Connector
U.S. 50/Hazel Avenue Interchange Project

The existing Aerojet Road off-ramp from U.S. 50 will be removed. The eastbound off-ramp diverge from U.S. 50 will be shifted approximately 680 feet to the east to provide decision sight distance. An auxiliary lane will precede the off-ramp. A retaining wall is proposed adjacent to the off-ramp to minimize right-of-way acquisition.

The eastbound off-ramp will split and introduce northbound and southbound Hazel Avenue ramps. The northbound ramp will also carry traffic headed for Aerojet Road/Folsom Boulevard. An overhead sign will direct vehicles heading to southbound Hazel Avenue to the right lane, and vehicles destined for northbound Hazel Avenue or Aerojet Road or Folsom Boulevard to use either lane. Retaining walls are proposed for the ramp as it approaches the horizontal curve towards Folsom Boulevard to accommodate the grade difference between the ramp and mainline and to minimize right-of-way acquisition at an apartment complex.

The northbound Hazel Avenue movement will cross under Hazel Avenue at the interchange, cross over U.S. 50 on a two-lane flyover structure, and then merge with the westbound off-ramp and terminate at the Hazel Avenue/Tributary Point intersection. The westbound off-ramp will split so that the southbound and through movements align to the left of the ramp, and the northbound movements are to the right.

The southbound ramp will connect directly to Hazel Avenue. However, in Alternative 2 an intersection is not required at Hazel Avenue and the eastbound ramp. By eliminating an intersection at the eastbound ramp, and by removing the heavy eastbound-to-northbound movements from the Hazel Avenue overcrossing, the existing structure can remain without widening.

The two-lane westbound off-ramp will be reconstructed to provide decision sight distance between the divergence point from U.S. 50 and a new ramp split that accommodates the flyover. The westbound off-ramp will split on either side of the flyover ramp, with one lane to the right carrying northbound Hazel Avenue traffic and the other crossing underneath the flyover ramp to join up on the left side of the flyover for the southbound Hazel Avenue movements. The profiles of the three ramps have been coordinated to match grade quickly to minimize retaining wall limits and enhance driver visibility. Overhead signage will direct drivers into the appropriate lanes for northbound and southbound Hazel Avenue traffic.

2.4 No Build Alternative

The No Build Alternative, would not modify the U.S. 50/Hazel Avenue Interchange. The interchange would remain with the same existing configuration, ramps, and lanes. This alternative does not meet the purpose and need of the project.

Chapter 3 Affected Environment; Environmental Consequences; and Avoidance, Minimization, and/or Mitigation Measures

This chapter describes the environmental setting (regulatory setting and physical setting/existing conditions) for air quality and climate change as it relates to the proposed project; the impacts on air quality that would result from the proposed project; and avoidance, minimization, and/or mitigation measures that would reduce these impacts, if applicable.

3.1 Affected Environment

3.1.1 Regulatory Setting

Air Quality

The air quality management agencies of direct importance in Sacramento County include the U.S. Environmental Protection Agency (EPA), California Air Resources Board (ARB), and Sacramento Metropolitan Air Quality Management District (SMAQMD). The EPA has established federal standards for which the ARB and SMAQMD have primary implementation responsibility. The ARB and SMAQMD are also responsible for ensuring that state standards are met. Federal, state, and local regulations applicable to the proposed project are described below.

Federal Air Quality Standards

The federal Clean Air Act (FCAA) as amended in 1990 is the federal law that governs air quality. The California Clean Air Act (California CAA) of 1988 is its companion state law, which is described in the section State Air Quality Standards. These laws and related regulations by the EPA and ARB set standards for the quantity of pollutants that can be in the air. At the federal level, the standards are called National Ambient Air Quality Standards (NAAQS). NAAQS have been established for six transportation-related criteria pollutants that have been linked to potential health concerns. The criteria pollutants are carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), particulate matter (PM, broken down for regulatory purposes into particles of 10 micrometers or smaller—PM10, and particles of 2.5 micrometers and smaller—PM2.5), lead, and sulfur dioxide (SO_2). In addition, state standards exist for visibility-reducing particles, sulfates, hydrogen sulfide, and vinyl chloride.

The NAAQS and California Ambient Air Quality Standards (CAAQS) are set at a level that protects public health with a margin of safety and are subject to periodic review and revision. The NAAQS and CAAQS are listed together in Table 2. Both state and federal regulations also cover toxic air contaminants (TACs). Note that some criteria pollutants are TACs or may include certain TACs within their general definition. The federal and state air quality standards and regulations provide the basic scheme for project-level air quality analysis under NEPA and CEQA. In addition to this type of environmental analysis, a parallel "conformity" requirement under the FCAA also applies.

Federal Clean Air Act Conformity Requirements for Transportation

FCAA Section 176(c) prohibits the U.S. Department of Transportation (DOT) and other federal agencies from funding, authorizing, or approving plans, programs, or projects that are not first found to conform to the State Implementation Plan (SIP) for achieving the goals of FCAA requirements related to the NAAQS. Transportation Conformity applies on two levels: the regional, or planning and programming level, and the project level. The proposed project must conform at both levels to be approved by the DOT. Conformity requirements apply only in nonattainment and maintenance (former nonattainment) areas for the NAAQS, and only for the specific NAAQS that are or were violated. A region is *nonattainment* if one or more monitoring stations in the region measures violation of the relevant standard, and the EPA officially designates the area nonattainment. Areas that were previously designated as nonattainment areas but subsequently meet the standard may be officially redesignated to *attainment* by the EPA, and are then called *maintenance* areas. EPA regulations at 40 Code of Federal Regulations (CFR) 93 govern the conformity process.

FHWA has assigned NEPA action authority to Caltrans. Associated with this, conformity approval is also assigned to Caltrans for some projects – those that fall under "326" provisions and typically are exempt from regional conformity requirements. FHWA retains conformity approval responsibility for "327" projects. This project is regionally significant and falls under "327" provisions.

Regional conformity is concerned with how well the regional transportation system supports plans for attaining the standards set for CO, NO_2, O_3, PM10, and PM2.5, and in some areas SO_2. California is nonattainment or maintenance for all of these transportation-related criteria pollutants except SO_2, and also has a nonattainment area for lead. However, lead is not currently required by the FCAA to be covered in a transportation conformity analysis. Regional conformity is determined for regional transportation plans (RTPs) and Federal Transportation Improvement Programs (FTIPs) that include all of the transportation projects planned for a region over a period of at least 20 years for the RTP and 4 years for the FTIP. RTP and FTIP

conformity uses travel demand and air quality models to determine whether or not implementation of those projects would conform to emission budgets or other tests showing that requirements of the FCAA and SIP are met. The Metropolitan Planning Organization and FHWA determine whether the RTP and FTIP conform to SIP goals for achieving the FCAA requirements. If the RTP and FTIP do not conform to the SIP, the projects in the RTP and/or the FTIP must be modified until conformity is attained. If the design, concept, scope, and open to traffic schedule of a proposed transportation project are the same as described in the RTP and the FTIP, then the proposed project is deemed to meet regional conformity requirements for purposes of project-level analysis. SACOG's current RTP is known as the MTP/SCS and their FTIP is known as the MTIP.

Table 2. National and California Ambient Air Quality Standards Applicable in California

Pollutant	Symbol	Average Time	Standard (ppm)		Standard (µg/m^3)		Violation Criteria	
			California	National	California	National	California	National
Ozone	O_3	1 hour	0.09	NA	180	NA	If exceeded	NA
		8 hours	0.070	0.070	137	137	If exceeded	If fourth highest 8-hour concentration in a year, averaged over 3 years, is exceeded at each monitor within an area
Carbon monoxide	CO	8 hours	9.0	9	10,000	10,000	If exceeded	If exceeded on more than 1 day per year
		1 hour	20	35	23,000	40,000	If exceeded	If exceeded on more than 1 day per year
(Lake Tahoe only)		8 hours	6	NA	7,000	NA	If equaled or exceeded	NA
Nitrogen dioxide	NO_2	Annual arithmetic mean	0.030	0.053	57	100	If exceeded	If exceeded on more than 1 day per year
		1 hour	0.18	0.100	339	188	If exceeded	NA
Sulfur dioxide	SO_2	Annual arithmetic mean	NA	0.030	NA	NA	NA	If exceeded
		24 hours	0.04	0.14	105	NA	If exceeded	If exceeded on more than 1 day per year
		1 hour	0.25	75	655	196	If exceeded	NA
Hydrogen sulfide	H_2S	1 hour	0.03	NA	42	NA	If equaled or exceeded	NA
Vinyl chloride	C_2H_3Cl	24 hours	0.01	NA	26	NA	If equaled or exceeded	NA
Inhalable PM	PM10	Annual arithmetic mean	NA	NA	20	NA	If exceeded	If exceeded at each monitor within area
		24 hours	NA	NA	50	150	If exceeded	If exceeded on more than 1 day per year
	PM2.5	Annual arithmetic mean	NA	NA	12	12.0	If exceeded	If 3-year average from single or multiple community-oriented monitors is exceeded
		24 hours	NA	NA	NA	35	NA	If 3-year average of 98th percentile at each population-oriented monitor within an area is exceeded

Pollutant	Symbol	Average Time	Standard (ppm)		Standard (µg/m^3)		Violation Criteria	
			California	National	California	National	California	National
Sulfate particles	SO_4	24 hours	NA	NA	25	NA	If equaled or exceeded	NA
Lead particles	Pb	Calendar quarter	NA	NA	NA	1.5	NA	If exceeded on more than 1 day per year
		30-day average	NA	NA	1.5	NA	If equaled or exceeded	NA
		Rolling 3-month average	NA	NA	NA	0.15	If equaled or exceeded	Averaged over a rolling 3-month period

Source: California Air Resources Board 2016a

Notes: All standards are based on measurements at 25ºC and 1 atmosphere pressure; national standards shown are the primary (health effects) standards; ppm = parts per million; µg/m^3 = micrograms per cubic meter; NA = not applicable.

EPA area designations and approved SIPs are based on the previous 0.075 ppm ozone standard. Therefore regional conformity analysis for ozone is also based on the older standard.

Conformity at the project level also requires a "hot-spot" analysis if an area is nonattainment or maintenance for CO, PM10, and/or PM2.5. A hot-spot analysis is essentially the same, for technical purposes, as CO or PM analysis performed for NEPA purposes. Conformity does include some specific procedural and documentation standards for projects that require a hot-spot analysis. In general, projects must not cause the hot-spot-related CO standard to be violated, and must not cause any increase in the number and severity of violations in nonattainment areas. If a known CO or PM violation is located in the project vicinity, the project must include measures to reduce or eliminate the existing violation(s) as well.

The concept of transportation conformity was introduced in the FCAA 1977 amendments. Transportation conformity requires that no federal dollars be used to fund a transportation project unless it can be demonstrated that the project would not cause or contribute to violations of the NAAQS. Conformity requirements were made substantially more rigorous in the FCAA 1990 amendments.

Transportation conformity regulations that detail implementation of the new requirements issued in November 1993 (40 CFR 51) and substantially revised in 1997 (most provisions moved to 40 CFR 93 and rewritten). Demonstration of conformity to the SIP is the responsibility of the local Metropolitan Planning Organization. 40 CFR 93.114 states that "there must be a currently conforming RTP and transportation improvement plan at the time of project approval."

State Air Quality Standards

Responsibility for achieving the CAAQS (see Table 2), which, for certain pollutants and averaging periods, are more stringent than federal standards, is placed on the ARB and local air pollution control districts. State standards are achieved through district-level air quality management plans that are incorporated into the SIP.

ARB traditionally has established state air quality standards, maintained oversight authority in air quality planning, developed programs for reducing emissions from motor vehicles, developed air emission inventories, collected air quality and meteorological data, and approved SIPs. Air district responsibilities include overseeing stationary source emissions, approving permits, maintaining emissions inventories, maintaining air quality stations, overseeing agricultural burning permits, and reviewing air quality–related sections of environmental documents required under CEQA. It should be noted, however, that Caltrans considers the use of locally adopted CEQA thresholds of significance for construction emissions as being not mandatory, but to help serve as guidance for scoping air quality studies. However, Caltrans Standard Specification Section 14-9.02, which includes specifications relating to air pollution control, requires that projects comply with air pollution control rules, regulations, ordinances, and statutes, including

those provided in Government Code Section 11017 (Public Contract Code Section 10231). In addition, Caltrans does not have the authority to require use of specific equipment or to apply other direct restrictions on contractor equipment fleet emissions in excess of EPA, ARB, and possibly local air district regulations.

The California CAA of 1988 substantially added to the authority and responsibilities of air districts. The California CAA designates air districts as lead air quality planning agencies, requires air districts to prepare air quality plans, and grants air districts authority to implement transportation control measures.

The California CAA focuses on attainment of the CAAQS and requires designation of attainment and nonattainment areas with respect to these standards. The California CAA also requires that local and regional air districts expeditiously adopt and prepare an air quality attainment plan (Clean Air Plan) if the district violates state air quality standards for O_3, CO, SO_2, or NO_2. These plans are specifically designed to attain CAAQS and must be designed to achieve an annual 5 percent reduction in district-wide emissions of each nonattainment pollutant or its precursors. No locally prepared attainment plans are required for areas that violate the state PM10 standards; ARB is responsible for developing plans and projects that achieve compliance with the state PM10 standards.

The California CAA requires that CAAQS be met as expeditiously as practicable, but, unlike the FCAA, does not set precise attainment deadlines. Instead, the California CAA establishes increasingly stringent requirements for areas that will require more time to achieve the standards.

The California CAA emphasizes the control of "indirect and area-wide sources" of air pollutant emissions. The act gives local air pollution control districts explicit authority to regulate indirect sources of air pollution and to establish transportation control measures. The California CAA does not define the terms *indirect sources* and *area-wide sources*. However, Section 110(a)(5)(C)) of the FCAA defines an indirect source as

> a facility, building, structure, installation, real property, road, or highway which attracts, or may attract, mobile sources of pollution. Such term includes parking lots, parking garages, and other facilities subject to any measure for management of parking supply….

The ARB defines area-wide sources as sources of pollution where the emissions are spread over a wide area, such as consumer products, fireplaces, road dust and farming operations. Area-wide sources do not include mobile sources or stationary sources (California Air Resources Board n.d.). Transportation control measures are defined in the California CAA as "any strategy to

reduce trips, vehicle use, vehicle miles travelled, vehicle idling, or traffic congestion for the purpose of reducing vehicle emissions."

Local and Regional Implementation of Federal and State Requirements

At the local level, air quality is managed through land use and development planning practices, which are implemented in Sacramento County through the general planning process. SMAQMD is responsible for establishing and enforcing local air quality rules and regulations that address the requirements of federal and state air quality laws. The air district is also responsible for implementing strategies for air quality improvement and recommending mitigation measures for new growth and development.

SMAQMD (2016) has specified significance thresholds in its *Guide to Air Quality Assessment in Sacramento County* (CEQA Guide) to assist lead agencies in determining air quality impacts for projects located in Sacramento County. Although not used to determine impacts associated with the proposed project under NEPA, SMAQMD's mass emission thresholds of significance, as indicated in their CEQA Guide, are summarized in Table 3 for informational purposes.

Table 3. Sacramento Metropolitan Air Quality Management District Thresholds of Significance

Emission Type	O_3 Precursor Emissions		PM10	PM2.5
	ROG	NO_X		
Construction (short-term)	-	85 pounds per day	Implementation of feasible BMPs and 80 pounds per day or 14.6 tons per year[a]	Implementation of feasible BMPs and 82 pounds per day or 15.0 tons per year[a]
Operational (long-term)	65 pounds per day	65 pounds per day	Same as construction	Same as construction

Source: Sacramento Metropolitan Air Quality Management District 2016

[a] Zero (0) pounds per day if feasible BMPs are not implemented.

3.1.2 Physical Setting

Ambient air quality is affected by climatological conditions, topography, and the types and amounts of pollutants emitted. The following discussion describes relevant characteristics of the air basin within which the project is located and offers an overview of conditions affecting pollutant ambient air concentrations in the basin.

Climate and Topography

The project is located in Sacramento County, California, within the Sacramento Valley Air Basin (SVAB). The SVAB includes Sacramento, Shasta, Tehama, Butte, Glenn, Colusa, Sutter, Yuba, and Yolo Counties, as well as parts of Solano and Placer Counties. The SVAB is bounded on the

west by the Coast Ranges and on the north and east by the Cascade Range and Sierra Nevada Range. The San Joaquin Valley Air Basin lies to the south.

The SVAB has a Mediterranean climate characterized by hot, dry summers and cool, rainy winters. During winter, the north Pacific storm track intermittently dominates Sacramento Valley weather, and fair weather alternates with periods of extensive clouds and precipitation. Periods of dense and persistent low-level fog, which is most prevalent between storms, are also characteristic of winter weather in the valley. The frequency and persistence of heavy fog in the valley diminish with the approach of spring. The average yearly temperature range for the Sacramento Valley is 20°F to 115°F, with summer high temperatures often exceeding 90°F and winter low temperatures occasionally dropping below freezing.

In general, the prevailing winds are moderate in strength and vary from moist clean breezes from the south to dry land flows from the north. The mountains surrounding the SVAB create a barrier to airflow that can trap air pollutants under certain meteorological conditions. The highest frequency of air stagnation occurs in the autumn and early winter when large high-pressure cells collect over the Sacramento Valley. The lack of surface wind during these periods and the reduced vertical flow caused by less surface heating reduce the influx of outside air and allow air pollutants to become concentrated in a stable volume of air. The surface concentrations of pollutants are highest when these conditions are combined with temperature inversions (warm air over cool air), which trap pollutants near the ground.

The ozone season (May through October) in the Sacramento Valley is characterized by stagnant morning air or light winds with the Delta sea breeze arriving in the afternoon out of the southwest. Usually the evening breeze transports the airborne pollutants to the north out of the Sacramento Valley. During about half of the days from July to September, however, a phenomenon called the Schultz eddy prevents this from occurring. Instead of allowing the prevailing wind patterns to move north carrying the pollutants out, the Schultz eddy causes the wind pattern to circle back to the south. Essentially, this phenomenon causes the air pollutants to be blown south toward the Sacramento Valley. This phenomenon has the effect of exacerbating the pollution levels in the area and increases the likelihood of violating federal or state standards. The eddy normally dissipates around noon when the Delta sea breeze arrives.

Description of Pollutants

The primary pollutants of concern in the project area are O_3 and its precursors, ROG and NO_X, as well as CO, PM10, and PM2.5. ROG, NO_X, PM10, and PM2.5 are considered to be regional pollutants because they affect air quality on a regional scale. NO_X reacts photochemically with ROG to form O_3, while PM10 and PM2.5 can form from chemical reaction of atmospheric

chemicals, including NO_X, sulfates, nitrates, and ammonia. These processes can occur at some distance downwind of the source of pollutants. Pollutants such as CO are considered to be local pollutants because they tend to disperse rapidly with distance from the source. Although PM10 and PM2.5 are regional pollutants, they can also be localized pollutants, as direct emissions of PM10 from automobile exhaust can accumulate in the air locally near the emission source.

The following is a brief overview of O_3, CO, PM10, and PM2.5. Carbon dioxide (CO_2), mobile source air toxics (MSAT), and asbestos are also discussed, even though there are currently no adopted standards to control these pollutants.

Ozone

O_3 is a respiratory irritant that increases susceptibility to respiratory infections. It is also an oxidant that can cause substantial damage to vegetation and other materials. O_3 is not emitted directly into the air but is formed by a photochemical reaction in the atmosphere. The O_3 precursors ROG and NO_X react in the atmosphere in the presence of sunlight to form O_3. O_3 levels tend to be highest in Sacramento County during late spring through early fall, when sunlight is strong and constant, and emissions of the precursor pollutants are highest.

Carbon Monoxide

CO is a public health concern because it combines readily with hemoglobin and reduces the amount of oxygen transported in the bloodstream. CO can cause health problems such as fatigue, headache, confusion, dizziness, and even death. Motor vehicles are the dominant source of CO emissions in most areas. High CO levels develop primarily during winter when periods of light winds combine with the formation of ground-level temperature inversions (typically from the evening through early morning). These conditions result in reduced dispersion of vehicle emissions. Motor vehicles also exhibit increased CO emission rates at low air temperatures.

Inhalable Particulate Matter

PM pollution consists of very small liquid and solid particles floating in the air, which can include smoke, soot, dust, salts, acids, and metals. PM also forms when gases emitted from industries and motor vehicles undergo chemical reactions in the atmosphere. PM less than 10 microns in diameter, about 1/7th the diameter of a human hair, is referred to as PM10. PM 2.5 microns or less in diameter, roughly 1/28th the diameter of a human hair, is referred to as PM2.5. Major sources of PM10 include motor vehicles; wood burning stoves and fireplaces; dust from construction, landfills, and agriculture; wildfires and brush or waste burning; industrial sources; windblown dust from open lands; and atmospheric chemical and photochemical reactions. PM2.5 results from fuel combustion (from motor vehicles, power generation, and industrial

facilities), residential fireplaces, and wood stoves. In addition, PM10 and PM2.5 can be formed in the atmosphere from gases such as SO_2, NO_X, and ROG.

PM10 and PM2.5 pose a greater health risk than larger-size particles. When inhaled, these tiny particles can penetrate the human respiratory system's natural defenses and damage the respiratory tract. PM10 and PM2.5 can increase the number and severity of asthma attacks, cause or aggravate bronchitis and other lung diseases, and reduce the body's ability to fight infections. Very small particles of certain substances, such as lead, sulfates, and nitrates, can cause lung damage directly. These substances can be absorbed into the blood stream and cause damage elsewhere in the body; they can also transport absorbed gases such as chlorides or ammonium into the lungs and cause injury. Whereas PM10 tend to collect in the upper portion of the respiratory system, PM2.5 can penetrate deeper into the lungs and damage lung tissues. Suspended particulates also damage and discolor surfaces on which they settle, contribute to haze, and reduce regional visibility.

Carbon Dioxide

CO_2 is the most important anthropogenic greenhouse gas (GHG) and accounts for more than 75 percent of all anthropogenic GHG emissions. Its long atmospheric lifetime (decades to centuries) ensures that atmospheric concentrations of CO_2 will remain elevated for decades after mitigation efforts to reduce GHG concentrations are instituted (Intergovernmental Panel on Climate Change 2007).

Increasing concentrations of CO_2 in the atmosphere are primarily a result of emissions from the burning of fossil fuels, gas flaring, cement production, and land use changes. Three quarters of anthropogenic CO_2 emissions are the result of fossil fuel burning (and to a very small extent, cement production), and approximately one quarter of emissions are the result of land use change (Intergovernmental Panel on Climate Change 2007).

Anthropogenic emissions of CO_2 have increased concentrations in the atmosphere, most notably since the industrial revolution; the concentration of CO_2 has increased from about 280 parts per million (ppm) to 390 ppm from 1750 to 2011 (Intergovernmental Panel on Climate Change 2013:161). The Intergovernmental Panel on Climate Change estimates that the present atmospheric concentration of CO_2 has not been exceeded in the last nearly 1 million years (Intergovernmental Panel on Climate Change 2007:100).

Toxic Air Contaminants/Mobile Source Air Toxics

TACs are pollutants that may result in an increase in mortality or serious illness or that may pose a present or potential hazard to human health. Health effects of TACs include cancer, birth

defects, neurological damage, damage to the body's natural defense system, and diseases that lead to death. In 1998, following a 10-year scientific assessment process, ARB identified PM from diesel-fueled engines as a TAC. Compared to other TACs that ARB has identified and controlled, diesel particulate matter (DPM) emissions are estimated to be responsible for about 70 percent of the total ambient TAC risk (California Air Resources Board 2000).

The FCAA made controlling TAC emissions a national priority, by which Congress mandated that EPA regulate 188 TACs. These substances are also known as hazardous air pollutants. In EPA's latest rule, *Control of Emissions of Hazardous Air Pollutants from Mobile Sources* (Federal Register, Vol. 72, No. 37, page 8430, February 2007), it identified a group of 93 compounds emitted from mobile sources that are listed in its Integrated Risk Information System. The Integrated Risk Information System is a comprehensive database of specific substances known to cause human health effects. In addition, EPA identified the following seven compounds as priority MSATs.

- Acrolein
- Benzene
- 1,3-Butadiene
- DPM/diesel exhaust organic gases
- Formaldehyde
- Naphthalene
- Polycyclic organic matter

While FHWA considers these compounds the priority MSATs, the list is subject to change and may be adjusted in consideration of future rules. To address emissions of MSATs, EPA has issued a number of regulations, including the 2007 rule mentioned above, that will dramatically decrease MSATs through cleaner fuels and cleaner engines.

The issue of TACs is an emerging area of analysis and continuing research. Although much work has been done to assess the overall health risk of TACs, many questions remain unanswered. In particular, the tools and techniques available for assessing project-specific health impacts from MSATs are currently limited. Given the emerging state of the science and of project-level analysis techniques, there are no established criteria for determining when MSAT emissions should be considered a significant issue in the context of NEPA.

FHWA released guidance for factoring mobile source health risks into project-level decision-making under NEPA in October 2016 (Federal Highway Administration 2016). However, EPA has not established regulatory concentration targets for the seven relevant MSAT pollutants appropriate for use in the project development process. The FHWA recommends MSAT

analyses be conducted using EPA's latest version of the Motor Vehicle Emissions Simulator (MOVES) model, released in November 2015, which estimates on- and off-road MSAT emissions from motor vehicles. FHWA's guidance advises the assessment of MSATs in NEPA documents (Federal Highway Administration 2016).

Asbestos

Asbestos most commonly occurs in ultramafic rock that has undergone partial or complete alteration to serpentine rock (proper rock name serpentinite) and often contains chrysotile asbestos. In addition, another form of asbestos, tremolite, can be found associated with ultramafic rock, particularly near faults. Sources of asbestos emissions include: unpaved roads or driveways surfaced with ultramafic rock, construction activities in ultramafic rock deposits, or rock quarrying activities where ultramafic rock is present. Naturally occurring asbestos (NOA) is present in approximately 44 of California's 58 counties.

Asbestos can be released from serpentinite and ultramafic rocks when the rock is broken or crushed. At the point of release, the asbestos fibers may become airborne, causing air quality and human health hazards. These rocks have been commonly used for unpaved gravel roads, landscaping, fill projects and other improvement projects in some localities. Asbestos may be released to the atmosphere due to vehicular traffic on unpaved roads, during grading for development projects and at quarry operations. All of these activities may have the effect of releasing potentially harmful asbestos into the air. Natural weathering and erosion processes can act on asbestos-bearing rock and make it easier for asbestos fibers to become airborne if such rock is disturbed.

Asbestos can result in a human health hazard when airborne. The inhalation of asbestos fibers into the lungs can result in a variety of adverse health effects, including inflammation of the lungs, respiratory ailments (such as asbestosis, which is scarring of lung tissue that results in constricted breathing), and cancer (such as lung cancer and mesothelioma, which is cancer of the linings of the lungs and abdomen).

Existing Air Quality Conditions

Existing air quality conditions in the project area can be characterized in terms of the ambient air quality standards that federal and state governments have established for various pollutants (Table 4) and by monitoring data collected in the region. Monitoring data concentrations are typically expressed in terms of ppm or micrograms per cubic meter ($\mu g/m^3$). The nearest air quality monitoring station in the vicinity of the project area that reported pollutant concentrations between 2014 and 2016 is the Folsom-Natoma Street monitoring station, located at 50 Natoma

Street, which is approximately 5 miles northeast of the project. Data for CO and PM10 was unavailable from the Folsom-Natoma Street monitoring station so PM10 data from the next nearest monitoring station was taken from the Sacramento-Del Paso monitoring station, located at 2701 Alton Avenue and approximately 9 miles west of the project.

Air quality monitoring data from the Natoma-Front Street and Sacramento-Del Paso Manor monitoring stations are summarized in Table 4. These data represent air quality monitoring data for the last 3 years (2014 through 2016).

Table 4. Ambient Air Quality Monitoring Data Measured at the Front-Natoma Street Sacramento-Del Paso Manor Monitoring Stations

Pollutant Standards	2014	2015	2016
O_3			
Maximum 1-hour concentration (ppm)	0.100	0.114	0.111
Maximum 8-hour concentration (ppm)	0.085	0.093	0.095
Number of days standard exceeded[a]			
CAAQS 1-hour (>0.09 ppm)	7	3	6
CAAQS 8-hour (>0.070 ppm)	35	11	24
Nitrogen Dioxide (NO_2)			
State maximum 1-hour concentration (ppm)	35	26	24
State second-highest 1-hour concentration (ppm)	31	26	24
Annual average concentration (ppm)	4	3	3
Number of days standard exceeded[a]			
CAAQS 1-hour (0.18 ppm)	0	0	0
Carbon Monoxide (CO)			
Maximum 8-hour concentration (ppm)	1.7	2	2.1
Maximum 1-hour concentration (ppm)	1.9	2.2	2.4
Number of days standard exceeded[a]			
NAAQS 8-hour ($\geq$9 ppm)	0	0	0
CAAQS 8-hour ($\geq$9.0 ppm)	0	0	0
NAAQS 1-hour ($\geq$35 ppm)[c]	0	0	0
Particulate Matter (PM10)			
National[b] maximum 24-hour concentration ($\mu g/m^3$)	40.0	42.0	31.0
National[b] second-highest 24-hour concentration ($\mu g/m^3$)	36.0	33.0	31.0
State[c] maximum 24-hour concentration ($\mu g/m^3$)	42.8	51.4	42.2
State[c] second-highest 24-hour concentration ($\mu g/m^3$)	40.3	50.7	39.6
National annual average concentration ($\mu g/m^3$)	15.2	17.6	16.4
State annual average concentration ($\mu g/m^3$)[d]	18.8	18.0	17.6
Number of days standard exceeded[a]			
NAAQS 24-hour (>150 $\mu g/m^3$)[e]	0	0	0
CAAQS 24-hour (>50 $\mu g/m^3$)[e]	0	2	0
Particulate Matter (PM2.5)			
National[b] maximum 24-hour concentration ($\mu g/m^3$)	52.0	38.8	25.7
National[b] second-highest 24-hour concentration ($\mu g/m^3$)	27.0	31.1	23.4
State[c] maximum 24-hour concentration ($\mu g/m^3$)	52.0	38.1	25.7
State[c] second-highest 24-hour concentration ($\mu g/m^3$)	27.0	31.1	23.4

Pollutant Standards	2014	2015	2016
National annual average concentration (μg/m^3)	7.1	8	6.8
State annual average concentration (μg/m^3)[d]	7.2	8.1	*
Number of days standard exceeded[a]			
NAAQS 24-hour (>35 μg/m^3)	1	1.1	0

Notes:
CAAQS = California ambient air quality standards.
NAAQS = national ambient air quality standards.
* = insufficient data available to determine the value.
ppm = parts per million.
μg/m^3 = micrograms per cubic meter.
[a] An exceedance is not necessarily a violation.
[b] National statistics are based on standard conditions data. In addition, national statistics are based on samplers using federal reference or equivalent methods.
[c] State statistics are based on local conditions data, except in the South Coast Air Basin, for which statistics are based on standard conditions data. In addition, State statistics are based on California approved samplers.
[d] State criteria for ensuring that data are sufficiently complete for calculating valid annual averages are more stringent than the national criteria.
[e] Mathematical estimate of how many days' concentrations would have been measured as higher than the level of the standard had each day been monitored.
Source: California Air Resources Board 2016b; California Air Resources Board 2017; U.S. Environmental Protection Agency 2016a, U.S. Environmental Protection Agency 2017.

As shown in Table 4, the Folsom-Natoma Street and Sacramento-Del Paso Manor monitoring stations have experienced violations of the O_3 and PM standards over the last 3 years. No violations of the CO or NO_2 CAAQS were reported.

Attainment Status

EPA has classified the portion of Sacramento County, including the project area, as nonattainment for the federal 8-hour O_3 and PM2.5 standards and maintenance for the federal CO and PM10 standards (U.S. Environmental Protection Agency 2016b). ARB has classified Sacramento County as a nonattainment area for the state 8-hour O_3 and PM10 standards, and an attainment area for the state PM2.5 and CO standards (California Air Resources Board 2016c). Federal and state attainment status information for the project area is summarized in Table 5.

Table 5. Attainment Status of the Project Area in Sacramento County

Pollutant	Attainment Status	
	Federal	State
8-hour O_3	Severe Nonattainment	Nonattainment
CO	Moderate Maintenance	Attainment
PM10	Moderate Maintenance	Nonattainment
PM2.5	Nonattainment	Attainment

Sources: Untied States Environmental Protection Agency 2016c; California Air Resources Board 2016c.

Sensitive Receptors

SMAQMD defines *sensitive receptors* as facilities or land uses that include members of the population that are particularly sensitive to the effects of air pollutants, such as children, the elderly, and people with illnesses. Examples of sensitive receptors include schools, hospitals, residential areas, and parks. Land use compatibility issues relative to the siting of pollution-emitting sources or the siting of sensitive receptors must be considered. In the case of schools, state law requires that siting decisions consider the potential for toxic or harmful air emissions in the surrounding area. Primary pollutants of concern to sensitive receptors are CO, DPM, and, to a lesser extent, odors or odorous compounds such as ammonia and SO_2. Sensitive receptors would not be directly affected by emissions of regional pollutants, such as O_3 precursors (ROG and NO_X).

The project is located in an urban environment along the U.S. 50 corridor. Commercial uses are adjacent to westbound onramps from southbound Hazel Ave and eastbound off- and onramps. The closet sensitive receptors are the Oak Brook Apartments, which includes a building approximately 50 feet south of eastbound lanes of U.S. 50. Other sensitive receptors within 1,000 feet of the interchange include the following (see Figure 5).

- Nimbus Dam Recreational Area—100 feet east of the westbound onramps from northbound Hazel Ave.
- Twilight RV & Mobile Home Park—100 feet south of eastbound lanes of U.S. 50.
- Cobble Oaks Apartments—650 feet west of Hazel Ave. north of U.S. 50.
- Sacramento State Aquatic Center—600 feet north of the westbound onramps from northbound Hazel Ave.
- Single family homes along Silver Point Lane and Gold Bluff Lane—1,000 feet north of westbound lanes of U.S. 50.

3.2 Environmental Consequences

3.2.1 Methods

The proposed project would generate construction-related and operational emissions. The methodology used to evaluate construction and operational effects is described below.

Operational Impact Assessment Methodology

The primary operational emissions associated with the project are ROG, NO_X, CO, PM10, PM2.5, and CO_2 emitted as vehicle exhaust. Transportation conformity with regard to criteria pollutants was evaluated by including the project in the most recent MTP/SCS and MTIP. In addition, the effects of criteria pollutant and CO_2 emissions were quantified with Caltrans' CT-EMFAC emission modeling program (version 6.0) and traffic data provided by the project traffic engineers, DKS (Shew pers. comm. A).

Transportation Conformity

Regional Conformity

The proposed project is located in a severe nonattainment area for the federal 8-hour O_3 standard. Because O_3 and its precursors are regional pollutants, the project must be evaluated under the transportation conformity requirements described in Section 3.1.1, *Regulatory Setting*. An affirmative regional conformity determination must be made before the project can proceed. Such a determination is not required if the project is described in an approved MTP/SCS and MTIP and the project has not been altered in design concept or scope.

Project-Level Conformity

The project area is designated nonattainment for the federal PM2.5 standard and a moderate maintenance area for the federal PM10 and CO standards. Consequently, an evaluation of transportation conformity for CO, PM10, and PM2.5 is required. Methods used to complete the conformity analysis are discussed below.

Carbon Monoxide

The CO transportation conformity analysis is based on the CO Protocol (Garza et al. 1997). This CO Protocol details a step-by-step procedure to determine whether project-related CO concentrations have a potential to generate new air quality violations, worsen existing violations, or delay attainment of NAAQS for CO.

CO hot spots were evaluated at roadway intersections within the project area. Existing (2015), opening (2022), and design (2042) year conditions were modeled. Modeled traffic volumes and operating conditions were obtained from the traffic data prepared by the project traffic engineers, DKS (2016). Ambient CO concentrations near the roadway under future project conditions were modeled using CALINE4. The greater of a.m. and p.m. peak hour traffic was modeled to evaluate conditions with the worst LOS and delay (DKS 2016).

Appendix A summarizes intersection operational data (i.e., delay, LOS, and volumes) from the Traffic Operations Report (TOR) (DKS 2016). CO intersection modeling was conducted for the following four intersections. These intersections were chosen because they were identified in the TOR as the ones with the highest traffic volumes and/or worst delay in the vicinity of the project area.

- Hazel Avenue & Gold Country Boulevard
- Hazel Avenue & U.S. 50 Westbound Ramps/Tributary Point Drive
- Folsom Boulevard & Auto Mall Circle (East)
- Folsom Boulevard & U.S. 50 Westbound Ramps

Vehicle emission rates were determined using the EMFAC2014 emission rate program. Free flow traffic speeds were adjusted to a speed of 5.0 mph for vehicles entering and exiting intersection segments to represent a worst-case scenario, as 5 mph is the lowest speed EMFAC allows. EMFAC2014 modeling procedures followed the guidelines recommended by Caltrans. The program assumed Sacramento County regional traffic data operating during the winter months. A January low temperature of 40° F was assumed.

CO concentrations were estimated at four receptor locations located at each of the four intersections analyzed, for a total of 16 receptors. The receptors were placed at the edge of the mixing zone from the corner of each intersection, accounting for the intersection dimensions as determined by the number of lanes in each direction. The mixing zone is defined by a 3 meter buffer from the outer edge of a roadway. Receptors were modeled at the edge of the mixing zone to represent a worst-case scenario as the nearest location in which a receptor could potentially be located adjacent to a traveled roadway. The modeled receptors are not representative of the actual sensitive receptors indicated in Figure 5. Receptors were chosen based on the CO Protocol (Garza et al. 1997). Receptor heights were set at 5.9 feet (or 1.8 meters).

Meteorological inputs to the CALINE4 model were determined using methodology recommended in Appendix B of the CO Protocol (Garza et al. 1997). The meteorological conditions used in the modeling represent a calm winter period. Worst-case wind angles were modeled to determine a worst-case concentration for each receptor. The meteorological inputs included: 0.5 meters per second wind speed, ground-level temperature inversion (atmospheric stability class G), wind direction standard deviation equal to 5 degrees, and a mixing height of 1.8 meters.

To account for sources of CO not included in the modeling, maximum monitored 1- and 8-hour CO values from the nearest monitoring station (Sacramento-Del Paso Manor) for 2013 through

2015 were averaged to obtain a background concentration (see Table 4). Eight-hour modeled values were calculated from the 1-hour values using a persistence factor of 0.7. Background concentrations for opening (2022) and design (2042) year conditions were assumed to be the same as existing conditions. Actual 1- and 8-hour background concentrations in future years would likely be lower than those used in the CO modeling analysis because the trend in CO emissions and concentrations is decreasing because of continuing improvements in engine technology and the retirement of older, higher-emitting vehicles.

Particulate Matter (PM10 and PM2.5)

On March 10, 2006, EPA published a final rule that establishes the transportation conformity criteria and procedures for determining which transportation projects must be analyzed for local air quality impacts in PM2.5 and PM10 nonattainment and maintenance areas. For the assessment of PM hot spots, the final rule stipulates that a hot-spot analysis is to be performed only for projects of air quality concern (POAQCs). POAQCs are certain highway and transit projects that involve significant levels of diesel traffic or any other project identified in the PM2.5 or PM10 SIP as a localized air quality concern. Section 93.123(b)(1) of the Conformity Rule defines the following projects that require a PM2.5 or PM10 hot-spot analysis (Table 6).

Table 6. POAQCs as Defined by Section 93.123(b)(1) of the Conformity Rule

Section 93.123(b)(1) Subsection	Type of Project
i	New highway projects that have a significant number of diesel vehicles, and expanded highway projects that have a significant increase in the number of diesel vehicles.
ii	Projects affecting intersections that are at LOS D, E, or F with a significant number of diesel vehicles, or those that will change to LOS D, E, or F because of increased traffic volumes from a significant number of diesel vehicles related to the project.
iii	New bus and rail terminals and transfer points that have a significant number of diesel vehicles congregating at a single location.
iv	Expanded bus and rail terminals and transfer points that significantly increase the number of diesel vehicles congregating at a single location.
v	Projects in or affecting locations, areas, or categories of sites which are identified in the PM2.5 or PM10 applicable implementation plan or implementation plan submission, as appropriate, as sites of violation or possible violation.

LOS = level of service

Source: 40 CFR 93.123(b)(1)

EPA noted in the March 2006 final rule that the examples below are considered to be the most likely projects that would be considered a POAQC under Section 93.123(b)(1)i and ii listed above.

- A project on a new highway or expressway that serves a significant volume of diesel truck traffic, such as facilities with greater than 125,000 annual average daily traffic (AADT) where 8 percent (10,000 truck AADT) or more is diesel truck traffic.
- New exit ramps and other highway facility improvements to connect a highway or expressway to a major freight, bus, or intermodal terminal.
- Expansion of an existing highway or other facility that affects a congested intersection (operated at level of service [LOS] D, E, or F) that has a significant increase in the number of diesel trucks.
- Similar highway projects that involve a significant increase in the number of diesel transit buses and/or diesel trucks.

EPA noted in the March 2006 final rule that the examples below are considered to be the most likely projects that would be considered a POAQC under Section 93.123(b)(1)iii and iv listed above.

- A major new bus or intermodal terminal that is considered to be a "regionally significant project."
- An existing bus or intermodal terminal that has a large vehicle fleet where the number of diesel buses increases by 50 percent or more, as measured by bus arrivals.

EPA noted in the March 2006 final rule that the examples below are considered to be the most likely projects that would not be considered a POAQC under Section 93.123(b)(1)i and ii listed above.

- Any new or expanded highway project that primarily services gasoline vehicle traffic (i.e., does not involve a significant number or increase in the number of diesel vehicles), including such projects involving congested intersections operating at LOS D, E, or F.
- An intersection channelization project or interchange configuration project that involves either turn lanes or slots, or lanes or movements that are physically separated. These kinds of projects improve freeway operations by smoothing traffic flow and vehicle speeds by improving weave and merge operations, which would not be expected to create or worsen PM2.5 or PM10 violations.
- Intersection channelization projects, traffic circles or roundabouts, intersection signalization projects at individual intersections, and interchange reconfiguration projects that are designed to improve traffic flow and vehicle speeds, and do not involve any

increases in idling. Thus, they would be expected to have a neutral or positive influence on PM2.5 or PM10 emissions.

EPA noted in the March 2006 final rule that the examples below are considered to be the most likely projects that would not be considered a POAQC under Section 93.123(b)(1)iii and iv listed above:

- A new or expanded bus terminal that is serviced by non-diesel vehicles (e.g., compressed natural gas) or hybrid-electric vehicles.
- A 50 percent increase in daily arrivals at a small terminal (e.g., a facility with 10 buses in the peak hour).

For projects identified as not being a POAQC, PM2.5 and PM10 hot-spot analyses are not required. For these types of projects, state and local project sponsors should briefly document in their project-level conformity determinations that FCAA and 40 CFR 93.116 requirements have been met without a hot-spot analysis since such projects have been found not to be of air quality concern under 40 CFR 93.123(b)(1). As indicated below in Impact AQ-3, the proposed project was identified as not being a POAQC; therefore, no PM10 or PM2.5 hot-spot analyses were performed.

Mobile Source Air Toxics

FHWA has issued an updated interim guidance using a tiered approach on how MSATs should be addressed in NEPA documents for highway projects (Federal Highway Administration 2016). Depending on the specific project circumstances, FHWA has identified the following three levels of analysis.

1. No analysis for exempt projects or projects that have no potential for meaningful MSAT effects.
2. Qualitative analysis for projects with low potential MSAT effects.
3. Quantitative analysis to differentiate alternatives for projects with higher potential MSAT effects.

Exempt Projects or Projects with No Meaningful Potential Mobile Source Air Toxic Effects

The types of projects that are exempt or have no meaningful potential MSAT effects are listed below.

- Projects qualifying as a categorical exclusion under 23 CFR 771.117(c).
- Projects exempt under the FCAA Conformity Rule under 40 CFR 93.126.
- Other projects with no meaningful impacts on traffic volumes or vehicle mix.

For projects that are categorically excluded under 23 CFR 771.117(c), or are exempt from all conformity requirements under the FCAA pursuant to 40 CFR 93.126, no analysis or discussion of MSATs is necessary. Documentation sufficient to demonstrate that the project qualifies as a categorical exclusion or exempt project will suffice. For other projects with no or negligible traffic impacts, regardless of the class of NEPA environmental document, no MSAT analysis is recommended.[1] However, the project record should document the basis for the determination of "no meaningful potential impacts" with a brief description of the factors considered.

Projects with Low Potential Mobile Source Air Toxic Effects

The types of projects with low potential MSAT effects are those that serve to improve operations of highway, transit, or freight without adding substantial new capacity or without creating a facility that is likely to meaningfully increase MSAT emissions. This category covers a broad range of projects.

FHWA anticipates that most highway projects that need an MSAT assessment will fall into this category. Any projects not meeting the criteria for exempt projects or projects without meaningful potential effects (discussed above) or projects with higher potential MSAT effects (discussed below) should be included in this category. Examples of these types of projects are minor widening projects, new interchanges, replacing a signalized intersection on a surface street, or projects where design year traffic is projected to be less than 140,000 to 150,000 AADT.

For these projects, a qualitative assessment of emissions projections should be conducted. This qualitative assessment would compare, in narrative form, the expected effect of the project on traffic volumes, vehicle mix, or routing of traffic and the associated changes in MSAT for the project alternatives, including the No Build Alternative, based on vehicle miles travelled (VMT), vehicle mix, and speed. It would also discuss national trend data projecting substantial overall reductions in emissions due to stricter engine and fuel regulations issued by EPA. Because the emission effects of these projects typically are low, we expect there would be no appreciable difference in overall MSAT emissions among the various alternatives.

[1] The types of projects categorically excluded under 23 CFR 771.117(d) or exempt from project-level conformity requirements under 40 CFR 93.127 do not warrant an automatic exemption from an MSAT analysis, but they usually will have no meaningful impact.

Projects with Higher Potential Mobile Source Air Toxic Effects

This category includes projects that have the potential for meaningful differences in MSAT emissions among project alternatives. It is expected that a limited number of projects would meet the criteria to fall into this category. The criteria are listed below.

- Projects that create or significantly alter a major intermodal freight facility that has the potential to concentrate high levels of DPM in a single location, involving a significant number of diesel vehicles for new projects or accommodating a significant increase in the number of diesel vehicles for expansion projects.
- Projects that create new capacity or add significant capacity to urban highways, such as interstates, urban arterials, or urban collector-distributor routes with traffic volumes where the AADT is projected to be in the range of 140,000 to 150,000[2] or greater, by the design year.
- Projects that are proposed to be located in proximity to populated areas.
- Projects falling within this category should be more rigorously assessed for impacts, including a quantitative analysis to forecast local specific emission trends of the priority MSAT for each alternative. Based on regulations now in effect, an analysis of national trends with EPA's MOVES model, as shown in Figure 6, even if VMT increases by 45% as assumed from 2010 to 2050, a combined reduction of 91% in the total annual emissions for the priority MSAT is projected for the same time period.

Mobile Source Air Toxic Category Assessment for the Project

The analysis of applicable MSAT categories for the project is based an analysis of AADT volumes were developed by DKS. AADT on U.S. 50 between Rancho Cordova Parkway and Hazel Avenue under design year (2042) build conditions is projected to be 209,940 (Shew pers. comm. B). Consequently, based on FHWA's 2016 MSAT guidance, the Build Alternatives are considered a project with high potential MSAT effects (**Level 3**). Therefore, a quantitative analysis of potential MSAT emissions was performed consistent with FHWA requirements for MSAT Level 3 analyses.

[2] Using EPA's MOVES 2014a emissions model, FHWA staff determined that this range of AADT would result in emissions significantly lower than the California CAA definition of a major hazardous air pollutant source, i.e., 25 tons/year for all hazardous air pollutants or 10 tons/year for any single hazardous air pollutant. Variations in conditions such as congestion or vehicle mix could warrant a different range for AADT; if this range does not seem appropriate for a proposed project, project proponents can consult with the contacts from Office of Natural Environment and Office of Project Development and Environmental Review identified in the FHWA interim MSAT guidance (Federal Highway Administration 2016).

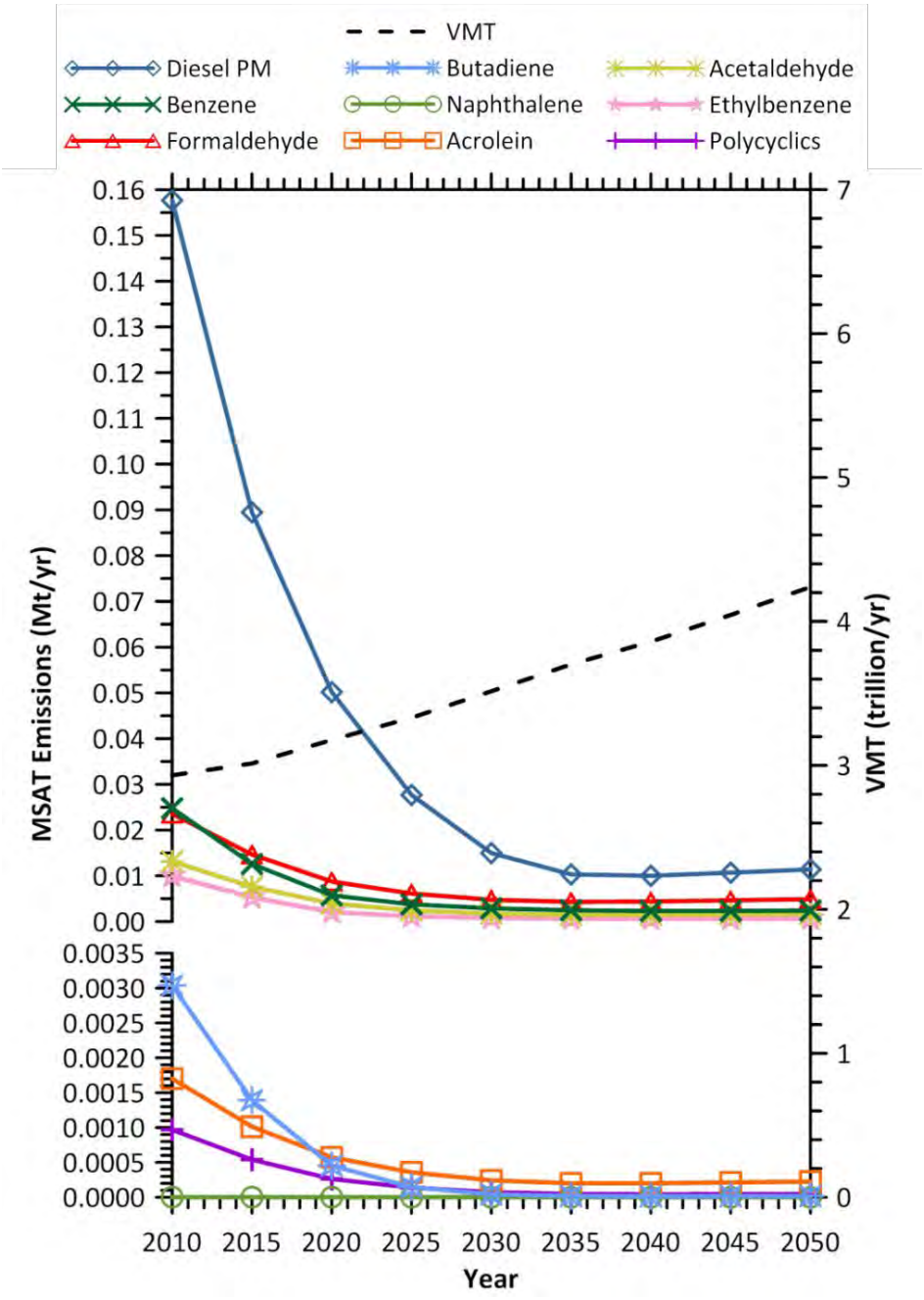


Figure 6. Projected National MSAT Emission Trends 2010–2050 For Vehicles Operating On Roadways Using EPA's MOVES2014a Model

Figure note: Trends for specific locations may be different, depending on locally derived information representing vehicle-miles travelled, vehicle speeds, vehicle mix, fuels, emission control programs, meteorology, and other factors (Federal Highway Administration 2016).

Criteria Pollutants and Greenhouse Gas Emissions

The estimation of criteria pollutant emissions associated with the project was conducted using Caltrans' CT-EMFAC model and vehicle activity data provided by the project traffic engineer, DKS (Shew pers. comm. A). CT-EMFAC is a California-specific project-level analysis tool developed for Caltrans by the University of California, Davis to model criteria pollutant, MSAT, and CO_2 emissions from on-road mobile sources. The model uses the latest version of ARB's EMFAC model to quantify running exhaust and running loss emissions using user-input traffic data, including peak-hour and off-peak-hour VMT data allocated into 5-mph speed bins.

Emission of ROG, NO_X, CO, PM10, PM2.5, and CO_2 were modeled for existing (2015), opening (2022), and design (2042) year conditions using VMT distributed by 5-mph speed bin data (5 mph to 70 mph). The data included vehicle activity on freeways and urban and rural roads in the immediate project region. Yearly GHG emissions were calculated by multiplying daily emissions by 347, consistent with ARB methodology to extrapolate yearly traffic emissions from daily (California Air Resources Board 2008).

The VMT distribution by speed bin is presented in Table 7. From a traffic operations perspective, the Build Alternatives differ only in terms of how traffic is routed through the interchange area. Traffic volumes, speeds, and other operational conditions under the alternatives are therefore identical (Shew pers. comm. C). Accordingly, the criteria pollutant and GHG impact assessment is based on a single set of traffic conditions, which is representative of both Build Alternatives.

Vehicle emission rates were determined using Caltrans' CT-EMFAC model. The CT-EMFAC program assumed project operating conditions during average annual conditions for Sacramento County. Vehicle fleet mixes, including truck volumes, were based on traffic data provided by DKS (Shew pers. comm. D). Appendix B presents the CT-EMFAC emission factors.

Table 7. Daily VMT Distribution by Speed Bin and Year

Bin	Existing (2015)		Opening (2022)		Design (2042)	
	No Build	Build	No Build	Build	No Build	Build
0–5	23,593	23,505	30,017	29,862	30,161	30,013
5–10	126,322	127,945	125,652	126,252	188,666	194,124
10–15	340,662	335,790	414,210	414,556	639,260	630,844
15–20	6,201,294	6,186,436	6,863,046	6,847,289	8,312,474	8,259,698
20–25	2,506,527	2,516,947	2,767,687	2,797,988	3,626,143	3,670,322
25–30	3,244,302	3,245,739	3,890,140	3,860,507	4,882,423	4,917,986
30–35	6,919,015	6,907,771	7,705,575	7,727,640	10,457,434	10,440,432
35–40	7,789,027	7,791,482	8,776,852	8,736,421	11,496,638	11,499,502
40–45	6,593,471	6,662,348	7,703,103	7,652,730	8,611,518	8,582,765
45–50	4,463,960	4,373,172	4,633,255	4,693,224	6,203,064	6,315,477
50–55	9,053,888	9,079,421	9,598,034	9,612,924	11,509,781	11,472,907
55–60	11,622,104	11,681,031	12,076,737	12,076,800	13,043,312	12,981,349
60–65	1,612,610	1,575,497	1,723,944	1,722,673	1,492,408	1,517,276
65-70	1,489,043	1,489,414	1,540,716	1,541,692	1,715,045	1,716,001
Total[a]	61,985,819	61,996,499	67,848,968	67,840,557	82,208,326	82,228,698

Source: Shew pers. comm. A

[a] Values may not add to total due to rounding.

Construction Impact Assessment Methodology

Construction activity is a source of dust and exhaust emissions that can have substantial temporary impacts on local air quality (i.e., exceeding CAAQS for O_3, CO, PM10, and PM2.5). Such emissions would result from earthmoving and use of heavy equipment, as well as land clearing, ground excavation, cut-and-fill operations, and roadway construction. Emissions can vary substantially from day to day, depending on the level of activity, the specific operations, and the prevailing weather. A major portion of dust emissions for the project would likely be caused by construction traffic on temporary areas.

Construction emissions of ROG, NO_X, CO, PM10, PM2.5, and CO_2e were estimated using the Sacramento Metropolitan Air Quality Management District's (SMAQMD) Road Construction Emissions Model (RCEM) (Version 8.1.0). The RCEM is a public-domain spreadsheet model formatted as a series of individual worksheets available to estimate construction-related emissions for roadway projects. The model enables users to estimate emissions using a minimum amount of project-specific information. The model estimates emissions for load hauling (on-road, heavy-duty vehicle trips), worker commute trips, construction site fugitive dust (PM10 and PM2.5), and off-road construction vehicles. This analysis is based on anticipated construction equipment calculated by the RCEM, which estimates construction equipment based on project size, duration of construction activities, and level of daily construction activities. While exhaust emissions are estimated for each activity, fugitive dust estimates are currently limited to major dust-generating activities, which include grubbing/land clearing and grading/excavation.

Construction of the project is expected to occur in multiple phases over a period of two years, beginning in 2020. Up to six activities per phase are anticipated to occur: (1) grubbing/land clearing; (2) grading/excavation; (3) drainage/utilities/sub-grade; (4) paving; (5) bridge (if applicable); and (6) wall (if applicable). Construction activity information and assumption data were provided by the project engineers, Mark Thomas & Company (Eden pers. comm.). Please refer to Appendix C for the equipment activity data, construction sequencing, and other emissions modeling assumptions.

Construction emissions need not be evaluated for conformity impacts unless the construction period will last 5 or more years. Since the construction of this project will require 2 years, construction emission analysis for transportation conformity is not required.

3.2.2 Effects

This section discusses air quality and climate change effects that could result from project implementation.

Impact AQ-1: Conformity of the Regional Transportation Plan with the State Implementation Plan

The proposed project is listed in SACOG's currently conforming 2016 MTP/SCS as SAC24255. The 2016 MTP/SCS, as amended, and the corresponding air quality conformity analysis were last approved by FHWA and FTA on December 16, 2016. The proposed project is also listed in the financially constrained 2017/20 MTIP. The design concept and scope of the proposed project is consistent with the project description in the 2016 MTP/SCS, 2017/20 FTIP, and SACOG's regional emissions analysis. Accordingly, it can be concluded that the project's operational emissions (which include the O_3 precursors ROG and NO_X) meet the transportation conformity requirements imposed by the EPA and SMAQMD and would not be expected to exacerbate O_3 nonattainment conditions. Therefore, regional conformity requirements are satisfied. Refer to Appendix D for the MTP and MTIP project listing and FHWA approval letter.

Impact AQ-2: Potential Violations of CO NAAQS or CAAQS

Existing year (2015), opening year (2022), and design year (2042) conditions were modeled to evaluate CO concentrations relative to the NAAQS and CAAQS. As previously discussed, CO concentrations were estimated at four roadway intersections within the project area. These roadway intersections were modeled because they represent the intersections that would have the worst LOS and/or highest traffic volumes. Table 8 summarizes the results of the intersection CO modeling.

Table 8. CO Modeling Concentration Results (Parts per Million)

Intersection	Receptor[a]	Existing (2015)		Opening Year (2022)				Design Year (2042)			
				No Build & Alt 1/1A		Alt 2		No Build & Alt 1/1A		Alt 2	
		1-hr CO[b]	8-hr CO[c]	1-hr CO[b]	8-hr CO[c]	1-hr CO[b]	8-hr CO[c]	1-hr CO[b]	8-hr CO[c]	1-hr CO[b]	8-hr CO[c]
Hazel Avenue & Gold Country Boulevard	1	4.0	3.0	4.0	3.0	Same as No Build		4.0	3.0	Same as No Build	
	2	3.7	2.8	3.6	2.7			3.6	2.7		
	3	3.5	2.6	3.8	2.8			3.7	2.8		
	4	4.6	3.4	4.3	3.2			4.2	3.1		
Hazel Avenue & U.S. 50 Westbound Ramps/Tributary Point Drive	5	5.3	3.9	5.0	3.7	4.9	3.6	5.1	3.8	5.0	3.7
	6	5.0	3.7	4.7	3.5	4.7	3.5	4.7	3.5	4.7	3.5
	7	7.0	5.1	6.2	4.5	5.9	4.3	5.9	4.3	5.7	4.2
	8	6.8	4.9	6.1	4.5	6.0	4.4	5.8	4.2	5.8	4.2
Folsom Boulevard & Auto Mall Circle (East)	9	2.8	2.1	2.9	2.2	Same as No Build		3.0	2.3	Same as No Build	
	10	2.7	2.1	2.8	2.1			2.9	2.2		
	11	2.9	2.2	2.9	2.2			2.9	2.2		
	12	3.1	2.4	3.1	2.4			3.1	2.4		
Folsom Boulevard & U.S. 50 Westbound Ramps	13	4.2	3.1	3.7	2.8	Same as No Build		3.9	2.9	Same as No Build	
	14	4.1	3.1	3.7	2.8			3.9	2.9		
	15	3.5	2.6	3.2	2.4			3.3	2.5		
	16	4.0	3.0	3.5	2.6			3.6	2.7		
State Standard (ppm)	-	20	9	20	9	20	9	20	9	20	9
Federal Standard (ppm)	-	35	9	35	9	35	9	35	9	35	9

[a] Consistent with Caltrans CO Protocol, receptors are located at 3 meters from the intersection, at each of the four corners to represent the nearest location in which a receptor could potentially be located adjacent to a traveled roadway. The modeled receptors (Receptors 1-16) are not representative of the actual sensitive receptors indicated in Figure 5. All intersections modeled have two intersecting roadways.

[b] Average 1-hour background concentration between 2013 and 2015 was 1.9 ppm (California Air Resources Board 2016b).

[c] 8-hour background concentration in 2012 was 1.5 ppm (U.S. Environmental Protection Agency 2016a).

CO = carbon monoxide; ppm = parts per million

As shown in Table 8, CO concentrations are not anticipated to exceed the 1- or 8- hour NAAQS and CAAQS. Consequently, project-level CO conformity requirements are satisfied.

Impact AQ-3: Potential Violations of PM10 or PM2.5 NAAQS or CAAQS

The project would be within a nonattainment area for the federal PM2.5 standard and maintenance area for the federal PM10 standard. Therefore, per 40 CFR Part 93, a project-level PM2.5 and PM10 analysis is required for conformity purposes.

As discussed in Section 3.1.1, a quantitative hot-spot analysis is only required for projects identified as a POAQC, as defined in 40 CFR 93.123(b)(1). As described below, the project does not meet any of the project types considered to be POAQCs by EPA's final rule. Accordingly, the project is not considered to be a POAQC, and project-level particulate matter conformity determination requirements are thus satisfied.

(i) **New highway projects that have a significant number of diesel vehicles, and expanded highway projects that have a significant increase in the number of diesel vehicles**. EPA's *Transportation Conformity Guidance for Quantitative Hot-Spot Analyses in PM2.5 and PM10 Nonattainment and Maintenance Areas* indicates that a facility with an AADT volume of 125,000 and 8 percent trucks (10,000 truck AADT) are likely considered a POAQC. The proposed project would construct improvements on an existing freeway interchange. For existing freeway facilities, the effect of a project on truck volumes is normally the main point on which this criterion is judged. A project may be located on a freeway with a substantial number of trucks, but if it does not change those truck volumes significantly, it may have a minimal effect on exhaust-related particulate matter. As shown in Table 9, the proposed project would increase design (2042) year truck volumes on U.S. 50 by approximately one percent, relative to No Build conditions. This increase is predominately a result of redistributed traffic from Folsom Boulevard. As described above, the Build Alternatives would reconstruct the Aerojet off-ramp at Hazel Avenue, providing direct and efficient access to Aerojet Drive from U.S. 50. Drivers seeking to bypass congestion on U.S. 50 between Hazel Avenue and the existing Aerojet off-ramp would no longer exit at Hazel Avenue and travel along Folsom Boulevard before reaching Aerojet Drive. Virtually all of the AADT increase on U.S. 50 is therefore accounted for in an AADT decrease on Folsom Boulevard (Shew pers. comm. E).

The reconstructed Aerojet off-ramp would run parallel to U.S. 50, approximately 600 feet north of Folsom Boulevard. As shown in Figure 5, the Twilight RV & Mobile

Home Park and Oak Brook Apartments are located between Folsom Boulevard and the reconstructed Aerojet off-ramp. Since the AADT increase on U.S. 50 is largely attributed to a corresponding AADT decrease on Folsom Boulevard, these receptors would be exposed to particulate matter emissions from the redistributed traffic under both Build and No Build conditions. However, particulate matter concentrations at these receptors locations may actually be lower under the Build Alternatives due to prevailing wind patterns. Data from the Mather Field Airport indicate that winds in the project area are predominately from the south (Western Regional Climate Center 2016). Accordingly, emissions generated by traffic on Folsom Boulevard are likely dispersed north toward the existing receptors. The Build Alternatives would redistribute traffic, and associated emissions, from Folsom Boulevard to U.S. 50/Aerojet off-ramp, which are north of the receptors. As such, even though traffic and truck volumes between U.S. 50 and Folsom Boulevard would remain similar under Build and No Build conditions, the effect of moving traffic north of the existing residential receptors would likely lower particulate matter concentrations as a result of the southerly winds in the project area.

(ii) **Projects affecting intersections that are at LOS D, E, or F with a significant number of diesel vehicles, or those that will change to LOS D, E, or F because of increased traffic volumes from a significant number of diesel vehicles related to the project**. Implementation of the project would relieve congestion on the local roadway network by redistributing traffic from the local roadways to the U.S. 50 corridor. The traffic analysis evaluated nine intersections under opening (2022) and design (2042) year conditions (see Appendix A). The Build Alternatives would have no effect or result in improved LOS and reduced vehicle delay at all but two study intersections (Hazel Avenue/Gold Country Boulevard and Hazel Avenue/U.S. 50 WB Ramps under Opening Year conditions, and Hazel Avenue/Gold Country Boulevard and Folsom Boulevard/U.S. 50 WB Ramps under Design Year conditions). However, none of the study intersections have a significant number of trucks (2%), therefore, the Build Alternatives would not affect any intersections with a high number of diesel vehicles.

(iii) **New bus and rail terminals and transfer points that have a significant number of diesel vehicles congregating at a single location**. The project does not include new bus or rail terminals and transfer points.

(iv) **Expanded bus and rail terminals and transfer points that significantly increase the number of diesel vehicles congregating at a single location**. The project does not include expanded bus or rail terminals and transfer points.

(v) **Projects in or affecting locations, areas, or categories of sites which are identified in the PM2.5 or PM10 applicable implementation plan or implementation plan submission, as appropriate, as sites of violation or possible violation**. Currently, there is no SIP for the federal PM2.5 standard. The project area is not identified as a site of possible violation in the PM10 maintenance plan.

Table 9. AADT Volumes and Truck Percentages under Opening (2022) and Design (2042) Year Conditions (Build and No Build Conditions)

Year	AADT			Truck Volume[a]		
	Build	No Build	Change[b]	Build	No Build	Change[b]
2022	168,180	166,910	1%	10,091	10,015	1%
2042	209,940	208,250	1%	12,596	12,495	1%

Source: Shew pers. comm. B
[a] Trucks represent 6% of AADT on U.S. 50 in the project area (Shew pers. comm. D)
[b] Represents the change in traffic volume under the Build Alternatives, relative to No Build conditions.

Based on the discussion above, the project would not be considered a POAQC, as defined by 40 CFR 93.123(b)(1). Therefore, FCAA and 40 CFR 93.116 requirements were met without a hot-spot analysis.

The project underwent interagency consultation through SACOG's Project Level Conformity Group (PLCG). EPA and FHWA issued concurrence that the project is not a POAQC on June 19, 2017. Appendix E contains the documentation submitted to SACOG and used to support its concurrence, as well as concurrence letters from EPA and FHWA that the project is not a POAQC.

Impact AQ-4: Potential for Generation of Mobile Source Air Toxic Emissions

As discussed in Section 3.2.1, *Methods,* the Build Alternatives are considered a project with high potential MSAT effects (**Level 3**) because AADT on U.S. 50 is greater than FHWA's MSAT AADT threshold of 140,000 (Federal Highway Administration 2016). Therefore, a quantitative analysis of potential MSAT emissions was performed.

MSAT emissions for existing (2015), opening (2022), and design (2042) year conditions were evaluated through modeling conducted using Caltrans' CT-EMFAC model and vehicle activity data provided by DKS (Shew pers. comm. A). Table 10 summarizes the modeled emissions by scenario and presents a comparison of Build Alternative emissions to No Build and existing conditions. The differences in emissions between the Build and No Build conditions represent emissions generated directly as a result of implementation of the project. The opening (2022) and design (2042) year analyses account for reductions in vehicular emission rates as a result of

continuing improvements in engine technology and the retirement of older, higher-emitting vehicles.

Table 10. Estimated MSAT Emissions from Operation of U.S. 50/Hazel Avenue Interchange Project (pounds per day)

Condition	Acetaldehyde	Acrolein	Benzene	Butadiene	Formaldehyde	Diesel PM
2015 Existing	205	15	3,973	69	514	591
2022 No Build	110	7	2,713	34	273	155
2022 Build	110	7	2,713	34	273	155
2042 No Build	82	5	1,420	23	198	50
2042 Build	82	5	1,420	23	198	50
Comparison to Existing						
2022 Build	-95	-8	-1,260	-35	-241	-436
% change between 2022 Build and Existing	-46%	-53%	-32%	-51%	-47%	-74%
2042 Build	-123	-10	-2,552	-46	-316	-541
% change between 2042 Build and Existing	-60%	-67%	-64%	-67%	-61%	-92%
Comparison to No Build						
2022 Build	<0	<0	<0	<0	<0	<0
2042 Build	<0	<0	<1	<0	<0	<1

The emissions analysis presented in Table 10 indicates that operation of the Build Alternatives under opening (2022) and design (2042) year conditions would decrease all MSAT emissions compared to existing conditions. The decreases are due to expected improvements in vehicle engine technology, fuel efficiency, and turnover in older, more heavily polluting vehicles, which reduces exhaust emissions.

Emissions effects resulting from implementation of the Build Alternatives are obtained through a comparison of with-project emissions to without-project emissions. As shown in Table 7, VMT under the Build and No Build conditions is nearly the same, with the Build Alternatives resulting in a slight (0.01%) reduction in VMT under opening (2022) year conditions and a slight (0.02%) increase in VMT under design (2042) year conditions. The MSAT results under opening (2022) year conditions mirror the VMT trend, with the Build Alternatives projected to decrease all MSAT emissions, relative to the No Build Alternative.

Under design (2042) year conditions, the Build Alternatives would result in minor increases of Benzene and DPM, and decreases of all other MSATs. These emissions trends are explained by the relationship between vehicle speeds and emissions rates. Virtually all MSAT emission rates decrease rapidly with increasing speeds between 0 and 15 mph, hold fairly steady between 15 mph and 60 mph, and then begin to slightly increase at speeds greater than 60 mph. The operational enhancements associated with the project will change the speed distribution of VMT, as shown in Table 7. The changes in the speed profile, coupled with the speed-based emission factor trends, yield minor decreases in all MSATs except Benzene and DPM, despite an overall

increase in daily VMT. While Benzene and DPM are forecasted to increase compared to the No Build Alternative, the predicted increase under the Build Alternatives would be minor.

MSAT Research and Incomplete Information

Air toxics analysis is an ongoing area of research. While much work has been done to assess the overall health risk of TACs, many questions remain unanswered. In particular, considerable uncertainties are associated with the existing estimates of MSAT toxicity, as well the acceptable risk levels. Because of these and other limitations, technical tools are not available to predict the project-specific health impacts of the emission changes associated with each project alternative. Because of these limitations, Appendix F is included in this report in accordance with Council on Environmental Quality regulations (40 CFR 1502.22[b]) regarding incomplete or unavailable information.

Impact AQ-5: Potential for Generation of Operation-Related Emissions of Ozone Precursors, Carbon Monoxide, and Particulate Matter

Long-term air quality impacts are those associated with motor vehicles operating on the roadway network, predominantly those operating in the project vicinity. Emission of ROG, NO_X, CO, PM10, and PM2.5 for existing (2015), opening (2022), and design (2042) year conditions were evaluated through modeling conducted using Caltrans' CT-EMFAC model and vehicle activity data provided by DKS (Shew pers. comm. A).

Table 11 summarizes the modeled emissions by scenario and presents a comparison of Build Alternative emissions to No Build and existing conditions. The differences in emissions between the Build and No Build conditions represent emissions generated directly as a result of implementation of the project. The opening (2022) and design (2042) year analyses account for reductions in vehicular emission rates as a result of continuing improvements in engine technology and the retirement of older, higher-emitting vehicles.

Because Caltrans has statewide jurisdiction, and the setting for projects varies so extensively across the state, Caltrans has not developed and has no intention to develop thresholds of significance for CEQA. Further, because most air district thresholds have not been established by regulation or by delegation from a federal or state agency with regulatory authority over Caltrans, Caltrans is not required to adopt those thresholds in Caltrans documents. Nevertheless, project-level operational emissions relative to SMAQMD thresholds are presented in Table 11 for informational purposes only.

Table 11. Estimated Criteria Pollutant Emissions from Operation of U.S. 50/Hazel Avenue Interchange Project (pounds per day)

Condition	Daily VMT	ROG	NO_X	CO	PM10	PM2.5
2015 Existing	61,985,819	374,575	65,326	231,039	7,740	3,542
2022 No Build	67,848,968	260,126	34,159	124,862	7,889	3,349
2022 Build	67,840,557	260,093	34,153	124,835	7,888	3,349
2042 No Build	82,208,326	134,334	13,692	70,743	9,185	3,733
2042 Build	82,228,698	134,366	13,687	70,755	9,187	3,734
Comparison to Existing						
2022 Build	5,854,738	-114,482	-31,173	-106,204	147	-193
% change between 2022 Build and Existing	9%	-31%	-48%	-46%	2%	-5%
2042 Build	20,242,879	-240,209	-51,639	-160,284	1,447	192
% change between 2042 Build and Existing	33%	-64%	-79%	-69%	19%	5%
Comparison to No Build						
2022 Build	-8,410	-33	-6	-28	-1	0
% change between 2022 Build and 2022 No Build	-0.01%	-0.01%	-0.02%	-0.02%	-0.01%	--
2042 Build	20,372	32	-5	12	2	1
% change between 2042 Build and 2042 No Build	0.02%	0.02%	-0.04%	0.02%	0.02%	0.03%
SMAQMD Threshold	-	*65*	*65*	-	*80*	*82*

SMAQMD= Sacramento Metropolitan Air Quality Management District
CO = carbon monoxide
NO_X = nitrogen oxides
PM10 = particles of 10 micrometers or smaller
PM2.5 = particles of 2.5 micrometers and smaller
ROG = reactive organic gases
VMT = vehicle miles travelled

The emissions analysis presented in Table 11 indicates that operation of the Build Alternatives under opening (2022) and design (2042) year conditions would increase PM10 and PM2.5 (design year only) emissions compared to existing conditions and decrease ROG, NO_X, and CO emissions. These results are primarily due to factors external to the project. The increase in PM is due to background growth in VMT (per Table 11, 5 million daily VMT between 2015 and 2022 and 20 million daily VMT between 2015 and 2042), as PM emissions are primarily a function of VMT. The decreases in other pollutants are due to expected improvements in vehicle engine technology and fuel efficiency, which reduces exhaust emissions.

Emissions effects resulting from implementation of the Build Alternatives under opening (2022) and design (2042) year conditions are obtained through a comparison of with-project emissions to without-project emissions. As discussed above and shown in Table 7, VMT under the Build and No Build conditions is nearly the same, with the Build Alternatives resulting in a slight (0.01%) reduction in VMT under opening (2022) year conditions and a slight (0.02%) increase in VMT under design (2042) year conditions. The criteria pollutant results under opening (2022)

year conditions mirror the VMT trend, with the Build Alternatives projected to decrease emissions, relative to the No Build Alternative.

Under design (2042) year conditions, the Build Alternatives would result in minor increases of all pollutants, except NO_X. The minor increase in ROG, CO, and PM emissions by approximately 0.02% to 0.03% is primarily a result of VMT growth and would be minor. The decrease in NO_X by approximately 0.04% is attributed to the relationship between vehicle speeds and emissions rates. Similar to MSATs (discussed above), decreasing NOx emissions are observed with increasing speeds. The changes in the speed profile, coupled with the speed-based emission factor trend, are sufficient to offset the minor increase in VMT, resulting in a slight NO_X reduction, relative to the No Build Alternative.

Impact AQ-6: Potential for Temporary Increase in Ozone Precursors (ROG and NO_X), CO, and Particulate Matter Emissions during Grading and Construction Activities

Implementation of the project would construct modifications to the existing interchange, and grade-separate and extend Hazel Avenue to the south to a future intersection with Atlanta Street. Temporary construction emissions would result from grubbing/land clearing, grading/excavation, drainage/utilities/sub-grade construction, paving activities, bridge and wall erection, and construction worker commuting patterns. Pollutant emissions would vary daily, depending on the level of activity, specific operations, and prevailing weather.

The SMAQMD's RCEM (Version 8.1.0) was used to estimate ROG, NO_X, CO, PM10, and PM2.5 emissions from construction based on activity data provided by the project engineers (Eden pers. comm.). As shown in Appendix C, several construction activities would likely occur concurrently. To ensure a conservative analysis, maximum daily emissions during these periods of overlap were estimated assuming all equipment would operate at the same time. This assumption identifies the maximum total project-related air quality impact during construction.

Tables 12 and 13 summarize maximum daily emissions levels for construction of Alternatives 1 and 2, respectively. Because Caltrans has statewide jurisdiction, and the setting for projects varies so extensively across the state, Caltrans has not developed and has no intention to develop thresholds of significance for CEQA. Further, because most air district thresholds have not been established by regulation or by delegation down from a federal or state agency with regulatory authority over Caltrans, Caltrans is not required to adopt those thresholds in Caltrans' documents. Nevertheless, SMAQMD's thresholds of significance are provided for informational purposes.

Table 12. Estimated Unmitigated Criteria Pollutant Emissions from Construction of Alternative 1 (pounds per day)

Year	ROG	NO_X	CO	PM10			PM2.5		
				Dust	Exhaust	Total	Dust	Exhaust	Total
2020	18	195	126	76	9	83	16	8	22
2021	11	113	79	58	5	62	12	5	16
SMAQMD Threshold	-	*85*	-	*BMPs*	-	*80[a]*	*BMPs*	-	*82[a]*

SMAQMD= Sacramento Metropolitan Air Quality Management District

[a] SMAQMD's (2016) CEQA Guidelines only consider PM10 and PM2.5 emissions below their 82 and 80 pound per day thresholds, respectively, to be less than significant with application of BMPs.

CO = carbon monoxide
NO_X = nitrogen oxides
PM10 = particles of 10 micrometers or smaller
PM2.5 = particles of 2.5 micrometers and smaller
ROG = reactive organic gases

Table 13. Estimated Unmitigated Criteria Pollutant Emissions from Construction of Alternative 2 (pounds per day)

Year	ROG	NO_X	CO	PM10			PM2.5		
				Dust	Exhaust	Total	Dust	Exhaust	Total
2020	18	193	124	44	9	52	9	8	17
2021	11	115	77	67	5	73	14	5	19
2022	2	26	19	<1	1	1	<1	1	1
SMAQMD Threshold	-	*85*	-	*BMPs*	-	*80[a]*	*BMPs*	-	*82[a]*

SMAQMD= Sacramento Metropolitan Air Quality Management District

[a] SMAQMD's (2016) CEQA Guidelines only consider PM10 and PM2.5 emissions below their 82 and 80 pound per day thresholds, respectively, to be less than significant with application of BMPs.

CO = carbon monoxide
NO_X = nitrogen oxides
PM10 = particles of 10 micrometers or smaller
PM2.5 = particles of 2.5 micrometers and smaller
ROG = reactive organic gases

Construction activities are subject to requirements found in the *Standard Specifications for Construction of Local Streets and Roads* (California Department of Transportation 2010). Standard Specification Section 14-9.02 requires compliance with SMAQMD rules, regulations, ordinances, and statutes that apply to work performed under the contract, including air pollution control rules, regulations, ordinances, and statutes provided in Government Code Section 11017 (Public Contract Code § 10231). Standard Specification Section 14-9.03 addresses dust control and palliative requirements. Implementation of Caltrans' Standard Specification and SMAQMD measures to control dust during construction would help to minimize air quality impacts from construction activities.

Asbestos and Lead-Based Paint

According to the California Department of Conservation's 2000 publication, *A General Location Guide for Ultramafic Rocks in California*, there are no geologic features normally associated

with NOA (i.e., serpentine rock or ultramafic rock near fault zones) in or near the project area (California Department of Conservation 2000). As such, there is no potential for impacts related to NOA emissions during construction activities.

Removal of the Cattleman's restaurant and Nimbus Winery may expose workers to asbestos and lead-based paint if the materials were used during original building construction. Standard Specification Section 14-9.02 requires compliance with SMAQMD rules and regulations, including Rule 902, which requires pre-construction surveys for asbestos. Testing for lead-based paint will also be conducted during the asbestos survey. Compliance with SMAQMD Rule 902 and testing for asbestos containing materials and lead based paint prior to construction will avoid adverse effects related to asbestos and lead-based paint during demolition activities.

Odors

Minor sources of odors would be present during construction of the proposed project. Diesel engines are the predominant source of power for construction equipment. Exhaust odors from diesel engines, as well as emissions associated with asphalt paving, may be considered offensive to some individuals. However, because odors would be temporary and would disperse rapidly with distance from the source, construction-generated odors are not anticipated to result in the adverse exposure of receptors to objectionable odorous emissions.

Impact AQ-7: Potential for Generation of Greenhouse Gas Contaminant Emissions

Operational Emissions

The project would reconfigure the U.S. 50/Hazel Avenue Interchange. Caltrans' CT-EMFAC model was used to estimate CO_2 emissions for existing (2015), opening (2022), and design (2042) year conditions. Table 14 summarizes the modeled emissions by scenario and presents a comparison of Build emissions to No Build and existing conditions. Emissions are presented with and without state mandates to reduce GHG emissions from on-road vehicles and transportation fuels.[3]

[3] Actions undertaken by the state will contribute to project-level GHG reductions. The state mandate analysis assumes implementation of Pavley and the low carbon fuel standard (LCFS). Pavley will improve the efficiency of automobiles and light duty trucks, whereas LCFS will reduce the carbon intensity of diesel and gasoline transportation fuels.

Table 14. Estimated Greenhouse Gas Emissions from Operation of the U.S. 50/Hazel Avenue Interchange Project (metric tons per year)

Condition	Annual VMT[a]	CO_2	CH_4	N_2O	CO_2e
2015 Existing	21,509,079,172	9,050,387	418	396	9,178,982
2022 No Build	23,543,591,726	8,309,893	248	222	8,382,284
2022 Build	23,540,673,310	8,308,671	248	222	8,381,050
2042 No Build	28,526,289,032	7,260,113	149	133	7,303,391
2042 Build	28,533,358,126	7,260,815	149	133	7,304,087
Comparison to Existing					
2022 Build	2,031,594,138	-741,716	-169	-174	-797,933
% change between 2022 Build and Existing	9%	-8%	-40%	-44%	-9%
2042 Build	7,024,278,954	-1,789,573	-268	-264	-1,874,895
% change between 2024 Build and Existing	33%	-20%	-64%	-67%	-20%
Comparison to No Build					
2022 Build	-2,918,416	-1,222	<0	<0	-1,234
2042 Build	7,069,094	702	<1	<1	697

CO_2 = carbon dioxide
CH_4 = methane
N_2O = nitrous oxide
CO_2e = carbon dioxide equivalent

Implementation of the Build Alternatives would decrease GHG emissions compared to the existing conditions. The decrease is due to expected improvements in vehicle engine technology, fuel efficiency, and turnover in older, more heavily polluting vehicles, which reduces exhaust emissions. Compared to the No Build conditions, the Build Alternatives would slightly decrease GHG emissions under opening (2022) year conditions and slightly increase GHG emissions under design (2042) year conditions. The emissions results mirror the change in VMT; as shown in Table 7, the Build Alternatives result in a slight (0.01%) reduction in VMT under opening (2022) year conditions and a slight (0.02%) increase in VMT under design (2042) year conditions.

Currently, there are no federal or state standards set for CO_2 emissions; therefore, the estimated emissions shown in Table 14 are only useful for a comparison between existing and 2042 conditions. The numbers are not necessarily an accurate reflection of what the true CO_2 emissions would be because CO_2 emissions are dependent on other factors that are not part of the model, such as the fuel mix[4], rate of acceleration, and the aerodynamics and efficiency of the vehicles.

[4] CT-EMFAC model emission rates are only for direct engine-out CO_2 emissions rather than full fuel cycle; fuel cycle emission rates can vary dramatically depending on the amount of additives like ethanol and the source of the fuel components.

Construction Emissions

Construction GHG emissions include emissions produced as a result of material processing, emissions produced by on-site construction equipment, and emissions arising from traffic delays due to construction. The SMAQMD's RCEM (Version 8.1.0) was used to estimate CO_2e emissions from construction activities. Table 15 summarizes estimated GHG emissions generated by construction equipment for Alternatives 1 and 2.

Table 15. GHG Emissions from Construction of the U.S. 50/Hazel Avenue Interchange Project (metric tons per year)

Alternative and Year	CO_2	CH_4	N_2O	CO_2e
Alternative 1				
2020	1,244	<1	<1	1,254
2021	715	<1	<1	720
Total	1,959	<1	<1	1,975
Alternative 2				
2020	1,026	<1	<1	1,035
2021	934	<1	<1	941
2022	38	<1	<1	38
Total	1,998	<1	<1	2,014

CO_2 = carbon dioxide
CH_4 = methane
N_2O = nitrous oxide
CO_2e = carbon dioxide equivalent

The emissions presented in Table 15 would be produced at different levels throughout the construction phase; their frequency and occurrence can be reduced through innovations in plans and specifications and by implementing better traffic management during construction phases. In addition, with innovations such as longer pavement lives, improved traffic management plans, and changes in materials, the GHG emissions produced during construction can be mitigated to some degree by longer intervals between maintenance and rehabilitation events. Measures to reduce construction emissions include maintenance of construction equipment and vehicles, limiting of construction vehicle idling time, and scheduling and routing of construction traffic to reduce engine emissions.

3.2.3 Avoidance, Minimization, and/or Mitigation Measures

Implement California Department of Transportation Standard Specification Section 14

To control the generation of construction-related PM10 emissions, the project proponent will follow Standard Specification Section 14, Environmental Stewardship, which addresses the contractor's responsibility on many items of concern, such as air pollution; protection of lakes,

streams, reservoirs, and other water bodies; use of pesticides; safety; sanitation; convenience for the public; and damage or injury to any person or property as a result of any construction operation. Standard Specification Section 14-9.02 requires compliance with SMAQMD rules, regulations, ordinances, and statutes that apply to work performed under the contract, including air pollution control rules, regulations, ordinances, and statutes provided in Government Code Section 11017 (Public Contract Code § 10231). Standard Specification Section 14-9.03 addresses dust control and palliative requirements.

Implement Additional Control Measures for Construction Emissions of Fugitive Dust

Additional measures to control dust will be borrowed from SMAQMD's recommended list of basic construction emission control practices to reduce fugitive dust and implemented to the extent practicable when the measures have not already been incorporated and do not conflict with requirements of Caltrans' Standard Specifications, Special Provisions, the National Pollutant Discharge Elimination System permit, and the Biological Opinions, Clean Water Act Section 404 permit, Clean Water Act Section 401 Certification, and other permits issued for the project. The following measures are taken from SMAQMD's (2016) CEQA Guide.

- Water all exposed surfaces two times daily. Exposed surfaces include, but are not limited to soil piles, graded areas, unpaved parking areas, staging areas, and access roads.
- Cover or maintain at least two feet of free board space on haul trucks transporting soil, sand, or other loose material on the site. Any haul trucks that would be traveling along freeways or major roadways should be covered.
- Use wet power vacuum street sweepers to remove any visible trackout mud or dirt onto adjacent public roads at least once a day. Use of dry power sweeping is prohibited.
- Limit vehicle speeds on unpaved roads to 15 miles per hour (mph).
- Pave all roadways, driveways, sidewalks, parking lots as soon as possible. In addition, building pads should be laid as soon as possible after grading unless seeding or soil binders are used.

Chapter 4 Air Quality Impacts under CEQA

The County of Sacramento is acting as state lead agency for this project under CEQA. Accordingly, the following analysis based on Appendix G of the State CEQA Guidelines is provided to support the project-level CEQA document. Operational and construction emissions are compared to SMAQMD thresholds to evaluate potentially significant air quality impacts. Emission results presented in Section 3.2.2, Effects, are referenced, as appropriate, to avoid duplicative tables and text.

Conflict with or obstruct implementation of the applicable air quality plan?

The proposed project (SAC24255) is listed in SACOG's 2016 MTP/SCS and 2017/20 MTIP. Projects included in the MTP/SCS and MTIP are required to be consistent with the planning goals of SIPs adopted by local air quality management agencies, which is demonstrated in the regional transportation conformity analysis presented in Impact AQ-1 above. While long-term operation of the project would result in an emissions increase relative to the No Build Alternative under design (2042) year conditions, emissions increases would be minor and would not exceed SMAQMD thresholds. Moreover, as described further below, implementation of the project would improve overall interchange efficiency and reduce vehicle congestion, both of which are consistent with the objectives and policies outlined in SACOG's MTP/SCS and SMAQMD's air quality attainment plans. This impact would be less than significant. No mitigation is required.

Violate any air quality standard or contribute substantially to an existing or projected air quality violation?

Construction

Implementation of the project would construct modifications to the existing interchange, and grade-separate and extend Hazel Avenue to the south to a future intersection with Atlanta Street. Temporary construction emissions would result from grubbing/land clearing, grading/excavation, drainage/utilities/sub-grade construction, paving activities, bridge and wall erection, and construction worker commuting patterns. Pollutant emissions would vary daily, depending on the level of activity, specific operations, and prevailing weather.

The SMAQMD's RCEM (Version 8.1.0) and information provided by the project engineers were used to estimate construction-related emissions. Tables 12 and 13 in Section 3.2.2 summarize maximum daily emissions levels for construction of Alternatives 1 and 2, respectively. The tables indicate that construction of both alternatives would exceed SMAQMD's threshold of significance for NO_X, and Alternative 1 would exceed SMAQMD's PM10 threshold in 2020.

SMAQMD's (2016) CEQA Guidelines also only consider PM10 and PM2.5 emissions below their 82 and 80 pound per day thresholds, respectively, to be less than significant with application of BMPs. This is a potentially significant impact.

Mitigation Measures AQ-1 through AQ-3 are available to reduce construction-related NOx and PM impacts. Mitigation Measure AQ-1 requires implementation of SMAQMD's basic and enhanced exhaust control practices, including a 20 percent and 45 percent reduction in NO_X and DPM exhaust emissions, respectively, generated by heavy-duty offroad equipment, relative to the statewide fleet average. Mitigation Measure AQ-2 requires the onroad heavy-duty truck fleet be limited to vehicles of model year 2010 or newer. Mitigation Measure AQ-3 requires implementation of SMAQMD's basic construction emission control practices to reduce fugitive dust. The project would also be subject to Caltrans Standard Specification 14, including compliance with SMAQMD enhanced dust controls (refer to Section 3.2.3).

Tables 16 and 17 summarize estimated construction emissions after the incorporation of Mitigation Measures AQ-1 through AQ-3. The tables demonstrate that implementation of Mitigation Measures AQ-1 and AQ-2 would reduce NO_X emissions, but not below SMAQMD's NO_X threshold.

Table 16. Estimated Mitigated Criteria Pollutant Emissions from Construction of Alternative 1 (pounds per day)

Year	ROG	NO_X	CO	PM10			PM2.5		
				Dust	Exhaust	Total	Dust	Exhaust	Total
2020	18	153	126	57	5	61	12	5	15
2021	11	89	79	43	3	46	9	3	11
SMAQMD Threshold	-	*85*	-	*BMPs*	-	*80* [a]	*BMPs*	-	*82* [a]

SMAQMD= Sacramento Metropolitan Air Quality Management District

[a] SMAQMD's (2016) CEQA Guidelines only consider PM10 and PM2.5 emissions below their 82 and 80 pound per day thresholds, respectively, to be less than significant with application of BMPs.

CO = carbon monoxide
NO_X = nitrogen oxides
PM10 = particles of 10 micrometers or smaller
PM2.5 = particles of 2.5 micrometers and smaller
ROG = reactive organic gases

Table 17. Estimated Mitigated Criteria Pollutant Emissions from Construction of Alternative 2 (pounds per day)

Year	ROG	NO_X	CO	PM10			PM2.5		
				Dust	Exhaust	Total	Dust	Exhaust	Total
2020	18	151	123	34	5	39	7	5	11
2021	11	90	77	51	3	54	11	3	13
2022	2	20	19	<1	1	1	<1	1	1
SMAQMD Threshold	-	*85*	-	*BMPs*	-	*80* [a]	*BMPs*	-	*82* [a]

SMAQMD= Sacramento Metropolitan Air Quality Management District

[a] SMAQMD's (2016) CEQA Guidelines only consider PM10 and PM2.5 emissions below their 82 and 80 pound per day thresholds, respectively, to be less than significant with application of BMPs.

CO = carbon monoxide
NO_X = nitrogen oxides
PM10 = particles of 10 micrometers or smaller
PM2.5 = particles of 2.5 micrometers and smaller
ROG = reactive organic gases

SMAQMD requires development projects implement all feasible mitigation measures to reduce potential impacts to air quality. If traditional, onsite mitigation (e.g., engine retrofits) are not sufficient to reduce adverse impacts, the County may contribute to SMAQMD's Heavy-Duty Low-Emission Vehicle Incentive Programs (HDLEVIP), which include the Carl Moyer and Sacramento Emergency Clean Air Transportation (SECAT) Programs. The HDLEVIP and associated incentive programs are a means of generating revenue to fund projects and programs capable of achieving emissions reductions. The Carl Moyer program is designed to reduce ROG, NO_X, and PM from on- and offroad sources, whereas the SECAT program primarily targets NO_X from heavy-duty onroad trucks. Mitigation Measure AQ-4 is available to reduce NO_X emissions to a less-than-significant level by offsetting emissions through the HDLEVIP to quantities below SMAQMD CEQA thresholds.

Mitigation Measure AQ-1: Implement SMAQMD's Basic and Enhanced Exhaust Control Practices to Reduce Construction-Related Exhaust Emissions from Offroad Equipment

The County will implement SMAQMD's basic and enhanced exhaust control practices, including, but not limited to the following measures.

1. Minimize idling time either by shutting equipment off when not in use or reducing the time of idling to 5 minutes [required by California Code of Regulations, Title 13, sections 2449(d)(3) and 2485]. Provide clear signage that posts this requirement for workers at the entrances to the site.

2. Maintain all construction equipment in proper working condition according to manufacturer's specifications. The equipment must be checked by a certified mechanic and determine to be running in proper condition before it is operated.

3. Submit to the lead agency and SMAQMD a comprehensive inventory of all off-road construction equipment, equal to or greater than 50 horsepower, that will be used an aggregate of 40 or more hours during any portion of the construction project. The inventory shall include the horsepower rating, engine model year, and projected hours of use for each piece of equipment. The County shall provide the anticipated construction timeline including start date, and name and phone number of the project manager and on-site foreman. This information shall be submitted at least 4 business days prior to the use of subject heavy-duty off-road equipment. SMAQMD's Construction Mitigation Tool can be used to submit this information. The inventory shall be updated and submitted monthly throughout the duration of the project, except that an inventory shall not be required for any 30-day period in which no construction activity occurs.

4. Provide a plan for approval by the lead agency and SMAQMD demonstrating that the heavy-duty off-road vehicles (50 horsepower or more) to be used in the construction project, including owned, leased, and subcontractor vehicles, will achieve a project wide fleet-average 20 percent NO_X reduction and 45 percent particulate reduction compared to the most recent ARB fleet average. This plan shall be submitted in conjunction with the equipment inventory. Acceptable options for reducing emissions may include use of late model engines, low-emission diesel products, alternative fuels, engine retrofit technology, after-treatment products, and/or other options as they become available. SMAQMD's Construction Mitigation Tool can be used to identify an equipment fleet that achieves this reduction.

5. Ensure that emissions from all off-road diesel powered equipment used on the project site do not exceed 40 percent opacity for more than three minutes in any one hour. Any equipment found to exceed 40 percent opacity (or Ringelmann 2.0) shall be repaired immediately. Non-compliant equipment will be documented and a summary provided to the lead agency and District monthly. A visual survey of all in-operation equipment shall be made at least weekly. A monthly summary of the visual survey results shall be submitted throughout the duration of the project, except that the monthly summary shall not be required for any 30-day period in which no construction activity occurs. The monthly summary shall include the quantity and type of vehicles surveyed as well as the dates of each survey.

6. SMAQMD and/or other officials may conduct periodic site inspections to determine compliance. Nothing in this mitigation shall supercede other SMAQMD, state or federal rules or regulations.

Mitigation Measure AQ-2: Utilize Model Year 2010 or Newer Engines to Reduce Construction-Related Exhaust Emissions from Onroad Vehicles

All on-road trucks shall consist of model year 2010 or newer engines. Construction contractors will provide documentation to the County of efforts to secure such a fleet. The contractors will keep a written record of equipment usage during project construction for each piece of equipment and provide the County with annual reports documenting compliance. These reports will be submitted to SMAQMD.

Mitigation Measure AQ-3: Implement SMAQMD's Basic Construction Emission Practices to Reduce Construction-Related Fugitive Dust

The County will implement SMAQMD's basic construction emission control practices, including, but not limited to the following measures.

1. Water all exposed surfaces two times daily. Exposed surfaces include, but are not limited to soil piles, graded areas, unpaved parking areas, staging areas, and access roads.

2. Cover or maintain at least two feet of free board space on haul trucks transporting soil, sand, or other loose material on the site. Any haul trucks that would be traveling along freeways or major roadways should be covered.

3. Use wet power vacuum street sweepers to remove any visible trackout mud or dirt onto adjacent public roads at least once a day. Use of dry power sweeping is prohibited.

4. Limit vehicle speeds on unpaved roads to 15 miles per hour (mph).

5. Pave all roadways, driveways, sidewalks, parking lots as soon as possible. In addition, building pads should be laid as soon as possible after grading unless seeding or soil binders are used.

Mitigation Measure AQ-4: Offset Construction-Generated NO_X Emissions to Quantities below SMAQMD CEQA Thresholds

The County will work with SMAQMD to reduce NO_X emissions generated by the construction of the Hazel Avenue Interchange project. The preferred source of emissions reductions for NO_X shall be through contributions to SMAQMD's HDLEVIP. The HDLEVIP is designed to reduce NO_X, PM, and ROG from on- and offroad sources. The program is managed and implemented by SMAQMD on behalf of all air districts within the Sacramento Federal Nonattainment Area (SFNA).

SMAQMD's incentive programs are a means of funding projects and programs capable of achieving emissions reductions. The payment fee is based on the average cost to achieve one ton per day (tpd) of reductions based on the average cost for reductions over the previous year. Onroad reductions averaged (nominally) $44 million ($NO_X$ only) and off-road reductions averaged $36 million ($NO_X$ only) over the previous year, thus working out to approximately $40 million per one tpd of reductions. This rate roughly correlates to the average cost effectiveness of the Carl Moyer Incentive Program.

Implementation of this mitigation would require the County to adopt the following specific responsibilities.

- Consult with the SMAQMD to contribute funds to the HDLEVIP. The necessary reductions must be achieved (contracted and delivered) by the applicable year in question (i.e., emissions generated in year 2020 would need to be reduced offsite in 2020). Funding would need to be received prior to contracting with participants and should allow sufficient time to receive and process applications to ensure offsite reduction projects are funded and implemented prior to commencement of activities being reduced. This would roughly equate to the equivalent of two years prior to the required mitigation; additional lead time may be necessary depending on the level of offsite emission reductions required for a specific year. Prior to construction activities, the County will submit proof that the off-site air quality mitigation fee of a specified amount has been paid to SMAQMD, and that the construction air quality mitigation plan has been approved by SMAQMD and the lead agency. The County and SMAQMD should also seek clarification and agreement on SMAQMD responsibilities, including the following.
    - Identification of appropriate offsite mitigation fees required for the project.
    - Timing required for obtaining necessary offsite emission credits.
    - Processing of mitigation fees paid by the County.
    - Verification of emissions inventories submitted by the County.
    - Verification that offsite fees are applied to appropriate mitigation programs within the SFNA.
- Quantify mitigation fees required to satisfy the appropriate reductions. As noted above, the payment fees may vary by year and are sensitive to the number of projects requiring reductions within the SFNA. The schedule in which payments are provided to SMAQMD also influences overall cost. For example, a higher rate on a per-tonnage basis will be

required for project elements that need accelerated equipment turn-over to achieve near-term reductions, whereas project elements that are established to contract to achieve far-term reductions will likely pay a lower rate on a per-tonnage basis.

- Develop a compliance program to calculate emissions and collect fees from the construction contractors for payment to SMAQMD. The program will require that construction contractors identify construction emissions and their share of required offsite fees, if applicable. Based on the emissions estimates, the County will collect fees from the individual construction contractors (as applicable) for payment to SMAQMD. Construction contractors will have the discretion to reduce their construction emissions to the lowest possible level through additional onsite mitigation, as the greater the emissions reductions that can be achieved by onsite mitigation, the lower the required offsite fee. Acceptable options for reducing emissions may include use of late-model engines, low-emission diesel products, additional electrification or alternative fuels, engine-retrofit technology, and/or after-treatment products (see Mitigation Measures AQ-1 and AQ-2). All control strategies must be verified by SMAQMD.

- Conduct daily and annual emissions monitoring to ensure onsite emissions reductions are achieved and no additional mitigation payments are required. Excess offsite funds can be carried from previous to subsequent years in the event that additional reductions are achieved by onsite mitigation. At the end of the project, if there are differences between the estimated equipment list and/or construction phasing used for the air quality analysis, and the construction air quality mitigation plan, then the fee may be recalculated by SMAQMD based on the new information.

Operation

Long-term air quality impacts are those associated with motor vehicles operating on the roadway network, predominantly those operating in the project vicinity. Emission of ROG, NO_X, CO, PM10, and PM2.5 for existing (2015), opening (2022), and design (2042) year conditions were evaluated through modeling conducted using Caltrans' CT-EMFAC model and vehicle activity data provided by DKS (Shew pers. comm. A). Table 11 in Section 3.2.2 summarizes the modeled emissions by scenario and presents a comparison of Build emissions to No Build and existing conditions.

The emissions analysis presented in Table 11 indicates that long-term operation (2042) of the project would increase PM10 and PM2.5 emissions compared to existing conditions and decrease ROG, NO_X, and CO emissions. These results are primarily due to factors external to the project, including background growth in VMT between 2015 and 2042 and expected

improvements in engine technology and fuel efficiency. Since an analysis of project emissions relative to existing conditions does not accurately reflect differences in emissions generated directly as a result of project implementation, the significance determination is based on a comparison of Build to No Build emissions under design year (2042) conditions.

As shown in Table 11, the Build Alternatives would result in minor increases of all pollutants, except NO_X. The minor increase in ROG, CO, and PM emissions by approximately 0.02% to 0.03% is primarily a result of VMT growth and would be minor. The decrease in NO_X by approximately 0.04% is attributed to the relationship between vehicle speeds and emissions rates. As discussed above, decreasing NOx emissions are observed with increasing speeds. The changes in the speed profile, coupled with the speed-based emission factor trend, are sufficient to offset the minor increase in VMT, resulting in a slight NO_X reduction, relative to the No Build Alternative. However, as shown in Table 11, the predicted emissions increase is well below SMAQMD thresholds. This impact would be less than significant. No mitigation is required.

Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is a nonattainment area for an applicable federal or state ambient air quality standard?

As discussed in Section 3.1, Affected Environment, SMAQMD has identified project-level thresholds to evaluate criteria pollutant impacts. In developing these thresholds, SMAQMD considered levels at which project emissions would be cumulatively considerable. As noted in SMAQMD's (2016) CEQA Handbook:

> [SMAQMD's] approach to thresholds of significance is relevant to whether a project's individual emissions would result in a cumulatively considerable adverse contribution to the SVAB's existing air quality conditions. If a project's emissions would be less than these levels, the project would not be expected to result in a cumulatively considerable contribution to the significant cumulative impact.

The project-level criteria pollutant thresholds therefore represent the maximum emissions the project may generate before contributing to a cumulative impact on regional air quality. Consequently, exceedances of the project-level thresholds would be cumulatively considerable. As shown in Tables 12 and 13, construction of Alternatives 1 and 2 would generate NO_X emissions in excess of SMAQMD's threshold of significance. Alternative 1 would also exceed SMAQMD's PM10 threshold in 2020. However, Mitigation Measures AQ-1 through AQ-3 would reduce NO_X and PM10 emissions to a less-than-significant level. Once construction is complete, long-term operation of the project would result in a slight NO_X increase relative to the No Build Alternative, but emissions would be minor and would not exceed SMAQMD thresholds (see Table 11). Emissions of all other criteria pollutants would decrease compared to

No Build conditions, contributing to a regional air quality benefit. Accordingly, this impact would be less than significant.

Expose sensitive receptors to substantial pollutant concentrations?

While all criteria pollutants are associated with some form of health risk (e.g., asthma, asphyxiation), significant health impacts are highly dependent on a multitude of interconnected variables (e.g., cumulative concentrations, local meteorology and atmospheric conditions, the number and character of exposed individuals [e.g., age, gender]). In particular, because O_3 precursors (ROGs and NO_X) affect air quality on a regional scale, associated health effects are the product of emissions generated by numerous sources throughout a region. Minor increases in regional air pollution from project-generated ROGs and NO_X would therefore have nominal or negligible impacts on human health.

As such, an analysis of impacts on human health associated with project-generated ROG and NO_X is not included in this analysis. Rather, consistent with the current state-of-practice and published guidance by SMAQMD (2016) and other state air quality management agencies, the analysis of project-related impacts on human health focuses only on those pollutants with the greatest potential to result a significant, material impact on human health, which are: (1) DPM, (2) localized CO concentrations, and (3) asbestos and lead-based paint.

Diesel Particulate Matter

Heavy-duty equipment would generate DPM during roadway-widening activities. As shown in Tables 16 and 17, DPM emissions would be minor (less than 3 pounds per day) and only occur over a period of 2 years. The short-term construction period is well below the 70-year exposure period typically associated with increased cancer risks. Moreover, DPM from construction equipment would be transitory and spread throughout the entire project area, as opposed to concentrated at a single location. Implementation of Mitigation Measures AQ-1 and AQ-2 would also reduce DPM emissions by requiring off-road and onroad equipment be equipped with newer engines and best available control technologies. Accordingly, construction of the proposed project would not expose sensitive populations to substantial pollutant concentrations. This impact is less than significant. No mitigation is required.

With respect to long-term operation, since the project is reconfiguring an existing interchange, it would not significantly increase truck volumes within the project area; as shown in Table 9, the proposed project would increase design (2042) year truck volumes on U.S. 50 by approximately one percent, relative to No Build conditions. This increase is predominately a result of redistributed traffic—the Build Alternatives would redistribute traffic, and associated emissions,

from Folsom Boulevard to U.S. 50/Aerojet off-ramp, which are north of the receptors. As such, even though traffic and truck volumes between U.S. 50 and Folsom Boulevard would remain similar under Build and No Build conditions, the effect of moving traffic north of the existing residential receptors would likely lower particulate matter concentrations as a result of the southerly winds in the project area. Accordingly, operation of the proposed project would not expose sensitive populations to substantial pollutant concentrations. This impact is less than significant. No mitigation is required.

Localized Carbon Monoxide Concentrations

Heavy traffic congestion can contribute to high levels of CO. Individuals exposed to these CO "hot-spots" may have a greater likelihood of developing significant health effects, including headaches and nausea. Existing (2015), opening (2022), and design (2042) year conditions were modeled using CALINE4 to evaluate CO concentrations at the four study area intersections relative to the NAAQS and CAAQS. As shown in Table 8, CO concentrations are not anticipated to exceed the 1- or 8- hour NAAQS or CAAQS. Consequently, implementation of the project is not expected to cause or contribute to new or worsened violations of the federal or state air quality standards. This impact would be less than significant. No mitigation is required.

Asbestos and Lead-Based Paint

According to the California Department of Conservation's 2000 publication, *A General Location Guide for Ultramafic Rocks in California*, there are no geologic features normally associated with NOA (i.e., serpentine rock or ultramafic rock near fault zones) in or near the project area (California Department of Conservation 2000). As such, there is no potential for impacts related to NOA emissions during construction activities.

Removal of the Cattleman's restaurant and Nimbus Winery may expose workers to asbestos and lead-based paint if the materials were used during original building construction. Standard Specification Section 14-9.02, as described in Section 3.2.3, requires compliance with SMAQMD rules and regulations, including Rule 902, which requires pre-construction surveys for asbestos. Testing for lead-based paint will also be conducted during the asbestos survey. Compliance with SMAQMD Rule 902 and testing for asbestos containing materials and lead based paint prior to construction will avoid significant impacts related to asbestos and lead-based paint during demolition activities.

Create objectionable odors affecting a substantial number of people?

Minor sources of odors would be present during construction of the proposed project. Diesel engines are the predominant source of power for construction equipment. Exhaust odors from

diesel engines, as well as emissions associated with asphalt paving, may be considered offensive to some individuals. However, because odors would be temporary and would disperse rapidly with distance from the source, construction-generated odors are not anticipated to result in the adverse exposure of receptors to objectionable odorous emissions.

Generate greenhouse gas emissions, either directly or indirectly, that may have a significant impact on the environment?

Construction activities would generate short-term emissions of CO_2, CH_4, and N_2O from the use of equipment (e.g., graders) and on-road vehicles (e.g., employee commuter cars). GHG emissions generated by construction activities were estimated using SMAQMD's RCEM (Version 8.1.0). Table 15 in Section 3.2.2 summarizes estimated GHG emissions. As shown in the table, construction of Alternatives 1 and 2 would generate approximately 1,975 and 2,014 metric tons CO_2e, respectively, which is equivalent to the annual GHG emissions generated by approximately 400 to 425 passenger vehicles (U.S. Environmental Protection Agency 2015).

Operational emissions for existing (2015), opening (2022), and design (2042) year conditions were modeled using Caltrans' CT-EMFAC model and traffic data provided by DKS (Shew pers. comm. A). As shown in Table 14 in Section 3.2.2, project implementation would increase GHG emissions compared to the existing conditions. Compared to the No Build conditions, the Build Alternatives would slightly decrease GHG emissions under opening (2022) year conditions and slightly increase GHG emissions under design (2042) year conditions. The emissions results mirror the change in VMT; as shown in Table 7, the Build Alternatives result in a slight (0.01%) reduction in VMT under opening (2022) year conditions and a slight (0.02%) increase in VMT under design (2042) year conditions.

The State CEQA Guidelines do not indicate what amount of GHG emissions would constitute a significant impact on the environment. Instead, they authorize the lead agency to consider thresholds of significance previously adopted or recommended by other public agencies or recommended by experts, provided the decision of the lead agency to adopt such thresholds is supported by substantial evidence (State CEQA Guidelines Sections 15064.4(a) and 15064.7(c)). The California Supreme Court decision[5] in the *Centers for Biological Diversity et al. vs. California Department of Fish and Wildlife, the Newhall Land and Farming Company* (November 30, 2015, Case No. S217763) (hereafter Newhall Ranch) confirmed that there are multiple potential pathways for evaluating project-level GHG emissions consistent with CEQA,

[5] It should be noted that the defendants in the Newhall Ranch case have requested a rehearing from the California Supreme Court on a number of grounds. If the Supreme Court decides to rehear the case, it is possible that the ruling may change.

depending on the circumstances of a given project. These potential pathways include reliance on business-as-usual (BAU) model[6], numeric thresholds, and compliance with regulatory programs.

Use of a BAU threshold is most applicable to land use development projects with emission sources covered by the Assembly Bill 32 scoping plan. Likewise, there are currently no drafted, adopted, or recommended numeric thresholds relevant to the analysis of GHG emissions from transportation projects. The County has adopted thresholds for residential energy use, commercial/industrial energy use, and land use development mobile source emissions. SMAQMD has also adopted a threshold of 1,100 metric tons CO_2e for construction and operation of land use development projects, such as new residential and commercial projects. While not explicitly applicable to transportation projects, this analysis considers the 1,100 metric ton threshold as a GHG benchmark. However, impact significance is ultimately determined based on compliance with regulatory programs, which is currently the most applicable approach for analyzing transportation-related GHG emissions.

As shown in Table 15 in Section 3.2.2, construction of Alternatives 1 and 2 would generate maximum annual emissions in 2021 of 1,254 and 1,035 metric tons CO_2e. Emissions generated by Alternative 1 would exceed SMAQMD's construction threshold of 1,100 metric tons CO_2e per year. However, when total construction emissions are amortized over the life of the project and added to net operational emissions under design year (2042) conditions (see Table 11), implementation of Alternative 1 generates a net increase of 749 metric tons CO_2e per year.[7] These emissions increases are less than SMAQMD's land use development threshold. Neither annual construction nor new operation of Alternative 2 would exceed 1,100 metric tons CO_2e.

The most applicable GHG regulation to transportation projects is Senate Bill (SB) 375. SB 375 was enacted to reduce GHG emissions from automobiles and light trucks through integrated transportation, land use, housing and environmental planning. Under this law, SACOG is tasked with developing an SCS that provides a plan for meeting per capita CO_2 emissions levels allocated to SACOG by ARB. These levels are seven percent below 2005 emissions levels by 2020 and 16 percent below 2005 levels by 2035. Accordingly, the targets established by SB 375 not only address near-term (2020) emissions, but also long-term (2035) emissions consistent

[6] Only if "an examination of the data behind the Scoping Plan's business-as-usual model allowed the lead agency to determine what level of reduction from business as usual a new land use development at the proposed location must contribute in order to comply with statewide goals."

[7] Total construction emissions under Alternative 1 = 1,975 metric tons CO_2e, or 49 metric tons CO_2e over a 40 year project life. Net operational emissions under Alternative 1 = 697 metric tons CO_2e. Total lifetime emissions under Alternative 1 = 49 + 697 = 746 metric tons CO_2e.

with statewide executive orders[8], judicial attention[9], and recommendations made by the Association of Environmental Professionals Climate Change Committee.[10]

The Final Environmental Impact Report (EIR) for the 2016 MTP/SCS demonstrates that projects identified in the MTP/SCS meet the ARB's issued SB 375 GHG targets for the SACOG region in 2020 and 2035. GHG emissions associated with the MTP/SCS, including those projects identified in the MTP/SCS, would therefore be less than significant (Sacramento Area Council of Governments 2016).

As discussed in Section 3.2.2, the proposed project is listed in the 2016 MTP/SCS. The design concept and scope of the proposed project is consistent with the project description in both documents (see Appendix D). Since the proposed project is identified and consistent with SACOG's 2016 MTP/SCS, which was found to have a less-than-significant GHG impact, project-level GHG emissions would be consistent with SB 375. Accordingly, this impact would be less than significant. No mitigation is required.

Conflict with an applicable plan, policy, or regulation adopted for the purpose of reducing the emissions of greenhouse gases?

As discussed above, SACOG's emission targets under SB375 are seven percent below 2005 emissions levels by 2020 and 16 percent below 2005 levels by 2035. SACOG's 2016 MTP/SCS meets these GHG targets. The Final EIR for the 2016 MTP/SCS also demonstrates that the land use and transportation projects in the proposed MTP/SCS would not conflict with AB 32 or Executive Orders S-3-04 or B-30-15. As such, projects consistent with the MTP/SCS would be consistent with SB 375, AB 32, and Executive Orders S-3-04 or B-30-15.

Since the proposed project is identified in SACOG's 2016 MTP/SCS (see Appendix D), project emissions would not conflict with SB 375, AB 32, and Executive Orders S-3-04 or B-30-15. Accordingly, this impact would be less than significant. No mitigation is required.

[8] EO B-30-15 has set forth an interim reduction target to reduce GHG emissions by 40 percent below 1990 levels by 2030 and EO S-03-05 has set forth an interim reduction target to reduce GHG emissions by 80 percent below 1990 levels by 2050.

[9] See the California Appellate Court, 4th District 2014 rulings in the *Cleveland National Forest Foundation et al. v. SANDAG* and *Sierra Club vs. County of San Diego* cases.

[10] The Association of Environmental Professional's *Beyond 2020: The Challenge of Greenhouse Gas Reduction Planning by Local Governments in California* white paper states that long-term projects should consider "post-2020 emissions consistent with 'substantial progress' along a post-2020 reduction trajectory toward meeting the 2050 target."

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5.2 Personal Communications

Eden, Jonathan. Design Engineer. Mark Thomas & Company, Sacramento, CA. June 1, 2016—email message to Laura Yoon regarding Hazel construction data.

Shew, Cameron. (A) Associate Transportation Engineer. DKS Associates, Sacramento, CA. January 29, 2016—email message to Laura Yoon regarding VMT data for Hazel Ave.

Shew, Cameron. (B) Associate Transportation Engineer. DKS Associates, Sacramento, CA. March 11, 2016—email message to Laura Yoon regarding AADT for Hazel Ave.

Shew, Cameron. (C) Associate Transportation Engineer. DKS Associates, Sacramento, CA. March 9, 2016—email message to Laura Yoon regarding alternatives analysis for Hazel Ave.

Shew, Cameron. (D) Associate Transportation Engineer. DKS Associates, Sacramento, CA. February 2, 2016—email message to Laura Yoon regarding truck percentages for Hazel Ave.

Shew, Cameron. (E) Associate Transportation Engineer. DKS Associates, Sacramento, CA. March 17, 2016—email message to Laura Yoon regarding AADT and truck volumes on the Aerojet Off-Ramp.

Appendix A Intersection Volume, Delay, and LOS

Table A-1
Opening Year (2022) Intersection Operations Analysis

No.	Intersection	Opening Year (2022) No Build				Opening Year (2022) with Alt. 1/1A				Opening Year (2022) with Alt. 2			
		AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour	
		LOS	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS	Delay (s)
1	Hazel Ave & Gold Country Blvd	C	23.7	E	66.1	C	26.5	E	69.3	C	23.7	E	78.5
2	Hazel Ave & US 50 WB Ramps/ Tributary Point Dr	D	40.3	D	42.6	D	36.2	D	45.8	C	30.0	E	63.7
3	Hazel Ave & US 50 EB Ramps	D	43.1	**F**	**82.7**	B	14.4	C	23.4	Free movement			
4	Hazel Ave & Folsom Blvd	D	50.9	**F**	**120.8**	Does not exist				Does not exist			
5	Folsom Blvd & Aerojet Rd	**D**	**37.5**	**E**	**61.0**	**D**	**37.5**	**E**	**61.0**	**D**	**37.5**	**E**	**61.0**
6	Folsom Blvd & Auto Mall Cir (West)	**(F)**	**50.7**	**(E)**	**(46.9)**	**(F)**	**50.7**	**(E)**	**(46.9)**	**(F)**	**50.7**	**(E)**	**(46.9)**
7	Folsom Blvd & Birkmont Dr/Auto Mall Cir (East)	C	25.7	**F**	**80.6**	C	25.7	**F**	**80.6**	C	25.7	**F**	**80.6**
8	Folsom Blvd & US 50 EB Ramps	C	24.1	B	18.0	C	24.1	B	18.0	C	24.1	B	18.0
9	Folsom Blvd & US 50 WB Ramps	**D**	**42.4**	**E**	**62.0**	**D**	**42.4**	**E**	**62.0**	**D**	**42.4**	**E**	**62.0**
10	Hazel Ave & Jug Handle	Does not exist				E	64.1	C	26.8	E	64.1	C	26.7
11	Folsom Blvd & Jug Handle	Does not exist				C	26.1	D	44.3	C	26.1	D	44.3

Note: **Bold** values indicate unacceptable level of service.
For intersections shared between Sacramento County (LOS "E" policy) and the City of Folsom (LOS "C" policy), Folsom's policy was used.
(X) (Y) indicates level of service shown for the highest delay stop-controlled approach.

Table A-2
Horizon Year (2042) Intersection Operations Analysis

No.	Intersection	Horizon Year (2042) No Build				Horizon Year (2042) with Alt. 1/1A				Horizon Year (2042) with Alt. 2			
		AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour	
		LOS	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS	Delay (s)
1	Hazel Ave & Gold Country Blvd	C	30.8	D	54.5	C	29.6	E	55.5	C	30.3	E	61.5
2	Hazel Ave & US 50 WB Ramps/ Tributary Point Dr	D	42.2	**F**	**86.6**	D	42.1	E	72.4	C	32.1	E	65.7
3	Hazel Ave & US 50 EB Ramps	E	78.2	**F**	**90.9**	C	27.1	D	36.6	Free movement			
4	Hazel Ave & Folsom Blvd	**F**	**84.3**	**F**	**316.8**	Does not exist				Does not exist			
5	Folsom Blvd & Aerojet Rd	B	10.5	B	15.8	B	10.5	B	15.8	B	10.5	B	15.8
6	Folsom Blvd & Auto Mall Cir (West)	**(D)**	**(33.4)**	**(F)**	**(280.8)**	**(D)**	**(33.4)**	**(F)**	**(280.8)**	**(D)**	**(33.4)**	**(F)**	**(280.8)**
7	Folsom Blvd & Birkmont Dr/Auto Mall Cir (East)	B	14.1	B	17.5	B	14.0	B	17.4	B	14.0	B	17.4
8	Folsom Blvd & US 50 EB Ramps	**D**	**43.1**	**D**	**40.2**	C	32.8	**D**	**39.4**	C	32.8	**D**	**39.4**
9	Folsom Blvd & US 50 WB Ramps	B	15.9	B	12.3	B	16.3	B	16.5	B	16.6	B	16.5
10	Hazel Ave & Jug Handle	Does not exist				D	37.2	E	71.9	C	32.8	E	68.0
11	Folsom Blvd & Jug Handle	Does not exist				B	12.5	E	61.6	B	12.5	E	61.6

Note: **Bold** values indicate unacceptable level of service.
For intersections shared between Sacramento County (LOS "E" policy) and the City of Folsom (LOS "C" policy), Folsom's policy was used.
(X) (Y) indicates level of service shown for the highest delay stop-controlled approach.

Table A-3A
Horizon Year (2042) Freeway Operations Analysis (US 50 Eastbound)

Horizon Year (2042) No Build						Horizon Year (2042) with Alternative 1/1A or Alternative 2					
Analysis Segment	Type	AM Peak Hour		PM Peak Hour		Analysis Segment	Type	AM Peak Hour		PM Peak Hour	
		LOS	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)			LOS	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)
Rancho Cordova Pkwy to Hazel Ave	Basic	**F**	**54.2**	**F**	**60.8**	Rancho Cordova Pkwy to Hazel Ave	Basic	**F**	**54.2**	**F**	**60.8**
Hazel Ave Exit	Two-Lane Diverge	**F**	**35.0**	**F**	**38.1**	Hazel Ave Exit	Two-Lane Diverge	**F**	**23.5**	**F**	**26.9**
SB Hazel Ave Loop Entrance	One-Lane Merge	D	34.1	D	33.0	SB Hazel Ave Loop Entrance	One-Lane Merge	D	32.1	D	31.4
NB Hazel Ave Slip Entrance	Weave	D	28.7	C	27.9	NB Hazel Ave Slip Entrance	Weave	C	26.2	C	26.2
Aerojet Exit						Folsom Blvd Exit					
Aerojet Rd to Folsom Blvd	Basic	E	35.7	E	35.5						
Folsom Blvd Exit	Two-Lane Diverge	**F**	**45.8**	**F**	**45.7**						
Folsom Blvd Entrance	One-Lane Merge	**F**	**41.4**	**F**	**44.4**	Folsom Blvd Entrance	One-Lane Merge	C	26.3	D	28.9
Folsom Blvd to Prairie City Rd	Basic	**F**	**56.2**	**F**	**67.7**	Folsom Blvd to Prairie City Rd	Basic	**F**	**56.2**	**F**	**67.7**

Note: **Bold** values indicate unacceptable level of service.

Table A-3B
Horizon Year (2042) Freeway Operations Analysis (US 50 Westbound)

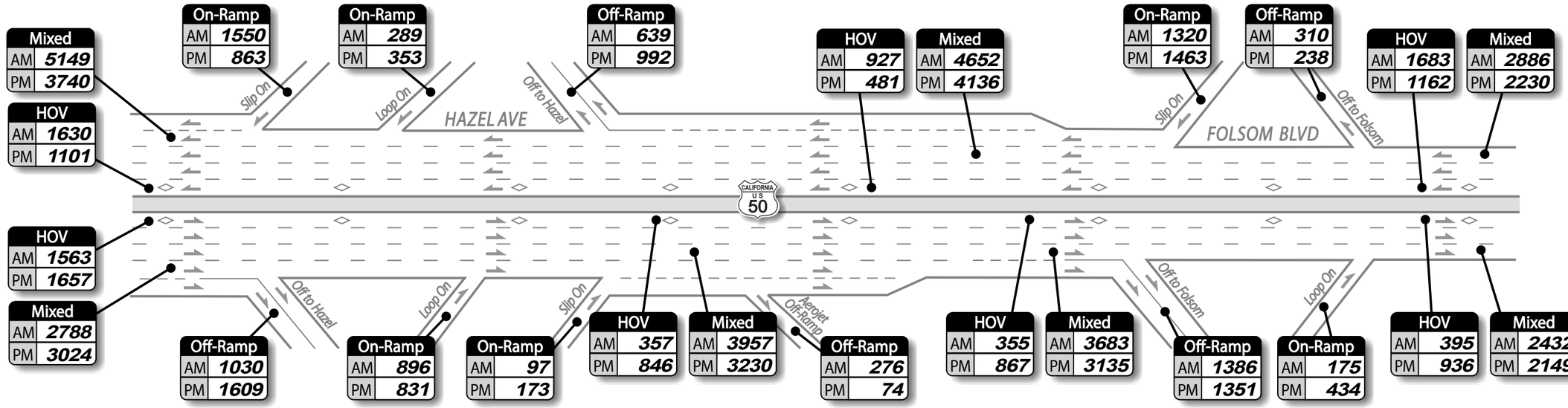
Horizon Year (2042) No Build						Horizon Year (2042) with Alternative 1/1A or Alternative 2					
Analysis Segment	Type	AM Peak Hour		PM Peak Hour		Analysis Segment	Type	AM Peak Hour		PM Peak Hour	
		LOS	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)			LOS	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)
Prairie City Rd to Folsom Blvd	Basic	E	41.4	**F**	**51.8**	Prairie City Rd to Folsom Blvd	Basic	E	41.4	**F**	**51.8**
Folsom Blvd Exit	One-Lane Diverge	E	44.0	**F**	**48.0**	Folsom Blvd Exit	One-Lane Diverge	E	44.0	**F**	**48.0**
Folsom Blvd Entrance	One-Lane Merge	**F**	**42.7**	**F**	**46.0**	Folsom Blvd Entrance	One-Lane Merge	**F**	**42.7**	**F**	**46.0**
Folsom Blvd to Hazel Ave	Basic	D	30.1	D	33.8	Folsom Blvd to Hazel Ave	Basic	D	30.1	D	33.8
Hazel Ave Exit	Two-Lane Diverge	B	11.5	B	13.0	Hazel Ave Exit	Two-Lane Diverge	B	11.5	B	13.0
NB Hazel Ave Loop Entrance	One-Lane Merge	D	29.4	D	32.6	NB Hazel Ave Loop Entrance	One-Lane Merge	D	29.4	D	32.6
SB Hazel Ave Slip Entrance	One-Lane Merge	**F**	**35.7**	**F**	**39.8**	SB Hazel Ave Slip Entrance	One-Lane Merge	**F**	**35.7**	**F**	**39.8**
Hazel Ave to Rancho Cordova Pkwy	Basic	E	41.8	**F**	**52.3**	Hazel Ave to Rancho Cordova Pkwy	Basic	E	41.8	**F**	**52.3**

Note: **Bold** values indicate unacceptable level of service.

Table A-4
Horizon Year (2042) Ramp Queuing Analysis

Direction	Ramp Queue	Horizon Year (2042) No Build			Horizon Year (2042) with Alternative 1/1A			Horizon Year (2042) with Alternative 2		
		Storage Length (ft)	AM Queue (ft)	PM Queue (ft)	Storage Length (ft)	AM Queue (ft)	PM Queue (ft)	Storage Length (ft)	AM Queue (ft)	PM Queue (ft)
US 50 Eastbound	Off-Ramp to Hazel Ave	1,350	1,037	**1,753**	2,400	644	835	2,250	-	-
	Off-Ramp to Aerojet Rd	1,425	131	262	2,400	131	262	2,250	131	262
	Off-Ramp to Folsom Blvd	1,300	546	473	1,300	512	464	1,300	512	464
US 50 Westbound	Off-Ramp to Folsom Blvd	1,550	116	132	1,550	120	178	1,550	120	178
	Off-Ramp to Hazel Ave	2,030	606	577	2,030	669	603	2,030	450	1,195

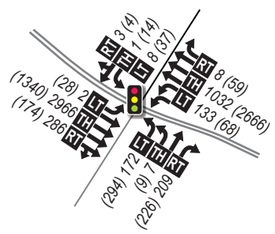
Note: **Bold** values indicate queuing exceeding storage capacity.
Gray shaded cells highlight changes to storage capacity due to the project.
Queues shown represent the 95th percentile.



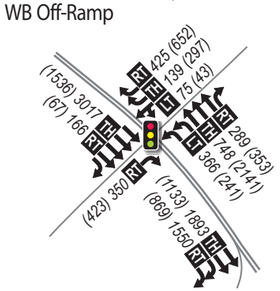
NORTH
Not to Scale

Freeway Schematic

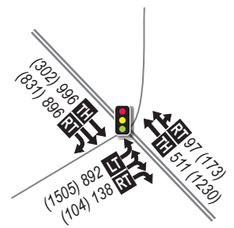
1 Hazel Ave. @ Gold Country Blvd.



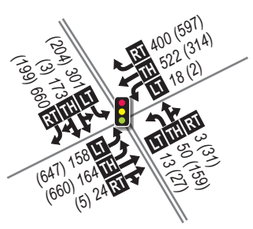
2 Hazel Ave. @ Tributary Pt. Dr./ WB Off-Ramp



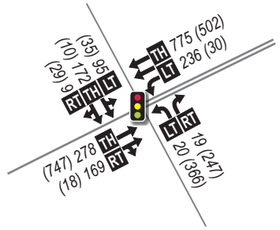
3 Hazel Ave. @ EB Ramps



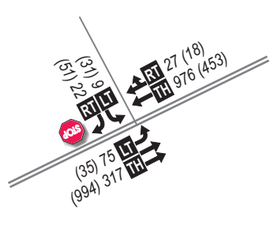
4 Hazel Ave. @ Folsom Blvd.



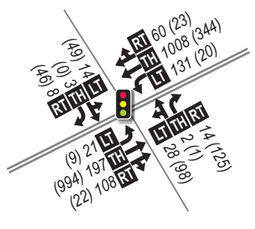
5 Aerojet Rd. @ Folsom Blvd.



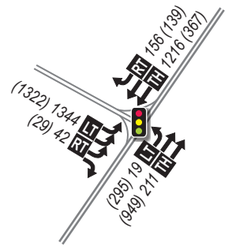
6 Folsom Blvd. @ Auto Mall Cir. (West)



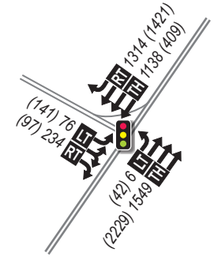
7 Folsom Blvd. @ Auto Mall Cir. (East)/ Birkmont Dr.



8 Folsom Blvd. @ EB Ramps

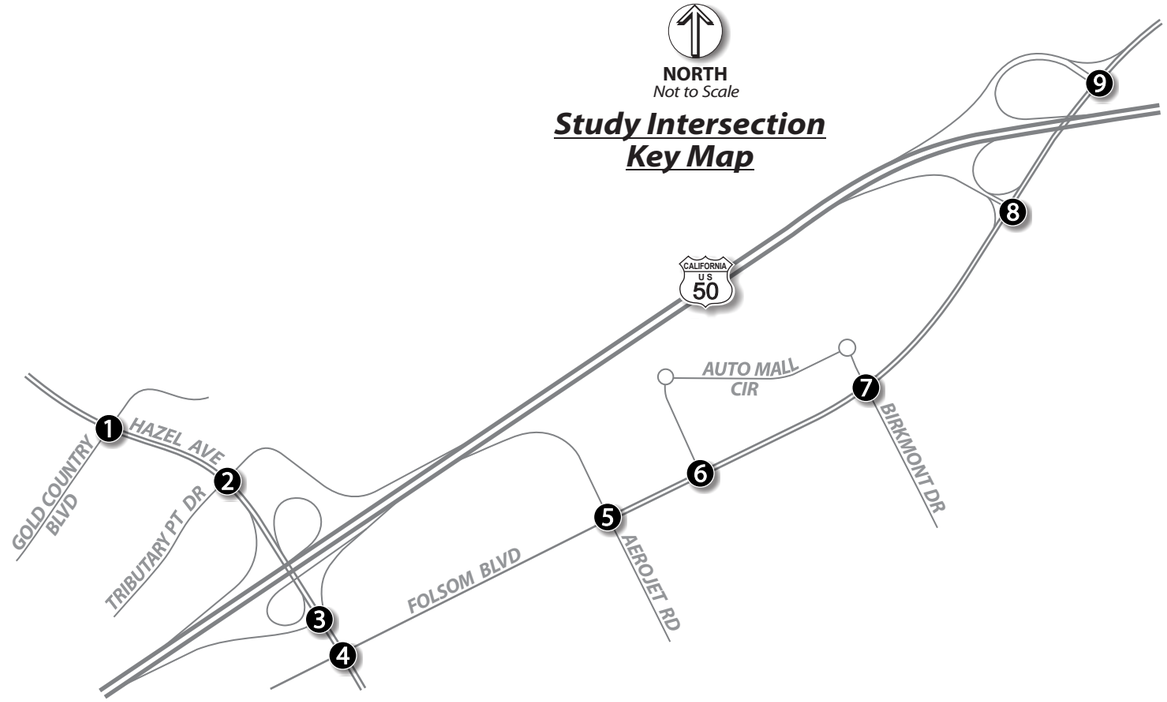


9 Folsom Blvd. @ WB Ramps



NORTH
Not to Scale

Study Intersection Key Map



LEGEND

Key Map

(#) - Study Intersection

Intersection Diagrams

STOP - Stop Sign

- Traffic Signal

- Lane Configuration

AM (PM) - Peak Hour Traffic Volumes

LT TH RT - Volume Turn Movement
Left•Thru•Right

Freeway Schematic

◇ - HOV (High Occupancy Vehicle) Lane

Data Location	
AM	0000
PM	0000

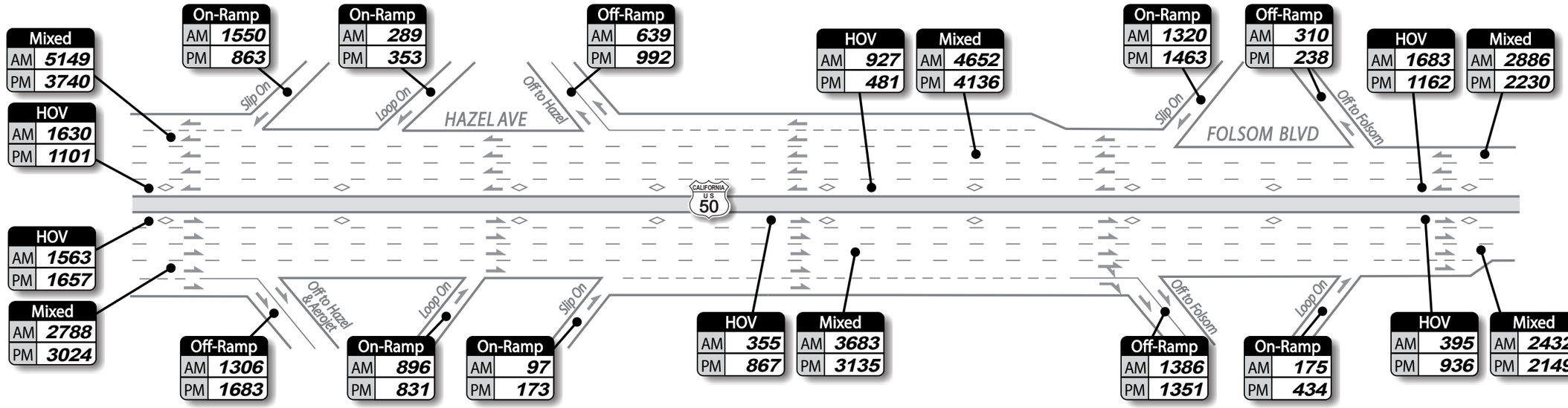
- Freeway Peak Hour Traffic Volumes

DKS

Figure **5-1**

2015 EXISTING CONDITIONS

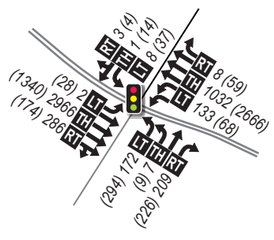
AM/PM Peak Hour Traffic Volumes and Lane Geometry



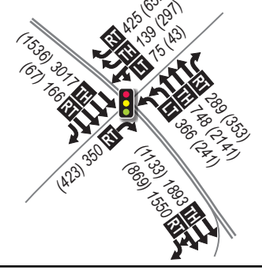
NORTH
Not to Scale

Freeway Schematic

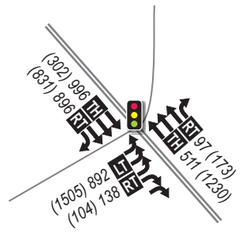
1 Hazel Ave. @ Gold Country Blvd.



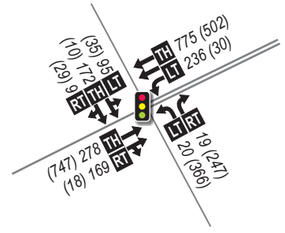
2 Hazel Ave. @ Tributary Pt. Dr./ WB Off-Ramp



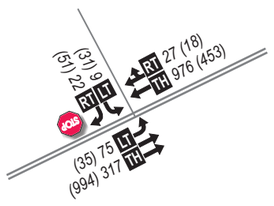
3 Hazel Ave. @ EB Ramps



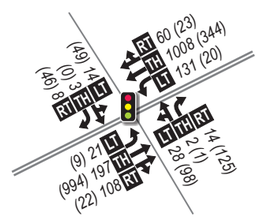
5 Aerojet Rd. @ Folsom Blvd.



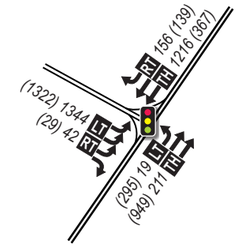
6 Folsom Blvd. @ Auto Mall Cir. (West)



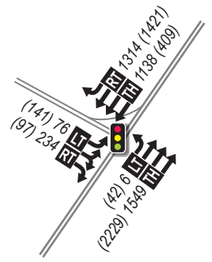
7 Folsom Blvd. @ Auto Mall Cir. (East)/ Birkmont Dr.



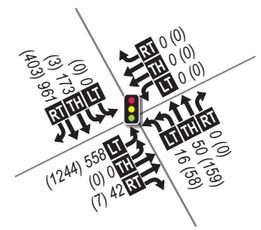
8 Folsom Blvd. @ EB Ramps



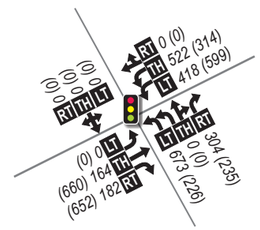
9 Folsom Blvd. @ WB Ramps



10 Hazel Ave. @ Jug Handle

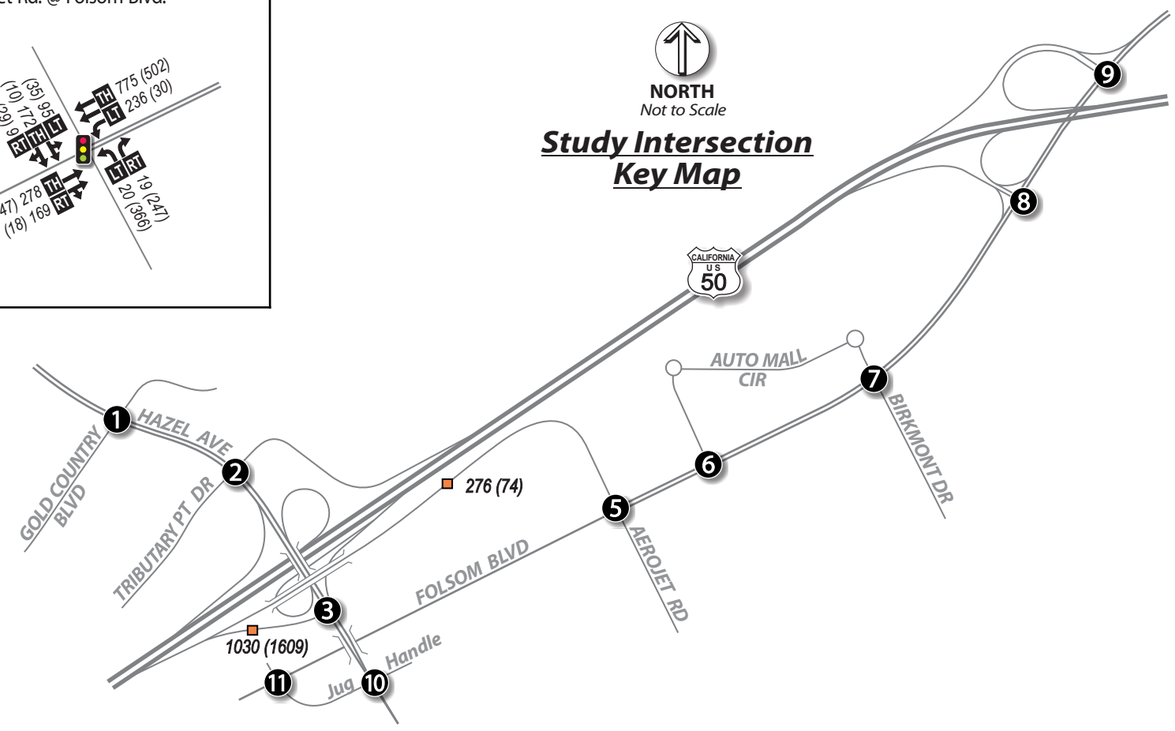


11 Folsom Blvd. @ Jug Handle



NORTH
Not to Scale

Study Intersection Key Map



LEGEND

Key Map
- # - Study Intersection
- AM (PM) - Peak Hour Fwy. Ramp Volumes

Intersection Diagrams
- STOP - Stop Sign
- Traffic Signal
- Lane Configuration
- AM (PM) - Peak Hour Traffic Volumes
- LT TH RT (Left•Thru•Right) - Volume Turn Movement

Freeway Schematic
- HOV (High Occupancy Vehicle) Lane

Data Location	
AM	0000
PM	0000

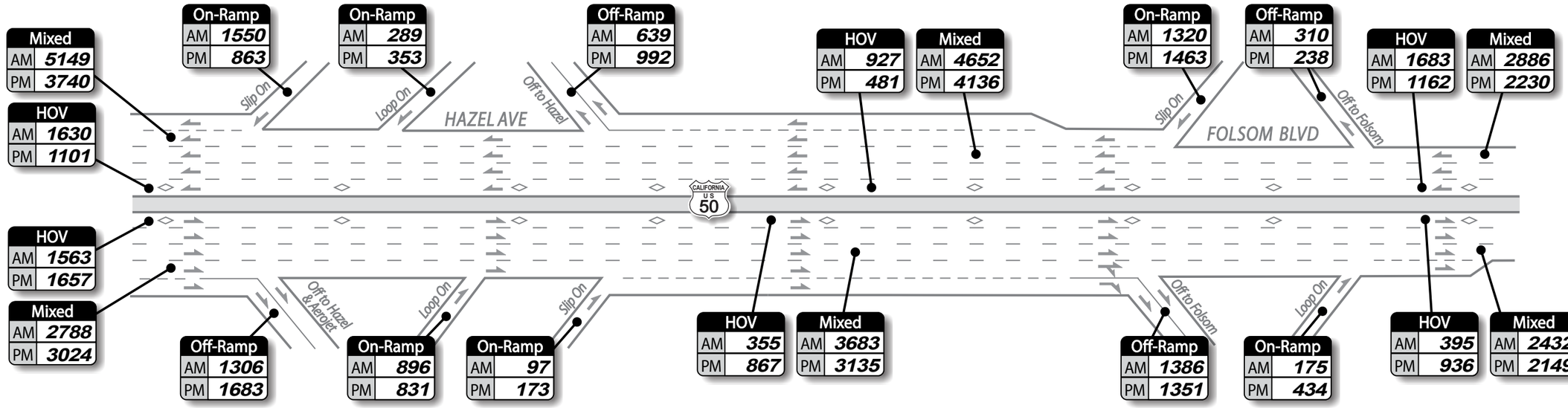
- Freeway Peak Hour Traffic Volumes

DKS

Figure **5-2**

2015 EXISTING WITH ALTERNATIVE 1

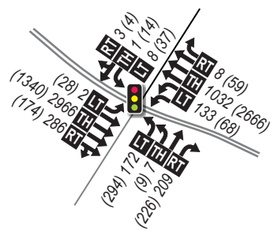
AM/PM Peak Hour Traffic Volumes and Lane Geometry



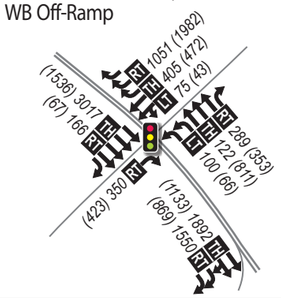
NORTH
Not to Scale

Freeway Schematic

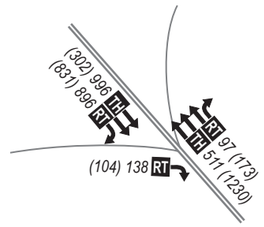
1 Hazel Ave. @ Gold Country Blvd.



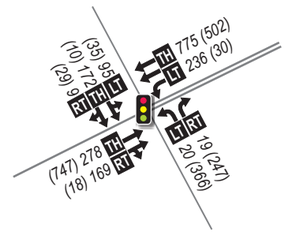
2 Hazel Ave. @ Tributary Pt. Dr./ WB Off-Ramp



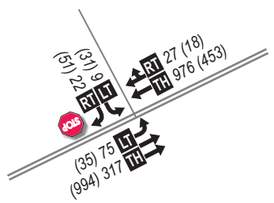
3 Hazel Ave. @ EB Ramps



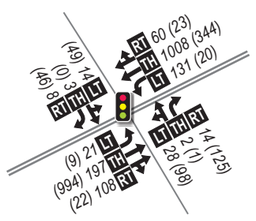
5 Aerojet Rd. @ Folsom Blvd.



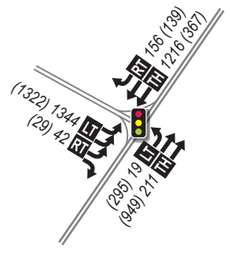
6 Folsom Blvd. @ Auto Mall Cir. (West)



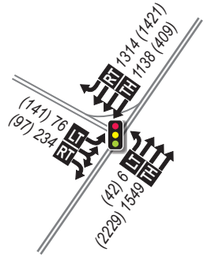
7 Folsom Blvd. @ Auto Mall Cir. (East)/ Birkmont Dr.



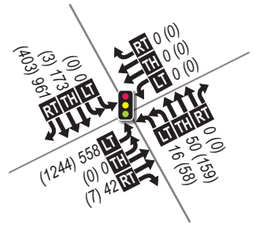
8 Folsom Blvd. @ EB Ramps



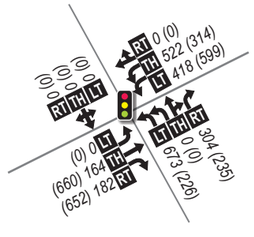
9 Folsom Blvd. @ WB Ramps



10 Hazel Ave. @ Jug Handle

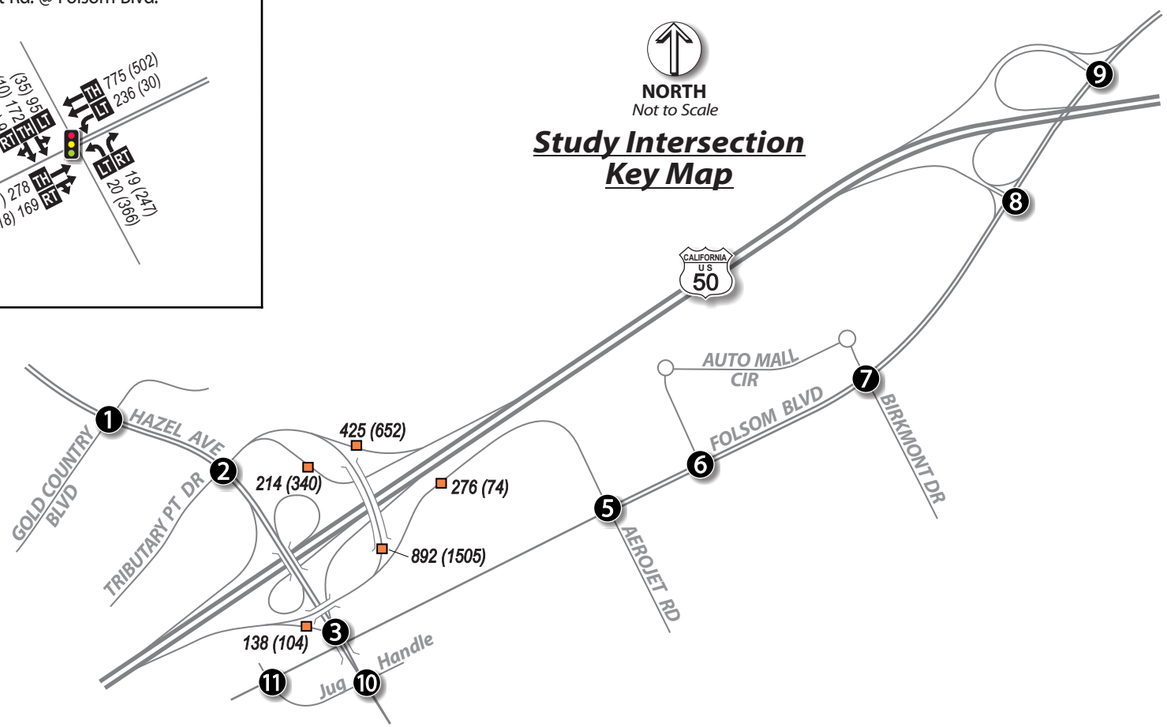


11 Folsom Blvd. @ Jug Handle



NORTH
Not to Scale

Study Intersection Key Map



LEGEND

Key Map
- # - Study Intersection
- AM (PM) ■ - Peak Hour Fwy. Ramp Volumes

Intersection Diagrams
- STOP - Stop Sign
- Traffic Signal
- ← - Lane Configuration
- AM (PM) - Peak Hour Traffic Volumes
- LT TH RT (Left•Thru•Right) - Volume Turn Movement

Freeway Schematic
- ◇ - HOV (High Occupancy Vehicle) Lane

Data Location	
AM	0000
PM	0000

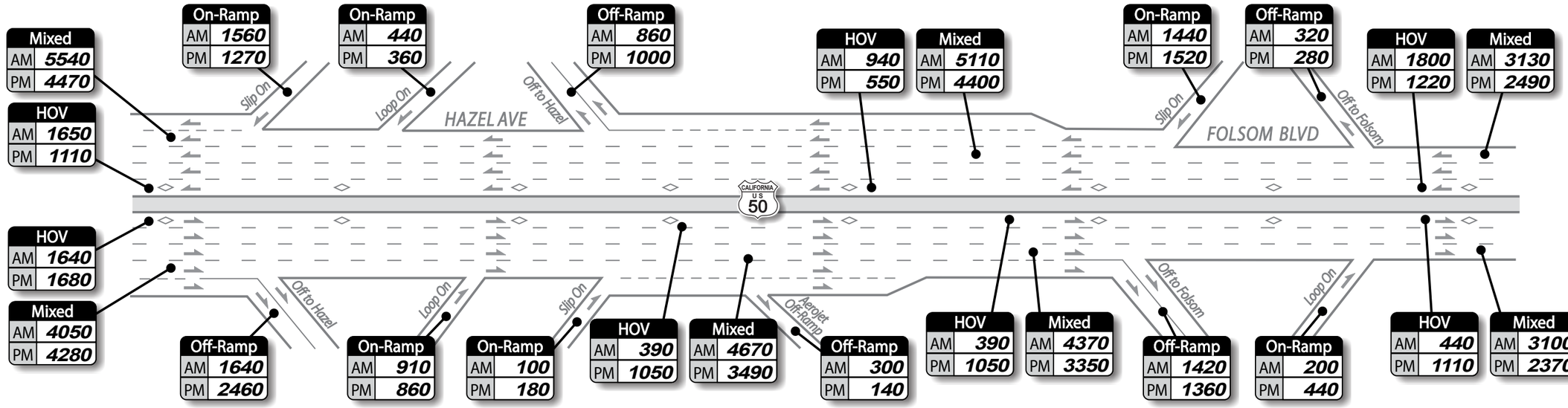
- Freeway Peak Hour Traffic Volumes

DKS

Figure **5-3**

2015 EXISTING WITH ALTERNATIVE 2

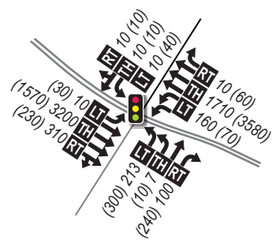
AM/PM Peak Hour Traffic Volumes and Lane Geometry



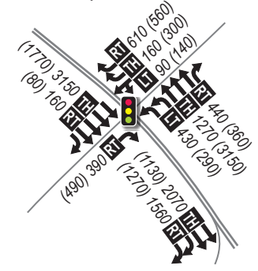
NORTH
Not to Scale

Freeway Schematic

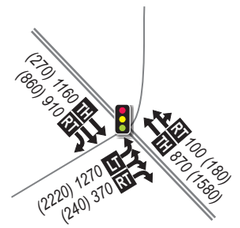
1 Hazel Ave. @ Gold Country Blvd.



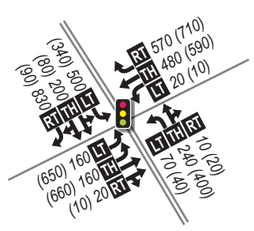
2 Hazel Ave. @ Tributary Pt. Dr./ WB Off-Ramp



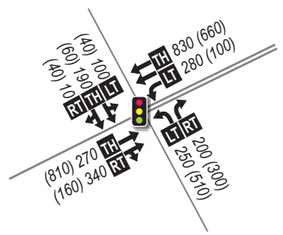
3 Hazel Ave. @ EB Ramps



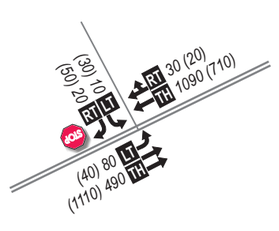
4 Hazel Ave. @ Folsom Blvd.



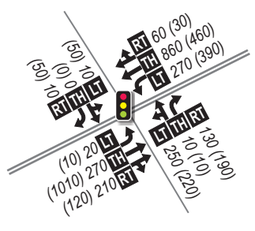
5 Aerojet Rd. @ Folsom Blvd.



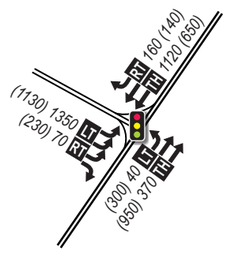
6 Folsom Blvd. @ Auto Mall Cir. (West)



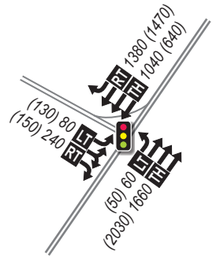
7 Folsom Blvd. @ Auto Mall Cir. (East)/ Birkmont Dr.



8 Folsom Blvd. @ EB Ramps

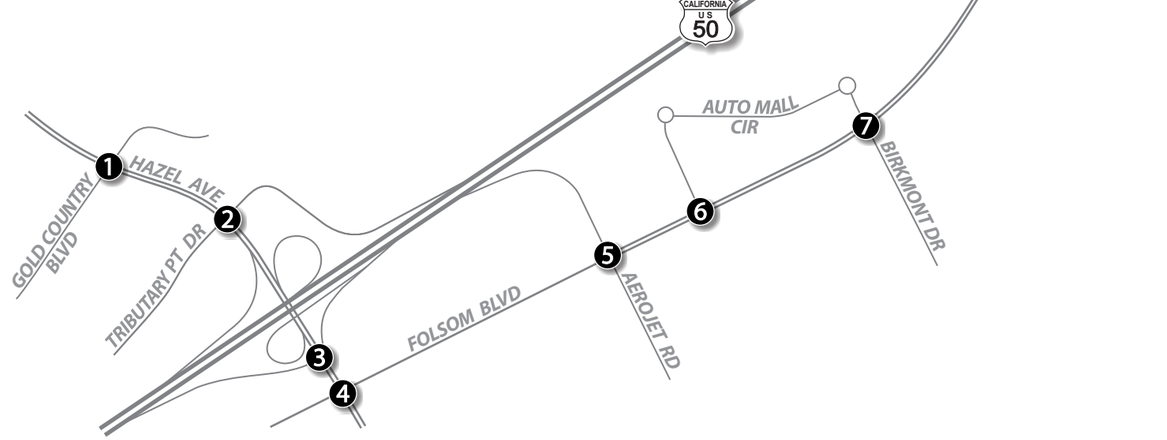


9 Folsom Blvd. @ WB Ramps



NORTH
Not to Scale

Study Intersection Key Map



LEGEND

Key Map

(#) - Study Intersection

Intersection Diagrams

STOP - Stop Sign

- Traffic Signal

- Lane Configuration

AM (PM) - Peak Hour Traffic Volumes

LT TH RT - Volume Turn Movement
Left • Thru • Right

Freeway Schematic

◇ - HOV (High Occupancy Vehicle) Lane

Data Location	
AM	0000
PM	0000

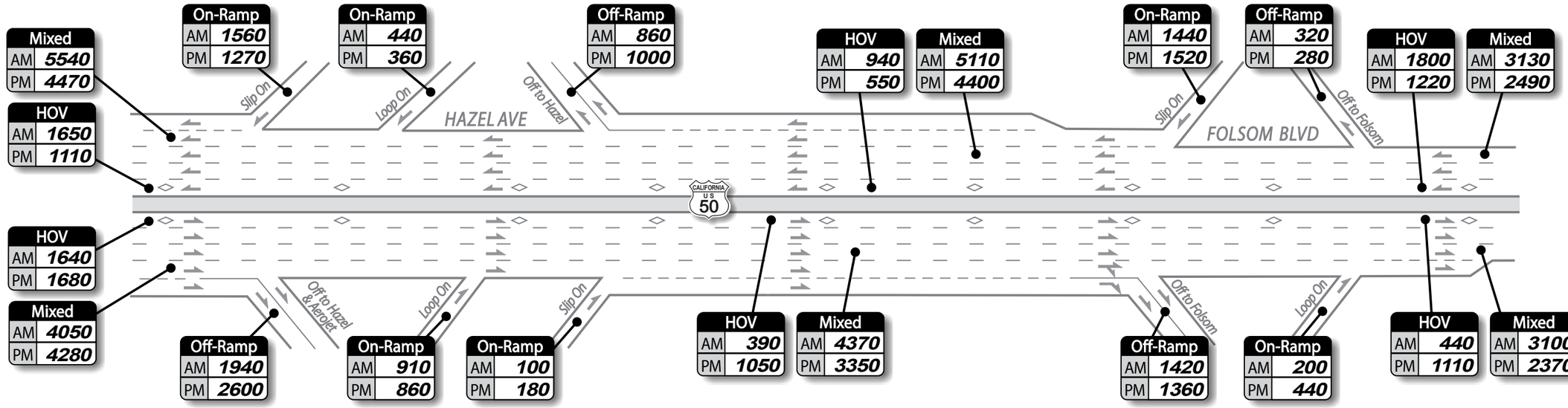
- Freeway Peak Hour Traffic Volumes

DKS

Figure **6-1**

YEAR 2022 NO BUILD

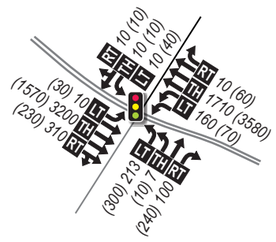
AM/PM Peak Hour Traffic Volumes and Lane Geometry



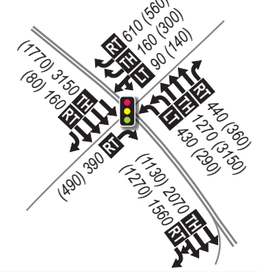
NORTH
Not to Scale

Freeway Schematic

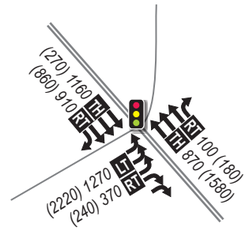
1 Hazel Ave. @ Gold Country Blvd.



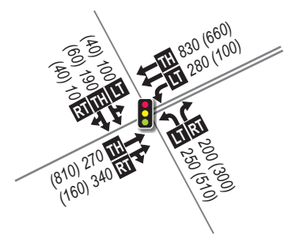
2 Hazel Ave. @ Tributary Pt. Dr./ WB Off-Ramp



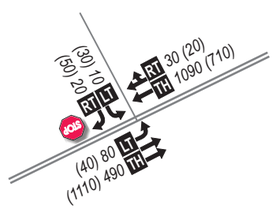
3 Hazel Ave. @ EB Ramps



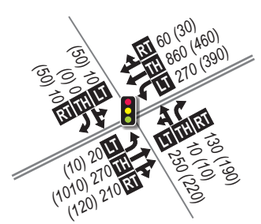
5 Aerojet Rd. @ Folsom Blvd.



6 Folsom Blvd. @ Auto Mall Cir. (West)



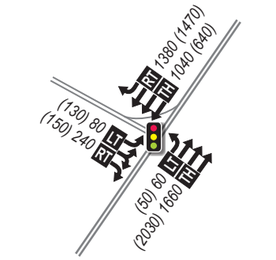
7 Folsom Blvd. @ Auto Mall Cir. (East)/ Birkmont Dr.



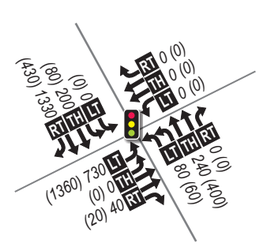
8 Folsom Blvd. @ EB Ramps



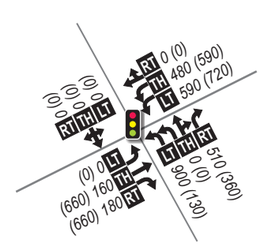
9 Folsom Blvd. @ WB Ramps



10 Hazel Ave. @ Jug Handle

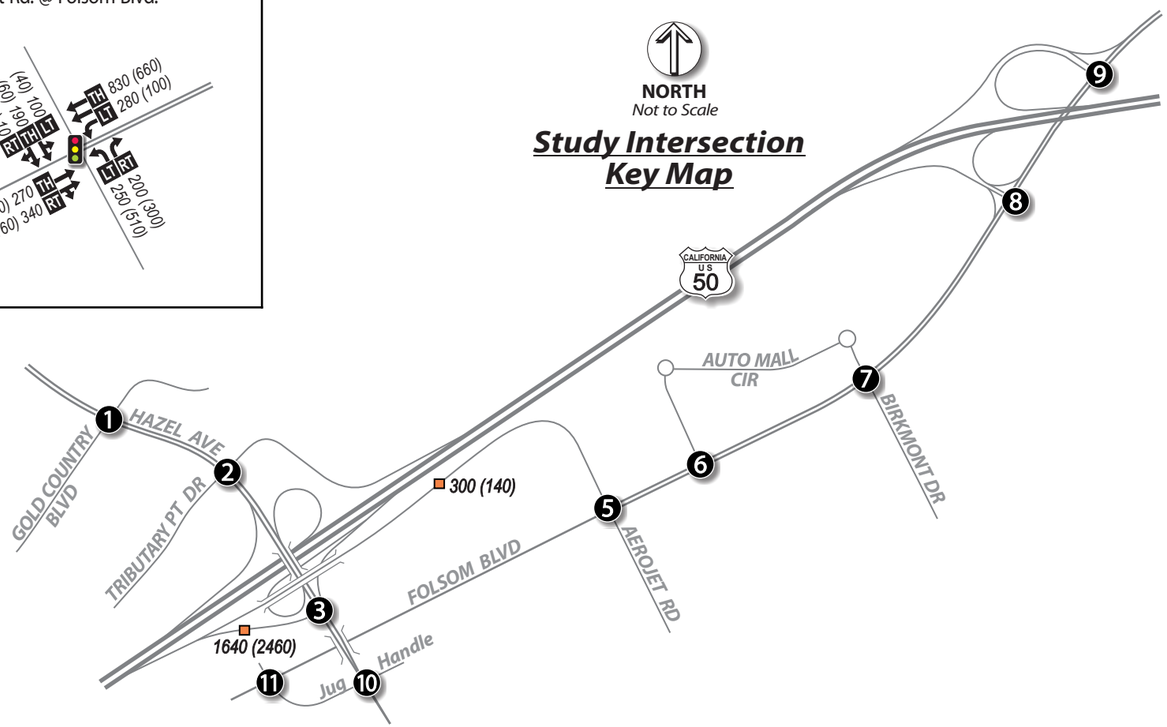


11 Folsom Blvd. @ Jug Handle



NORTH
Not to Scale

Study Intersection Key Map



LEGEND

Key Map

(#) - Study Intersection

AM (PM) ■ - Peak Hour Fwy. Ramp Volumes

Intersection Diagrams

STOP - Stop Sign

- Traffic Signal

← - Lane Configuration

AM (PM) - Peak Hour Traffic Volumes

LT TH RT - Volume Turn Movement
Left•Thru•Right

Freeway Schematic

◇ - HOV (High Occupancy Vehicle) Lane

Data Location	
AM	0000
PM	0000

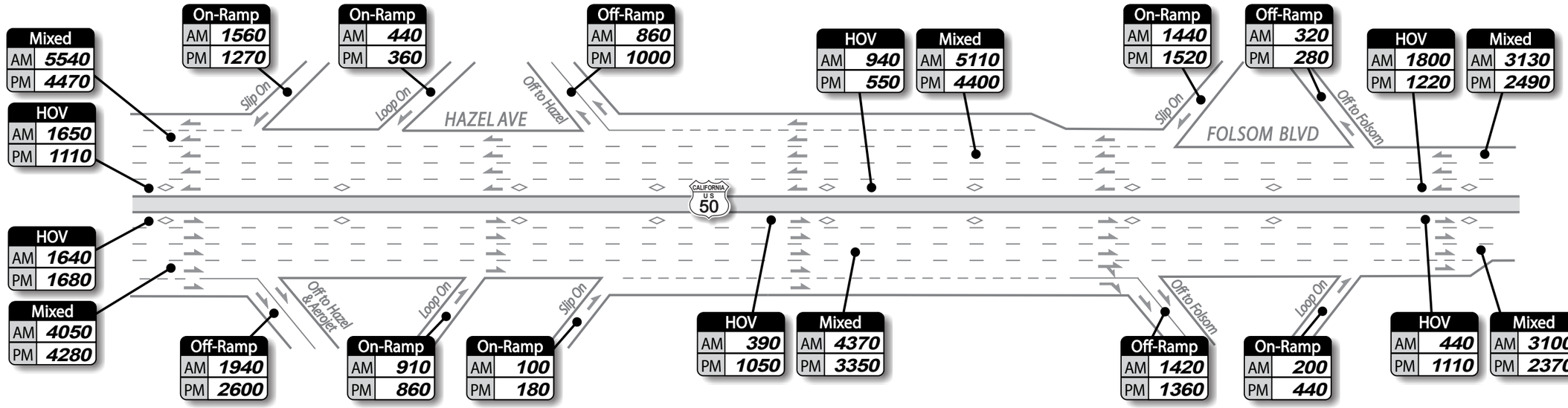
- Freeway Peak Hour Traffic Volumes

DKS

Figure **6-2**

YEAR 2022 WITH ALTERNATIVE 1

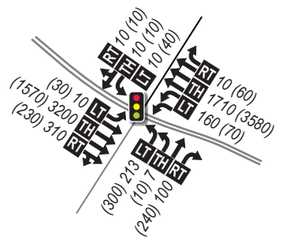
AM/PM Peak Hour Traffic Volumes and Lane Geometry



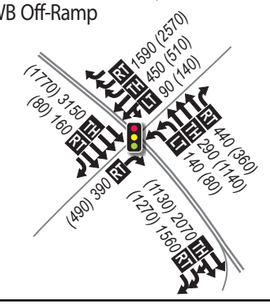
NORTH
Not to Scale

Freeway Schematic

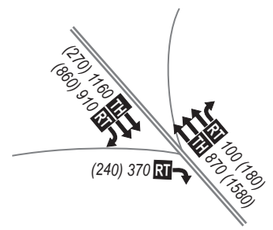
1 Hazel Ave. @ Gold Country Blvd.



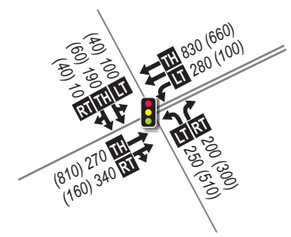
2 Hazel Ave. @ Tributary Pt. Dr./ WB Off-Ramp



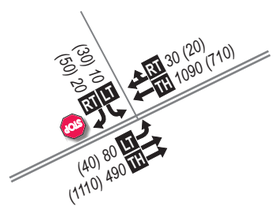
3 Hazel Ave. @ EB Ramps



5 Aerojet Rd. @ Folsom Blvd.



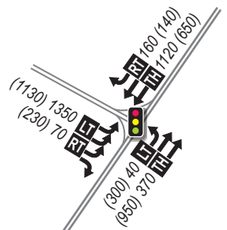
6 Folsom Blvd. @ Auto Mall Cir. (West)



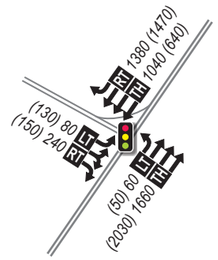
7 Folsom Blvd. @ Auto Mall Cir. (East)/ Birkmont Dr.



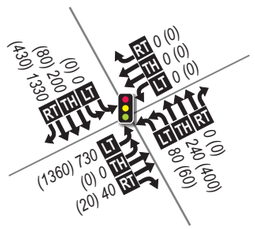
8 Folsom Blvd. @ EB Ramps



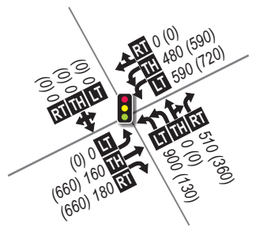
9 Folsom Blvd. @ WB Ramps



10 Hazel Ave. @ Jug Handle

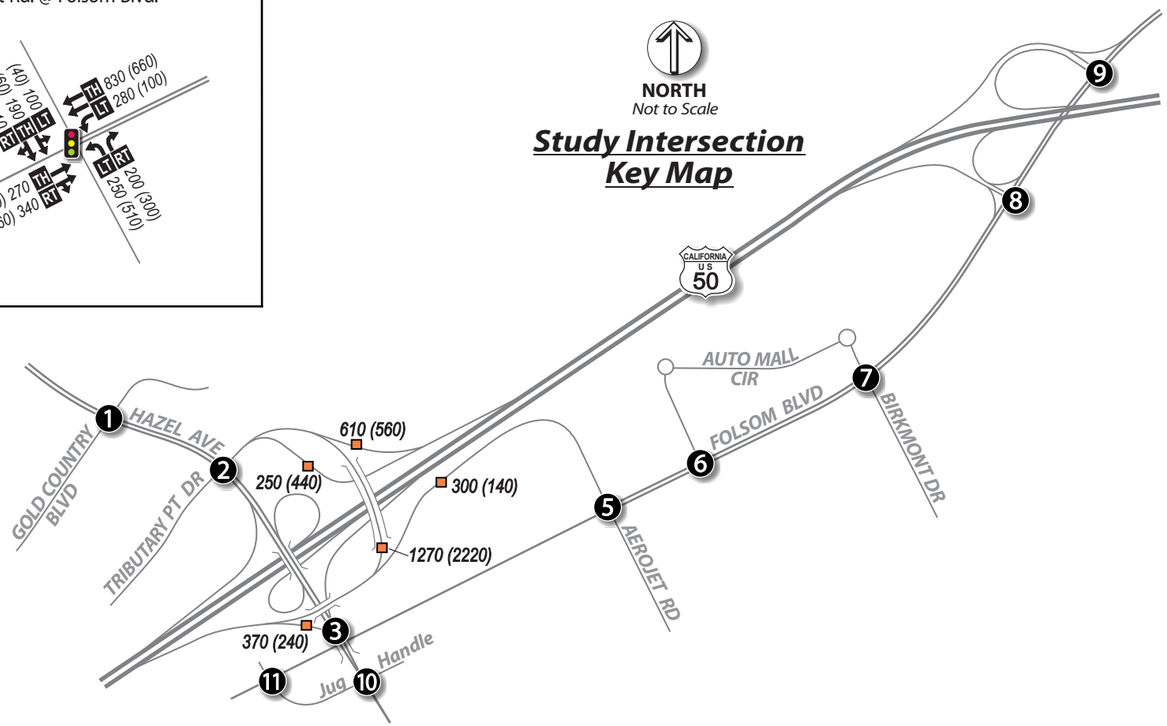


11 Folsom Blvd. @ Jug Handle



NORTH
Not to Scale

Study Intersection Key Map



LEGEND

Key Map
- (#) - Study Intersection
- AM (PM) ■ - Peak Hour Fwy. Ramp Volumes

Intersection Diagrams
- STOP - Stop Sign
- Traffic Signal
- ← - Lane Configuration
- *AM (PM)* - Peak Hour Traffic Volumes
- LT TH RT - Volume Turn Movement (Left•Thru•Right)

Freeway Schematic
- ◇ - HOV (High Occupancy Vehicle) Lane

Data Location	
AM	0000
PM	0000

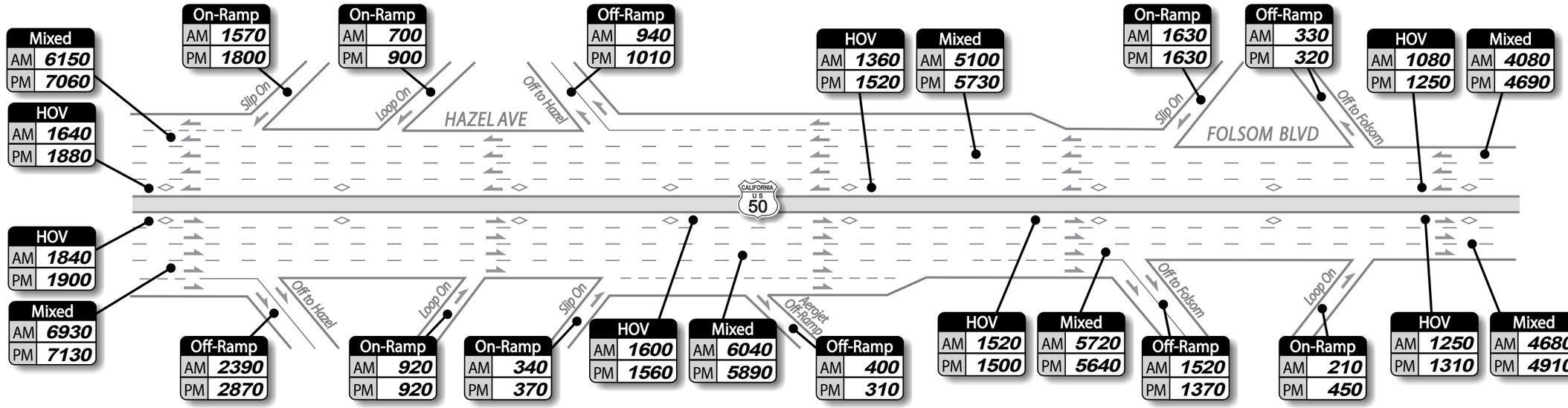
- Freeway Peak Hour Traffic Volumes

DKS

Figure **6-3**

YEAR 2022 WITH ALTERNATIVE 2

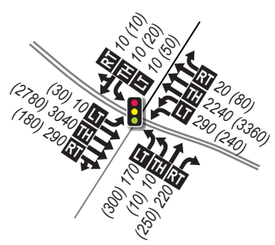
AM/PM Peak Hour Traffic Volumes and Lane Geometry



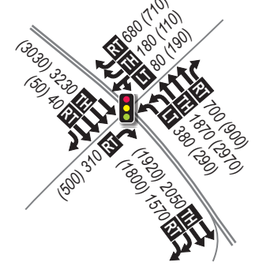
NORTH
Not to Scale

Freeway Schematic

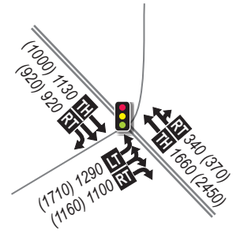
1 Hazel Ave. @ Gold Country Blvd.



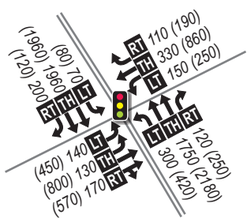
2 Hazel Ave. @ Tributary Pt. Dr./ WB Off-Ramp



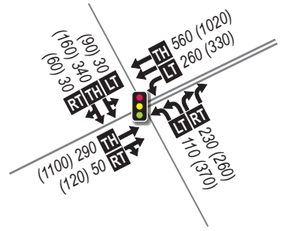
3 Hazel Ave. @ EB Ramps



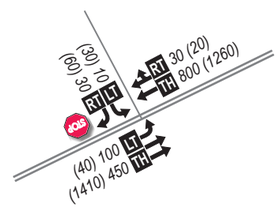
4 Hazel Ave. @ Folsom Blvd.



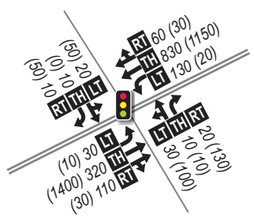
5 Aerojet Rd. @ Folsom Blvd.



6 Folsom Blvd. @ Auto Mall Cir. (West)



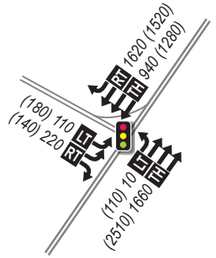
7 Folsom Blvd. @ Auto Mall Cir. (East)/ Birkmont Dr.



8 Folsom Blvd. @ EB Ramps

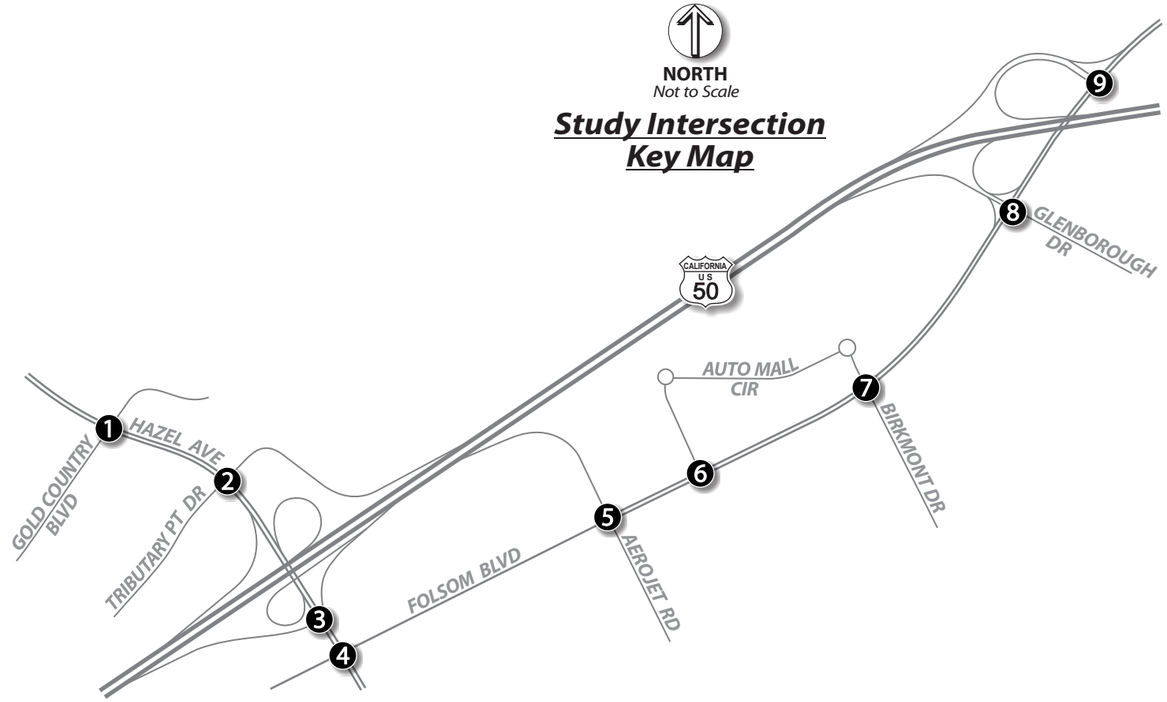


9 Folsom Blvd. @ WB Ramps



NORTH
Not to Scale

Study Intersection Key Map



LEGEND

Key Map
(#) - Study Intersection

Intersection Diagrams
STOP - Stop Sign
- Traffic Signal
← - Lane Configuration
AM (PM) - Peak Hour Traffic Volumes
LT TH RT - Volume Turn Movement
Left•Thru•Right

Freeway Schematic
◇ - HOV (High Occupancy Vehicle) Lane

Data Location	
AM	0000
PM	0000

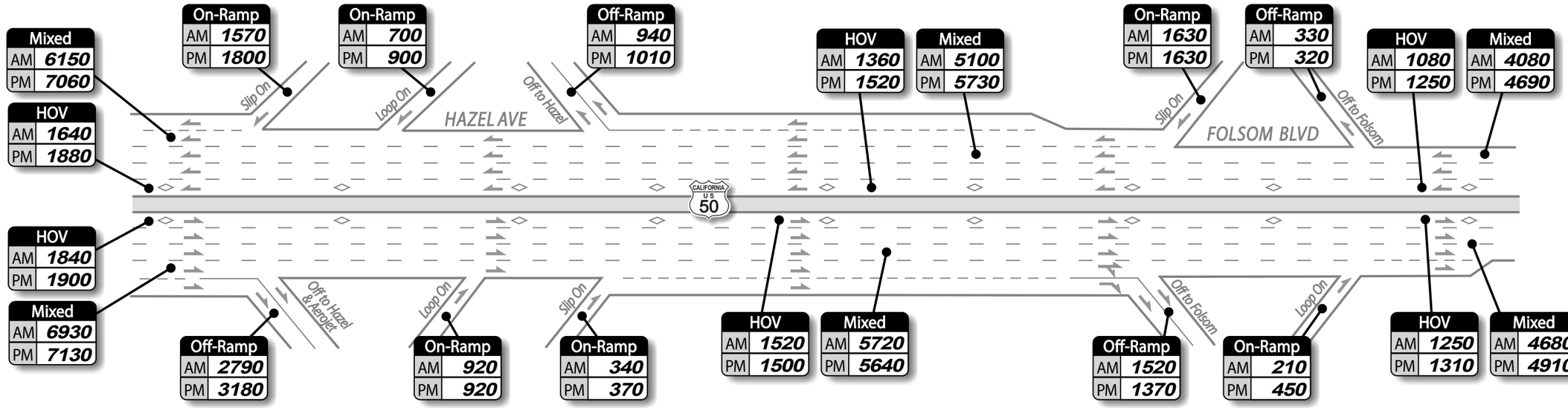
- Freeway Peak Hour Traffic Volumes

DKS

Figure **7-1**

YEAR 2042 NO BUILD

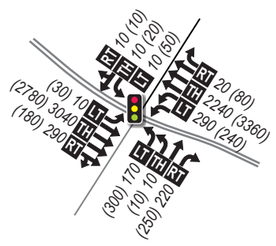
AM/PM Peak Hour Traffic Volumes and Lane Geometry



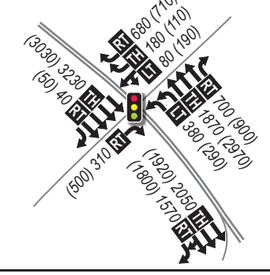
NORTH
Not to Scale

Freeway Schematic

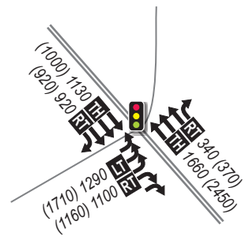
1 Hazel Ave. @ Gold Country Blvd.



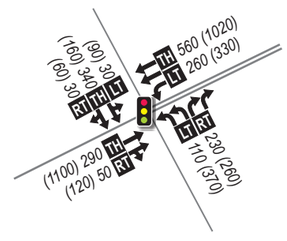
2 Hazel Ave. @ Tributary Pt. Dr./ WB Off-Ramp



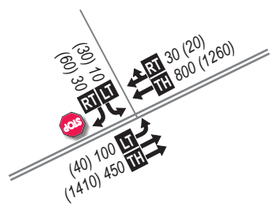
3 Hazel Ave. @ EB Ramps



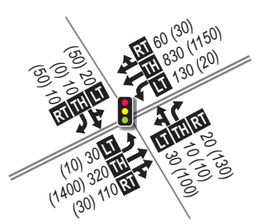
5 Aerojet Rd. @ Folsom Blvd.



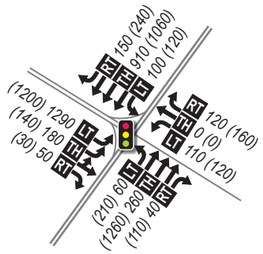
6 Folsom Blvd. @ Auto Mall Cir. (West)



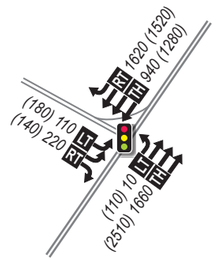
7 Folsom Blvd. @ Auto Mall Cir. (East)/ Birkmont Dr.



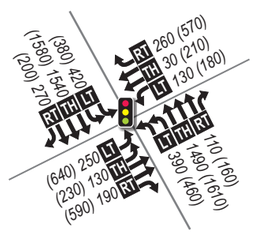
8 Folsom Blvd. @ EB Ramps



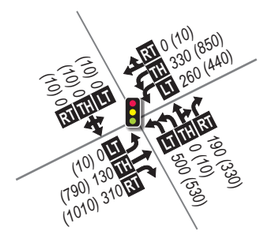
9 Folsom Blvd. @ WB Ramps



10 Hazel Ave. @ Jug Handle

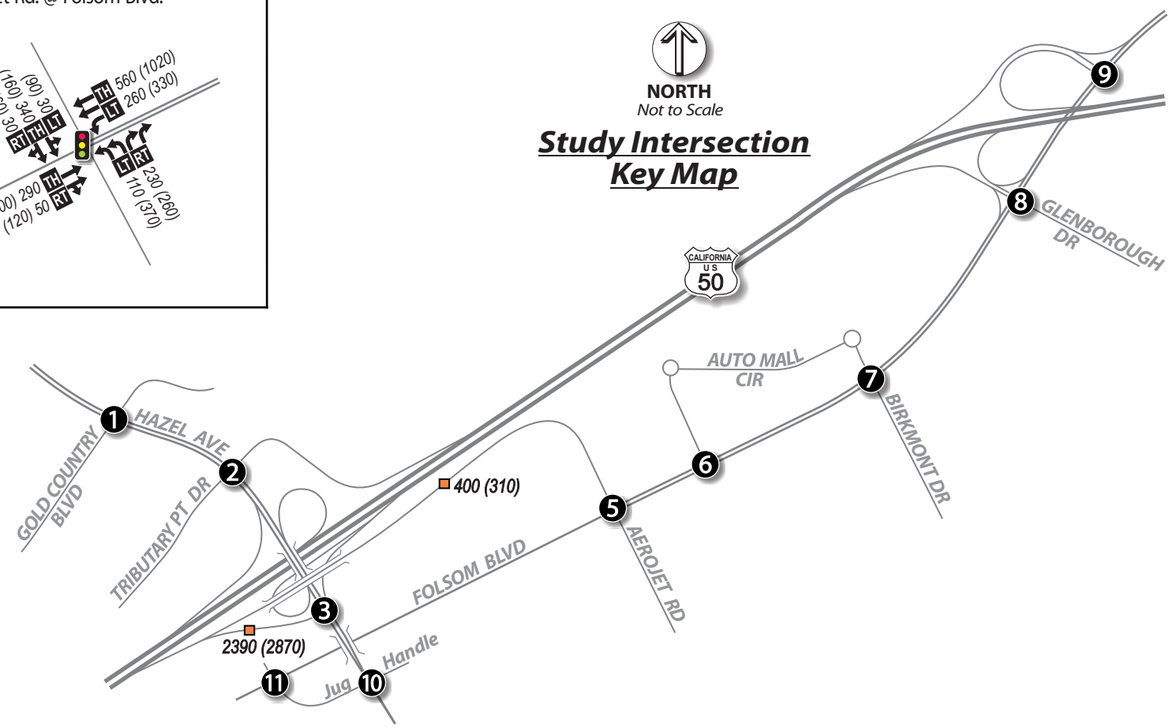


11 Folsom Blvd. @ Jug Handle



NORTH
Not to Scale

Study Intersection Key Map



LEGEND

Key Map

(#) - Study Intersection

AM (PM) - Peak Hour Fwy. Ramp Volumes

Intersection Diagrams

STOP - Stop Sign

- Traffic Signal

- Lane Configuration

AM (PM) - Peak Hour Traffic Volumes

LT TH RT - Volume Turn Movement
Left•Thru•Right

Freeway Schematic

◇ - HOV (High Occupancy Vehicle) Lane

Data Location	
AM	0000
PM	0000

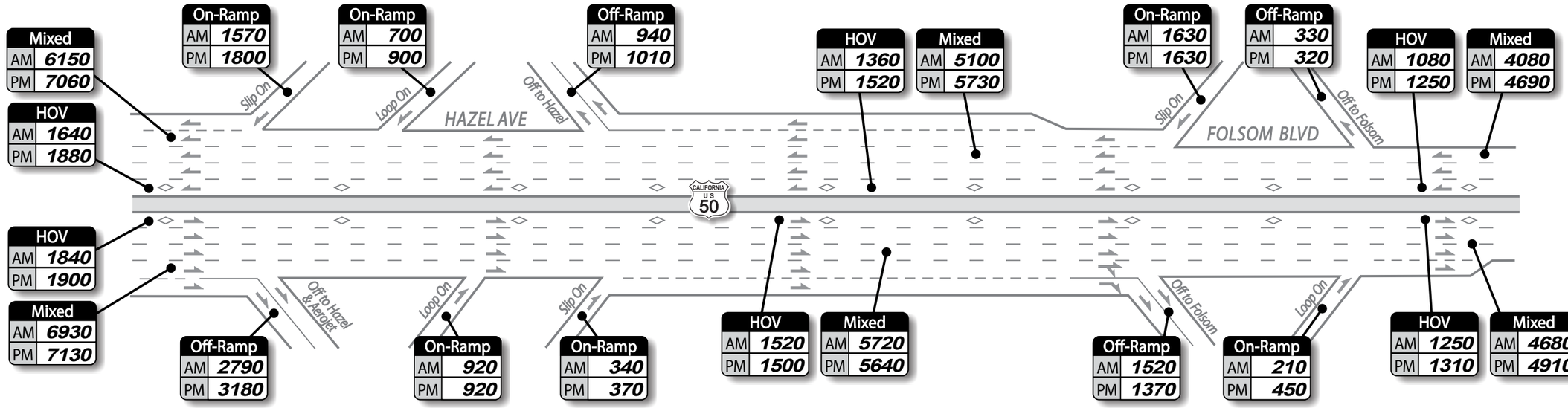
- Freeway Peak Hour Traffic Volumes

DKS

Figure **7-2**

YEAR 2042 WITH ALTERNATIVE 1

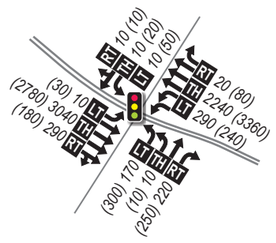
AM/PM Peak Hour Traffic Volumes and Lane Geometry



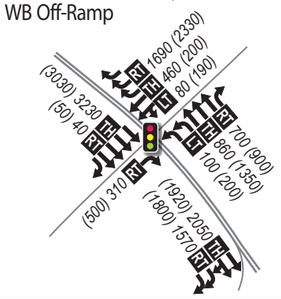
NORTH
Not to Scale

Freeway Schematic

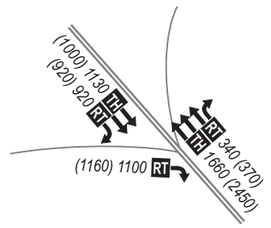
1 Hazel Ave. @ Gold Country Blvd.



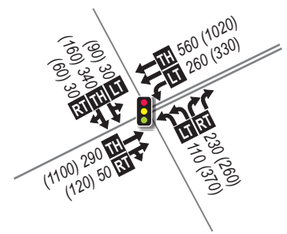
2 Hazel Ave. @ Tributary Pt. Dr./ WB Off-Ramp



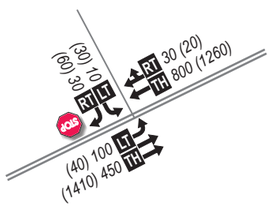
3 Hazel Ave. @ EB Ramps



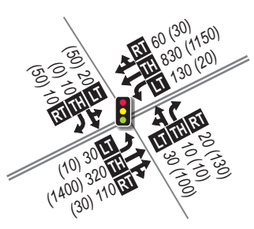
5 Aerojet Rd. @ Folsom Blvd.



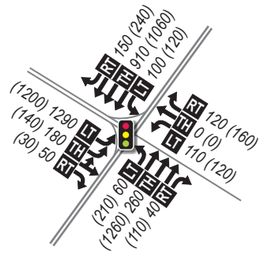
6 Folsom Blvd. @ Auto Mall Cir. (West)



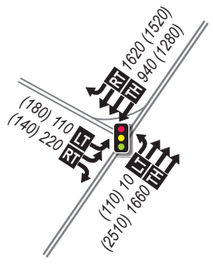
7 Folsom Blvd. @ Auto Mall Cir. (East)/ Birkmont Dr.



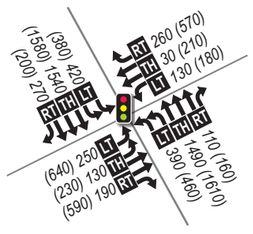
8 Folsom Blvd. @ EB Ramps



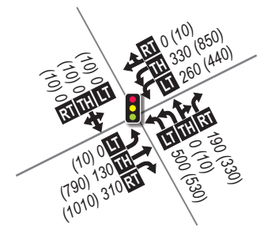
9 Folsom Blvd. @ WB Ramps



10 Hazel Ave. @ Jug Handle

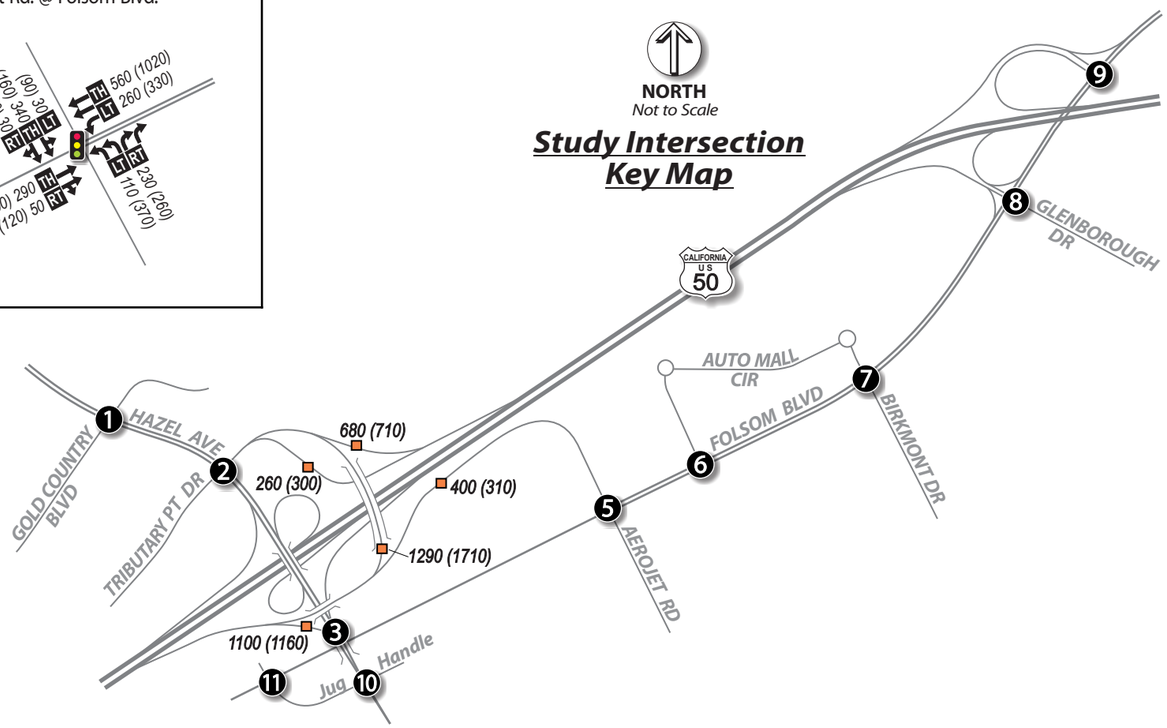


11 Folsom Blvd. @ Jug Handle



NORTH
Not to Scale

Study Intersection Key Map



LEGEND

Key Map

(#) - Study Intersection

AM (PM) - Peak Hour Fwy. Ramp Volumes

Intersection Diagrams

STOP - Stop Sign

- Traffic Signal

- Lane Configuration

AM (PM) - Peak Hour Traffic Volumes

LT TH RT - Volume Turn Movement
Left•Thru•Right

Freeway Schematic

◇ - HOV (High Occupancy Vehicle) Lane

Data Location	
AM	0000
PM	0000

- Freeway Peak Hour Traffic Volumes

DKS

Figure **7-3**

YEAR 2042 WITH ALTERNATIVE 2

AM/PM Peak Hour Traffic Volumes and Lane Geometry

Appendix B CT-EMFAC Emission Factors

2015 grams/mile

Speed	ROG	TOG	CO	NOx	CO_2	CH_4	PM10	PM2.5	Benzene	Acrolein	Acetaldehyde	Formaldehyde	Butadiene	Naphthalene	POM	DPM	DEOG
0-5	3.09	3.25	3.83	1.01	1297	0.14	0.08	0.04	0.04	0.00	0.01	0.03	0.00	0.00	0.00	0.01	0.14
5-10	2.96	3.07	3.20	0.86	987	0.10	0.07	0.04	0.04	0.00	0.01	0.02	0.00	0.00	0.00	0.01	0.11
10-15	2.86	2.93	2.73	0.68	760	0.06	0.06	0.03	0.03	0.00	0.01	0.01	0.00	0.00	0.00	0.01	0.06
15-20	2.80	2.85	2.37	0.57	611	0.04	0.06	0.03	0.03	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.03
20-25	2.77	2.80	2.12	0.52	514	0.03	0.06	0.03	0.03	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.02
25-30	2.75	2.78	1.92	0.49	448	0.02	0.06	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
30-35	2.74	2.76	1.76	0.47	405	0.02	0.06	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
35-40	2.73	2.75	1.64	0.46	378	0.02	0.06	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
40-45	2.73	2.74	1.55	0.45	364	0.01	0.06	0.02	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
45-50	2.72	2.74	1.49	0.45	363	0.01	0.06	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
50-55	2.73	2.74	1.46	0.46	373	0.01	0.06	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
55-60	2.73	2.75	1.48	0.46	396	0.02	0.06	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
60-65	2.74	2.76	1.54	0.48	435	0.02	0.06	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
65-70	2.74	2.77	1.60	0.49	462	0.02	0.06	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01

2022 grams/mile

Speed	ROG	TOG	CO	NOx	CO_2	CH_4	PM10	PM2.5	Benzene	Acrolein	Acetaldehyde	Formaldehyde	Butadiene	Naphthalene	POM	DPM	DEOG
0-5	1.91	2.00	1.87	0.76	1065	0.08	0.06	0.03	0.02	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.07
5-10	1.84	1.90	1.60	0.62	814	0.05	0.06	0.03	0.02	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.05
10-15	1.80	1.84	1.37	0.45	629	0.03	0.06	0.03	0.02	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.03
15-20	1.77	1.80	1.20	0.34	509	0.02	0.05	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
20-25	1.75	1.77	1.07	0.28	430	0.02	0.05	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
25-30	1.74	1.76	0.97	0.24	376	0.01	0.05	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
30-35	1.74	1.75	0.89	0.22	341	0.01	0.05	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
35-40	1.73	1.74	0.83	0.21	318	0.01	0.05	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
40-45	1.73	1.74	0.77	0.20	307	0.01	0.05	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
45-50	1.73	1.74	0.73	0.20	305	0.01	0.05	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50-55	1.73	1.74	0.70	0.20	313	0.01	0.05	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
55-60	1.73	1.74	0.69	0.20	331	0.01	0.05	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
60-65	1.74	1.75	0.69	0.21	362	0.01	0.05	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
65-70	1.74	1.75	0.70	0.21	383	0.01	0.05	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

2042 grams/mile

Speed	ROG	TOG	CO	NOx	CO_2	CH_4	PM10	PM2.5	Benzene	Acrolein	Acetaldehyde	Formaldehyde	Butadiene	Naphthalene	POM	DPM	DEOG
0-5	0.84	0.88	0.95	0.70	737	0.04	0.05	0.02	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.04
5-10	0.80	0.83	0.80	0.54	569	0.03	0.05	0.02	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.03
10-15	0.78	0.80	0.67	0.34	443	0.02	0.05	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
15-20	0.76	0.77	0.57	0.20	360	0.01	0.05	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
20-25	0.75	0.76	0.51	0.12	307	0.01	0.05	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
25-30	0.74	0.75	0.46	0.09	271	0.01	0.05	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
30-35	0.74	0.75	0.42	0.07	247	0.01	0.05	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
35-40	0.74	0.74	0.38	0.06	232	0.00	0.05	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
40-45	0.74	0.74	0.36	0.05	223	0.00	0.05	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
45-50	0.74	0.74	0.33	0.05	221	0.00	0.05	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50-55	0.74	0.74	0.32	0.04	226	0.00	0.05	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
55-60	0.74	0.74	0.31	0.04	237	0.00	0.05	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

60-65	0.74	0.74	0.31	0.04	257	0.00	0.05	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
65-70	0.74	0.74	0.32	0.04	271	0.00	0.05	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Appendix C Construction Assumptions

Alternative 1 Construction Schedule

Activity/Phase	Start	End	Days
Construct temporary EB diagonal on-ramp			
Clearing/Demo	5/18/2020	5/20/2020	3
Grading	5/21/2020	6/9/2020	14
Drainage	6/10/2020	6/12/2020	3
Paving	6/15/2020	6/25/2020	5
Demolish gas station			
Clearing/Demo	5/18/2020	6/12/2020	10
Realign Hazel Ave			
Clearing/Demo	6/15/2020	6/19/2020	1
Grading	6/15/2020	6/19/2020	4
Drainage	6/22/2020	6/24/2020	3
Paving	6/25/2020	6/26/2020	2
Widen Hazel Ave OC			
Clearing/Demo	6/22/2020	6/23/2020	1
Bridge	6/24/2020	9/15/2020	60
Construct east portion of Hazel OH & roadway approaches			
Clearing/Demo	6/29/2020	6/30/2020	1
Grading	7/1/2020	9/4/2020	47
Drainage	9/8/2020	9/10/2020	3
Paving	12/15/2020	1/4/2021	15
Bridge	9/22/2020	12/14/2020	70
Wall	7/1/2020	9/1/2020	44
Construct EB off-ramp ("R1")/retaining walls/barriers			
Clearing/Demo	11/20/2020	11/23/2020	1
Grading	11/24/2020	1/27/2021	47
Drainage	1/28/2021	2/1/2021	3
Paving	2/2/2021	2/24/2021	17
Wall	9/5/2020	1/27/2021	100
Construct EB diagonal ("R3") on-ramp with retaining walls/barriers			
Clearing/Demo	3/12/2021	3/15/2021	1
Grading	3/16/2021	3/24/2021	7
Drainage	3/25/2021	3/29/2021	3
Paving	3/30/2021	4/13/2021	11
Wall	1/28/2021	3/24/2021	40
Construct western portion of Hazel OH and roadway approaches			
Clearing/Demo	3/25/2021	3/26/2021	1
Grading	3/29/2021	5/6/2021	28
Drainage	5/7/2021	5/9/2021	3
Paving	5/12/2021	5/15/2021	4
Bridge	1/19/2021	4/12/2021	60
EB loop on-ramp ("R2")			
Clearing/Demo	8/18/2021	8/19/2021	1
Grading	8/20/2021	8/30/2021	7
Drainage	8/31/2021	9/2/2021	3

Paving	9/3/2021	9/20/2021	12
Wall	7/13/2021	7/26/2021	40
Construct Viaduct ("V Line")			
Clearing/Demo	6/29/2021	6/30/2021	10
Grading	7/1/2021	8/12/2021	30
Drainage	8/13/2021	8/17/2021	3
Paving	8/18/2021	8/31/2021	10
Bridge	4/13/2021	7/5/2021	80
Wall	5/4/2021	6/1/2021	48
Construct WB loop on-ramp ("R5")			
Clearing/Demo	5/7/2021	5/10/2021	1
Grading	5/11/2021	6/28/2021	35
Drainage	6/29/2021	7/1/2021	3
Paving	7/2/2021	7/27/2021	17
Construct auxiliary lane			
Clearing/Demo	8/31/2021	9/1/2021	1
Grading	9/2/2021	9/15/2021	10
Drainage	9/16/2021	9/20/2021	3
Paving	9/21/2021	10/18/2021	20
Wall	8/19/2021	9/15/2021	20
Construct Jughandle			
Clearing/Demo	9/16/2021	9/17/2021	1
Grading	9/20/2021	10/1/2021	10
Drainage	10/4/2021	10/6/2021	3
Paving	10/7/2021	11/2/2021	19

Alternative 1 Construction Assumptions

Activity	Length (mi)	Earthwork			Haul Trucks			Water Trucks	
		Acres Distrubed	Import Per Day	Export Per Day	Trips/Day (Soil)	Trips/Day (Asphalt)	Miles/Trip	Trips/Day	Miles/Trip
Stage 1									
Construct temporary EB diagonal on-ramp	0.19	3	988	12	80	20	5	4	1.25
Demolish gas station	0.02	1	0	0	0	0		4	1.25
Realign Hazel Ave	0.11	1	445	55	40	10	5	4	1.25
Widen Hazel Ave OC	0.07	0	0	0	0	0		4	1.25
Construct east portion of Hazel OH & roadway approaches	0.31	5	1462	38	120	30	5	4	1.25
Construct EB off-ramp ("R1")/retaining walls/barriers	0.44	3	724	76	64	16	5	4	1.25
Construct EB diagonal ("R3") on-ramp with retaining walls/barriers	0.30	2	160	340	40	10	5	4	1.25
Stage 2									
Construct western portion of Hazel OH and roadway approaches	0.25	1	1425	75	120	30	5	4	1.25
EB loop on-ramp ("R2")	0.25	3	635	865	120	30	5	4	1.25
Construct Viaduct ("V Line")	0.27	4	543	257	64	16	5	4	1.25
Construct WB loop on-ramp ("R5")	0.27	6	398	102	40	10	5	4	1.25
Construct auxiliary lane	1.04	4	288	712	80	20	5	4	1.25
Construct Jughandle	0.30	4	0	860	120	30	5	4	1.25

Daily Equipment Quantities by Phase

Phase	Crawler Tractors/ Excavators	Cranes	Graders	Rollers	Rubber Tire Loaders	Scrapers	Tractors/Loaders Backhoes	Air Compressors	Generator Sets	Plate Compactors	Pumps	Rough Terrain Forklifts
Clearing/Demo	4				2		1	1	1	1	1	1
Grading	4		3	1	2	1	1	1	1	1	1	1
Paving	4			3			1	1	1	1	1	1
Bridge	4	1					1	1	1	1	1	1
Wall	4						1	1	1	1	1	1
Drainage	4						1	1	1	1	1	1

Operating Hours per Day by Equipment Type

Equipment	**Hours/day**
Air Compressors	6
Cranes	2
Crawler Tractors	4
Generator Sets	6
Graders	4
Plate Compactors	4
Pumps	6
Rollers	4
Rough Terrain Forklifts	2
Rubber Tired Loaders	4
Scrapers	2
Tractors/Loaders/Backhoes	6

Appendix D MTP/SCS and MTIP Documentation

Project ID	COUNTY	LEAD AGENCY	TITLE	PROJECT DESCRIPTION	TOTAL COST	Milestone Year for Conformity	2017	2018	2020	2022	2024	2026	2027	2036	Status
SAC24255	Sacramento	Sacramento County	Hazel Ave - U.S. 50 to Folsom Blvd	In Sacramento County, Hazel Avenue, between Folsom Boulevard and US Highway 50: multi-modal corridor improvements, interchange improvements; widen from 4 lanes to 6 lanes of Hazel Avenue between Folsom Boulevard and US Highway 50.	$82,563,000	2022				X	X	X	X	X	Programmed
SAC24626	Sacramento	Sacramento County	Hazel Ave Widening Phase 3	Sacramento County, Hazel Avenue, from Sunset Ave. to Madison Ave.: Widen from 4 to 6 lanes. New traffic signals at Roediger Lane and Phoenix Avenue. Improve existing and projected traffic congestion; enhance pedestrian and bicycle mobility in the corridor, address safety concerns, and improve the aesthetics of the corridor.	$14,649,000	2020			X	X	X	X	X	X	Programmed
SAC24625	Sacramento	Sacramento County	Hazel Ave Widening, Phase 2	Sacramento County between Curragh Downs Drive and Sunset Avenue; Widen Hazel Avenue from four to six lanes. Includes appraisals and acquisitions of necessary right of way adjacent to the proposed improvements. Traffic signal modifications at Curragh Downs Drive, Winding Way, Sunset Avenue, and La Serena Drive. Improvements also include new facilities for pedestrians and	$23,518,000	2017	X	X	X	X	X	X	X	X	Programmed
SAC24268	Sacramento	Sacramento County	Hazel Ave. Improvements	In Sacramento County and City of Rancho Cordova: Between Easton Valley Parkway and Folsom Boulevard; joint project with the City of Rancho Cordova to construct a new 6-lane expressway with special treatment.	$15,000,000	2021				X	X	X	X	X	Programmed
CAL15410	Sacramento	Sacramento County	Jackson Hwy. (SR 16)	Widen: 4 lanes from South Watt Ave. to Excelsior Rd. Includes: continuous left turn lane.	$60,000,000	2026						X	X	X	Planned
SAC16500	Sacramento	Sacramento County	Madison Avenue Widening	Madison Avenue from Fair Oaks Blvd. to Hazel Ave.: Widen from 4 to 6 lanes.	$29,045,000	2025						X	X	X	Programmed
SAC24512	Sacramento	Sacramento County	Metro Air Parkway	In Sacramento County, Metro Air Parkway from north of I-5 to Elverta Road: Widen roadway from 2 to 4 lanes.	$5,320,000	2019			X	X	X	X	X	X	Programmed
SAC18150	Sacramento	Sacramento County	Metro Air Parkway Interchange at I-5	In Sacramento County, I-5 @ Metro Air Parkway near Sacramento International Airport: Construct the first phase of a five-lane partial clover Type L-9 interchange for Metro Air Parkway at Interstate 5 (I-5). Construct a three lane overcrossing facility with a median, bike lanes and a sidewalk on the west side. Metro Air Parkway will connect on the north of the interchange and terminate south of I-5	$24,139,000	2020			X	X	X	X	X	X	Programmed
SAC25035	Sacramento	Sacramento County	Power Inn Improvement Project	Power Inn Road, from Florin Rd. to 52nd Ave.: Widen from three to four lanes, and from 450 feet south of Loucreta Dr. to 52nd Ave.: Install curb, gutter, sidewalk infills, ADA ramps, bike lane improvements, and landscape medians. (Scope included in MTP/SCS project SAC24274. Related ATP project is SAC25022)	$4,522,000	2020			X	X	X	X	X	X	Programmed
SAC24274	Sacramento	Sacramento County	Power Inn Rd Widening	This project will include the road widening of Power Inn Rd between Florin Rd and Elder Creek Rd to accommodate two through lanes in each direction, a center two way left turn lane, a 6-foot bike lane on the east side, and a 5-foot bike lane with curb, gutter, and sidewalk on the west side.	$1,662,000	2022				X	X	X	X	X	Planned

U.S. Department of Transportation
Federal Highway Administration

California Division

650 Capitol Mall, Suite 4-100
Sacramento, CA 95814
(916) 498-5001
(916) 498-5008

December 16, 2016

In Reply Refer To:
HAD-CA

Mr. Malcolm Dougherty
Director, California Department of Transportation
1120 N Street
Sacramento, CA 95814

SUBJECT: APPROVAL OF THE 2017 FEDERAL STATEWIDE TRANSPORTATION IMPROVEMENT PROGRAM

Dear Mr. Dougherty:

We have completed our review of California's proposed 2016/17 - 2019/20 Federal Statewide Transportation Improvement Program (2017 FSTIP) and Statewide and Metropolitan Planning Certifications and supporting documentation submitted by the California Department of Transportation (Caltrans) on November 16, 2016. The Federal Transit Administration (FTA) and the Federal Highway Administration (FHWA) approve the 2017 FSTIP and this approval supersedes California's 2015 FSTIP and all subsequent amendments to the 2015 FSTIP that were approved by the FHWA and FTA on or after December 15, 2014.

Section 450.218 of Title 23, Code of Federal Regulations, requires the State to submit the updated FSTIP concurrently to the FTA and the FHWA at least every four years for joint approval. California's proposed 2017 FSTIP includes the project and project phase listings for proposed transportation projects located outside the planning area boundaries of the State's designated Metropolitan Planning Organizations (MPOs). California's proposed 2017 FSTIP also incorporates, by reference, those projects included in 2017 Federal Transportation Improvements Programs (FTIPs) that were adopted in 2016 by the eighteen designated MPOs in California.

With the exception of the eastern San Luis Obispo County ozone non-attainment area, FHWA and the FTA have completed the air quality conformity determinations required by 23 CFR 450.218(b) for the MPO FTIPs in areas of the State designated as nonattainment or maintenance for national ambient air quality standards (NAAQS). Further, our review indicated that no projects subject to regional modeling and air quality conformity are proposed in the SLOCOG 2017 FTIP for the ozone non-attainment area in eastern San Luis Obispo County.

Based on our review of the information submitted with the State's proposed 2017 FSTIP, including revenue and proposed project funding information required to demonstrate financial

constraint, and documentation for statewide and metropolitan planning process in support of California's Statewide Planning Certification, we are approving the 2017 FSTIP as proposed. Any project or project phase listed in a MPO FTIP that is not included in the MPO's Regional Transportation Plan, is not approved for inclusion in the FSTIP pursuant to 23 CFR §§450.218(k) and 450.326(i).

Our FSTIP approval action includes project listings that indicate no funds are proposed for obligation during the four-year program period from 2016/17 to 2019/20. These projects and project phases cannot be advanced to implementation without an action by the FHWA and the FTA on the FSTIP pursuant to 23 CFR 450.218(l) and 450.330(e). Further, project or project phase funding included in the 2017 FSTIP that is listed/proposed for obligation outside the four year program cycle is accepted by the FHWA and the FTA as 'informational' in accord with 23 CFR §§450.218(a) and 450.326(a).

We are approving the 2017 FSTIP with the understanding that the eligibility of individual projects for funding is subject to the applicant's satisfaction of all FHWA and FTA funding requirements. This joint FHWA and FTA approval of the FSTIP does not constitute an eligibility determination for the federal funds proposed for obligation on the listed projects.

If you have questions or need additional information concerning our approval of the 2017 FSTIP, please contact Wade Hobbs in the FHWA California Division office at (916) 498-5027, or by email at Wade.Hobbs@dot.gov; or Ted Matley in the FTA Region IX office at (415) 744-2590, or by email at Ted.Matley@dot.gov.

Sincerely,

For Leslie T. Rogers
Regional Administrator
Federal Transit Administration

For Vincent P. Mammano
Division Administrator
Federal Highway Administration

cc: (email)
Ray Sukys, FTA Region IX
Ted Matley, FTA Region IX
Karina O'Connor, EPA Region IX (OConnor.Karina@epa.gov)
Cari Anderson, CARB (Cari.Anderson@arb.ca.gov)
Muhaned Aljabiry, Caltrans OFTMP (Muhaned.Aljabiry@dot.ca.gov)
Fardad Falakfarsa, Federal Resources Office (Fardad.Falakfarsa@dot.ca.gov)
Erin Thompson, Caltrans ORP (Garth.Hopkins@dot.ca.gov)
Bureau of Indian Affairs, Pacific Region Roads Engineer
All California MPOs (18)
Wade Hobbs, FHWA CADO
Tashia Clemons, FHWA CADO
Christina Leach, FHWA NVDO

FHWA:
LA Metro Office
CFLHD
NVDO

cc:
2017 FSTIP Binder

WEH/

Appendix E Interagency Consultation

The U.S. 50/Hazel Avenue Interchange Project underwent interagency consultation (IAC) through SACOG's PLCG Group. EPA and FHWA issued concurrence that the project is not a POAQC on June 19, 2017. This appendix provides evidence that the IAC concurred with the conclusion that the project is not a POAQC, including concurrence emails from EPA and FHWA.

MTIP ID# *(required):* SAC24255

Project Description *(clearly describe project):*
The County of Sacramento, in cooperation with the California Department of Transportation (Caltrans) and the City of Rancho Cordova, proposes to modify the existing U.S. 50/Hazel Avenue interchange and extend and grade-separate Hazel Avenue over Folsom Boulevard and the Sacramento Placerville Transportation Corridor Joint Powers Authority (SPTC-JPA) rail corridor. Hazel Avenue will be extended further south to a proposed intersection with the future Atlanta Street (a new roadway that will be constructed as part of the Easton Place development). Both Build Alternatives would reconstruct the existing interchange on- and off-ramps, construct eastbound on- and off-ramp auxiliary lanes on U.S. 50, modify the existing Aerojet Road off-ramp from U.S. 50, construct a portion of an eastbound transition auxiliary lane on Highway 50 from Hazel Avenue through the Folsom Boulevard Overcrossing, improve pedestrian access on the east side of Hazel Avenue, and provide various roadway improvements along Folsom Boulevard.

Type of Project:	**County:**
Reconfigure existing Interchange	Sacramento

Narrative Location/Route & Post Miles: The project is located in the County of Sacramento at the interchange of Hazel Avenue and U.S. 50 (PM 15.1-17.4).
Caltrans Projects – EA#: 03-3E380

Lead Agency: Sacramento County (CEQA) and Caltrans (NEPA)

Contact Person:	**Email:**
Marianne Biner, Sacramento County	binerm@saccounty.net

Phone#: #: 916-874-7520

Hot Spot Pollutant of Concern *(check one or both)*
PM2.5 ☒ **PM10** ☒

Is this a 23 USC 326 or a 23 USC 327 federal process under MAP-21 (formerly 6004 and 6005)?
Typically, EA or above is a 23 USC 327 project.

(check one)
23 USC 326 ☐ **23 USC 327** ☒

Federal Action for which Project-Level PM Conformity is Needed *(check appropriate box)*
Categorical Exclusion (NEPA) ☐ **EA or Draft EIS** ☒ **FONSI or Final EIS** ☐

Scheduled Date of Federal Action: December 2017

Current Programming Dates *(as appropriate)*

	PE/Environmental	**ENG**	**ROW**	**CON**
Start	2016	2018	2019	2020
End	2017	2019	2020	2022

Project Purpose and Need *(Summary):*
(attach additional sheets as necessary)
The primary purpose of the project is to modify the existing U.S. 50/Hazel Avenue Interchange to reduce congestion, improve traffic operations, accommodate travel demand due to planned and approved developments, and improve safety of all modes of travel including bicycles and pedestrians. The following objectives will be met by the Build Alternatives:

- Improve operations by removing the close intersection spacing between the eastbound ramps and Folsom Boulevard, and minimizing conflict with heavy and light rail.
- Provide sufficient capacity in the ramps and roadways for future traffic volumes.
- Maintain the Aerojet Road off-ramp connection to the approved development while improving the mainline operations.

The project is needed to relieve existing congestion at the interchange and to accommodate planned and approved developments identified by the adopted Sacramento County General Plan and SACOG's Metropolitan Transportation Plan/Sustainable Communities Strategy.

The approved developments within and near the project area will increase traffic demand beyond what the existing interchange can accommodate. The close intersection spacing between the Folsom Boulevard and eastbound ramp intersections does not provide sufficient queuing for increased traffic volumes. Additionally, the County of Sacramento is currently widening Hazel Avenue from the interchange to Madison Avenue from four to six traffic lanes. This increase in roadway capacity is expected to deliver more traffic to the interchange during peak traffic periods.

Surrounding Land Use/Traffic Generators *(Describe effect of traffic generators or diesel traffic. Also, provide a map, preferably aerial photo, with labeled locations of nearby (within 500 ft.) sensitive receptors, such as daycare facilities and schools)*:
The area surrounding the interchange contains several major traffic generators, such as retail shopping, the Nimbus Winery, and restaurants. The closet sensitive receptors are the Oak Brook Apartments, which includes a building approximately 50 feet south of eastbound lanes of U.S. 50. Other sensitive receptors within 1,000 feet of the interchange include the following (see Figure 1). Because the alternatives differ primarily by how traffic is routed through the interchange area, sensitive receptors are the same under all alternatives.

- Nimbus Dam Recreational Area—100 feet east of the westbound onramps from northbound Hazel Ave.
- Twilight RV & Mobile Home Park—100 feet south of eastbound lanes of U.S. 50.
- Cobble Oaks Apartments—650 feet west of Hazel Ave. north of U.S. 50.
- Sacramento State Aquatic Center—600 feet north of the westbound onramps from northbound Hazel Ave.
- Single family homes along Silver Point Lane and Gold Bluff Lane—1,000 feet north of westbound lanes of U.S. 50.

There are no schools, child care facilities, hospitals, or educational land uses in the immediate project vicinity.

Only if Facility is an Interchange or Intersection: Opening Year *Build and No Build cross-street AADT, % and # trucks, truck AADT)*:

Table 1 summarizes AADT and truck volumes on U.S. 50, while Table 2 summarizes AADT and truck volumes on the Aerojet Road/U.S. 50 off ramp, for the Build and No-Build alternatives for opening (2022) year. From a traffic operations perspective, the Build Alternatives differ only in terms of how traffic is routed through the interchange area. Traffic volumes, speeds, and other operational conditions under the alternatives are therefore identical (Shew pers. comm. A). Accordingly, the AADT volumes shown in Tables 1 and 2 are based on a single set of traffic conditions, which is representative of both Build Alternatives

Table 1: Mainline U.S. 50 Opening Year (2022) Build and No Build AADT and Truck Volumes

AADT			Truck Volume[a]		
Build	No Build	Change[b]	Build	No Build	Change[b]
168,180	166,910	1,270 (1%)	10,091	10,015	76 (1%)

Source: Shew pers. comm. B
[a] Trucks represent 6% of AADT on U.S. 50 in the project area (Shew pers. comm. C)
[b] Represents the change in traffic volume under the Build Alternatives, relative to No Build conditions.

Table 2: Aerojet Road/U.S. 50 Off-Ramp Opening Year (2022) AADT and Truck Volumes[a]

AADT	Truck %[b]	Truck Volume
2,070	2%	41

Source: Shew pers. comm. D
[a] No change in traffic volume nor truck percentage between the No Build and Build Alternatives or between the Build Alternatives (Shew pers. comm. D).
[b] Trucks represent 2% of AADT on Aerojet Road/U.S. 50 Off-Ramp (Shew pers. comm. D).

Intersections in the study area that are potentially affected by the proposed project were analyzed in the Draft Traffic Operations Report prepared by DKS Associates (2016). A summary of intersection operations under opening year (2022) Build and No-Build conditions are shown in Table A-1 in Attachment A. Trucks comprise approximately 6% of AADT on U.S. 50 in the project area and 2% of local traffic at the study intersections (Shew pers. comm. D).

Only if Facility is an Interchange or Intersection: MTP Horizon Year / Design Year *Build and No Build cross-street AADT, % and # trucks, truck AADT)*:

Table 3 summarizes AADT and truck volumes on U.S. 50, while Table 4 summarizes AADT and truck volumes on the Aerojet Road/U.S. 50 off ramp, for the Build and No-Build alternatives for design (2042) year. The design year was selected to provide a 20-year life based on Caltrans guidelines. As noted above, traffic volumes, speeds, and other operational conditions under the alternatives are identical (Shew pers. comm. A) Accordingly, the AADT volumes shown in Tables 3 and 4 are based on a single set of traffic conditions, which is representative of both Build Alternatives

Table 3: Mainline U.S. 50 Design Year (2042) Build and No Build AADT and Truck Volumes

AADT			Truck Volume[a]		
Build	No Build	Change[b]	Build	No Build	Change[b]
209,940	208,250	1,690 (1%)	12,596	12,495	101 (1%)

Source: Shew pers. comm. B
[a] Trucks represent 6% of AADT on U.S. 50 in the project area (Shew pers. comm. C)
[b] Represents the change in traffic volume under the Build Alternatives, relative to No Build conditions.

Table 4: Aerojet Road/U.S. 50 Off-Ramp Design Year (2042) AADT and Truck Volumes[a]

AADT	Truck %[b]	Truck Volume
4,200	2%	84

Source: Shew pers. comm. D
[a] No change in traffic volume nor truck percentage between the No Build and Build Alternatives or between the Build Alternatives (Shew pers. comm. D).
[b] Trucks represent 2% of AADT on Aerojet Road/U.S. 50 Off-Ramp (Shew pers. comm. D).

Intersections in the study area that are potentially affected by the proposed project were analyzed in the Draft Traffic Operations Report prepared by DKS Associates (2016). A summary of intersection operations under design year (2042) Build and No-Build conditions are shown in Tables A-2 in Attachment A. Trucks comprise approximately 6% of AADT on U.S. 50 in the project area and 2% of local traffic at the study intersections (Shew pers. comm. D).

Describe potential traffic redistribution effects of congestion relief *(impact on other facilities):* Implementation of the Build Alternatives would redistribute traffic from Folsom Boulevard to the U.S. 50 corridor, relieving congestion on the local roadway network. Under No Build conditions, a portion of drivers bound for Aerojet Drive exit the interchange at Hazel Avenue and turn left onto Folsom Boulevard. This is due to heavy congestion on U.S. 50 between Hazel Avenue and the existing Aerojet Drive off-ramp. The reconstructed Aerojet off-ramp would allow drivers to continue to exit before Hazel Avenue, but would bypass the Hazel Avenue & U.S. 50 off-ramp intersection, reducing congestion and enhancing interchange operations. Implementation of the Build Alternatives is expected to increase truck traffic on U.S. 50 as truck traffic is redistributed from Folsom Boulevard onto U.S. 50. The redistribution of truck traffic onto U.S. 50 from Folsom Boulevard could result in improvements to diesel exhaust emissions, as diesel emissions are likely currently higher on Folsom due to greater congestion and queuing on Folsom relative to U.S. 50. Overall traffic volumes and congestion on Folsom Boulevard between Hazel Avenue and Aerojet Drive would likewise decrease (DKS Associates 2016).

The Build Alternatives would also address southbound queues on Hazel Avenue. Under No Build conditions, queues along southbound Hazel Avenue at the westbound off-ramp extend past the upstream intersection with Gold Country Boulevard. This is due to the heavy commute traffic using Hazel Avenue to access U.S. 50. Queuing is expected to be a major problem at the Folsom Boulevard/ Hazel Avenue intersection under the No Build condition, due to the short distance between the off-ramp and Folsom Boulevard. The grade separation of Hazel Avenue over Folsom Boulevard, together with the construction of the Jug Handle, eliminates the excessive queues at this location (DKS Associates 2016).

The freeway operations and ramp queuing analyses under design (2042) year conditions are provided in Tables A-3 and A-4, respectively, in Attachment A. As shown, the Build Alternatives reduce peak hour densities along several freeway segments, and dramatically increase vehicle storage on the Hazel Avenue and Aerojet Drive off-ramps.

Comments/Explanations/Details *(attach additional sheets as necessary):*
EPA's 2006 final transportation conformity rule (40 CFR 51.390 and Part 93) that addresses local air quality impacts in PM10 and PM2.5 nonattainment and maintenance areas specifies in 40 CFR93.123(b)(1) that only "projects of air quality concern" are required to undergo a PM2.5 or PM10 hotspot analysis. EPA defines projects of air quality concern as certain highway and transit projects that involve significant levels of diesel vehicle traffic, or any other project that is identified by thePM10/PM2.5 SIP as a localized concern. A list of projects of air quality concern, as defined by 40 CFR93.123(b)(1), is provided below

1. New highway projects that have a significant number of diesel vehicles, and expanded highway projects that have a significant increase in the number of diesel vehicles.
2. Projects affecting intersections that are at level –of –service (LOS) D, E, or F with a significant number of diesel vehicles or those that will change to LOS D, E, or F because of increased traffic volumes from a significant number of diesel vehicles related to the project.
3. New bus and rail terminals and transfer points that have a significant number of diesel vehicles congregating at a single location.
4. Expanded bus and rail terminals and transfer points that significantly increase the number of diesel vehicles congregating at a single location.
5. Projects in or affecting locations, areas, or categories of sites that are identified in the $PM_{2.5}$- or PM_{10}-applicable implementation plan or implementation plan submission, as appropriate, as sites of violation or possible violation.

The proposed project is not considered a project of air quality concern for PM10 and/or PM2.5 (POAQC) because it does not meet the definition of a POAQC as defined in EPA's Transportation Conformity Guidance.

1. **New highway projects that have a significant number of diesel vehicles, and expanded highway projects that have a significant increase in the number of diesel vehicles.**

   The proposed project would construct improvements on an existing freeway interchange. For existing freeway facilities, the effect of a project on truck volumes is normally the main point on which this criterion is judged. A project may be located on a freeway with a substantial number of trucks, but if it does not change those truck volumes significantly, it may have a minimal effect on exhaust-related particulate matter. As shown in Table 2, the proposed project would increase design (2042) year truck volumes on U.S. 50 by approximately one percent, relative to No Build conditions. This increase is predominately a result of redistributed traffic from Folsom Boulevard. As described above, the Build Alternatives would reconstruct the Aerojet off-ramp at Hazel Avenue, providing direct and efficient access to Aerojet Drive from U.S. 50. Drivers seeking to bypass congestion on U.S. 50 between Hazel Avenue and the existing Aerojet off-ramp would no longer exit at Hazel Avenue and travel along Folsom Boulevard before reaching Aerojet Drive. Virtually all of the

AADT increase on U.S. 50 is therefore accounted for in an AADT decrease on Folsom Boulevard (Shew pers. comm. D).

The reconstructed Aerojet off-ramp would run parallel to U.S. 50, approximately 600 feet north of Folsom Boulevard. As shown in Figure 1, the Twilight RV & Mobile Home Park and Oak Brook Apartments are located between Folsom Boulevard and the reconstructed Aerojet off-ramp. Since the AADT increase on U.S. 50 is largely attributed to a corresponding AADT decrease on Folsom Boulevard, these receptors would be exposed to particulate matter emissions from the redistributed traffic under both Build and No Build conditions. However, particulate matter concentrations at these receptors locations may actually be lower under the Build Alternatives due to prevailing wind patterns and reduced truck congestion and queuing along Folsom Boulevard as truck traffic is redistributed onto U.S. 50. Data from the Sacramento International Airport indicate that winds in the project area are predominately from the south (Sacramento Metropolitan Air Quality Management District 2014) (see Figure 2). Accordingly, emissions generated by traffic on Folsom Boulevard are located downwind of the existing receptors and the predominant wind direction would direct roadway exhaust emissions towards these sensitive receptors. The Build Alternatives would redistribute traffic and associated emissions from Folsom Boulevard (downwind of sensitive receptors) to the north to U.S. 50/Aerojet off-ramp, which is upwind of the receptors. As such, while traffic and truck volumes between U.S. 50 and Folsom Boulevard would remain similar under Build and No Build conditions, the effect of moving traffic upwind of the existing residential receptors would likely lower particulate matter concentrations as a result of the southerly winds in the project area.

2. **Projects affecting intersections that are at level –of –service (LOS) D, E, or F with a significant number of diesel vehicles or those that will change to LOS D, E, or F because of increased traffic volumes from a significant number of diesel vehicles related to the project.**
   Implementation of the project would relieve congestion on the local roadway network by redistributing traffic from the local roadways to the U.S. 50 corridor. The traffic analysis evaluated nine intersections under opening (2022) and design (2042) year conditions (see Tables A-1 and A-2 in Attachment A). The Build Alternatives would have no effect or result in improved LOS and reduced vehicle delay at all but two study intersections (Hazel Avenue/Gold Country Boulevard and Hazel Avenue/U.S. 50 WB Ramps under Opening Year conditions, and Hazel Avenue/Gold Country Boulevard and Folsom Boulevard/U.S. 50 WB Ramps under Design Year conditions). However, none of the study intersections have a significant number of trucks (2%), therefore, the Build Alternatives would not affect any intersections with a high number of diesel vehicles.

3. **New bus and rail terminals and transfer points that have a significant number of diesel vehicles congregating at a single location.**
   The project does not include new bus or rail terminals and transfer points.

4. **Expanded bus and rail terminals and transfer points that significantly increase the number of diesel vehicles congregating at a single location.**
   The project does not include expanded bus or rail terminals and transfer points.

5. **Projects in or affecting locations, areas, or categories of sites that are identified in the $PM_{2.5}$- or PM_{10}-applicable implementation plan or implementation plan submission, as appropriate, as sites of violation or possible violation.**
   Currently, there is no SIP for the federal PM2.5 standard. The project area is not identified as a site of possible violation in the PM10 maintenance plan.

References Cited:

DKS Associates. 2016. Traffic Operations Report for Hazel Avenue/Route 50. March.

Sacramento Metropolitan Air Quality Management District. 2014. AERMOD meteorological data files (International Airport). http://www.airquality.org/businesses/ceqa-land-use-planning/ceqa-guidance-tools. Accessed June 6, 2017.

Shew, Cameron. (A) Associate Transportation Engineer. DKS Associates, Sacramento, CA. March 9, 2016—email message to Laura Yoon regarding alternatives analysis for Hazel Ave.

Shew, Cameron. (B) Associate Transportation Engineer. DKS Associates, Sacramento, CA. March 11, 2016—email message to Laura Yoon regarding AADT for Hazel Ave.

Shew, Cameron. (C) Associate Transportation Engineer. DKS Associates, Sacramento, CA. February 2, 2016—email message to Laura Yoon regarding truck percentages for Hazel Ave.

Shew, Cameron. (D) Associate Transportation Engineer. DKS Associates, Sacramento, CA. March 17, 2016—email message to Laura Yoon regarding AADT and truck volumes on the Aerojet Off-Ramp.

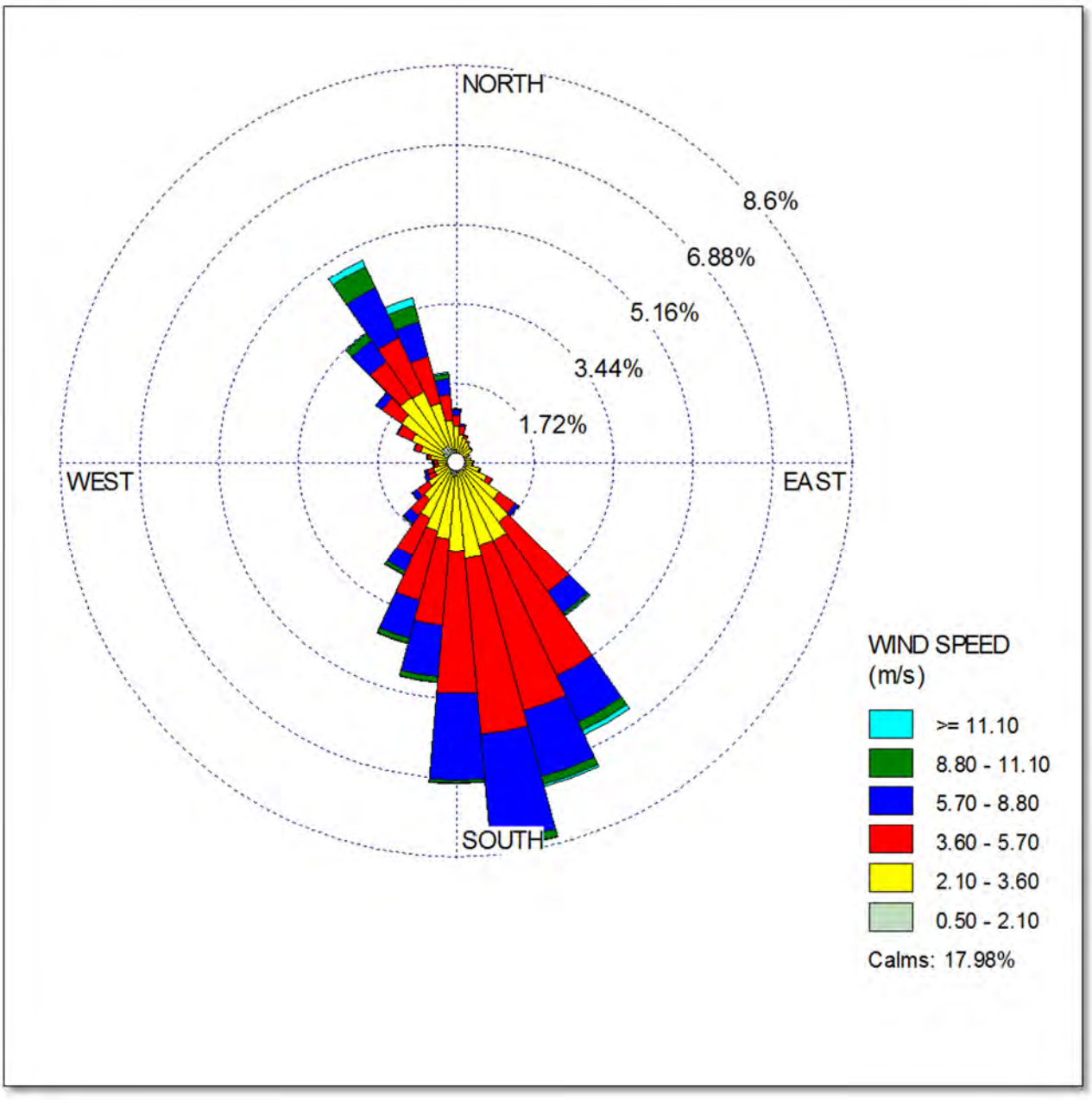
Figure 1


Legend
Alt 1
Sacramento State Aquatic Center
Single Family Homes
Cobble Oaks Apartments
Nimbus Dam Recreational Area
Oak Brook Apartments
Twilight RV & Mobile Home Park
American River Parkway
Hazel Ave
Old Eureka Rd
Gold Pointe Ln
Gold Bluff Ln
Gold Arbor Ct
Folsom South Canal
Tributary Point Dr
Tributary Ln
American River Bike Trail
50
Lincoln Hwy
Rocket Ct
Auto Mall Dr
Folsom Blvd
Marketplace Lane
Detroit St
Delaware St
Del Mar Ave
Nimbus Rd
Automall Pkwy
Arizona Ave
Birkmont Dr
Atlanta St
California Dr
Baltimore St
Florida Rd
Google earth
2000 ft
N

Figure 2

Wind Rose Plot – Sacramento International Airport

[Windspeed Direction (Blowing from)]



Source:

WRPlot View – Lakes Environmental Software

Meteorological data from Sacramento Metropolitan Air Quality Management District

Attachment A

Table A-1
Opening Year (2022) Intersection Operations Analysis

No.	Intersection	Opening Year (2022) No Build				Opening Year (2022) with Alt. 1/1A				Opening Year (2022) with Alt. 2			
		AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour	
		LOS	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS	Delay (s)
1	Hazel Ave & Gold Country Blvd	C	23.7	E	66.1	C	26.5	E	69.3	C	23.7	E	78.5
2	Hazel Ave & US 50 WB Ramps/ Tributary Point Dr	D	40.3	D	42.6	D	36.2	D	45.8	C	30.0	E	63.7
3	Hazel Ave & US 50 EB Ramps	D	43.1	**F**	**82.7**	B	14.4	C	23.4	Free movement			
4	Hazel Ave & Folsom Blvd	D	50.9	**F**	**120.8**	Does not exist				Does not exist			
5	Folsom Blvd & Aerojet Rd	**D**	**37.5**	**E**	**61.0**	**D**	**37.5**	**E**	**61.0**	**D**	**37.5**	**E**	**61.0**
6	Folsom Blvd & Auto Mall Cir (West)	**(F)**	**50.7**	**(E)**	**(46.9)**	**(F)**	**50.7**	**(E)**	**(46.9)**	**(F)**	**50.7**	**(E)**	**(46.9)**
7	Folsom Blvd & Birkmont Dr/Auto Mall Cir (East)	C	25.7	**F**	**80.6**	C	25.7	**F**	**80.6**	C	25.7	**F**	**80.6**
8	Folsom Blvd & US 50 EB Ramps	C	24.1	B	18.0	C	24.1	B	18.0	C	24.1	B	18.0
9	Folsom Blvd & US 50 WB Ramps	**D**	**42.4**	**E**	**62.0**	**D**	**42.4**	**E**	**62.0**	**D**	**42.4**	**E**	**62.0**
10	Hazel Ave & Jug Handle	Does not exist				E	64.1	C	26.8	E	64.1	C	26.7
11	Folsom Blvd & Jug Handle	Does not exist				C	26.1	D	44.3	C	26.1	D	44.3

Note: **Bold** values indicate unacceptable level of service.
For intersections shared between Sacramento County (LOS "E" policy) and the City of Folsom (LOS "C" policy), Folsom's policy was used.
(X) (Y) indicates level of service shown for the highest delay stop-controlled approach.

Table A-2
Horizon Year (2042) Intersection Operations Analysis

No.	Intersection	Horizon Year (2042) No Build				Horizon Year (2042) with Alt. 1/1A				Horizon Year (2042) with Alt. 2			
		AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour	
		LOS	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS	Delay (s)
1	Hazel Ave & Gold Country Blvd	C	30.8	D	54.5	C	29.6	E	55.5	C	30.3	E	61.5
2	Hazel Ave & US 50 WB Ramps/ Tributary Point Dr	D	42.2	**F**	**86.6**	D	42.1	E	72.4	C	32.1	E	65.7
3	Hazel Ave & US 50 EB Ramps	E	78.2	**F**	**90.9**	C	27.1	D	36.6	Free movement			
4	Hazel Ave & Folsom Blvd	**F**	**84.3**	**F**	**316.8**	Does not exist				Does not exist			
5	Folsom Blvd & Aerojet Rd	B	10.5	B	15.8	B	10.5	B	15.8	B	10.5	B	15.8
6	Folsom Blvd & Auto Mall Cir (West)	**(D)**	**(33.4)**	**(F)**	**(280.8)**	**(D)**	**(33.4)**	**(F)**	**(280.8)**	**(D)**	**(33.4)**	**(F)**	**(280.8)**
7	Folsom Blvd & Birkmont Dr/Auto Mall Cir (East)	B	14.1	B	17.5	B	14.0	B	17.4	B	14.0	B	17.4
8	Folsom Blvd & US 50 EB Ramps	**D**	**43.1**	**D**	**40.2**	C	32.8	**D**	**39.4**	C	32.8	**D**	**39.4**
9	Folsom Blvd & US 50 WB Ramps	B	15.9	B	12.3	B	16.3	B	16.5	B	16.6	B	16.5
10	Hazel Ave & Jug Handle	Does not exist				D	37.2	E	71.9	C	32.8	E	68.0
11	Folsom Blvd & Jug Handle	Does not exist				B	12.5	E	61.6	B	12.5	E	61.6

Note: **Bold** values indicate unacceptable level of service.
For intersections shared between Sacramento County (LOS "E" policy) and the City of Folsom (LOS "C" policy), Folsom's policy was used.
(X) (Y) indicates level of service shown for the highest delay stop-controlled approach.

Table A-3A
Horizon Year (2042) Freeway Operations Analysis (US 50 Eastbound)

Horizon Year (2042) No Build						Horizon Year (2042) with Alternative 1/1A or Alternative 2					
Analysis Segment	Type	AM Peak Hour		PM Peak Hour		Analysis Segment	Type	AM Peak Hour		PM Peak Hour	
		LOS	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)			LOS	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)
Rancho Cordova Pkwy to Hazel Ave	Basic	**F**	**54.2**	**F**	**60.8**	Rancho Cordova Pkwy to Hazel Ave	Basic	**F**	**54.2**	**F**	**60.8**
Hazel Ave Exit	Two-Lane Diverge	**F**	**35.0**	**F**	**38.1**	Hazel Ave Exit	Two-Lane Diverge	**F**	**23.5**	**F**	**26.9**
SB Hazel Ave Loop Entrance	One-Lane Merge	D	34.1	D	33.0	SB Hazel Ave Loop Entrance	One-Lane Merge	D	32.1	D	31.4
NB Hazel Ave Slip Entrance	Weave	D	28.7	C	27.9	NB Hazel Ave Slip Entrance	Weave	C	26.2	C	26.2
Aerojet Exit						Folsom Blvd Exit					
Aerojet Rd to Folsom Blvd	Basic	E	35.7	E	35.5						
Folsom Blvd Exit	Two-Lane Diverge	**F**	**45.8**	**F**	**45.7**						
Folsom Blvd Entrance	One-Lane Merge	**F**	**41.4**	**F**	**44.4**	Folsom Blvd Entrance	One-Lane Merge	C	26.3	D	28.9
Folsom Blvd to Prairie City Rd	Basic	**F**	**56.2**	**F**	**67.7**	Folsom Blvd to Prairie City Rd	Basic	**F**	**56.2**	**F**	**67.7**

Note: **Bold** values indicate unacceptable level of service.

Table A-3B
Horizon Year (2042) Freeway Operations Analysis (US 50 Westbound)

Horizon Year (2042) No Build						Horizon Year (2042) with Alternative 1/1A or Alternative 2					
Analysis Segment	Type	AM Peak Hour		PM Peak Hour		Analysis Segment	Type	AM Peak Hour		PM Peak Hour	
		LOS	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)			LOS	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)
Prairie City Rd to Folsom Blvd	Basic	E	41.4	**F**	**51.8**	Prairie City Rd to Folsom Blvd	Basic	E	41.4	**F**	**51.8**
Folsom Blvd Exit	One-Lane Diverge	E	44.0	**F**	**48.0**	Folsom Blvd Exit	One-Lane Diverge	E	44.0	**F**	**48.0**
Folsom Blvd Entrance	One-Lane Merge	**F**	**42.7**	**F**	**46.0**	Folsom Blvd Entrance	One-Lane Merge	**F**	**42.7**	**F**	**46.0**
Folsom Blvd to Hazel Ave	Basic	D	30.1	D	33.8	Folsom Blvd to Hazel Ave	Basic	D	30.1	D	33.8
Hazel Ave Exit	Two-Lane Diverge	B	11.5	B	13.0	Hazel Ave Exit	Two-Lane Diverge	B	11.5	B	13.0
NB Hazel Ave Loop Entrance	One-Lane Merge	D	29.4	D	32.6	NB Hazel Ave Loop Entrance	One-Lane Merge	D	29.4	D	32.6
SB Hazel Ave Slip Entrance	One-Lane Merge	**F**	**35.7**	**F**	**39.8**	SB Hazel Ave Slip Entrance	One-Lane Merge	**F**	**35.7**	**F**	**39.8**
Hazel Ave to Rancho Cordova Pkwy	Basic	E	41.8	**F**	**52.3**	Hazel Ave to Rancho Cordova Pkwy	Basic	E	41.8	**F**	**52.3**

Note: **Bold** values indicate unacceptable level of service.

Table A-4
Horizon Year (2042) Ramp Queuing Analysis

Direction	Ramp Queue	Horizon Year (2042) No Build			Horizon Year (2042) with Alternative 1/1A			Horizon Year (2042) with Alternative 2		
		Storage Length (ft)	AM Queue (ft)	PM Queue (ft)	Storage Length (ft)	AM Queue (ft)	PM Queue (ft)	Storage Length (ft)	AM Queue (ft)	PM Queue (ft)
US 50 Eastbound	Off-Ramp to Hazel Ave	1,350	1,037	**1,753**	2,400	644	835	2,250	-	-
	Off-Ramp to Aerojet Rd	1,425	131	262	2,400	131	262	2,250	131	262
	Off-Ramp to Folsom Blvd	1,300	546	473	1,300	512	464	1,300	512	464
US 50 Westbound	Off-Ramp to Folsom Blvd	1,550	116	132	1,550	120	178	1,550	120	178
	Off-Ramp to Hazel Ave	2,030	606	577	2,030	669	603	2,030	450	1,195

Note: **Bold** values indicate queuing exceeding storage capacity.
Gray shaded cells highlight changes to storage capacity due to the project.
Queues shown represent the 95th percentile.

Lin, Sandy

From: Jose Luis Caceres <JCaceres@sacog.org>
Sent: Monday, July 10, 2017 8:30 AM
To: Hatcher, Shannon
Subject: FW: Not a POAQC: US 50/Hazel Interchange Project (SAC24255)

- José Luis Cáceres

From: Jose Luis Caceres
Sent: Monday, June 19, 2017 2:08 PM
To: ALETA KENNARD; alexander.fong@dot.ca.gov; AGreen@placer.ca.gov; Jose Luis Caceres; CAnderson@airquality.org; dave.johnston@edcgov.us; douglas.coleman@dot.ca.gov; Heather.Phillips@arb.ca.gov; Lee Jason (jason.lee@dot.ca.gov); jbarton@edctc.org; Ungvarsky.John@epa.gov; Joseph.Vaughn@dot.gov; oconnor.karina@epa.gov; lmcneel-caird@pctpa.net; mjones@ysaqmd.org; Wright Molly (mwright@airquality.org); pphilley@airquality.org; Renee DeVere-Oki; rodney.tavitas@dot.ca.gov; shalanda_christian@dot.ca.gov; sharon.tang@dot.ca.gov; Shengyi Gao; sspaethe@fraqmd.org; Yu-Shuo (YChang@placer.ca.gov)
Subject: Not a POAQC: US 50/Hazel Interchange Project (SAC24255)

All,

The Project Level Conformity Group has determined that Sacramento County's project, US 50/Hazel Interchange Project, is **NOT** a Project of Air Quality Concern (POAQC).

EPA and FHWA concurred on 6/19/2017.

Thank you everyone.

- José Luis Cáceres

From: Vaughn, Joseph (FHWA) [mailto:Joseph.Vaughn@dot.gov]
Sent: Monday, June 19, 2017 9:55 AM
To: Jose Luis Caceres; ALETA KENNARD; alexander.fong@dot.ca.gov; AGreen@placer.ca.gov; CAnderson@airquality.org; dave.johnston@edcgov.us; douglas.coleman@dot.ca.gov; Heather.Phillips@arb.ca.gov; Lee Jason (jason.lee@dot.ca.gov); jbarton@edctc.org; Ungvarsky.John@epa.gov; oconnor.karina@epa.gov; lmcneel-caird@pctpa.net; mjones@ysaqmd.org; Wright Molly (mwright@airquality.org); pphilley@airquality.org; Renee DeVere-Oki; rodney.tavitas@dot.ca.gov; shalanda_christian@dot.ca.gov; sharon.tang@dot.ca.gov; Shengyi Gao; sspaethe@fraqmd.org; Yu-Shuo (YChang@placer.ca.gov)
Cc: Hatcher, Shannon; Biner. Marianne; RAZOR@SacCounty.NET; raygania@saccounty.net
Subject: RE: POAQC: US 50/Hazel Interchange Project (SAC24255): Due 6/30

FHWA concurs that this is not a project of air quality concern.

Joseph Vaughn
Environmental Specialist
FHWA, CA Division
(916) 498-5346

From: Jose Luis Caceres [mailto:JCaceres@sacog.org]
Sent: Friday, June 16, 2017 9:02 AM
To: ALETA KENNARD <akennard@airquality.org>; alexander.fong@dot.ca.gov; AGreen@placer.ca.gov; Jose Luis Caceres <JCaceres@sacog.org>; CAnderson@airquality.org; dave.johnston@edcgov.us; douglas.coleman@dot.ca.gov; Heather.Phillips@arb.ca.gov; Lee Jason (jason.lee@dot.ca.gov) <jason.lee@dot.ca.gov>; jbarton@edctc.org; Ungvarsky.John@epa.gov; Vaughn, Joseph (FHWA) <Joseph.Vaughn@dot.gov>; oconnor.karina@epa.gov; lmcneel-caird@pctpa.net; mjones@ysaqmd.org; Wright Molly (mwright@airquality.org) <mwright@airquality.org>; pphilley@airquality.org; Renee DeVere-Oki <RDeVere-Oki@sacog.org>; rodney.tavitas@dot.ca.gov; shalanda_christian@dot.ca.gov; sharon.tang@dot.ca.gov; Shengyi Gao <SGao@sacog.org>; sspaethe@fraqmd.org; Yu-Shuo (YChang@placer.ca.gov) <YChang@placer.ca.gov>
Cc: Hatcher, Shannon <Shannon.Hatcher@icf.com>; Biner. Marianne <binerm@saccounty.net>; RAZOR@SacCounty.NET; raygania@saccounty.net
Subject: POAQC: US 50/Hazel Interchange Project (SAC24255): Due 6/30

Project Level Conformity Working Group:

Attached for interagency review is the Sacramento County's project, US 50/Hazel Interchange Project (CAL20728). As part of project level conformity under NEPA, it requires a determination of whether it is a project of air quality concern.

Please confirm that you concur that this is NOT a Project of Air Quality Concern (POAQC). Please email questions and comments **by 5 p.m., Friday, June 30th.**

This project falls under the 23 USC 327 (formerly 6005) federal process. As such, it requires written concurrence by EPA (Karina O'Conner) and FHWA (Joseph Vaughn). Please remember to use "reply all," to make comments to the group. Otherwise, you may also contact the sponsor directly:

Mr. Shannon Hatcher | Senior Air Quality and Climate Change Supervisor | 916.231.9528 direct
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- José Luis Cáceres

From: Hatcher, Shannon [mailto:Shannon.Hatcher@icf.com]
Sent: Friday, June 09, 2017 2:54 PM
To: Jose Luis Caceres
Subject: PLCG Review for US 50/Hazel Interchange Project

Hi José Luis,

On behalf of the Sacramento County, ICF is submitting the attached POAQC analysis for the US 50/Hazel Interchange Project. It is requested that the project be circulated among SACOG's Project Level Conformity Group and concurrence that the project is not a POAQC be obtained.

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Please let me know if you have any questions or would like revisions to the analysis prior to circulation.

Thank you,
Shannon Hatcher

Mr. Shannon Hatcher | Senior Air Quality and Climate Change Supervisor | 916.231.9528 direct
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Lin, Sandy

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Sent: Monday, June 19, 2017 9:45 AM
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Cc: Hatcher, Shannon; Biner. Marianne; RAZOR@SacCounty.NET; raygania@saccounty.net
Subject: RE: POAQC: US 50/Hazel Interchange Project (SAC24255): Due 6/30

EPA concurs that this is not a project of air quality concern.

Karina OConnor
EPA, Region 9
Air Planning Office (AIR-2)
(775) 434-8176
oconnor.karina@epa.gov

From: Jose Luis Caceres [mailto:JCaceres@sacog.org]
Sent: Friday, June 16, 2017 9:02 AM
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Appendix F Compliance with CFR 1502.22

This text based on Appendix C from the FHWA's *Interim Guidance on Air Toxic Analysis in NEPA Documents* (Federal Highway Administration 2016).

Sec. 1502.22 INCOMPETE OR UNAVAILABLE INFORMATION

When an agency is evaluating reasonably foreseeable significant adverse effects on the human environment in an environmental impact statement and there is incomplete or unavailable information, the agency shall always make clear that such information is lacking.

(a) If the incomplete information relevant to reasonably foreseeable significant adverse impacts is essential to a reasoned choice among alternatives and the overall costs of obtaining it are not exorbitant, the agency shall include the information in the environmental impact statement.

(b) If the information relevant to reasonably foreseeable significant adverse impacts cannot be obtained because the overall costs of obtaining it are exorbitant or the means to obtain it are not known, the agency shall include within the environmental impact statement:

1. a statement that such information is incomplete or unavailable;

2. a statement of the relevance of the incomplete or unavailable information to evaluating reasonably foreseeable significant adverse impacts on the human environment;

3. a summary of existing credible scientific evidence which is relevant to evaluating the reasonably foreseeable significant adverse impacts on the human environment; and

4. the agency's evaluation of such impacts based upon theoretical approaches or research methods generally accepted in the scientific community. For the purposes of this section, "reasonably foreseeable" includes impacts that have catastrophic consequences, even if their probability of occurrence is low, provided that the analysis of the impacts is supported by credible scientific evidence, is not based on pure conjecture, and is within the rule of reason.

(c) The amended regulation will be applicable to all environmental impact statements for which a Notice to Intent (40 CFR 1508.22) is published in the Federal Register on or after May 27, 1986. For environmental impact statements in progress, agencies may choose to comply with the requirements of either the original or amended regulation.

INCOMPLETE OR UNAVAILABLE INFORMATION FOR PROJECT-SPECIFIC MSAT HEALTH IMPACTS ANALYSIS

In FHWA's view, information is incomplete or unavailable to credibly predict the project-specific health impacts due to changes in MSAT emissions associated with a proposed set of highway alternatives. The outcome of such an assessment, adverse or not, would be influenced more by the uncertainty introduced into the process through assumption and speculation rather than any genuine insight into the actual health impacts directly attributable to MSAT exposure associated with a proposed action.

The U.S. Environmental Protection Agency (EPA) is responsible for protecting the public health and welfare from any known or anticipated effect of an air pollutant. They are the lead authority for administering the Clean Air Act and its amendments and have specific statutory obligations with respect to hazardous air pollutants and MSAT. The EPA is in the continual process of assessing human health effects, exposures, and risks posed by air pollutants. They maintain the Integrated Risk Information System (IRIS), which is "a compilation of electronic reports on specific substances found in the environment and their potential to cause human health effects" (EPA, https://www.epa.gov/iris/). Each report contains assessments of non-cancerous and cancerous effects for individual compounds and quantitative estimates of risk levels from lifetime oral and inhalation exposures with uncertainty spanning perhaps an order of magnitude.

Other organizations are also active in the research and analyses of the human health effects of MSAT, including the Health Effects Institute (HEI). A number of HEI studies are summarized in Appendix D of FHWA's Updated Interim Guidance on Mobile Source Air Toxic Analysis in NEPA Documents. Among the adverse health effects linked to MSAT compounds at high exposures are: cancer in humans in occupational settings; cancer in animals; and irritation to the respiratory tract, including the exacerbation of asthma. Less obvious is the adverse human health effects of MSAT compounds at current environmental concentrations (HEI Special Report 16, https://www.healtheffects.org/publication/mobile-source-air-toxics-critical-reviewliterature-exposure-and-health-effects) or in the future as vehicle emissions substantially decrease.

The methodologies for forecasting health impacts include emissions modeling; dispersion modeling; exposure modeling; and then final determination of health impacts – each step in the process building on the model predictions obtained in the previous step. All are encumbered by technical shortcomings or uncertain science that prevents a more complete differentiation of the MSAT health impacts among a set of project alternatives. These difficulties are magnified for lifetime (i.e., 70 year) assessments, particularly because unsupportable assumptions would have to be made regarding changes in travel patterns and vehicle technology (which affects emissions rates) over that time frame, since such information is unavailable.

It is particularly difficult to reliably forecast 70-year lifetime MSAT concentrations and exposure near roadways; to determine the portion of time that people are actually exposed at a specific location; and to establish the extent attributable to a proposed action, especially given that some of the information needed is unavailable.

There are considerable uncertainties associated with the existing estimates of toxicity of the various MSAT, because of factors such as low-dose extrapolation and translation of occupational exposure data to the general population, a concern expressed by HEI (Special Report 16, https://www.healtheffects.org/publication/mobile-source-air-toxicscritical-review-literature-exposure-and-health-effects). As a result, there is no national consensus on air dose-response values assumed to protect the public health and welfare for MSAT compounds, and in particular for diesel PM. The EPA states that with respect to diesel engine exhaust, "[t]he absence of adequate data to develop a sufficiently confident dose-response relationship from the epidemiologic studies has prevented the estimation of inhalation carcinogenic risk (https://www.epa.gov/iris)."

There is also the lack of a national consensus on an acceptable level of risk. The current context is the process used by the EPA as provided by the Clean Air Act to determine whether more stringent controls are required in order to provide an ample margin of safety to protect public health or to prevent an adverse environmental effect for industrial sources subject to the maximum achievable control technology standards, such as benzene emissions from refineries. The decision framework is a two-step process. The first step requires EPA to determine an "acceptable" level of risk due to emissions from a source, which is generally no greater than approximately 100 in a million. Additional factors are considered in the second step, the goal of which is to maximize the number of people with risks less than 1 in a million due to emissions from a source. The results of this statutory two-step process do not guarantee that cancer risks from exposure to air toxics are less than 1 in a million; in some cases, the residual risk determination could result in maximum individual cancer risks that are as high as approximately 100 in a million. In a June 2008 decision, the U.S. Court of Appeals for the District of Columbia Circuit upheld EPA's approach to addressing risk in its two step decision framework. Information is incomplete or unavailable to establish that even the largest of highway projects would result in levels of risk greater than deemed acceptable (https://www.cadc.uscourts.gov/internet/opinions.nsf/284E23FFE079CD5985257800005 0C9DA/$file/07-1053-1120274.pdf).

Because of the limitations in the methodologies for forecasting health impacts described, any predicted difference in health impacts between alternatives is likely to be much smaller than the uncertainties associated with predicting the impacts. Consequently, the results of such

assessments would not be useful to decision makers, who would need to weigh this information against project benefits, such as reducing traffic congestion, accident rates, and fatalities plus improved access for emergency response, that are better suited for quantitative analysis.

Due to the limitations cited, a discussion such as the example provided in this Appendix (reflecting any local and project-specific circumstances), should be included regarding incomplete or unavailable information in accordance with Council on Environmental Quality (CEQ) regulations [40 CFR 1502.22(b)]. The FHWA Headquarters and Resource Center staff, Victoria Martinez (787) 771-2524, James Gavin (202) 366-1473, and Michael Claggett (505) 820-2047, are available to provide guidance and technical assistance and support.

Hazel Avenue/U.S. Route 50 Interchange Project



Noise Study Report

Hazel Avenue/U.S. Route 50 Interchange Project

City of Rancho Cordova, Sacramento County

03-SAC-50/PM 15.1-17.5

Federal Project No.: EA 03-3E380/E-FIS 0300020439

January 2017

Caltrans
CALIFORNIA DEPARTMENT OF TRANSPORTATION

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Noise Study Report

Hazel Avenue/U.S. Route 50 Interchange Project

City of Rancho Cordova, Sacramento County

03-SAC-50/PM 15.1-17.5

Federal Project No.: EA 03-3E380/E-FIS 0300020439

January 2017

STATE OF CALIFORNIA
Department of Transportation
District 3

Prepared By: _____ Date: 2/1/17

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916-737-3000

Recommended for Approval By: _____ Date: 2/2/2017

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Approved By: _____ Date: 2/2/17

Julia Green, Chief
Environmental Management, S1 Branch
California Department of Transportation, District 3
916-274-0570

Summary

The County of Sacramento, in cooperation with California Department of Transportation (Caltrans) and the City of Rancho Cordova, is proposing the Hazel Avenue/U.S. Route 50 (US 50) Interchange Project (proposed project) to modify the existing interchange, and extend and grade-separate Hazel Avenue over Folsom Boulevard and the Sacramento Placerville Transportation Corridor Joint Powers Authority (SPTC-JPA) rail corridor. The primary purpose of the project is to reduce congestion, improve traffic operations, accommodate travel demand due to planned and approved developments, and improve safety of all modes of travel including bicycles and pedestrians. Caltrans is considering three build alternatives and a no-build alternative. Alternative 1 consists of a modified type L-9 interchange configuration. Alternative 1A is identical to Alternative 1 except that the eastbound off-ramp will split and introduce a direct tunnel ramp under Hazel Avenue to carry eastbound off-ramp traffic to Aerojet Road and Folsom Boulevard. Alternative 2 consists of a modified type L-9 interchange configuration, with a flyover ramp carrying vehicles travelling from eastbound US 50 to northbound Hazel Avenue over the freeway to join with the westbound off-ramp. Under the No Build Alternative, the interchange would retain the existing configuration, ramps, and lanes.

This report has been prepared to comply with Title 23, Part 772, of the Code of Federal Regulations, "*Procedures for Abatement of Highway Traffic Noise and Construction Noise*," and Caltrans noise analysis policy, as described in the *Traffic Noise Analysis Protocol for New Highway Construction, Reconstruction, and Retrofit Barrier Projects* (Protocol) (California Department of Transportation 2011).

As stated in the Protocol, noise abatement is considered only where frequent human use occurs and where a reduced noise level would be beneficial. In general, an area of frequent human use is an area where people are exposed to traffic noise for an extended period of time on a regular basis. Accordingly, an impact assessment focuses on locations with defined outdoor activity areas, such as residential backyards, common-use areas at multifamily residences, or active sporting areas.

Land uses in the project area consist of a mobile home park (Activity Category B), multi-family apartment buildings (Activity Category B), parks (Activity Category C), recreational use areas (Activity Category C), hotels (Activity Category E), and several commercial uses that include no apparent outdoor areas of frequent human use (Activity Category F).

The Federal Highway Administration (FHWA) Traffic Noise Prediction Model Version 2.5 was used in this analysis to evaluate traffic noise conditions for existing (2015) and design-year

(2042) conditions. Existing traffic noise levels, expressed in terms of the A-weighted equivalent sound level (dBA L_{eq}[h]), were found to range from 57 to 79 dBA L_{eq}(h) at modeled receiver locations. Predicted worst-case traffic noise levels range from 58 to 80 dBA L_{eq}(h) for design-year no-build conditions and 58 to 81 dBA L_{eq}(h) for design year build conditions under all 3 alternatives. The highest increase in noise levels is predicted to be 4 decibels (dB), which would not be considered a substantial increase in noise levels.

Traffic noise levels from the proposed project are predicted to approach or exceed the noise abatement criteria (NAC) for 41 Activity Category B land uses under Alternative 1, 47 Activity Category B land uses under Alternative 1A, and 49 Activity Category B land uses under Alternative 2. For all build alternatives, traffic noise levels would approach or exceed the noise abatement criteria at park uses (Activity Category C). Traffic noise impacts are therefore predicted to result at these locations under design year build conditions.

Pursuant to Caltrans and FHWA regulations and guidance, noise abatement must be considered for land uses affected by traffic noise. For noise-sensitive receptors where traffic noise levels were predicted to approach or exceed the noise abatement criteria, noise abatement in the form of barriers was considered. One noise barrier was evaluated to benefit Activity Category B land uses along the proposed Aerojet Drive offramp for each of the three build alternatives. All design options were found to be acoustically feasible and met the design goal of 7 dB of noise reduction for at least one receiver at 10 feet under Alternatives 1 and 1A, and at 12 feet under Alternative 2.

During construction of the proposed project, noise from construction activities would intermittently dominate the noise environment in the immediate area of construction. Conventional construction equipment is expected to generate maximum noise levels ranging from 80 to 90 dB at a distance of 50 feet. No adverse noise impacts from construction are anticipated because construction would be conducted in accordance with Caltrans' provisions in Section 14-8.02, "Noise Control," of the Caltrans Standard Specifications and applicable local noise standards.

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List of Abbreviated Terms

µPa	micro-Pascals
CAD	Computer Aided Design
Caltrans	California Department of Transportation
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
CNEL	Community Noise Equivalent Level
County	County of Sacramento
CPI	Construction Price Index
dB	decibels
dBA	A-weighted decibels
dBA L_{eq}[h]	A-weighted equivalent sound level
FHWA	Federal Highway Administration
HOT	high-occupancy toll
HOV	high-occupancy vehicle
Hz	Hertz
kHz	kilohertz
L_{dn}	Day-Night Level
L_{eq}	Equivalent Sound Level
L_{eq}[h]	1-hour A-weighted equivalent sound level
L_{max}	Maximum Sound Level
LOS	Level of Service
L_{xx}	Percentile-Exceeded Sound Level
MSE	Mechanically Stabilized Earth
MTP	Metropolitan Transportation Plan
NAC	noise abatement criteria
NEPA	National Environmental Policy Act
NSR	Noise Study Report
proposed project	Hazel Avenue/U.S. 50 Interchange Project
Protocol	Traffic Noise Analysis Protocol for New Highway Construction, Reconstruction, and Retrofit Barrier Projects

ROW	right-of-way
SACOG	Sacramento Area Council of Government's
SPL	sound pressure level
SPTC-JPA	Sacramento Placerville Transportation Corridor Joint Powers Authority
TeNS	Caltrans' Technical Noise Supplement
TNM 2.5	FHWA Traffic Noise Model Version 2.5
US 50	U.S. 50
UPRR	Union Pacific Railroad

Chapter 1 Introduction

The County of Sacramento, in cooperation with Caltrans and the City of Rancho Cordova, proposes to modify the existing Hazel Avenue/U.S. Route 50 (US 50) Interchange, and extend and grade-separate Hazel Avenue over Folsom Boulevard and the Sacramento Placerville Transportation Corridor Joint Powers Authority rail corridor.

The project is subject to state and federal environmental review requirements because the use of federal funds from the Federal Highway Administration (FHWA) is proposed. Accordingly, project documentation is being prepared in compliance with both the National Environmental Policy Act (NEPA) and the California Environmental Quality Act (CEQA). Caltrans is the lead agency under NEPA and the County of Sacramento (County) is the lead agency under CEQA.

The purpose of this Noise Study Report (NSR) is to evaluate noise impacts and abatement under the requirements of Title 23, Part 772, of the Code of Federal Regulations (CFR), "Procedures for Abatement of Highway Traffic Noise," related to construction and operation of the project. Specifically, 23 CFR 772 provides procedures for preparing operational and construction noise studies and evaluating noise abatement considered for federal and federal-aid highway projects. According to 23 CFR 772.3, all highway projects that are developed in conformance with this regulation are deemed to be in conformance with Federal Highway Administration (FHWA) noise standards.

Caltrans' *Traffic Noise Analysis Protocol for New Highway Construction, Reconstruction, and Retrofit Barrier Projects* (Protocol) provides Caltrans policy for implementing 23 CFR 772 in California (California Department of Transportation 2011). The Protocol outlines the requirements for preparing NSRs.

1.1 Introduction

The proposed project would extend Hazel Avenue south to a proposed intersection with the future Atlanta Street (a new roadway that will be constructed as part of the Easton Place development). The proposed project also includes:

- Construction of a portion of an eastbound transition auxiliary lane on US 50 from Hazel Avenue through the Folsom Boulevard Overcrossing, also known as the Natoma Overhead.
- Modification of the existing Aerojet Road off-ramp from US 50.
- Reconstruction of the westbound loop on-ramp.

- Reconstruction of the eastbound diagonal off-ramp, and both eastbound on-ramps.
- Eastbound on- and off-ramp auxiliary lanes, from west of the Hazel Avenue to the eastbound off-ramp, and from the loop on-ramp extending to the Folsom Boulevard interchange.
- Roadway improvements constructed along approximately 2,300 feet of Folsom Boulevard. Improvements include sidewalks, street lighting, and landscaping along the north side of Folsom Boulevard, and landscaping and lighting along the south.

The project is at the interchange of Hazel Avenue and US 50 in Sacramento County (Figure 1-1 and 1-2). The project area is bounded along Hazel Avenue by the Tributary Point/westbound off-ramp intersection to the north, and extends approximately 1,000 feet south of Folsom Boulevard to a future intersection within the proposed Easton Place development. The project limits along US 50 begin approximately 3,200 feet west of the existing Hazel Avenue Overcrossing, and extend 2,500 feet east of the Natoma Overhead. Improvements along Folsom Boulevard would extend from approximately 1,200 feet west of the Hazel Avenue intersection to a terminus 900 feet to the east.

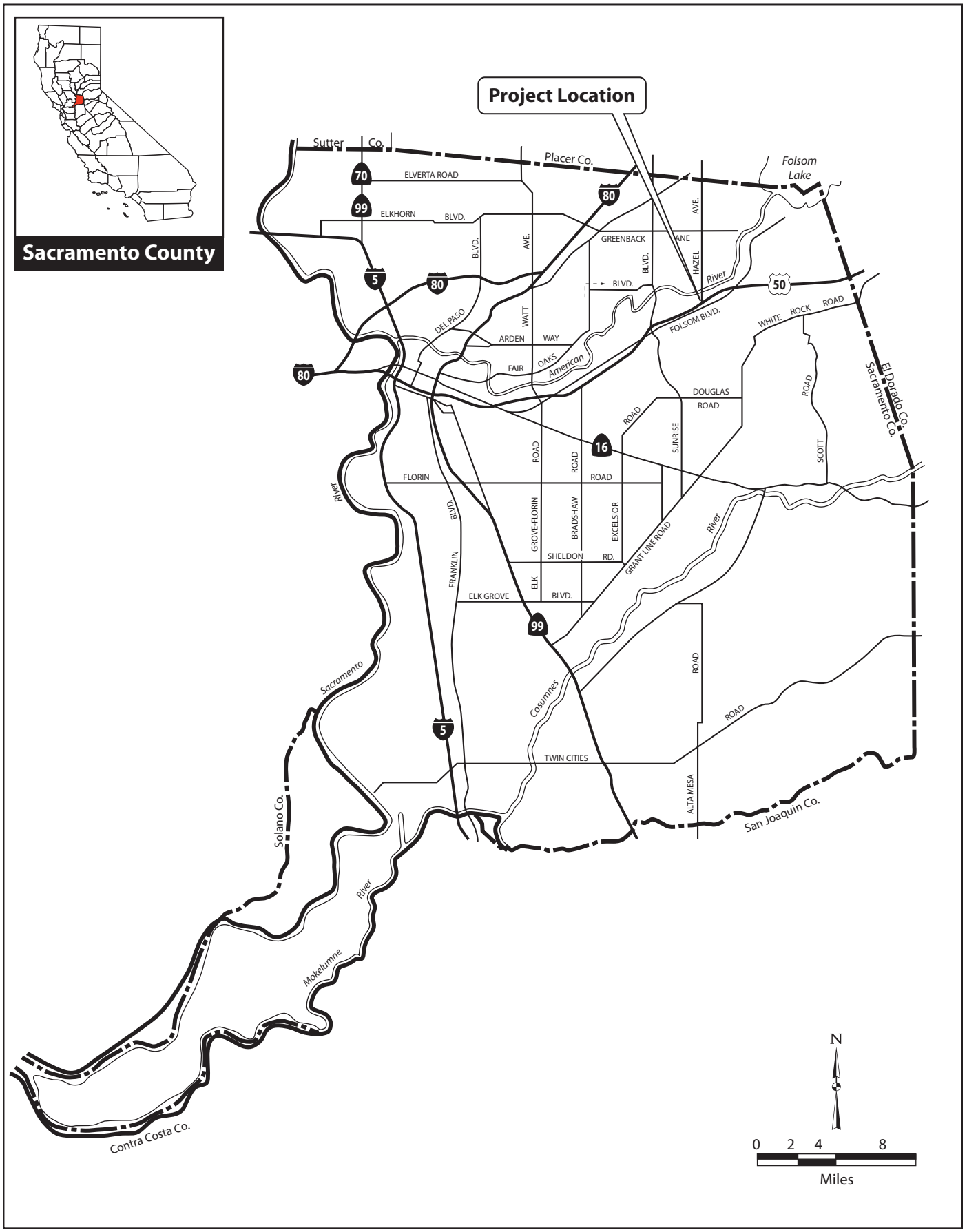
1.2 Purpose and Need

1.2.1 Need

The proposed project is needed to relieve congestion at the existing interchange and to accommodate planned and approved developments identified by the adopted Sacramento County General Plan and the Sacramento Area Council of Government's (SACOG's) Regional Transportation Plan.

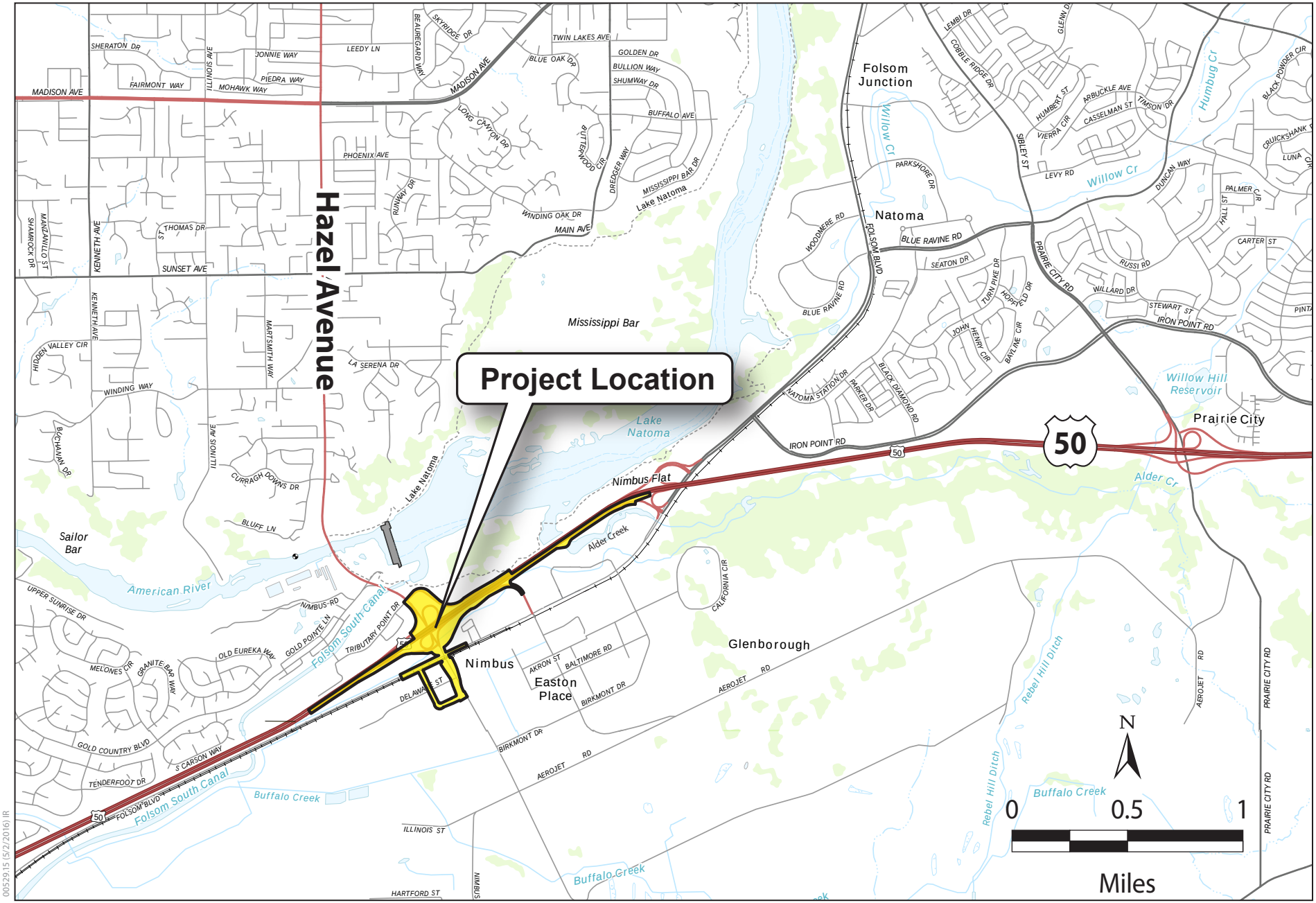
The approved developments within and near the project area will increase traffic demand beyond what the existing interchange can accommodate. The close spacing between the Folsom Boulevard intersection and the eastbound off-ramp intersection does not provide sufficient queuing for increased traffic volumes. Additionally, the County of Sacramento is currently widening Hazel Avenue from four to six traffic lanes between the existing interchange and Madison Avenue. This increase in roadway capacity is expected to deliver more traffic to the Hazel Avenue/US 50 interchange during peak traffic periods.

Traffic demand forecasts for the proposed project were conducted using the SACOG 2035 Metropolitan Transportation Plan (MTP) projected to 2038 (20 years after anticipated opening day) and supplemented by anticipated levels of additional development currently in application or advanced planning stages. Based on these projections, it is anticipated the existing interchange will degrade to Level of Service (LOS) "F".



00529.15 (05/02/2016) IR

Figure 1-1
Project Vicinity



00529.15 (5/2/2016) IR

Figure 1-2
Project Location

1.2.2 Purpose

The primary purpose of the proposed project is to modify the existing interchange to reduce congestion, improve traffic operations, accommodate travel demand due to planned and approved developments, and improve safety of all modes of travel, including bicycles and pedestrians.

The build alternatives for the proposed project would meet the following objectives.

- Improve operations by removing the close intersection spacing between the eastbound ramps and Folsom Boulevard, and minimizing conflict with heavy and light rail.
- Provide sufficient capacity in the ramps and roadways for future traffic volumes.
- Maintain the Aerojet Road off-ramp connection to the approved development while improving the mainline operations.

Chapter 2 Proposed Project

2.1 Proposed Project

The proposed project would construct modifications to the existing interchange, and grade-separate and extend Hazel Avenue to the south to a future intersection with Atlanta Street, which will be built with the approved Easton Place development. Three alternatives have been developed for the project.

The following is a description of elements and design components that are common to all alternatives.

Roadway Modifications

- Construction of a portion of an eastbound transition auxiliary lane on US 50 from Hazel Avenue through the Folsom Boulevard Overcrossing, also known as the Natoma Overhead.
- Modification of the existing Aerojet Road off-ramp from US 50.
- Reconstruction of the westbound loop on-ramp, with the ramp intersection shifted north towards the westbound off-ramp terminus, increasing storage lengths. The ramp would be metered with two lanes (one mixed use, and one high occupancy vehicle [HOV]) bypass), and a squared-up, pedestrian-friendly entrance.
- Reconstruction of the eastbound diagonal off-ramp to conform with the new Hazel Avenue profile and accommodate the Aerojet Road ramp divergence.
- Reconstruction of the eastbound diagonal on-ramp to conform with the new Hazel Avenue profile. The ramp would be metered with two lanes; one mixed flow, and one HOV bypass.
- Reconstruction of the eastbound loop on-ramp to conform with the new Hazel Avenue profile. The ramp would be metered with two lanes; one mixed flow, and one HOV bypass. A tie-back wall at the abutment of the overcrossing is proposed to maximize the opening through the structure. The loop ramp would develop an additional lane on US 50 that will continue on to the Folsom Boulevard interchange.
- Construction of eastbound on- and off-ramp auxiliary lanes on US 50, from west of the Hazel Avenue interchange to the eastbound off-ramp, and from the loop on-ramp extending to the Folsom Boulevard interchange.

- Modification of traffic signals and installation of safety lighting at the ramp intersections. A new signalized intersection and at-grade railroad crossing would be constructed for the jughandle.
- Maintenance of pedestrian access on the east side of Hazel Avenue with 6-feet sidewalks; however, the existing sidewalk on the overcrossing will remain 5 feet wide. Bicyclists may utilize the County standard 7-feet shoulders. It is expected that pedestrians and bicyclists would continue to use the nearby Bikeway and Pedestrian Overcrossing as the primary means for crossing US 50.
- Construction of roadway improvements along approximately 2,300 feet of Folsom Boulevard. Improvements include the removal of the existing signalized intersection with Hazel Avenue, and installation of sidewalks, street lighting, and landscaping along the north side of Folsom Boulevard, and landscaping and lighting along the south.

Transition Lane to Folsom Boulevard/US 50 Interchange

As indicated in Caltrans' 2009 Corridor System Management Plan, eastbound US 50 is shown to have one HOV lane and three mixed flow lanes to Hazel Avenue as the Concept Facility. Additionally, eastbound US 50 is shown to have one HOV lane and three mixed flow lanes across Folsom Boulevard as the Ultimate Facility. The proposed project would accommodate these future facility improvements; conform to the approved Caltrans improvements at the Folsom Boulevard/US 50 interchange, some of which will occur in 2016; and would restripe the third mixed flow lane through the Folsom Boulevard/US 50 interchange.

The proposed project is required to add the mixed flow lane because it has been determined in the traffic analysis for this project, and in studies for adjacent projects, that the additional eastbound lane on US 50 extending through the Folsom Boulevard interchange is needed for operations.

Under all proposed project alternatives, accommodating this mixed flow lane will require the eastbound loop on-ramp to extend its auxiliary lane to the Folsom Boulevard/US 50 eastbound off-ramp. This would require widening and a new structure over Alder Creek.

Alder Creek currently flows under US 50 through a box culvert (Br. No. 24-0033). A Mechanically Stabilized Earth (MSE) wall (Br. No. 24-0372) is above the culvert. A new bridge would be required to widen US 50 over Alder Creek. The new bridge is necessary because there is insufficient lateral space to construct an adjacent MSE wall on top of the culvert and because the creek maintains a high operating water level.

Railroad Overhead

Hazel Avenue would extend and be grade-separated over Folsom Boulevard and the SPTC-JPA rail corridor. There is currently one light rail track on the north side of the Union Pacific Railroad (UPRR) tracks. Sacramento Regional Transit plans to add another track at this location; when the addition occurs, the existing UPRR track will be relocated south to accommodate the second light rail track. The proposed project design meets the requirements for all three tracks, with the clearances shown in the figure below.

Temporary vertical clearances of 21 feet, 6 inches and permanent vertical clearances of 24 feet have been accounted for in the layout of all three alternatives for the Hazel Avenue Railroad Overhead. The vertical clearance provided would accommodate the Overhead Catenary System for the light rail.

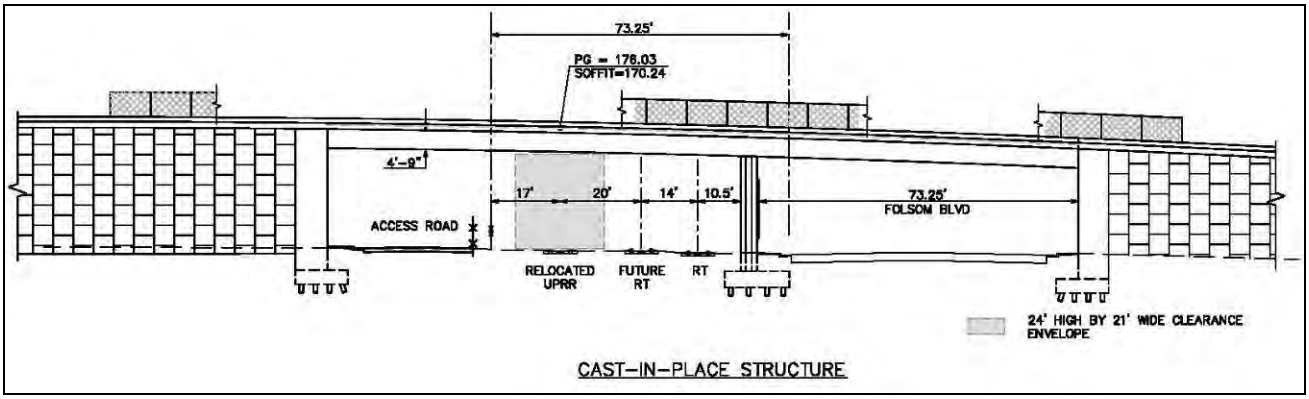


Figure 2-1. Cast-in-Place Structure

2.2 Alternative 1: L-9 Interchange with Viaduct Connector

Alternative 1 consists of a modified type L-9 interchange configuration. A Caltrans Type L-9 interchange indicates a ramp configuration that includes a diagonal off-ramp, a diagonal on-ramp and a loop on-ramp. This alternative would provide a viaduct connection to Aerojet Road.

As with all alternatives, Hazel Avenue would grade-separate over Folsom Boulevard and the SPTC-JPA rail corridor and would extend south to a proposed intersection with the future Atlanta Street. The existing at-grade intersection of Hazel Avenue and Folsom Boulevard would be removed, sidewalks would be extended across the former intersection, and the lanes would be restriped to remove left-turn lanes.

The location of the departure point of the existing Aerojet Road off-ramp from US 50 would be moved to join with the eastbound Hazel Avenue off-ramp. The eastbound Hazel Avenue off-ramp would split and introduce a direct viaduct ramp over Hazel Avenue to carry eastbound off-

ramp traffic to Aerojet Road and Folsom Boulevard. The US 50 off-ramp would shift approximately 830 feet to the east to provide decision sight distance before the Aerojet Road split. The two-lane off-ramp would widen to five lanes at the ramp terminal intersection, with three left-turn lanes and two right-turn lanes. Retaining walls and barriers placed at the proposed right-of-way (ROW) would minimize acquisition. The eastbound off-ramp would also have an auxiliary lane prior to the exit.

The Aerojet Road viaduct would land adjacent to the eastbound diagonal on-ramp and then turn southerly to conform to Folsom Boulevard along its existing alignment. Retaining walls are proposed between the viaduct and the diagonal on-ramp to accommodate the grade difference, and to the outside of the ramp after the viaduct lands, to minimize ROW acquisitions. Retaining walls are also proposed along Aerojet Road as it approaches the horizontal curve towards Folsom Boulevard to accommodate the grade difference between the ramp and mainline and to minimize ROW acquisition.

The existing Hazel Avenue Overcrossing of US 50 would be widened on the west side to accommodate eight lanes (three through lanes and one freeway-only lane in both directions). The existing raised concrete median across the structure would be removed, and the roadway would be restriped with a 6-feet striped median. The existing sidewalk and barrier on the east side of the structure would remain.

2.3 Alternative 1A: L-9 Interchange with Undercrossing Connector

Alternative 1A is the same as Alternative 1, with the following exceptions:

- The eastbound US 50 off-ramp would split and introduce a direct tunnel ramp under Hazel Avenue to carry eastbound off-ramp traffic to Aerojet Road and Folsom Boulevard (Figure 2-3).

2.4 Alternative 2: Direct Flyover to Hazel Avenue With Connector

Alternative 2 consists of a modified type L-9 interchange configuration, with a flyover ramp carrying vehicles travelling from eastbound US 50 to northbound Hazel Avenue over the freeway to join with the westbound US 50 off-ramp (Figure 2-4).

The existing Aerojet Road off-ramp from US 50 would be removed.

The eastbound off-ramp divergence point from US 50 would be shifted approximately 680 feet to the east to provide decision sight distance. An auxiliary lane would precede the off-ramp. A retaining wall is proposed adjacent to the off-ramp to minimize ROW acquisition.



Figure 2-2
Alternative 1: L-9 Interchange with Viaduct Connector
Hazel Avenue/U.S. 50 Interchange Project



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Figure 2-3
Alternative 1a: L-9 Interchange with Undercrossing Connector
Hazel Avenue/U.S. 50 Interchange Project



Figure 2-4
Alternative 2: Direct Flyover to Hazel Avenue with Connector
Hazel Avenue/U.S. 50 Interchange Project

The eastbound off-ramp would split and introduce northbound and southbound Hazel Avenue ramps. The northbound ramp would also carry traffic headed for Aerojet Road/Folsom Boulevard. An overhead sign would direct vehicles heading to southbound Hazel Avenue into the right lane and direct vehicles destined for northbound Hazel Avenue or Aerojet Road or Folsom Boulevard to use either lane. Retaining walls are proposed for the ramp as it approaches the horizontal curve towards Folsom Boulevard to accommodate the grade difference between the ramp and mainline and to minimize ROW acquisition at an apartment complex.

The northbound Hazel Avenue movement would cross under Hazel Avenue at the interchange, cross over US 50 on a two-lane flyover structure, and then merge with the westbound off-ramp and terminate at the Hazel Avenue/Tributary Point intersection. The westbound off-ramp would split so that the southbound and through movements align to the left of the ramp, and the northbound movements are to the right.

The southbound ramp would connect directly to Hazel Avenue; however, for Alternative 2 an intersection is not required at Hazel Avenue and the eastbound ramp. By eliminating an intersection at the eastbound ramp, and by removing the heavy eastbound-to-northbound movements from the Hazel Avenue overcrossing, the existing structure could remain without widening.

The two-lane westbound off-ramp would be reconstructed to provide decision sight distance between the divergence point from US 50 and a new ramp split that accommodates the flyover. The westbound off-ramp would split on either side of the flyover ramp, with one lane to the right carrying northbound Hazel Avenue traffic and the other crossing underneath the flyover ramp to join up on the left side of the flyover for the southbound Hazel Avenue movements. The profiles of the three ramps have been coordinated to match grade quickly in order to minimize retaining wall limits and enhance driver visibility. Overhead signage would direct drivers into the appropriate lanes for northbound and southbound Hazel Avenue traffic.

2.5 Right of Way and Utilities

For Alternative 1, ROW acquisition is anticipated from parcels in the southwest quadrant of the interchange. It is anticipated that 12 parcels would be affected by the improvements, including full acquisition and demolition of structures at the Chevron gas station (APN 069-0160-012) and Cattleman's restaurant (APN 069-0060-085). The viaduct structure is proposed to cross over the northern portion of the Nimbus Winery parking lot (APN 069-0050-013) on an aerial easement, to allow parking below the structure and minimize project effects on the business.

The ROW take at the Nimbus Winery property (APN 069-0050-013) would be larger in Alternative 1A because acquisition would be required instead of using an aerial easement.

For Alternative 2, ROW acquisition is anticipated from parcels in the southwest quadrant of the interchange. It is anticipated that 13 parcels would be affected by the improvements, including full acquisition and demolition of structures at the Chevron gas station (APN 069-0160-012), Cattleman's restaurant (APN 069-0060-085) and the Nimbus Winery property (APN 069-0050-013).

These acquisition needs described above are preliminary and would be finalized during the ROW acquisition process and Final Design of the project.

The proposed project would require the relocation of utilities for all build alternatives, and it is anticipated that this would include: gas lines, overhead electric lines, underground electric lines, fiber optic cables, water lines, sewer lines, and storm drain lines. There is also potential for project effects on other unknown utilities.

2.6 Alternative 3: No Build Alternative

Alternative 3, the No Build Alternative, would not modify the existing interchange and would retain the same existing configuration, ramps, and lanes. The No Build Alternative does not meet the purpose and need of the proposed project.

Chapter 3 Fundamentals of Traffic Noise

The following is a brief discussion of fundamental traffic noise concepts. For a detailed discussion, please refer to Caltrans' *Technical Noise Supplement* (TeNS) (California Department of Transportation 2013), a technical supplement to the Protocol.

3.1 Sound, Noise, and Acoustics

Sound can be described as the mechanical energy of a vibrating object transmitted by pressure waves through a liquid or gaseous medium (e.g., air) to a hearing organ, such as a human ear. Noise is defined as loud, unexpected, or annoying sound.

In the science of acoustics, the fundamental model consists of a sound (or noise) source, a receiver, and the propagation path between the two. The loudness of the noise source and obstructions or atmospheric factors affecting the propagation path to the receiver determine the sound level and characteristics of the noise perceived by the receiver. The field of acoustics deals primarily with the propagation and control of sound.

3.2 Frequency

Continuous sound can be described by frequency (pitch) and amplitude (loudness). A low-frequency sound is perceived as low in pitch. Frequency is expressed in terms of cycles per second, or Hertz (Hz) (e.g., a frequency of 250 cycles per second is referred to as 250 Hz). High frequencies are sometimes more conveniently expressed in kilohertz (kHz), or thousands of Hertz. The audible frequency range for humans is generally between 20 Hz and 20,000 Hz (20 kHz).

3.3 Sound Pressure Levels and Decibels

The amplitude of pressure waves generated by a sound source determines the loudness of that source. Sound pressure amplitude is measured in micro-Pascals (μPa). One μPa is approximately one hundred-billionth (0.00000000001) of normal atmospheric pressure. Sound pressure amplitudes for different kinds of noise environments can range from less than 100 μPa to 100,000,000 μPa. Because of this huge range of values, sound is rarely expressed in terms of μPa. Instead, a logarithmic scale is used to describe sound pressure level (SPL) in terms of decibels. The threshold of hearing for young people is roughly 0 dB, which corresponds to 20 μPa.

3.4 Addition of Decibels

Because decibels are logarithmic units, SPL cannot be added or subtracted through ordinary arithmetic. Under the decibel scale, a doubling of sound energy corresponds to a 3-dB increase. In other words, when two identical sources are each producing sound of the same loudness, the resulting sound level at a given distance would be 3 dB higher than one source under the same conditions. For example, if one automobile produces an SPL of 70 dB when it passes an observer, two cars passing simultaneously would not produce 140 dB—rather, they would combine to produce 73 dB. Under the decibel scale, three sources of equal loudness together produce a sound level 5 dB louder than one source.

3.5 A-Weighted Decibels

The decibel scale alone does not adequately characterize how humans perceive noise. The dominant frequencies of a sound have a substantial effect on the human response to that sound. Although the intensity (energy per unit area) of the sound is a purely physical quantity, the loudness or human response is determined by the characteristics of the human ear.

Human hearing is limited in the range of audible frequencies, as well as in the way it perceives the SPL in that range. In general, people are most sensitive to the frequency range of 1,000–8,000 Hz, and perceive sounds within that range better than sounds of the same amplitude in higher or lower frequencies. To approximate the response of the human ear, sound levels of individual frequency bands are weighted, depending on the human sensitivity to those frequencies. Then, an "A-weighted" sound level (expressed in units of dBA) can be computed based on this information.

The A-weighting network approximates the frequency response of the average young ear when listening to most ordinary sounds. When people make judgments of the relative loudness or annoyance of a sound, their judgments correlate well with the A-scale sound levels of those sounds. Other weighting networks have been devised to address high noise levels or other special problems (e.g., B-, C-, and D-scales), but these scales are rarely used in conjunction with highway-traffic noise. Noise levels for traffic noise reports are typically reported in terms of A-weighted decibels or dBA. Table 3-1 describes typical A-weighted noise levels for various noise sources.

Table 3-1. Typical A-Weighted Noise Levels

Common Outdoor Activities	Noise Level (dBA)	Common Indoor Activities
	—110—	Rock band
Jet fly-over at 1,000 feet		
	—100—	
Gas lawn mower at 3 feet		
	—90—	
Diesel truck at 50 feet at 50 miles per hour		Food blender at 3 feet
	—80—	Garbage disposal at 3 feet
Noisy urban area, daytime		
Gas lawn mower, 100 feet	—70—	Vacuum cleaner at 10 feet
Commercial area		Normal speech at 3 feet
Heavy traffic at 300 feet	—60—	
		Large business office
Quiet urban daytime	—50—	Dishwasher in the next room
Quiet urban nighttime	—40—	Theater, large conference room (background)
Quiet suburban nighttime		
	—30—	Library
Quiet rural nighttime		Bedroom at night, concert hall (background)
	—20—	
		Broadcast/recording studio
	—10—	
Lowest threshold of human hearing	—0—	Lowest threshold of human hearing

Source: California Department of Transportation 2013

3.6 Human Response to Changes in Noise Levels

As discussed above, doubling sound energy results in a 3-dB increase in sound. However, given a sound level change measured with precise instrumentation, the subjective human perception of a doubling of loudness will usually be different than what is measured.

Under controlled conditions in an acoustical laboratory, the trained, healthy human ear is able to discern 1-dB changes in sound levels when exposed to steady, single-frequency (“pure-tone”) signals in the midfrequency (1,000 Hz–8,000 Hz) range. In typical noisy environments, changes in noise of 1 to 2 dB are generally not perceptible. However, it is widely accepted that people are able to begin to detect sound level increases of 3 dB in typical noisy environments. Further, a 5-dB increase is generally perceived as a distinctly noticeable increase, and a 10-dB increase is generally perceived as a doubling of loudness. Therefore, a doubling of sound energy (e.g., doubling the volume of traffic on a highway) that would result in a 3-dB increase in sound, would generally be perceived as barely detectable.

3.7 Noise Descriptors

Noise in our daily environment fluctuates over time. Various noise descriptors have been developed to describe time-varying noise levels. The following are the noise descriptors most commonly used in traffic noise analysis.

- **Equivalent Sound Level (L_{eq}):** L_{eq} represents an average of the sound energy occurring over a specified period. In effect, L_{eq} is the steady-state sound level containing the same acoustical energy as the time-varying sound that actually occurs during the same period. The 1-hour A-weighted equivalent sound level ($L_{eq}[h]$) is the energy average of A-weighted sound levels occurring during a 1-hour period, and is the basis for NAC used by Caltrans and FHWA.
- **Percentile-Exceeded Sound Level (L_{xx}):** L_{xx} represents the sound level exceeded for a given percentage of a specified period (e.g., L_{10} is the sound level exceeded 10% of the time, and L_{90} is the sound level exceeded 90% of the time).
- **Maximum Sound Level (L_{max}):** L_{max} is the highest instantaneous sound level measured during a specified period.
- **Day-Night Level (L_{dn}):** L_{dn} is the energy average of A-weighted sound levels occurring over a 24-hour period, with a 10-dB penalty applied to A-weighted sound levels occurring during nighttime hours between 10:00 p.m. and 7:00 a.m.
- **Community Noise Equivalent Level (CNEL):** Similar to L_{dn}, CNEL is the energy average of the A-weighted sound levels occurring over a 24-hour period, with a 10-dB penalty applied to A-weighted sound levels occurring during the nighttime hours between 10:00 p.m. and 7:00 a.m., and a 5-dB penalty applied to the A-weighted sound levels occurring during evening hours between 7:00 p.m. and 10:00 p.m.

3.8 Sound Propagation

When sound propagates over a distance, it changes in level and frequency content. The manner in which noise reduces with distance depends on the following factors.

3.8.1 Geometric Spreading

Sound from a localized source (i.e., a point source) propagates uniformly outward in a spherical pattern. The sound level attenuates (or decreases) at a rate of 6 dB for each doubling of distance from a point source. Highways consist of several localized noise sources on a defined path, and therefore can be treated as a line source, which approximates the effect of several point sources. Noise from a line source propagates outward in a cylindrical pattern, often referred to as

cylindrical spreading. Sound levels attenuate at a rate of 3 dB for each doubling of distance from a line source.

3.8.2 Ground Absorption

The propagation path of noise from a highway to a receiver is usually very close to the ground. Noise attenuation from ground absorption and reflective-wave canceling adds to the attenuation associated with geometric spreading. Traditionally, the excess attenuation has also been expressed in terms of attenuation per doubling of distance. This approximation is usually sufficiently accurate for distances of less than 200 feet. For acoustically hard sites (i.e., sites with a reflective surface between the source and the receiver, such as a parking lot or body of water), no excess ground attenuation is assumed. For acoustically absorptive or soft sites (i.e., those sites with an absorptive ground surface between the source and the receiver, such as soft dirt, grass, or scattered bushes and trees), an excess ground-attenuation value of 1.5 dB per doubling of distance is normally assumed. When added to the cylindrical spreading, the excess ground attenuation results in an overall drop-off rate of 4.5 dB per doubling of distance.

3.8.3 Atmospheric Effects

Receptors located downwind from a source can be exposed to increased noise levels relative to calm conditions, whereas locations upwind can have lowered noise levels. Sound levels can be increased at large distances (e.g., more than 500 feet) from the highway due to atmospheric temperature inversion (i.e., increasing temperature with elevation). Other factors such as air temperature, humidity, and turbulence can also have significant effects.

3.8.4 Shielding by Natural or Human-Made Features

A large object or barrier in the path between a noise source and a receiver can substantially attenuate noise levels at the receiver. The amount of attenuation provided by shielding depends on the size of the object and the frequency content of the noise source. Natural terrain features (e.g., hills and dense woods) and human-made features (e.g., buildings and walls) can substantially reduce noise levels. Walls are often constructed between a source and a receiver specifically to reduce noise. A barrier that breaks the line of sight between a source and a receiver will typically result in at least 5 dB of noise reduction. Taller barriers provide increased noise reduction. Vegetation between the highway and receiver is rarely effective in reducing noise because it does not create a solid barrier.

Chapter 4 Federal Regulations and State Policies

This report focuses on the requirements of 23 CFR 772, discussed below.

4.1 Federal Regulations

4.1.1 23 CFR 772

23 CFR 772 provides procedures for preparing operational and construction noise studies and evaluating noise abatement considered for federal and federal-aid highway projects. Under 23 CFR 772.7, projects are categorized as Type I, Type II, or Type III projects.

FHWA defines a Type I project as a proposed federal or federal-aid highway project for the construction of a highway on a new location or the physical alteration of an existing highway which significantly changes either the horizontal or vertical alignment of the highway. The following projects are also considered to be Type I projects:

- The addition of a through-traffic lane(s). This includes the addition of a through-traffic lane that functions as a HOV lane, high-occupancy toll (HOT) lane, bus lane, or truck climbing lane.
- The addition of an auxiliary lane, except for when the auxiliary lane is a turn lane.
- The addition or relocation of interchange lanes or ramps added to a quadrant to complete an existing partial interchange.
- Restriping existing pavement for the purpose of adding a through traffic lane or an auxiliary lane.
- The addition of a new or substantial alteration of a weigh station, rest stop, ride-share lot, or toll plaza.

If a project is determined to be a Type I project under this definition, the entire project area as defined in the environmental document is a Type I project.

A Type II project is a noise barrier retrofit project that involves no changes to highway capacity or alignment. A Type III project is a project that does not meet the classifications of a Type I or Type II project. Type III projects do not require a noise analysis. The proposed project is considered to be a Type I project because the three build alternatives involve addition of through lanes, which are capacity-increasing improvements.

Under 23 CFR 772.11, noise abatement must be considered for Type I projects if the project is predicted to result in a traffic noise impact. In such cases, 23 CFR 772 requires that the project sponsor "consider" noise abatement before adoption of the final NEPA document. This process involves identification of noise abatement measures that are reasonable, feasible, and likely to be incorporated into the project, and of noise impacts for which no apparent solution is available.

Traffic noise impacts, as defined in 23 CFR 772.5, occur when the predicted noise level in the design-year approaches or exceeds the NAC specified in 23 CFR 772, or a predicted noise level substantially exceeds the existing noise level (a *substantial* noise increase). However, 23 CFR 772 does not specifically define the terms *substantial increase* or *approach*; these criteria are defined in the Protocol, as described below.

Table 4-1 summarizes NAC that correspond to various land use activity categories. Activity categories and related traffic noise impacts are determined based on the actual or permitted land use in a given area.

4.1.2 Traffic Noise Analysis Protocol for New Highway Construction and Reconstruction Projects

The Protocol specifies the policies, procedures, and practices to be used by agencies that sponsor new construction or reconstruction of federal or federal-aid highway projects. The Protocol defines a noise increase as *substantial* when the predicted noise levels with project implementation exceed existing noise levels by 12 dBA or more. The Protocol also states that a sound level is considered to *approach* an NAC level when the sound level is within 1 dB of the NAC identified in 23 CFR 772 (e.g., 66 dBA is considered to approach the NAC of 67 dBA, but 65 dBA is not).

The TeNS provides detailed technical guidance for the evaluation of highway traffic noise. This includes field measurement methods, noise modeling methods, and report preparation guidance.

Table 4-1. Activity Categories and Noise Abatement Criteria (23 CFR 772)

Activity Category	Activity $L_{eq}[h]$[1]	Evaluation Location	Description of Activities
A	57	Exterior	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B2	67	Exterior	Residential.
C2	67	Exterior	Active sport areas, amphitheaters, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreation areas, Section 4(f) sites, schools, television studios, trails, and trail crossings.
D	52	Interior	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios.
E	72	Exterior	Hotels, motels, offices, restaurants/bars, and other developed lands, properties, or activities not included in A–D or F.
F			Agriculture, airports, bus yards, emergency services, industrial, logging, maintenance facilities, manufacturing, mining, rail yards, retail facilities, shipyards, utilities (water resources, water treatment, electrical), and warehousing.
G			Undeveloped lands that are not permitted.

[1] The $L_{eq}(h)$ activity criteria values are for impact determination only and are not design standards for noise abatement measures. All values are A-weighted decibels (dBA).

[2] Includes undeveloped lands permitted for this activity category.

4.2 State Regulations and Policies

4.2.1 California Environmental Quality Act (CEQA)

Noise analysis under the California Environmental Quality Act (CEQA) may be required regardless of whether or not the project is a Type I project. The CEQA noise analysis is completely independent of the 23 CFR 772 analysis done for NEPA. Under CEQA, the baseline noise level is compared to the build noise level. The assessment entails looking at the setting of the noise impact and then how large or perceptible any noise increase would be in the given area. Key considerations include: the uniqueness of the setting, the sensitive nature of the noise receptors, the magnitude of the noise increase, the number of residences affected, and the absolute noise level.

The significance of noise impacts under CEQA are addressed in the environmental document rather than the NSR. Even though the NSR (or noise technical memorandum) does not specifically evaluate the significance of noise impacts under CEQA, it must contain the technical information that is needed to make that determination in the environmental document.

4.2.2 Section 216 of the California Streets and Highways Code

Section 216 of the California Streets and Highways Code relates to the noise effects of a proposed freeway project on public and private elementary and secondary schools. Under this code, a noise impact occurs if, as a result of a proposed freeway project, noise levels exceed 52 dBA $L_{eq}(h)$ in the interior of public or private elementary or secondary classrooms, libraries, multipurpose rooms, or spaces. This requirement does not replace the "approach or exceed" NAC criterion for FHWA Activity Category D for classroom interiors, but it is a requirement that must be addressed in addition to the requirements of 23 CFR 772.

If a project results in a noise impact under this code, noise abatement must be provided to reduce classroom noise to a level that is at or below 52 dBA $L_{eq}(h)$. If the noise levels generated from freeway and roadway sources exceed 52 dBA $L_{eq}(h)$ prior to the construction of the proposed freeway project, then noise abatement must be provided to reduce the noise to the level that existed prior to construction of the project.

Chapter 5 Study Methods and Procedures

5.1 Methods for Identifying Land Uses and Selecting Noise Measurement and Modeling Receiver Locations

ICF noise specialists conducted a field investigation during March 15–18, 2016, to identify land uses that could be subject to traffic and construction noise impacts from the proposed project. Land uses in the project area were categorized by land use type, by Activity Category as defined in Table 4-1, and by the extent of frequent human use. As stated in the Protocol, noise abatement is only considered for areas of frequent human use that would benefit from a lowered noise level. Although all developed land uses are evaluated in this analysis, the focus is on locations of frequent human use. Accordingly, this effect analysis focuses on locations with defined outdoor activity areas, such as residential backyards and common use areas at multi-family residences. The geometry of the proposed project relative to nearby existing and planned land uses was also identified.

Short-term measurement locations were selected to characterize the ambient noise environment at various locations near the proposed project build alternatives. Short-term measurement locations were also selected to be used as representative modeling locations.

5.2 Field Measurement Procedures

The field noise study was conducted in accordance with recommended procedures in TeNS. The following is a summary of the procedures that were used to collect short-term and long-term sound level data.

5.2.1 Short-Term Measurements

ICF noise specialists monitored short-term sound levels at five locations on Tuesday, March 15, 2016, using a Larson-Davis Model 831 Precision Type 1 sound level meter. The short-term measurement locations are identified in Figure 5-1. Short-term measurements were attended by field staff to count traffic and record observations concurrent with each measurement. The L_{eq} values calculated by the sound level meter during each measurement period (15 minutes in duration) were logged manually on field data sheets for each measurement location. Dominant noise sources observed and other relevant measurement conditions were identified and logged on field data sheets. The calibration of meters was checked before and after the measurement period, using a Larson-Davis Model CAL 200 calibrator.

Temperature, wind speed, and humidity were recorded manually during each short-term measurement period using a Kestrel 3000 portable weather station. During the short-term measurements, skies were clear and sunny, with wind speeds varying from 1 to 4 miles per hour, and temperatures ranging from 58°F to 71°F.

5.2.2 Long-Term Measurements

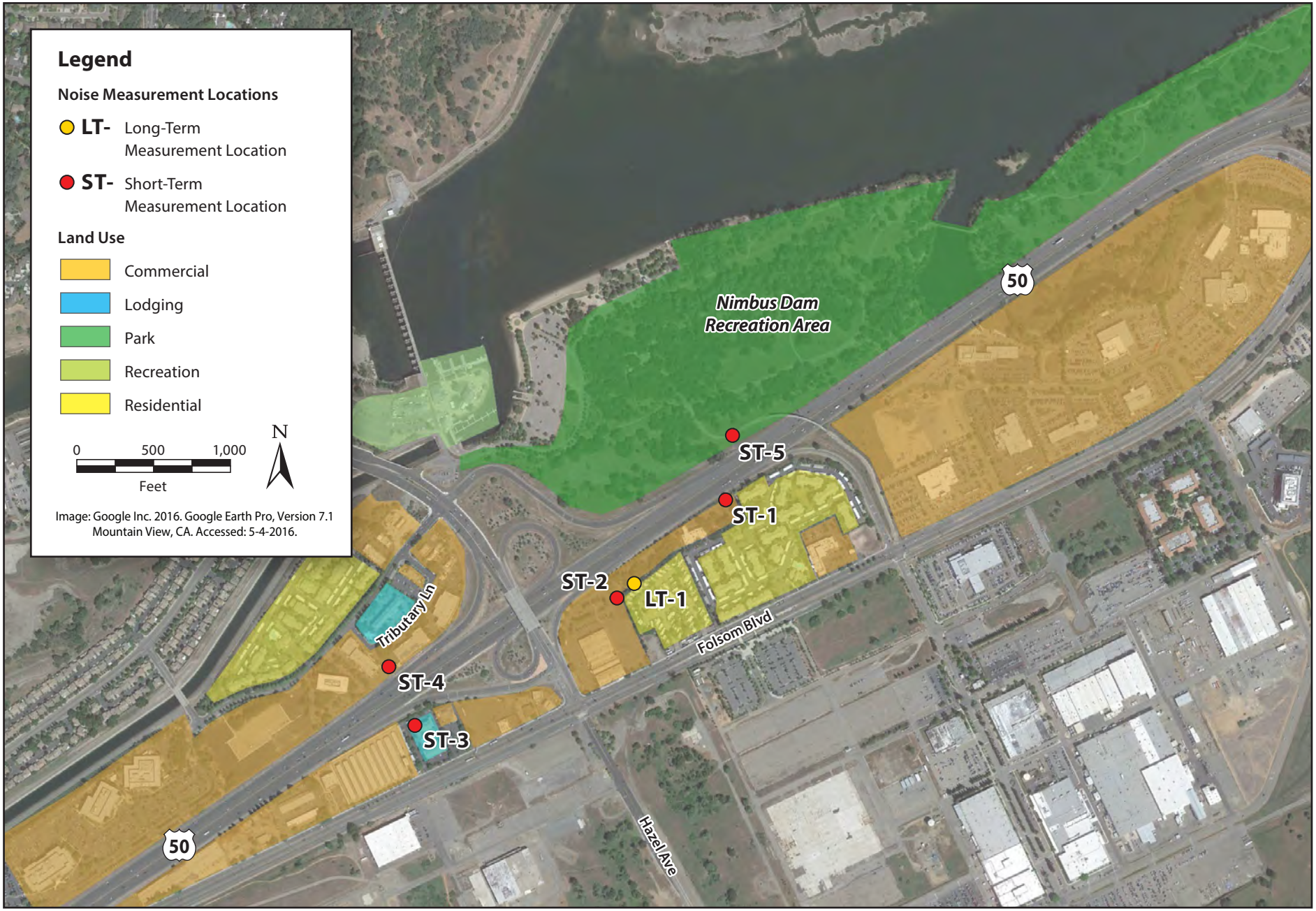
ICF noise specialists monitored long-term sound levels at one location in the project area (Figure 5-1) using a Piccolo Type 2 sound level meter. The purpose of the measurement was to quantify the daily trend in noise levels throughout a 24-hour period and identify the peak traffic noise hour or "loudest" hour. This measurement was used to describe variations in sound levels throughout the day, rather than absolute sound levels at a specific receptor of concern. The long-term sound level data were collected between Tuesday, March 15 and Friday, March 18, 2016. Field notes are included in Appendix D.

5.3 Traffic Noise Levels Prediction Methods

Traffic noise levels were predicted using the FHWA Traffic Noise Model Version 2.5 (TNM 2.5). TNM 2.5 is a computer model based on two FHWA reports: FHWA-PD-96-009 and FHWA-PD-96-010 (Federal Highway Administration 1998a, 1998b). Three-dimensional representations of roadways, shielding features (e.g., topography and buildings), noise barriers, ground type, and receivers were developed using Computer Aided Design (CAD) drawings, aerials, and topographic contours provided by Mark Thomas, Inc. and input into the traffic noise model.

Traffic noise was evaluated under existing conditions (year 2015), design-year (2042) no-project conditions, and design-year conditions under three build alternatives. Loudest-hour traffic volumes, vehicle classification percentages, and traffic speeds under existing and design-year were provided by DKS Associates for input into the traffic noise model (DKS Associates 2016). The highest average traffic volumes on US 50 are predicted to occur during AM hours; therefore AM peak hour traffic volumes were used in the model. Tables in Appendix A summarize traffic volumes used for modeling existing and design-year conditions. Because traffic noise is generally loudest when roads operate at maximum vehicle capacity and free-flow traffic conditions, a maximum volume of 1,900 vehicles per hour per lane traveling at the posted speed was used to characterize worst-hour noise conditions for the US 50 mainline.

To validate the accuracy of the model, TNM 2.5 was used to compare measured traffic noise levels to modeled noise levels at field measurement locations. For each receiver, traffic volumes counted during the short-term measurement periods were normalized to 1-hour volumes. These



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Figure 5-1
Noise Measurement Sites

normalized volumes were assigned to the corresponding project area roadways to simulate the noise source strength at the roadways during the actual measurement period. Modeled and measured sound levels were then compared to determine the accuracy of the model and re-calibrate if necessary.

5.4 Methods for Identifying Traffic Noise Impacts and Consideration of Abatement

Traffic noise impacts are considered to occur at receptor locations where predicted design-year noise levels are 12 dB or more greater than existing noise levels, or where predicted design-year noise levels approach or exceed the NAC for the applicable activity category. Where traffic noise impacts are identified, noise abatement must be considered for reasonableness and feasibility as required by 23 CFR 772 and the Protocol.

According to the Protocol, abatement measures are considered acoustically feasible if a minimum noise reduction of 5 dB at impacted receptor locations is predicted with implementation of the abatement measures. In addition, barriers should be designed to intercept the line-of-sight from the exhaust stack of a truck to the first tier of receptors, as required by the *Highway Design Manual*, Chapter 1100 (Caltrans 2015a). Other factors that affect feasibility include topography, access requirements for driveways and ramps, presence of local cross streets, utility conflicts, other noise sources in the area, and safety considerations.

The overall reasonableness of noise abatement is determined by the following three factors.

- The noise reduction design goal.
- The cost of noise abatement.
- The viewpoints of benefited receptors (including property owners and residents of the benefited receptors).

The Caltrans' acoustical design goal is that a barrier must be predicted to provide at least 7 dB of noise reduction at one benefited receptor. This design goal applies to any receptor and is not limited to impacted receptors.

The Protocol defines the procedure for assessing reasonableness of noise barriers from a cost perspective. Based on 2016 construction costs, an allowance of $80,000 is provided for each benefited receptor (i.e., receptors that receive at least 5 dB of noise reduction from a noise barrier). The total allowance for each barrier is calculated by multiplying the number of benefited receptors by $80,000. The allowance should be adjusted annually based on the published Caltrans Construction Price Index (CPI) and a base 2011 allowance of $55,000. If the

estimated construction cost of a barrier is less than the total calculated allowance for the barrier, the barrier is considered reasonable from a cost perspective. The viewpoints of benefits receptors are determined by a survey that is typically conducted after completion of the noise study report. The process for conducting the survey is described in detail in the Protocol.

The feasibility and reasonableness of noise abatement is reported in the Noise Abatement Decision Report.

Chapter 6 Existing Noise Environment

6.1 Existing Land Uses

The field investigation identified land uses that could be subject to traffic and construction noise impacts from the proposed project. As required by the Protocol, although all types of land use are evaluated in this analysis, noise abatement is only considered for areas of frequent human use that would benefit from a lowered noise level.

Land uses in the proposed project area consist of a mobile home park (Activity Category B), multi-family apartment buildings (Activity Category B), parks (Activity Category C), recreational use (Activity Category C), hotels (Activity Category E), and several commercial uses that include no apparent outdoor areas of frequent human use (Activity Category F).

6.2 Short-Term Measurement Results

The existing noise environment in the project area is characterized based on short-term noise monitoring that was conducted as described in Chapter 5. Table 6-1 summarizes the results of the short-term noise monitoring. Locations of short-term measurement sites are shown in Figure 5-1.

Table 6-1. Summary of Short-Term Measurements

Site	Location	Primary Source	Time	Duration of Measurement (minutes)	Measured L_{eq} (dBA)
M01	Oak Brook Apartment Homes, Aerojet Drive	U.S. 50	12:51 p.m.	15	73.0
M02	Twilight Mobile Park, Folsom Blvd.	U.S. 50	2:44 p.m.	15	68.9
M03	Comfort Inn & Suites, Folsom Blvd.	U.S. 50	10:43 a.m.	15	72.2
M04	Tributary Lane	U.S. 50	9:55 a.m.	15	67.1
M05	Nimbus Dam Recreation Area	U.S. 50	2:02 p.m.	15	71.4

6.3 Long-Term Measurement Results

The purpose of the long-term noise measurement was to determine the changes in noise levels within the project area throughout a typical day and to identify the worst noise hour. The data is presented for documentation purposes and is not used in the prediction analysis. Long-term sound level data was collected from Tuesday, March 15 to Friday, March 18, 2016.

Long-term monitoring site LT-1 (shown on Figure 5-1) was mounted on a tree just outside the northern fence at Twilight Mobile Park. There was a clear line of sight to US 50 at this location. The worst-hour noise level measured was 73.6 dBA L_{eq}(h) during the 7:00 a.m. hour. Hourly

noise levels and offsets between the worst-hour noise and each of the 24 hours of the measurement period are shown in Table 6-2.

Table 6-2. Summary of Long-Term Measurements at Location LT-1

Date	Time (hour beginning)	1-Hour Leq (dBA)	Difference from Worst-Hour Noise (dB)
March 17, 2016	0:00:00	63.2	-10.4
	1:00:00	61.1	-12.5
	2:00:00	60.4	-13.2
	3:00:00	63.2	-10.4
	4:00:00	67.2	-6.4
	5:00:00	71.0	-2.6
	6:00:00	72.8	-0.8
	7:00:00	**73.6**	0.0
	8:00:00	72.5	-1.1
	9:00:00	71.2	-2.4
	10:00:00	71.2	-2.4
	11:00:00	70.9	-2.7
	12:00:00	70.7	-2.9
	13:00:00	70.8	-2.8
	14:00:00	71.1	-2.5
	15:00:00	71.6	-2.0
	16:00:00	71.1	-2.5
	17:00:00	70.1	-3.5
	18:00:00	69.9	-3.7
	19:00:00	70.4	-3.2
	20:00:00	69.7	-3.9
	21:00:00	69.0	-4.6
	22:00:00	67.7	-5.9
	23:00:00	65.7	-7.9
Maximum		73.6	
Minimum		60.4	

Note: Worst-hour noise is shown in **bold**.

dBA Leq[h] = A-weighted equivalent sound level; dB = decibels

6.4 Noise Model Calibration

TNM 2.5 was used in this analysis to compare measured traffic noise levels to modeled noise levels at field measurement site locations. Traffic counts were conducted simultaneously with noise measurements and input into the model for calibration. Traffic volumes were classified into three vehicle types: (1) light-duty autos and trucks, (2) medium-duty trucks (typically trucks with two axles and more than four wheels), and (3) heavy-duty trucks (typically trucks with more than two axles).

For each receiver, traffic volumes counted during the short-term measurement periods were normalized to one-hour volumes. These normalized volumes were assigned to the corresponding project roadways to simulate the noise source strength of the roadways during the actual measurement period. Table 6-4 compares measured and modeled noise levels at each measurement position. In general, modeled sound level predictions using counted traffic are considered to be in reasonable agreement if they are within 3 dB of measured sound levels. Modeled sound levels for all five measurement locations were found to be in the range of minus-1 to plus-2 dB, which is in close agreement with measured sound levels, therefore, no adjustment factors were applied to the model.

The comparison between measured and predicted sound levels and associated calibration factors is shown in Table 6-4.

Table 6-4. Comparison of Measured to Predicted Sound Levels in the TNM Model

Site	Measured Sound Level (dBA)	Predicted Sound Level (dBA)	Predicted minus Measured (dB)	Adjustment Factor Applied to the TNM Model (dB)
M01	73.0	74.0	+ 1.0	0.0
M02	68.9	70.9	+ 2.0	0.0
M03	72.2	71.2	- 1.0	0.0
M04	67.1	69.4	+ 2.3	0.0
M05	71.4	73.5	+ 2.1	0.0

6.5 Existing Modeled Noise Levels

Predicted traffic noise levels under existing conditions are shown in predicted noise level tables in Appendix B. As shown in Table B-1, existing worst-hour traffic noise levels range from 57 to 79 dBA $L_{eq}(h)$ for all receivers. Existing worst-hour traffic noise levels at residential land uses, or Activity Category B land uses, range from 57 to 78 dBA $L_{eq}(h)$.

Chapter 7 Future Noise Environment, Impacts, and Considered Abatement

7.1 Future Noise Environment and Impacts

Results tables in Appendix B summarize the traffic noise modeling results for existing conditions and design-year conditions with and without the proposed project. Predicted design-year traffic noise levels with implementation of the proposed project are compared with existing conditions as well as design-year no-project conditions. The comparison with existing conditions is included in the analysis to identify traffic noise impacts under 23 CFR 772. The comparison with no-project conditions indicates the direct effect of the proposed project.

Predicted traffic noise levels under design-year conditions are shown in Table B-1 for Alternative 1, Table B-2 for Alternative 1A, and Table B-3 for Alternative 2. Predicted worst-case traffic noise levels for design-year no-build conditions range from 58 to 80 dBA $L_{eq}(h)$ for all land uses, with noise levels of up to 80 dBA at Activity Category B land uses (residential). Predicted worst-case traffic noise levels for design-year build conditions range from 58 to 81 dBA $L_{eq}(h)$ for all land uses, with noise levels of up to 80 dBA at Activity Category B land uses. Therefore, traffic noise levels are predicted to approach or exceed the NAC at Activity Category B land uses.

Traffic noise levels are predicted to approach or exceed the NAC for Activity Category B land use at 41 dwelling units under Alternative 1, 47 dwelling units under Alternative 1A, and 49 dwelling units under Alternative 2. Impacted units by land use activity category are shown in Table 7-1. Modeled receivers used in the noise analysis are shown in Figure 7-1.

Table 7-1. Impacted Units by Design Alternative

Roadway Segment	Alternative 1	Alternative 1A	Alternative 2
Activity Category B	41	47	49
Activity Category C	2	2	2
Activity Category E	0	0	0

Noise levels are predicted to approach or exceed the NAC of 67 dBA $L_{eq}(h)$ at two receptors modeled at Nimbus Dam Recreation Area (Activity Category C); therefore, traffic noise impacts are predicted to occur at these Activity Category C land uses. There are several commercial uses in the area which are considered Activity Category F land uses. However, these do not include outdoor areas of frequent human use, so there is no NAC associated with these receptors. Predicted traffic noise levels for Activity Category F locations are reported in Appendix B for informational purposes.

Traffic noise levels are predicted to increase at receptor locations by a maximum of 4 dB, across all design alternatives. This is less than the substantial increase threshold of 12 dB, so no impacts from substantial increase are predicted to occur under design-year build conditions.

Traffic noise impacts are predicted to occur at Activity Category B and Activity Category C land uses under all three build alternatives. Therefore, noise abatement must be considered.

7.2 Preliminary Noise Abatement Analysis

According to 23 CFR 772(13)(c), federal funding may be used for the following abatement measures.

- Construction of noise barriers, including acquisition of property rights, either within or outside the highway ROW. Landscaping is not a viable noise abatement measure.
- Traffic management measures including, but not limited to, traffic control devices and signage for prohibition of certain vehicle types, time-use restrictions for certain vehicle types, modified speed limits, and exclusive lane designations.
- Alteration of horizontal and vertical alignments.
- Acquisition of real property or interests therein (predominantly unimproved property) to serve as a buffer zone to preempt development that would be adversely affected by traffic noise.
- Noise insulation of Activity Category D land use facilities. Post-installation maintenance and operational costs for noise insulation are not eligible for federal-aid funding.

Among these options, noise barriers are the only feasible abatement measure for the proposed project. Each noise barrier was evaluated for feasibility based on achievable noise reduction. For each noise barrier found to be acoustically feasible, reasonable cost allowances were calculated. For any noise barrier to be considered reasonable from a cost perspective, the estimated cost of the noise barrier should be equal to or less than the total cost allowance calculated for the barrier. The cost calculations of the noise barrier should include all items appropriate and necessary for construction of the barrier, such as traffic control, drainage modification, and retaining walls.

The design of noise barriers presented in this report is preliminary and has been conducted at a level appropriate for environmental review and not for final design of the project. Preliminary information on the physical location, length, and height of noise barriers is provided in this report. If pertinent parameters change substantially during final project design, preliminary noise barrier designs may be modified or eliminated from the final project. A final decision on construction of the noise abatement will be made upon completion of the project design.

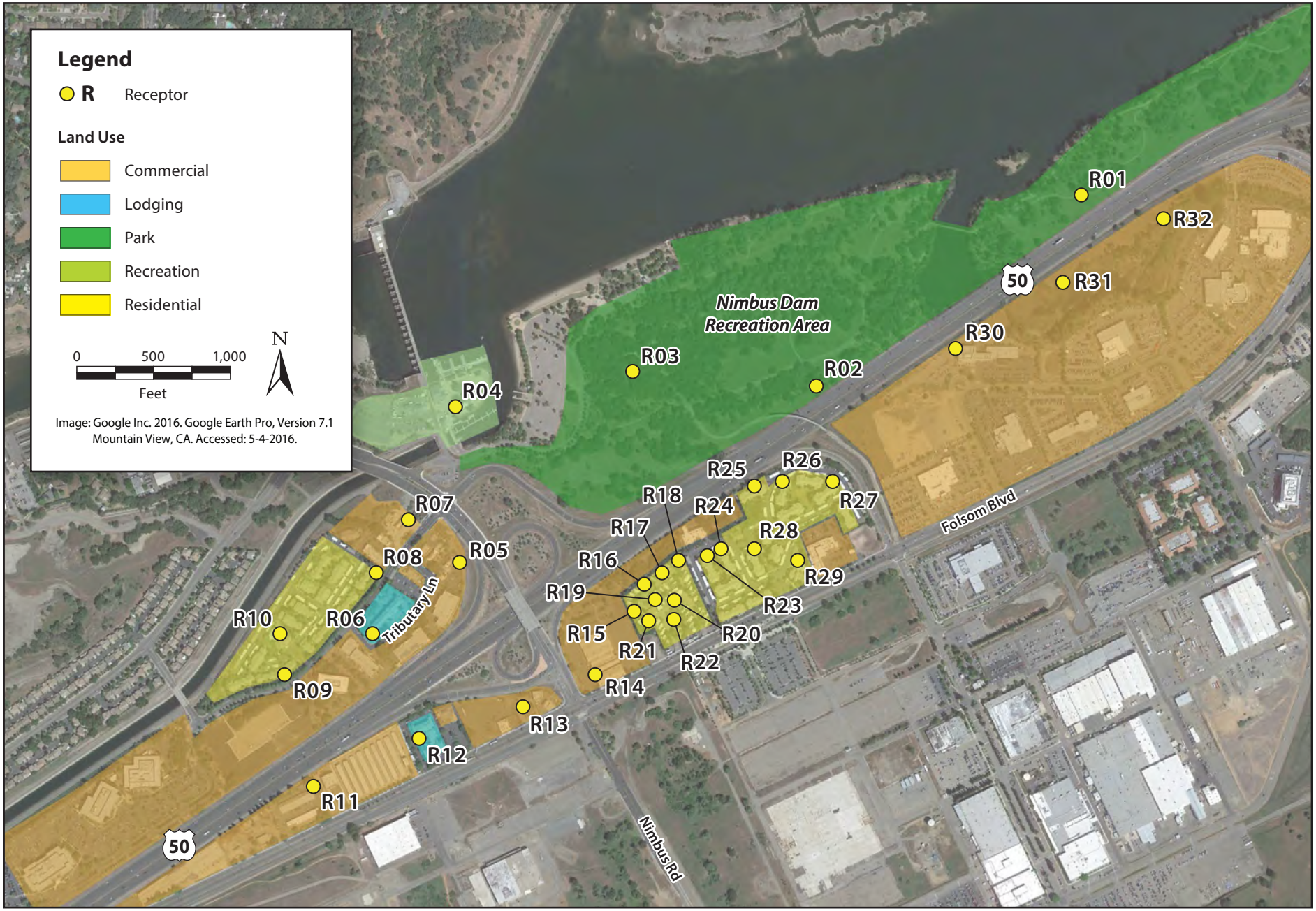


Figure 7-1
Noise Prediction Locations

The following is a discussion of noise barriers evaluated in TNM for each of the project alternatives. The noise barrier analysis summary tables are shown in Appendix C.

7.2.1 Nimbus Dam Recreation Area, all Alternatives

Traffic noise levels under all build alternatives are predicted to approach or exceed the NAC of 67 dBA Leq(h) for Activity Category C land uses along the frontage of the proposed Aerojet Drive offramp. The features of the park along US 50 frontage include segments of the American River bike trail and open space areas. Use of the trail is generally transitory, and the trail is not considered an area of frequent human use. There are no areas of frequent human use as defined in the Protocol within 500 feet of edge-of-pavement of US 50. Therefore, a noise barrier was not evaluated further.

7.2.2 Aerojet Drive Offramp Barrier, Alternative 1

Traffic noise levels are predicted to approach or exceed the NAC of 67 dBA Leq(h) for Activity Category B land uses along the frontage of the proposed Aerojet Drive offramp. Detailed modeling analysis was conducted for a noise barrier along the proposed Aerojet Drive offramp under Alternative 1, located along the edge-of-shoulder of the offramp. The barrier is shown in Figure 7-2.

Barrier heights in the range of 8 to 14 feet were evaluated in 2-foot increments, as shown in Appendix C. The total length including both wall segments of the evaluated barrier would be 1,520 feet. The barrier would meet the barrier design goal of 7 dB at a minimum height of 10 feet. At a maximum height of 14 feet, the barrier would provide up to 13 dB of noise reduction at affected receiver locations. Therefore, the barrier is considered feasible. Calculated noise reductions and reasonable allowances for each barrier height are summarized in Table 7-2.

Table 7-2. Summary of Reasonableness Determination Data— Aerojet Drive Offramp Barrier, Alternative 1

Location: Aerojet Drive, proposed offramp, Alternative 1				
Predicted Sound Level without Barrier				
Design year noise level, dBA Leq(h):	81 dBA			
Design year noise level minus existing noise level:	2 dBA			
Design Year with Barrier	**8-foot Noise Barrier**	**10-foot Noise Barrier**	**12-foot Noise Barrier**	**14-foot Noise Barrier**
Barrier noise reduction, dB	6	9	11	13
Barrier design goal met?	No	Yes	Yes	Yes
Number of benefited receivers [1]	5	12	28	33
Reasonable allowance per benefited receiver	$80,000	$80,000	$80,000	$80,000
Total reasonable allowance	$400,000	$960,000	$2,240,000	$2,640,000

[1] Based on noise barrier analysis results in Appendix C.
dBA = A-weighted decibels.
dBA Leq(h) = A-weighted decibels hourly equivalent sound level.

7.2.3 Aerojet Drive Offramp Barrier, Alternative 1A

Detailed modeling analysis was conducted for a noise barrier along the proposed Aerojet Drive offramp under Alternative 1A, located along the edge-of-shoulder of the offramp. The barrier is shown in Figure 7-3.

Barrier heights in the range of 8 to 14 feet were evaluated in 2-foot increments, as shown in Appendix C. The total length including both wall segments of the evaluated barrier would be 1,900 feet. The barrier would meet the barrier design goal of 7 dB at a minimum height of 10 feet. At a maximum height of 14 feet, the barrier would provide up to 13 dB of noise reduction at affected receiver locations. Therefore, the barrier is considered feasible. Calculated noise reductions and reasonable allowances for each barrier height are summarized in Table 7-3.



Figure 7-2
Noise Barrier, Alternative 1



Figure 7-3
Noise Barrier, Alternative 1A

Table 7-3. Summary of Reasonableness Determination Data—Aerojet Drive Offramp Barrier, Alternative 1A

Location: Aerojet Drive, proposed offramp, Alternative 1A				
Predicted Sound Level without Barrier				
Design year noise level, dBA Leq(h):	81 dBA			
Design year noise level minus existing noise level:	3 dBA			
Design Year with Barrier	**8-foot Noise Barrier**	**10-foot Noise Barrier**	**12-foot Noise Barrier**	**14-foot Noise Barrier**
Barrier noise reduction, dB	6	10	11	13
Barrier design goal met?	No	Yes	Yes	Yes
Number of benefited receivers [1]	3	23	37	41
Reasonable allowance per benefited receiver	$80,000	$80,000	$80,000	$80,000
Total reasonable allowance	$240,000	$1,840,000	$2,960,000	$3,280,000

1 Based on noise barrier analysis results in Appendix C.
dBA = A-weighted decibels.
dBA Leq(h) = A-weighted decibels hourly equivalent sound level.

7.2.4 Aerojet Drive Offramp Barrier, Alternative 2

Detailed modeling analysis was conducted for a noise barrier along the proposed Aerojet Drive offramp under Alternative 2, located along the edge-of-shoulder of the offramp. The barrier is shown in Figure 7-4.

Barrier heights in the range of 8 to 14 feet were evaluated in 2-foot increments, as shown in Appendix C. The total length including both wall segments of the evaluated barrier would be 1,960 feet. The barrier would meet the barrier design goal of 7 dB at a minimum height of 12 feet. At a maximum height of 14 feet, the barrier would provide up to 12 dB of noise reduction at affected receiver locations. Therefore, the barrier is considered feasible. Calculated noise reductions and reasonable allowances for each barrier height are summarized in Table 7-4.

Table 7-4. Summary of Reasonableness Determination Data— Aerojet Drive Offramp Barrier, Alternative 2

Location: Aerojet Drive, proposed offramp, Alternative 2				
Predicted Sound Level without Barrier				
Design year noise level, dBA Leq(h):	81 dBA			
Design year noise level minus existing noise level:	4 dBA			
Design Year with Barrier	**8-foot Noise Barrier**	**10-foot Noise Barrier**	**12-foot Noise Barrier**	**14-foot Noise Barrier**
Barrier noise reduction, dB	4	6	10	12
Barrier design goal met?	No	No	Yes	Yes
Number of benefited receivers [1]	0	15	28	38
Reasonable allowance per benefited receiver	$80,000	$80,000	$80,000	$80,000
Total reasonable allowance	$0	$1,200,000	$2,240,000	$3,040,000

[1] Based on noise barrier analysis results in Appendix C.
dBA = A-weighted decibels.
dBA Leq(h) = A-weighted decibels hourly equivalent sound level.

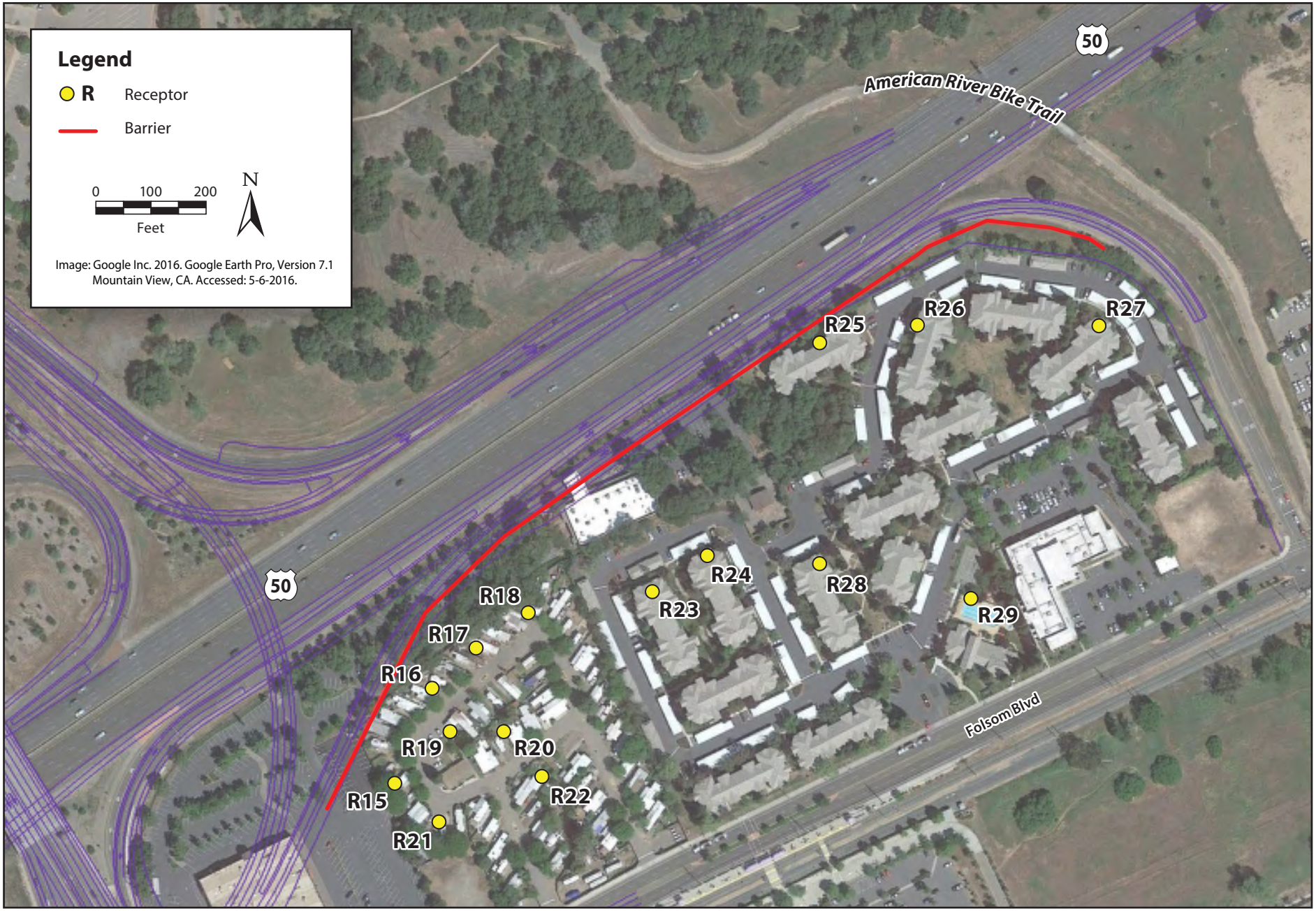


Figure 7-4
Noise Barrier, Alternative 2

Chapter 8 Construction Noise

Noise from project construction activities may intermittently dominate the noise environment in the immediate area of construction. Construction activities would include demolition of existing structures, building of new structures, and implementation of detours. Equipment operations associated with demolition and building activities would be a source of noise. Implementation of detours may increase noise in some areas as a result of temporarily diverted traffic. Construction noise is controlled by Caltrans Standard Specifications Section 14-8.02, Noise Control, which states the following (Caltrans 2015b).

- Control and monitor noise resulting from work activities.
- Do not exceed 86 dBA at 50 feet from the job site activities from 9:00 p.m. to 6:00 a.m.

Table 8-1 summarizes noise levels produced by construction equipment that is commonly used on roadway construction projects. Construction equipment is expected to generate noise levels ranging from 80 to 90 dB at a distance of 50 feet, which would be reduced over distance at a rate of about 6 dB per doubling of distance.

Table 8-1. Construction Equipment Noise

Equipment	Maximum Noise Level (dBA at 50 feet)
Scrapers	89
Bulldozers	85
Heavy Trucks	88
Backhoe	80
Pneumatic Tools	85
Concrete Pump	82

Source: Federal Transit Administration 2006

No adverse noise impacts from construction are anticipated because construction would be conducted in accordance with Caltrans Standard Specifications Section 14-8.02 and applicable local noise standards. Construction noise would be short-term, intermittent, and overshadowed by local traffic noise. Although not required, implementing the following measures will minimize the temporary noise impacts from construction.

- All equipment will have sound-control devices that are no less effective than those provided on the original equipment. No equipment will have an unmuffled exhaust.
- As directed by Caltrans, the contractor will implement appropriate additional noise mitigation measures, including changing the location of stationary construction equipment, turning off idling equipment, rescheduling construction activity, notifying adjacent residents

in advance of construction work, and installing acoustic barriers around stationary construction noise sources.

Chapter 9 References

9.1 Printed References

California Department of Transportation. 2011. Traffic Noise Analysis Protocol for New Highway Construction, Reconstruction, and Retrofit Barrier Projects. August. Sacramento, CA.

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DKS Associates. 2016. Traffic Operations Report for Hazel Avenue/Route 50. Sacramento. March.

Federal Highway Administration. 1998a. *FHWA Traffic Noise Model, Version 1.0 User's Guide.* January. FHWA-PD-96-009. Washington D.C.

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Federal Transit Administration. 2006. *Transit noise and vibration impact assessment.* (FTA-VA-90-1003-06.) Office of Planning, Washington, DC. Prepared by Harris Miller Miller & Hanson, Inc. Burlington, MA.

Appendix A Traffic Data

Table A-1. Existing Peak Hour Traffic Volumes

Roadway	Segment	Number of Lanes	Total Volume PM Peak Hour Volume	Auto		Heavy Trucks		Speed
				%	Volume	%	Volume	(A/HT)
US 50 EB Mixed lanes	west of Hazel Avenue	3	2,788	94%	2,621	6%	167	70/70
US 50 EB HOV	west of Hazel Avenue	1	1,563	94%	1,469	6%	94	70/70
US 50 EB Mixed lanes	east of Hazel Avenue	3	3,683	94%	3,462	6%	221	70/70
US 50 EB HOV	east of Hazel Avenue	1	355	94%	334	6%	21	70/70
US 50 WB Mixed lanes	east of Hazel Avenue	3	4,652	94%	4,373	6%	279	70/70
US 50 WB HOV	east of Hazel Avenue	1	927	94%	871	6%	56	70/70
US 50 WB Mixed lanes	west of Hazel Avenue	3	5,149	94%	4,840	6%	309	70/70
US 50 WB HOV	west of Hazel Avenue	1	1,630	94%	1,532	6%	98	70/70
US 50 EB offramp	US 50 EB to Hazel Avenue SB	1	1,306	94%	1,228	6%	78	45/45
US 50 WB offramp	US 50 WB to Hazel Avenue NB	1	639	94%	601	6%	38	45/45

Table A-2. Project Alternative 1 Peak Hour Traffic Volumes

Roadway	Segment	Number of Lanes	Total Volume PM Peak Hour Volume	Auto		Heavy Trucks		Speed
				%	Volume	%	Volume	(A/HT)
US 50 EB Mixed lanes	west of Hazel Avenue	3	6,930	94%	6,514	6%	416	70/70
US 50 EB HOV	west of Hazel Avenue	1	1,840	94%	1,730	6%	110	70/70
US 50 EB Mixed lanes	east of Hazel Avenue	3	5,720	94%	5,377	6%	343	70/70
US 50 EB HOV	east of Hazel Avenue	1	1,520	94%	1,429	6%	91	70/70
US 50 WB Mixed lanes	east of Hazel Avenue	3	5,100	94%	4,794	6%	306	70/70
US 50 WB HOV	east of Hazel Avenue	1	1,360	94%	1,278	6%	82	70/70
US 50 WB Mixed lanes	west of Hazel Avenue	3	6,150	94%	5,781	6%	369	70/70
US 50 WB HOV	west of Hazel Avenue	1	1,640	94%	1,542	6%	98	70/70
US 50 EB offramp	US 50 EB to Hazel Avenue SB	1	2,790	94%	2,623	6%	167	45/45
US 50 WB offramp	US 50 WB to Hazel Avenue NB	1	940	94%	884	6%	56	45/45

Table A-3. Project Alternative 1A Peak Hour Traffic Volumes

Roadway	Segment	Number of Lanes	Total Volume PM Peak Hour Volume	Auto		Heavy Trucks		Speed
				%	Volume	%	Volume	(A/HT)
US 50 EB Mixed lanes	west of Hazel Avenue	3	6,930	94%	6,514	6%	416	70/70
US 50 EB HOV	west of Hazel Avenue	1	1,840	94%	1,730	6%	110	70/70
US 50 EB Mixed lanes	east of Hazel Avenue	3	5,720	94%	5,377	6%	343	70/70
US 50 EB HOV	east of Hazel Avenue	1	1,520	94%	1,429	6%	91	70/70
US 50 WB Mixed lanes	east of Hazel Avenue	3	5,100	94%	4,794	6%	306	70/70
US 50 WB HOV	east of Hazel Avenue	1	1,360	94%	1,278	6%	82	70/70
US 50 WB Mixed lanes	west of Hazel Avenue	3	6,150	94%	5,781	6%	369	70/70
US 50 WB HOV	west of Hazel Avenue	1	1,640	94%	1,542	6%	98	70/70
US 50 EB offramp	US 50 EB to Hazel Avenue SB	1	2,790	94%	2,623	6%	167	45/45
US 50 WB offramp	US 50 WB to Hazel Avenue NB	1	940	94%	884	6%	56	45/45

Table A-4. Project Alternative 2 Peak Hour Traffic Volumes

Roadway	Segment	Number of Lanes	Total Volume PM Peak Hour Volume	Auto		Medium Trucks		Heavy Trucks		Speed
				%	Volume	%	Volume	%	Volume	(A/HT)
US 50 EB Mixed lanes	west of Hazel Avenue	3	6,930	94%	6,514	0%	0	6%	416	70/70
US 50 EB HOV	west of Hazel Avenue	1	1,840	94%	1,730	0%	0	6%	110	70/70
US 50 EB Mixed lanes	east of Hazel Avenue	3	5,720	94%	5,377	0%	0	6%	343	70/70
US 50 EB HOV	east of Hazel Avenue	1	1,520	94%	1,429	0%	0	6%	91	70/70
US 50 WB Mixed lanes	east of Hazel Avenue	3	5,100	94%	4,794	0%	0	6%	306	70/70
US 50 WB HOV	east of Hazel Avenue	1	1,360	94%	1,278	0%	0	6%	82	70/70
US 50 WB Mixed lanes	west of Hazel Avenue	3	6,150	94%	5,781	0%	0	6%	369	70/70
US 50 WB HOV	west of Hazel Avenue	1	1,640	94%	1,542	0%	0	6%	98	70/70
US 50 EB offramp	US 50 EB to Hazel Avenue SB	1	2,790	94%	2,623	0%	0	6%	167	45/45
US 50 EB offramp	US 50 EB to Hazel Avenue NB	1	940	94%	884	0%	0	6%	56	45/45

Table A-5. Alternative 3 - No Project Peak Hour Traffic Volumes

Roadway	Segment	Number of Lanes	Total Volume PM Peak Hour Volume	Auto		Heavy Trucks		Speed
				%	Volume	%	Volume	(A/HT)
US 50 EB Mixed lanes	west of Hazel Avenue	3	6,930	94%	6,514	6%	416	70/70
US 50 EB HOV	west of Hazel Avenue	1	1,840	94%	1,730	6%	110	70/70
US 50 EB Mixed lanes	east of Hazel Avenue	3	6,040	94%	5,678	6%	362	70/70
US 50 EB HOV	east of Hazel Avenue	1	1,600	94%	1,504	6%	96	70/70
US 50 WB Mixed lanes	east of Hazel Avenue	3	5,100	94%	4,794	6%	306	70/70
US 50 WB HOV	east of Hazel Avenue	1	1,360	94%	1,278	6%	82	70/70
US 50 WB Mixed lanes	west of Hazel Avenue	3	6,150	94%	5,781	6%	369	70/70
US 50 WB HOV	west of Hazel Avenue	1	1,640	94%	1,542	6%	98	70/70
US 50 EB offramp	US 50 to Hazel Avenue SB	1	2,390	94%	2,247	6%	143	45/45
US 50 WB offramp	US 50 to Hazel Avenue NB	1	940	94%	884	6%	56	45/45

Appendix B Predicted Future Noise Levels and Impacts

Receiver I.D.	Land Use / Activity Category	Location	Existing Noise Level $L_{eq}(h)$, dBA	Future Worst Hour Noise Levels (Traffic Noise Only) - $L_{eq}(h)$, dBA						
				Design Year Noise Level without Project, Leq(h), dBA	Design Year Noise Level with Project, Leq(h), dBA	Design Year Noise Level without Project minus Existing Conditions Leq(h), dBA	Design Year Noise Level with Project minus No Project Conditions Leq(h), dBA	Design Year Noise Level with Project minus Existing Conditions Leq(h), dBA	Activity Category (NAC)	Impact Type (None, or A/E)
R01	Park / C	Nimbus Dam Recreation Area	76	77	77	+ 1	0	+ 1	C	A/E
R02	Park / C	Nimbus Dam Recreation Area	77	78	78	+ 1	0	+ 1	C	A/E
R03	Park / C	Nimbus Dam Recreation Area	61	63	62	+ 2	- 1	+ 1	C	None
R04	Recreation / C	Sacramento State Aquatic Center	58	60	60	+ 2	0	+ 2	C	None
R05	Commercial / F	Tributary Point Drive	67	68	68	+ 1	0	+ 1	F	None
R06	Hotel / C	Tributary Point Drive	66	67	67	+ 1	0	+ 1	C	None
R07	Commercial / F	Tributary Point Drive	66	67	67	+ 1	0	+ 1	F	None
R08	Residential / B	Cobble Oaks Apartments, Tributary Point Drive	61	63	63	+ 2	0	+ 2	B	None
R09	Residential / B	Cobble Oaks Apartments, Tributary Point Drive	64	65	65	+ 1	0	+ 1	B	None
R10	Residential / B	Cobble Oaks Apartments, Tributary Point Drive	57	58	58	+ 1	0	+ 1	B	None
R11	Commercial / F	Folsom Boulevard	77	79	79	+ 2	0	+ 2	F	None
R12	Hotel / C	Folsom Boulevard	66	67	63	+ 1	- 4	- 3	C	None
R13	Commercial / F	Folsom Boulevard	71	72	70	+ 1	- 2	- 1	F	None
R14	Commercial / F	Folsom Boulevard	70	71	70	+ 1	- 1	0	F	None
R15	Residential / B	Twilight Mobile Park, Folsom Boulevard	64	65	62	+ 1	- 3	- 2	B	None
R16	Residential / B	Twilight Mobile Park, Folsom Boulevard	74	76	66	+ 2	- 10	- 8	B	A/E
R17	Residential / B	Twilight Mobile Park, Folsom Boulevard	74	76	67	+ 2	- 9	- 7	B	A/E
R18	Residential / B	Twilight Mobile Park, Folsom Boulevard	74	76	69	+ 2	- 7	- 5	B	A/E
R19	Residential / B	Twilight Mobile Park, Folsom Boulevard	63	65	62	+ 2	- 3	- 1	B	None
R20	Residential / B	Twilight Mobile Park, Folsom Boulevard	58	59	60	+ 1	+ 1	+ 2	B	None
R21	Residential / B	Twilight Mobile Park, Folsom Boulevard	61	62	62	+ 1	0	+ 1	B	None
R22	Residential / B	Twilight Mobile Park, Folsom Boulevard	60	60	61	0	+ 1	+ 1	B	None
R23	Residential / B	Oak Brook Apt Homes, Folsom Boulevard	71	72	69	+ 1	- 3	- 2	B	A/E
R24	Residential / B	Oak Brook Apt Homes, Folsom Boulevard	70	72	69	+ 2	- 3	- 1	B	A/E
R25	Residential / B	Oak Brook Apt Homes, Folsom Boulevard	78	80	80	+ 2	0	+ 2	B	A/E
R26	Residential / B	Oak Brook Apt Homes, Folsom Boulevard	75	77	76	+ 2	- 1	+ 1	B	A/E
R27	Residential / B	Oak Brook Apt Homes, Folsom Boulevard	66	67	65	+ 1	- 2	- 1	B	None
R28	Residential / B	Oak Brook Apt Homes, Folsom Boulevard	65	66	64	+ 1	- 2	- 1	B	None
R29	Residential / B	Oak Brook Apt Homes, Folsom Boulevard	61	61	61	0	0	0	B	None
R30	Commercial / F	Folsom Boulevard	78	80	80	+ 2	0	+ 2	F	None
R31	Commercial / F	Folsom Boulevard	77	79	79	+ 2	0	+ 2	F	None
R32	Commercial / F	Folsom Boulevard	76	78	78	+ 2	0	+ 2	F	None
ST-1	Commercial / F	Folsom Boulevard	79	80	81	+ 1	+ 1	+ 2	F	None
ST-2	Commercial / F	Folsom Boulevard	74	76	68	+ 2	- 8	- 6	F	None
ST-3	Hotel / C	Folsom Boulevard	77	78	73	+ 1	- 5	- 4	C	None
ST-4	Commercial / F	Tributary Point Drive	76	76	76	0	0	0	F	None
ST-5	Park / C	Nimbus Dam Recreation Area	78	79	79	+ 1	0	+ 1	C	None

Notes:
A/E= Future noise conditions approach or exceed the Noise Abatement Criteria.

Receiver I.D.	Land Use / Activity Category	Location	Existing Noise Level $L_{eq}(h)$, dBA	Future Worst Hour Noise Levels (Traffic Noise Only) - $L_{eq}(h)$, dBA						
				Design Year Noise Level without Project, Leq(h), dBA	Design Year Noise Level with Project, Leq(h), dBA	Design Year Noise Level without Project minus Existing Conditions Leq(h), dBA	Design Year Noise Level with Project minus No Project Conditions Leq(h), dBA	Design Year Noise Level with Project minus Existing Conditions Leq(h), dBA	Activity Category (NAC)	Impact Type (None, or A/E)
R01	Park / C	Nimbus Dam Recreation Area	76	77	77	+ 1	0	+ 1	C	A/E
R02	Park / C	Nimbus Dam Recreation Area	77	78	78	+ 1	0	+ 1	C	A/E
R03	Park / C	Nimbus Dam Recreation Area	61	63	62	+ 2	- 1	+ 1	C	None
R04	Recreation / C	Sacramento State Aquatic Center	58	60	60	+ 2	0	+ 2	C	None
R05	Commercial / F	Tributary Point Drive	67	68	68	+ 1	0	+ 1	F	None
R06	Hotel / C	Tributary Point Drive	66	67	67	+ 1	0	+ 1	C	None
R07	Commercial / F	Tributary Point Drive	66	67	67	+ 1	0	+ 1	F	None
R08	Residential / B	Cobble Oaks Apartments, Tributary Point Drive	61	63	63	+ 2	0	+ 2	B	None
R09	Residential / B	Cobble Oaks Apartments, Tributary Point Drive	64	65	65	+ 1	0	+ 1	B	None
R10	Residential / B	Cobble Oaks Apartments, Tributary Point Drive	57	58	58	+ 1	0	+ 1	B	None
R11	Commercial / F	Folsom Boulevard	77	79	79	+ 2	0	+ 2	F	None
R12	Hotel / C	Folsom Boulevard	66	67	65	+ 1	- 2	- 1	C	None
R13	Commercial / F	Folsom Boulevard	71	72	70	+ 1	- 2	- 1	F	None
R14	Commercial / F	Folsom Boulevard	70	71	71	+ 1	0	+ 1	F	None
R15	Residential / B	Twilight Mobile Park, Folsom Boulevard	64	65	66	+ 1	+ 1	+ 2	B	A/E
R16	Residential / B	Twilight Mobile Park, Folsom Boulevard	74	76	76	+ 2	0	+ 2	B	A/E
R17	Residential / B	Twilight Mobile Park, Folsom Boulevard	74	76	76	+ 2	0	+ 2	B	A/E
R18	Residential / B	Twilight Mobile Park, Folsom Boulevard	74	76	76	+ 2	0	+ 2	B	A/E
R19	Residential / B	Twilight Mobile Park, Folsom Boulevard	63	65	65	+ 2	0	+ 2	B	None
R20	Residential / B	Twilight Mobile Park, Folsom Boulevard	58	59	60	+ 1	+ 1	+ 2	B	None
R21	Residential / B	Twilight Mobile Park, Folsom Boulevard	61	62	64	+ 1	+ 2	+ 3	B	None
R22	Residential / B	Twilight Mobile Park, Folsom Boulevard	60	60	62	0	+ 2	+ 2	B	None
R23	Residential / B	Oak Brook Apt Homes, Folsom Boulevard	71	72	70	+ 1	- 2	- 1	B	A/E
R24	Residential / B	Oak Brook Apt Homes, Folsom Boulevard	70	72	69	+ 2	- 3	- 1	B	A/E
R25	Residential / B	Oak Brook Apt Homes, Folsom Boulevard	78	80	80	+ 2	0	+ 2	B	A/E
R26	Residential / B	Oak Brook Apt Homes, Folsom Boulevard	75	77	75	+ 2	- 2	0	B	A/E
R27	Residential / B	Oak Brook Apt Homes, Folsom Boulevard	66	67	66	+ 1	- 1	0	B	A/E
R28	Residential / B	Oak Brook Apt Homes, Folsom Boulevard	65	66	64	+ 1	- 2	- 1	B	None
R29	Residential / B	Oak Brook Apt Homes, Folsom Boulevard	61	61	61	0	0	0	B	None
R30	Commercial / F	Folsom Boulevard	78	80	80	+ 2	0	+ 2	F	None
R31	Commercial / F	Folsom Boulevard	77	79	79	+ 2	0	+ 2	F	None
R32	Commercial / F	Folsom Boulevard	76	78	78	+ 2	0	+ 2	F	None
ST-1	Commercial / F	Folsom Boulevard	79	80	81	+ 1	+ 1	+ 2	F	None
ST-2	Commercial / F	Folsom Boulevard	74	76	77	+ 2	+ 1	+ 3	F	None
ST-3	Hotel / C	Folsom Boulevard	77	78	74	+ 1	- 4	- 3	C	None
ST-4	Commercial / F	Tributary Point Drive	76	76	77	0	+ 1	+ 1	F	None
ST-5	Park / C	Nimbus Dam Recreation Area	78	79	79	+ 1	0	+ 1	C	None

Notes:
A/E= Future noise conditions approach or exceed the Noise Abatement Criteria.

Receiver I.D.	Land Use / Activity Category	Location	Existing Noise Level $L_{eq}(h)$, dBA	Future Worst Hour Noise Levels (Traffic Noise Only) - $L_{eq}(h)$, dBA						
				Design Year Noise Level without Project, Leq(h), dBA	Design Year Noise Level with Project, Leq(h), dBA	Design Year Noise Level without Project minus Existing Conditions Leq(h), dBA	Design Year Noise Level with Project minus No Project Conditions Leq(h), dBA	Design Year Noise Level with Project minus Existing Conditions Leq(h), dBA	Activity Category (NAC)	Impact Type (None, or A/E)
R01	Park / C	Nimbus Dam Recreation Area	76	77	77	+ 1	0	+ 1	C	A/E
R02	Park / C	Nimbus Dam Recreation Area	77	78	78	+ 1	0	+ 1	C	A/E
R03	Park / C	Nimbus Dam Recreation Area	61	63	62	+ 2	- 1	+ 1	C	None
R04	Recreation / C	Sacramento State Aquatic Center	58	60	59	+ 2	- 1	+ 1	C	None
R05	Commercial / F	Tributary Point Drive	67	68	68	+ 1	0	+ 1	F	None
R06	Hotel / C	Tributary Point Drive	66	67	67	+ 1	0	+ 1	C	None
R07	Commercial / F	Tributary Point Drive	66	67	66	+ 1	- 1	0	F	None
R08	Residential / B	Cobble Oaks Apartments, Tributary Point Drive	61	63	62	+ 2	- 1	+ 1	B	None
R09	Residential / B	Cobble Oaks Apartments, Tributary Point Drive	64	65	65	+ 1	0	+ 1	B	None
R10	Residential / B	Cobble Oaks Apartments, Tributary Point Drive	57	58	58	`	0	+ 1	B	None
R11	Commercial / F	Folsom Boulevard	77	79	79	+ 2	0	+ 2	F	None
R12	Hotel / C	Folsom Boulevard	66	67	65	+ 1	- 2	- 1	C	None
R13	Commercial / F	Folsom Boulevard	71	72	72	+ 1	0	+ 1	F	None
R14	Commercial / F	Folsom Boulevard	70	71	70	+ 1	- 1	0	F	None
R15	Residential / B	Twilight Mobile Park, Folsom Boulevard	64	65	63	+ 1	- 2	- 1	B	None
R16	Residential / B	Twilight Mobile Park, Folsom Boulevard	74	76	70	+ 2	- 6	- 4	B	A/E
R17	Residential / B	Twilight Mobile Park, Folsom Boulevard	74	76	72	+ 2	- 4	- 2	B	A/E
R18	Residential / B	Twilight Mobile Park, Folsom Boulevard	74	76	74	+ 2	- 2	0	B	A/E
R19	Residential / B	Twilight Mobile Park, Folsom Boulevard	63	65	64	+ 2	- 1	+ 1	B	None
R20	Residential / B	Twilight Mobile Park, Folsom Boulevard	58	59	61	+ 1	+ 2	+ 3	B	None
R21	Residential / B	Twilight Mobile Park, Folsom Boulevard	61	62	62	+ 1	0	+ 1	B	None
R22	Residential / B	Twilight Mobile Park, Folsom Boulevard	60	60	61	0	+ 1	+ 1	B	None
R23	Residential / B	Oak Brook Apt Homes, Folsom Boulevard	71	72	72	+ 1	0	+ 1	B	A/E
R24	Residential / B	Oak Brook Apt Homes, Folsom Boulevard	70	72	71	+ 2	- 1	+ 1	B	A/E
R25	Residential / B	Oak Brook Apt Homes, Folsom Boulevard	78	80	80	+ 2	0	+ 2	B	A/E
R26	Residential / B	Oak Brook Apt Homes, Folsom Boulevard	75	77	78	+ 2	+ 1	+ 3	B	A/E
R27	Residential / B	Oak Brook Apt Homes, Folsom Boulevard	66	67	70	+ 1	+ 3	+ 4	B	A/E
R28	Residential / B	Oak Brook Apt Homes, Folsom Boulevard	65	66	66	+ 1	0	+ 1	B	A/E
R29	Residential / B	Oak Brook Apt Homes, Folsom Boulevard	61	61	60	0	- 1	- 1	B	None
R30	Commercial / F	Folsom Boulevard	78	80	80	+ 2	0	+ 2	F	None
R31	Commercial / F	Folsom Boulevard	77	79	79	+ 2	0	+ 2	F	None
R32	Commercial / F	Folsom Boulevard	76	78	78	+ 2	0	+ 2	F	None
ST-1	Commercial / F	Folsom Boulevard	79	80	81	+ 1	+ 1	+ 2	F	None
ST-2	Commercial / F	Folsom Boulevard	74	76	n/a	+ 2	n/a	n/a	F	None
ST-3	Hotel / C	Folsom Boulevard	77	78	73	+ 1	- 5	- 4	C	None
ST-4	Commercial / F	Tributary Point Drive	76	76	77	0	+ 1	+ 1	F	None
ST-5	Park / C	Nimbus Dam Recreation Area	78	79	79	+ 1	0	+ 1	C	None

Notes:
A/E= Future noise conditions approach or exceed the Noise Abatement Criteria.

Appendix C Noise Barrier Analysis

Table C-1. Aerojet Drive Barrier Analysis, Alternative 1

	Position																																		Total Number of Benefited Receivers
	R15	R16	R17	R18	R19	R20	R21	R22	R23	R24	R25	R26	R27	R28	R29	R25-1	R26-1	R28-1a	R27-1e	R27-1d	R27-1c	R27-1a	R27-1b	R23-1	R24-1	R28-1b	R28-1c	R25-2	R26-2	R27-2	R27-2a	R27-2b	R28-2	R24-2	R23-2	R28-2a	
Number of Units Represented	3	5	3	3	8	8	5	6	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	--
Future with Project Traffic Noise Level (dBA Leq[h]) [a]	62	**66**	**67**	**69**	62	60	62	61	**69**	**69**	**80**	**76**	65	64	61	**81**	**69**	64	65	62	62	**69**	**74**	64	64	62	61	**81**	**77**	**76**	**70**	**69**	**70**	**71**	**71**	**68**	--
8-Foot Barrier[b]																																					
Future with Project Traffic Noise Level (dBA Leq[h])	62	66	65	66	61	60	62	61	67	67	74	71	65	63	61	76	68	64	64	62	62	67	70	62	63	62	61	81	75	75	68	66	67	67	68	65	--
Predicted Noise Reduction (dB)	0	0	2	3	1	0	0	0	2	2	6	5	0	1	0	5	1	0	1	0	0	2	4	2	1	0	0	0	2	1	2	3	3	4	3	3	--
Number of Benefited Receivers	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
10-Foot Barrier[b]																																					
Future with Project Traffic Noise Level (dBA Leq[h])	62	65	65	65	61	59	62	61	65	65	71	68	64	61	61	72	65	62	63	61	62	65	68	60	61	60	59	81	72	73	67	66	66	66	66	64	--
Predicted Noise Reduction (dB)	0	1	2	4	1	1	0	0	4	4	9	8	1	3	0	9	4	2	2	1	0	4	6	4	3	2	2	0	5	3	3	3	4	5	5	4	--
Number of Benefited Receivers	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	2	0	0	0	0	2	2	0	12
12-Foot Barrier[b]																																					
Future with Project Traffic Noise Level (dBA Leq[h])	61	65	64	64	61	59	61	61	64	63	69	67	64	61	61	70	64	61	62	60	61	64	66	59	60	60	59	80	71	72	66	64	64	64	64	62	--
Predicted Noise Reduction (dB)	1	1	3	5	1	1	1	0	5	6	11	9	1	3	0	11	5	3	3	2	1	5	8	5	4	2	2	1	6	4	4	5	6	7	7	6	--
Number of Benefited Receivers	0	0	0	3	0	0	0	0	2	2	2	2	0	0	0	1	1	0	0	0	0	1	1	1	0	0	0	0	2	0	0	2	2	2	2	2	28
14-Foot Barrier[b]																																					
Future with Project Traffic Noise Level (dBA Leq[h])	61	65	64	64	61	59	61	61	63	62	67	66	63	60	61	68	63	61	61	59	61	63	65	58	59	59	58	78	69	70	65	63	63	62	63	61	--
Predicted Noise Reduction (dB)	1	1	3	5	1	1	1	0	6	7	13	10	2	4	0	13	6	3	4	3	1	6	9	6	5	3	3	3	8	6	5	6	7	9	8	7	--
Number of Benefited Receivers	0	0	0	3	0	0	0	0	2	2	2	2	0	0	0	1	1	0	0	0	0	1	1	1	1	0	0	0	2	2	2	2	2	2	2	2	33

a Traffic noise levels that approach or exceed 67 dBA Leq(h) are shown in bold/orange fill.
b Noise barriers that block the line-of-sight from the receptor to truck exhaust stacks are shaded in yellow for receptors exceeding NAC.

Table C-2. Aerojet Drive Barrier Analysis, Alternative 1A

	Position																																		Total Number of Benefited Receivers
	R15	R16	R17	R18	R19	R20	R21	R22	R23	R24	R25	R26	R27	R28	R29	R25-1	R26-1	R28-1a	R27-1e	R27-1d	R27-1c	R27-1a	R27-1b	R23-1	R24-1	R28-1b	R28-1c	R25-2	R26-2	R27-2	R27-2a	R27-2b	R28-2	R24-2	R23-2	R28-2a	
Number of Units Represented	3	5	3	3	8	8	5	6	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	--
Future with Project Traffic Noise Level (dBA Leq[h]) [a]	**66**	**76**	**76**	**76**	65	60	64	62	**70**	**69**	**80**	**75**	**66**	64	61	**81**	**69**	65	**66**	64	63	**69**	**74**	64	64	63	61	**81**	**77**	**76**	**71**	**70**	**70**	**71**	**73**	**68**	--
8-Foot Barrier[b]																																					
Future with Project Traffic Noise Level (dBA Leq[h])	65	73	72	72	64	60	63	61	68	68	74	71	65	64	61	75	67	64	64	62	62	67	70	63	63	62	61	81	75	74	69	67	67	67	69	65	--
Predicted Noise Reduction (dB)	1	3	4	4	1	0	1	1	2	1	6	4	1	0	0	6	2	1	2	2	1	2	4	1	1	1	0	0	2	2	2	3	3	4	4	3	--
Number of Benefited Receivers	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
10-Foot Barrier[b]																																					
Future with Project Traffic Noise Level (dBA Leq[h])	64	71	70	70	63	60	63	61	66	66	71	68	64	62	61	71	65	62	63	61	62	65	68	61	61	61	59	81	72	73	67	66	66	66	68	64	--
Predicted Noise Reduction (dB)	2	5	6	6	2	0	1	1	4	3	9	7	2	2	0	10	4	3	3	3	1	4	6	3	3	2	2	0	5	3	4	4	4	5	5	4	--
Number of Benefited Receivers	0	5	3	3	0	0	0	0	0	0	2	2	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	2	0	0	0	0	2	2	0	23
12-Foot Barrier[b]																																					
Future with Project Traffic Noise Level (dBA Leq[h])	63	70	69	68	63	60	63	61	65	64	69	67	64	61	61	69	64	61	62	60	61	64	66	60	60	60	59	79	71	72	66	65	65	65	66	62	--
Predicted Noise Reduction (dB)	3	6	7	8	2	0	1	1	5	5	11	8	2	3	0	12	5	4	4	4	2	5	8	4	4	3	2	2	6	4	5	5	5	6	7	6	--
Number of Benefited Receivers	0	5	3	3	0	0	0	0	2	2	2	2	0	0	0	1	1	0	0	0	0	1	1	0	0	0	0	0	2	0	2	2	2	2	2	2	37
14-Foot Barrier[b]																																					
Future with Project Traffic Noise Level (dBA Leq[h])	63	69	67	67	62	60	62	61	64	63	67	66	63	60	61	68	63	61	62	60	61	63	65	59	59	59	58	78	69	70	65	64	63	63	64	61	--
Predicted Noise Reduction (dB)	3	7	9	9	3	0	2	1	6	6	13	9	3	4	0	13	6	4	4	4	2	6	9	5	5	4	3	3	8	6	6	6	7	8	9	7	--
Number of Benefited Receivers	0	5	3	3	0	0	0	0	2	2	2	2	0	0	0	1	1	0	0	0	0	1	1	1	1	0	0	0	2	2	2	2	2	2	2	2	41

a Traffic noise levels that approach or exceed 67 dBA Leq(h) are shown in bold/orange fill.
b Noise barriers that block the line-of-sight from the receptor to truck exhaust stacks are shaded in yellow for receptors exceeding NAC.

Table C-3. Aerojet Drive Barrier Analysis, Alternative 2

	Position																																				Total Number of Benefited Receivers
	R15	R16	R17	R18	R19	R20	R21	R22	R23	R24	R25	R26	R27	R28	R29	R25-1	R26-1	R28-1a	R27-1e	R27-1d	R27-1c	R27-1a	R27-1b	R23-1	R24-1	R28-1b	R28-1c	R25-2	R26-2	R27-2	R27-2a	R27-2b	R28-2	R24-2	R23-2	R28-2a	
Number of Units Represented	3	5	3	3	8	8	5	6	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	--
Future with Project Traffic Noise Level (dBA Leq[h]) [a]	63	**70**	**72**	**74**	64	61	62	61	**72**	**71**	**80**	**78**	**70**	**66**	60	**81**	**72**	**66**	**68**	65	64	**75**	**77**	**66**	**66**	64	63	**81**	**77**	**77**	**71**	**70**	**71**	**72**	**73**	**70**	--
8-Foot Barrier[b]																																					
Future with Project Traffic Noise Level (dBA Leq[h])	62	67	68	70	62	60	61	61	69	69	77	74	70	64	60	80	70	65	66	64	64	74	75	64	64	63	62	81	76	76	71	69	69	70	71	66	--
Predicted Noise Reduction (dB)	1	3	4	4	2	1	1	0	3	2	3	4	0	2	0	1	2	1	2	1	0	1	2	2	2	1	1	0	1	1	0	1	2	2	2	4	--
Number of Benefited Receivers	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10-Foot Barrier[b]																																					
Future with Project Traffic Noise Level (dBA Leq[h])	61	66	67	68	61	60	62	61	68	68	74	73	70	64	60	76	69	65	65	63	64	73	74	63	64	62	62	81	75	75	70	68	68	68	68	65	--
Predicted Noise Reduction (dB)	2	4	5	6	3	1	0	0	4	3	6	5	0	2	0	5	3	1	3	2	0	2	3	3	2	2	1	0	2	2	1	2	3	4	5	5	--
Number of Benefited Receivers	0	0	3	3	0	0	0	0	0	0	2	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	15
12-Foot Barrier[b]																																					
Future with Project Traffic Noise Level (dBA Leq[h])	61	65	66	66	61	59	62	60	66	66	71	70	69	62	60	72	66	63	64	62	63	72	73	62	61	61	60	81	73	75	70	67	67	67	67	65	--
Predicted Noise Reduction (dB)	2	5	6	8	3	2	0	1	6	5	9	8	1	4	0	9	6	3	4	3	1	3	4	4	5	3	3	0	4	2	1	3	4	5	6	5	--
Number of Benefited Receivers	0	5	3	3	0	0	0	0	2	2	2	2	0	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	2	2	28
14-Foot Barrier[b]																																					
Future with Project Traffic Noise Level (dBA Leq[h])	60	64	65	65	61	59	61	60	65	64	69	68	67	61	60	70	65	62	63	61	62	69	71	61	60	60	60	80	72	74	70	66	65	65	66	63	--
Predicted Noise Reduction (dB)	3	6	7	9	3	2	1	1	7	7	11	10	3	5	0	11	7	4	5	4	2	6	6	5	6	4	3	1	5	3	1	4	6	7	7	7	--
Number of Benefited Receivers	0	5	3	3	0	0	0	0	2	2	2	2	0	2	0	1	1	0	1	0	0	1	1	1	1	0	0	0	2	0	0	0	2	2	2	2	38

a Traffic noise levels that approach or exceed 67 dBA Leq(h) are shown in bold/orange fill.
b Noise barriers that block the line-of-sight from the receptor to truck exhaust stacks are shaded in yellow for receptors exceeding NAC.

Appendix D Field Measurements

NOISE MEASUREMENT SITE INFORMATION SHEET

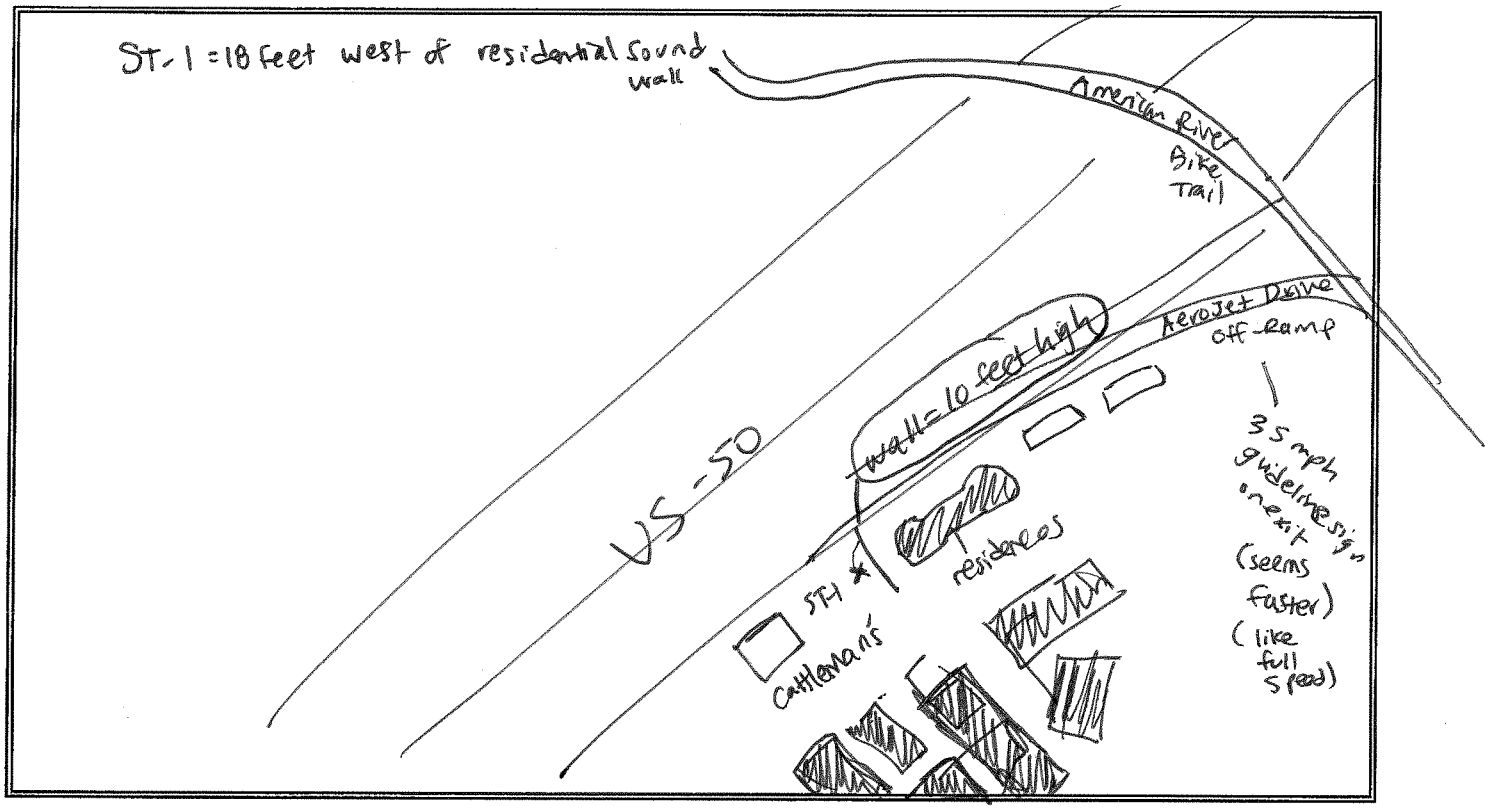
Jones & Stokes

PROJECT NAME: Hazel Ave/US-50 PROJECT #:

SITE NUMBER: ST-1 DATE/TIME: 3/15/2016 1:50 (meter says 12:50)

LOCATION/ADDRESS: Near residences & NE of Cattlemans ENGINEERS: C. Matsui & E. Scott

SITE SKETCH: Show microphone location, nearby residences/buildings, potential reflective surfaces, project roadways, local roadways, driveways, ground type, trees. Indicate reference distances between objects, arrows showing wind direction, North, and camera locations/directions. Describe the line-of-sight and topography/elevation changes relative to noise sources.



WEATHER DATA: (temperature, wind speed/direction, sky conditions, relative humidity)

67°F, 48% RH, 2mph Avg winds, clear

EQUIPMENT DATA: (sound level meter, microphone, preamp, calibrator, factory cal. date)

LD-831, Cal 200

ESTIMATED CONSTRUCTION DATE OF RESIDENCES: (Pre-1978, or new construction)

POSTED SPEED: _____ COMMENTS: Wall in front & side of multi-family res = 10-feet high

TRAFFIC COUNTS:

Roadway/Direction	Autos	Medium	Heavy	Speed	Start Time	Duration
Aerojet off ramp - EB	18	Ø	Ø			
Hazel to US-50 WB on-ramp	39	Ø	Ø			

NOISE MEASUREMENT LOG SHEET (20)

Jones & Stokes

PROJECT NAME: Hazel Ave/US-50 PROJECT #:

SITE NUMBER: ST-1 DATE/TIME: 3/15/2016

LOCATION/ADDRESS: near residences ENGINEERS: C Matsui & E. Scott

#	Minute Starting	Measured Leq (dBA)	O or X	Autos	Medium Trucks	Heavy Trucks	Other Noise Sources/Comments (include SLM equipment, Calibration Data)
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							Bird chirping
13							Sneeze 20 feet away, quietly
14							Leq 73.0
15							Lmax
16							Lmin
17							L10
18							L33
19							L50
20							L90

Overall Leq (Include "O" minutes, Exclude "X" minutes) = 73.0 **dBA**

Subset Leq (Exclude "O" and "X" minutes) = **dBA**

"O" = other characteristic sources that contributed to the Leq

"X" = exclude from Leq calculation; a non-typical source contaminated the measurement

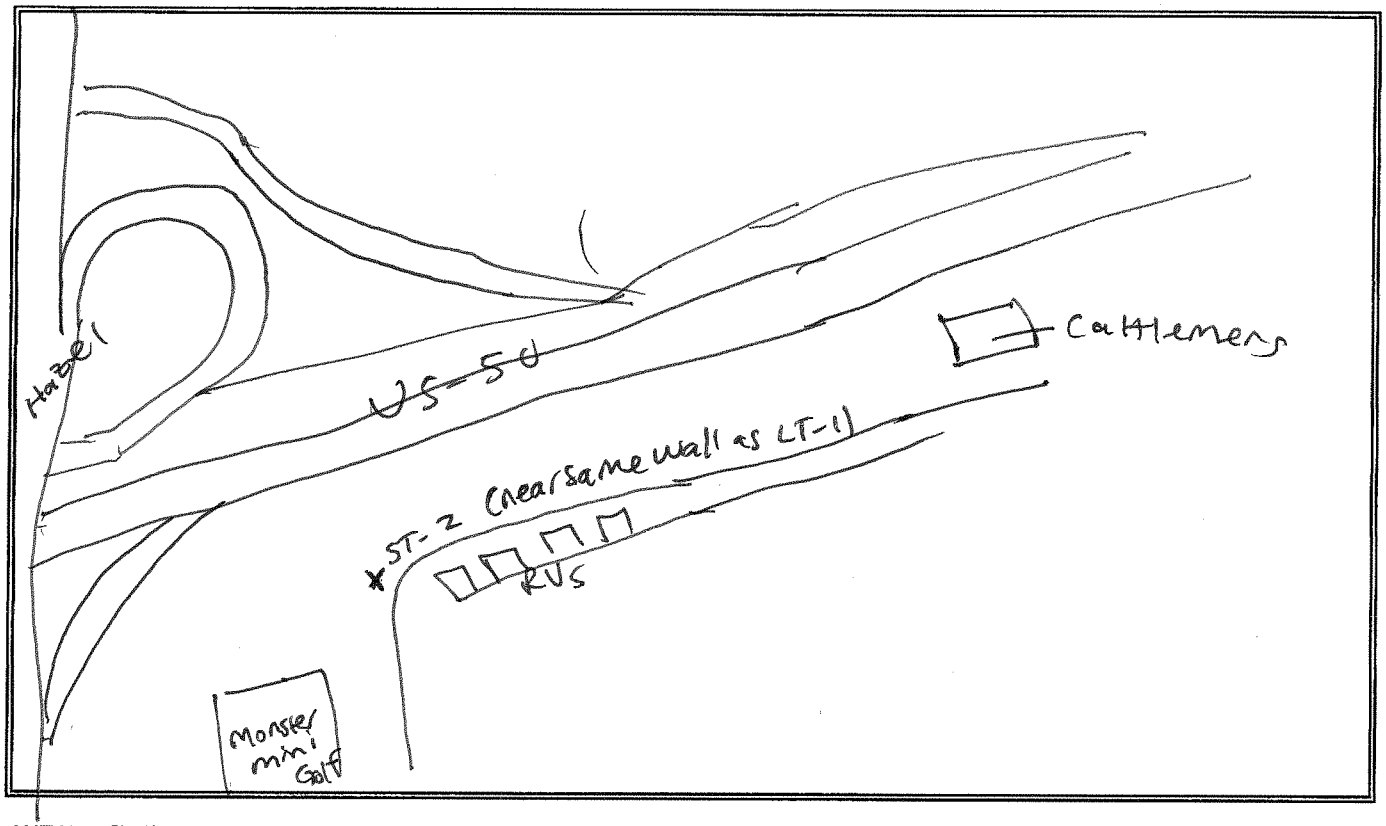
NN 1
cars in parking lot near meter (6 total)

NOISE MEASUREMENT SITE INFORMATION SHEET

Jones & Stokes

PROJECT NAME: Hazel
PROJECT #:
SITE NUMBER: ST-2
DATE/TIME: 3/15/2016 - 3:45 (meter says 2:45)
LOCATION/ADDRESS: near LT-1 & RV park
ENGINEERS: C. Matsui & E. Scott

SITE SKETCH: Show microphone location, nearby residences/buildings, potential reflective surfaces, project roadways, local roadways, driveways, ground type, trees. Indicate reference distances between objects, arrows showing wind direction, North, and camera locations/directions. Describe the line-of-sight and topography/elevation changes relative to noise sources.



WEATHER DATA: (temperature, wind speed/direction, sky conditions, relative humidity)

4 mph Avg, Sunny, 66°F, 44% RH

EQUIPMENT DATA: (sound level meter, microphone, preamp, calibrator, factory cal. date)

LD-831, cal 200

ESTIMATED CONSTRUCTION DATE OF RESIDENCES: (Pre-1978, or new construction)

POSTED SPEED: _____ COMMENTS: ~fence (not a wall) is 6-feet high but not a sound-wall (Gaps in fence)

TRAFFIC COUNTS:

Roadway/Direction	Autos	Medium	Heavy	Speed	Start Time	Duration
WB-50 Hazel on-ramp	67	2	Ø			

NOISE MEASUREMENT LOG SHEET (20)

Jones & Stokes

PROJECT NAME: Hazel/US-50 Interchange
PROJECT #:
SITE NUMBER: ST-2
DATE/TIME: 3/15/2016 - 3:45 (meter says 2:45)
LOCATION/ADDRESS: near RV park & LT-1
ENGINEERS: E. Scott & C. Matsui

#	Minute Starting	Measured Leq (dBA)	O or X	Autos	Medium Trucks	Heavy Trucks	Other Noise Sources/Comments (include SLM equipment, Calibration Data)
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

No noticible audible other sources (except 6 cars driving close by over the 15 minutes)

Leq	68.9
Lmax	
Lmin	
L10	
L33	
L50	
L90	

Overall Leq (Include "O" minutes, Exclude "X" minutes) = 68.9 **dBA**

Subset Leq (Exclude "O" and "X" minutes) = **dBA**

"O" = other characteristic sources that contributed to the Leq

"X" = exclude from Leq calculation; a non-typical source contaminated the measurement

NOISE MEASUREMENT SITE INFORMATION SHEET

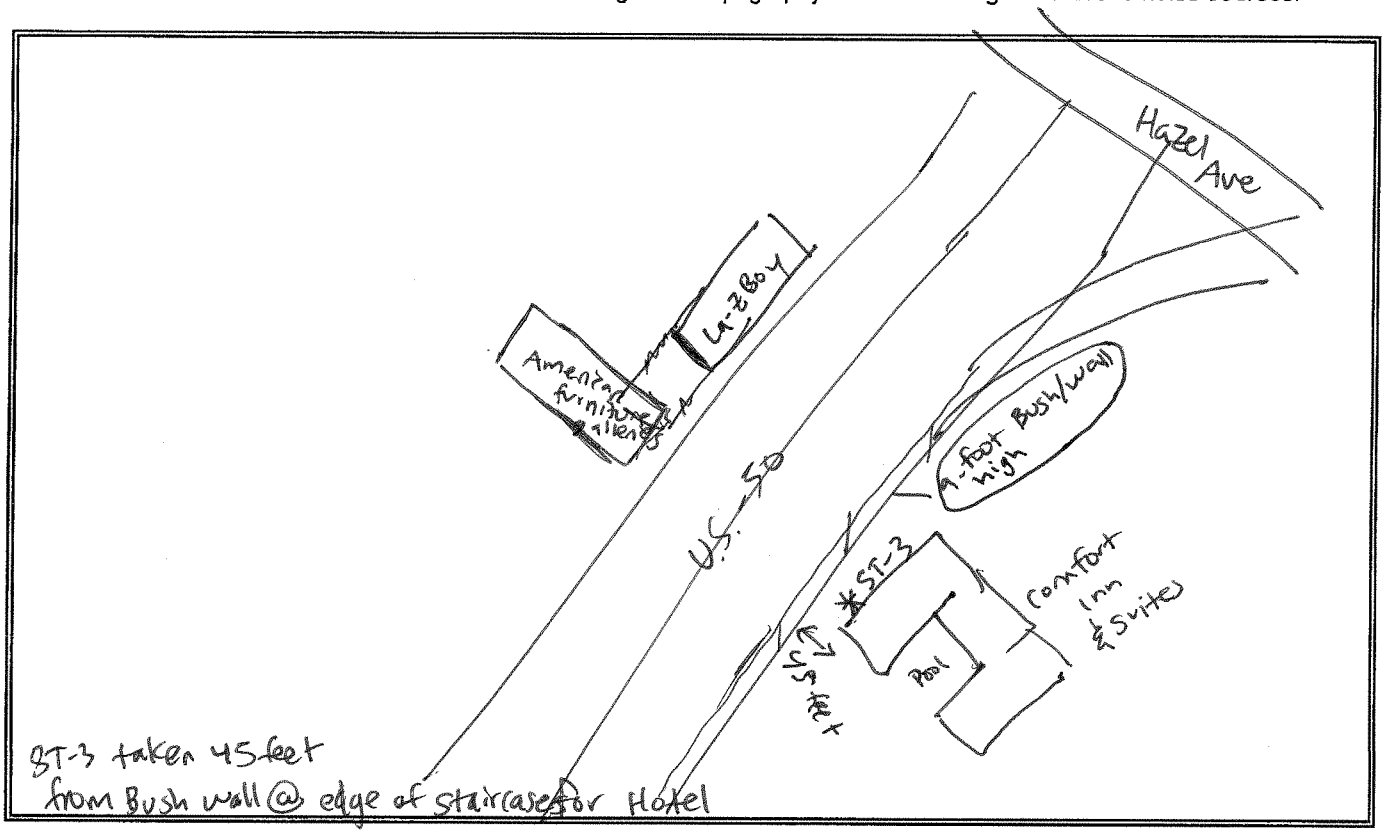
Jones & Stokes

PROJECT NAME: Hazel Ave/US-50 PROJECT #:

SITE NUMBER: ST-3 DATE/TIME: 3/15/2016 11:45

LOCATION/ADDRESS: Comfort Inn & Suites ENGINEERS: C. Matsui & E. Smith

SITE SKETCH: Show microphone location, nearby residences/buildings, potential reflective surfaces, project roadways, local roadways, driveways, ground type, trees. Indicate reference distances between objects, arrows showing wind direction, North, and camera locations/directions. Describe the line-of-sight and topography/elevation changes relative to noise sources.



WEATHER DATA: (temperature, wind speed/direction, sky conditions, relative humidity)

58°F, 2mph Avg wind, 53% RH, clear skies

EQUIPMENT DATA: (sound level meter, microphone, preamp, calibrator, factory cal. date)

LD-831, Cal 200

ESTIMATED CONSTRUCTION DATE OF RESIDENCES: (Pre-1978, or new construction) 1980s?

POSTED SPEED: NA Not visible COMMENTS: Shrubs = 9 feet high

TRAFFIC COUNTS:

Roadway/Direction	Autos	Medium	Heavy	Mot	Speed	Start Time	Duration
US 50 EB Hazel off-ramp	160	1	3	2			

NOISE MEASUREMENT LOG SHEET (20)

Jones & Stokes

PROJECT NAME: Hazel Ave/US -50
PROJECT #:
SITE NUMBER: ST-3
DATE/TIME: 3/15/16 ~11:45 – meter says 10:45 b/c daylight Savings
LOCATION/ADDRESS: Comfort Inn & Suites
ENGINEERS: E. Scott & C. Matsui

#	Minute Starting	Measured Leq (dBA)	O or X	Autos	Medium Trucks	Heavy Trucks	Other Noise Sources/Comments (include SLM equipment, Calibration Data)
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							Bird chirping close by
12							
13							
14							Leq 72.2
15							Lmax
16							Lmin
17							L10
18							L33
19							L50
20							L90

Overall Leq (Include "O" minutes, Exclude "X" minutes) = 72.2 **dBA**

Subset Leq (Exclude "O" and "X" minutes) = **dBA**

"O" = other characteristic sources that contributed to the Leq

"X" = exclude from Leq calculation; a non-typical source contaminated the measurement

NOISE MEASUREMENT SITE INFORMATION SHEET

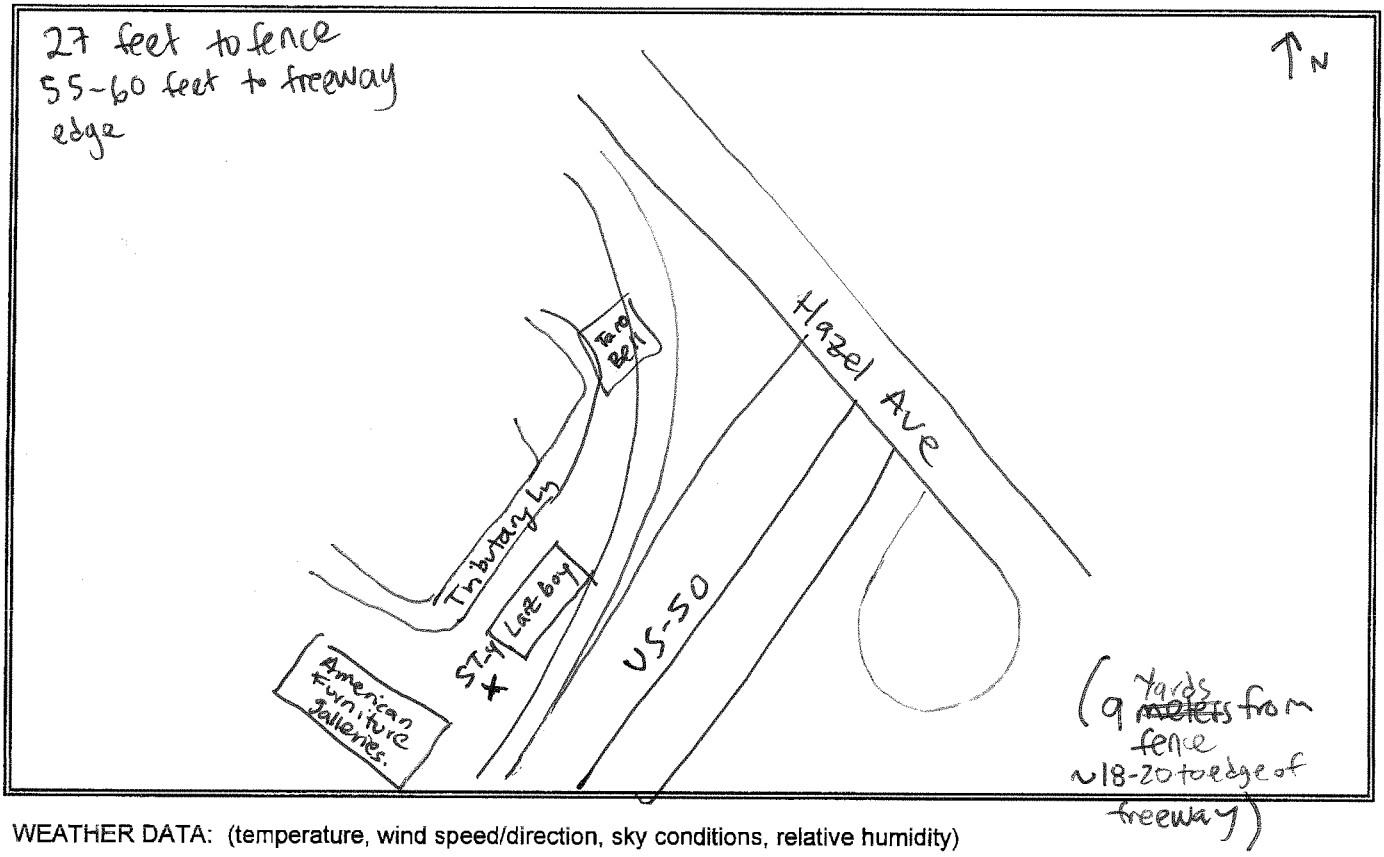
Jones & Stokes

PROJECT NAME: Hazel Ave/US-50 interchange PROJECT #:

SITE NUMBER: ST-4 DATE/TIME: 3/15/2016

LOCATION/ADDRESS: near Taco Bell & American Furniture galleries ENGINEERS: E. Scott & C. Matsui

SITE SKETCH: Show microphone location, nearby residences/buildings, potential reflective surfaces, project roadways, local roadways, driveways, ground type, trees. Indicate reference distances between objects, arrows showing wind direction, North, and camera locations/directions. Describe the line-of-sight and topography/elevation changes relative to noise sources.



WEATHER DATA: (temperature, wind speed/direction, sky conditions, relative humidity)

1 mph Avg winds, 58.5°F, 44% RH, clear skies

EQUIPMENT DATA: (sound level meter, microphone, preamp, calibrator, factory cal. date)

LD-831, Cal 200 (SIN: 4593)

ESTIMATED CONSTRUCTION DATE OF RESIDENCES: (Pre-1978, or new construction)

POSTED SPEED: COMMENTS:

measured speeds of on-ramp: 35-55
TRAFFIC COUNTS: Freeway speeds 55-65

Roadway/Direction	Autos	Medium	Heavy	Moto	Speed	Start Time	Duration
US EB Hazel off-ramp	143	2	5	1			

NOISE MEASUREMENT LOG SHEET (20)

Note: Meter time not adjusted for daylight savings

Jones & Stokes

PROJECT NAME: Hazel Ave/US-50 interchange
PROJECT #: ~~E~~
SITE NUMBER: ST-4
DATE/TIME: 3/15/2016 ~10:55 AM
LOCATION/ADDRESS: near Taco Bell
ENGINEERS: E. Scott & C. Matsui

Meter says 9:55

#	Minute Starting	Measured Leq (dBA)	O or X	Autos	Medium Trucks	Heavy Trucks	Other Noise Sources/Comments (include SLM equipment, Calibration Data)
1	0:00						
2	0:01						
3	0:02						
4	0:03						
5	0:04						
6	0:05						Door closing at nearby building
7	0:06						
8	0:07						
9	0:08						
10	0:09						9:25 - car door closing
11	0:10						
12	0:11						
13	0:12						12:45 car door closing
14	0:13						
15	0:14						
16	Duration = 15:30						
17							
18							
19							
20							

Leq	67.1
Lmax	
Lmin	
L10	
L33	
L50	
L90	

Overall Leq (Include "O" minutes, Exclude "X" minutes) = 67.1 **dBA**

Subset Leq (Exclude "O" and "X" minutes) = **dBA**

"O" = other characteristic sources that contributed to the Leq

"X" = exclude from Leq calculation; a non-typical source contaminated the measurement

NOISE MEASUREMENT SITE INFORMATION SHEET

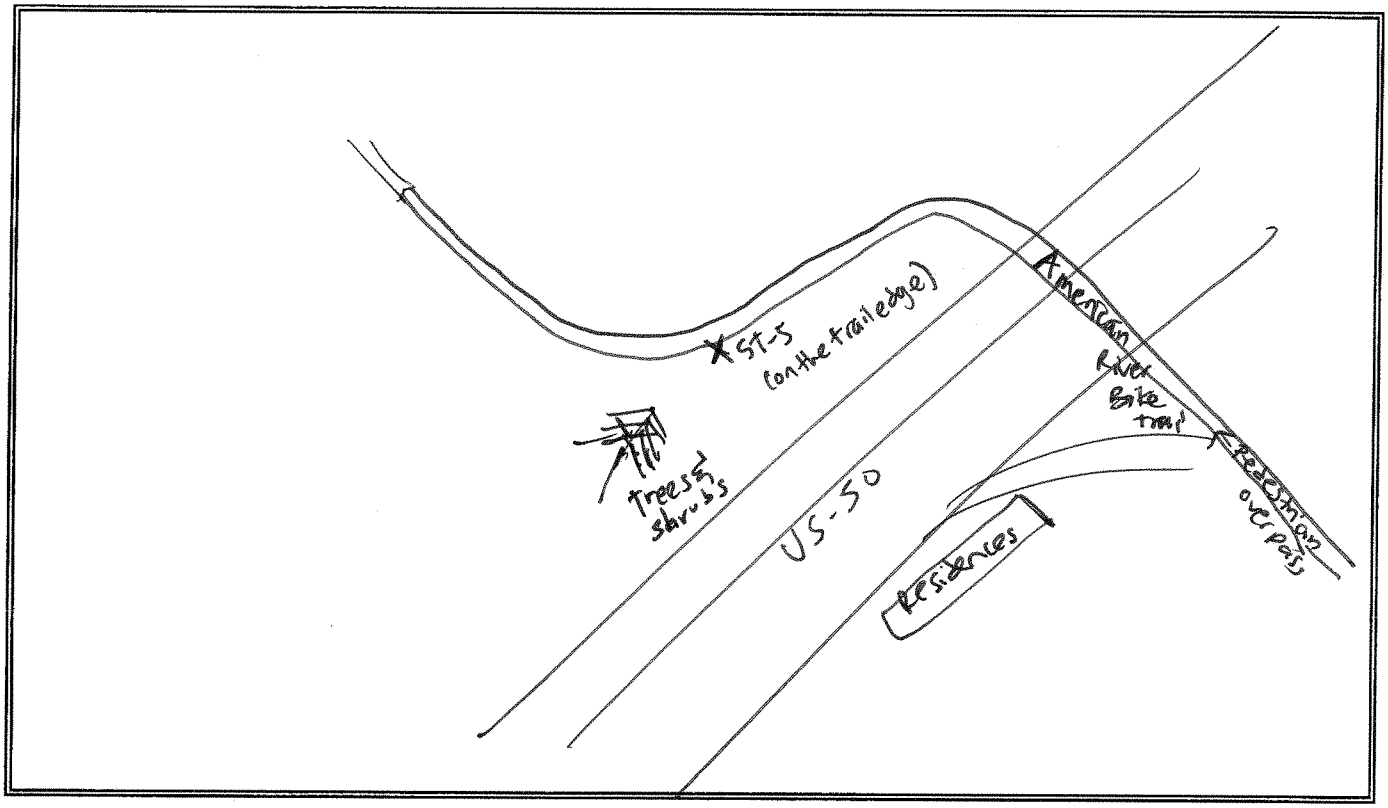
Jones & Stokes

PROJECT NAME: Hazel Ave/U.S. 50 PROJECT #:

SITE NUMBER: ST-5 DATE/TIME: 3/15/2016 ~2:45 pm (Meter says 1:45)

LOCATION/ADDRESS: on American River Bike trail ENGINEERS: C. Matsui & E. Scott

SITE SKETCH: Show microphone location, nearby residences/buildings, potential reflective surfaces, project roadways, local roadways, driveways, ground type, trees. Indicate reference distances between objects, arrows showing wind direction, North, and camera locations/directions. Describe the line-of-sight and topography/elevation changes relative to noise sources.



WEATHER DATA: (temperature, wind speed/direction, sky conditions, relative humidity)

Sunny, 15 MPH avg, 71°F, 42% RH

EQUIPMENT DATA: (sound level meter, microphone, preamp, calibrator, factory cal. date)

LD-831, Cal 200

ESTIMATED CONSTRUCTION DATE OF RESIDENCES: (Pre-1978, or new construction)

POSTED SPEED: COMMENTS:

TRAFFIC COUNTS:

Roadway/Direction	Autos	Medium	Heavy	Motor	Speed	Start Time	Duration
Aerojet EB off ramp	20	0	1				
WB-50 to Hazel off-ramp	222	5	0	1			

NOISE MEASUREMENT LOG SHEET (20)

Jones & Stokes

PROJECT NAME: Hazel Ave/U.S.-50 PROJECT #:

SITE NUMBER: ST-5 DATE/TIME: 3/15/2016

LOCATION/ADDRESS: ENGINEERS: C. Matsui & E. Scott

#	Minute Starting	Measured Leq (dBA)	O or X	Autos	Medium Trucks	Heavy Trucks	Other Noise Sources/Comments (include SLM equipment, Calibration Data)
1							
2							
3							
4				no noticible/audible other noise sources			
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

Leq	71.4
Lmax	
Lmin	
L10	
L33	
L50	
L90	

Overall Leq (Include "O" minutes, Exclude "X" minutes) = 71.4 **dBA**

Subset Leq (Exclude "O" and "X" minutes) = **dBA**

"O" = other characteristic sources that contributed to the Leq

"X" = exclude from Leq calculation; a non-typical source contaminated the measurement

LT - 1

Location: west of cattleman's near RV resort

Start time & date: 2:25

Lock combo: PAST

Meter #: 4

Cal:

Wall Height: 6 feet



Noise Abatement Decision Report

Hazel Avenue/U.S. Route 50 Interchange Project

City of Rancho Cordova, Sacramento County

03-SAC-50/PM 15.1-17.5

Federal Project No.: EA 03-3E380/E-FIS 0300020439

April 2017

Caltrans
CALIFORNIA DEPARTMENT OF TRANSPORTATION

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Noise Abatement Decision Report

Hazel Avenue/U.S. Route 50 Interchange Project

City of Rancho Cordova, Sacramento County

03-SAC-50/PM 15.1-17.5

Federal Project No.: EA 03-3E380/E-FIS 0300020439

April 2017

Prepared By: _____ Date: 4/17/2017

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List of Abbreviated Terms

Benefited residence	A dwelling unit expected to receive a noise reducton of at least 5 dBA from the proposed abatement measure
Caltrans	California Department of Transportation
CE	Categorical Exclusion
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
Critical design receiver	The design receiver that is affected and for which the absolute noise levels, build vs. existing noise levels, or achievable noise reduction will be at a maximum where noise abatement is considered
Date of public knowledge	The date that a project is approved—approval of the final environmental documentation (e.g., Record of Decision) is complete
dB	decibel
dBA	A-weighted decibel
ED	Environmental document
FHWA	Federal Highway Administration
FONSI	Finding of No Significant Impact
HOV	high occupancy vehicle
L_{eq}	Equivalent sound level (energy averaged sound level)
$L_{eq}(h)$	A-weighted, energy average sound level during a 1-hour period
NAC	Noise abatement criteria
NADR	Noise Abatement Decision Report
NSR	Noise study report
Planned, designed, and programmed	A noise-sensitive land use is considered planned, designed, and programmed when it has received final development approval (generally the issuance of a building permit) from the local agency with jurisdiction
proposed project	US 50/Hazel Avenue Interchange Project
Protocol	Caltrans Traffic Noise Analysis Protocol
Reasonable allowance	A single dollar value—a reasonable allowance per benefited residence that embodies five reasonableness factors
ROD	Record of Decision
ROW	right-of-way

Chapter 1 Introduction

The Noise Abatement Decision Report (NADR) presents the preliminary noise abatement decision as defined in the California Department of Transportation (Caltrans) Traffic Noise Analysis Protocol (Protocol) for the US 50/Hazel Avenue Interchange Project (proposed project). This report has been approved by a California licensed professional civil engineer. The project-level noise study report (NSR) (ICF 2017) was approved by Caltrans on February 1, 2017.

1.1 Noise Abatement Assessment Requirements

Title 23, Code of Federal Regulations (CFR), Part 772 of the Federal Highway Administration (FHWA) standards (23 CFR 772) and the Protocol require that noise abatement be considered for projects that are predicted to result in traffic noise impacts. A traffic noise impact is considered to occur when future predicted design-year noise levels with the project approach or exceed Noise Abatement Criteria (NAC) defined in 23 CFR 772 or when the predicted design-year noise levels with the project substantially exceed existing noise levels. A predicted design-year noise level is considered to approach the NAC when it is within 1 decibel (dB) of the NAC. A substantial increase is defined as being a 12-dB increase above existing conditions.

FHWA requires that noise abatement measures that are reasonable and feasible and are likely to be incorporated into the project be identified before adoption of the final environmental document (ED).

The Protocol establishes a process for assessing the reasonableness and feasibility of noise abatement. Before publication of the draft ED, a *preliminary noise abatement decision* is made. The preliminary noise abatement decision is based on the *feasibility* of evaluated abatement and the *preliminary reasonableness determination.* Noise abatement is considered to be acoustically feasible if it provides noise reduction of at least 5 A-weighted decibels (dBA) at receivers subject to noise impacts. Other nonacoustical factors relating to geometric standards (e.g., sight distances), safety, maintenance, and security can also affect feasibility.

The preliminary reasonableness determination is made by calculating an allowance that is considered to be a reasonable amount of money, per benefited residence, to spend on abatement. This *reasonable allowance* is then compared to the engineer's cost estimate for the abatement. If the engineer's cost estimate is less than the allowance, the preliminary determination is that the abatement is reasonable. If the cost estimate is higher than the allowance, the preliminary determination is that abatement is not reasonable.

The NADR presents the preliminary noise abatement decision based on acoustical and nonacoustical feasibility factors and reasonableness. The NADR does not present the final decision regarding noise abatement; rather, it presents key information on abatement to be considered throughout the environmental review process, based on the best available information at the time the draft ED is published.

Noise abatement must be predicted to reduce noise by at least 5 dB at an affected receptor to be considered feasible from an acoustical perspective. The determination of the reasonableness of noise abatement is more subjective than the determination of its feasibility. As defined in Section 772.5 of 23 CFR 772, reasonableness is the combination of social, economic, and environmental factors considered in the evaluation of a noise abatement measure. As defined in the Protocol, the overall reasonableness of noise abatement is determined by the following three factors:

- The noise reduction design goal.
- The cost of noise abatement.
- The viewpoints of benefited receptors (including property owners and residents of the benefited receptors).

The NADR addresses the noise reduction design goal (7 dB reduction at one or more benefited receptors) and the cost of noise abatement. Polling of benefited receptors is normally completed prior to circulation of the draft environmental document. The results of the polling and the final reasonableness determination are included in the Categorical Exclusion (CE), Finding of No Significant Impact (FONSI), or Record of Decision (ROD).

At the end of the public review process for the ED, the final noise abatement decision is made and is indicated in the final ED. The preliminary noise abatement decision will become the final noise abatement decision unless compelling information received during the environmental review process indicates that it should be changed.

1.2 Purpose of the Noise Abatement Decision Report

The purpose of the NADR is to:

- Summarize the conclusions of the NSR relating to acoustical feasibility and the reasonable allowances for abatement evaluated.
- Present the engineer's cost estimate for evaluated abatement.
- Present the engineer's evaluation of nonacoustical feasibility issues.
- Present the preliminary noise abatement decision.
- Present preliminary information on secondary effects of abatement (impacts on cultural resources, scenic views, hazardous materials, biology, etc.).

The NADR does not address noise barriers or other noise-reducing treatments required as mitigation for significant adverse environmental effects identified under the California Environmental Quality Act (CEQA).

1.3 Project Description

The proposed project would construct modifications to the existing interchange, and grade-separate and extend Hazel Avenue to the south to a future intersection with Atlanta Street, which will be built with the approved Easton Place development. Three build alternatives have been developed for the project. The proposed project includes:

- Construction of a portion of an eastbound transition auxiliary lane on US 50 from Hazel Avenue through the Folsom Boulevard Overcrossing, also known as the Natoma Overhead.
- Modification of the existing Aerojet Road off-ramp from US 50.
- Reconstruction of the westbound loop on-ramp.
- Reconstruction of the eastbound diagonal off-ramp, and both eastbound on-ramps.
- Eastbound on- and off-ramp auxiliary lanes, from west of the Hazel Avenue to the eastbound off-ramp, and from the loop on-ramp extending to the Folsom Boulevard interchange.
- Roadway improvements constructed along approximately 2,300 feet of Folsom Boulevard. Improvements include sidewalks, street lighting, and landscaping along the north side of Folsom Boulevard, and landscaping and lighting along the south.

The build alternatives for the proposed project would meet the following objectives:

- Improve operations by removing the close intersection spacing between the eastbound ramps and Folsom Boulevard, and minimizing conflict with heavy and light rail.
- Provide sufficient capacity in the ramps and roadways for future traffic volumes.
- Maintain the Aerojet Road off-ramp connection to the approved development while improving the mainline operations.

The proposed project is needed to relieve congestion at the existing interchange and to accommodate planned and approved developments identified by the adopted Sacramento County General Plan and the Sacramento Area Council of Government's (SACOG's) Regional Transportation Plan.

The approved developments within and near the project area will increase traffic demand beyond what the existing interchange can accommodate. The close spacing between the Folsom Boulevard intersection and the eastbound off-ramp intersection does not provide sufficient queuing for increased traffic volumes. Additionally, the County of Sacramento is currently widening Hazel Avenue from four to six traffic lanes between the existing interchange and Madison Avenue. This increase in roadway capacity is expected to deliver more traffic to the US 50/Hazel Avenue interchange during peak traffic periods.

1.3.1 Project Location

The project is at the interchange of Hazel Avenue and US 50 in Sacramento County. The project area is bounded along Hazel Avenue by the Tributary Point/westbound off-ramp intersection to

the north, and extends approximately 1,000 feet south of Folsom Boulevard to a future intersection within the proposed Easton Place development. The project limits along US 50 begin approximately 3,200 feet west of the existing Hazel Avenue Overcrossing, and extend 2,500 feet east of the Natoma Overhead. Improvements along Folsom Boulevard would extend from approximately 1,200 feet west of the Hazel Avenue intersection to a terminus 900 feet to the east.

1.3.2 Project Alternatives

The following build alternatives are under consideration and were designed to satisfy the proposed project's purpose and need while avoiding or minimizing environmental impacts. The build alternatives include common design features and have similar phasing approaches, staging, storage, and site access. For alignment and other improvement features that differ between alternative, see the individual alternative descriptions below.

1.3.2.1 Alternative 1: L-9 Interchange with Viaduct Connector

Alternative 1 consists of a modified type L-9 interchange configuration. A Caltrans Type L-9 interchange indicates a ramp configuration that includes a diagonal off-ramp, a diagonal on-ramp and a loop on-ramp. This alternative would provide a viaduct connection to Aerojet Road.

As with all alternatives, Hazel Avenue would grade-separate over Folsom Boulevard and the Sacramento Placerville Transportation Corridor Joint Powers Authority rail corridor and would extend south to a proposed intersection with the future Atlanta Street. The existing at-grade intersection of Hazel Avenue and Folsom Boulevard would be removed, sidewalks would be extended across the former intersection, and the lanes would be restriped to remove left-turn lanes.

The location of the departure point of the existing Aerojet Road off-ramp from US 50 would be moved to join with the eastbound Hazel Avenue off-ramp. The eastbound Hazel Avenue off-ramp would split and introduce a direct viaduct ramp over Hazel Avenue to carry eastbound off-ramp traffic to Aerojet Road and Folsom Boulevard. The US 50 off-ramp would shift approximately 830 feet to the east to provide decision sight distance before the Aerojet Road split. The two-lane off-ramp would widen to five lanes at the ramp terminal intersection, with three left-turn lanes and two right-turn lanes. Retaining walls and barriers placed at the proposed right-of-way (ROW) would minimize acquisition. The eastbound off-ramp would also have an auxiliary lane prior to the exit.

The Aerojet Road viaduct would land adjacent to the eastbound diagonal on-ramp and then turn southerly to conform to Folsom Boulevard along its existing alignment. Retaining walls are proposed between the viaduct and the diagonal on-ramp to accommodate the grade difference and to the outside of the ramp after the viaduct lands to minimize ROW acquisitions. Retaining walls are also proposed along Aerojet Road as it approaches the horizontal curve towards Folsom Boulevard to accommodate the grade difference between the ramp and mainline and to minimize ROW acquisition.

The existing Hazel Avenue overcrossing of US 50 would be widened on the west side to accommodate eight lanes (three through lanes and one freeway-only lane in both directions). The existing raised concrete median across the structure would be removed, and the roadway would be restriped with a 6-foot striped median. The existing sidewalk and barrier on the east side of the structure would remain.

1.3.2.2 Alternative 1A: L-9 Interchange with Undercrossing Connector

Alternative 1A is the same as Alternative 1, with the following exceptions:

The eastbound US 50 off-ramp would split and introduce a direct tunnel ramp under Hazel Avenue to carry eastbound off-ramp traffic to Aerojet Road and Folsom Boulevard.

1.3.2.3 Alternative 2: Direct Flyover to Hazel Avenue With Connector

Alternative 2 consists of a modified type L-9 interchange configuration, with a flyover ramp carrying vehicles travelling from eastbound US 50 to northbound Hazel Avenue over the freeway to join with the westbound US 50 off-ramp. The existing Aerojet Road off-ramp from US 50 would be removed.

The eastbound off-ramp divergence point from US 50 would be shifted approximately 680 feet to the east to provide decision sight distance. An auxiliary lane would precede the off-ramp. A retaining wall is proposed adjacent to the off-ramp to minimize ROW acquisition.

The eastbound off-ramp would split and introduce northbound and southbound Hazel Avenue ramps. The northbound ramp would also carry traffic headed for Aerojet Road/Folsom Boulevard. An overhead sign would direct vehicles heading to southbound Hazel Avenue into the right lane and direct vehicles destined for northbound Hazel Avenue, Aerojet Road, or Folsom Boulevard to use either lane. Retaining walls are proposed for the ramp as it approaches the horizontal curve towards Folsom Boulevard to accommodate the grade difference between the ramp and mainline and to minimize ROW acquisition at an apartment complex.

The northbound Hazel Avenue movement would cross under Hazel Avenue at the interchange, cross over US 50 on a two-lane flyover structure, and then merge with the westbound off-ramp and terminate at the Hazel Avenue/Tributary Point intersection. The westbound off-ramp would split so that the southbound and through movements align to the left of the ramp, and the northbound movements are to the right.

The southbound ramp would connect directly to Hazel Avenue; however, for Alternative 2 an intersection is not required at Hazel Avenue and the eastbound ramp. By eliminating an intersection at the eastbound ramp, and by removing the heavy eastbound-to-northbound movements from the Hazel Avenue overcrossing, the existing structure could remain without widening.

The two-lane westbound US 50 off-ramp would be reconstructed to provide decision sight distance between the divergence point from US 50 and a new ramp split that accommodates the flyover. The westbound off-ramp would split on either side of the flyover ramp, with one lane to

the right carrying northbound Hazel Avenue traffic and the other crossing underneath the flyover ramp to join up on the left side of the flyover for the southbound Hazel Avenue movements. The profiles of the three ramps have been coordinated to match grade quickly in order to minimize retaining wall limits and enhance driver visibility. Overhead signage would direct drivers into the appropriate lanes for northbound and southbound Hazel Avenue traffic.

1.3.2.4 Alternative 3: No Build Alternative

Alternative 3, the No Build Alternative, would not modify the existing interchange and would retain the same existing configuration, ramps, and lanes. The No Build Alternative does not meet the purpose and need of the proposed project.

1.4 Affected Land Uses

A field investigation was conducted to identify land uses that could be subject to traffic and construction noise impacts resulting from the proposed project. Land uses in the project area consist of a mobile home park (Activity Category B), multi-family apartment buildings (Activity Category B), parks (Activity Category C), recreational use areas (Activity Category C), hotels (Activity Category E), and several commercial uses that include no apparent outdoor areas of frequent human use (Activity Category F).

As required by the Protocol, all developed land uses were evaluated in this analysis. However, noise abatement is only considered for areas of frequent human use that would benefit from a lowered noise level. Accordingly, the impact analysis in the NSR focused on locations with defined outdoor activity areas, such as residential backyards and public outdoor use areas.

Chapter 2 Results of the Noise Study Report

The NSR for this project was prepared by ICF in January 2017 and approved by Caltrans on February 1, 2017.

Traffic noise levels under design-year with-project conditions indicate that a substantial increase in noise levels over existing conditions is not predicted to occur under any of the three build alternatives. However, levels are predicted to approach or exceed the NAC of 67 dBA-L_{eq}(h) for Activity Category B and Activity Category C land uses under all three build alternatives. Therefore, traffic noise impacts are predicted to occur, and noise abatement was considered.

For each of the three build alternatives studied in the NSR, a noise barrier was evaluated to benefit Activity Category B land uses along the proposed Aerojet Road off-ramp. Each wall option was found to be acoustically feasible, and met the design goal of 7 dB of noise reduction for at least one receiver at 10 feet under Alternatives 1 and 1A, and at 12 feet under Alternative 2. The barriers determined to be feasible in the NSR are described below.

2.1 Aerojet Road Off-Ramp Barrier, Alternative 1

Traffic noise levels are predicted to approach or exceed the NAC of 67 dBA Leq(h) for Activity Category B land uses along the frontage of the proposed Aerojet Road off-ramp. Detailed modeling analysis was conducted for a noise barrier along the proposed Aerojet Road off-ramp under Alternative 1, located along the edge-of-shoulder of the off-ramp. The barrier is shown in Figure 1.

Barrier heights in the range of 8 to 14 feet were evaluated in 2-foot increments, as shown in Appendix A. The total barrier length, including both wall segments, would be 1,520 feet. The barrier would meet the barrier design goal of 7 dB at a minimum height of 10 feet. At a maximum height of 14 feet, the barrier would provide up to 13 dB of noise reduction at affected receiver locations. Therefore, the barrier is considered feasible. Calculated noise reductions and reasonable allowances for each barrier height are summarized in Table 1.

Table 1. Summary of Reasonable Allowance Data— Aerojet Road Off-Ramp Barrier, Alternative 1

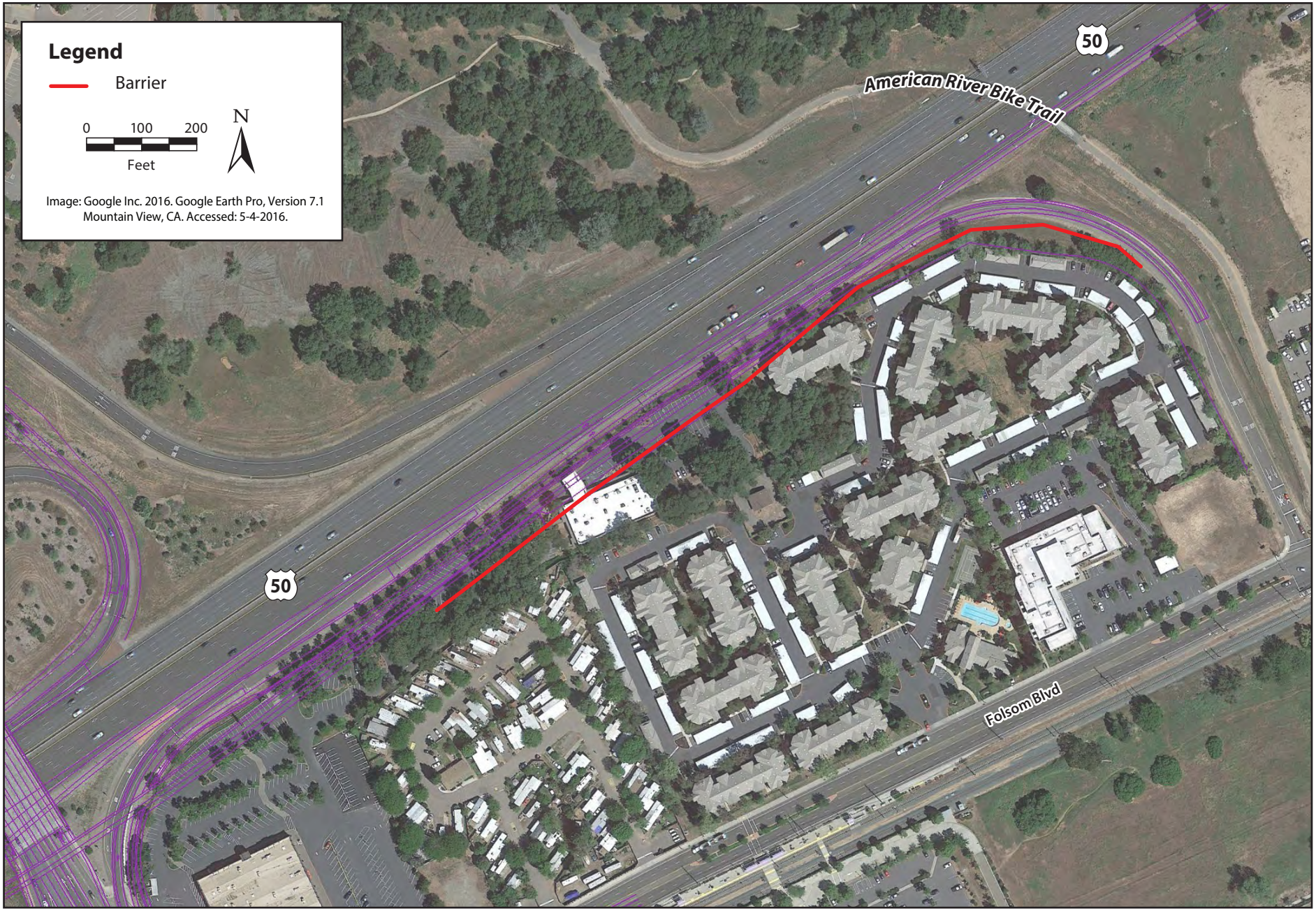
Location: Aerojet Road, Proposed Off-ramp, Alternative 1				
Predicted Sound Level without Barrier				
Design year noise level, dBA Leq(h):	81 dBA			
Design year noise level minus existing noise level:	2 dBA			
Design Year with Barrier	**8-foot Noise Barrier**	**10-foot Noise Barrier**	**12-foot Noise Barrier**	**14-foot Noise Barrier**
Barrier noise reduction, dB	6	9	11	13
Barrier design goal met?	No	Yes	Yes	Yes
Number of benefited receivers	5	12	28	33
Reasonable allowance per benefited receiver	$80,000	$80,000	$80,000	$80,000
Total reasonable allowance	$400,000	$960,000	$2,240,000	$2,640,000

dBA = A-weighted decibels.

2.2 Aerojet Road Off-Ramp Barrier, Alternative 1A

Detailed modeling analysis was conducted for a noise barrier along the proposed Aerojet Road off-ramp under Alternative 1A, located along the edge-of-shoulder of the off-ramp. The barrier is shown in Figure 2.

Barrier heights in the range of 8 to 14 feet were evaluated in 2-foot increments, as shown in Appendix A. The total barrier length, including both wall segments, would be 1,900 feet. The barrier would meet the barrier design goal of 7 dB at a minimum height of 10 feet. At a maximum height of 14 feet, the barrier would provide up to 13 dB of noise reduction at affected receiver locations. Therefore, the barrier is considered feasible. Calculated noise reductions and reasonable allowances for each barrier height are summarized in Table 2.



Graphics \ 0052915 (4-12-2017)

Figure 1
Noise Barrier, Alternative 1



Graphics \ 0052915 (4-12-2017)

Figure 2
Noise Barrier, Alternative 1A

**Table 2. Summary of Reasonable Allowance Data—
Aerojet Road Off-Ramp Barrier, Alternative 1A**

Location: Aerojet Road, proposed off-ramp, Alternative 1A				
Predicted Sound Level without Barrier				
Design year noise level, dBA Leq(h):	81 dBA			
Design year noise level minus existing noise level:	3 dBA			
Design Year with Barrier	**8-foot Noise Barrier**	**10-foot Noise Barrier**	**12-foot Noise Barrier**	**14-foot Noise Barrier**
Barrier noise reduction, dB	6	10	11	13
Barrier design goal met?	No	Yes	Yes	Yes
Number of benefited receivers	3	23	37	41
Reasonable allowance per benefited receiver	$80,000	$80,000	$80,000	$80,000
Total reasonable allowance	$240,000	$1,840,000	$2,960,000	$3,280,000

dBA = A-weighted decibels.

2.3 Aerojet Road Off-Ramp Barrier, Alternative 2

Detailed modeling analysis was conducted for a noise barrier along the proposed Aerojet Road off-ramp under Alternative 2, located along the edge-of-shoulder of the off-ramp. The barrier is shown in Figure 3.

Barrier heights in the range of 8 to 14 feet were evaluated in 2-foot increments, as shown in Appendix A. The total barrier length, including both wall segments, would be 1,960 feet. The barrier would meet the barrier design goal of 7 dB at a minimum height of 12 feet. At a maximum height of 14 feet, the barrier would provide up to 12 dB of noise reduction at affected receiver locations. Therefore, the barrier is considered feasible. Calculated noise reductions and reasonable allowances for each barrier height are summarized in Table 3.

**Table 3. Summary of Reasonableness Determination Data—
Aerojet Road Off-Ramp Barrier, Alternative 2**

Location: Aerojet Road, proposed off-ramp, Alternative 2				
Predicted Sound Level without Barrier				
Design year noise level, dBA Leq(h):	81 dBA			
Design year noise level minus existing noise level:	4 dBA			
Design Year with Barrier	**8-foot Noise Barrier**	**10-foot Noise Barrier**	**12-foot Noise Barrier**	**14-foot Noise Barrier**
Barrier noise reduction, dB	4	6	10	12
Barrier design goal met?	No	No	Yes	Yes
Number of benefited receivers	0	15	28	38
Reasonable allowance per benefited receiver	$80,000	$80,000	$80,000	$80,000
Total reasonable allowance	$0	$1,200,000	$2,240,000	$3,040,000

dBA = A-weighted decibels.



Graphics \ 0052915 (4-12-2017)

Figure 3
Noise Barrier, Alternative 2

Chapter 3 Preliminary Noise Abatement Decision

3.1 Summary of Key Information

For each of the barriers evaluated, noise abatement allowances were calculated for a range of barrier heights. Allowances were only calculated for barrier heights that were acoustically feasible. Table 4 summarizes the calculated noise abatement allowances for barrier heights of 6 to 14 feet. The estimated cost to construct each barrier was calculated by Mark Thomas, the project engineering firm (Mark Thomas 2017).

3.2 Nonacoustical Factors Relating to Feasibility

There are no nonacoustical factors relating to feasibility of barriers for the proposed project.

3.3 Preliminary Recommendation and Decision

As shown in Table 4, estimated construction costs for barrier heights of 10 to 14 feet for the Aerojet Road off-ramp barrier under Alternatives 1 and 1A are projected to be within cost-reasonableness allowances. The same is true for the barrier under Alternative 2, at heights of 12 to 14 feet. Accordingly, these barrier designs are considered to be reasonable from a cost perspective.

The recommended height of the barrier is 14 feet for all project build alternatives. A barrier at this height would benefit the greatest number of affected receptors for all build alternatives.

At a height of 14 feet, the barrier under Alternative 1 would benefit 33 residences at a reasonable allowance of $80,000 per residence, yielding a total reasonable allowance of $2,640,000. The estimated construction cost to build the 14-foot barrier is $713,288, which is lower than the barrier cost allowance.

At a height of 14 feet, the barrier under Alternative 1A would benefit 41 residences at a reasonable allowance of $80,000 per residence, yielding a total reasonable allowance of $3,280,000. The estimated construction cost to build the 14-foot barrier is $891,413, which is lower than the barrier cost allowance.

At a height of 14 feet, the barrier under Alternative 2 would benefit 38 residences at a reasonable allowance of $80,000 per residence, yielding a total reasonable allowance of $3,040,000. The estimated construction cost to build the 14-foot barrier is $919,538, which is lower than the barrier cost allowance.

The preliminary noise abatement decision presented in this report is based on preliminary project alignments and profiles, which may be subject to change. As such, the physical characteristics of noise abatement described herein also may be subject to change. If pertinent parameters change substantially during the final project design, the preliminary noise abatement decision may be changed or eliminated from the final project design. A final decision to construct noise abatement will be made upon completion of the project design. The preliminary noise abatement decision presented here will be included in the draft environmental document, which will be circulated for public review.

Table 4. Summary of Cost Reasonableness of Evaluated Barriers

Noise Barrier	Barrier Height (feet) [1]	Total Noise-Sensitive Receptors Benefited	Barrier Length (feet)	Barrier Surface Area (sq feet) [2]	Barrier Cost Allowance (dollars per benefited receptor)	Barrier Cost Allowance (total dollars)	Engineer's Cost Estimate (total dollars)	Design Goal Met	Is Barrier Cost-Reasonable?
Aerojet Road Off-ramp Barrier, Alternative 1	8	5	1,520	7,600	$80,000	$400,000	n/a [3]	No	n/a 3
	10	12	1,520	10,640	$80,000	$960,000	$544,075	Yes	Yes
	12	28	1,520	13,680	$80,000	$2,240,000	$625,813	Yes	Yes
	14	33	1,520	16,720	$80,000	$2,640,000	$713,288	Yes	Yes
Aerojet Road Off-ramp Barrier, Alternative 1A	8	3	1,900	9,500	$80,000	$240,000	n/a [3]	No	n/a 3
	10	23	1,900	13,300	$80,000	$1,840,000	$679,925	Yes	Yes
	12	37	1,900	17,100	$80,000	$2,960,000	$782,088	Yes	Yes
	14	41	1,900	20,900	$80,000	$3,280,000	$891,413	Yes	Yes
Aerojet Road Off-ramp Barrier, Alternative 2	10	15	1,960	9,800	$80,000	$1,200,000	n/a [3]	No	n/a 3
	12	28	1,960	17,640	$80,000	$2,240,000	$806,763	Yes	Yes
	14	38	1,960	21,560	$80,000	$3,040,000	$919,538	Yes	Yes

[1] Barrier height consists of sound wall mounted on 3-foot concrete safety barrier.

[2] Barrier surface area accounts for the portion of wall mounted atop the 3-foot safety barrier.

[3] Design goal is met for greater heights, so cost reasonableness is not considered at this height.

Chapter 4 Secondary Effects of Abatement

Noise has the potential to result in secondary effects on cultural resources, scenic views, hazardous materials, biology, or other resources. Noise barriers described in this NADR would have a top elevation of no more than 14 feet above ground, and would be located along the frontage of residences and outdoor areas that face US 50. It is not anticipated that noise barriers under any of the alternatives would adversely affect any scenic views or otherwise result in visual impacts. In addition, since the barriers would be built within the State ROW, it is not anticipated that any other secondary effects related to other resources will occur. Therefore no secondary effects of abatement are anticipated.

Chapter 5 References

ICF. 2017. Noise Study Report for Hazel Avenue/U.S. Route 50 Interchange Project, City of Rancho Cordova, Sacramento County. Sacramento, CA. January.

Mark Thomas. 2017. Estimated cost of sound walls for the Hazel Avenue/U.S. Route 50 Interchange Project. Data received April 6, 2017.

Appendix A Noise Barrier Analysis

Table A-1. Aerojet Drive Barrier Analysis, Alternative 1

	Position																																	Total Number of Benefited Receivers
	R15	R16	R17	R18	R19	R20	R21	R22	R23	R24	R25	R26	R27	R28	R29	R25-1	R26-1	R28-1a	R27-1e	R27-1d	R27-1c	R27-1a	R27-1b	R23-1	R24-1	R28-1b	R28-1c	R25-2	R26-2	R27-2	R27-2a	R27-2b	R28-2	R24-2	R23-2	R28-2a	
Number of Units Represented	3	5	3	3	8	8	5	6	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	--
Future with Project Traffic Noise Level (dBA Leq[h]) [a]	62	**66**	**67**	**69**	62	60	62	61	**69**	**69**	**80**	**76**	65	64	61	**81**	**69**	64	65	62	62	**69**	**74**	64	64	62	61	**81**	**77**	**76**	**70**	**69**	**70**	**71**	**71**	**68**	--
8-Foot Barrier [b]																																					
Future with Project Traffic Noise Level (dBA Leq[h])	62	66	65	66	61	60	62	61	67	67	74	71	65	63	61	76	68	64	64	62	62	67	70	62	63	62	61	81	75	75	68	66	67	67	68	65	--
Predicted Noise Reduction (dB)	0	0	2	3	1	0	0	0	2	2	6	5	0	1	0	5	1	0	1	0	0	2	4	2	1	0	0	0	2	1	2	3	3	4	3	3	--
Number of Benefited Receivers	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
10-Foot Barrier [b]																																					
Future with Project Traffic Noise Level (dBA Leq[h])	62	65	65	65	61	59	62	61	65	65	71	68	64	61	61	72	65	62	63	61	62	65	68	60	61	60	59	81	72	73	67	66	66	66	66	64	--
Predicted Noise Reduction (dB)	0	1	2	4	1	1	0	0	4	4	9	8	1	3	0	9	4	2	2	1	0	4	6	4	3	2	2	0	5	3	3	3	4	5	5	4	--
Number of Benefited Receivers	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	2	0	0	0	0	2	2	0	12
12-Foot Barrier [b]																																					
Future with Project Traffic Noise Level (dBA Leq[h])	61	65	64	64	61	59	61	61	64	63	69	67	64	61	61	70	64	61	62	60	61	64	66	59	60	60	59	80	71	72	66	64	64	64	64	62	--
Predicted Noise Reduction (dB)	1	1	3	5	1	1	1	0	5	6	11	9	1	3	0	11	5	3	3	2	1	5	8	5	4	2	2	1	6	4	4	5	6	7	7	6	--
Number of Benefited Receivers	0	0	0	3	0	0	0	0	2	2	2	2	0	0	0	1	1	0	0	0	0	1	1	1	1	0	0	0	2	0	0	2	2	2	2	2	28
14-Foot Barrier [b]																																					
Future with Project Traffic Noise Level (dBA Leq[h])	61	65	64	64	61	59	61	61	63	62	67	66	63	60	61	68	63	61	61	59	61	63	65	58	59	59	58	78	69	70	65	63	63	62	63	61	--
Predicted Noise Reduction (dB)	1	1	3	5	1	1	1	0	6	7	13	10	2	4	0	13	6	3	4	3	1	6	9	6	5	3	3	3	8	6	5	6	7	9	8	7	--
Number of Benefited Receivers	0	0	0	3	0	0	0	0	2	2	2	2	0	0	0	1	1	0	0	0	0	1	1	1	1	0	0	0	2	2	2	2	2	2	2	2	33

a Traffic noise levels that approach or exceed 67 dBA Leq(h) are shown in bold/orange fill.
b Noise barriers that block the line-of-sight from the receptor to truck exhaust stacks are shaded in yellow for receptors exceeding NAC.

Table A-2. Aerojet Drive Barrier Analysis, Alternative 1A

	Position																																		Total Number of Benefited Receivers
	R15	R16	R17	R18	R19	R20	R21	R22	R23	R24	R25	R26	R27	R28	R29	R25-1	R26-1	R28-1a	R27-1e	R27-1d	R27-1c	R27-1a	R27-1b	R23-1	R24-1	R28-1b	R28-1c	R25-2	R26-2	R27-2	R27-2a	R27-2b	R28-2	R24-2	R23-2	R28-2a	
Number of Units Represented	3	5	3	3	8	8	5	6	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	--
Future with Project Traffic Noise Level (dBA Leq[h]) [a]	**66**	**76**	**76**	**76**	65	60	64	62	**70**	**69**	**80**	**75**	**66**	64	61	**81**	**69**	65	**66**	64	63	**69**	**74**	64	64	63	61	**81**	**77**	**76**	**71**	**70**	**70**	**71**	**73**	**68**	--
8-Foot Barrier [b]																																					
Future with Project Traffic Noise Level (dBA Leq[h])	65	73	72	72	64	60	63	61	68	68	74	71	65	64	61	75	67	64	64	62	62	67	70	63	63	62	61	81	75	74	69	67	67	67	69	65	--
Predicted Noise Reduction (dB)	1	3	4	4	1	0	1	1	2	1	6	4	1	0	0	6	2	1	2	2	1	2	4	1	1	1	0	0	2	2	2	3	3	4	4	3	--
Number of Benefited Receivers	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
10-Foot Barrier [b]																																					
Future with Project Traffic Noise Level (dBA Leq[h])	64	71	70	70	63	60	63	61	66	66	71	68	64	62	61	71	65	62	63	61	62	65	68	61	61	61	59	81	72	73	67	66	66	66	68	64	--
Predicted Noise Reduction (dB)	2	5	6	6	2	0	1	1	4	3	9	7	2	2	0	10	4	3	3	3	1	4	6	3	3	2	2	0	5	3	4	4	4	5	5	4	--
Number of Benefited Receivers	0	5	3	3	0	0	0	0	0	0	2	2	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	2	0	0	0	0	2	2	23
12-Foot Barrier [b]																																					
Future with Project Traffic Noise Level (dBA Leq[h])	63	70	69	68	63	60	63	61	65	64	69	67	64	61	61	69	64	61	62	60	61	64	66	60	60	60	59	79	71	72	66	65	65	65	66	62	--
Predicted Noise Reduction (dB)	3	6	7	8	2	0	1	1	5	5	11	8	2	3	0	12	5	4	4	4	2	5	8	4	4	3	2	2	6	4	5	5	5	6	7	6	--
Number of Benefited Receivers	0	5	3	3	0	0	0	0	2	2	2	2	0	0	0	1	1	0	0	0	0	1	1	0	0	0	0	0	2	0	2	2	2	2	2	2	37
14-Foot Barrier [b]																																					
Future with Project Traffic Noise Level (dBA Leq[h])	63	69	67	67	62	60	62	61	64	63	67	66	63	60	61	68	63	61	62	60	61	63	65	59	59	59	58	78	69	70	65	64	63	63	64	61	--
Predicted Noise Reduction (dB)	3	7	9	9	3	0	2	1	6	6	13	9	3	4	0	13	6	4	4	4	2	6	9	5	5	4	3	3	8	6	6	6	7	8	9	7	--
Number of Benefited Receivers	0	5	3	3	0	0	0	0	2	2	2	2	0	0	0	1	1	0	0	0	0	1	1	1	1	0	0	0	2	2	2	2	2	2	2	2	41

a Traffic noise levels that approach or exceed 67 dBA Leq(h) are shown in bold/orange fill.
b Noise barriers that block the line-of-sight from the receptor to truck exhaust stacks are shaded in yellow for receptors exceeding NAC.

Table A-3. Aerojet Drive Barrier Analysis, Alternative 2

	Position																																		Total Number of Benefited Receivers
	R15	R16	R17	R18	R19	R20	R21	R22	R23	R24	R25	R26	R27	R28	R29	R25-1	R26-1	R28-1a	R27-1e	R27-1d	R27-1c	R27-1a	R27-1b	R23-1	R24-1	R28-1b	R28-1c	R25-2	R26-2	R27-2	R27-2a	R27-2b	R28-2	R24-2	R23-2	R28-2a	
Number of Units Represented	3	5	3	3	8	8	5	6	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	--
Future with Project Traffic Noise Level (dBA Leq[h]) [a]	63	**70**	**72**	**74**	64	61	62	61	**72**	**71**	**80**	**78**	**70**	**66**	60	**81**	**72**	**66**	**68**	65	64	**75**	**77**	**66**	**66**	64	63	**81**	**77**	**77**	**71**	**70**	**71**	**72**	**73**	**70**	--
8-Foot Barrier [b]																																					
Future with Project Traffic Noise Level (dBA Leq[h])	62	67	68	70	62	60	61	61	69	69	77	74	70	64	60	80	70	65	66	64	64	74	75	64	64	63	62	81	76	76	71	69	69	70	71	66	--
Predicted Noise Reduction (dB)	1	3	4	4	2	1	1	0	3	2	3	4	0	2	0	1	2	1	2	1	0	1	2	2	2	1	1	0	1	1	0	1	2	2	2	4	--
Number of Benefited Receivers	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10-Foot Barrier [b]																																					
Future with Project Traffic Noise Level (dBA Leq[h])	61	66	67	68	61	60	62	61	68	68	74	73	70	64	60	76	69	65	65	63	64	73	74	63	64	62	62	81	75	75	70	68	68	68	68	65	--
Predicted Noise Reduction (dB)	2	4	5	6	3	1	0	0	4	3	6	5	0	2	0	5	3	1	3	2	0	2	3	3	2	2	1	0	2	2	1	2	3	4	5	5	--
Number of Benefited Receivers	0	0	3	3	0	0	0	0	0	0	2	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	15
12-Foot Barrier [b]																																					
Future with Project Traffic Noise Level (dBA Leq[h])	61	65	66	66	61	59	62	60	66	66	71	70	69	62	60	72	66	63	64	62	63	72	73	62	61	61	60	81	73	75	70	67	67	67	67	65	--
Predicted Noise Reduction (dB)	2	5	6	8	3	2	0	1	6	5	9	8	1	4	0	9	6	3	4	3	1	3	4	4	5	3	3	0	4	2	1	3	4	5	6	5	--
Number of Benefited Receivers	0	5	3	3	0	0	0	0	2	2	2	2	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	2	28
14-Foot Barrier [b]																																					
Future with Project Traffic Noise Level (dBA Leq[h])	60	64	65	65	61	59	61	60	65	64	69	68	67	61	60	70	65	62	63	61	62	69	71	61	60	60	60	80	72	74	70	66	65	65	66	63	--
Predicted Noise Reduction (dB)	3	6	7	9	3	2	1	1	7	7	11	10	3	5	0	11	7	4	5	4	2	6	6	5	6	4	3	1	5	3	1	4	6	7	7	7	--
Number of Benefited Receivers	0	5	3	3	0	0	0	0	2	2	2	2	0	2	0	1	1	0	1	0	0	1	1	1	1	0	0	0	2	0	0	0	2	2	2	2	38

a Traffic noise levels that approach or exceed 67 dBA Leq(h) are shown in bold/orange fill.
b Noise barriers that block the line-of-sight from the receptor to truck exhaust stacks are shaded in yellow for receptors exceeding NAC.

Hazel Avenue/U.S. 50 Interchange Project



Natural Environment Study

Hazel Avenue/U.S. 50 Interchange Project

Sacramento County

03-SAC-50-PM 15.1/17.5

Federal Project No.: EA 03-3E380/E-FIS 0300020439

County Control Number 2011-70062

July 2018

Caltrans

CALIFORNIA DEPARTMENT OF TRANSPORTATION

Natural Environment Study

Hazel Avenue/U.S. 50 Interchange Project
Sacramento County
03-SAC-50-PM 15.1/17.5
Federal Project No.: EA 03-3E380/E-FIS 0300020439
County Control Number 2011-70062

July 2018

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Summary

S.1 Project Description

The County of Sacramento (County), in cooperation with California Department of Transportation (Caltrans) and the City of Rancho Cordova, is proposing the Hazel Avenue/U.S. Route (US 50) Interchange Project (proposed project) to modify the existing interchange, and extend and grade-separate Hazel Avenue over Folsom Boulevard and the Sacramento Placerville Transportation Corridor Joint Powers Authority (SPTC-JPA) rail corridor. The proposed project is subject to state and federal environmental review requirements because the use of federal funds from the Federal Highway Administration is proposed. Accordingly, project documentation is being prepared in compliance with both the California Environmental Quality Act (CEQA) and the National Environmental Policy Act (NEPA). Caltrans is the lead agency under NEPA and the County of Sacramento, in cooperation with the City of Rancho Cordova, is the lead agency under CEQA.

S.2 Project Purpose and Need

The primary purpose of the proposed project is to modify the existing Hazel Avenue/US 50 Interchange to reduce congestion, improve traffic operations, accommodate travel demand due to planned and approved developments, and improve safety of all modes of travel including bicycles and pedestrians. The proposed project is needed to relieve existing congestion at the interchange and to accommodate planned and approved developments identified by the adopted Sacramento County General Plan and the Sacramento Area Council of Government's (SACOG's) Regional Transportation Plan.

S.3 Summary of Impacts on Natural Communities of Special Concern

Four natural communities of special concern were mapped in the biological study area (BSA): Fremont cottonwood-oak woodland, valley foothill riparian woodland, emergent wetland, and seasonal wetland. Although three other (i.e., non-wetland) waters of the United States (perennial drainage, ephemeral drainage, and ditch) that occur in the BSA are not vegetated natural communities of special concern, they are included in this summary because they are subject to federal and state regulation.

The temporary and permanent impacts on natural communities of special concern are summarized by alternative in Table S-1. As shown in this table, the impacts associated with Alternatives 1, 1A, and 2 are very similar.

Table S-1. Impacts on Natural Communities of Special Concern by Alternative

Feature Type	Alternative 1		Alternative 1A		Alternative 2	
	Permanent Impact Area (acres)	Temporary Impact Area (acres)	Permanent Impact Area (acres)	Temporary Impact Area (acres)	Permanent Impact Area (acres)	Temporary Impact Area (acres)
Fremont cottonwood-oak woodland	2.97	0.19	2.97	0.19	2.97	0.19
Valley foothill riparian woodland	0.03	0.17	0.03	0.17	0.03	0.17
Wetlands						
Emergent wetland	0.06	0.14	0.06	0.14	0.06	0.14
Seasonal wetland	0.02	0	0.02	0	0.02	0
Subtotal Wetlands	***0.08***	***0.14***	***0.08***	***0.14***	***0.08***	***0.14***
Non-Wetland Waters						
Perennial drainage	0.11	0.46	0.11	0.46	0.11	0.46
Ephemeral drainage	0.0002	0.0003	0.0002	0.0003	0.0002	0.0003
Ditch*	0.14	0.03	0.14	0.03	0.14	0.03
Subtotal Non-Wetland Waters	***0.25***	***0.49***	***0.25***	***0.49***	***0.25***	***0.49***
Total All Natural Communities	**3.33**	**0.99**	**3.33**	**0.99**	**3.33**	**0.99**

* Because ditch habitat will be replaced as part of the project design, no mitigation is required for impacts on ditch habitat.

S.4 Summary of Impacts on Special-Status Species

S.4.1 Special-Status Plants

The BSA contains potential habitat for 3 of the 18 special-status plant species (Brandegee's clarkia [*Clarkia biloba* ssp. *brandegeeae*], legenere [*Legenere limosa*], and Sanford's arrowhead [*Sagittaria sanfordii*]) that are known to occur in the project region. However, no special-status plants were observed during the April and May 2016 botanical surveys, which were conducted during the reported identification periods of the 18 special-status plant species known to occur in the project region. Therefore, special-status plants are presumed to be absent from the BSA, and there would be no impacts on special-status plants as a result of the proposed project.

S.4.2 Special-Status Wildlife

The following potential impacts on special-status wildlife species could result from the proposed project:

- Potential indirect impacts on vernal pool fairy shrimp (*Branchinecta lynchi*) and midvalley fairy shrimp (*Branchinecta mesovallensis*) from changes in hydrology and increased contaminants (same impacts under all Alternatives). These potential impacts would be avoided through implementation of Measure 6.
- Permanent and temporary direct impacts on valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*) habitat and potential injury or mortality of valley elderberry longhorn beetle.
- Permanent and temporary direct impacts on western pond turtle (*Actinemys marmorata*) habitat, indirect impacts on western pond turtle habitat from degradation of habitat adjacent to the new roadway, and potential injury or mortality of western pond turtle.

- Permanent and temporary impacts on suitable Swainson's hawk (*Buteo swainsoni*) and white-tailed kite (*Elanus leucurus*) nesting and foraging habitats, and potential disturbance of active nests.
- Permanent and temporary impacts on suitable yellow-breasted chat (*Icteria virens*) nesting habitat, and potential disturbance of active nests.
- Permanent and temporary impacts on suitable tricolored blackbird (*Agelaius tricolor*) nesting and foraging habitats, and potential disturbance of active nests.
- Permanent and temporary impacts on suitable song sparrow (Modesto population) (*Melospiza melodia*) nesting habitat, and potential disturbance of active nests.
- Removal or disturbance of suitable roosting habitat for pallid bat (*Antrozous pallidus*) and western red bat (*Lasiurus blossevillii*). Potential impacts on roosting habitat would be avoided or minimized through implementation of Measure 15.
- Removal or disturbance of suitable nesting habitat for migratory birds and potential disturbance, injury, or mortality of nesting migratory birds.

Impacts on valley elderberry longhorn beetle, western pond turtle, Swainson's hawk, white-tailed kite, yellow-breasted chat, tricolored blackbird, and song sparrow habitats from each alternative are summarized in Tables S-2 through S-7.

Table S-2. Impacts on Valley Elderberry Longhorn Beetle Habitat by Alternative

Habitat Type	Alternative 1 (number removed)	Alternative 1A (number removed)	Alternative 2 (number removed)
Elderberry shrubs	3	4	3

Table S-3. Impacts on Western Pond Turtle Habitat by Alternative

Habitat Type	Alternative 1		Alternative 1A		Alternative 2	
	Permanent (acres)	Temporary (acres)	Permanent (acres)	Temporary (acres)	Permanent (acres)	Temporary (acres)
Aquatic						
Perennial drainage (Alder Creek)	0.11	0.46	0.11	0.46	0.11	0.46
Upland						
Valley foothill riparian woodland	0.03	0.17	0.03	0.17	0.03	0.17
Annual grassland	0.15	0.63	0.15	0.63	0.15	0.63
Total Upland Impacts	**0.18**	**0.80**	**0.18**	**0.80**	**0.18**	**0.80**

Table S-4. Impacts on Swainson's Hawk and White-tailed Kite Habitat by Alternative

Habitat Type	Alternative 1		Alternative 1A		Alternative 2	
	Permanent (acres)	Temporary (acres)	Permanent (acres)	Temporary (acres)	Permanent (acres)	Temporary (acres)
Nesting						
Fremont cottonwood-oak woodland	2.97	0.19	2.97	0.19	2.97	0.19
Valley foothill riparian woodland	0.03	0.17	0.03	0.17	0.03	0.17
Total Nesting Habitat Impacts	**3.00**	**0.36**	**3.00**	**0.36**	**3.00**	**0.36**
Foraging						
Annual grassland	16.10	2.35	16.10	2.35	17.44	2.35

Table S-5. Impacts on Yellow-breasted Chat Habitat by Alternative

Habitat Type	Alternative 1		Alternative 1A		Alternative 2	
	Permanent (acres)	Temporary (acres)	Permanent (acres)	Temporary (acres)	Permanent (acres)	Temporary (acres)
Valley foothill riparian woodland	0.03	0.17	0.03	0.17	0.03	0.17

Table S-6. Impacts on Tricolored Blackbird Habitat by Alternative

Habitat Type	Alternative 1		Alternative 1A		Alternative 2	
	Permanent (acres)	Temporary (acres)	Permanent (acres)	Temporary (acres)	Permanent (acres)	Temporary (acres)
Nesting						
Emergent wetland	0.06	0.14	0.06	0.14	0.06	0.14
Foraging						
Annual grassland	16.10	2.35	16.10	2.35	17.44	2.35

Table S-7. Impacts on Song Sparrow Habitat by Alternative

Habitat Type	Alternative 1		Alternative 1A		Alternative 2	
	Permanent (acres)	Temporary (acres)	Permanent (acres)	Temporary (acres)	Permanent (acres)	Temporary (acres)
Valley foothill riparian woodland	0.03	0.17	0.03	0.17	0.03	0.17
Emergent wetland	0.064	0.140	0.064	0.140	0.064	0.140
Total	0.092	0.310	0.092	0.310	0.092	0.310

S.4.3 Special-Status Fish

The proposed project is outside the known range of special-status fish identified as potentially occurring in the project vicinity. Therefore, there would be no impacts on special-status fish as a result of the proposed project.

S.5 Summary of Impacts on Other Protected and Managed Biological Resources

S.5.1 Migratory Birds

The proposed project could result in the disturbance, injury, and/or mortality of migratory birds during the nesting season. Impacts on nesting migratory birds would be minimized or avoided through the implementation of avoidance and minimization measures prior to and during construction.

S.5.2 Protected Trees

Under Alternative 1, the proposed project would result in the removal of up to 293 protected oak trees and other native trees in landscaped areas and planted oak woodland areas or individual trees in annual grassland. Under Alternative 2, the proposed project would result in the removal of up to 249 protected oak trees and other native trees in landscaped areas and planted oak woodland areas or individual trees in annual grassland.

S.5.3 Invasive Plants

The proposed project would create additional disturbed areas for a temporary period. Areas where temporary disturbance occurs would be more susceptible to colonization or spread by invasive plants.

S.5.4 Dispersal/Migration Corridors

No Natural Landscape Blocks or Essential Connectivity Areas were identified by the CEHC Project in or adjacent to the BSA (California Department of Fish and Wildlife 2016a). Because the proposed project area does not provide areas through which animals can travel to other natural areas, the project would not impact wildlife dispersal and migration corridors.

S.6 Permits Required

The following applicable federal and state permits could be required before construction of the proposed project.

- Endangered Species Act Section 7: Consultation and Incidental Take Statement (U.S. Fish and Wildlife Service)
- Clean Water Act Section 404: Permit for Placement of Fill Material into Waters of the United States (U.S. Army Corps of Engineers)
- Clean Water Act Section 401: Water Quality Certification (Central Valley Regional Water Quality Control Board)
- California Fish and Game Code Section 1602: Lake or Streambed Alteration Agreement (California Department of Fish and Wildlife)

S.7 Mitigation Agreements

As part of the proposed project, the County will implement the avoidance, minimization, and mitigation measures listed below, which are described in more detail in Chapter 4, *Results: Biological Resources, Discussion of Impacts, and Mitigation*. These measures have been identified on the basis of natural resources identified as present or having the potential to occur in or near the BSA and the potential impacts that could result from the proposed project alternatives.

- Measure 1: Conduct Environmental Awareness Training for Construction Employees
- Measure 2: Monitor Disturbance of Woody Vegetation and Replant Affected Areas if Necessary
- Measure 3: Compensate for the Permanent and Temporary Loss of Fremont Cottonwood-Oak Woodland
- Measure 4: Compensate for the Permanent and Temporary Loss of Valley Foothill Riparian Woodland
- Measure 5: Compensate for Loss of Wetlands and Non-Wetland Waters of the United States/Waters of the State
- Measure 6. Design and Implement Water Conveyance Systems that Maintain Hydrology of and Prevent Contaminant from Entering Suitable Vernal Pool Branchiopod Habitat
- Measure 7: Fence Elderberry Shrubs to be Protected
- Measure 8: Compensate for Direct Effects on Valley Elderberry Longhorn Beetle and its Habitat
- Measure 9: Conduct Preconstruction Surveys for Western Pond Turtle and Monitor Initial In-Water Work
- Measure 10: Restore Temporarily Disturbed Grassland
- Measure 11: Conduct Vegetation Removal during the Non-Breeding Season of Nesting Migratory Birds
- Measure 12: Conduct Focused Surveys for Nesting Swainson's Hawk and White-tailed Kite Prior to Construction and Implement Protective Measures during Construction
- Measure 13: Compensate for the Permanent Loss of Foraging Habitat for Swainson's Hawk
- Measure 14: Conduct Preconstruction Surveys for Nesting Migratory Birds
- Measure 15: Identify Suitable Roosting Habitat for Bats and Implement Avoidance and Protective Measures
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List of Abbreviated Terms

Basin Plans	Water Quality Control Basin Plans
BMPs	best management practices
BSA	biological study area
Cal-IPC	California Invasive Plant Council
Caltrans	California Department of Transportaion
CCR	California Code of Regulations
CDFA	California Deartment of Food and Agriculture
CDFW	California Department of Fish and Wildlife
CEHC	California Essential Habitat Connectivity
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CFGC	California Fish and Game Code
CFR	Code of Federal Regulations
County	County of Sacramento
CNDDB	California Natural Diversity Database
CNPPA	California Native Plant Protection Act
CNPS's	California Native Plant Society's
CRPR	California Rare Plant Rank
CWA	Clean Water Act
dbh	diameter at breast height
ECAs	Essential Connectivity Areas
EFH	essential fish habitat
EIR	Environmental Impact Report
EO	Executive Order
FESA	federal Endangered Species Act
FR	Federal Register
HOV	high occupancy vehicle
HUC	hydrologic unit
ICF	ICF International
ISAC	Invasive Species Advisory Committee
LOS	Level of Service
LSAA	Lake or Streambed Alteration Agreement
MBTA	Migratory Bird Treaty Act
MOU	memorandum of understanding
MSA	Magnuson-Stevens Fishery Management and Conservation Act
MSE	Mechanically Stabilized Earth
MTP	Metropolitan Transportation Plan
NEPA	National Environmental Policy Act
NCCP	Natural Community Conservation Plan
NISC	National Invasive Species Council
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
ONHW	Ordinary High Water Mark
Porter-Cologne Act	Porter-Cologne Water Quality Control Act
ROW	right-of-way
RWQCB	Regional Water Control Board
SACOG	Sacramento Area Council of Government

SPCC	spill prevention control and countermeasure
SPTC-JPA	Sacramento Placerville Transportation Corridor Joint Powers Authority
State Water Board	State Water Resources Control Board
SWPPP	stormwater pollution prevention plan
TNW	traditional navigable water
UPRR	Union Pacific Railroad
US 50	U.S. Route 50
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
USFWS	U.S. Fish and Wildlife Service
WDRs	waste discharge requirements

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Chapter 1 Introduction

The County of Sacramento (County), in cooperation with California Department of Transportation (Caltrans) and the City of Rancho Cordova, is proposing the Hazel Avenue/U.S. Route (US 50) Interchange Project (proposed project) to modify the existing interchange, and extend and grade-separate Hazel Avenue over Folsom Boulevard and the Sacramento Placerville Transportation Corridor Joint Powers Authority (SPTC-JPA) rail corridor. Accordingly, project documentation is being prepared in compliance with both the California Environmental Quality Act (CEQA) and the National Environmental Policy Act (NEPA). Caltrans is the lead agency under NEPA and the County of Sacramento, in cooperation with the City of Rancho Cordova, is the lead agency under CEQA.

1.1 Project Description

1.1.1 Introduction

The County of Sacramento, in cooperation with Caltrans and the City of Rancho Cordova, proposes to modify the existing Hazel Avenue/US 50 interchange, and extend and grade-separate Hazel Avenue over Folsom Boulevard and the SPTC-JPA rail corridor. Hazel Avenue will be extended south to a proposed intersection with the future Atlanta Street (a new roadway that will be constructed as part of the Easton Place development). The project also includes:

- Construction of a portion of an eastbound transition auxiliary lane on US 50 from Hazel Avenue through the Folsom Boulevard Overcrossing, also known as the Natoma Overhead.
- The modification of the existing Aerojet Road off-ramp from US 50.
- Reconstruction of the westbound loop on-ramp.
- Reconstruction of the eastbound diagonal off-ramp, and both eastbound on-ramps.
- Eastbound on- and off-ramp auxiliary lanes, from west of the Hazel Avenue to the eastbound off-ramp, and from the loop on-ramp extending to the Folsom Boulevard interchange.
- Roadway improvements constructed along approximately 2,300 feet of Folsom Boulevard. Improvements include sidewalks, street lighting, and landscaping along the north side of Folsom Boulevard, and landscaping and lighting along the south.

The project is in Sacramento County at the interchange of Hazel Avenue and US 50 (Figure 1). The project area is bounded along Hazel Avenue by the Tributary Point/westbound off-ramp intersection to the north, and extends approximately 1,000 feet south of Folsom Boulevard to a future intersection within the Easton Place development (Figure 2). The project limits along US 50 begin approximately 3,200 feet west of the existing Hazel Avenue Overcrossing, and extend 2,500 feet east of the Natoma Overhead. Improvements along Folsom Boulevard would extend from approximately 1,200 feet west of the Hazel Avenue intersection to 900 feet to the east.

1.2 Purpose and Need

1.2.1 Purpose

The primary purpose of the proposed project is to modify the existing interchange to reduce congestion, improve traffic operations, accommodate travel demand due to planned and approved developments, and improve safety of all modes of travel, including bicycles and pedestrians.

The following objectives will be met by the proposed build alternatives:

- Improve operations by removing the close intersection spacing between the eastbound ramps and Folsom Boulevard, and minimizing conflict with heavy and light rail.
  - Proposed alternatives accomplish this by grade-separating Hazel Avenue over Folsom Boulevard.
- Provide sufficient capacity in the ramps and roadways for future traffic volumes.
  - Proposed alternatives accomplish this by widening and/or lengthening the on-/off-ramps and Hazel Avenue as required by their respective traffic analysis.
- Maintain the Aerojet Road off-ramp connection to the approved development while improving the mainline operations.
  - Proposed alternatives accomplish this by removing the Aerojet Road exit from US 50 but still providing direct access to Aerojet Road through the eastbound Hazel Avenue off-ramp.

1.2.2 Need

The proposed project is needed to relieve existing congestion at the interchange and to accommodate planned and approved developments identified by the adopted Sacramento County General Plan and SACOG's Regional Transportation Plan.

The approved developments within and near the project area will increase traffic demand beyond what the existing interchange can accommodate. The close intersection spacing between the Folsom Boulevard and eastbound ramp intersections does not provide sufficient queuing for increased traffic volumes. Additionally, the County is currently widening Hazel Avenue from four to six traffic lanes between the Hazel Avenue/US 50 interchange and Madison Avenue. This increase in roadway capacity is expected to deliver more traffic to the interchange during peak traffic periods.

Traffic demand forecasts for this project were conducted using the SACOG 2035 Metropolitan Transportation Plan (MTP) projected to 2038 (20 years after anticipated opening day) and supplemented by anticipated levels of additional development currently in application or advanced planning stages. Based on these projections, it is anticipated the existing interchange will become more congested."

1.3 Proposed Project

The proposed project would construct modifications to the existing interchange, and grade-separate and extend Hazel Avenue to the south to a future intersection with Atlanta Street, which will be built with the approved Easton Place development. Two alternatives, with one sub-alternative, have been developed for the project.

The following is a description of elements and design components that are common to all alternatives:

1.3.1 Roadway Modifications

- Construction of a portion of an eastbound transition auxiliary lane on US 50 from Hazel Avenue through the Folsom Boulevard Overcrossing, also known as the Natoma Overhead.
- Modification of the existing Aerojet Road off-ramp from US 50.
- Reconstruction of the westbound loop on-ramp, with the ramp intersection shifted north towards the westbound off-ramp terminus, increasing storage lengths. The ramp would be metered with two lanes (one mixed use and one high occupancy vehicle [HOV] bypass), and a squared-up pedestrian-friendly entrance.
- Reconstruction of the eastbound diagonal off-ramp to conform with the new Hazel Avenue profile and accommodate the Aerojet Road ramp divergence.
- Reconstruction of the eastbound diagonal on-ramp to conform with the new Hazel Avenue profile. The ramp would be metered with two lanes; one mixed flow and one HOV bypass.
- Reconstruction of the eastbound loop on-ramp to conform with the new Hazel Avenue profile. The ramp would be metered with two lanes; one mixed flow and one HOV bypass. A tie-back wall at the abutment of the overcrossing is proposed to maximize the opening through the structure. The loop ramp would develop an additional lane on US 50 that would continue on to the Folsom Boulevard interchange.
- Construction of eastbound on- and off-ramp auxiliary lanes on US 50, from west of the Hazel Avenue to the eastbound off-ramp, and from the loop on-ramp extending to the Folsom Boulevard interchange.
- Modification of traffic signals and installation of safety lighting at the ramp intersections. A new signalized intersection and at-grade railroad crossing would be constructed for the jughandle.
- Maintenance of pedestrian access on the east side of Hazel Avenue with 6-foot sidewalks (however the existing sidewalk on the overcrossing would remain 5 feet wide). Bicyclists may utilize the County standard 7-foot shoulders. It is expected that pedestrians and bicyclists would continue to use the nearby Bikeway and Pedestrian Overcrossing as the primary means for crossing US 50.
- Construction of roadway improvements along approximately 2,300 feet of Folsom Boulevard. Improvements include the removal of the existing signalized intersection with

Hazel Avenue, and installation of sidewalks, street lighting, and landscaping along the north side of Folsom Boulevard, and landscaping and lighting along the south.

1.3.2 Transition Lane to Folsom Boulevard/US 50 Interchange

As indicated in Caltrans' 2009 Corridor System Management Plan, eastbound US 50 is shown to have one HOV lane and three mixed flow lanes to Hazel Avenue as the Concept Facility. Additionally, eastbound US 50 is shown to have one HOV lane and three mixed flow lanes across Folsom Boulevard as the Ultimate Facility. The proposed project would accommodate these future facility improvements; would conform to the approved Caltrans project at the Folsom Boulevard/US 50 interchange, some of which occurred in 2017; and would then restripe the third mixed flow lane through the Folsom Boulevard/US 50 interchange.

The proposed project is required to add the mixed flow lane because it has been determined in the traffic analysis for this project, and in studies for adjacent projects, that the additional eastbound lane on US 50 extending through the Folsom Boulevard interchange is needed for operations.

Under all proposed build alternatives, accommodating this mixed flow lane would require the eastbound loop on-ramp to extend its auxiliary lane to the Folsom Boulevard/US 50 eastbound off-ramp. This would require widening and a new structure over Alder Creek.

Alder Creek currently flows under US 50 through a box culvert (Br. No. 24-0033). A Mechanically Stabilized Earth (MSE) wall (Br. No. 24-0372) is above the culvert. A new bridge would be required to widen US 50 over Alder Creek. The new bridge is necessary because there is insufficient lateral space to construct an adjacent MSE wall on top of the culvert and because the creek maintains a high operating water level.

1.3.3 Railroad Overhead

Hazel Avenue would extend and be grade-separated over Folsom Boulevard and the SPTC-JPA rail corridor. Currently there is one light rail track on the north side of the Union Pacific Railroad (UPRR) tracks. Sacramento Regional Transit plans to add another track at this location in the future; when the addition occurs, the existing UPRR track would be relocated south to accommodate the second light rail track. The proposed design meets the requirements for all three tracks.

Temporary vertical clearances of 21 feet, 6 inches and permanent vertical clearances of 24 feet have been accounted for in the layout of all three alternatives for the Hazel Avenue Overhead. The vertical clearance provided will accommodate the Overhead Catenary System for the light rail.

1.3.4 Right of Way and Utilities

For Alternative 1, ROW acquisition is anticipated from parcels in the southwest quadrant of the interchange. It is anticipated that 12 parcels would be affected by the improvements, including full acquisition and demolition of structures at the Chevron gas station (APN 069-0160-012) and Cattlemen's restaurant (APN 069-0060-085). The viaduct structure is proposed to cross over the northern portion of the Nimbus Winery parking lot (APN 069-0050-013) on an aerial easement, to allow parking below the structure and minimize project effects on the business. The ROW take at the Nimbus Winery property (APN 069-0050-013) would be larger in Alternative 1A because acquisition is required as opposed to an aerial easement.

For Alternative 2, ROW acquisition is anticipated from parcels in the southwest quadrant of the interchange. It is anticipated that 13 parcels would be affected by the improvements, including full acquisition and demolition of structures at the Chevron gas station, Cattlemen's restaurant and the Nimbus Winery property.

The acquisition needs described above are preliminary and would be finalized during the ROW process and Final Design of the project. For all alternatives, the proposed project would require the relocation of utilities, and it is anticipated that this would include: gas lines, overhead electric lines, underground electric lines, fiber optic cables, water lines, sewer lines, and storm drain lines. The potential for project effects on other unknown utilities also exists.

1.3.5 Project Features and Best Management Practices

The following project features and best management practices (BMPs) would be implemented as part of the proposed project and are common to all alternatives.

Install Orange Construction Fencing between the Construction Area and Adjacent Sensitive Biological Resources

The County and/or their contractor will install orange construction fencing between the construction area and adjacent sensitive biological resource areas. Sensitive biological resources that occur adjacent to the construction area that could be directly affected by the project include natural communities of special concern; valley elderberry longhorn beetle and western pond turtle habitats; nest sites of Swainson's hawk, yellow-breasted chat, tricolored blackbird, song sparrow, and other migratory birds; roosting bats; and protected trees to be avoided.

Barrier fencing around sensitive areas will be installed as one of the first orders of work and prior to equipment staging. Before construction begins, the construction contractor will work with the project engineer and a resource specialist to identify the locations for the orange construction fencing, and will place stakes around the sensitive resource sites to indicate these locations. The protected areas will be designated as environmentally sensitive areas and clearly identified on the construction plans and described in the specifications. To minimize the potential for snakes and other ground-dwelling animals from being caught in the orange construction fencing, the fencing will be placed with at least a 1-foot gap between the ground and the bottom of the orange construction fencing. The exception to this condition is where construction barrier

fencing overlaps with erosion control fencing and must be secured to prevent sediment runoff. Barrier fencing will be installed before construction activities are initiated, maintained throughout the construction period, and removed after completion of construction.

Retain a Qualified Biologist to Conduct Monitoring during Construction in Sensitive Habitats

The County will retain a qualified biologist to monitor all construction activities that involve ground disturbance (e.g., vegetation removal, grading, excavation, road construction) within or adjacent to environmentally sensitive areas (e.g., wetlands, streams, riparian vegetation, special-status species habitat, and active bird nests). The purpose of the monitoring is to ensure that avoidance and minimization measures are properly implemented to protect sensitive biological resources and to ensure that the project complies with all applicable permit requirements and agency conditions of approval. The biologist will inspect the fencing around environmentally sensitive areas regularly and will communicate any issues to the resident engineer or construction foreman. The contractor will be responsible for maintaining the fence during construction and ensuring that no construction personnel, equipment, or runoff/sediment from the construction area enters environmentally sensitive areas. The monitor will complete daily logs, and a final monitoring report will be prepared at the end of each construction season that will be submitted to the County and other overseeing agencies (i.e., CDFW, USFWS, and USACE), as appropriate.

Avoid and Minimize Potential Disturbance of Woody Vegetation

The County will require their contractor to minimize the potential for long-term loss of woody vegetation by trimming vegetation rather than removing entire trees or shrubs in areas where complete removal is not required. Trees or shrubs that need to be trimmed will be cut at least 1 foot above ground level to leave the root systems intact and allow for more rapid regeneration. Cutting will be limited to the minimum area necessary within the construction zone. To protect nesting birds, the County will not allow pruning or removal of woody vegetation between February 1 and September 30 without preconstruction surveys. A certified arborist will be retained to perform any necessary pruning or root cutting of retained trees.

Protect Water Quality and Prevent Erosion and Sedimentation in Wetlands and Drainages

The County will ensure the construction specifications include the following water quality protection and erosion and sediment control BMPs, based on standard County/Caltrans requirements, to minimize construction-related contaminants and mobilization of sediment in wetlands and drainages, including Alder Creek, in and adjacent to the project area.

The BMPs will be selected to achieve maximum sediment removal and represent the best available technology that is economically achievable and are subject to review and approval by the County. The County will perform routine inspections of the construction area to verify the BMPs are properly implemented and maintained. The County will notify contractors immediately if there is a noncompliance issue and will require compliance.

The BMPs will include, but are not limited to, the following practices.

- Ensure that equipment used in and around drainages is in good working order and free of dripping or leaking engine fluids. All vehicle maintenance will be performed at least 300 feet from all drainages. Any necessary equipment washing will be carried out where the water cannot flow into drainages.
- Prepare and implement a hazardous material spill prevention control and countermeasure (SPCC) plan before construction begins that will minimize the potential for, and the effects of, spills of hazardous or toxic substances during construction. The SPCC plan will include storage and containment procedures to prevent and respond to spills, and will identify the parties responsible for monitoring the spill response. The SPCC plan will also include the following stipulations.
  - Prevent raw cement, concrete or concrete washings, asphalt, paint or other coating material, oil or other petroleum products, or any other substances that could be hazardous to aquatic life from contaminating the soil or entering watercourses.
  - Clean up all spills immediately according to the spill prevention control and countermeasure plan.
  - Avoid operation of vehicles and equipment in flowing water.
  - Provide areas located outside all stream OHWMs for staging and storing equipment, materials, fuels, lubricants, solvents, and other possible contaminants.
  - Ensure that areas where equipment is refueled or lubricated are storm-proofed to prevent contaminants from being discharged to the streams. Pump contaminated water to a holding tank for proper disposal.
- The County will review and approve the contractor's hazardous materials SPCC plan before allowing construction to begin.
- Prohibit the following types of materials from being rinsed or washed into the roads, shoulder areas, or gutters: concrete; solvents and adhesives; thinners; paints; fuels; sawdust; dirt; gasoline; asphalt and concrete saw slurry; heavily chlorinated water.
- Dispose of any surplus concrete rubble, asphalt, or other rubble from construction at a local landfill.
- Prepare and implement an erosion and sediment control plan for the proposed project. The plan will include the following provisions and protocols.
  - Runoff from disturbed areas will be made to conform to the water quality requirements of the waste discharge permit issued by the Central Valley RWQCB.
  - Temporary erosion control measures, such as sandbagged silt fences, will be applied throughout construction of the proposed project and will be removed after the working area is stabilized or as directed by the engineer. Soil exposure will be minimized through use of temporary BMPs, groundcover, and stabilization measures. Exposed dust-producing surfaces will be sprinkled daily, if necessary, until wet; this measure will be controlled to avoid producing runoff. Paved roads will be swept daily following construction activities.

  - The contractor will conduct periodic maintenance of erosion and sediment control measures.
  - An appropriate seed mix of native species will be planted on disturbed areas upon completion of construction.
  - Cover or apply nontoxic soil stabilizers to inactive construction areas (previously graded areas inactive for 10 days or more) that could contribute sediment to waterways.
  - Enclose and cover exposed stockpiles of dirt or other loose, granular construction materials that could contribute sediment to waterways. Material stockpiles will be located in non-traffic areas only. Side slopes will not be steeper than 2:1. All stockpile areas will be surrounded by a filter fabric fence and interceptor dike.
  - Contain soil and filter runoff from disturbed areas by berms, vegetated filters, silt fencing, straw wattle, plastic sheeting, catch basins, or other means necessary to prevent the escape of sediment from the disturbed area.
  - Use other temporary erosion control measures (such as silt fences, staked straw bales/wattles, silt/sediment basins and traps, check dams, geofabric, sandbag dikes, and temporary revegetation or other ground cover) to control erosion from disturbed areas as necessary.
  - Avoid earth or organic material from being deposited or placed where it may be directly carried into drainages.
- Minimize the extent of all areas requiring clearing, grading, revegetation, and recontouring.
- Grade areas following construction to minimize surface erosion.
- Cover bare areas with mulch and revegetate all cleared areas.

The County will also obtain a Clean Water Act Section 404 permit from the U.S. Army Corps of Engineers and a Section 401 Water Quality Certification from the Central Valley Regional Water Quality Control Board, which may contain additional BMPs and measures to ensure the protection of water quality.

Avoid and Minimize the Spread of Invasive Plant Species during Project Construction

The County will require its contractor to avoid and minimize the introduction of new invasive plants and the spread of invasive plants previously documented in the project area. BMPs that may be used, though not limited to, include the following.

- Retain all fill material onsite to prevent the spread of invasive plants to uninfested areas.
- Use a weed-free source for project materials (e.g., straw wattles for erosion control that are weed-free or contain less than 1% weed seed).
- Prevent invasive plant contamination of project materials during transport and when stockpiling (e.g., by covering soil stockpiles with a heavy-duty, contractor-grade tarpaulin).
- Use sterile wheatgrass seed and native plant stock during revegetation.

- Revegetate or mulch disturbed soils within 30 days of completion of ground-disturbing activities to reduce the likelihood of invasive plant establishment.

The goal for implementation of these BMPs is to minimize the disturbance and transport of soil and vegetation to the greatest extent feasible to complete the work. Detailed information about implementing these BMPs is available in the Cal-IPC publication *Preventing the Spread of Invasive Plants: Best Management Practices for Transportation and Utility Corridors* (California Invasive Plant Council 2012).

1.3.6 Alternative 1: L-9 Interchange with Viaduct Connector

Alternative 1 consists of a modified type L-9 interchange configuration (Figure 3). A Caltrans Type L-9 interchange indicates a ramp configuration that includes a diagonal off-ramp, a diagonal on-ramp and a loop on-ramp. This alternative would provide a viaduct connection to Aerojet Road.

As with all alternatives, Hazel Avenue would grade-separate over Folsom Boulevard and the SPTC-JPA rail corridor and would extend south to a proposed intersection with the future Atlanta Street. The existing at-grade intersection of Hazel Avenue and Folsom Boulevard would be removed, sidewalks would be extended across the former intersection, and the lanes would be re-striped to remove left turn lanes.

The location of the departure point of the existing Aerojet Road off-ramp from US 50 would be moved to join with the eastbound Hazel Avenue off-ramp. The eastbound Hazel Avenue off-ramp would split and introduce a direct viaduct ramp over Hazel Avenue to carry eastbound off-ramp traffic to Aerojet Road and Folsom Boulevard. The off-ramp divergence from US 50 would be shifted approximately 830 feet to the east to provide decision sight distance before the Aerojet Road split. The two-lane off-ramp would widen to five lanes at the ramp terminal intersection, with three left-turn lanes and two right-turn lanes. Retaining walls and barriers placed at the proposed right-of-way (ROW) would minimize acquisition. The eastbound off-ramp would also have an auxiliary lane prior to the exit.

The Aerojet Road viaduct would land adjacent to the eastbound diagonal on-ramp and then turn southerly to conform to Folsom Boulevard along its existing alignment. Retaining walls are proposed between the viaduct and the diagonal on-ramp to accommodate the grade difference, and to the outside of the ramp after the viaduct lands, to minimize ROW acquisitions. Retaining walls are also proposed along Aerojet Road as it approaches the horizontal curve towards Folsom Boulevard to accommodate the grade difference between the ramp and mainline and to minimize ROW acquisition.

The existing Hazel Avenue Overcrossing of US 50 would be widened on the west side to accommodate eight lanes (three through lanes and one freeway-only lane in both directions). The existing raised concrete median across the structure would be removed, and the roadway would be re-striped with a 6-foot striped median. The existing sidewalk and barrier on the east side of the structure would remain.

1.3.7 Alternative 1A: L-9 Interchange with Undercrossing Connector

Alternative 1A is the same as Alternative 1, except that the eastbound off-ramp would split and introduce a direct tunnel ramp under Hazel Avenue to carry eastbound off-ramp traffic to Aerojet Road and Folsom Boulevard (Figure 4).

1.3.8 Alternative 2: Direct Flyover to Hazel Avenue With Connector

Alternative 2 consists of a modified type L-9 interchange configuration, with a flyover ramp carrying vehicles travelling from eastbound US 50 to northbound Hazel Avenue over the freeway to join with the westbound off-ramp (Figure 5).

The existing Aerojet Road off-ramp from US 50 would be removed. The eastbound off-ramp diverge from US 50 would be shifted approximately 680 feet to the east to provide decision sight distance. An auxiliary lane would precede the off-ramp. A retaining wall is proposed adjacent to the off-ramp to minimize ROW acquisition.

The eastbound off-ramp would split and introduce northbound and southbound Hazel Avenue ramps. The northbound ramp would also carry traffic headed for Aerojet Road/Folsom Boulevard. An overhead sign would direct vehicles heading to southbound Hazel Avenue into the right lane and direct vehicles destined for northbound Hazel Avenue or Aerojet Road or Folsom Boulevard to use either lane. Retaining walls are proposed for the ramp as it approaches the horizontal curve towards Folsom Boulevard to accommodate the grade difference between the ramp and mainline and to minimize ROW acquisition at an apartment complex.

The northbound Hazel Avenue movement would cross under Hazel Avenue at the interchange, cross over US 50 on a two-lane flyover structure, and then merge with the westbound off-ramp and terminate at the Hazel Avenue/Tributary Point intersection. The westbound off-ramp would split so that the southbound and through movements align to the left of the ramp, and the northbound movements are to the right.

The southbound ramp would connect directly to Hazel Avenue; however, for Alternative 2 an intersection is not required at Hazel Avenue and the eastbound ramp. By eliminating an intersection at the eastbound ramp, and by removing the heavy eastbound-to-northbound movements from the Hazel Avenue overcrossing, the existing structure could remain without widening.

The two-lane westbound off-ramp would be reconstructed to provide decision sight distance between the divergence point from US 50 and a new ramp split that accommodates the flyover. The westbound off-ramp would split on either side of the flyover ramp, with one lane to the right carrying northbound Hazel Avenue traffic and the other crossing underneath the flyover ramp to join up on the left side of the flyover for the southbound Hazel Avenue movements. The profiles of the three ramps have been coordinated to match grade quickly to minimize retaining wall limits and enhance driver visibility. Overhead signage would direct drivers into the appropriate lanes for northbound and southbound Hazel Avenue traffic.

1.3.9 Alternative 3: No Build Alternative

Alternative 3, the No Build Alternative, would not modify the Hazel Avenue/US 50 interchange, and would retain the same existing configuration, ramps, and lanes. This alternative does not meet the purpose and need of the proposed project.

1.3.10 Construction Schedule

Construction of the project is anticipated to last 24 months, beginning in 2019 and concluding in 2021.

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Chapter 2 Study Methods

This chapter describes regulatory requirements relevant to biological resources and methods used to identify special-status species and their habitats, sensitive natural communities, and waters of the United States and State (including wetlands) in the approximately 98-acre biological study area (BSA). The BSA includes all areas of potential permanent and temporary impacts, and is further defined in Chapter 3.

2.1 Regulatory Requirements

This section summarizes the federal and state regulations that protect special-status species; waters of the United States (which also are considered waters of the State), including wetlands; and sensitive natural communities. This section also discusses pertinent local general plan policies and ordinances related to the protection and preservation of biological resources.

2.1.1 Federal Regulations

2.1.1.1 Federal Endangered Species Act

The federal Endangered Species Act (FESA) of 1973, and subsequent amendments, provide regulations for the conservation of endangered and threatened species and the ecosystems on which they depend. The U.S. Fish and Wildlife Service (USFWS) (with jurisdiction over plants, wildlife, and resident fish) and the National Marine Fisheries Service (NMFS) (with jurisdiction over anadromous fish and marine fish and mammals) oversee the FESA. Section 7 of the FESA mandates all federal agencies to consult with USFWS and NMFS if they determine that a proposed project may affect a listed species or destroy or adversely modify designated critical habitat. Section 7 requirements do not apply to nonfederal actions. A Clean Water Act (CWA) Section 404 permit from the U.S. Army Corps of Engineers (USACE) will be required for project construction. Consequently, consultation under Section 7 for effects to federally listed species will be required. Under Section 7, the federal lead agency must obtain incidental take authorization or a letter of concurrence stating that the proposed project is not likely to adversely affect federally listed species.

Section 9 of the FESA prohibits the take of any fish or wildlife species listed as endangered, including the destruction of habitat that prevents the species' recovery. *Take* is defined as any action or attempt to hunt, harm, harass, pursue, shoot, wound, capture, kill, trap, or collect a species. Section 9 prohibitions also apply to threatened species unless a special rule has been defined with regard to take at the time of listing. Under Section 9 of the FESA, the take prohibition applies only to wildlife and fish species. However, Section 9 does prohibit the unlawful removal and possession, or malicious damage or destruction, of any endangered plant from federal land. Section 9 prohibits acts to remove, cut, dig up, damage, or destroy an endangered plant species in nonfederal areas in knowing violation of any state law or in the course of criminal trespass. Candidate species and species proposed for or under petition for listing receive no protection under Section 9.

Two species that are federally listed (vernal pool fairy shrimp [*Branchinecta lynchi*] and valley elderberry longhorn beetle [*Desmocerus californicus dimorphus*]) have the potential to occur in the BSA and may be affected by the proposed project. Chapter 4 describes potential project-related impacts and implementation of avoidance and minimization measures to minimize direct and indirect impacts on these species.

2.1.1.2 Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Fishery Management and Conservation Act (MSA), as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267) and the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006 (Public Law 109-479), requires federal agencies to consult with NMFS on activities that may adversely affect essential fish habitat (EFH). The purpose of the MSA is to conserve and manage the fishery resources of the United States and to promote protection of EFH. EFH is the aquatic habitat necessary for fish to spawn, breed, feed, or grow to maturity that will allow a level of production needed to support a long-term, sustainable commercial fishery and contribute to a healthy ecosystem (Pacific Fishery Management Council 2014). Important components of EFH include substrate, water quality, water quantity, depth, velocity, channel gradient and stability, food, cover, habitat complexity, space, access and passage, and habitat connectivity. EFH is described for Pacific salmon fisheries (specifically Chinook salmon) in Chapter 4. The MSA requires the following.

- Federal agencies undertaking, permitting, or funding an activity that may adversely affect EFH are required to consult with NMFS.
- NMFS is required to provide conservation recommendations for any federal or state activity that may adversely affect EFH.
- Within 30 days of receiving conservation recommendations from NMFS, federal agencies must provide a detailed response in writing to NMFS regarding the conservation recommendations (the response must include a description of measures proposed by the agency for avoiding, mitigating, or offsetting the impact of the activity on EFH, or reasons for not following the recommendations).

EFH for Pacific salmon (i.e., Chinook salmon) has been designated for the lower American River below Nimbus Dam. Because Alder Creek is located upstream of Nimbus Dam, Alder Creek in the BSA (defined in Chapter 3) is not designated as EFH. Therefore, EFH is not further discussed in this NES.

2.1.1.3 Executive Order 11990: Protection of Wetlands

Executive Order (EO) 11990, signed May 24, 1977, directs all federal agencies to refrain from assisting in or providing financial support to projects that encroach on publicly or privately owned wetlands. EO 11990 further requires that federal agencies support a policy to minimize the destruction, loss, or degradation of wetlands. A project that encroaches on wetlands may not be undertaken unless the agency has determined that (1) there are no practicable alternatives to such construction, (2) the project includes all practicable measures to minimize harm to wetlands that would be affected by the project, and (3) the impact will be minor.

The proposed project could affect wetlands, and federal agencies would be required to consider this EO prior to issuing permits. Chapter 4 includes a discussion about potential project effects on wetlands within the proposed project.

2.1.1.4 Executive Order 13112: Prevention and Control of Invasive Species

EO 13112, signed February 3, 1999, directs all federal agencies to prevent and control the introduction of invasive species in a cost-effective and environmentally sound manner. This EO established the National Invasive Species Council (NISC), which is composed of federal agencies and departments, and a supporting Invasive Species Advisory Committee (ISAC) composed of state, local, and private entities. In 2008, NISC released an updated *National Invasive Species Management Plan* (National Invasive Species Council 2008) that recommends objectives and measures to implement EO 13112 and to prevent the introduction and spread of invasive species. EO 13112 requires consideration of invasive species in NEPA analyses, including species identification and distribution, potential impacts, and prevention and eradication measures.

Because the proposed project may introduce or spread invasive species into the BSA, federal agencies are required to consider EO 13112 prior to issuing permits. Measures identified in Chapter 4 will avoid or minimize the introduction and spread of invasive species as a result of project activities.

2.1.1.5 Migratory Bird Treaty Act

The Migratory Bird Treaty Act (MBTA) protects migratory bird species from take. Under the MBTA, *take* is defined as to (or attempt to) pursue, hunt, shoot, capture, collect, or kill (50 Code of Federal Regulations [CFR] 10.12). The definition differentiates between intentional take (take that is the purpose of the activity in question) and unintentional take (take that results from, but is not the purpose of, the activity in question). EO 13186, signed January 10, 2001, directs each federal agency taking actions that would, or likely would, negatively affect migratory bird populations to work with USFWS to develop a Memorandum of Understanding (MOU) to promote the conservation of migratory bird populations. Protocols developed under the MOU must include the following agency responsibilities.

- Avoid and minimize, to the extent practicable, adverse impacts on migratory bird resources when conducting agency actions.
- Restore and enhance habitat of migratory birds, as practicable.
- Prevent or abate the pollution or detrimental alteration of the environment for the benefit of migratory birds, as practicable.

EO 13186 is designed to assist federal agencies in their efforts to comply with the MBTA; the EO does not constitute any legal authorization to take migratory birds. Migratory birds could nest in the BSA. The discussion of nesting migratory birds in Chapter 4 describes potential project impacts on migratory birds and measures to avoid or minimize impacts on those species.

2.1.1.6 Clean Water Act

The CWA was passed by Congress in 1972 with a broad mandate "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters." The chief purpose of the CWA is to establish the basic structure for regulating discharges of pollutants into waters of the United States. The CWA authorizes the U.S. Environmental Protection Agency (EPA) to set national water quality standards and effluent limitations, and includes programs addressing both point-source and nonpoint-source pollution. *Point-source pollution* is pollution that originates or enters surface waters at a single, discrete location, such as an outfall structure or an excavation or construction site. *Nonpoint-source pollution* originates over a broader area and includes urban contaminants in storm water runoff and sediment loading from upstream areas. The CWA operates on the principle that all discharges into the nation's waters are unlawful unless specifically authorized by a permit; permit review is the CWA's primary regulatory tool. Aquatic resources (e.g., emergent and seasonal wetlands, drainages) are present in the BSA and may be regulated under CWA Section 404 (described below).

Section 401: Water Quality Certification

Under CWA Section 401, applicants for a federal license or permit to conduct activities that may result in the discharge of a pollutant into waters of the United States must apply for water quality certification from the State. Therefore, all projects with a federal component that may affect state water quality (including projects that require federal agency approval, such as a Section 404 permit) must comply with CWA Section 401. Aquatic resources that appear to qualify as waters of the United States are present in the BSA.

Under the current proposed design, it is anticipated that roadway construction associated with the proposed project will result in a discharge of pollutants into waters of the United States; therefore, a Section 401 water quality certification from the Central Valley Regional Water Control Board (RWQCB) will be required for the proposed project.

Section 402: Permits for Stormwater Discharge

CWA Section 402 regulates construction-related storm water discharges to surface waters through the National Pollutant Discharge Elimination System (NPDES) program, administered by EPA. In California, the State Water Resources Control Board (State Water Board) is authorized by EPA to oversee the NPDES program through RWQCB.

NPDES permits are required for projects that disturb more than 1 acre of land. The NPDES permitting process requires the applicant to file a public notice of intent to discharge storm water and to prepare and implement a Storm Water Pollution Prevention Plan (SWPPP). The SWPPP must include a site map, a description of proposed construction activities, and the best management practices (BMPs) that will be implemented to prevent soil erosion and discharge of other construction-related pollutants (e.g., petroleum products, solvents, paints, and cement) that could contaminate nearby water resources.

Permittees are required to conduct annual monitoring and reporting to ensure that BMPs are correctly implemented and effective in controlling the discharge of storm water-related

pollutants. Because the proposed project would disturb more than 1 acre of land, the County will prepare a SWPPP and apply for an NPDES permit.

Section 404: Permits for Fill Placement in Waters of the United States (Including Wetlands)

Waters of the United States (including wetlands) are protected under Section 404 of the CWA. Any activity that involves a discharge of dredged or fill material into waters of the United States, including wetlands, is subject to regulation by USACE. *Waters of the United States* is defined to encompass navigable waters of the United States; interstate waters; all other waters where their use, degradation, or destruction could affect interstate or foreign commerce; tributaries of any of these waters; and wetlands that meet any of these criteria or are adjacent to any of these waters or their tributaries. *Wetlands* are defined under Section 404 as those areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Jurisdictional wetlands must meet three wetland criteria.

- They support hydrophytic vegetation (i.e., plants that grow in saturated soil).
- They have hydric soil types (i.e., soils that are wet or moist enough to develop anaerobic conditions).
- They have wetland hydrology.

Under the current proposed design, it is anticipated that construction associated with the proposed project would result in a discharge of fill material into waters of the United States; therefore, a Section 404 CWA permit will be required for the proposed project. An aquatic resources delineation has been completed for the project and will be submitted to USACE to support a preliminary jurisdictional determination for the project and the Section 404 permit application.

2.1.2 State Regulations

2.1.2.1 California Endangered Species Act

The California Endangered Species Act (CESA) (California Fish and Game Code [CFGC] Section 2050 et seq.) establishes state policy to conserve, protect, restore, and enhance threatened or endangered species and their habitats. CESA mandates that state agencies should not approve projects that jeopardize the continued existence of threatened or endangered species if reasonable and prudent alternatives are available that would avoid jeopardy. For projects that would affect a species on the federal and state lists, compliance with FESA satisfies CESA if the California Department of Fish and Wildlife (CDFW) determines that the federal incidental take authorization is consistent with CESA under CFGC Section 2080.1. For projects that would result in take of a species that is only state listed, the project proponent must apply for a take permit under Section 2081(b).

Two species that are state listed (Swainson's hawk [*Buteo swainsoni*]) or are candidates for listing (tricolored blackbird [*Agelaius tricolor*]) and have the potential to occur in the BSA and may be affected by the proposed project. Chapter 4 describes potential project-related impacts and implementation of avoidance and minimization measures to minimize direct and indirect impacts on these species.

2.1.2.2 California Environmental Quality Act

CEQA is the regulatory framework by which California public agencies identify and mitigate significant environmental impacts. A project normally is considered to cause a significant environmental impact on biological resources if it would substantially affect a rare or endangered species or the habitat of that species; substantially interfere with the movement of resident or migratory fish or wildlife; or substantially diminish habitat for fish, wildlife, or plants. The State CEQA Guidelines define *rare, threatened, and endangered species* as those listed under the FESA and CESA and any other species that meets the criteria of the resource agencies or local agencies (e.g., CDFW-designated species of special concern). The State CEQA Guidelines state that the lead agency preparing an Environmental Impact Report (EIR) must consult with and receive written findings from CDFW concerning project impacts on species listed as endangered or threatened. The impacts of a proposed project on these resources are important in determining whether the project would result in significant environmental impacts under CEQA. The County will prepare an EIR to comply with the State CEQA Guidelines.

2.1.2.3 California Native Plant Protection Act

The California Native Plant Protection Act (CNPPA) of 1977 prohibits importation of rare and endangered plants into California, take of rare and endangered plants, and sale of rare and endangered plants, except for a broad range of activities. Chapters 3 and 4 discuss the potential for special-status plants to occur in the BSA.

2.1.2.4 California Fish and Game Code

Several sections of the CFGC apply to the proposed project, as described below.

Lake or Streambed Alteration (Section 1602)

CDFW regulates activities that would interfere with the natural flow of—or substantially alter the channel, bed, or bank of—a lake, river, or stream, including disturbance of riparian vegetation, under CFGC Sections 1600–1616. CDFW requires a Lake or Streambed Alteration Agreement (LSAA) permit for these activities. Requirements to protect the integrity of biological resources and water quality often are conditions of LSAAs. CDFW may establish conditions that include avoiding or minimizing vegetation removal, using standard erosion control measures, limiting the use of heavy equipment, limiting work periods to avoid impacts on fisheries and wildlife resources, and restoring degraded sites or compensating for permanent habitat losses. Waters of the State (i.e., perennial drainage) that would be regulated by CDFW are present in the BSA.

Because the proposed project is anticipated to result in modification of the bed, bank, or channel of Alder Creek, a LSAA will be required.

Protection of Birds and Raptors (Sections 3503 and 3503.5)

Section 3503 of the CFGC prohibits killing of birds and destruction of bird nests. Section 3503.5 prohibits killing of raptor species and destruction of raptor nests. Typical violations include destruction of active bird and raptor nests as a result of tree removal, and failure of nesting attempts (loss of eggs or young) as a result of disturbance of nesting pairs caused by nearby human activity.

The proposed project has the potential to adversely affect birds and raptors protected under Sections 3503 and 3503.5 of the CFGC. The County will avoid violation of CFGC Sections 3503 and 3503.5 by implementing measures identified for protecting nesting birds in Chapter 4.

Fully Protected Species (Sections 3511, 3513, 4700, and 5050)

CFGC Sections 3511, 3513, 4700, and 5050 pertain to fully protected wildlife species (birds in Sections 3511 and 3513, mammals in Section 4700, and reptiles and amphibians in Section 5050) and strictly prohibit take of these species. CDFW cannot issue a take permit for fully protected species, except under narrow conditions for scientific research or the protection of livestock, or the adoption of a Natural Community Conservation Plan (NCCP). Specifically, Section 3513 prohibits any take or possession of birds designated by the MBTA as migratory nongame birds except as allowed by federal rules and regulations pursuant to the MBTA.

One fully protected bird species, white-tailed kite (*Elanus leucurus*), has the potential to nest in the BSA and be affected by the proposed project. The County will avoid take of white-tailed kite by implementing measures identified for protecting nesting birds in Chapter 4.

2.1.2.5 Porter-Cologne Water Quality Control Act

The California Water Code addresses the full range of water issues in the state and includes Division 7, known as the Porter-Cologne Water Quality Control Act (Porter-Cologne Act) (California Water Code Sections 13000–16104). Section 13260 requires "any person discharging waste, or proposing to discharge waste, in any region that could affect the waters of the State to file a report of discharge (an application for waste discharge requirements [WDRs])" with the appropriate RWQCB. Under this act, each of the nine RWQCBs must prepare and periodically update Water Quality Control Basin Plans (Basin Plans). Each Basin Plan sets forth water quality standards for surface water and groundwater, as well as actions to control nonpoint and point sources of pollution. Projects that affect waters of the State must meet the WDRs of the RWQCB.

Section 13050 of the Porter-Cologne Act authorizes the State Water Board and the relevant RWQCB to regulate biological pollutants. Pursuant to CWA Section 401, an applicant for a Section 404 permit to conduct any activity that may result in discharge into navigable waters must provide a certification from the RWQCB that such discharge will comply with state water quality standards. The California Water Code generally regulates more substances contained in

discharges and defines discharges to receiving waters more broadly than does the CWA. As part of the wetlands permitting process under Section 404, the County will be required to apply for water quality certification from the Central Valley RWQCB.

2.1.3 Local Regulations

2.1.3.1 Sacramento County General Plan

Goals and policies in the Sacramento County General Plan Conservation Element (Sacramento County Community Planning and Development Department 2011) apply to biological resources in the proposed project area that would be affected by implementation of the project. These policies include allowing no net loss of wetlands, riparian woodlands, and oak woodlands; mitigating for loss or modification of these and other native vegetation and special-status species habitats; discouraging introduction of invasive non-native aquatic species; retaining wetland and riparian vegetation whenever possible in channel modifications; protecting, enhancing, and restoring riparian, in-channel and shaded riverine aquatic habitat; mitigating for loss of native trees for road expansion consistent with other General Plan policies and/or the County Tree Preservation Ordinance; protecting and preserving native trees in riparian areas that are used by Swainson's hawk; and ensuring no net loss of oak and riparian tree canopy coverage by preservation or mitigation on-site, off-site, or through payment into the County's Tree Preservation Fund or another appropriate fund.

The General Plan includes the following three policies specific to native trees.

CO-139. Native trees other than oaks, which cannot be protected through development, shall be replaced with in-kind species in accordance with established tree planting specifications, the combined diameter of which shall equal the combined diameter of the trees removed.

CO-140. For projects involving native oak woodlands, oak savannah or mixed riparian areas, ensure mitigation through either of the following methods:

- An adopted habitat conservation plan.
- Ensure no net loss of canopy area through a combination of the following: (1) preserving the main, central portions of consolidated and isolated groves constituting the existing canopy and (2) provide an area on-site to mitigate any canopy lost. Native oak mitigation area must be a contiguous area on-site which is equal to the size of canopy area lost and shall be adjacent to existing oak canopy to ensure opportunities for regeneration.
- Removal of native oaks shall be compensated with native oak species with a minimum of a one to one dbh replacement.

- A provision for a comparable on-site area for the propagation of oak trees may substitute for replacement tree planting requirements at the discretion of the County Tree Coordinator when removal of a mature oak tree is necessary.
- If the project site is not capable of supporting all the required replacement trees, a sum equivalent to the replacement cost of the number of trees that cannot be accommodated may be paid to the County's Tree Preservation Fund or another appropriate tree preservation fund.
- If on-site mitigation is not possible given site limitation, off-site mitigation may be considered. Such a mitigation area must meet all of the following criteria to preserve, enhance, and maintain a natural woodland habitat in perpetuity, preferably by transfer of title to an appropriate public entity. Protected woodland habitat could be used as a suitable site for replacement tree plantings required by ordinances or other mitigations.
    - Equal or greater in area to the total area that is included within a radius
    - of 30 feet of the dripline of all trees to be removed;
    - Adjacent to protected stream corridor or other preserved natural areas;
    - Supports a significant number of native broadleaf trees; and
    - Offers good potential for continued regeneration of an integrated woodland community.

CO-141. In 15 years the native oak canopy within on-site mitigation areas shall be 50 percent canopy coverage for valley oak and 30 percent canopy coverage for blue oak and other native oaks.

2.1.3.2 Sacramento County Tree Preservation Ordinance

The County's Tree Preservation Ordinance protects native oak trees (valley oak [*Quercus lobata*], interior live oak [*Q. wislizeni*], blue oak [*Q. douglasii*], and oracle oak [*Q. ×morehus*) that have at least one trunk of 6 inches or more in diameter at breast height (dbh) or multiple trunks with an aggregate dbh of 10 inches or more. Heritage trees (native oaks with a dbh of 19 inches or more) and landmark trees are also protected. Tree removal or trenching, grading, or filling within the tree dripline requires a permit. Retained trees must be protected by implementing control measures to mitigate tree damage during grading, filling, trenching, paving, and landscaping within the driplines. No irrigation system may be installed within the driplines of protected trees.

2.1.3.3 City of Rancho Cordova Tree Preservation Ordinance

Similar to the Sacramento County Tree Preservation Ordinance, the City of Rancho Cordova Tree Preservation Ordinance protects valley oak, interior live oak, blue oak, and oracle oak trees that have at least one trunk with a dbh of 6 inches or more or multiple trunks with an aggregate dbh of 10 inches or more. Tree removal or trenching, grading, or filling within the tree dripline requires a permit.

2.2 Studies Required

Potential biological resource issues associated with the proposed project were identified through review of existing information and field surveys. Caltrans and ICF International (ICF) biologists determined that the following studies and surveys would be required to document biological resources in the BSA.

- General habitat evaluation to determine whether suitable habitat exists for special-status plant and animal species.
- Botanical field surveys to map land cover types, including natural communities, and survey for special-status plant species.
- Delineation of waters of the United States and waters of the State.
- Elderberry shrub (*Sambucus* sp.) and valley elderberry longhorn beetle surveys.

To prepare for the field surveys, biologists reviewed existing resource information related to the project to evaluate whether special-status species or other sensitive biological resources (e.g., waters of the United States) could occur in the BSA. The sources listed below were reviewed.

- California Native Plant Society's (CNPS's) online *Inventory of Rare and Endangered Plants of California* records search of the Buffalo Creek, Carmichael, Citrus Heights, Clarksville, Folsom, and Folsom SE U.S. Geological Survey (USGS) 7.5-minute quadrangles (California Native Plant Society 2016).
- California Natural Diversity Database (CNDDB) records search of the Buffalo Creek, Carmichael, Citrus Heights, Clarksville, Folsom, and Folsom SE USGS 7.5-minute quadrangles (California Department of Fish and Wildlife 2016a).
- USFWS's list of endangered and threatened species that may occur in or be affected by the proposed project (U.S. Fish and Wildlife Service 2016).
- Lists of plants identified as noxious weeds or invasive plants by the U.S. Department of Agriculture (USDA) (U.S. Department of Agriculture 2016), the California Department of Food and Agriculture (CDFA) (California Department of Food and Agriculture 2016), and the California Invasive Plant Council (Cal-IPC) (2016).
- Soil map unit descriptions for the BSA (Natural Resources Conservation Service 2015).

This information was used to develop lists of special-status species and other sensitive biological resources that could be present in the project region. Species from the lists were considered if they were known to occur in the project region (i.e., within approximately 5 miles of the BSA) or had potential habitat in the BSA and the BSA was within the species' range. For preparation of this document, updated USFWS (2017 and 2018) species lists were obtained from the IPaC website, a list of threatened and endangered species for the Folsom USGS 7.5-minute quadrangle was obtained from NMFS's California Species List Tools website (National Marine Fisheries Service 2018), and the most recent versions of the CNDDB (California Department of Fish and Wildlife 2018) and CNPS inventory (California Native Plant Society 2018) were reviewed and are included in Appendix B.

2.3 Personnel and Survey Dates

ICF biologists conducted biological surveys of accessible parcels in the BSA in April and May 2016 (Table 2-1).

Table 2-1. Biological Survey Personnel and Dates

Survey Type	Survey Date	Surveyors
Natural community mapping and botanical surveys	April 6 and May 31, 2016	Lisa Webber, ICF Botanist/Wetland Ecologist, 25 years of experience
Habitat-based assessment for special-status animal species	April 6 and May 31, 2016 June 11, 2016	Jennifer Haire, ICF Wildlife Biologist, 20 years of experience Jeff Kozlowski, ICF Fish Biologist, 30 years of experience
Aquatic resources delineation (waters of the United States and waters of the State)	April 6 and May 31, 2016	Lisa Webber
Elderberry shrub and valley elderberry longhorn beetle surveys	May 31, 2016	Jennifer Haire
Arborist survey	July 17, 18, and 31, 2017	Renee Richardson, Certified Arborist, 10 years of experience

2.4 Survey Methods

Methods for the natural community (land cover type) mapping; botanical surveys; habitat-based assessment for special-status species; aquatic resources delineation; and elderberry shrub and valley elderberry longhorn beetle surveys are described below. Figure 6 in Appendix A shows the BSA. Appendix C provides representative photographs taken during field surveys.

2.4.1 Natural Community Mapping and Botanical and Arborist Surveys

ICF botanist and wetland ecologist Lisa Webber identified and mapped land cover types and natural communities in the BSA on April 6 and May 31, 2016. Ms. Webber also conducted botanical surveys in the BSA on these dates. The surveys coincided with the identification periods of special-status plants identified as having potential to occur in the project region. Ms. Webber walked or visually surveyed all of the BSA and compiled a list of all plant species observed (Appendix D).

ICF biologist and International Society of Arboriculture– (ISA-) certified arborist Renee Richardson inventoried and assessed all trees in the BSA on July 17, 18, and 31, 2017. All accessible trees in the BSA that were greater than 4 inches in dbh (defined as the diameter of a tree measured at 4.5 feet above ground level on the high side of the tree) were assigned an individual number and tagged. The location of each tree was recorded with a Global Positioning System unit, and the species, health, vigor, structure, height, dripline radius, and dbh of each tree was recorded.

2.4.2 Habitat-Based Assessment for Special-Status Animal Species

ICF wildlife biologist Jennifer Haire conducted a reconnaissance-level field survey of the BSA on April 6 and May 31, 2016. This survey focused on evaluating natural communities in the BSA and determining their suitability for special-status animal species. Ms. Haire walked or visually surveyed all of the BSA, making notes on the types and suitability of habitat present, and recording any wildlife species observed (Appendix D). Ms. Haire also surveyed a 250-foot buffer on the west, south, and east sides of the jughandle area off of Folsom Boulevard for vernal pool branchiopod habitat in order to assess potential indirect effects on vernal pool branchiopods. She also looked for elderberry shrubs within 100 feet of the BSA in order to assess direct and indirect effects on valley elderberry longhorn beetle.

The assessment for the presence of special-status fish in the vicinity of the BSA was based on a reconnaissance-level field survey of the BSA on June 11, 2016, conducted by ICF fish biologist Jeff Kozlowski. Mr. Kozlowski observed aquatic habitats in the BSA and vicinity in Lake Natomas on the north side of US 50.

2.4.3 Delineation of Aquatic Resources (Waters of the United States/Waters of the State)

Ms. Webber conducted delineation fieldwork in the BSA on April 6 and May 31, 2016. The delineation was conducted using the routine onsite determination method described in the *U.S. Army Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987) and the supplemental procedures and wetland indicators provided in the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Arid West Region* (U.S. Army Corps of Engineers 2008).

Other waters of the United States were mapped and delineated in the field in accordance with indicators and guidance in USACE Regulatory Guidance Letter No. 05-05, dated December 7, 2005 (U.S. Army Corps of Engineers 2005), and *A Field Guide to the Identification of the Ordinary High Water Mark (OHWM) in the Arid West Region* (Lichvar and McColley 2008). Methods and standards conform to the USACE Sacramento District's *Minimum Standards for Acceptance of Aquatic Resources Delineation Reports* (U.S. Army Corps of Engineers 2016a) and *Revised Map and Drawing Standards for the Pacific Division Regulatory Program Delineations* (U.S. Army Corps of Engineers 2016b). The delineation report is included as Appendix E.

2.4.4 Elderberry Shrub and Valley Elderberry Longhorn Beetle Surveys

Ms. Haire mapped the locations of elderberry shrubs, which provide habitat for valley elderberry longhorn beetle, on May 31, 2016. Surveys for the presence of valley elderberry longhorn beetle and their exit holes were conducted at three elderberry shrubs within the project footprint that may be directly affected by the project. Surveys were conducted in accordance with the *Conservation Guidelines for the Valley Elderberry Longhorn Beetle* (U.S. Fish and Wildlife Service 1999). The shrub height, canopy area, number of stems, and stem diameters were

estimated or measured for each shrub. One additional elderberry shrub is located within the project footprint but was not surveyed because impacts on and mitigation for this shrub have already been accounted for during the permitting process for Glenborough at Easton Project. Eight elderberry shrubs within 100 feet of the project footprint were not surveyed because they are not expected to be directly affected by the proposed project (see discussion in Chapter 4).

2.5 Agency Coordination and Professional Contacts

On April 4, 2016, Ms. Haire obtained a list of threatened and endangered species for the proposed project from the USFWS Sacramento Field Office through the IPaC website (U.S. Fish and Wildlife Service 2016). On March 31, 2017, September 25, 2017, March 2, 2018, and July 10, 2018 Ms. Haire obtained updated lists of threatened and endangered species from the IPaC website (U.S. Fish and Wildlife Service 2017 and 2018). The most recent version of the species list is included in Appendix B.

On April 7, 2017, Mr. Kozlowski obtained a list of threatened and endangered species for the Folsom USGS 7.5-minute quadrangle from NMFS's California Species List Tools website (National Marine Fisheries Service 2017). Caltrans biologist Michelle Lukkarila obtained an updated list from the NMFS website on July 10, 2018 (National Marine Fisheries Service 2018; Appendix B).

On April 28, 2016, Debra Sykes of ECORP Consulting provided a map of biological resources identified during surveys for the Glenborough at Easton and Easton Place Project, which overlaps with the portion of the proposed project that is on Aerojet property. ECORP is Aerojet's consultant and had done previous biological survey work for the Glenborough at Easton and Easton Place Project. On June 14, 2016, Ms. Sykes also provided ICF with the following information from the Glenborough at Easton and Easton Place Project.

- USACE 404 permit
- USFWS Biological Opinion
- A map showing the portions of the project where required mitigation had been completed.

To date, ICF has not contacted any state or local agencies to obtain information from or discuss the proposed project.

2.6 Limitations That May Influence Results

There were no limitations on the natural community, botanical, special-status species habitat assessment, aquatic resources delineation, or elderberry shrub and valley elderberry longhorn beetle surveys that would influence the results presented in this NES.

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Chapter 3 Results: Environmental Setting

3.1 Existing Biological and Physical Conditions

3.1.1 Biological Study Area

The approximately 98-acre BSA encompasses the project footprint as described in Chapter 1 (Figure 6 in Appendix A). Additionally, a 250-foot buffer on the west, south, and east sides of the jughandle area off of Folsom Boulevard was surveyed for vernal pool branchiopod habitat in order to assess potential indirect effects on vernal pool branchiopods. This area is depicted as "vernal pool branchiopod indirect effects assessment area" on Figure 6 in Appendix A. During surveys, the wildlife biologist also looked for elderberry shrubs within 100 feet of the BSA in order to assess direct and indirect effects on valley elderberry longhorn beetle. Other than the vernal pool branchiopod indirect effects assessment area and elderberry shrubs within 100 feet of the BSA, impacts from the proposed project (i.e., project-related ground-disturbing construction, staging, or access activities) are expected to be contained within the project footprint.

3.1.2 Physical Conditions

This section discusses the topography, land uses, soils, hydrology, and climate in the BSA. The BSA is relatively level, with elevations ranging from approximately 110 to 150 feet above mean sea level. Land uses in the BSA and surrounding area are primarily commercial and recreational properties. Most of the BSA has a relatively high level of historical and ongoing disturbance.

The BSA includes the following seven soil map units (Natural Resources Conservation Service 2015), which are shown in the delineation report (Appendix E).

- Natomas loam, 0%–2% slopes
- Natomas-Xerorthents, dredge tailings complex, 0%–50% slopes
- Urban land
- Urban land-Natomas complex, 0%–2% slopes
- Xerorthents, dredge tailings, 2%–50% slopes
- Xerorthents, dredge tailings-Urban land complex, 0%–2% slopes
- Water

The BSA is in the Upper American River watershed hydrologic unit (hydrologic unit code [HUC] 18020111) (U.S. Environmental Protection Agency 2016). Alder Creek is the only perennial drainage in the BSA. Alder Creek drains north under US 50 to Lake Natoma, which is approximately 0.7 mile upstream of the Nimbus Dam. Lake Natoma is part of the American River, a traditional navigable water (TNW).

The climate in the BSA is characterized by hot, dry summers and cool, moist winters. The average temperature is approximately 63.3°F, with an average range from a minimum of 51.3°F to a maximum of 75.2°F. The average annual precipitation is 22.21 inches, with precipitation falling entirely as rain, mostly between October and April. Extended periods of freezing weather are very rare, and the growing season is essentially year-round. (Natural Resources Conservation Service 2008).

3.1.3 Biological Conditions

This section discusses the regional floristic setting, land cover types (including natural communities), and typical wildlife species associated with each land cover type in the BSA. The BSA is within the Sacramento Valley subregion of the California Floristic Province (Baldwin et al. 2012:41). There are 11 land cover types in the BSA that are listed in Table 3-1 and shown in Figure 6 in Appendix A.

Table 3-1. Land Cover Types in the Biological Study Area

Land Cover Type	Acreage in the BSA
Fremont cottonwood-oak woodland*	3.16
Planted oak woodland	3.88
Valley foothill riparian woodland*	0.20
Emergent wetland*	0.20
Seasonal wetland *	0.02
Perennial drainage*	0.56
Ephemeral drainage*	<0.01
Ditch	0.17
Annual grassland	19.79
Landscaped	6.77
Developed	63.13
Total	**97.91**

Notes: *Land cover type is considered a natural community of special concern.

As identified in Table 3-1, the BSA supports six natural communities of special concern (Fremont cottonwood-oak woodland, valley foothill riparian woodland, emergent wetland, seasonal wetland, perennial drainage, and ephemeral drainage), which are habitats considered sensitive because of their high species diversity, high productivity, unusual nature, limited distribution, or declining status. Local, state, and federal agencies consider these habitats important, and compensation for loss of sensitive communities is generally required by agencies. The CNDDB contains a current list of rare natural communities throughout the state. USFWS considers certain habitats, such as riparian communities, important to wildlife; and USACE and EPA consider stream habitats important for water quality and wildlife. Waters of the United States and waters of the State are regulated by USACE and RWQCBs, respectively.

Locations, dominant plant species, and typical animal species found in the land cover types within the BSA are described below. Appendix D contains the lists of plant and animal species observed in the BSA during field surveys.

3.1.3.1 Fremont Cottonwood-Oak Woodland

The proposed jughandle road area that is south of Folsom Boulevard supports Fremont cottonwood-oak woodland (Appendix C, Photo 1). The overstory is dominated by interior live oak, Fremont cottonwood (*Populus fremontii* ssp. *fremontii*), and willows (*Salix* spp.). The understory includes small willows, coyote brush (*Baccharis pilularis*), poison-oak (*Toxicodendron diversilobum*), and annual grasses and forbs. Blue elderberry shrubs (*Sambucus nigra* ssp. *caerulea*) occur in this area.

The BSA also contains individual oak trees that occur outside of the more extensive woodland in areas mapped as landscaped and annual grassland land cover types. Areas of planted oak woodland species associated with the Hazel Avenue/US 50 interchange are described separately below.

Oak woodlands are important habitats because of their high value to wildlife in the form of nesting sites, cover, and food (Mayer and Laudenslayer 1988:80). Birds associated with oak woodlands include acorn woodpecker (*Melanerpes formicivorus*), western scrub jay (*Aphelocoma californica)*, yellow-billed magpie (*Pica nuttalli*), and many warblers and flycatchers (Zeiner et al. 1990a:376, 452, 460). Cavities in oak trees are important nesting sites for acorn woodpecker, oak titmouse (*Baeolophus inornatus*), Bewick's wren (*Thryomanes bewickii*), and western bluebird (*Sialia mexicana*) (California Partners in Flight 2002:24). Oak woodlands provide nesting sites and foraging habitat for raptors, such as red-tailed hawks (*Buteo jamaicensis*), red-shouldered hawks (*Buteo lineatus*), and great-horned owls (*Bubo virginianus*) (Zeiner et al. 1990a:132, 136, 326; California Partners in Flight 2002:24). Mammals associated with oak woodlands include western gray squirrel (*Sciurus griseus*), pallid bat (*Antrozous pallidus*), bobcat (*Lynx rufus*), mule deer (*Odocoileus hemionus*), and gray fox (*Urocyon cinereoargenteus*) (Zeiner et al. 1990b:70, 146, 324, 352). Acorns are an important food source for species such as California quail (*Callipepla californica*), wild turkey (*Meleagris gallopavo*), western gray squirrel, and mule deer (Mayer and Laudenslayer 1988:79).

3.1.3.2 Planted Oak Woodland

The areas between the US 50 on-ramps and off-ramps are planted with native trees and shrubs found in oak woodlands such as interior live oak, valley oak, buckeye (*Aesculus californica*), Lemmon's ceanothus (*Ceanothus lemmonii*), coffeeberry (*Frangula californica*), California flannelbush (*Fremontodendron californicum*), and Fremont cottonwood, with annual grassland species in the understory. Two mature interior live oak trees and a large elderberry cluster occur between the US 50 westbound off-ramp to Hazel Avenue and the westbound loop on-ramp, as well as a large elderberry cluster adjacent to the US 50 eastbound Hazel Avenue off-ramp, appear to be older than the planted trees and shrubs and may have been extant on the site prior to construction of the ramps.

Wildlife use of planted oak woodland would be similar to that described above for oak woodland; however, the number and diversity of species would be lower because of the location of this land cover type in the US 50 on- and off-ramps.

3.1.3.3 Valley Foothill Riparian Woodland

Valley foothill riparian woodland occurs on the banks of Alder Creek above the ordinary high water mark (OHWM) (Appendix C, Photo 2). Dominant species in this community include willow (*Salix* spp.), white alder (*Alnus rhombifolia*), and California blackberry (*Rubus ursinus*). California foothill pine (*Pinus sabiniana*) and interior live oak are also associated with the dominant species.

When vegetation is diverse and well developed, riparian woodland provides high-value habitat for wildlife, including several special-status species. Riparian woodland habitat provides food, water, and migration and dispersal corridors, as well as escape, nesting, and thermal cover for many wildlife species (Mayer and Laudenslayer 1988:86). Invertebrates, amphibians, and aquatic reptiles live in aquatic and adjacent upland habitats. Raptors, herons, egrets, and other birds nest in the upper canopy. A variety of songbirds use the shrub canopy, and cavity-nesting birds, such as Nuttall's woodpecker (*Picoides nuttallii*), and oak titmouse, occupy dying trees and snags (Zeiner et al. 1990a:388, 472). Several mammals including raccoon (*Procyon lotor*), Virginia opossum (*Didelphis virginiana*), and striped skunk (*Mephitis mephitis*) are common in riparian habitats (Zeiner et al. 1990b:2, 298, 316).

3.1.3.4 Emergent Wetland

Emergent wetland occurs at the edges of open water in Alder Creek below valley foothill riparian woodland vegetation and below the OHWM of the creek (Appendix C, Photo 2). Dominant species in this community include white alder saplings, tall flatsedge (*Cyperus eragrostis*), Pacific rush (*Juncus effusus* ssp. *pacificus*), tule (*Schoenoplectus acutus*), California blackberry, curly dock (*Rumex crispus*), and floating water primrose (*Ludwigia peploides* ssp. *peploides*). The emergent wetlands in the BSA are potential waters of the United States and are waters of the State. Additional information about the emergent wetlands is provided in Appendix E.

Emergent wetlands provide food, cover, and water for a variety of amphibians, reptiles, birds, and mammals (Mayer and Laudenslayer 1988:124). Wildlife species that utilize freshwater marsh habitat include Sierran treefrog (*Pseudacris sierra*), western aquatic garter snake (*Thamnophis couchi*) (Zeiner et al. 1988:78, 216), great blue heron (*Ardea herodias*), great egret (*Ardea alba*), Virginia rail (*Rallus limicola*), and red-winged blackbird (*Agelaius phoeniceus*) (Zeiner et al. 1990a:32, 34, 176, 638).

3.1.3.5 Seasonal Wetland

Seasonal wetlands are normally inundated during the winter and early spring but are dry by late spring. The seasonal wetlands in the BSA consist of created features that occur in the cloverleaf loops of the Hazel Avenue/US 50 interchange and are not naturally occurring features (Appendix C, Photos 3–5). These wetlands support few native plant species. Dominant species in the seasonal wetlands are nonnatives, including Mediterranean barley (*Hordeum marinum* var. *gussoneanum*), Italian ryegrass (*Festuca perennis*), and hyssop loosestrife (*Lythrum hyssopifolia*). The seasonal wetlands in the BSA are potential waters of the United States and are

waters of the State. Additional information about the seasonal wetlands in the BSA is provided in Appendix E.

The vernal pool branchiopod indirect effects survey area (Figure 6 in Appendix A) surrounding the jughandle area contains several small inclusions of seasonal wetland vegetation in depressions (Appendix C, Photos 6–9). These potential seasonal wetlands are dominated by native and nonnative species, including Canada horseweed (*Erigeron canadensis*), Mediterranean barley, Harding grass (*Phalaris aquatica*), rabbitsfoot grass (*Polypogon monspeliensis*), and curly dock. The potential seasonal wetlands are outside of the BSA and, therefore, were not part of the delineation area. These features could be waters of the United States and waters of the State.

Seasonal wetlands provide unique habitat for a variety of aquatic invertebrates, which provide food for other wildlife species including great blue heron, killdeer (*Charadrius vociferus*), American avocet (*Recurvirostra americana*), black-necked stilt (*Himantopus mexicanus*) and greater yellowlegs (*Tringa melanoleuca*) (Zeiner et al. 1990a:32, 192, 200, 202). Amphibians such as Sierran treefrog, western spadefoot (*Spea hammondii*), and California toad (*Anaxyrus boreas halophilus*) use seasonal wetlands for breeding and feeding (Zeiner et al. 1988:56, 64, 78).

3.1.3.6 Perennial Drainage

The BSA contains one perennial drainage, Alder Creek, which connects to Lake Natoma on the north side of US 50. Alder Creek flows under US 50 through a box culvert that is beneath an MSE wall. As a result of the MSE, the water in Alder Creek backs up at the south side of the US 50 crossing, creating a 150-200-foot wide, pond-like area with mostly stagnant water (Appendix C, Photo 2). An emergent wetland fringe is present on both sides of the creek. The open water portion of Alder Creek appears to qualify as an ‘other’ (i.e., non-wetland) water of the United States on the basis of its hydrologic connection to the American River, a TNW. Alder Creek is also a water of the State. Additional information about Alder Creek is provided in Appendix E.

Wildlife use of this land cover type is dependent on the extent of emergent and submergent vegetation, and adjacent streamside (riparian) vegetation. Drainages with well-vegetated areas provide food, water, and migration and dispersal corridors, as well as escape, nesting and thermal cover for many wildlife species (Mayer and Laudenslayer 1988). Wildlife species associated with stream and riparian habitats include western toad (*Bufo boreas*), California newt (*Taricha torosa*), black phoebe (*Sayornis nigricans*), Anna’s hummingbird (*Calypte anna*), great egret, belted kingfisher (*Megaceryle alcyon*), raccoon, and striped skunk (Zeiner et. al 1990a, 1990b). Many species of insectivorous birds, including white-throated swift (*Aeronautes saxatalis*), barn swallow (*Hirundo rustica*), cliff swallow (*Petrochelidon pyrrhonota*), black phoebe, and ash-throated flycatcher (*Myiarchus cinerascens*) catch their prey over open water.

Fish use of Alder Creek likely consists of a combination of introduced and native species. Native species may include sculpin (*Cottus* spp.) and Cyprinid (minnow) species, while introduced species may include Centrarchid (blackbass and sunfish) and Ictalurid (bullhead and catfish) species, as well as Western mosquitofish (*Gambusia affinis*). Because Alder Creek is a tributary

to Lake Natoma, it is not accessible to anadromous species found in the Lower American River. No special-status fish species occur in Alder Creek.

3.1.3.7 Ephemeral Drainage

A 10-foot long segment of a 3.5-foot wide ephemeral drainage crosses the interchange north of US 50. A 20-foot long segment of a 1-foot wide ephemeral drainage crosses the BSA east of Alder Creek. This drainage extends south from the edge of US 50 to Alder Creek. The drainages supports annual grassland vegetation. The ephemeral drainages are potential non-wetland waters of the United States and are waters of the State. Additional information about the ephemeral drainages are provided in Appendix E.

Ephemeral drainages provide temporary sources of water for several common wildlife species. Banks of the channels may be used by California ground squirrels (*Spermophilus beecheyi*), western fence lizards (*Sceloporus occidentalis*), and gopher snakes (*Pituophis melanoleucus*).

3.1.3.8 Ditch

The BSA contains three ditches: two excavated drainage ditches that have been verified as waters of the United States, and an excavated roadside ditch that was delineated by ICF in 2016. Additional information about ditches in the BSA is provided in Appendix E. The two excavated drainage ditches are in the BSA south of Folsom Boulevard. These are constructed features, but are included as waters of the United States in the verified delineation for this part of the BSA that was done for the Glenborough at Easton and Easton Place Project (U.S. Army Corps of Engineers 2012). The ditches support weedy annual grassland vegetation.

The constructed roadside ditch extends from the east end of the BSA to Alder Creek (Appendix C, Photo 10). This ditch supports annual grassland vegetation and receives runoff from US 50 and from the interchange loop at Folsom Boulevard. The ditch is approximately 3 feet wide. The constructed roadside ditch is a potential other water of the United States and is a water of the State.

Wildlife use of ditches is dependent several factors including the extent of vegetation within and along the ditch, whether or not the ditch is concrete lined, the period of time that water remains within the ditch, and the velocity of flow. Concrete-lined ditches or those with high flow velocities typically have low value for wildlife, although large ditches/canals with slower flows can be used by waterfowl. Ditches with vegetated channels and banks and adequate duration of water can provide food, water, cover, and dispersal corridors for various wildlife species, such as Sierran treefrog, California newt, great egret, raccoon, and striped skunk. Ditch banks could be used by California ground squirrel and western fence lizard.

3.1.3.9 Annual Grassland

Annual grassland occurs throughout the BSA within the US 50 ROW and south of Folsom Boulevard. Areas mapped as annual grassland in the existing Hazel Avenue/US 50 interchange and the area south of Folsom Boulevard support primarily nonnative, weedy species (Appendix C, Photo 1). Dominant species in this community include annual grasses such as wild oat (*Avena*

fatua), ripgut brome (*Bromus diandrus*), soft chess (*B. hordeaceus*), foxtail barley (*Hordeum murinum* ssp. *leporinum*), and perennial ryegrass. Typical forbs in annual grassland in the BSA are Italian thistle (*Carduus pycnocephalus*), heron's bill (*Erodium botrys* and *E. cicutarium*), hawkbit (*Leontodon saxatilis* ssp. *longirostris*), milk thistle (*Silybum marianum*), hairy clover (*Trifolium hirtum*), and hairy vetch (*Vicia villosa*). The annual grassland on both sides of Alder Creek also supports some native forbs, including elegant clarkia (*Clarkia unguiculata*) and dwarf brodiaea (*Brodiaea nana*). Scattered native trees such as Fremont cottonwood, interior live oak, valley oak, and California foothill pine also occur in areas mapped as annual grassland. A blue elderberry shrub cluster also occurs in annual grassland along US 50.

Many wildlife species use annual grasslands for foraging. Some of these species also inhabit annual grassland if special features such as cliffs, caves, ponds, or woody plants are available for breeding or resting habitat, or as escape cover. Reptiles that breed in annual grassland habitats include western fence lizard, common garter snake (*Thamnophis sirtalis*), and western rattlesnake (*Crotalus tigris*). Grasslands provide foraging habitat for wide-ranging species such as red-tailed hawk, turkey vulture (*Cathartes aura*), American kestrel (*Falco sparverius*), and northern harrier (*Circus cyaneus*). Mammals typically found in this habitat include California vole (*Microtus californicus*), western harvest mouse (*Reithrodontomys megalotis*), California ground squirrel, black-tailed hare (*Lepus californicus*), coyote (*Canis latrans*), and American badger (*Taxidea taxus*). (Mayer and Laudenslayer 1988:118.) In addition, many species that nest or roost in open woodlands may forage in associated grasslands, including western bluebirds, western kingbirds (*Tyrannus verticalis*), and some species of bats (Zeiner et al. 1990a:428, 510; 1990b).

3.1.3.10 Developed and Landscaped

Developed and landscaped land cover types are discussed together because they are similar from a wildlife habitat value standpoint. These cover types comprise the largest portion of the BSA. Developed areas largely consist of hardscape, including buildings, parking lots, driveways, and sidewalks. Native vegetation has been removed or replaced with grass lawn and ornamental plantings. The landscaping adjacent to developed facilities consists of shade and street trees, hedges and shrubs, lawns and gardens. The growth of vegetation in this land cover type is typically managed by trimming or mowing.

Because landscaped areas typically are disturbed on a regular basis by human activity, they provide low-quality habitat for wildlife. Wildlife species commonly found in urban areas are also found in landscaped areas. Such species may include Brewer's blackbird (*Euphagus cyanocephalus*), house finch (*Haemorhous mexicanus*), house sparrow (*Passer domesticus*), yellow-billed magpie, mourning dove (*Zenaida macroura*), Virginia opossum, and striped skunk (Zeiner et al. 1990a:310, 460, 646, 668, 682; 1990b:2, 316). American kestrels and red-tailed hawks frequently forage in this habitat (Zeiner et al. 1990a:136, 144). Bats may also roost in or on, and some birds may nest in or on, built structures.

3.2 Regional Special-Status Species

Tables 3-2 and 3-3 list the special-status plant and animal species that are known to occur or have the potential to occur in the project region (i.e., within 5 miles of the proposed project). These species were identified based on the CNDDB records search, the CNPS *Inventory of Rare and Endangered Plants*, the USFWS species list (Appendix B). Species were also identified on the basis of distribution and habitat requirements data. CNDDB records within 5 miles of the BSA are shown on Figure 7 in Appendix A.

For the purpose of this NES, special-status species are plants and animals that are legally protected under FESA, CESA, or other regulations, and species that are considered sufficiently rare by the scientific community to qualify for such listing. Special-status plants and animals are those species in any of the categories listed below:

- Species listed or proposed for listing as threatened or endangered under FESA (50 CFR 17.11 [listed animals], 50 CFR 17.12 [listed plants], and various notices in the Federal Register [FR] [proposed species]).
- Species that are candidates for possible future listing as threatened or endangered under FESA (81 FR 87246, December 2, 2016).
- Species listed or proposed for listing by the State of California as threatened or endangered under CESA (14 California Code of Regulations [CCR] 670.5).
- Species that meet the definitions of rare or endangered under CEQA (State CEQA Guidelines Section 15380).
- Plants listed as rare under CNPPA (California Fish and Game Code 1900 et seq.).
- Plants with a California Rare Plant Rank (CRPR) of 1 or 2 (California Department of Fish and Wildlife 2017a).
- Plants about which more information is needed to determine their status and plants of limited distribution (CRPR 3 and 4) (California Department of Fish and Wildlife 2017a), which may be included as special-status species on the basis of local significance or recent biological information.
- Animal species of special concern to CDFW (California Department of Fish and Wildlife 2017b).
- Animals fully protected in California (CFGC Section 3511 [birds], 4700 [mammals], 5050 [amphibians and reptiles], and 5515 [fish]).

If an animal species identified from the CNDDB records search was not in one of the categories listed above, it was not included in Table 3-3.

3.2.1 Special-Status Plant Species

Twenty-three special-status plant species were identified as occurring in the BSA vicinity based on the CNDDB search results, the CNPS Inventory, and the USFWS list for the project area (Appendix B) (Table 3-2). None of these special-status plants have been recorded within the BSA (Appendix A, Figure 7). The Brandegee's clarkia (*Clarkia biloba* ssp. *brandegeeae*) polygon that overlaps the BSA on Figure 7 represents an observation made approximately 0.25 mile north of the BSA in the Folsom Lake Recreation Area. A non-special-status clarkia species, elegant clarkia (*Clarkia unguiculata*), was observed growing on a slope along the south edge of US 50 east of the Alder Creek crossing during the May 2016 surveys in the BSA.

Twelve of the 23 special-status plant species would not be expected to occur in the BSA because suitable soils for these species have not been mapped in the BSA (i.e., serpentine, gabbro, and clay soils). Six of the 23 special-status species would not be expected, because there is no suitable habitat present in the BSA (i.e., chaparral and vernal pool). Potential habitat for the remaining five special-status plant species (big-scale balsamroot, Brandegee's clarkia, Red Bluff dwarf rush, legenere, and Sanford's arrowhead) was identified in the BSA. The survey results for special-status plant species are discussed in Chapter. 4.

Table 3-2. Special-Status Plant Species with Potential to Occur in the Vicinity of the Hazel Avenue/US 50 Interchange Project Biological Study Area

Common and *Scientific Name*	Legal Status Federal/State/CRPR	General Habitat Description	Blooming Period	Habitat Present/ Absent	Rationale
Big-scale balsamroot *Balsamorhiza macrolepis*	–/–/1B.2	Scattered occurrences in the Coast Ranges and Sierra Nevada foothills. Sometimes on serpentine soils in chaparral, cismontane woodland, and valley and foothill grassland; 90–1,555 meters.	March–June	Habitat Present	Marginal habitat in annual grassland and oak woodland in the BSA. Nearest recorded occurrence is more than 5 miles outside of the BSA. Not observed during May 2016 surveys.
Stebbins' morning-glory *Calystegia stebbinsii*	E/E/1B.1	Northern Sierra Nevada foothills, with reported occurrences in El Dorado and Nevada Counties. Serpentine or gabbroic soils in chaparral openings and cismontane woodland; 185–1,090 meters.	April–July	Habitat Absent	No suitable soils in the BSA. Nearest recorded occurrence is more than 5 miles outside of the BSA.
Chaparral sedge *Carex xerophila*	–/–/1B.2	Central Sierra Nevada foothills, Butte, El Dorado, Nevada, and Yuba Counties . Serpentinite, gabbroic soils in chaparral, cismontane woodland, and lower montane coniferous forest; 440–770 meters.	March–June	Habitat absent	No suitable soils in the BSA. Nearest recorded occurrence is more than 5 miles outside of the BSA.
Pine Hill ceanothus *Ceanothus roderickii*	E/R/1B.1	Endemic to El Dorado County. Serpentine or gabbro soils in chaparral or cismontane woodland; 245–630 meters.	April–June	Habitat Absent	No suitable soils in the BSA. Nearest recorded occurrence is more than 5 miles outside of the BSA.
Red Hills soaproot *Chlorogalum grandiflorum*	–/–/1B.2	Northern and central Sierra Nevada Foothills: Amador, Butte, Calaveras, El Dorado, Placer, and Tuolumne Counties. Serpentine or gabbro soils in chaparral, lower montane coniferous forest, and cismontane woodland; 245–1,240 meters.	May–June	Habitat Absent	No suitable soils in the BSA. Nearest recorded occurrence is more than 5 miles outside of the BSA.
Hispid bird's-beak *Chloropyon molle* ssp. *hispidum*	–/–/1B.1	Central Valley: Alameda, Fresno, Kern, Merced, Placer, and Solano Counties . Meadow and seeps, valley and foothill grassland, playa, on alkaline soils; 1–155 meters.	June–September	Habitat Absent	No suitable soils in the BSA. Nearest recorded occurrence is more than 5 miles outside of the BSA.

Common and *Scientific Name*	Legal Status Federal/State/CRPR	General Habitat Description	Blooming Period	Habitat Present/ Absent	Rationale
Brandegee's clarkia *Clarkia biloba* ssp. *brandegeeae*	–/–/4.2	Northern Sierra Nevada Foothills from Butte to El Dorado Counties. Chaparral, cismontane woodland, lower coniferous forest, often on roadcuts; 75–915 meters.	May–July	Habitat Present	Suitable habitat along south edge of US 50. Nearest recorded occurrence is ~0.25 mile north of the BSA in the Folsom Lake Recreation Area. Not observed during May 2016 surveys.
Bisbee Peak rush-rose *Crocanthemum suffrutescens*	–/–/3.2	Amador, Calaveras, El Dorado, Mariposa, Sacramento, and Tuolumne Counties. Chaparral openings, often on serpentine, gabbro, or Ione soils; 45–840 meters.	April–August	Habitat Absent	No suitable soils or plant communities in the BSA. Nearest recorded occurrence is more than 5 miles outside of the BSA.
Dwarf downingia *Downingia pusilla*	–/–/2B.2	Central Valley. Vernal pools and mesic valley and foothill grasslands; below 445 meters.	March–May	Habitat Absent	No vernal pool habitat in the BSA. Nearest recorded occurrence is ~1.25 miles north of the BSA at Phoenix Park.
Tuolumne button-celery *Eryngium pinnatisectum*	–/–/1B.2	Amador, Calaveras, Sacramento, and Tuolumne Counties. Vernal pools and moist areas in cismontane woodland and lower montane coniferous forest; 70–915 meters.	May–August	Habitat Absent	No vernal pool habitat in the BSA. Nearest recorded occurrence is more than 5 miles outside of the BSA.
Pine Hill flannelbush *Fremontodendron decumbens*	E/R/1B.2	Pine Hill area in El Dorado County, Grass Valley vicinity in Nevada County, Yuba County. Rocky gabbro or serpentine soils in chaparral, cismontane woodland; 425–760 meters.	April–July	Habitat Absent	No suitable soils in the BSA. Nearest recorded occurrence is more than 5 miles outside of the BSA.
Stinkbells *Fritillaria agrestis*	–/–/4.2	Alameda, Contra Costa, Fresno, Kern, Mendocino, Monterey, Merced, Monterey, Mariposa, Placer, Sacramento, Santa Barbara, San Benito, San Luis Obispo, San Mateo, Stanislaus, and Tuolumne Counties. Chaparral, cismontane woodland, pinyon-juniper woodland, valley and foothill grassland, on clay, sometimes serpentinite substrate; 10–1,555 meters.	March–June	Habitat Absent	No suitable soils in the BSA. Nearest recorded occurrence is more than 5 miles outside of the BSA.
El Dorado bedstraw *Galium californicum* ssp. *sierrae*	E/R/1B.2	Endemic to El Dorado County. On gabbro soils in chaparral, cismontane woodland, lower montane coniferous forest; 100–585 meters.	May–June	Habitat Absent	No suitable soils in the BSA. Nearest recorded occurrence is more than 5 miles outside of the BSA.

Common and *Scientific Name*	Legal Status Federal/State/CRPR	General Habitat Description	Blooming Period	Habitat Present/ Absent	Rationale
Boggs Lake hedge-hyssop *Gratiola heterosepala*	–/E/1B.2	Inner North Coast Ranges, Central Sierra Nevada Foothills, Sacramento Valley and Modoc Plateau: Fresno, Lake, Lassen, Madera, Merced, Modoc, Placer, Sacramento, Shasta, Siskiyou, San Joaquin, Solano, Sonoma, and Tehama Counties; also Oregon. Clay soils in areas of shallow water, lake margins of swamps and marshes, vernal pool margins; 10–2,375 meters.	April–August	Habitat Absent	No suitable soils in the BSA, although the margins of Alder Creek could be suitable habitat. Nearest recorded occurrences are ~2.5 miles south of the BSA.
Ahart's dwarf rush *Juncus leiospermus* var. *ahartii*	–/–/1B.2	Eastern Sacramento Valley, northeastern San Joaquin Valley with occurrences in Butte, Calaveras, Placer, Sacramento, Tehama, and Yuba Counties. Wet areas in valley and foothill grassland, vernal pool margins; 30–229 meters.	March–May	Habitat Absent	No vernal pool habitat in the BSA. Nearest recorded occurrence is more than 5 miles outside of the BSA.
Red Bluff dwarf rush *Juncus leiospermus* var. *leiospermus*	–/–/1B.1	Northern Sacramento Valley and Cascade Range foothills, with occurrences in Butte, Placer, Shasta, and Tehama Counties. Seasonally wet areas in chaparral, cismontane woodland, meadows and seeps, valley and foothill grassland, and vernal pools; 35–1,250 meters.	March–June	Habitat Present	Marginal habitat present in seasonal wetland and ditch habitats. Nearest recorded occurrences are more than 5 miles outside of the BSA. Not observed during April or May 2016 surveys.
Legenere *Legenere limosa*	–/–/1B.1	Primarily in the lower Sacramento Valley, also from north Coast Ranges, northern San Joaquin Valley and the Santa Cruz Mountains. Deep, seasonally wet habitats such as vernal pools, ditches, marsh edges, and river banks; below 880 meters.	April–June	Habitat Present	Marginal habitat present in seasonal wetland and ditch habitats. Nearest recorded occurrences are ~4 miles south of the BSA. Not observed during April or May 2016 surveys.
Pincushion navarretia *Navarretia myersii* ssp. *myersii*	–/–/1B.1	Central Valley in Amador, Calaveras, Merced, Placer, and Sacramento Counties. Edges of vernal pools; 20-330 meters.	April–May	Habitat Absent	No vernal pool habitat in the BSA. Nearest recorded occurrence is ~1.25 miles north of the BSA at Phoenix Field Ecological Reserve.

Common and *Scientific Name*	Legal Status Federal/State/CRPR	General Habitat Description	Blooming Period	Habitat Present/ Absent	Rationale
Slender Orcutt grass *Orcuttia tenuis*	T/E/1B.1	Sierra Nevada and Cascade Range foothills from Siskiyou to Sacramento Counties. Vernal pools; 35–1,760 meters.	May–September (rarely October)	Habitat Absent	No vernal pool habitat in the BSA. Nearest recorded occurrence is ~5 miles south of the BSA.
Sacramento Orcutt grass *Orcuttia viscida*	E/E/1B.1	Endemic to Sacramento County. Vernal pools; 30–100 meters.	April–July	Habitat Absent	No vernal pool habitat in the BSA. Nearest recorded occurrence is ~1.25 miles north of the BSA at Phoenix Park.
Layne's ragwort (or Layne's butterweed) *Packera layneae*	T/R/1B.2	Northern Sierra Nevada Foothills, Butte, El Dorado, Placer, Tuolumne, and Yuba Counties. Rocky serpentine or gabbro soils in chaparral and foothill woodland; 200–1,000 meters.	April–August	Habitat Absent	No suitable soils in the BSA. Nearest recorded occurrence is more than 5 miles outside of the BSA.
Sanford's arrowhead *Sagittaria sanfordii*	–/–/1B.2	Scattered locations in Central Valley and Coast Ranges. Freshwater marshes, sloughs, canals, and other slow-moving water habitats; below 650 meters.	May–October	Habitat Present	Potential habitat present in emergent wetland at edges of Alder Creek. Nearest recorded occurrence is ~3.9 miles southwest of the BSA. Not observed during April or May 2016 surveys.
El Dorado County mule ears *Wyethia reticulata*	–/–/1B.2	El Dorado and Yuba Counties. On clay or gabbro soils in chaparral, cismontane woodland, and lower montane coniferous forest; 185–630 meters.	April–August	Habitat Absent	No suitable soils in the BSA. Nearest recorded occurrence is more than 5 miles outside of the BSA.

BSA = biological study area

[a] Status explanations:

Federal

E = Listed as endangered under the federal ESA.
T = Listed as threatened under the federal ESA.
— = No listing status.

State

E = Listed as endangered under CESA.
R = Listed as rare under the CESA. This category is no longer used for newly listed plants, but some plants previously listed as rare retain this designation.
— = No listing status.

California Rare Plant Rank (CRPR)

1B = List 1B species: rare, threatened, or endangered in California and elsewhere.
2 = List 2 species: rare, threatened, or endangered in California but more common elsewhere.
3 = List 3 species: more information is needed about this plant.
4 = List 4 species: limited distribution; species on a watch list
.1 = Seriously endangered in California (over 80% of occurrences threatened—high degree and immediacy of threat).
.2 = Fairly endangered in California (20-80% occurrences threatened).

Table 3-3. Special-Status Animal Species with Potential to Occur in the Vicinity of the Hazel Avenue/US 50 Interchange Project Biological Study Area

Common and Scientific Name	Legal Status (Federal/State/ Other)	General Habitat Description	Habitat Present/ Absent	Rationale
Invertebrates				
Conservancy fairy shrimp *Branchinecta conservatio*	E/–/–	Disjunct occurrences in Solano, Merced, Tehama, Ventura, Butte, Placer, and Glenn Counties; Central Valley. Large, deep vernal pools in annual grasslands	Absent	There are no large, deep vernal pools in the BSA.
Vernal pool fairy shrimp *Branchinecta lynchi*	T/–/–	Found in Central Valley, central and south Coast Ranges from Tehama County to Santa Barbara County. Isolated populations also in Riverside County. Common in vernal pools; also found in sandstone rock outcrop pools.	Present	Seasonal wetlands on Aerojet property provide potentially suitable habitat.
Midvalley fairy shrimp *Branchinecta mesovallensis*	–/–/–	Occurs in Sacramento, Solano, Merced, Madera, San Joaquin, Fresno, and Contra Costa Counties. Has been found in small, short-lived vernal pools and grass-bottomed swales.	Present	Seasonal wetlands on Aerojet property provide potentially suitable habitat.
Vernal pool tadpole shrimp *Lepidurus packardi*	E/–/–	Found from Shasta County south to Merced County in vernal pools and ephemeral stock ponds.	Absent	There are no vernal or seasonal pools that are deep enough or that would hold water long enough to support this species.
Hairy water flea *Dumontia oregonensis*	–/–/–	In California, only found at Mather Field. Also occurs at three pools in Medford, Oregon. Occurs in vernal pools.	Absent	No vernal pools in the BSA; unlikely to be associated with seasonal wetlands in the BSA because of disturbed nature of area.
Valley elderberry longhorn beetle *Desmocerus californicus dimorphus*	T/–/–	Stream side habitats below 3,000 feet throughout the Central Valley Occur in riparian and oak savanna habitats with elderberry shrubs; elderberries are the host plant.	Present	Several elderberry shrubs are present in the BSA.
Ricksecker's water scavenger beetle *Hydrochara ricksecker*i	–/–/–	San Francisco Bay Area including San Mateo, Sonoma, Alameda, and Marin Counties; Also in Solano, Contra Costa, and Sacramento Counties. Occurs in playa-like vernal pools and ponds.	Absent	There are no playa-like vernal pools or ponds in the BSA.
Blennosperma vernal pool andrenid bee *Andrena blennospermatis*	–/–/–	Tehama, Placer, El Dorado, Sacramento, Yolo, Lake, Sonoma, Solano, San Joaquin, and Contra Costa Counties. Upland areas near vernal pools.	Absent	No vernal pools in BSA; unlikely to be associated with seasonal wetlands in the BSA because of disturbed nature of area.

Common and Scientific Name	Legal Status (Federal/State/ Other)	General Habitat Description	Habitat Present/ Absent	Rationale
An andrenid bee *Andrena subapasta*	–/–/–	Range information not known. Nests in uplands near vernal pools. Collects pollen primarily from *Arenaria californica* but also *Orthocarpus erianthus* and *Lasthenia* species.	Absent	No vernal pools in BSA; unlikely to be associated with seasonal wetlands in the BSA because of disturbed nature of area.
Fish				
Delta smelt *Hypomesus transpacificus*	T/E/–	Found primarily in the Sacramento–San Joaquin Estuary, but has been found as far upstream as the mouth of the American River on the Sacramento River and Mossdale on the San Joaquin River; range extends downstream to San Pablo Bay. Occur in estuary habitat in the Delta where fresh and brackish water mix in the salinity range of 2–7 parts per thousand. (Moyle 2002.)	Absent	The BSA is outside the known range of this species. The lower American River and BSA are not designated as critical habitat for the species.
Central Valley steelhead DPS *Oncorhynchus mykiss* Critical Habitat	T/–/–	Sacramento River and tributary Central Valley rivers. Occurs in well-oxygenated, cool, riverine habitat with water temperatures from 7.8 to 18°C (Moyle 2002). Habitat types are riffles, runs, and pools.	Absent	Nimbus Dam on the lower American River represents the upstream limit of anadromy; consequently, the BSA is outside the range of this population of steelhead. The BSA is not located within designated critical habitat for this DPS. Project effects would not extend to the lower American River.
Central Valley spring-run Chinook salmon Evolutionarily Significant Unit (ESU) *Oncorhynchus tshawytscha*	T/T/–	Upper Sacramento River, Feather River, and Yuba River and several perennial tributaries of the Sacramento River (Battle, Butte, Clear, Deer, and Mill Creeks); occurs in well-oxygenated, riverine habitats; coldwater pools are needed for holding over-summering adults (Moyle 2002).	Absent	Nimbus Dam on the lower American River represents the upstream limit of anadromy; consequently, the BSA is outside the range of this population of Central Valley spring-run Chinook salmon. The Sacramento River is designated as critical habitat for this ESU. Project effects would not extend to the lower American River or Sacramento River.

Common and Scientific Name	Legal Status (Federal/State/ Other)	General Habitat Description	Habitat Present/ Absent	Rationale
Amphibians				
California tiger salamander *Ambystoma californiense*	T/T/–	Central Valley, including Sierra Nevada foothills, up to approximately 1,000 feet, and coastal region from Butte County south to northeastern San Luis Obispo County. Small ponds, lakes, or vernal pools in grasslands and oak woodlands for reproduction and larval development; rodent burrows, rock crevices, or fallen logs for cover for adults and juveniles for summer dormancy.	Absent	There are no ponds, lakes, or vernal pools of adequate size and depth to support this species in or adjacent to the BSA. The majority of the project area is between freeway and dense development.
Western spadefoot *Spea hammondii*	–/SSC/–	Occurs in the Sierra Nevada foothills, Central Valley, Coast Ranges, and coastal counties in southern California; west of Sierran-desert range axis. Shallow streams with riffles and seasonal wetlands, such as vernal pools in annual grasslands and oak woodlands, also temporary rain pools.	Absent	There are no appropriate streams, ponds, or vernal pools of adequate size and depth to support this species in or adjacent to the BSA. The majority of the project area is between freeway and dense development.
California red-legged frog *Rana draytonii*	T/SSC/–	Found along the coast and coastal mountain ranges of California from Marin County to San Diego County and in the Sierra Nevada from Tehama County to Fresno County. Occurs in permanent and semipermanent aquatic habitats, such as creeks and cold-water ponds, with emergent and submergent vegetation. May estivate in rodent burrows or cracks during dry periods.	Absent	Within historic range of species but not within current range (U.S. Fish and Wildlife Service 2002:4-5); not expected to occur.
Foothill yellow-legged frog *Rana boylii*	–/C/–	Occurs in the Klamath, Cascade, north Coast, south Coast, Transverse, and Sierra Nevada Ranges up to approximately 6,000 feet. Creeks or rivers in woodland, forest, mixed chaparral, and wet meadow habitats with rock and gravel substrate and low overhanging vegetation along the edge. Usually found near riffles with rocks and sunny banks nearby.	Absent	The BSA is not located with the species known range.
Reptiles				
Western pond turtle *Actinemys marmorata*	–/SSC/–	Occurs throughout California west of the Sierra-Cascade crest. Found from sea level to 6,000 feet. Does not occur in desert regions except for along the Mojave River and its tributaries. Occupies ponds, marshes, rivers, streams, and irrigation canals with muddy or rocky bottoms and with watercress, cattails, water lilies, or other aquatic vegetation in woodlands, grasslands, and open forests.	Present	Species observed in Alder Creek during the field survey. Alder Creek provides suitable aquatic habitat and adjacent grassland areas provide suitable upland habitat.

Common and Scientific Name	Legal Status (Federal/State/ Other)	General Habitat Description	Habitat Present/ Absent	Rationale
Giant gartersnake *Thamnophis gigas*	T/T/–	Central Valley from the vicinity of Burrel in Fresno County north to near Chico in Butte County; has been extirpated from areas south of Fresno. Sloughs, canals, low gradient streams and freshwater marsh habitats where there is a prey base of small fish and amphibians; also found in irrigation ditches and rice fields; requires grassy banks and emergent vegetation for basking and areas of high ground protected from flooding during winter.	Absent	There are no sloughs, canals, rice fields, or freshwater marshes that provide suitable habitat. Although the ponded area of Alder Creek at US 50 provides appropriate conditions, the remainder of the creek has a rocky substrate and is predominantly shaded.
Birds				
Golden eagle *Aquila chrysaetos*	–/FP/P	Foothills and mountains throughout California; uncommon nonbreeding visitor to lowlands such as the Central Valley; ranges from sea level to around 11,500 feet. Rolling foothills, mountain ranges, sage-juniper flats, and desert. Nests on cliffs and escarpments or in tall trees overlooking open country. Forages in annual grassland, chaparral, and oak woodland with plentiful medium and large-sized mammals.	Absent	Could occasionally occur in the BSA but would not nest there.
Bald eagle *Haliaeetus leucocephalus*	–/E/P	Nests in Siskiyou, Modoc, Trinity, Shasta, Lassen, Plumas, Butte, Tehama, Lake, and Mendocino Counties and in the Lake Tahoe Basin. Reintroduced into central coast. Winter range includes the rest of California, except the southeastern deserts, very high altitudes in the Sierra Nevada, east of the Sierra Nevada south of Mono County, and some rangelands and coastal wetlands. In western North America, nests and roosts in coniferous forests, woodlands, grasslands, and wetland habitats within 1 mile of a lake, reservoir, stream, or the ocean; nests are normally built in upper canopy of large trees, such as conifers.	Absent	Could occasionally occur in the BSA but would not nest there.
Swainson's hawk *Buteo swainsoni*	–/T/–	Lower Sacramento and San Joaquin Valleys, the Klamath Basin, and Butte Valley. Highest nesting densities occur near Davis and Woodland, Yolo County. Commonly nests in oaks or cottonwoods in or near riparian habitats. Forages in grasslands, irrigated pastures, and grain fields.	Present	Suitable nesting and foraging habitat present in the BSA
White-tailed kite *Elanus leucurus*	–/FP/–	Lowland areas west of Sierra Nevada from the head of the Sacramento Valley south, including coastal valleys and foothills to western San Diego County at the Mexico border. Low foothills or valley areas with valley or live oaks, riparian areas, and marshes near open grasslands for foraging.	Present	Suitable nesting and foraging habitat present in the BSA

Common and Scientific Name	Legal Status (Federal/State/ Other)	General Habitat Description	Habitat Present/ Absent	Rationale
California black rail *Laterallus jamaicensis coturniculus*	–/T, FP/–	Permanent resident in the San Francisco Bay and east-ward through the Delta into Sacramento and San Joaquin Counties; small populations in Marin, Santa Cruz, San Luis Obispo, Orange, Riverside, and Imperial Counties Tidal salt marshes associated with heavy growth of pickleweed; also occurs in brackish marshes or freshwater marshes at low elevations.	Absent	Emergent wetland in the BSA provides poor quality habitat (i.e., limited emergent vegetation, deep water, adjacent to freeway) and black rail is not expected to occur.
Western burrowing owl *Athene cunicularia hypugea*	–/SSC/–	Lowlands throughout California, including the Central Valley, northeastern plateau, southeastern deserts, and coastal areas. Rare along south coast. Level, open, dry, heavily grazed or low stature grassland or desert vegetation with available burrows.	Absent	Annual grasslands are either located adjacent to the freeway or are tall and dense on the Aerojet property and no burrows were observed in either area.
Bank swallow *Riparia riparia*	–/T/–	Occurs along the Sacramento River from Tehama County to Sacramento County, along the Feather and lower American Rivers, in the Owens Valley; and in the plains east of the Cascade Range in Modoc, Lassen, and northern Siskiyou Counties. Small populations near the coast from San Francisco County to Monterey County. Nests in bluffs or banks, usually adjacent to water, where the soil consists of sand or sandy loam, along streams, coastal bluffs, and sand/gravel pits.	Absent	No bluffs or banks adjacent to water in the BSA.
Yellow-breasted chat *Icteria virens*	–/SSC/–	Summer resident and migrant in coastal California and Sierra Nevada foothills, east of the Cascades in northern California, along the Colorado river, and very locally inland in southern California; numerous in norwestern region of the state. Nests in dense riparian habitats with a well-developed shrub layer and an open canopy, dominated by willows, alders, Oregon ash, tall weeds, blackberry vines, and grapevines.	Present	Valley foothill riparian provides suitable habitat; no CNDDB records but eBird record within 1 mile of the BSA (eBird 2016).
Grasshopper sparrow *Ammodramus savannarum*	–/SSC/–	Central Valley and foothills, west slope of Sierra Nevada, Coast Ranges, and coastal areas from Del Norte County south to San Diego County; rare breeder in the Shasta Valley area of Siskiyou County. Occurs in short to medium height dry grasslands with scattered shrubs in the Central Valley and foothills and south coast; found prairies and pastures scattered in largely forested areas along north coast. Nests on ground in slight depression.	Absent	Annual grasslands are either located adjacent to the freeway or are tall and dense on the Aerojet property and would not likely provide nesting habitat.

Common and Scientific Name	Legal Status (Federal/State/ Other)	General Habitat Description	Habitat Present/ Absent	Rationale
Tricolored blackbird *Agelaius tricolor*	–/C/–	Permanent resident in the Central Valley from Butte County to Kern County. Breeds at scattered coastal locations from Marin County south to San Diego County; and at scattered locations in Lake, Sonoma, and Solano Counties. Rare nester in Siskiyou, Modoc, and Lassen Counties. Nests in dense colonies in emergent marsh vegetation, such as tules and cattails, or upland sites with blackberries, nettles, thistles, and grain fields. Habitat must be large enough to support 50 pairs. Probably requires water at or near the nesting colony.	Present	Emergent wetland vegetation along Alder Creek provides suitable nesting habitat; could forage in grassland areas on the Aerojet property.
Song sparrow (Modesto population) *Melospiza melodia*	–/SSC/–	Resides in the north-central portion of the Central Valley, with the highest densities in the Butte Sink area of the Sacramento Valley and in the Sacramento–San Joaquin River Delta. Associated with freshwater marshes dominated by tules and cattails and riparian willow thickets. Also nests in riparian forests with blackberry understory and along vegetated irrigation canals and levees.	Present	Emergent wetland and valley foothill riparian provides suitable habitat; no CNDDB records but numerous eBird records within 1 mile of the BSA (eBird 2016).
Mammals				
Pallid bat *Antrozous pallidus*	–/SSC/–	Occurs throughout California except the high Sierra from Shasta to Kern County and the northwest coast, primarily at lower and mid elevations. Occurs in a variety of habitats from desert to coniferous forest. Most closely associated with oak, yellow pine, redwood, and giant sequoia habitats in northern California and oak woodland, grassland, and desert scrub in southern California. Relies heavily on trees for roosts.	Present	Could roost in valley foothill riparian, oak woodland, and other trees in the BSA.
Western red bat *Lasiurus blossevillii*	–/SSC/–	Occurs throughout much of California at lower elevations. Found primarily in riparian and wooded habitats. Occurs at least seasonally in urban areas. Day roosts in trees within the foliage. Found in fruit orchards and sycamore riparian habitats in the Central Valley.	Present	Could roost in valley foothill riparian, oak woodland, and other trees in the BSA.
North American porcupine *Erethizon dorsatum*	–/–/–	Occurs in forests in the Sierra Nevada, Cascade, Coast , and Transverse Ranges Found in coniferous forest and mixed woodlands. Den in hollow trees or rocky areas.	Absent	Could occasionally occur in the Fremont cottonwood-oak woodland portion of the BSA but denning habitat not present.

Common and Scientific Name	Legal Status (Federal/State/ Other)	General Habitat Description	Habitat Present/ Absent	Rationale
American badger *Taxidea taxus*	–/SSC/–	Throughout California, except for the humid coastal forests of northwestern California in Del Norte and the northwestern Humboldt Counties. Occurs in a wide variety of open, arid habitats but are most commonly associated with grasslands, savannas, and mountain meadows near timberline; they require sufficient food (burrowing rodents), friable soils, and relatively open, uncultivated ground.	Absent	Annual grasslands are either located adjacent to the freeway or are tall and dense on the Aerojet property and no burrows were observed in either area.

[a] Status explanations:

Federal

E = listed as endangered under the federal Endangered Species Act.
T = listed as threatened under the federal Endangered Species Act.
– = no listing.

State

E = listed as endangered under the California Endangered Species Act.
T = listed as threatened under the California Endangered Species Act.
C = candidate for listing under the California Endangered Species
FP = fully protected under the California Fish and Game Code.
SSC = species of special concern in California.
– = no listing.

Other

P = protected under the Bald and Golden Eagle Protection Act.

3.2.2 Special-Status Animal Species

Based on the CNDDB search results and the USFWS and NMFS lists (Appendix B), 30 special-status animal species were determined to have the potential to occur in the project region (Table 3-3). After a review of species distribution and habitat requirements data and the field survey, the wildlife and fish biologists determined that 22 of the 30 special-status species would not occur in the BSA because the area lacks suitable habitat for the species or is outside the species' known range. Table 3-3 provides an explanation for the absence each of these species from the BSA. Three additional special-status species (yellow-breasted chat [*Icteria virens*], song sparrow [Modesto population; *Melospiza melodia*], and western red bat [*Lasiurus blossevillii*]) that were not in the CNDDB search results or on the USFWS list, were added to Table 3-3 because of the presence of suitable habitat in the BSA. The 11 special-status animal species that may occur in the BSA or be affected by the proposed project are listed below and discussed in Chapter 4.

- Vernal pool fairy shrimp (*Branchinecta lynchi*)
- Midvalley fairy shrimp (*Branchinecta mesovallensis*)
- Valley elderberry longhorn beetle
- Western pond turtle
- Swainson's hawk
- White-tailed kite
- Yellow-breasted chat
- Tricolored blackbird
- Song sparrow (Modesto population)
- Pallid bat (*Antrozous pallidus*)
- Western red bat

3.2.3 Other Protected and Managed Biological Resources

Other protected and managed biological resources consist of migratory birds, protected trees, invasive species, and dispersal/migration corridors.

3.2.3.1 Migratory Birds

Non-special-status migratory birds, including raptors, have the potential to nest in trees, shrubs, and ground vegetation in the BSA. Additionally, the culvert under Alder Creek provides suitable nesting substrate for cliff swallow, barn swallow, and black phoebe. Although these species are not considered special-status animal species, their occupied nests and eggs are protected by CFGC Sections 3503 and 3503.5 and the MBTA.

3.2.3.2 Protected Trees

The BSA contains oaks and other native trees in the Fremont cottonwood-oak woodland, planted oak woodland, and valley foothill riparian woodland natural communities. Native trees, oak woodlands, and riparian areas are protected under the County's General Plan policies. Native oaks with a dbh of 6 inches or more, or 10 inches or more in total for multi-trunked oaks, are also protected under the County's tree preservation ordinance, and native oaks with a dbh of 19 inches or more are protected as heritage trees. In the City of Rancho Cordova, the same size oaks are protected. Protected trees in the BSA include 241 mature interior live, coast live, and valley oak trees and 86 other mature native trees, including buckeye, western redbud (*Cersis occidentalis*), California black walnut (*Juglans hindsii*), gray pine, California sycamore (*Platanus racemosa*), Fremont's cottonwood, and arroyo willow (*Salix lasiolepis*). Of the 241 oak trees in the BSA, 37 are heritage trees.

3.2.3.3 Invasive Plant Species

Invasive plant species include species designated as federal noxious weeds by USDA, species listed by CDFA, and invasive plants identified by Cal-IPC. Invasive plants displace native species, change ecosystem processes, alter plant community structure, and lower wildlife habitat quality (California Invasive Plant Council 2006:1). Road, highway, and related construction projects are some of the principal dispersal pathways for invasive plants and their propagules. Table 3-4 lists the invasive plant species identified by CDFA and Cal-IPC that are known to occur in the BSA (California Department of Food and Agriculture 2016; California Invasive Plant Council 2016). No plant species designated as federal noxious weeds (Natural Resources Conservation Service 2014) have been identified in the BSA. Invasive plant species occur in all plant communities in the BSA, but are more prevalent in annual grassland.

Table 3-4. Invasive Plant Species Identified in the Biological Study Area

Species	CDFA	Cal-IPC
Slender wild oat (*Avena barbata*)	–	Moderate
Wild oat (*Avena fatua*)	–	Moderate
Black mustard (*Brassica nigra*)	–	Moderate
Common mustard (*Brassica rapa*)	–	Limited
Ripgut brome (*Bromus diandrus*)	–	Moderate
Soft chess (*Bromus hordeaceus*)	–	Limited
Red brome (*Bromus madritensis* ssp. *rubens*)	–	High
Italian thistle (*Carduus pycnocephalus*)	C	Moderate
Maltese star thistle (*Centaurea melitensis*)	C	Moderate
Yellow star-thistle (*Centaurea solstitialis*)	C	High
Canada thistle (*Cirsium arvense*)	B	Moderate
Poison-hemlock (*Conium maculatum*)	–	Moderate
Bindweed (*Convolvulus arvensis*)	C	–
Pampas grass (*Cortaderia jubata*)	–	High
Red-stemmed filaree (*Erodium cicutarium*)	–	Limited

Species	CDFA	Cal-IPC
Rattail fescue (*Festuca myuros*)		Moderate
Italian ryegrass (*Festuca perennis*)	–	Moderate
Edible fig (*Ficus carica*)	–	Moderate
Sweet fennel (*Foeniculum vulgare*)	–	High
Cutleaf geranium (*Geranium dissectum*)	–	Limited
Mediterranean barley (*Hordeum marinum* var. *gussoneanum*)	–	Moderate
Foxtail barley (*Hordeum murinum* ssp. *leporinum*)	–	Moderate
Smooth cat's-ear (*Hypochaeris glabra*)	–	Limited
Water iris (*Iris pseudacorus*)	–	Limited
Hyssop loosestrife (*Lythrum hyssopifolia*)	–	Limited
Horehound (*Marrubium vulgare*)	–	Limited
California burclover (*Medicago polymorpha*)	–	Limited
Harding grass (*Phalaris aquatica*)	–	Moderate
English plantain (*Plantago lanceolata*)	–	Limited
Rabbitsfoot grass (*Polypogon monspeliensis*)	–	Limited
Wild radish (*Raphanus sativus*)	–	Limited
Himalayan blackberry (*Rubus armeniacus*)	–	High
Curly dock (*Rumex crispus*)	–	Limited
Milk thistle (*Silybum marianum*)	–	Limited
Rose clover (*Trifolium hirtum*)	–	Moderate

Note: The California Department of Agriculture (CDFA) and California Invasive Plant Council (Cal-IPC) lists assign ratings that reflect the CDFA and Cal-IPC views of the statewide importance of the pest, likelihood that eradication or control efforts would be successful, and present distribution of the pest in the state. These ratings are guidelines that indicate the most appropriate action to take against a pest under general circumstances. The Cal-IPC species list is more inclusive than the CDFA list.

The **CDFA categories** indicated in the table are defined as follows:

B: Eradication, containment, control or other holding action at the discretion of the county agricultural commissioner.

C: State-endorsed holding action and eradication only when found in a nursery; action to retard spread outside nurseries at the discretion of the county agricultural commissioner.

The **Cal-IPC categories** indicated in the table are defined as follows:

High: Species with severe ecological impacts, high rates of dispersal and establishment, and usually widely distributed.

Moderate: Species with substantial and apparent ecological impacts, moderate to high rates of dispersal, establishment dependent on disturbance, and limited to widespread distribution.

Limited: Species with minor ecological impacts, low to moderate rates of invasion, limited distribution, and locally persistent and problematic.

3.2.3.4 Dispersal/Migration Corridors

Wildlife movement corridors in California are identified and described for the California Essential Habitat Connectivity (CEHC) Project. The CEHC Project was commissioned by Caltrans and CDFW to identify a functional network of connected wildlands, which are essential for maintaining California's native biodiversity. The CEHC Project was also intended to make transportation and land-use planning more efficient and less costly, while helping reduce dangerous wildlife-vehicle collisions (Spencer et al. 2010).

The CEHC Project identified large, relatively natural blocks of habitat (Natural Landscape Blocks) across California and Essential Connectivity Areas (ECAs) that provide essential connectivity between the habitat blocks. ECAs are identified as lands likely to be important to wildlife movement between large, mostly natural areas at the statewide level. The ECAs form a functional network of wildlands that are considered important to the continued support of California's diverse habitat types. ECAs were not developed for the needs of particular species but were based primarily on the concept of ecological integrity, which considers the degree of land conversion, residential housing impacts, road impacts, and status of forest structure (for forested areas). In addition, consideration was given to the degree of conservation protection and areas known to support high biological values, such as mapped critical habitat and areas of high species endemism. The ECAs are intended as placeholder polygons that can inform land-planning efforts, but eventually they should be replaced by more detailed linkage designs, developed at finer resolution at the regional and, ultimately, local scale based on the needs of particular species and ecological processes (Spencer et al. 2010).

No Natural Landscape Blocks or ECAs were identified by the CEHC Project in or adjacent to the BSA, likely because of the presence of US 50 and the high amount of development in the area (California Department of Fish and Wildlife 2016b). The closest Natural Landscape Block is south of White Rock Road, south of the project. Although no wildlife movement corridors were identified, the jughandle area and surrounding area at the Aerojet property contain a substantial amount of natural land that is used by wildlife. Animals could travel from the south into this area, but would be blocked from further travel by Folsom Boulevard and US 50.

Chapter 4 Results: Biological Resources, Discussion of Impacts and Mitigation

ICF biologists evaluated the potential changes to existing land cover types based on the anticipated project construction activities listed below that could cause impacts of varying degrees on sensitive biological resources present or potentially present in the BSA:

- Vegetation removal
- Grading and fill placement during construction
- Temporary stockpiling and sidecasting of soil, construction materials, or other construction wastes
- Soil compaction, dust, and siltation from the construction site into adjacent areas
- Introduction or spread of new invasive plant species
- Runoff of herbicides, fertilizers, diesel fuel, gasoline, oil, raw concrete, or other toxic materials used for project construction and maintenance into sensitive biological resource areas (e.g., riparian habitat, wetlands)

Figures 8 and 9 in Appendix A show the temporary and permanent impacts from each alternative on each land cover type. Table 4-1 lists the acreages of each land cover type in the portions of the BSA that would be permanently or temporarily affected by each of the three proposed project alternatives. The following assumptions were used in assessing the magnitude of possible impacts on biological resources.

- Two alternatives (1 and 2), with one sub-alternative (1A) have been developed for the proposed project. Impacts from each alternative and sub-alternative were assessed for the proposed project. Under the No-Build Alternative, no construction would take place; accordingly, no impacts on habitat or increases in impervious surfaces would occur. The No-Build Alternative (Alternative 3) would not directly affect biological resources and is not discussed further.
- All construction, staging (including vehicle parking), storage, and access areas will be restricted to the permanent and temporary impact areas shown on Figures 8 and 9 in Appendix A.
- Impacts on land cover types and associated wildlife were determined by overlaying preliminary footprints for permanent project features and temporary work areas (e.g., access roads, equipment staging) onto aerial photographs of mapped habitats (Appendix A, Figures 8 and 9). Impact acreages presented in this chapter are intended to provide a worst-case scenario; actual impacts are expected to be less based on avoidance of trees and other vegetation within temporary work areas.

- Fremont cottonwood-oak woodland and valley foothill riparian woodland areas were generally mapped as polygons based on canopy cover and include small openings between trees.
- Temporary impacts on vegetation in natural communities of special concern would result from equipment access during construction.
- Two ditches in the BSA are within the Glenborough at Easton and Easton Place Project Phase 2 project area, and mitigation for the loss of these ditches has already been provided for that project. A third ditch in the BSA is discussed below.

Table 4-1. Permanent and Temporary Impacts on Land Cover Types in the Biological Study Area

Land Cover Type	Alternative 1		Alternative 1A		Alternative 2	
	Permanent Impact Area (acres)	Temporary Impact Area (acres)	Permanent Impact Area (acres)	Temporary Impact Area (acres)	Permanent Impact Area (acres)	Temporary Impact Area (acres)
Fremont cottonwood-oak woodland*	2.97	0.19	2.97	0.19	2.97	0.19
Planted oak woodland	3.88	0.00	3.88	0.00	3.88	0.00
Valley foothill riparian woodland*	0.03	0.17	0.03	0.17	0.03	0.17
Emergent wetland*	0.06	0.14	0.06	0.14	0.06	0.14
Seasonal wetland *	0.02	0.00	0.02	0.00	0.02	0.00
Perennial drainage*	0.11	0.46	0.11	0.46	0.11	0.46
Ephemeral drainage*	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Ditch**	0.14	0.03	0.14	0.03	0.14	0.03
Canal	0.01	0.02	0.01	0.02	0.01	0.02
Annual grassland	16.10	2.35	16.10	2.35	17.44	2.35
Developed	41.38	14.93	41.38	14.93	49.30	13.84
Landscaped	5.66	0.71	5.66	0.71	6.08	0.70
Total	**70.36**	**19.00**	**70.36**	**19.00**	**80.04**	**17.90**

* These are natural communities of special concern, which are discussed in this chapter.
** No additional mitigation is required for impacts on ditch habitat.

4.1 Natural Communities of Special Concern

The BSA supports four natural communities of special concern: Fremont cottonwood-oak woodland, valley foothill riparian woodland, emergent wetland, and seasonal wetland. The other waters of the United States (i.e., non-wetlands) in the BSA consist of Alder Creek (perennial drainage), an ephemeral drainage, and Folsom South Canal (canal) and are discussed in this section because they are subject to federal (CWA) and state (Porter-Cologne Act and CFGC Section 1602) regulation.

4.1.1 Fremont Cottonwood-Oak Woodland

4.1.1.1 Survey Results

Fremont cottonwood-oak woodland (3.156 acres) occurs in the proposed jughandle road area that is south of Folsom Boulevard (Appendix C, Photo 1). The overstory of this woodland is

dominated by interior live oak, Fremont cottonwood, and willows. The understory includes small willows, coyote brush, poison-oak, and annual grasses and forbs. This natural community also contains blue elderberry shrubs.

4.1.1.2 Project Impacts

Construction of the jughandle road for the proposed project would result in trimming or removal of Fremont cottonwood-oak woodland vegetation. For the purposes of this analysis, all tree removal in Fremont cottonwood-oak woodland would be considered a permanent impact because of the time required for habitat regeneration, even if the project construction component requiring the removal is considered a temporary impact. Table 4-2 summarizes the permanent and temporary impacts on Fremont cottonwood-oak woodland by build alternative.

Table 4-2. Impacts on Fremont Cottonwood-Oak Woodland by Alternative

Alternative 1		Alternative 1A		Alternative 2	
Permanent (acres)	Temporary (acres)	Permanent (acres)	Temporary (acres)	Permanent (acres)	Temporary (acres)
2.97	0.19	2.97	0.19	2.97	0.19

Implementation of the avoidance and minimization efforts described below would minimize the impacts on Fremont cottonwood-oak woodland. Additional mitigation is proposed to compensate for the permanent loss of Fremont cottonwood-oak woodland, as discussed below in Section 4.1.1.4.

4.1.1.3 Avoidance and Minimization Efforts

To avoid and minimize impacts on Fremont cottonwood-oak woodlands in and adjacent to the construction area, Measures 1 and 2 below will be implemented.

Measure 1: Conduct Environmental Awareness Training for Construction Employees

The County will retain a qualified biologist to conduct environmental awareness training for construction crews before project implementation. The awareness training will be provided to all construction personnel and will brief them on the need to avoid effects on sensitive biological resources (e.g., native trees, natural communities of special concern, and special-status species habitats in and adjacent to the construction area). The education program will include a brief review of the special-status species with the potential to occur in the BSA (including their life history, habitat requirements, and photographs of the species). The training will identify the portions of the BSA in which the species may occur, as well as their legal status and protection. The program also will cover the restrictions and guidelines that must be followed by all construction personnel to reduce or avoid effects on these species during project implementation. This will include the steps to be taken if a sensitive species is found within the construction area (i.e., notifying the crew foreman, who will call a designated biologist). In addition, construction employees will be educated about the importance of controlling and

preventing the spread of invasive plant infestations. An environmental awareness handout that describes and illustrates sensitive resources to be avoided during project construction and identifies all relevant permit conditions will be provided to each crew member. The crew foreman will be responsible for ensuring that crew members adhere to the guidelines and restrictions. Education programs will be conducted for appropriate new personnel as they are brought on the job during the construction period.

Measure 2: Monitor Disturbance of Woody Vegetation and Replant Affected Areas if Necessary

The County will retain a certified arborist to inspect areas that undergo vegetative pruning and tree removal immediately before construction, immediately after construction, and 1 year after construction to determine the amount of existing vegetative cover, cover that has been removed, and cover that resprouts. After 1 year, if these areas have not resprouted sufficiently to return the cover to the pre-project level, the County will replant the areas with appropriate native species to reestablish the cover to the pre-project condition.

4.1.1.4 Compensatory Mitigation

Compensatory mitigation for permanent and temporary direct effects on Fremont cottonwood-oak woodland will be mitigated either by additional planting of Fremont cottonwood-oak woodland species or by payment in the County's tree preservation fund. Based on the County General Plan policies, an equal area of oak canopy must replace the area of canopy removed. Because 2.07 acre of the affected habitat under all 3 alternatives has already been mitigated for Phase 2 of the Easton Place and Glenborough at Easton Project (County of Sacramento Department of Environmental Review and Assessment 2008), the required mitigation for the proposed project would be 2.12 acre less than the total permanent impact and 0.14 acre less than the total temporary impacts on Fremont cottonwood-oak woodland, as summarized in Table 4-3. Implementation of Measure 3 would be necessary to prevent a net loss of Fremont cottonwood-oak woodland. Even with compensatory mitigation, however, impacts would not be compensated in the near-term due to the time required for planted woodland to reach the maturity of the removed woodland. Compensation ratios in Measure 3 are based on information from the County and were confirmed as current (Nagao pers. comm. 2016).

Table 4-3. Compensation for Permanent and Temporary Impacts on Fremont Cottonwood-Oak Woodland by Alternative

Alternative 1	Alternative 1A	Alternative 2
Compensation (acres)	Compensation (acres)	Compensation (acres)
0.90	0.90	0.90

Measure 3: Compensate for the Permanent and Temporary Loss of Fremont Cottonwood-Oak Woodland

The County will compensate for the permanent and temporary loss of Fremont cottonwood-oak woodland at a minimum ratio of 1:1 (1 acre planted for every 1 acre

permanently affected). As part of the woodland mitigation, compensation will include in-kind replacement of the native tree species removed and with a combined dbh equal to the combined dbh of the removed trees. Compensation will be implemented by a combination of onsite planting, offsite planting, and/or payment into the County's tree preservation fund at the prevailing rate per dbh inch removed. Any offsite planting location will be authorized by the County's Environmental Coordinator.

Compensatory tree planting will be based on the following equivalents:

- One preserved native tree onsite < 6 inches dbh = 1 inch removed dbh
- One D-pot seedling (40 cubic inches or larger) = 1 inch removed dbh
- One 15-gallon tree = 1 inch removed dbh
- One 24-inch box tree = 2 inches removed dbh
- One 36-inch box tree = 3 inches removed dbh

For onsite replacement plantings of Fremont cottonwood-oak woodland, if feasible, and/or offsite plantings, the County will prepare a Fremont cottonwood-oak woodland mitigation planting plan, including a species list and number of each species to be removed or preserved, planting locations, and maintenance requirements. Plantings will consist of cuttings taken from local plants or plants grown from local material. Planted species for the mitigation plantings will be the same as those removed from the project area, including interior live oak and Fremont cottonwood. All plantings will be fitted with exclusion cages or other suitable protection from herbivory until the plantings are established. Plantings will be irrigated seasonally for up to 3 years or until established.

The County will monitor plantings annually for 3 years or as required in the project permits and then for every 5 years through 15 years post-planting. To be considered successful, 75% of the plants must have survived at the end of the first 3 years, and tree canopy coverage must be at least 30% at the end of 15 years. If the survival and canopy criteria are not met at the end of the 3-year and 15-year monitoring periods, respectively, planting and monitoring will be repeated after causes of tree stress or mortality have been identified and corrected.

4.1.1.5 Cumulative Impacts

Cumulative impacts on Fremont cottonwood-oak woodlands would result from construction of other general development projects in Sacramento County. Construction of the proposed project would add to the cumulative loss of Fremont cottonwood-oak woodlands. Implementation of compensatory mitigation, however, will replace Fremont cottonwood-oak woodland habitat. Therefore, with implementation of measures to avoid and minimize potential impacts on Fremont cottonwood-oak woodland in the BSA and planting of Fremont cottonwood-oak woodland as compensatory mitigation, the project will not contribute to cumulatively considerable impacts on Fremont cottonwood-oak woodlands.

4.1.2 Valley Foothill Riparian Woodland

4.1.2.1 Survey Results

Valley foothill riparian woodland (0.198 acre) occurs on the banks of Alder Creek above the OHWM (Appendix C, Photo 2). Willow, white alder, and California blackberry are the dominant species. California foothill pine and interior live oak also found in this natural community.

4.1.2.2 Project Impacts

Construction of the proposed project would result in trimming or removal of valley foothill riparian woodland vegetation. For the purposes of this analysis, all riparian vegetation disturbance and tree removal are considered permanent impacts because of the time required for habitat regeneration, even if the project construction component requiring the disturbance or removal is considered a temporary impact. Table 4-4 summarizes the permanent and temporary impacts on valley foothill riparian woodland by build alternative.

Table 4-4. Impacts on Valley Foothill Riparian by Alternative

Alternative 1		Alternative 1A		Alternative 2	
Permanent (acres)	Temporary (acres)	Permanent (acres)	Temporary (acres)	Permanent (acres)	Temporary (acres)
0.03	0.17	0.03	0.17	0.03	0.17

Implementation of the avoidance and minimization efforts described below would minimize the impacts on valley foothill riparian woodland. Additional mitigation is proposed to compensate for the permanent loss of valley foothill riparian woodland.

4.1.2.3 Avoidance and Minimization Efforts

To avoid and minimize impacts on valley foothill riparian woodland in and adjacent to the construction area, Measures 1 and 2 will be implemented. These measures are described above for Fremont cottonwood-oak woodland and listed below.

Measure 1: Conduct Environmental Awareness Training for Construction Employees

Please see Section 4.1.1.3 for the description of this measure.

Measure 2: Monitor Disturbance of Woody Vegetation and Replant Affected Areas if Necessary

Please see Section 4.1.1.3 for the description of this measure.

4.1.2.4 Compensatory Mitigation

Compensatory mitigation for permanent and temporary direct effects on valley foothill riparian woodland will consist of either additional planting of valley foothill riparian woodland species or by purchase of credits at a CDFW-approved mitigation bank. Based on the County General Plan policies, the amount of restored or preserved habitat must be equal to that removed to mitigate for the loss of riparian habitat.

Table 4-5 summarizes acreages of compensation required by alternative for permanent and temporary impacts on valley foothill riparian woodland. Implementation of Measure 4 would be necessary to prevent a net loss of valley foothill riparian woodland. Even with compensatory mitigation, however, impacts would not be compensated in the near-term due to the time required for planted riparian habitat to reach the maturity of the removed habitat.

Table 4-5. Compensation for Permanent and Temporary Impacts on Valley Foothill Riparian Woodland by Alternative

Alternative 1	Alternative 1A	Alternative 2
Compensation (acres)	Compensation (acres)	Compensation (acres)
0.20	0.20	0.20

Measure 4: Compensate for the Permanent and Temporary Loss of Valley Foothill Riparian Woodland

The County will compensate for the permanent and temporary loss of valley foothill riparian habitat at a minimum ratio of 1:1 (1 acre planted for every 1 acre permanently and temporarily affected) by implementing onsite and, if necessary, offsite compensation measures and/or purchasing mitigation bank credits for valley foothill riparian habitat. As part of the riparian habitat mitigation, compensation will include in-kind replacement of the native trees removed and with a combined dbh equal to the combined dbh of the removed trees. Any offsite planting location will be authorized by the County's Environmental Coordinator.

Compensatory tree planting will be based on the following equivalents:

- One preserved native tree onsite < 6 inches dbh = 1 inch removed dbh
- One D-pot seedling (40 cubic inches or larger) = 1 inch removed dbh
- One 15-gallon tree = 1 inch removed dbh
- One 24-inch box tree = 2 inches removed dbh
- One 36-inch box tree = 3 inches removed dbh

Onsite compensation will be used to the maximum extent practicable, but offsite compensation and/or purchase of mitigation bank credits may be needed to achieve no net loss of existing in-kind riparian habitat. Each of these options is discussed below.

- Riparian habitat restoration and/or enhancement onsite or offsite should occur in the same year construction is completed. For onsite or offsite plantings, the County will prepare a mitigation planting plan, including a species list and number of each species, planting locations, and maintenance requirements. Plantings will consist of cuttings taken from local plants or plants grown from local material. Planted species for the mitigation plantings will be similar to those in and adjacent to the project area and will include native species, such as white alder, Fremont cottonwood, valley oak, black walnut (*Juglans hindsii*), Oregon ash (*Fraxinus latifolia*), boxelder (*Acer negundo*), and black willow. All plantings will be fitted with exclusion cages or other suitable protection from herbivory until plantings are established. Plantings will be irrigated for up to 3 years or until established. Plantings will be monitored annually for 3 years or as required in the project permits. If 75% of the plants survive at the end of the monitoring period, the re-vegetation will be considered successful. If the survival criterion is not met at the end of the monitoring period, planting and monitoring will be repeated after mortality causes have been identified and corrected.
- The County will provide written evidence to the resource agencies that compensation has been established through the purchase of mitigation credits. The amount to be paid will be the fee that is in effect at the time the fee is paid. The mitigation will be approved by CDFW and may be modified during the permitting process. Mitigation will be at a minimum ratio of 1:1 (1 acre of restored or preserved riparian habitat for each acre of riparian habitat removed). The final compensation ratio will be approved by CDFW. The County will purchase riparian habitat credits from a CDFW-approved mitigation bank with service areas for Sacramento County, such as the Cosumnes Floodplain Mitigation Bank, Fremont Landing Conservation Bank, or Elsie Gridley Mitigation Bank.

Replacement riparian habitat will include tree species that would support nesting Swainson's hawk (i.e., oak, cottonwood) and will occur within the range of nesting Swainson's hawk within the Sacramento Valley.

4.1.2.5 Cumulative Impacts

Cumulative impacts on valley foothill riparian woodland would result from construction of other general development projects in Sacramento County. Construction of the proposed project would add to the cumulative loss of valley foothill riparian woodland. With implementation of measures to avoid and minimize potential impacts on valley foothill riparian woodland in the BSA and compensation for the loss of riparian habitat, the project would not contribute to cumulatively considerable impacts on valley foothill riparian woodland.

4.1.3 Wetlands

4.1.3.1 Survey Results

Emergent Wetland

Emergent wetlands (0.20 acre) occur at the edges of open water in Alder Creek below riparian woodland vegetation and below the OHWM of the creek (Appendix C, Photo 2). Dominant species include white alder saplings, tall flatsedge, Pacific rush, tule, California blackberry, curly dock, and floating water primrose, an invasive species.

Seasonal Wetland

Seasonal wetlands (0.02 acre) occur in the cloverleaf areas of the Hazel Avenue/US 50 interchange (Appendix C, Photos 3–5). The vegetation is dominated by nonnative species such as Mediterranean barley, Italian ryegrass, and hyssop loosestrife.

4.1.3.2 Project Impacts

Construction of the proposed project would result in permanent and temporary impacts on emergent wetland and seasonal wetland natural communities. Project impacts were considered to be permanent if they would result in the placement of permanent fill in wetlands. Impacts were considered to be temporary if fill would be removed following completion of construction and temporarily disturbed portions of wetlands would be restored. Table 4-6 summarizes the direct impacts on wetland type by build alternative. These acreages are pending verification of the delineation by USACE Sacramento District. Additional indirect impacts caused by sedimentation or modification of hydrology could occur in portions of wetlands that lie outside the project footprint.

Table 4-6. Impacts on Wetland Type by Alternative*

Wetland Type	Alternative 1		Alternative 1A		Alternative 2	
	Permanent (acres)	Temporary (acres)	Permanent (acres)	Temporary (acres)	Permanent (acres)	Temporary (acres)
Emergent wetland	0.06	0.14	0.06	0.14	0.06	0.14
Seasonal wetland	0.02	0.000	0.020	0.000	0.02	0.00
Total Wetland Impact	**0.08**	**0.14**	**0.08**	**0.14**	**0.08**	**0.14**

* Final impact acreages are pending verification of the delineation by the USACE.

4.1.3.3 Avoidance and Minimization Measures

To avoid and minimize impacts on wetlands, Measure 1 will be implemented. This measure is described above for the Fremont cottonwood-oak woodland.

Measure 1: Conduct Environmental Awareness Training for Construction Employees

Please see Section 4.1.1.3 for the description of this measure.

4.1.3.4 Compensatory Mitigation

The County will comply with any regulatory requirements identified as part of the CWA Section 404 permit for the work that occurs in wetlands. Compensatory mitigation for permanent and temporary direct effects on emergent wetland and permanent effects on seasonal wetland will be mitigated either by purchase of credits at a USACE-approved mitigation bank or by payment into an in-lieu fee program. Table 4-7 summarizes acreages of compensation required by alternative for permanent and temporary impacts on wetlands. The actual affected acreage is pending verification of the delineation and the Section 404 permit approval by USACE. The County will compensate for the permanent and temporary loss of emergent wetland and permanent loss of seasonal wetland by implementing Measure 5 below.

Table 4-7. Compensation for Permanent Impacts on Wetlands by Alternative*

Habitat Type	Alternative 1 Compensation (acres)	Alternative 1A Compensation (acres)	Alternative 2 Compensation (acres)
Emergent wetland	0.20	0.20	0.20
Seasonal wetland	0.02	0.02	0.02
Total Compensation	**0.22**	**0.22**	**0.22**

* Final compensatory acreages are pending verification of the delineation by the USACE and the Section 404 permit requirements.

Measure 5: Compensate for Loss of Wetlands and Non-Wetland Waters of the United States/Waters of the State

The County will compensate for the permanent fill of waters of the United States/waters of the State (a direct impact associated with roadway and interchange construction) in two wetland habitat types, emergent wetland and seasonal wetland, and in one non-wetland waters type, perennial drainage. The minimum wetland compensation ratio to ensure no net loss of wetland or drainage functions and values will be 1:1 (1 acre of habitat credit for every 1 acre of permanent impact). The final compensation ratio will be approved by USACE. The County will compensate for permanent loss of wetlands and non-wetland waters through one or more of the following mitigation options:

- Purchase habitat credits from a USACE-approved mitigation bank with service areas for Sacramento County, such as the Cosumnes Floodplain Mitigation Bank or Elsie Gridley Mitigation Bank, and provide written evidence to the resource agencies that compensation has been established through the purchase of mitigation credits. The amount to be paid will be according to the fee schedule that is in effect at the time the fee is paid. The mitigation will be approved by USACE and may be modified during the permitting process.

- Pay into the National Fish and Wildlife Foundation Sacramento District In-Lieu Fee Program.

Temporarily disturbed wetlands and non-wetland waters will be returned to pre-construction condition following construction. The County also will implement the conditions and requirements of state and federal permits that will be obtained for the proposed project.

4.1.3.5 Cumulative Impacts

Cumulative impacts on wetlands would result from construction of other general development projects in Sacramento County. Construction of the proposed project would add to the cumulative loss of wetlands; however, this contribution would not be cumulatively considerable because of the mitigation to minimize impacts and restore and compensate for permanent and temporary loss of wetlands. The proposed project would not contribute to a net loss of wetland habitat.

4.1.4 Perennial Drainage

4.1.4.1 Survey Results

The BSA contains a 0.56-acre segment of Alder Creek, a perennial drainage that connects to Lake Natoma on the north side of US 50. Alder Creek flows under US 50 through a box culvert that is beneath an MSE wall. As a result of the MSE, the water in Alder Creek backs up at the south side of the US 50 crossing, creating a 150-200-foot wide, pond-like area with mostly stagnant water (Appendix C, Photo 2). An emergent wetland fringe is present on both sides of the creek.

4.1.4.2 Project Impacts

Construction of the proposed project would result in direct permanent and temporary impacts on perennial drainage habitat (i.e., non-emergent wetland areas) in Alder Creek. Impacts were considered to be permanent if they would result in the placement of permanent fill in Alder Creek associated with widening US 50 to accommodate an auxiliary lane. Impacts were considered to be temporary if fill would be removed following completion of construction and temporarily disturbed portions of Alder Creek would be restored. Temporary impacts may include modification of the bank or channel of Alder Creek, increased turbidity, and runoff of chemical substances. Table 4-8 summarizes the direct impacts on perennial drainage habitat in Alder Creek by build alternative. These acreages are pending verification of the delineation by USACE Sacramento District. Additional indirect impacts from project construction on water quality, such as increased turbidity and chemical runoff, could occur in perennial drainage habitat outside of the project footprint.

Table 4-8. Impacts on Perennial Drainage by Alternative*

Alternative 1		Alternative 1A		Alternative 2	
Permanent (acres)	Temporary (acres)	Permanent (acres)	Temporary (acres)	Permanent (acres)	Temporary (acres)
0.11	0.46	0.11	0.46	0.11	0.46

* Final impact acreages are pending verification of the delineation by the USACE.

4.1.4.3 Avoidance and Minimization Efforts

To avoid and minimize impacts on perennial drainage habitat in Alder Creek, Measure 1, which is described above for Fremont cottonwood-oak woodland will be implemented.

Measure 1: Conduct Environmental Awareness Training for Construction Employees

Please see Section 4.1.1.3 for the description of this measure.

4.1.4.4 Compensatory Mitigation

The County will comply with any regulatory requirements identified as part of the CWA Section 404 permit for the work that occurs in perennial drainage habitat in Alder Creek. Compensatory mitigation for permanent and temporary direct effects on perennial drainage will be mitigated either by purchase of credits at a USACE-approved mitigation bank or by payment into an in-lieu fee program. Table 4-9 summarizes acreages of compensation required by alternative for direct impacts on perennial drainage. The actual affected acreage is pending verification of the delineation and the Section 404 permit approval by USACE.

Table 4-9. Compensation for Permanent and Temporary Impacts on Perennial Drainage Habitat by Alternative*

Alternative 1	Alternative 1A	Alternative 2
Compensation (acres)	Compensation (acres)	Compensation (acres)
0.57	0.57	0.57

* Final compensatory acreages are pending verification of the delineation by the USACE and the Section 404 permit requirements.

The County will compensate for the permanent loss of perennial drainage by implementing Measure 5, which is described above.

Measure 5: Compensate for Loss of Wetlands and Non-Wetland Waters of the United States/Waters of the State

4.1.4.5 Cumulative Impacts

Cumulative impacts on perennial drainages would result from construction of other general development projects in Sacramento County. Construction of the proposed project would add to the cumulative loss of perennial drainages. However, with implementation of the measure

prescribed for minimizing impacts and compensating for remaining impacts, the proposed project would not contribute to a net loss of perennial drainage and would not contribute to cumulatively considerable impacts on perennial drainage habitat.

4.1.5 Ephemeral Drainage

4.1.5.1 Survey Results

A 10-foot long segment of a 3.5-foot wide ephemeral drainage crosses the interchange north of US 50. A 20-foot long segment of a 1-foot wide ephemeral drainage (0.0004 acre) crosses the BSA east of Alder Creek. This drainage extends south from the edge of US 50 to Alder Creek. The drainages supports annual grassland vegetation.

4.1.5.2 Project Impacts

Construction of the proposed project would result in direct permanent and temporary impacts on the ephemeral drainage. Impacts were considered to be permanent if they would result in the placement of permanent fill in the ephemeral drainage associated with widening of US 50 to accommodate an auxiliary lane. Impacts were considered to be temporary if fill would be removed following completion of construction and temporarily disturbed portions of the ephemeral drainage would be restored. Temporary impacts may include modification of the bank or channel, increased turbidity, and runoff of chemical substances. Table 4-10 summarizes the direct impacts on the ephemeral drainage by build alternative. These acreages are pending verification of the delineation by USACE Sacramento District. Additional indirect impacts from project construction on water quality, such as increased turbidity and chemical runoff, could occur in the portion of the ephemeral drainage that is outside the project footprint.

Table 4-10. Impacts on Ephemeral Drainage by Alternative*

Alternative 1		Alternative 1A		Alternative 2	
Permanent (acres)	Temporary (acres)	Permanent (acres)	Temporary (acres)	Permanent (acres)	Temporary (acres)
0.0002	0.0003	0.0002	0.0003	0.0002	0.0003

* Final impact acreages are pending verification of the delineation by the USACE.

4.1.5.3 Avoidance and Minimization Efforts

To avoid and minimize impacts on the ephemeral drainage, Measure 1, which is described above for the Fremont cottonwood-oak woodland will be implemented.

Measure 1: Conduct Environmental Awareness Training for Construction Employees

Please see Section 4.1.1.3 for the description of this measure.

4.1.5.4 Compensatory Mitigation

The County will comply with any regulatory requirements identified as part of the CWA Section 404 permit for the work that occurs in the ephemeral drainage. Compensatory mitigation for permanent and temporary direct effects on the ephemeral drainage will be mitigated either by purchase of credits at a USACE-approved mitigation bank or by payment into an in-lieu fee program. Table 4-11 summarizes acreages of compensation required by alternative for direct impacts on ephemeral drainage. The actual affected acreage is pending verification of the delineation and the Section 404 permit approval by USACE Sacramento District.

Table 4-11. Compensation for Permanent and Temporary Impacts on Ephemeral Drainage by Alternative*

Alternative 1	Alternative 1A	Alternative 2
Compensation (acres)	Compensation (acres)	Compensation (acres)
0.001	0.001	0.001

* Final compensatory acreages are pending verification of the delineation by the USACE and the Section 404 permit requirements.

The County will compensate for the permanent loss of ephemeral drainage by implementing Measure 5, which is described above for wetlands.

Measure 5: Compensate for Loss of Wetlands and Non-Wetland Waters of the United States/Waters of the State

4.1.5.5 Cumulative Impacts

Cumulative impacts on ephemeral drainages would result from construction of other general development projects in Sacramento County. Construction of the proposed project would add to the cumulative loss of ephemeral drainages. However, with implementation of the measures prescribed for minimizing impacts and compensating for remaining impacts, the proposed project would not contribute to a net loss of ephemeral drainage and would not contribute to cumulatively considerable impacts on ephemeral drainage habitat.

4.1.6 Ditch

4.1.6.1 Survey Results

The BSA contains three ditches: two excavated drainage ditches that have been verified as waters of the United States, and a third excavated roadside ditch that was delineated by ICF in 2016. The two excavated drainage ditches are in the BSA south of Folsom Boulevard. These two features were verified as waters of the United States in a delineation prepared for the Glenborough at Easton and Easton Place Project. The ditches support weedy annual grassland vegetation.

The third ditch in the BSA is a constructed roadside ditch that extends from the east end of the BSA to Alder Creek (Appendix C, Photo 10). This ditch is approximately 3 feet wide, supports

annual grassland vegetation, and receives runoff from US 50 and from the interchange loop at Folsom Boulevard.

4.1.6.2 Project Impacts

Impacts on the two excavated drainage ditches were mitigated as part of Glenborough at Easton and Easton Place Project; therefore, impacts on these two ditches are not discussed in this NES. Construction of the proposed project would result in direct permanent and temporary impacts on the constructed roadside ditch. Impacts were considered to be permanent if they would result in the placement of permanent fill in the ditch associated with widening of US 50 to accommodate an auxiliary lane. Impacts were considered to be temporary if fill would be removed following completion of construction and temporarily disturbed portions of the ditch would be restored. Temporary impacts may include modification of the ditch bank or channel, increased turbidity, and runoff of chemical substances. Table 4-12 summarizes the direct impacts on the constructed roadside ditch by build alternative. These acreages are pending verification of the delineation by USACE Sacramento District. Additional indirect impacts from project construction on water quality, such as increased turbidity and chemical runoff, could occur in the portion of the ditch that is outside the project footprint.

Table 4-12. Impacts on Ditch by Alternative*

Alternative 1		Alternative 1A		Alternative 2	
Permanent (acres)	Temporary (acres)	Permanent (acres)	Temporary (acres)	Permanent (acres)	Temporary (acres)
0.14	0.03	0.14	0.03	0.14	0.03

* Final impact acreages are pending verification of the delineation by the USACE.

4.1.6.3 Avoidance and Minimization Efforts

To avoid and minimize impacts on the constructed roadside ditch, Measure 1, which is described above for Fremont cottonwood-oak woodland will be implemented.

Measure 1: Conduct Environmental Awareness Training for Construction Employees

Please see Section 4.1.1.3 for the description of this measure.

4.1.6.4 Compensatory Mitigation

The County will comply with any regulatory requirements identified as part of the CWA Section 404 permit for the work that occurs in jurisdictional ditch habitat. The ditch is an artificial feature created to intercept runoff from the adjacent roadway, and new road construction would replace the ditch to maintain the drainage function. Because the constructed roadside ditch provides minimal habitat for wildlife species and will be replaced, no additional compensatory mitigation would be necessary.

4.1.6.5 Cumulative Impacts

Cumulative impacts on ditches would result from construction of other general development projects in Sacramento County. However, because the ditch would be replaced as part of the project design, construction of the proposed project would not add to the cumulative loss of ditches, contribute to a net loss of habitat, or contribute to cumulatively considerable impacts on ditches.

4.2 Special-Status Plant Species

As discussed in Chapter 3, information obtained from the CNDDB, CNPS, and USFWS was used to compile a list of 23 special-status plant species known to occur in the project region (Table 3-2) (Appendix B). Of these 23 species, 18 have habitat (i.e., chaparral, vernal pool) or microhabitat requirements (i.e., serpentine, gabbro, and clay soils) that are not present in the BSA. The roadside slopes on the south side of US 50, ditches, and seasonal wetland, and emergent wetland natural communities in the BSA were determined during prefield investigation to contain potential habitat for the remaining three special-status plant species (Brandegee's clarkia, legenere, and Sanford's arrowhead), which are known to occur within 5 miles of the BSA (Table 3-2, Figure 7). Although big-scale balsamroot and Red Bluff dwarf rush were included in the CNPS inventory search, the nearest known occurrences are more than 10 miles outside the BSA.

Although potential habitats are present, the natural communities in the BSA have been substantially altered from historical conditions and were determined to have a low likelihood of supporting special-status plants. For example, seasonal wetlands in the BSA provide very marginal habitat for special-status plants because they consist of created features that occur in the freeway interchange, rather than as naturally occurring features.

4.2.1 Survey Results

No special-status plants were observed during the April and May 2016 botanical surveys, which were conducted during the reported identification periods of the 23 special-status plant species known to occur in the project region and/or identified as having potential habitat in the BSA. Therefore, special-status plants were presumed to be absent from the BSA.

4.2.2 Project Impacts

Because no special-status plants were observed within the BSA during appropriately-timed botanical surveys, special-status plants were presumed absent from the BSA. Therefore, there would be no impacts on special-status plants as a result of the proposed project. No avoidance and minimization efforts or compensatory mitigation would be required.

4.2.3 Cumulative Impacts

The project would not have impacts on special-status plants and therefore would not contribute to cumulative impacts on special-status plants.

4.3 Special-Status Animal Species

As discussed in Chapter 3, the CNDDB search results and USFWS list were used to compile a list of 30 special-status animal species that have potential to occur in the project region (Table 3-3). After a review of species distribution and habitat requirements data and the field survey, it was determined that of the 30 species would not occur in the BSA because the area lacks suitable habitat for the species or is outside the species' known range. Table 3-3 provides an explanation for the absence each of these species from the BSA. Three additional special-status species (yellow-breasted chat, song sparrow [Modesto population], and western red bat) that were not in the CNDDB search results or on the USFWS list were added to the table because of the presence of suitable habitat in the BSA. The 11 animal special-status species that may occur in the BSA are discussed below.

4.3.1 Vernal Pool Fairy Shrimp and Midvalley Fairy Shrimp

Vernal pool fairy shrimp is federally listed as threatened. The species is found in southern Oregon and in California. There are approximately 32 populations scattered from Shasta County in the north through the Central Valley to the southern border of Tulare County, and along the central Coast Range from northern Solano County to San Benito County. Four disjunct populations occur in San Luis Obispo, Santa Barbara, and Riverside Counties (Eriksen and Belk 1999:92, 125; U.S. Fish and Wildlife Service 2007:17). Final designation of critical habitat for vernal pool fairy shrimp occurred on August 11, 2005 (70 FR 46945).

Vernal pool fairy shrimp commonly inhabit vernal pools or vernal pool-like habitats, typically in grassland landscapes. Most frequently, vernal pool fairy shrimp are found in vernal pools or vernal swales, in unplowed grasslands (Eng et al. 1990:257). The chemical composition of the habitat and temperature variations resulting from pools filling at different times and distribution of pools along altitudinal and longitudinal gradients are the most important factors in determining the distribution of different species fairy shrimp (including vernal pool fairy shrimp), or their appearance from year to year (Eng et al. 1990:273; U.S. Fish and Wildlife Service 2007:5). Vernal pool fairy shrimp sometimes occur in other wetlands that provide habitat characteristics similar to those of vernal pools; these other wetlands include alkaline rain pools, rock outcrop pools, and some disturbed and constructed sites, including tire ruts, ditches, and puddles (59 FR 48136–48153, September 16, 1994; Eriksen and Belk 1999:93, U.S. Fish and Wildlife Service 2007:24, 58). Suitable pools must stay inundated long enough for the shrimp to complete their life cycle.

Midvalley fairy shrimp is not listed or a species of special concern, but is considered rare because of its limited range within the center of the Central Valley (U.S. Fish and Wildlife Service 2005). Midvalley fairy shrimp has been found in Sacramento County around the city of Sacramento and Mather Regional Park, in Merced County in the vicinity of the Virginia Smith

Trust property, and in San Joaquin, Madera, and Fresno Counties in isolated locations (U.S. Fish and Wildlife Service 2005). The species has been found in shallow, short-lived vernal pools and swales dominated by wetland grasses and ranging from 17 to 2,174 square feet in area and averaging less than 4 inches in depth (Helm 1998:131, 133, 137). Midvalley fairy shrimp has been observed to reach maturity in as little as 8 days and reproduction was observed in as few as 16 days after hatching (Helm 1998:133). It appears that midvalley fairy shrimp can tolerate fairly high water temperatures (e.g., 89.6°F) (Helm 1998:131). Midvalley fairy shrimp occasionally co-occurs with vernal pool fairy shrimp (Erickson and Belk 1999:91).

Vernal pool fairy shrimp and midvalley fairy shrimp are collectively called "vernal pool branchiopods" in this NES.

4.3.1.1 Survey Results

No vernal pool branchiopod surveys were conducted for the proposed project. There are six CNDDB records for vernal pool fairy shrimp and one record for midvalley fairy shrimp within 5 miles of the project (Appendix A, Figure 7). The closest vernal pool fairy shrimp record is approximately 3 miles southeast of the BSA. The record for midvalley fairy shrimp is approximately 5 miles southwest of the BSA. There are four potential seasonal wetlands in the vernal pool branchiopod indirect effects assessment area (within 250 feet of the BSA) that provide potential habitat for vernal pool branchiopods (Appendix A, Figure 6; Appendix C, Photos 6–9). Because these four potential seasonal wetlands are outside the BSA, they were not included in the delineation conducted for the proposed project in 2016. ECORP biologists conducted 2 years of wet season surveys (2008–2010) for vernal pool branchiopods for the Glenborough at Easton and Easton Place Project at one potential seasonal wetland in the indirect effects assessment area. No federally listed vernal pool branchiopods were found in this pool during these surveys. Because negative results for vernal pool branchiopod surveys are good for a period of 5 years, impacts on this pool are still considered for the proposed project.

The seasonal wetlands between the Hazel Avenue/US 50 on-ramp and off-ramp are located in an area where the surface was likely removed/disturbed during construction of the interchange. Additionally, the repeated drying and filling from road run-off would likely deplete the cyst bank, if present in these wetlands. Therefore, these wetlands are not considered suitable habitat for vernal pool branchiopods. There is no designated critical habitat for vernal pool fairy shrimp in the BSA.

4.3.1.2 Project Impacts

Direct Impacts

Construction of the proposed project would not result in the removal or filling of the four potential seasonal wetlands that provide potential habitat for vernal pool branchiopods. Potential temporary direct impacts from the proposed project would be construction equipment driving through pools when they are dry or other short-term construction-related disturbance that does not alter the pool or its hydrology, and fuel or oil leaks or spills from construction equipment adjacent to the pools that could result in injury to or mortality of vernal pool branchiopods and

degradation of habitat. Temporary direct impacts will be avoided through the implementation of avoidance and minimization measures discussed below.

Indirect Impacts

Potential indirect effects on vernal pool branchiopods that were considered were changes in hydrology and increased contaminants from runoff containing fuel, oil, and other pollutants. Degradation of habitat from increased human presence and introduction of exotic predators are indirect impacts that were considered but were dismissed as potentially impacting vernal pool branchiopods. In general, indirect effects were assumed to occur at seasonal wetlands that are outside of, but within 250 feet of, the project footprint.

Changes in Hydrology

Compacting soil and increasing the amount of paved surface within 250 feet of seasonal wetlands has the potential to modify the hydrologic regime of the pools if the increase in impermeable surface results in additional water entering the pools either through sheet flow or a water conveyance structure. This could result in water persisting (ponding) for a longer time (several days or possibly weeks), which could extend the seasonal inundation period for vernal pool branchiopods. However, it is unlikely that the increased amount of surface runoff would cause the habitats to become ponded year round, a condition that would make the habitat unsuitable for vernal pool branchiopods. Water conveyance structures (i.e., ditches) would likely be constructed along the edges of the newly constructed roadway to capture water draining off the roadway. The implementation of Measure 9, described below, will ensure that water conveyance structures near the four pools would not result in changes in the hydrologic regime of the pools.

Increased Contaminants

New roadway would be constructed near the four pools that provide potential habitat for vernal pool branchiopods. Fuel, oil, and other contaminants from vehicles on the roadway adjacent to the pools could be carried into the pools from road runoff during storm events. These contaminants could result in sickness or mortality of vernal pool branchiopods, or degradation of habitat. Water conveyance structures (i.e., ditches) would likely be constructed along the edges of the newly constructed roadway to capture water draining off the roadway. The implementation of Measure 6, described below, will ensure that water conveyance structures near the four seasonal wetlands would prevent contaminants from entering the pools.

Because there would be no direct impacts on vernal pool fairy shrimp and potential indirect effects will be avoided through implementation of Measure 6, the FESA effects determination for any of the alternatives would be the proposed project will have no effect on vernal pool fairy shrimp.

4.3.1.3 Avoidance and Minimization Efforts

To avoid and minimize direct impacts on vernal pool branchiopods, Measure 1, described above and Measure 6, described below, will be implemented to ensure that potential indirect effects on suitable vernal pool branchiopod habitat are avoided.

Measure 1: Conduct Environmental Awareness Training for Construction Employees

Please see Section 4.1.1.3 for the description of this measure.

Measure 6: Design and Implement Water Conveyance Systems that Maintain Hydrology of and Prevent Contaminant from Entering Suitable Vernal Pool Branchiopod Habitat

Concentrated flow conveyance systems identified for the proposed project may include roadside ditches, biofiltration swales, curb and gutters, dikes, overside drains, and culverts. Water conveyance systems surrounding suitable vernal pool branchiopod habitat in the project area will be evaluated, designed, and installed to maintain the existing hydrology of four seasonal wetlands that provide potential habitat for vernal pool branchiopods.

4.3.1.4 Compensatory Mitigation

Because potential direct and indirect effects would be avoided, compensatory mitigation for vernal pool branchiopods is not required.

4.3.1.5 Cumulative Impacts

Because the project would have no effect on vernal pool branchiopods, it would not contribute to cumulative impacts on listed vernal pool branchiopods.

4.3.2 Valley Elderberry Longhorn Beetle

Valley elderberry longhorn beetle is federally listed as threatened. The presumed historical range and current range of valley elderberry longhorn beetle extend from Tehama County south to Fresno County through the Central Valley and associated foothills from about the 3,000-foot contour on the east and the watershed of the Central Valley on the west (79 FR 55881-55884; U.S. Fish and Wildlife Service 1999:1). Valley elderberry longhorn beetle is dependent on its host plant, elderberry, which is a common component of riparian corridors and adjacent upland areas in the Central Valley (Barr 1991:5).

Valley elderberry longhorn beetle has four life stages: egg, larva, pupa, and adult. Females deposit eggs on or adjacent to the host elderberry. Egg production varies; females have been observed to lay between 16 and 180 eggs. Eggs hatch within a few days of being deposited. Larvae emerge and bore into the woody stems of the host plant, creating a long feeding gallery in

the pith. The larvae feed on the pith for 1 to 2 years. When a larva is ready to pupate, it chews an exit hole and then plugs it with frass. The larva then retreats into the feeding gallery and constructs a pupal chamber from wood and frass. The larvae metamorphose between December and April and the pupal stage lasts about a month. The adult remains in the pupal chamber for several weeks after metamorphosis and then emerges from the chamber through the exit hole. Adults emerge between mid-March and mid-June, which corresponds with elderberry flowering. Adults feed on elderberry leaves and mate within the elderberry canopy (Talley et al. 2006a:7–9).

4.3.2.1 Survey Results

There are 10 CNDDB records for valley elderberry longhorn beetle within 5 miles of the BSA (Appendix A, Figure 7). Five elderberry shrubs/clusters (#s 1, 2, 3, 4, and 5) are present in the BSA (Appendix A, Figure 6). Three of these shrubs (#s 1, 2, and 3) are located along US 50 or between on- and off-ramps in the BSA. Two elderberry shrubs (#s 4 and 5) are located in the jughandle off of Folsom Boulevard in the BSA.

Eight additional elderberry shrubs are located within 100 feet of the BSA. Six of the elderberry shrubs/clusters (#s 6–11) within 100 feet of the BSA are located along Folsom Boulevard on Aerojet property in the vernal pool branchiopod indirect effects assessment area. The two other shrubs within 100 feet of the BSA are south of Folsom Boulevard and north of Nimbus Road (#12) and next to the Cattlemen's Restaurant parking lot (#13) (Appendix A, Figure 6).

Surveys for valley elderberry longhorn beetle exit holes, stem counts, and stem diameter measurements were conducted for the four shrubs (#s 1 through 4) that are expected to be affected by the proposed project (see discussion below) and the results of these surveys are shown in Table 4-13. None of these shrubs are located within riparian habitat. Photographs of these four shrubs and representative photographs of observed potential exit holes are included Appendix C (photos 11–17).

Table 4-13. Results of Surveys of Elderberry Shrubs in the BSA that May be Affected by the Proposed Project

Elderberry Number	Riparian (Y/N)	Exit Holes (Y/N)	Number of Stems ≥1" and ≤3"	Number of Stems >3" and <5"	Number of Stems ≥5"	Total Number of Stems
1	N	Y	21	8	7	35
2	N	Y	22	0	5	27
3	N	Y	0	0	1	1
4	N	N	0	2	0	2
Total			**43**	**10**	**13**	**65**

4.3.2.2 Project Impacts

Direct Impacts

Direct impacts on valley elderberry longhorn beetle would consist of removing individual elderberry shrubs in non-riparian habitat. Construction of any of the alternatives would result in the removal of elderberry #1 (because of the embankment for the loop ramp), elderberry #3 (because of construction of the auxiliary lane between Hazel Avenue and the Folsom Boulevard interchange) and elderberry #4 (because of construction of the new intersection and at-grade railroad crossing for the jughandle) (Figures 8 and 9). Construction of Alternative 2 would also result in the removal of elderberry #2 (Figure 9). Elderberry #5 was previously affected by the Glenborough at Easton and Easton Place Project. As such, impacts on this shrub have already been permitted and mitigated for and no impacts from the proposed project would occur. Elderberry #5 is not discussed further.

Ground disturbance within 20 feet of an elderberry shrub's dripline could result in disturbance of roots. Root damage could result in stress or reduced vigor of elderberry shrubs. There would be no soil disturbance within 20 feet of the eight elderberry shrubs/clusters that are within 100 feet of the BSA. The roots of the six shrubs along Folsom Boulevard on the Aerojet property would not be affected because railroad tracks are located between the work area on Folsom Boulevard and the elderberry shrubs, and no work would occur on the south side of the tracks. The other two shrubs are located more than 20 feet from work areas. Therefore, there would be no direct impacts on the eight elderberry shrubs/clusters within 100 feet of the BSA.

Indirect Impacts

Potential indirect impacts on eight elderberry shrubs/clusters within 100 feet of the BSA were considered. Potential indirect effects on valley elderberry longhorn beetle that were considered were altered hydrology, exposure to dust, loss of connectivity to adjacent habitat, increased lighting, and disturbance from operations and maintenance activities. Each of these potential indirect effects is discussed briefly below.

Altered Hydrology

Reduction of water to elderberry shrubs as a result of altered of hydrology from changes in topography or compaction of soil could result in reduced shrub vigor/vitality and an associated decrease in shoot, leaf, and flower production that could ultimately reduce the suitability of the shrubs to provide habitat for valley elderberry longhorn beetle. Because elderberry #s 5–11 are in flat areas with moderate amounts of pavement next to or near them, changes in the hydrology for these shrubs from altered topography or increased paved surface are unlikely to occur. Elderberry #12 would not likely be affected by changes in topography and increase paved surface from the proposed project because it is approximately 80 feet from the BSA in a low area adjacent to the Cattlemen's Restaurant parking lot.

Dust

Ground-disturbing activities during construction of the proposed project could result in dust becoming airborne and settling on elderberries within 100 feet of the BSA. Exposure of elderberries shrubs to dust is likely limited under current conditions because surrounding areas are paved or vegetated. Dust control measures will likely be required to meet air quality standards and would minimize the amount of dust generated during construction. Additionally, according to Talley et al. (2006b), in an experiment along the American River Parkway, conditions of elderberry shrubs related to dust from nearby trails and roads (paved and dirt) did not affect the presence of valley elderberry longhorn beetle. Additional work by Talley and Holyoak (2009) found no effect on elderberries from dust accumulations. Because dust has not been found to greatly affect elderberry shrubs and because dust control measures would likely be implemented during construction, this indirect effect is not expected to affect the beetle.

Loss of Connectivity to Adjacent Habitat

Loss of connectivity between elderberry shrubs may result when elderberries or associated vegetation is removed. Removal of such vegetation could result in gaps in vegetation that are too wide for valley elderberry longhorn beetle to travel across due to their fairly limited movement distances (Talley et al. 2006a), resulting in separation of individuals or a reduction in the possibility of colonization of adjacent areas. Removal of associated vegetation may result in an altered habitat structure or microclimate that could affect behaviors of the beetle in response to these changes in unforeseen ways (U.S. Fish and Wildlife Service 2003).

Although more research is needed, valley elderberry longhorn beetle has been observed to fly a mile or more in contiguous or fairly contiguous habitat, and exit holes have been observed on isolated shrubs that are a minimum of 0.25 mile (0.4 kilometer) from the next nearest elderberry (Arnold pers. comm.). Within the American River Basin, evidence suggests that local beetle movements are farther within the riparian corridor (141±144 feet [43±44 meters]) than in the adjacent non-riparian scrub (82±52 feet [25±16 meters]) (average±1 standard deviation nearest neighbor distances between recent exit holes) illustrating that valley elderberry longhorn beetle population extents may also be habitat-specific (Talley et al. 2006a).

The removal of three or four elderberry shrubs (depending on the alternative that is constructed) would result in a greater distance between existing shrubs. It is possible that the removal of these shrubs could result in the isolation of a beetle population or greater dispersal distances between shrubs. A search for all elderberry shrubs in the project vicinity was not conducted but the distances between mapped elderberry shrubs are shown in Table 4-14. The distances between the shrubs are within the observed flight distance of the beetle, and therefore movement between the shrubs is possible. However, developed areas and the busy interstate may preclude the beetle from flying between some of the elderberry shrubs in and within 100 feet of the BSA. As such, loss of connectivity of habitat is not expected to be an indirect effect on valley elderberry longhorn beetle.

Table 4-14. Distances (Miles) to Nearest Mapped Elderberry Shrubs in the BSA

Elderberry Number	1	2	3	4–11	12
1	0	0.19	0.43	0.11	0.36
2	0.19	0.0	0.6	0.22	0.21
3	0.43	0.6	0.0	0.43	0.58
4–11	0.11	0.22	0.43	0.0	0.21
12	0.36	0.21	0.58	0.21	0.0

The FESA effects determination for any of the alternatives would be the proposed project is likely to adversely affect valley elderberry longhorn beetle.

4.3.2.3 Avoidance and Minimization Efforts

Measure 1, described above and Measure 7, described below, will be implemented to avoid and minimize potential effects on valley elderberry longhorn beetle and its habitat.

Measure 1: Conduct Environmental Awareness Training for Construction Employees

Please see Section 4.1.1.3 for the description of this measure.

Measure 7: Fence Elderberry Shrubs to be Protected

Elderberry shrubs/clusters within 100 feet of the construction area that will not be removed will be protected during construction. A qualified biologist (i.e., with elderberry/valley elderberry longhorn beetle experience) will mark the elderberry shrubs and clusters that will be protected during construction. Orange construction barrier fencing will be placed at the edge of the buffer areas established for each shrub or cluster. The buffer area distances will be proposed by the biologist and approved by USFWS. No construction activities will be permitted in the buffer zone other than those activities necessary to erect the fencing. Signs will be posted along fencing for the duration of construction and will contain the following information.

This area is habitat of the valley elderberry longhorn beetle, a threatened species, and must not be disturbed. This species is protected by the Endangered Species Act of 1973, as amended. Violators are subject to prosecution, fines, and imprisonment.

Temporary fences around the elderberry shrubs will be installed as the first order of work. Temporary fences will be furnished, constructed, maintained, and later removed, as shown on the plans, as specified in the special provisions, and as directed by the project engineer. Temporary fencing will be 4 feet tall, commercial-quality woven polypropylene, and orange in color. To minimize the potential for snakes and other ground-dwelling animals from being caught in the orange construction fencing, the fencing will be placed with at least a 1-foot gap between the ground and the bottom of the orange construction fencing.

Buffer area fences around elderberry shrubs will be inspected periodically by a qualified biologist until project construction is complete or until the fences are removed, as approved by the biological monitor and the resident engineer. The contractor will be responsible for maintaining the buffer area fences around elderberry shrubs throughout construction. Biological inspection reports will be provided to the County and USFWS.

4.3.2.4 Compensatory Mitigation

The following measure will be implemented to compensate for direct effects on valley elderberry longhorn beetle and its habitat.

Measure 8: Compensate for Direct Effects on Valley Elderberry Longhorn Beetle and its Habitat

Before construction begins, the County will compensate for direct effects on valley elderberry longhorn beetle by transplanting shrubs that cannot be avoided to a USFWS-approved conservation bank. The County will also purchase credits at the approved conservation bank in accordance with ratios shown by alternative in Table 4-15.

The relocation of the elderberry shrubs will be conducted according to USFWS-approved procedures outlined in the *Framework for Assessing Impacts to the Valley Elderberry Longhorn Beetle* (U. S. Fish and Wildlife Service 2017). Elderberry shrubs within the project construction area that cannot be avoided will be transplanted during the plant's dormant phase (November through the first 2 weeks of February). A qualified biological monitor will remain onsite while the shrubs are being transplanted.

Table 4-15. Required Compensation for Direct Effects on Elderberry Shrubs by Alternative

Alternative	Number of Elderberry Shrubs	Compensation Ratio (non-riparian)	Number of Conservation Credits Required
1	3	1:1	3
1A	3	1:1	3
2	4	1:1	4

4.3.2.5 Cumulative Impacts

Implementation of the proposed project would result in the removal of suitable and possibly occupied habitat (i.e., due to the presence of potential exit holes) for valley elderberry longhorn beetle. The removal of the habitat would contribute to the cumulative loss of habitat for the beetle in the region. However, with implementation of protective measures (Measures 1 and 7) that will ensure that elderberry shrubs within 100 feet of the BSA are protected and with compensation for the elderberries that would have to be removed (Measure 8), the project's effect on valley elderberry longhorn beetle would not be cumulatively considerable.

4.3.3 Western Pond Turtle

Western pond turtle is a California species of special concern. In California, the species' range is discontinuously distributed throughout the state west of the Cascade-Sierran crest (Jennings and Hayes 1994:99). Aquatic habitats used by western pond turtles include ponds, lakes, marshes, rivers, streams, and irrigation ditches with a muddy or rocky bottom in grassland, woodland, and open forest areas (Stebbins 2003:250). Western pond turtles spend a considerable amount of time basking on rocks, logs, emergent vegetation, mud or sand banks, or human-generated debris (Jennings et al. 1992:11). Western pond turtles move to upland areas adjacent to watercourses to deposit eggs and overwinter (Jennings and Hayes 1994:98). Turtles have been observed overwintering several hundred meters from aquatic habitat. In the southern portion of the range and along the central coast, western pond turtles are active year-round. In the remainder of their range, western pond turtles typically become active in March and return to overwintering sites by October or November (Jennings et al. 1992:11).

4.3.3.1 Survey Results

Focused surveys for western pond turtle were not conducted; however, five western pond turtles were observed in the ponded portion of Alder Creek during the April field survey. One dead turtle was also observed along the US 50 road shoulder by a WRGCO biologist that was doing a hydrology survey on the same day. There are five CNDDB records for western pond turtle within 5 miles of the BSA (Appendix A, Figure 4). The closest record is for an occurrence in the American River, approximately 0.5 mile from the BSA. Alder Creek in the BSA provides suitable aquatic habitat for western pond turtle. The valley foothill riparian woodland and annual grassland areas adjacent to the creek provide suitable upland habitat for western pond turtle (Appendix A, Figure 6).

4.3.3.2 Project Impacts

Direct Impacts

Construction of the proposed project would result in direct permanent and temporary impacts on suitable aquatic (Alder Creek) and upland habitat (riparian and grassland) for western pond turtle. Because suitable habitat for western pond turtle is limited to Alder Creek and adjacent riparian and grassland habitats, direct impacts from all alternatives would be the same (Table 4-16; Figures 8 and 9).

Table 4-16. Impacts on Western Pond Turtle Habitat by Alternative

Habitat Type	Alternative 1		Alternative 1A		Alternative 2	
	Permanent (acres)	Temporary (acres)	Permanent (acres)	Temporary (acres)	Permanent (acres)	Temporary (acres)
Aquatic						
Perennial drainage (Alder Creek)	0.11	0.46	0.11	0.46	0.11	0.46
Upland						
Valley foothill riparian woodland	0.03	0.17	0.03	0.17	0.03	0.17
Annual grassland	0.15	0.63	0.15	0.63	0.15	0.63
Total Upland Impacts	**0.18**	**0.80**	**0.18**	**0.80**	**0.18**	**0.80**

Permanent impacts on aquatic habitat would result from construction of piers within the creek and permanent impacts on upland habitat would result from construction of abutments, removal of riparian vegetation, and paving over and/or fencing of grassland near the creek. Temporary impacts on upland habitat would consist of construction impacts that temporarily remove or disturb habitat, but the habitat would be restored to pre-project conditions. Construction activities could also result in the injury or mortality of western pond turtle from being struck or crushed by construction equipment or becoming entrapped in open trenches. Fuel or oil leaks, or spills into suitable aquatic habitat, also have the potential to result in sickness or mortality of western pond turtle and degradation of habitat.

Indirect Impacts

Because the additional roadway would be operated and maintained similar to existing conditions, the only indirect effect that is expected is degradation of habitat adjacent to the additional lane of roadway near Alder Creek. Temporarily disturbed or undisturbed upland habitat adjacent to the new lane of roadway would likely be degraded from weedy plant species that would colonize this area.

4.3.3.3 Avoidance and Minimization Efforts

Measure 1, described above and Measures 9 and 10, described below, will be implemented to avoid and minimize potential effects on western pond turtle and its habitat.

Measure 1: Conduct Environmental Awareness Training for Construction Employees

Please see Section 4.1.1.3 for the description of this measure.

Measure 9: Conduct Preconstruction Surveys for Western Pond Turtle and Monitor Initial In-Water Work

To avoid potential injury or mortality of western pond turtles, the project proponent will retain a qualified wildlife biologist who is CDFW-approved to capture and relocate turtles. The biologist will conduct a preconstruction survey for western pond turtles

within 24 hours of the start of construction and will survey Alder Creek and the adjacent riparian and grassland habitat within the construction area. If in-water work does not start immediately, the biologist will return to the construction site immediately prior to the start of in-water work to conduct another preconstruction survey. The biologist will remain onsite until initial in-water work is complete. If a turtle becomes trapped during initial in-water work, the biologist will relocate the individual to suitable aquatic habitat upstream of the construction area (the area downstream of the construction area is not accessible because of US 50). For the remainder of construction, the biologist will remain on-call in case a turtle is discovered. The construction crew will be instructed to notify the crew foreman, who will contact the biologist if a turtle is found trapped within the construction area. Work in the area where the turtle is trapped will stop until the biologist arrives and removes and relocates the turtle. The biologist will report their activities to the County and CDFW within 1 day of relocating any turtle.

Measure 10. Restore Temporarily Disturbed Grassland

Upon project completion, the County will restore all temporarily disturbed grassland to pre-project or better conditions. To the extent feasible, native grasses and forbs will be used to reseed disturbed areas.

4.3.3.4 Compensatory Mitigation

Because a very small amount (0.11 acre under any alternative) of aquatic habitat would be permanently removed and the upland habitat that would be permanently removed is along the existing US 50 alignment, permanent impacts on western pond turtle habitat would be minimal. With the implementation of Measures 1, 9, and 10, other impacts on western pond turtle will be avoided or minimized. Permanent and temporary losses of valley foothill riparian woodland will be compensated through the implementation of Measure 4 and permanent loss of emergent wetland will be compensated through the implementation of Measure 5. No further compensatory mitigation would be required.

4.3.3.5 Cumulative Impacts

Because permanent impacts on western pond turtle habitat would be minimal and along US 50, as described above, temporarily disturbed grassland and riparian areas will be restored (Measure 10), and injury and mortality of turtles will be avoided or minimized through implementation of Measures 1 and 9, the project would not contribute to cumulative impacts on western pond turtle in the project region.

4.3.4 Swainson's Hawk and White-tailed Kite

Swainson's hawk is a state-listed threatened species. Swainson's hawks forage in grasslands, grazed pastures, alfalfa and other hay crops, and certain grain and row croplands. Vineyards, orchards, rice, and cotton crops are generally unsuitable for foraging because of the density of the vegetation (California Department of Fish and Game 1992:41). The majority of Swainson's hawks winter in South America, although some winter in the United States. Swainson's hawks

arrive in California in early March to establish nesting territories and breed (California Department of Fish and Game 1994). They usually nest in large, mature trees. Most nest sites (87%) in the Central Valley are found in riparian habitats (Estep 1989:35), primarily because trees are more available there. Swainson's hawks also nest in mature roadside trees and in isolated trees in agricultural fields or pastures. The breeding season is from March through August (Estep 1989:12, 35).

White-tailed kite is fully protected under the CFGC. White-tailed kites generally inhabit low-elevation grassland, savannah, oak woodland, wetland, agricultural, and riparian habitats. Some large shrubs or trees are required for nesting and for communal roosting sites. Nest trees range from small, isolated shrubs and trees to trees in relatively large stands (Dunk 1995). White-tailed kites make nests of loosely piled sticks and twigs, lined with grass and straw, near the top of dense oaks, willows, and other tree stands. The breeding season lasts from February through October and peaks between May and August. White-tailed kites forage in undisturbed, open grassland, meadows, farmland, and emergent wetlands (Zeiner et al. 1990a:120).

4.3.4.1 Survey Results

Focused surveys for Swainson's hawk were not conducted; however, a Swainson's hawk was observed in the jughandle portion of the BSA during the May field survey. There are six CNDDB records for Swainson's hawk nests within 5 miles of the BSA (Appendix A, Figure 4). The closest record is for a nest from 2007 that is approximately 2.5 miles southeast of the BSA. Swainson's hawks could nest in valley foothill riparian woodland, oak woodland, and in individual trees in the BSA and could forage in annual grassland throughout the BSA.

Focused surveys for white-tailed kite were not conducted. There are eight records for white-tailed kite nests within 10 miles of the BSA (Figure 4 in Appendix A). The closest record is from 1991 for a nest approximately 0.4 mile southeast of the BSA. White-tailed kite could nest in valley foothill riparian woodland, oak woodland, and in individual trees in the BSA and could forage in annual grassland throughout the BSA.

4.3.4.2 Project Impacts

Direct Impacts

Construction activities would occur during the Swainson's hawk and white-tailed kite nesting seasons (March through August and February to October, respectively) and could result in the disturbance of these species. Trees that provide suitable nesting habitat for Swainson's hawk and white-tailed kite would be removed to construct the proposed project. Construction disturbance (noise and/or activity) during the breeding season could result in the incidental loss of fertile eggs or nestlings or otherwise lead to nest abandonment. Because white-tailed kite is fully protected, removal of occupied nest trees during the breeding season and activities that may result in loss of white-tailed kites are prohibited.

Removal of suitable nest trees in the BSA would reduce the amount of available nesting habitat for Swainson's hawk and white-tailed kite and a temporal loss of nesting habitat would continue until replacement trees mature. Construction of the proposed project would also result in direct

permanent and temporary impacts on suitable foraging habitat for Swainson's hawk and white-tailed kite (consisting of annual grassland). Table 4-17 summarizes estimated permanent and temporary impacts on suitable Swainson's hawk and white-tailed kite nesting and foraging habitat by alternative. This table does not include the loss of suitable nest trees in the landscaped cover type.

Table 4-17. Impacts on Swainson's Hawk and White-tailed Kite Habitat by Alternative

Habitat Type	Alternative 1		Alternative 1A		Alternative 2	
	Permanent (acres)	Temporary (acres)	Permanent (acres)	Temporary (acres)	Permanent (acres)	Temporary (acres)
Nesting						
Fremont cottonwood-oak woodland	2.97	0.19	2.97	0.19	2.97	0.19
Valley foothill riparian woodland	0.03	0.17	0.03	0.17	0.03	0.17
Total Impacts	**3.00**	**0.36**	**3.00**	**0.36**	**3.00**	**0.36**
Foraging						
Annual grassland	16.10	2.35	16.10	2.35	17.44	2.35

Indirect Impacts

It is not anticipated that there would be any indirect effects on Swainson's hawk or white-tailed kite as a result of the proposed project.

4.3.4.3 Avoidance and Minimization Efforts

Measures 1, 2, and 10, described above and listed below, and Measures 11 and 12, described below, will be implemented to avoid or reduce potential impacts on Swainson's hawk and white-tailed kite.

Measure 1: Conduct Environmental Awareness Training for Construction Employees

Please see Section 4.1.1.3 for the description of this measure.

Measure 2: Monitor Disturbance of Woody Vegetation and Replant Affected Areas if Necessary

Please see Section 4.1.1.3 for the description of this measure.

Measure 10. Restore Temporarily Disturbed Grassland

Please see Section 4.3.3.3 for the description of this measure.

Measure 11: Conduct Vegetation Removal during the Non-Breeding Season of Nesting Migratory Birds

To the maximum extent feasible, vegetation removal (trees, shrubs, and ground vegetation) will occur during the non-breeding season for most migratory birds (generally between October 1 and January 31). This timing is highly preferable because if an active nest is found during preconstruction surveys (described below) in a tree (or other vegetation) that would be removed by project construction, the tree (or other vegetation) cannot be removed until the end of the nesting season, which could delay construction. If vegetation cannot be removed between October and January, or if ground cover re-establishes in areas where vegetation has been removed, the affected area must be surveyed for nesting birds, as discussed in Measures 12 and 13 below.

Measure 12: Conduct Focused Surveys for Nesting Swainson's Hawk and White-tailed Kite Prior to Construction and Implement Protective Measures during Construction

Prior to conducting surveys, the County or its consultant will conduct a search of the CNDDB and contact CDFW for information on the nearest known Swainson's hawk nests in the project vicinity. During the spring before construction begins (i.e., in 2017 if construction is expected to begin in 2018), the County or its consultant will conduct surveys for nesting Swainson's hawks and white-tailed kite to provide information in preparation for construction (i.e., locations of nests, hawks' responses to disturbance, sizes of buffer areas, anticipated impacts on project schedule). Surveys will also be conducted in the spring of the year of construction (projected to be 2018) to determine if there are active nests when construction activities begin. Because the area surrounding the construction area is largely developed, focused surveys for Swainson's hawk and white-tailed kite will be conducted in the project area and in a buffer area up to 0.25 mile around the project area. The size of the buffer area surveyed will be based on the type of habitat present and line of sight from the construction area to surrounding suitable breeding habitat. Buffer areas containing unsuitable nesting habitat and/or with an obstructed line of sight to the project area will not be surveyed. Survey methodology will follow the Swainson's Hawk Technical Advisory Committee's methodology (Swainson's Hawk Technical Advisory Committee 2000). A minimum of six surveys will be conducted during the appropriate timeframes discussed in the methodology. If needed, biologists will coordinate with CDFW regarding the extent and number of surveys. Surveys will generally be conducted from February to July. Survey methods and results will be reported to CDFW.

4.3.4.4 Compensatory Mitigation

With the implementation of Measures 1, 2, 10, 11, and 12, impacts on Swainson's hawk and white-tailed kite will be avoided or minimized. Permanent and temporary losses of Fremont cottonwood-oak woodland and valley foothill riparian woodland will be compensated through the implementation of Measures 3 and 4. Measure 16, described below under Section 4.4.2.4, will also compensate for the loss of potential nest trees for Swainson's hawk and white-tailed kite.

CDFW requires compensation for the permanent loss of foraging habitat for Swainson's hawk, when a nest is located within 10 miles of the habitat removal. Consequently, Measure 13 will be implemented. If required, compensation for the permanent loss of foraging habitat for Swainson's hawk, as described below, will also benefit white-tailed kite.

Measure 13: Compensate for the Permanent Loss of Foraging Habitat for Swainson's Hawk

The County will mitigate for the permanent removal of suitable foraging habitat for Swainson's hawks by providing off-site habitat management lands as described in CDFW's *Staff Report Regarding Mitigation for Impacts to Swainson's Hawks in the Central Valley of California* (California Department of Fish and Game 1994). The final acreage of off-site management lands to be provided will depend on the distance between the project area and the nearest active nest site (an active nest site is one that has been used in one or more of the last 5 years). The mitigation ratio varies from 0.5:1 to 1:1 of habitat preserved for each acre lost. Information on the nearest nest will be collected prior to and during Swainson's hawk surveys conducted under Measure 11, as discussed above. If no active nests are found during the surveys, information from the CNDDB and CDFW will be used to determine the distance to the nearest active nest and corresponding mitigation ratio. Mitigation may be purchased under the County's Swainson's Hawk Mitigation Program, which for projects that result in less than 40 acres of impact, allows a project proponent to provide title or easement to suitable Swainson's hawk mitigation lands on a per-acre basis or to pay an impact fee per acre of impact and an endowment fee[1]. An administrative processing fee is also required for each project.

4.3.4.5 Cumulative Impacts

Because a net loss of foraging habitat would result even after mitigation, construction of the proposed project would contribute to the cumulative loss of foraging habitat for Swainson's hawk and white-tailed kite in the project region. However, with implementation of measures to avoid and minimize potential impacts on Swainson's hawk and white-tailed kite (removing vegetation during the non-breeding season, avoiding disturbance of occupied nest sites, and restoring temporarily affected grassland to pre-project or better conditions) and compensation for permanent loss of suitable nesting habitat through implementation of Measures 3 and 4, and the possible preservation of foraging habitat through implementation of Measure 13, the proposed project's effect on Swainson's hawk and white-tailed kite would not be cumulatively considerable.

4.3.5 Yellow-breasted Chat

Yellow-breasted chat is a California species of special concern. Yellow-breasted chat occurs in the northern Sacramento Valley in scattered areas, Cascade Range, low to mid-elevations in the Sierra Nevada, northwestern California, most of the central and southern coasts, and scattered locations in the southern deserts of California. Yellow-breasted chats nest regularly along low-

[1] http://www.per.saccounty.net/EnvironmentalDocuments/Pages/SwainsonsHawkOrdinance.aspx

and mid-elevation streams in the Sierra Nevada. They occur in early successional riparian habitats with a well-developed shrub layer and an open canopy. Nesting habitat is usually restricted to the narrow border of streams, creeks, sloughs, and rivers. Nests are built in Himalayan blackberry, wild grape (*Vitis* spp.), willow, and other plants that form dense thickets and tangles. Breeding occurs from late April through early August. (Shuford and Gardali 2008:351–355.)

4.3.5.1 Survey Results

Focused surveys for yellow-breasted chat were not conducted. There are no CNDDB records for nesting yellow-breasted chats within 5 miles of the BSA; however, there is one eBird record for an individual observed within 1 mile of the BSA (eBird 2016). The valley foothill riparian woodland along Alder Creek in and near the BSA provides suitable nesting habitat for yellow-breasted chat.

4.3.5.2 Project Impacts

Direct Impacts

Construction of the proposed project would result in direct permanent and temporary impacts on suitable nesting habitat (valley foothill riparian woodland) for yellow-breasted chat. Additionally, construction disturbance (noise and/or activity) during the breeding season (late April through early August) could result in the incidental loss of fertile eggs or nestlings or otherwise lead to nest abandonment. Table 4-18 summarizes estimated permanent and temporary impacts on suitable yellow-breasted chat habitat by alternative.

Table 4-18. Impacts on Yellow-breasted Chat Habitat by Alternative

Habitat Type	Alternative 1		Alternative 1A		Alternative 2	
	Permanent (acres)	Temporary (acres)	Permanent (acres)	Temporary (acres)	Permanent (acres)	Temporary (acres)
Valley foothill riparian woodland	0.03	0.17	0.03	0.17	0.03	0.17

Indirect Impacts

It is not anticipated that there would be any indirect effects on yellow-breasted chat as a result of the proposed project.

4.3.5.3 Avoidance and Minimization Efforts

Measures 1, 2, and 11, described above and listed below, and Measure 14, described below, will be implemented to avoid or reduce potential impacts on yellow-breasted chat.

Measure 1: Conduct Environmental Awareness Training for Construction Employees

Please see Section 4.1.1.3 for the description of this measure.

Measure 2: Monitor Disturbance of Woody Vegetation and Replant Affected Areas if Necessary

Please see Section 4.1.1.3 for the description of this measure.

Measure 11: Conduct Vegetation Removal during the Non-Breeding Season of Nesting Migratory Birds

Please see Section 4.3.4.3 for the description of this measure.

Measure 14: Conduct Preconstruction Surveys for Nesting Migratory Birds

If construction activities (including vegetation removal) would occur during the breeding season (generally February 1 through September 30), the County will retain a qualified wildlife biologist with knowledge of the relevant species to conduct nesting surveys before the start of construction. A minimum of two separate surveys will be conducted for migratory birds, including raptors. Surveys will include a search of all trees and shrubs, marsh, wetland, and grassland vegetation that provide suitable nesting habitat in the project area. In addition, a 500-foot area around the project area will be surveyed for nesting raptors. If possible, the first survey should occur during the height of the breeding season (March 1 to June 1) and the final survey will occur within 1 week of the start of construction. If no active nests are detected during these surveys, no additional measures are required.

If an active nest is found in the survey area, a no-disturbance buffer will be established around the nest site to avoid disturbance or destruction of the site until the end of the breeding season (September 30) or until after a qualified wildlife biologist determines that the young have fledged and moved out of the project area (this date varies by species). The extent of these buffers will be determined by the biologist in coordination with USFWS and CDFW and will depend on the level of noise or construction disturbance, line-of-sight between the nest and the disturbance, ambient levels of noise and other disturbances, and other topographical or artificial barriers. Suitable buffer distances may vary between species.

4.3.5.4 Compensatory Mitigation

With the implementation of Measures 1, 2, 11, and 14, impacts on yellow-breasted chat will be avoided or minimized. Permanent and temporary losses of valley foothill riparian woodland will be compensated through the implementation of Measure 4. No further compensatory mitigation would be required.

4.3.5.5 Cumulative Impacts

Because a net loss of suitable nesting habitat would result even after mitigation, construction of the proposed project would contribute to the cumulative loss of suitable habitat for yellow-breasted chat in the project region. However, with implementation of measures to avoid and minimize potential impacts (removing vegetation during the non-breeding season, preconstruction surveys, and restoring temporarily affected habitat) and compensation for the permanent loss of valley foothill riparian woodland, the project's effect on yellow-breasted chat would not be cumulatively considerable.

4.3.6 Tricolored Blackbird

Tricolored blackbird is a candidate for listing under CESA and a California species of special concern. Tricolored blackbird is a highly colonial species that is largely endemic to California. Tricolored blackbird breeding colony sites require open, accessible water; a protected nesting substrate, including either flooded, thorny, or spiny vegetation; and a suitable foraging space providing adequate insect prey within a few miles of the nesting colony. Tricolored blackbird breeding colonies occur in freshwater marshes dominated by tules and cattails (*Typha* spp.), in Himalayan blackberries, and in silage and grain fields (Beedy and Hamilton 1997:3–4). The breeding season is from late February to early August (Meese et al. 2014). Tricolored blackbird foraging habitats in all seasons include annual grasslands, dry seasonal pools, agricultural fields (such as large tracts of alfalfa with continuous mowing schedules, and recently tilled fields), cattle feedlots, and dairies. Tricolored blackbirds also forage occasionally in riparian scrub habitats and along marsh borders. Weed-free row crops and intensively managed vineyards and orchards do not serve as regular foraging sites. Most tricolored blackbirds forage within 3 miles of their colony sites but commute distances of up to 8 miles have been reported (Beedy and Hamilton 1997:5).

4.3.6.1 Survey Results

Focused surveys for tricolored blackbird were not conducted. There are eight CNDDB records for tricolored blackbird nesting colonies within 5 miles of the BSA; however, three of the records are extirpated or possibly extirpated (Appendix A, Figure 4). The closest records are for four colonies approximately 3 miles southeast of the BSA that were active in either 2012 or 2014. The only area of potentially suitable nesting habitat in or adjacent to the BSA is the patch of emergent wetland along the ponded portion of Alder Creek. The dominant vegetation in the emergent wetland is tule, and the patch is approximately 200 feet long and its width varies from 10 to 30 feet, depending on location. Tricolored blackbirds could forage in annual grassland throughout the BSA.

4.3.6.2 Project Impacts

Direct Impacts

Construction of the proposed project would result in direct permanent and temporary impacts on suitable nesting (emergent wetland) and foraging habitat (annual grassland) for tricolored

blackbird. Additionally, construction disturbance (noise and/or activity) during the breeding season (late February through early August) could result in the incidental loss of fertile eggs or nestlings or otherwise lead to nest abandonment. Table 4-19 summarizes estimated permanent and temporary impacts on suitable tricolored blackbird habitat by alternative.

Table 4-19. Impacts on Tricolored Blackbird Habitat by Alternative

Habitat Type	Alternative 1		Alternative 1A		Alternative 2	
	Permanent (acres)	Temporary (acres)	Permanent (acres)	Temporary (acres)	Permanent (acres)	Temporary (acres)
Nesting						
Emergent wetland	0.06	0.14	0.06	0.14	0.06	0.14
Foraging						
Annual grassland	16.10	2.35	16.10	2.35	17.44	2.35

Indirect Impacts

It is not anticipated that there would be any indirect effects on tricolored blackbird as a result of the proposed project.

4.3.6.3 Avoidance and Minimization Efforts

Measures 1, 10, 11, and 14, described above and listed below, will be implemented to avoid or reduce potential impacts on tricolored blackbird.

Measure 1: Conduct Environmental Awareness Training for Construction Employees

Please see Section 4.1.1.3 for the description of this measure.

Measure 10. Restore Temporarily Disturbed Grassland

Please see Section 4.3.3.3 for the description of this measure.

Measure 11: Conduct Vegetation Removal during the Non-Breeding Season of Nesting Migratory Birds

Please see Section 4.3.4.3 for the description of this measure.

Measure 14: Conduct Preconstruction Surveys for Nesting Migratory Birds

Please see Section 4.3.5.3 for the description of this measure.

4.3.6.4 Compensatory Mitigation

With the implementation of Measures 1, 10, 11, and 14, impacts on tricolored blackbird will be avoided or minimized. Permanent loss of emergent wetland will be compensated through the

implementation of Measure 5. Compensation for the permanent loss of foraging habitat for Swainson's hawk, if required and as described in Measure 13, will also benefit tricolored blackbird. No further compensatory mitigation would be required.

4.3.6.5 Cumulative Impacts

Because a net loss of nesting and foraging habitat would result even after mitigation, construction of the proposed project would contribute to the cumulative loss of suitable habitat for tricolored blackbird in the project region. However, with implementation of measures to avoid and minimize potential impacts on tricolored blackbird (removing vegetation during the nonbreeding season, preconstruction surveys, and restoring temporarily affected grassland to pre-project or better conditions) and compensation for permanent loss of emergent wetland, the project's effect on tricolored blackbird would not be cumulatively considerable.

4.3.7 Song Sparrow (Modesto Population)

The Modesto population of song sparrow is a California species of special concern. This population of song sparrow occurs primarily at elevations below 200 feet above mean sea level from Colusa County south through the Sacramento-San Joaquin River Delta (except for Suisun Marsh) to Stanislaus County. Song sparrows are associated with freshwater marsh that is dominated by tules and cattails, as well as riparian willow thickets. They may also nest in valley oak riparian forests with blackberry understory, along vegetated irrigation canals and levees, and in recently planted oak restoration sites. Song sparrows require moderately dense vegetation that provides cover for nest sites, a source of standing or running water, semi-open canopies to allow light penetration, and exposed ground or leaf litter for foraging. (Shuford and Gardali 2008:400–402.) The breeding season for the Modesto population of song sparrow is late March to early August (Gardali no date:1)

4.3.7.1 Survey Results

Focused surveys for song sparrow were not conducted. There are no CNDDB records for nesting song sparrows within 5 miles of the BSA; however, there are numerous eBird records for individuals observed within 1 mile of the BSA (eBird 2016). The valley foothill riparian woodland and emergent wetland along Alder Creek in and near the BSA provide suitable nesting habitat for song sparrow.

4.3.7.2 Project Impacts

Direct Impacts

Construction of the proposed project would result in direct permanent and temporary impacts on suitable nesting habitat (valley foothill riparian woodland and emergent wetland) for song sparrow. Additionally, construction disturbance (noise and/or activity) during the breeding season (late March through early August) could result in the incidental loss of fertile eggs or nestlings or otherwise lead to nest abandonment. Table 4-20 summarizes estimated permanent and temporary impacts on suitable song sparrow habitat by alternative.

Table 4-20. Impacts on Song Sparrow Habitat by Alternative

Habitat Type	Alternative 1		Alternative 1A		Alternative 2	
	Permanent (acres)	Temporary (acres)	Permanent (acres)	Temporary (acres)	Permanent (acres)	Temporary (acres)
Valley foothill riparian woodland	0.03	0.17	0.03	0.17	0.03	0.17
Emergent wetland	0.06	0.14	0.06	0.14	0.06	0.14
Total	**0.09**	**0.31**	**0.09**	**0.31**	**0.09**	**0.31**

Indirect Impacts

It is not anticipated that there would be any indirect effects on song sparrow as a result of the proposed project.

4.3.7.3 Avoidance and Minimization Efforts

Measures 1, 2, 11, and 14, described above and listed below, will be implemented to avoid or reduce potential impacts on song sparrow.

Measure 1: Conduct Environmental Awareness Training for Construction Employees

Please see Section 4.1.1.3 for the description of this measure.

Measure 2: Monitor Disturbance of Woody Vegetation and Replant Affected Areas if Necessary

Please see Section 4.1.1.3 for the description of this measure.

Measure 11: Conduct Vegetation Removal during the Non-Breeding Season of Nesting Migratory Birds

Please see Section 4.3.4.3 for the description of this measure.

Measure 14: Conduct Preconstruction Surveys for Nesting Migratory Birds

Please see Section 4.3.5.3 for the description of this measure.

4.3.7.4 Compensatory Mitigation

With the implementation of Measures 1, 2, 11, and 14, impacts on song sparrow will be avoided or minimized. Permanent and temporary losses of valley foothill riparian woodland and permanent loss of emergent wetland will be compensated through the implementation of Measures 4 and 5. No further compensatory mitigation would be required.

4.3.7.5 Cumulative Impacts

Because a net loss of suitable nesting habitat would result even after mitigation, construction of the proposed project would contribute to the cumulative loss of suitable habitat for song sparrow in the project region. However, with implementation of measures to avoid and minimize potential impacts (removing vegetation during the non-breeding season, preconstruction surveys, and restoring temporarily impacted habitat) and compensation for the permanent loss of valley foothill riparian woodland and emergent wetland, the project's effect on song sparrow would not be cumulatively considerable.

4.3.8 Special-Status Bats, and Roosting Colonies of Non-Special-Status Bats

Two special-status bat species, pallid bat and western red bat, were identified as potentially occurring in the BSA. Pallid bat and western red bat are California species of concern and are considered high priority species in California by the Western Bat Working Group (2015). These species are described below.

Pallid bat is found throughout most of California at low to middle elevations (6,000 feet), in a variety of habitats including desert, brushy terrain, coniferous forest, and non-coniferous woodlands. Daytime roost sites include rock outcrops, mines, caves, hollow trees, buildings, and bridges. Night roosts are commonly under bridges but are also in caves and mines (Brown and Pierson 1996). Hibernation may occur during late November through March. Pallid bats breed from late October through February (Zeiner et al. 1990b:70) and one or two young are born in May or June (Brown and Pierson 1996).

Western red bat is found throughout much of California at lower elevations, primarily in riparian and wooded habitats but also occurs seasonally in urban areas (Brown and Pierson 1996). Western red bats roost in the foliage of trees that are often located on the edge of habitats adjacent to streams, fields, or urban areas. This species breeds in August and September and young are born in May through July (Zeiner et al. 1990b:60).

CDFW also requires that substantial roost colonies of non-special-status bats (such as Mexican free-tailed bat [*Tadarida brasiliensis*]) be protected from disturbance, especially during the breeding and hibernation seasons.

4.3.8.1 Survey Results

Focused surveys for special-status bats were not conducted; however, the Hazel Avenue bridge structure, Alder Creek box culvert, and buildings to be removed were examined for roosting habitat during the April 6, 2016, survey. There is one CNDDB record for pallid within 5 miles of the BSA (Appendix A, Figure 7). There are no CNDDB records for western red bat; however, the BSA provides suitable habitat for this species. Although no evidence of bat use (e.g., guano, urine staining) was observed, the Hazel Avenue bridge structure contains weep holes and an opening with metal bars across it that could allow bats to enter the open space within the bridge. The Alder Creek box culvert does not contain any open space through which bats could enter the culvert (because of the MSE wall above it and the high water level). Shallow, recessed areas

along the sides of the culvert structure are not deep enough to provide suitable cover for roosting bats. Buildings in the BSA that would be removed do not have any openings that provide entry into spaces that would provide suitable roosting habitat for bats. Trees in valley foothill riparian woodland and oak woodland, and other larger trees in the BSA (such as the oak trees in the Cattlemen's Restaurant parking lot) provide suitable roosting habitat for pallid bat and western red bat.

4.3.8.2 Project Impacts

Direct Impacts

Construction of the proposed project would occur during the bat maternity season (April 1 through September 15). The proposed project would result in the removal or disturbance of trees that provide suitable roosting habitat (cavities, crevices, furrowed bark, and foliage) for special-status bats. The Hazel Avenue bridge structure would be disturbed (i.e., vibrations, noise) during widening under Alternatives 1 and 1A but would not be removed. As such, the structure would continue to provide suitable roosting habitat for bats. Under Alternative 2, the Hazel Avenue bridge structure would not be widened and therefore would not disturb bats potentially in the bridge. Removal or disturbance of trees providing suitable roosting habitat could result in the injury or mortality of roosting bats, if present during removal or disturbance of the tree. Removal of occupied roost habitat would also displace bats, causing them to relocate to another roost site, and potentially competing with other bats for the roost site.

Indirect Impacts

It is not anticipated that there would be any indirect effects on special-status or non-special-status bats as a result of the proposed project.

4.3.8.3 Avoidance and Minimization Efforts

Measures 1 and 2, described above and listed below, and Measure 15, described below, will be implemented to avoid or reduce potential impacts on special-status bats.

Measure 1: Conduct Environmental Awareness Training for Construction Employees

Please see Section 4.1.1.3 for the description of this measure.

Measure 2: Monitor Disturbance of Woody Vegetation and Replant Affected Areas if Necessary

Please see Section 4.1.1.3 for the description of this measure.

Measure 15: Identify Suitable Roosting Habitat for Bats and Implement Avoidance and Protective Measures

If tree removal or trimming cannot be conducted between September 15 and October 30, qualified biologists will examine trees for suitable bat roosting habitat before tree removal or trimming. High-quality habitat features (e.g., large tree cavities, basal hollows, loose or peeling bark, larger snags, palm trees with intact thatch) will be identified and the area around these features searched for bats and bat signs (e.g., guano, culled insect parts, staining). Riparian woodland and stands of mature broadleaf trees are considered potential habitat for solitary foliage-roosting bat species. Because signs of bat use are not easily found, and trees cannot be completely surveyed for bat roosts, the protective measures listed below will be implemented for trees containing high-quality habitat features.

- Removal or disturbance of trees providing bat roosting habitat will be avoided between April 1 and September 15 (the maternity period) to avoid effects on pregnant females and active maternity roosts (whether colonial or solitary).
- Removal of trees providing bat roosting habitat will be conducted between September 15 and October 30, which corresponds to a time period when bats have not yet entered torpor or would be caring for nonvolant young.
- Trees will be removed in pieces rather than felling an entire tree.
- If a maternity roost is found, whether solitary or colonial, that roost will remain undisturbed until September 15 or until a qualified biologist has determined the roost is no longer active.
- If avoidance of non-maternity roost trees is not possible, and tree removal or trimming must occur between October 30 and August 31, qualified biologists will monitor tree trimming/removal of the habitat. If possible, tree trimming or removal should occur in the late afternoon or evening when it is closer to the time that bats would normally arouse. Prior to trimming or removal of trees providing suitable roosting habitat, each tree will be shaken gently and several minutes should pass before felling trees or removing limbs to allow bats time to arouse and leave the tree. Biologists should search downed vegetation for dead and injured bats. The presence of dead or injured bats that are species of special concern will be reported to CDFW. The biologist will prepare a biological monitoring report, which will be provided to the County and CDFW.

4.3.8.4 Compensatory Mitigation

The proposed project would result in the removal of trees that provide suitable roosting habitat for special-status bats. The removal of oak trees and riparian trees will be compensated through implementation of Measures 3 and 4. Although the planting of oak and riparian trees onsite or offsite would replace the trees lost, it would be many years before the trees are large enough to provide suitable roosting habitat for bats. Therefore, there would be a temporary loss of suitable roosting habitat until the trees mature. CDFW may require additional trees to be planted if any trees removed are found to be occupied by special-status roosting bats during tree removal.

4.3.8.5 Cumulative Impacts

Implementation of avoidance and minimization measures will avoid and minimize potential construction impacts on special-status bats. The loss of oak and riparian trees that provide suitable roosting habitat for special-status bats would be compensated through the implementation of Measures 3 and 4; however, there would be a temporal loss of habitat because it would take many years before the trees are large enough to provide suitable roosting sites for bats. Although construction of the proposed project could contribute to the cumulative loss of suitable roosting habitat (through the temporal loss of large trees), with implementation of avoidance and minimization measures and compensation for the loss of oak and riparian trees, the proposed project's effect on special-status bats would not be cumulatively considerable.

4.4 Other Protected and Managed Biological Resources

4.4.1 Migratory Birds

Several non-special-status migratory birds, including red-tailed hawk, Anna's hummingbird, and acorn woodpecker, could nest on the ground or in shrubs or trees in and adjacent to the BSA. These generally common species are locally and regionally abundant. The breeding season for most birds is generally from February 1 to August 31. In addition, swallows and black phoebes could nest on the Alder Creek box culvert. Cliff swallows and barn swallows are species that frequently build mud nests on the sides or undersides of artificial structures such as bridges. Swallows winter in South America and return to California to breed in February. Swallows nest from April to August and migrate south in September and October (Zeiner et al. 1990a). Black phoebes also build mud nests on near or over water on cliff faces, on walls of old buildings, under bridges, under eaves, and on other natural and artificial sheltered locations near water. Black phoebes breed from March to August (Zeiner et al. 1990a). The occupied nests and eggs of migratory birds are protected by federal and state laws, including the MBTA and CFGC Sections 3503 and 3503.5. USFWS is responsible for overseeing compliance with the MBTA, and CDFW is responsible for overseeing compliance with the CFGC and making recommendations on nesting bird protection.

4.4.1.1 Survey Results

The habitat-based field survey was conducted during the breeding season for most birds but a focused survey for nest structures was not conducted. The viewable portion of the side of the Alder Creek box culvert was examined for swallow nests during the April 6, 2016, field survey and no nests were observed. An active red-tailed hawk nest was observed during the May 31, 2016, survey in the vernal pool branchiopod indirect effects assessment area (Appendix A, Figure 6). Suitable nesting habitat for migratory birds is present within the Fremont cottonwood-oak woodland, planted oak woodland, valley foothill riparian woodland, emergent wetland, annual grassland, and landscaped land cover types in and adjacent to the BSA.

4.4.1.2 Project Impacts

Direct Impacts

Tree removal and trimming is expected to occur for construction of the proposed project. Clearing of annual grassland, where ground nesting birds may be present, may also occur. Additionally, the Alder Creek box culvert that provides suitable nesting substrate for swallows and black phoebes would be disturbed when the new bridge is constructed next to the culvert. Construction activities would occur during the nesting season of migratory birds (generally February 1 through August 31) and could result in the possible injury or mortality of nesting birds. Removal or destruction of nests or construction disturbance during the breeding season could result in the incidental loss of fertile eggs or nestlings or otherwise lead to nest abandonment.

Indirect Impacts

It is not anticipated that there would be any indirect effects on nesting migratory birds as a result of the proposed project.

4.4.1.3 Avoidance and Minimization Efforts

Measures 1, 2, 10, 11, and 14, described above and listed below, will be implemented to avoid or reduce potential impacts on nesting migratory birds.

Measure 1: Conduct Environmental Awareness Training for Construction Employees

Please see Section 4.1.1.3 for the description of this measure.

Measure 2: Monitor Disturbance of Woody Vegetation and Replant Affected Areas if Necessary

Please see Section 4.1.1.3 for the description of this measure.

Measure 10. Restore Temporarily Disturbed Grassland

Please see Section 4.3.3.3 for the description of this measure.

Measure 11: Conduct Vegetation Removal during the Non-Breeding Season of Nesting Migratory Birds

Please see Section 4.3.4.3 for the description of this measure.

Measure 14: Conduct Preconstruction Surveys for Nesting Migratory Birds

Please see Section 4.3.5.3 for the description of this measure.

4.4.1.4 Compensatory Mitigation

With the implementation of Measures 1, 2, 10, 11, and 14, impacts on migratory birds will be avoided or minimized. Permanent and temporary losses of Fremont cottonwood-oak woodland and valley foothill riparian woodland will be compensated though the implementation of Measures 3 and 4, and permanent loss of emergent wetland will be compensated through the implementation of Measure 5. Compensation for the permanent loss of foraging habitat for Swainson's hawk, if required and as described in Measure 13, will also benefit migratory birds. Measure 16, described below under Section 4.4.2.4, will also compensate for the loss of potential nest trees for migratory birds. No further compensatory mitigation would be required.

4.4.1.5 Cumulative Impacts

Implementation of avoidance and minimization measures will avoid and minimize potential injury or mortality of nesting migratory birds. Measures that require compensation for the loss of Freemont cottonwood-oak woodland, valley foothill riparian woodland, emergent wetland, and Swainson's hawk foraging habitat will also benefit migratory birds by replacing or preserving suitable habitats that provide nesting and foraging opportunities for birds. Temporarily affected annual grassland would also be restored to pre-project or better conditions. With implementation of avoidance and minimization measures and compensation for habitat loss, the project's effect on migratory birds would not be cumulatively considerable.

4.4.2 Protected Trees

4.4.2.1 Survey Results

The BSA contains oaks and other native trees in the Fremont cottonwood-oak woodland and valley foothill riparian woodland, as well as native trees that occur in landscaped areas, planted oak woodland, and annual grassland. Native trees, oak woodlands, and riparian areas are protected under the County's General Plan policies. Native oaks with a dbh of 6 inches or more, or 10 inches or more in total for multi-trunked oaks, are additionally protected under the County's tree preservation ordinance, and native oaks with a dbh of 19 inches or more are protected as heritage trees. In the City of Rancho Cordova, the same size oaks are protected. Protected trees in the BSA include 241 interior live, coast live, and valley oak trees and 86 other native trees, including buckeye, western redbud, California black walnut, gray pine, California sycamore, Fremont's cottonwood, and arroyo willow. Of the 241 oak trees in the BSA, 37 are heritage trees.

4.4.2.2 Project Impacts

The proposed project would result in removal of oak trees and other native trees in cottonwood-oak woodland and valley foothill riparian habitat. Implementation of the avoidance and minimization efforts described above for Fremont cottonwood-oak woodland and valley foothill riparian woodland would minimize the impacts on these trees. The compensatory mitigation proposed for the permanent loss of cottonwood-oak woodland and valley foothill riparian woodland would include compensation for the loss of trees in those habitats.

Under Alternatives 1 and 1A, the proposed project would also remove up to 126 native oak, 71 native non-oak, and 29 heritage trees that grow in landscaped areas and planted oak woodland areas or individual trees in annual grassland (Figure 10 in Appendix A). Under Alternative 2, the proposed project would remove up to 140 native oak, 72 native non-oak, and 37 heritage trees in these same habitats (Figure 11 in Appendix A). These trees are protected under the County's General Plan policies and tree preservation ordinance, and the oaks are also protected under the City of Rancho Cordova Tree Ordinance.

4.4.2.3 Avoidance and Minimization Efforts

Implementation of Measures 1 and 2 will avoid and minimize impacts on protected trees in the BSA. These measures are described above for Fremont cottonwood-oak woodland in Section 4.1.1.3 and listed below.

Measure 1: Conduct Environmental Awareness Training for Construction Employees

Please see Section 4.1.1.3 for the description of this measure.

Measure 2: Monitor Disturbance of Woody Vegetation and Replant Affected Areas if Necessary

Please see Section 4.1.1.3 for the description of this measure.

4.4.2.4 Compensatory Mitigation

Implementation of Measures 3 and 4 for oak woodlands and valley foothill riparian woodland, respectively, will also compensate for the loss of oaks and other native trees by planting new trees. Implementation of Measure 16 will be necessary to compensate for loss of protected trees in landscaped areas, planted oak woodland, and annual grassland. A total of 226 trees would require mitigation under Alternatives 1 or 1A or 249 trees under Alternative 2.

Measure 16: Compensate for Loss of Protected Trees Outside of Oak Woodland and Riparian Habitats

Based on the arborist survey data, the County will compensate for all protected trees to be removed within the areas mapped as landscaped, planted oak woodland, and annual grassland cover types in the BSA (Appendix A, Figures 10 and 11). Arborist data, including the location, species, diameter of all trunks, approximate height and canopy diameter, and approximate age, will be used in support of a tree permit for removal of the protected trees. All conditions of the tree permit will be implemented.

Compensation will be implemented by a combination of onsite planting, offsite planting, and/or payment into the County's tree preservation fund at the prevailing rate per dbh inch removed. Any offsite planting location will be authorized by the County's Environmental Coordinator.

Compensatory tree planting will be based on the following equivalents:

- One preserved native tree onsite < 6 inches dbh = 1 inch removed dbh
- One D-pot seedling (40 cubic inches or larger) = 1 inch removed dbh
- One 15-gallon tree = 1 inch removed dbh
- One 24-inch box tree = 2 inches removed dbh
- One 36-inch box tree = 3 inches removed dbh

For onsite replacement plantings, if feasible, and/or offsite plantings, the County will prepare a native tree mitigation planting plan, including a species list and number of each species to be removed or preserved, planting locations, and maintenance requirements. Plantings will consist of cuttings taken from local plants or plants grown from local material. Planted species for the mitigation plantings will be the same as those removed from the project area. All plantings will be fitted with exclusion cages or other suitable protection from herbivory. Plantings will be irrigated seasonally for up to 3 years or until established.

The County Department of Planning and Environmental Review will monitor plantings annually for 3 years or as required in the project permits. Oak trees will require additional monitoring every 5 years through 15 years post-planting. To be considered successful, 75 percent of the plants must have survived at the end of the first 3 years, and oak tree canopy coverage must be at least 30% at the end of 15 years. If the survival and canopy criteria are not met at the end of the 3-year and 15-year monitoring periods, respectively, planting and monitoring will be repeated after causes of tree stress or mortality have been identified and corrected.

4.4.2.5 Cumulative Impacts

Cumulative impacts on protected oaks and other native trees would result from construction of other general development projects in Sacramento County. Construction of the proposed project would add to the cumulative loss of protected trees. Implementation of compensatory mitigation, however, would replace protected trees. Therefore, with implementation of measures to avoid and minimize potential impacts on protected trees and planting of native trees as compensatory mitigation, the project would not contribute to cumulatively considerable impacts on protected oaks and other native trees.

4.4.3 Invasive Plant Species

4.4.3.1 Survey Results

Table 3-4 in Chapter 3 lists the invasive plant species identified by CDFA and Cal-IPC that are known to occur in the BSA. No plant species designated as federal noxious weeds have been identified in the BSA. Invasive plant species occur in all plant communities in the BSA, but are more prevalent in annual grassland.

4.4.3.2 Project Impacts

The proposed project would create additional disturbed areas for a temporary period. Areas where temporary disturbance occurs would be more susceptible to colonization or spread of invasive plants. Project features for avoiding the spread in invasive plants during construction will help to prevent the introduction and spread of invasive plants.

4.4.3.3 Avoidance and Minimization Efforts

To avoid and minimize impacts due to invasive plant species in and adjacent to the construction area, Measure 1 will be implemented. This measure is described above for Fremont cottonwood-oak woodland.

Measure 1: Conduct Environmental Awareness Training for Construction Employees

Please see Section 4.1.1.3 for the description of this measure.

4.4.3.4 Compensatory Mitigation

No compensatory mitigation pertaining to invasive plants is required.

4.4.3.5 Cumulative Impacts

Cumulative impacts due to the spread of invasive plant species would result from construction of other general development projects in Sacramento County. Ground disturbance and construction vehicle traffic associated with the proposed project have the potential to add to the introduction and spread of invasive plant species. With implementation of the prescribed avoidance and minimization measures, the proposed project would not substantially contribute to cumulatively considerable impacts related to the spread of invasive plants.

4.4.4 Dispersal/Migration Corridors

4.4.4.1 Survey Results

As discussed in Chapter 3, no Natural Landscape Blocks or ECAs were identified by the CEHC Project in or adjacent to the BSA (California Department of Fish and Wildlife 2016b). This is likely because of the presence of US 50 and the high amount of development in the area. The closest Natural Landscape Block is south of White Rock Road, south of the project. Although no wildlife movement corridors were identified, the jughandle area and surrounding area at the Aerojet property contains a substantial amount of natural land that is used by wildlife. Animals could travel from the south into this area, but would be blocked from further travel by Folsom Boulevard and US 50. Animals may also travel along Alder Creek; however, the high water level created by the MSE wall above the box culvert prevents any crossing of terrestrial wildlife underneath US 50.

4.4.4.2 Project Impacts

Because of the existing amount of development in the surrounding area and the presence of U.S. 50, the BSA provides limited opportunities for animal movement or migration. As described above, animals moving along Alder Creek or through the Aerojet property to the jughandle area of the proposed project are blocked by the presence of the freeway and/or development. Construction activities and presence of construction equipment and personnel are not expected to limit animal movement or migration any greater than already limited by existing development. Because the proposed project area does not provide areas through which animals can travel to other natural areas, the project, once constructed, would not affect wildlife dispersal and migration corridors.

4.4.4.3 Avoidance and Minimization Efforts

Because there would be no impact on wildlife dispersal and migration corridors, no avoidance and minimization measures are necessary.

4.4.4.4 Compensatory Mitigation

Because there would be no impact on wildlife dispersal and migration corridors, no compensatory mitigation is necessary.

4.4.4.5 Cumulative Impacts

Because there would be no impact on wildlife dispersal and migration corridors, the proposed project would not contribute to cumulative impacts on wildlife dispersal and migration.

Chapter 5 Conclusions and Regulatory Determinations

Permits or compliance with the federal and state regulations listed in Table 5-1 may be required either before or during construction of the proposed project.

Table 5-1. Federal and State Regulations Applicable to the Proposed Project

Regulation	Approving Agency
Endangered Species Act Section 7: Consultation and Incidental Take Statement	USFWS
Executive Order 11990: Protection of Wetlands	USFWS
Executive Order 13112: Prevention and Control of Invasive Species	USFWS
Executive Order 13186: Migratory Bird Treaty Act	USFWS
Clean Water Act Section 404: Permit for Placement of Fill	USACE
Clean Water Act Section 401: Water Quality Certification	Central Valley RWQCB
California Fish and Game Code Section 1602: Lake or Streambed Alteration Agreement	CDFW
California Fish and Game Code Sections 3503 and 3503.5: Birds and Raptors	CDFW
California Fish and Game Code Section 3513: Migratory Birds	CDFW
California Fish and Game Code Sections 3511, 4700, 5050, and 5515: Fully Protected Species	CDFW

Summaries of the consultation and coordination efforts and determinations (where applicable) related to these regulations are provided below.

5.1 Federal Endangered Species Act Consultation Summary

A USFWS species list and updated species lists were obtained from the IPaC website on April 4, 2016, March 31, 2017, September 25, 2017, March 2, 2018, and July 10, 2018. A list of threatened and endangered fish species for the Folsom USGS 7.5-minute quadrangle was obtained from NMFS's California Species List Tools website on July 10, 2018. Twelve federally listed species were identified on the species lists as potentially occurring in the proposed project area (Appendix B). Four additional federally listed plants were identified during the CNDDB search as occurring in the project region (Appendix B). Two wildlife species (vernal pool fairy shrimp and valley elderberry longhorn beetle) are federally listed and have the potential to occur in the BSA. As discussed in Chapter 4, effects on vernal pool fairy shrimp are expected to be avoided through project design and avoidance and minimization measures implemented during construction such that the project would have no effect on this species. Caltrans and the County will prepare a Biological Assessment and consult with USFWS under Section 7 for potential effects on valley elderberry longhorn beetle. Table 5-2 lists effect determinations for federally listed species that were identified on the USFWS list or in the CNDDB search results as having the potential to occur in the BSA of the proposed project. No discussions with USFWS have occurred to date.

Table 5-2. Effect Determinations for Federally Listed Species

Species	Effect Determination
Pine Hill ceanothus	No effect
Pine Hill flannelbush	No effect
El Dorado bedstraw	No effect
Layne's ragwort (Layne's butterweed)	No effect
Slender Orcutt grass	No effect
Sacramento Orcutt grass	No effect
Vernal pool fairy shrimp	No effect
Conservancy fairy shrimp	No effect
Vernal pool tadpole shrimp	No effect
Valley elderberry longhorn beetle	Likely to adversely affect
Delta smelt	No effect
Central Valley steelhead DPS	No effect
Central Valley spring-run Chinook Salmon ESU	No effect
California tiger salamander	No effect
California red-legged frog	No effect
Giant garter snake	No effect

5.2 California Endangered Species Act Consultation Summary

One species that is state listed (Swainson's hawk) and one that is a candidate for listing (tricolored blackbird) have the potential to occur in the BSA and may be affected by the proposed project. With implementation of avoidance and minimization measures and compensation described in Chapter 4, impacts on Swainson's hawk and tricolored blackbird are expected to be minimized and fully mitigated. The need for a 2081 incidental take permit from CDFW is not anticipated. No discussions with CDFW have occurred to date.

5.3 Wetlands and Other Waters Coordination Summary

The BSA contains two types of wetlands and three types of non-wetland waters that are considered waters of the United States and waters of the State. As indicated in Chapter 4, the proposed project would result in placement of fill in these waterbodies. Therefore, Caltrans and the County will comply with the Clean Water Act by obtaining permits from the Sacramento District of the USACE, and with the Porter-Cologne Water Quality Control Act by obtaining a permit from the Central Valley RWQCB before discharging fill into, or excavating within, federally and state-regulated waters and wetlands. In addition, requirements of the CWA Section 404 permit for wetland and non-wetland waters compensation will be implemented.

5.4 Invasive Species

With implementation of the avoidance and minimization measures described in Chapter 4, the proposed project is not anticipated to increase or decrease the area currently occupied by invasive plants or the potential for spreading invasive plant species.

5.5 Other

5.5.1 Migratory Bird Treaty Act

Several non-special-status migratory birds, including red-tailed hawk, Anna's hummingbird, and acorn woodpecker, could nest on the ground or in shrubs or trees in and adjacent to the BSA. Implementation of avoidance and minimization measures, as discussed in Chapter 4, would avoid or minimize potential impacts on nesting migratory birds.

5.5.2 Protected Trees

The BSA includes oak trees and other native trees in Fremont cottonwood-oak woodland and valley foothill riparian habitat, as well as protected native trees that occur in landscaped areas, planted oak woodland, and annual grassland. With implementation of the avoidance and minimization efforts and compensatory mitigation described in Chapter 4 for Fremont cottonwood-oak woodland, valley foothill riparian woodland, and protected trees, the proposed project would minimize impacts on protected trees and compensate for the unavoidable loss of protected trees in the BSA.

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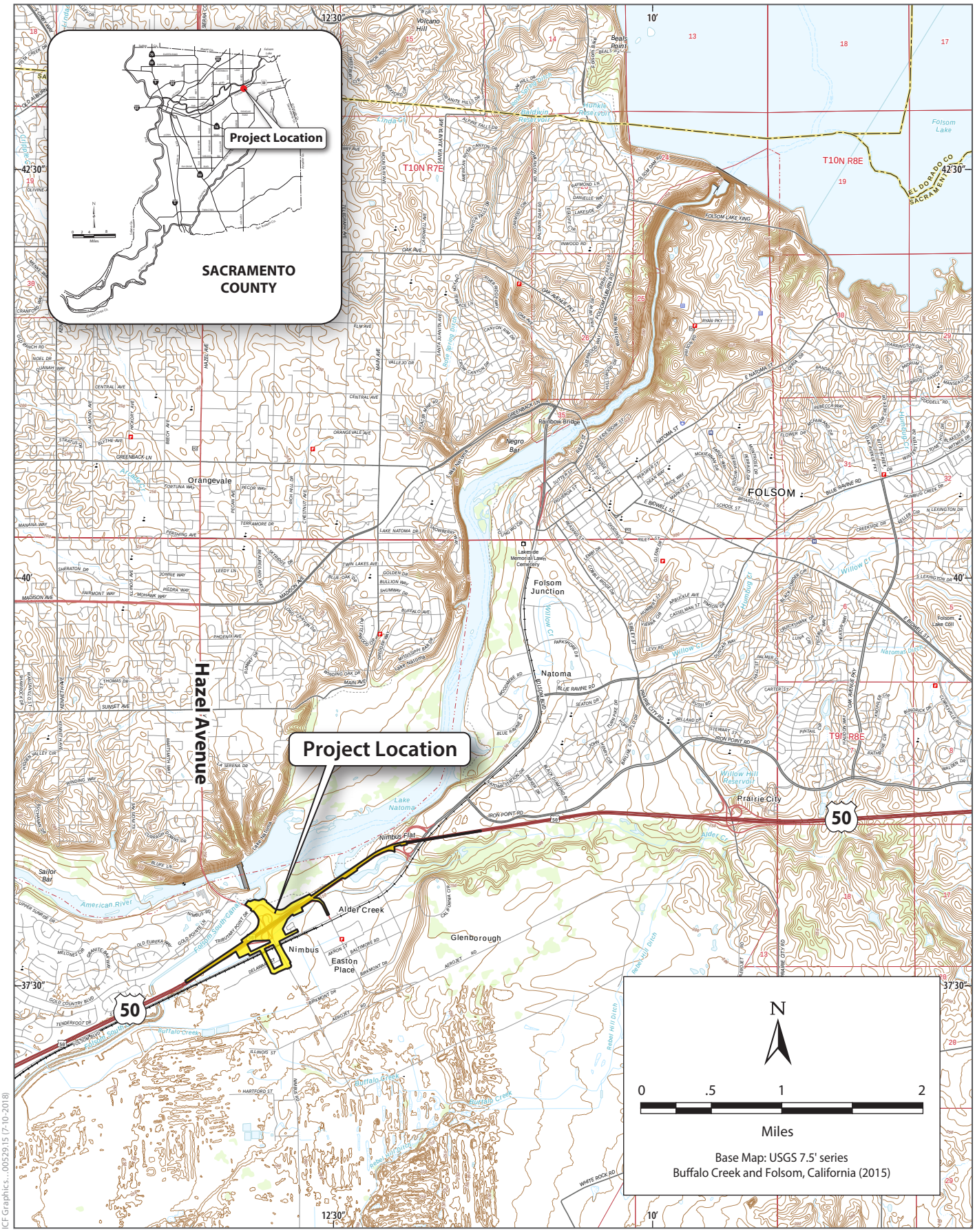
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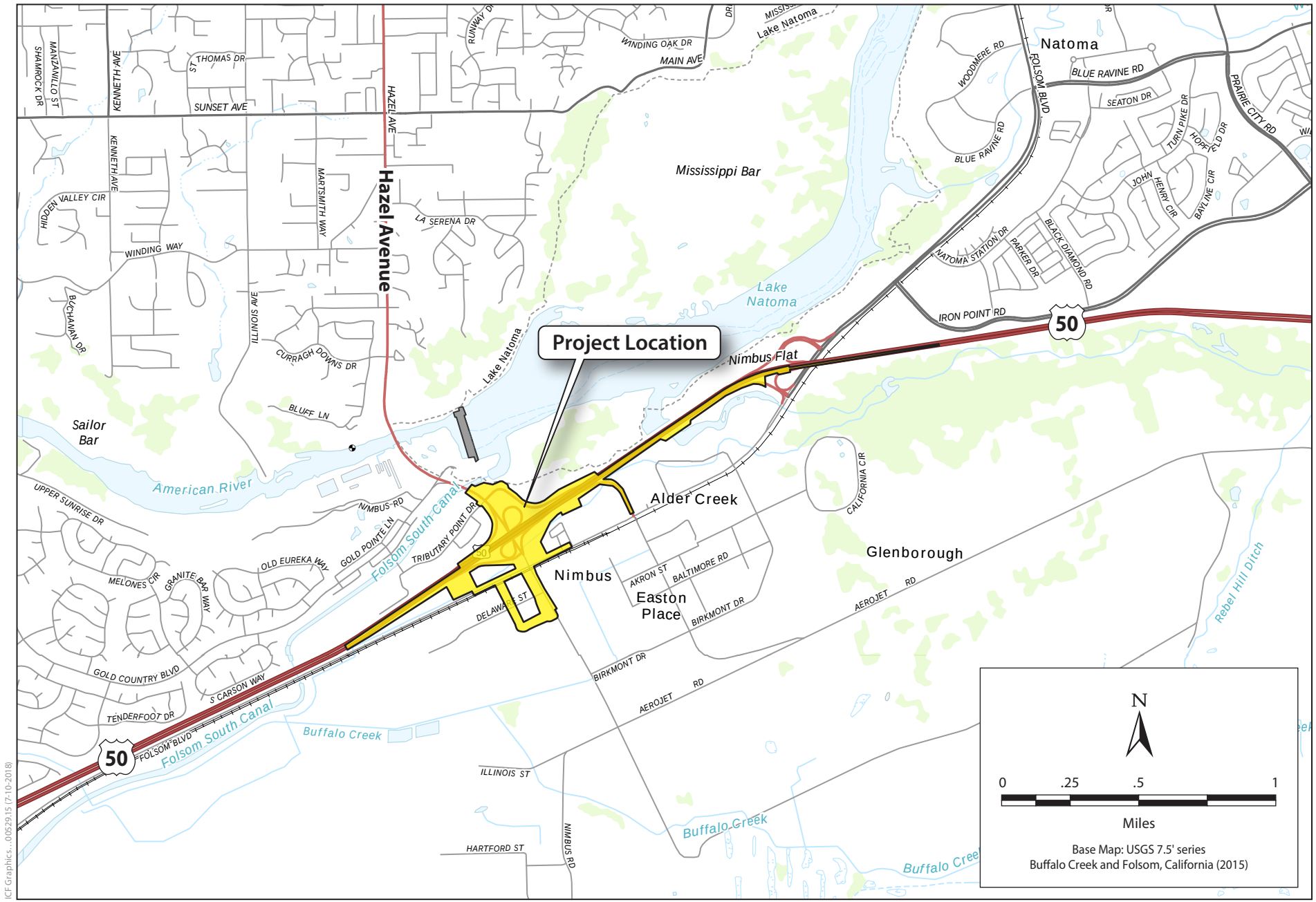
Nagao, Michelle. 2016. Environmental Analyst, Sacramento County Development Department. July 14, 2016–Phone call to discuss County's regulation of protected trees and monitoring of its own projects.

Appendix A Figures



ICF Graphics...0052915 (7-10-2018)

Figure 1
Project Vicinity



ICF Graphics...00529.15 (7-10-2018)

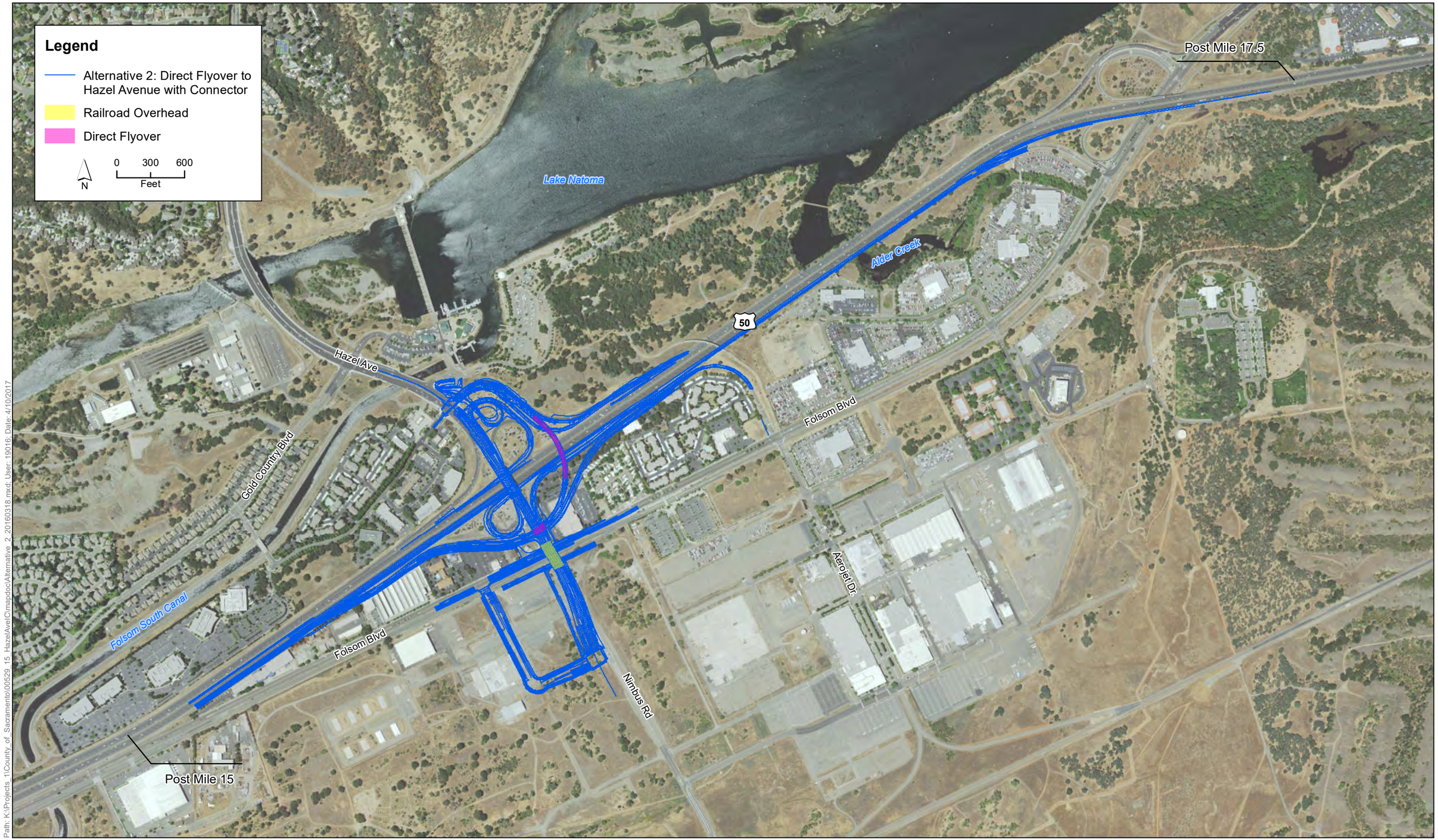
Figure 2
Project Location



Figure 3
Alternative 1: L-9 Interchange with Viaduct Connector
U.S. 50/Hazel Avenue Interchange Project



Figure 4
Alternative 1a: L-9 Interchange with Undercrossing Connector
U.S. 50/Hazel Avenue Interchange Project



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Figure 5
Alternative 2: Direct Flyover to Hazel Avenue with Connector
U.S. 50/Hazel Avenue Interchange Project



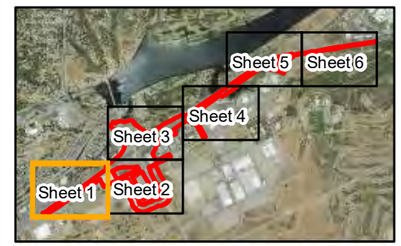
Hazel Avenue / U.S. 50 Interchange Project
May 2018
Sheet 1 of 5

Legend

Biological Study Area (88 Acres)

Landcover

- Annual Grassland
- Developed
- Landscaped



0 50 100 200
Feet

1 inch = 200 feet

Notes:

Base Map Source: ICF and ECORP
Imagery Source: NAIP 2014
USGS Topo Quad: Folsom and Buffalo Creek
PLSS: Rio De Los Americanos Land Grant

Prepared By: ICF International
Delineated By: L. Webber
Delineation Date: May 31. 2016
Drawn By: A. Angier

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Figure 6
Land Cover and Biological Resources

121°13'10"W
121°13'0"W
121°12'50"W
38°37'40"N
38°37'30"N
50
Folsom Blvd
Nimbus Rd
1
4
5
6
7
8
9
10
11
12
See Inset
Inset Map

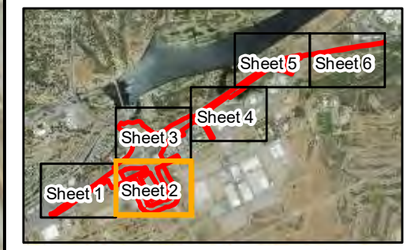
Hazel Avenue / U.S. 50 Interchange Project
May 2018
Sheet 2 of 5

Legend

- Biological Study Area (88 Acres)
- Indirect Effects Area for Branchiopods (29 Acres)
- Elderberry Shrub
- Red-tailed Hawk Nest

Landcover

- Annual Grassland
- Developed
- Ditch
- Landscaped
- Fremont Cottonwood-Oak Woodland
- Planted Oak Woodland
- Seasonal Wetland



0 50 100 200
Feet
1 inch = 200 feet

Notes:
Base Map Source: ICF and ECORP
Imagery Source: NAIP 2014
USGS Topo Quad: Folsom and Buffalo Creek
PLSS: Rio De Los Americanos Land Grant

Prepared By: ICF International
Delineated By: L. Webber
Delineation Date: May 31. 2016
Drawn By: A. Angier

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Figure 6
Land Cover and Biological Resources



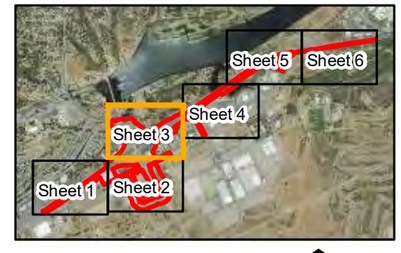
Hazel Avenue / U.S. 50 Interchange Project
May 2018
Sheet 3 of 5

Legend

- Biological Study Area (88 Acres)
- Elderberry Shrub

Landcover

- Annual Grassland
- Developed
- Landscaped
- Canal
- Planted Oak Woodland
- Seasonal Wetland



0 50 100 200
Feet
1 inch = 200 feet

Notes:
Base Map Source: ICF and ECORP
Imagery Source: NAIP 2014
USGS Topo Quad: Folsom and Buffalo Creek
PLSS: Rio De Los Americanos Land Grant

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Delineation Date: May 31. 2016
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Figure 6
Land Cover and Biological Resources

121°12'40"W
121°12'30"W
121°12'20"W
121°12'10"W
38°38'10"N
38°38'0"N
50
Alder Creek
Folsom Blvd

Hazel Avenue / U.S. 50 Interchange Project
May 2018
Sheet 4 of 5

Legend

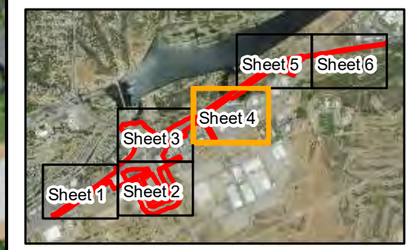
- Biological Study Area (88 Acres)

Western Pond Turtle Habitat

- Aquatic
- Upland

Landcover

- Annual Grassland
- Developed
- Ditch
- Emergent Wetland
- Landscaped
- Perennial Drainage
- Perennial Drainage (Culverted)
- Valley Foothill Riparian



0 50 100 200
Feet
1 inch = 200 feet

Notes:

Base Map Source: ICF and ECORP
Imagery Source: NAIP 2014
USGS Topo Quad: Folsom and Buffalo Creek
PLSS: Rio De Los Americanos Land Grant

Prepared By: ICF International
Delineated By: L. Webber
Delineation Date: May 31. 2016
Drawn By: A. Angier

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Figure 6
Land Cover and Biological Resources

121°12'20"W
121°12'10"W
121°12'0"W
121°11'50"W
38°38'30"N
38°38'20"N
50
Folsom Blvd
3

Hazel Avenue / U.S. 50 Interchange Project
May 2018
Sheet 5 of 5

Legend

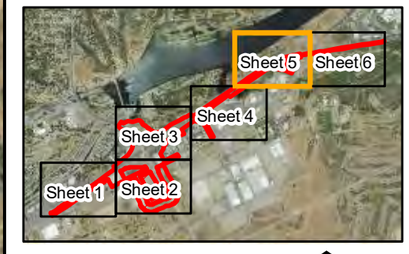
- Biological Study Area (88 Acres)
- Elderberry Shrub

Western Pond Turtle Habitat

- Upland

Landcover

- Annual Grassland
- Developed
- Ditch
- Ephemeral Drainage



0 50 100 200
Feet
1 inch = 200 feet

Notes:
Base Map Source: ICF and ECORP
Imagery Source: NAIP 2014
USGS Topo Quad: Folsom and Buffalo Creek
PLSS: Rio De Los Americanos Land Grant

Prepared By: ICF International
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Figure 6
Land Cover and Biological Resources

121°11'40"W

121°11'30"W

121°11'20"W

38°38'30"N

38°38'20"N

Hazel Avenue / U.S. 50 Interchange Project
May 2018
Sheet 6 of 5

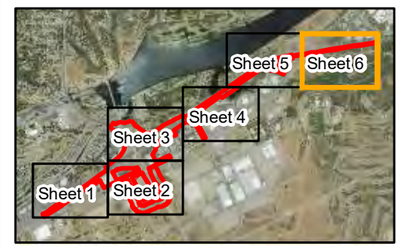
Legend

Biological Study Area (88 Acres)

Landcover

Annual Grassland

Developed



0 50 100 200
Feet

1 inch = 200 feet

Notes:

Base Map Source: ICF and ECORP
Imagery Source: NAIP 2014
USGS Topo Quad: Folsom and Buffalo Creek
PLSS: Rio De Los Americanos Land Grant

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Figure 6
Land Cover and Biological Resources

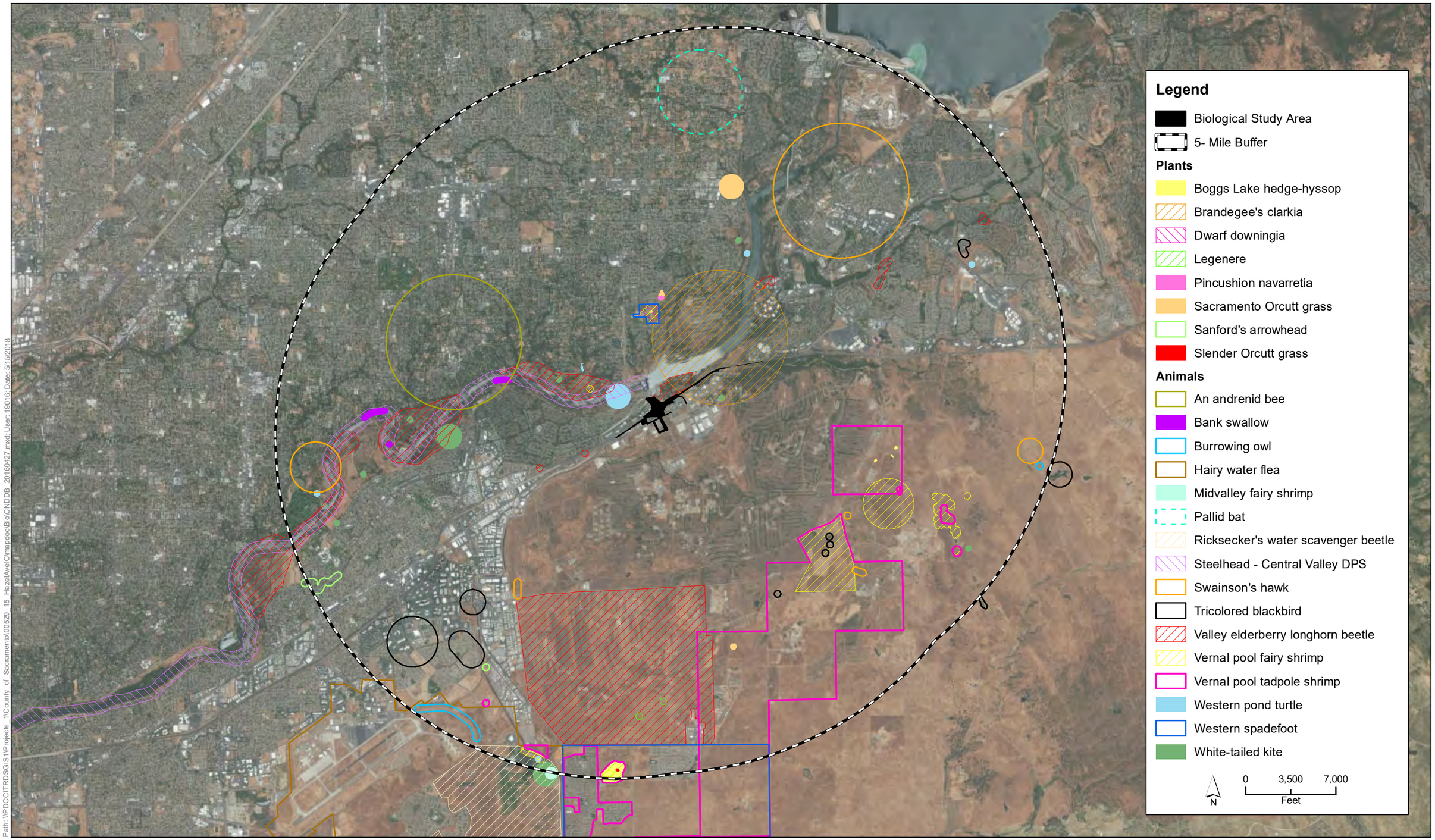


Figure 7
California Natural Diversity Database Records within 5-miles of the Biological Study Area



Hazel Avenue / U.S. 50 Interchange Project
April 2018
Sheet 1 of 6

Legend

Biological Study Area

Alternatives 1 and 1A

Permanent Impact

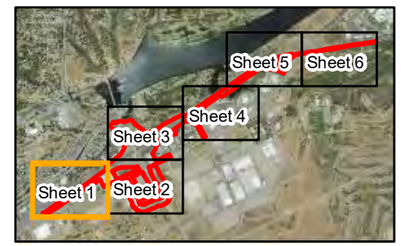
Temporary Impact

Landcover

Annual Grassland

Developed

Landscaped



0 50 100 200
Feet

1 inch = 200 feet

Notes:

Base Map Source: ICF and ECORP
Imagery Source: NAIP 2014
USGS Topo Quad: Folsom and Buffalo Creek
PLSS: Rio De Los Americanos Land Grant

Prepared By: ICF International
Delineated By: L. Webber
Delineation Date: May 31. 2016
Drawn By: A. Angier

Path: \\P\DCC\TRDSci\S1\Projects_1\County_of_Sacramento\100529_15_Hazel/AvelC\map\doc\Bio\Alt_1_Impacts_Bio_Resources_20160906.mxd; Author: ; Date: 5/2/2018

Figure 8
Impacts on Land Cover and Biological Resources
Alternatives 1 and 1A

121°13'10"W
121°13'0"W
121°12'50"W
38°37'40"N
38°37'30"N
50
Folsom Blvd
Nimbus Rd
1
4
5
6
7
8
9
10
11
12

Hazel Avenue / U.S. 50 Interchange Project
April 2018
Sheet 2 of 6

Legend

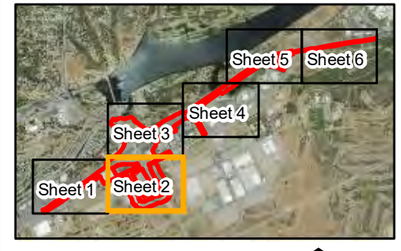
- Biological Study Area

Alternatives 1 and 1A

- Permanent Impact
- Temporary Impact
- Elderberry Shrub
- Red-tailed Hawk Nest

Landcover

- Annual Grassland
- Developed
- Ditch
- Landscaped
- Fremont Cottonwood-Oak Woodland
- Planted Oak Woodland
- Seasonal Wetland



0 50 100 200
Feet
1 inch = 200 feet

Notes:
Base Map Source: ICF and ECORP
Imagery Source: NAIP 2014
USGS Topo Quad: Folsom and Buffalo Creek
PLSS: Rio De Los Americanos Land Grant

Prepared By: ICF International
Delineated By: L. Webber
Delineation Date: May 31. 2016
Drawn By: A. Angier

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Figure 8
Impacts on Land Cover and Biological Resources
Alternatives 1 and 1A

121°13'10"W
121°13'0"W
121°12'50"W
38°38'0"N
38°37'50"N
Hazel Ave
Folsom Blvd
50
2
13

Hazel Avenue / U.S. 50 Interchange Project
April 2018
Sheet 3 of 6

Legend

Biological Study Area

Alternatives 1 and 1A

Permanent Impact

Temporary Impact

Elderberry Shrub

Landcover

Annual Grassland

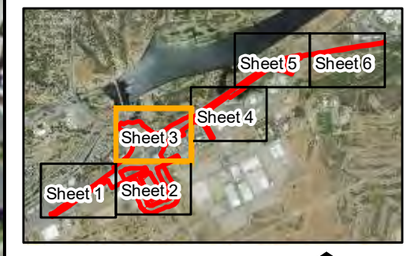
Canal

Developed

Landscaped

Planted Oak Woodland

Seasonal Wetland



0 50 100 200
Feet
1 inch = 200 feet

Notes:

Base Map Source: ICF and ECORP
Imagery Source: NAIP 2014
USGS Topo Quad: Folsom and Buffalo Creek
PLSS: Rio De Los Americanos Land Grant

Prepared By: ICF International
Delineated By: L. Webber
Delineation Date: May 31. 2016
Drawn By: A. Angier

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Figure 8
Impacts on Land Cover and Biological Resources
Alternatives 1 and 1A

121°12'40"W
121°12'30"W
121°12'20"W
121°12'10"W
38°38'10"N
38°38'0"N
Alder Creek
50
Folsom Blvd

Hazel Avenue / U.S. 50 Interchange Project
April 2018
Sheet 4 of 6

Legend

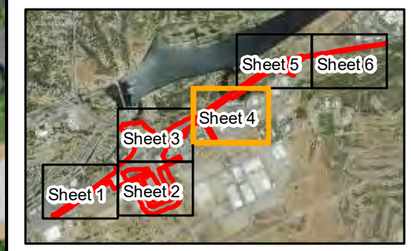
- Biological Study Area

Alternatives 1 and 1A

- Permanent Impact
- Temporary Impact

Landcover

- Annual Grassland
- Developed
- Ditch
- Emergent Wetland
- Landscaped
- Perennial Drainage
- Perennial Drainage (Culverted)
- Valley Foothill Riparian



0 50 100 200
Feet
1 inch = 200 feet

Notes:

Base Map Source: ICF and ECORP
Imagery Source: NAIP 2014
USGS Topo Quad: Folsom and Buffalo Creek
PLSS: Rio De Los Americanos Land Grant

Prepared By: ICF International
Delineated By: L. Webber
Delineation Date: May 31. 2016
Drawn By: A. Angier

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Figure 8
Impacts on Land Cover and Biological Resources
Alternatives 1 and 1A

121°12'20"W
121°12'10"W
121°12'0"W
121°11'50"W
38°38'30"N
38°38'20"N
50
Folsom Blvd
3

Hazel Avenue / U.S. 50 Interchange Project
April 2018
Sheet 5 of 6

Legend

Biological Study Area

Alternatives 1 and 1A

Permanent Impact

Temporary Impact

Elderberry Shrub

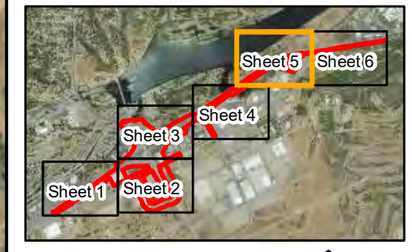
Landcover

Annual Grassland

Developed

Ditch

Ephemeral Drainage



0 50 100 200
Feet
1 inch = 200 feet

N

Notes:
Base Map Source: ICF and ECORP
Imagery Source: NAIP 2014
USGS Topo Quad: Folsom and Buffalo Creek
PLSS: Rio De Los Americanos Land Grant

Prepared By: ICF International
Delineated By: L. Webber
Delineation Date: May 31. 2016
Drawn By: A. Angier

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Figure 8
Impacts on Land Cover and Biological Resources
Alternatives 1 and 1A

121°11'40"W

121°11'30"W

121°11'20"W

38°38'30"N

38°38'20"N

Hazel Avenue / U.S. 50 Interchange Project
April 2018
Sheet 6 of 6

Legend

Biological Study Area

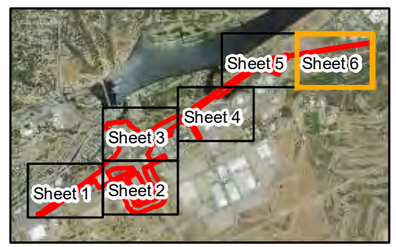
Alternatives 1 and 1A

Permanent Impact

Landcover

Annual Grassland

Developed



0 50 100 200
Feet

1 inch = 200 feet

Notes:

Base Map Source: ICF and ECORP
Imagery Source: NAIP 2014
USGS Topo Quad: Folsom and Buffalo Creek
PLSS: Rio De Los Americanos Land Grant

Prepared By: ICF International
Delineated By: L. Webber
Delineation Date: May 31. 2016
Drawn By: A. Angier

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Figure 8
Impacts on Land Cover and Biological Resources
Alternatives 1 and 1A



Hazel Avenue / U.S. 50 Interchange Project
April 2018
Sheet 1 of 6

Legend

Biological Study Area

Alternative 2

Permanent

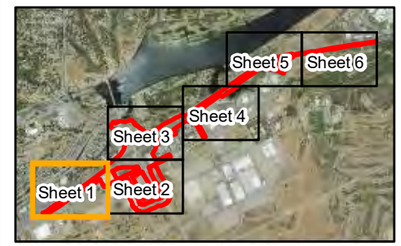
Temporary

Landcover

Annual Grassland

Developed

Landscaped



0 50 100 200
Feet

1 inch = 200 feet

Notes:

Base Map Source: ICF and ECORP
Imagery Source: NAIP 2014
USGS Topo Quad: Folsom and Buffalo Creek
PLSS: Rio De Los Americanos Land Grant

Prepared By: ICF International
Delineated By: L. Webber
Delineation Date: May 31. 2016
Drawn By: A. Angier

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Figure 9
Impacts on Land Cover and Biological Resources
Alternative 2

121°13'10"W
121°13'0"W
121°12'50"W
38°37'40"N
38°37'30"N
50
Folsom Blvd
Nimbus Rd
1
4
5
6
7
8
9
10
11
12

Hazel Avenue / U.S. 50 Interchange Project
April 2018
Sheet 2 of 6

Legend

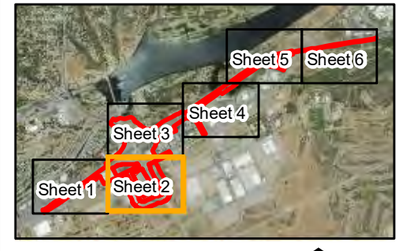
- Biological Study Area

Alternative 2

- Permanent
- Temporary
- Elderberry Shrub
- Red-tailed Hawk Nest

Landcover

- Annual Grassland
- Developed
- Ditch
- Landscaped
- Fremont Cottonwood-Oak Woodland
- Planted Oak Woodland
- Seasonal Wetland



0 50 100 200
Feet
1 inch = 200 feet

Notes:
Base Map Source: ICF and ECORP
Imagery Source: NAIP 2014
USGS Topo Quad: Folsom and Buffalo Creek
PLSS: Rio De Los Americanos Land Grant

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Figure 9
Impacts on Land Cover and Biological Resources
Alternative 2

121°13'10"W
121°13'0"W
121°12'50"W
38°38'0"N
38°37'50"N
Hazel Ave
50
Folsom Blvd
2
13

Hazel Avenue / U.S. 50 Interchange Project
April 2018
Sheet 3 of 6

Legend

Biological Study Area

Alternative 2

Permanent

Temporary

Elderberry Shrub

Landcover

Annual Grassland

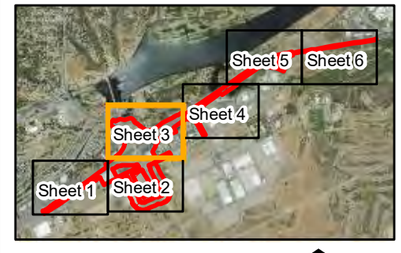
Canal

Developed

Landscaped

Planted Oak Woodland

Seasonal Wetland



0 50 100 200
Feet
1 inch = 200 feet

Notes:

Base Map Source: ICF and ECORP
Imagery Source: NAIP 2014
USGS Topo Quad: Folsom and Buffalo Creek
PLSS: Rio De Los Americanos Land Grant

Prepared By: ICF International
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Drawn By: A. Angier

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Figure 9
Impacts on Land Cover and Biological Resources
Alternative 2

121°12'40"W
121°12'30"W
121°12'20"W
121°12'10"W
38°38'10"N
38°38'0"N
50
Alder Creek
Folsom Blvd

Hazel Avenue / U.S. 50 Interchange Project
April 2018
Sheet 4 of 6

Legend

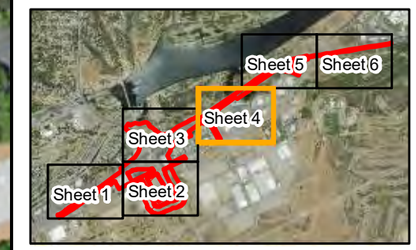
- Biological Study Area

Alternative 2

- Permanent
- Temporary

Landcover

- Annual Grassland
- Developed
- Ditch
- Emergent Wetland
- Landscaped
- Perennial Drainage
- Perennial Drainage (Culverted)
- Valley Foothill Riparian



0 50 100 200
Feet
1 inch = 200 feet

Notes:

Base Map Source: ICF and ECORP
Imagery Source: NAIP 2014
USGS Topo Quad: Folsom and Buffalo Creek
PLSS: Rio De Los Americanos Land Grant

Prepared By: ICF International
Delineated By: L. Webber
Delineation Date: May 31. 2016
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Path: \\PDCCITRDSGIS1\Projects_1\County_of_Sacramento\c000529_15_HazelAve1\Cmap\docBIO\Alt_2_Impacts_Bio_Resources_20160906.mxd; Author: ; Date: 5/2/2018

Figure 9
Impacts on Land Cover and Biological Resources
Alternative 2

121°12'20"W
121°12'10"W
121°12'0"W
121°11'50"W
38°38'30"N
38°38'20"N
50
Folsom Blvd
3

Hazel Avenue / U.S. 50 Interchange Project
April 2018
Sheet 5 of 6

Legend

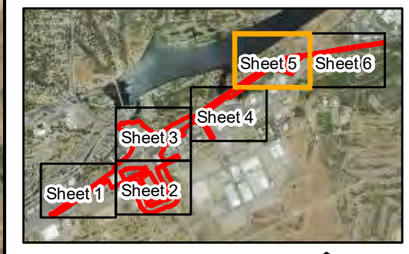
Biological Study Area

Alternative 2

Permanent
Temporary
Elderberry Shrub

Landcover

Annual Grassland
Developed
Ditch
Ephemeral Drainage



0 50 100 200
Feet
1 inch = 200 feet

Notes:
Base Map Source: ICF and ECORP
Imagery Source: NAIP 2014
USGS Topo Quad: Folsom and Buffalo Creek
PLSS: Rio De Los Americanos Land Grant

Prepared By: ICF International
Delineated By: L. Webber
Delineation Date: May 31. 2016
Drawn By: A. Angier

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Figure 9
Impacts on Land Cover and Biological Resources
Alternative 2



Hazel Avenue / U.S. 50 Interchange Project
April 2018
Sheet 6 of 6

Legend

Biological Study Area

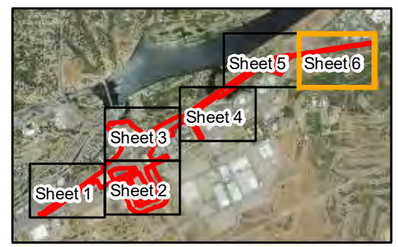
Alternative 2

Permanent

Landcover

Annual Grassland

Developed



0 50 100 200
Feet

1 inch = 200 feet

Notes:

Base Map Source: ICF and ECORP
Imagery Source: NAIP 2014
USGS Topo Quad: Folsom and Buffalo Creek
PLSS: Rio De Los Americanos Land Grant

Prepared By: ICF International
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Delineation Date: May 31. 2016
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Figure 9
Impacts on Land Cover and Biological Resources
Alternative 2

121°13'40"W

121°13'30"W

38°37'30"N

Hazel Avenue/U.S. 50 Interchange Project
April 2018
Sheet 1 of 16

Legend

- Project Boundary
- City of Rancho Cordova (within Project Area)

Tree Type

- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

N

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: \\PDCCITRDSGIS1\Projects_1\County_of_Sacramento\100529_15_HazelAve\CIP\mapdoc\Bio\Arborist_Report_Att1_2018.mxd; Author: ; Date: 5/2/2018

Figure 10
Impacts on Protected Trees - Alternatives 1 and 1A
NES

121°13'30"W

121°13'20"W

38°37'40"N

Hazel Avenue/U.S. 50 Interchange Project
April 2018
Sheet 2 of 16

Legend

- Project Boundary
- City of Rancho Cordova (within Project Area)

Tree Type

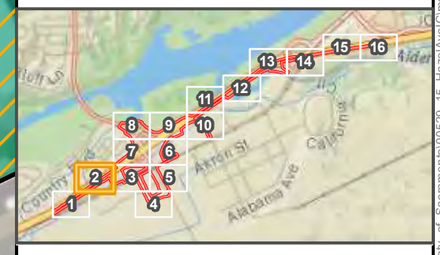
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: \\PDCIITRDSGIS1\Projects_1\County_of_Sacramento\v00529_15_HazelAve\Cmaps\doc\BioArborist_Report__Alt1_2018.mxd; Author: ; Date: 5/2/2018

Figure 10
Impacts on Protected Trees - Alternatives 1 and 1A
NES



Hazel Avenue/U.S. 50 Interchange Project
April 2018
Sheet 3 of 16

Legend

- Project Boundary
- City of Rancho Cordova (within Project Area)

Tree Type

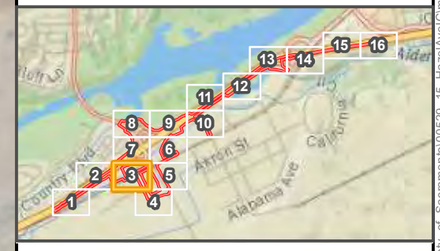
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: \\PDCIITRDSGIS1\Projects_1\County_of_Sacramento\c0100529_15_HazelAve\Mxd\doc\BioArborist_Report_Alt1_2018.mxd; Author: ; Date: 5/2/2018

Figure 10
Impacts on Protected Trees - Alternatives 1 and 1A
NES



Hazel Avenue/U.S. 50 Interchange Project
April 2018
Sheet 4 of 16

Legend

- Project Boundary
- City of Rancho Cordova (within Project Area)

Tree Type

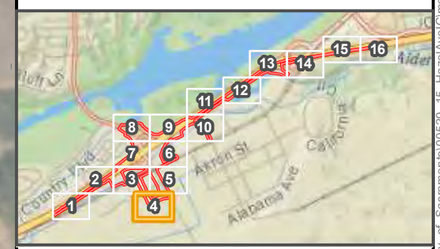
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: \\PDCCITRDSGIS1\Projects_1\County_of_Sacramento\100529_15_HazelAve\CIP\mapdoc\Bio\Arborist_Report_Att1_2018.mxd; Author: ; Date: 5/2/2018

Figure 10
Impacts on Protected Trees - Alternatives 1 and 1A
NES

121°12'50"W

38°37'40"N

668 669 1243 670 671 672 673 674 675 676 677 678 679 680 681 682 683 684 685 686 687

Inaccesible area (2)

Hazel Avenue/U.S. 50 Interchange Project
April 2018
Sheet 5 of 16

Legend

- Project Boundary
- City of Rancho Cordova (within Project Area)

Tree Type

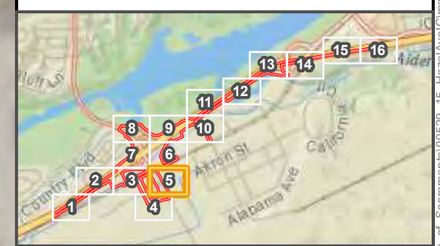
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

N

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: \\PDOCIT\RDSGIS1\Projects_1\County_of_Sacramento\100529_15_HazelAve\CImaps\doc\Bio\Arborist_Report_Att1_2018.mxd; Author: ; Date: 5/2/2018

Figure 10
Impacts on Protected Trees - Alternatives 1 and 1A
NES

121°12'50"W

38°37'50"N

Hazel Avenue/U.S. 50 Interchange Project
April 2018
Sheet 6 of 16

Legend

- Project Boundary
- City of Rancho Cordova (within Project Area)

Tree Type

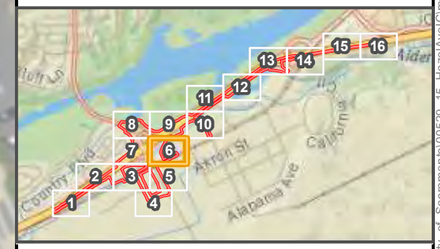
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

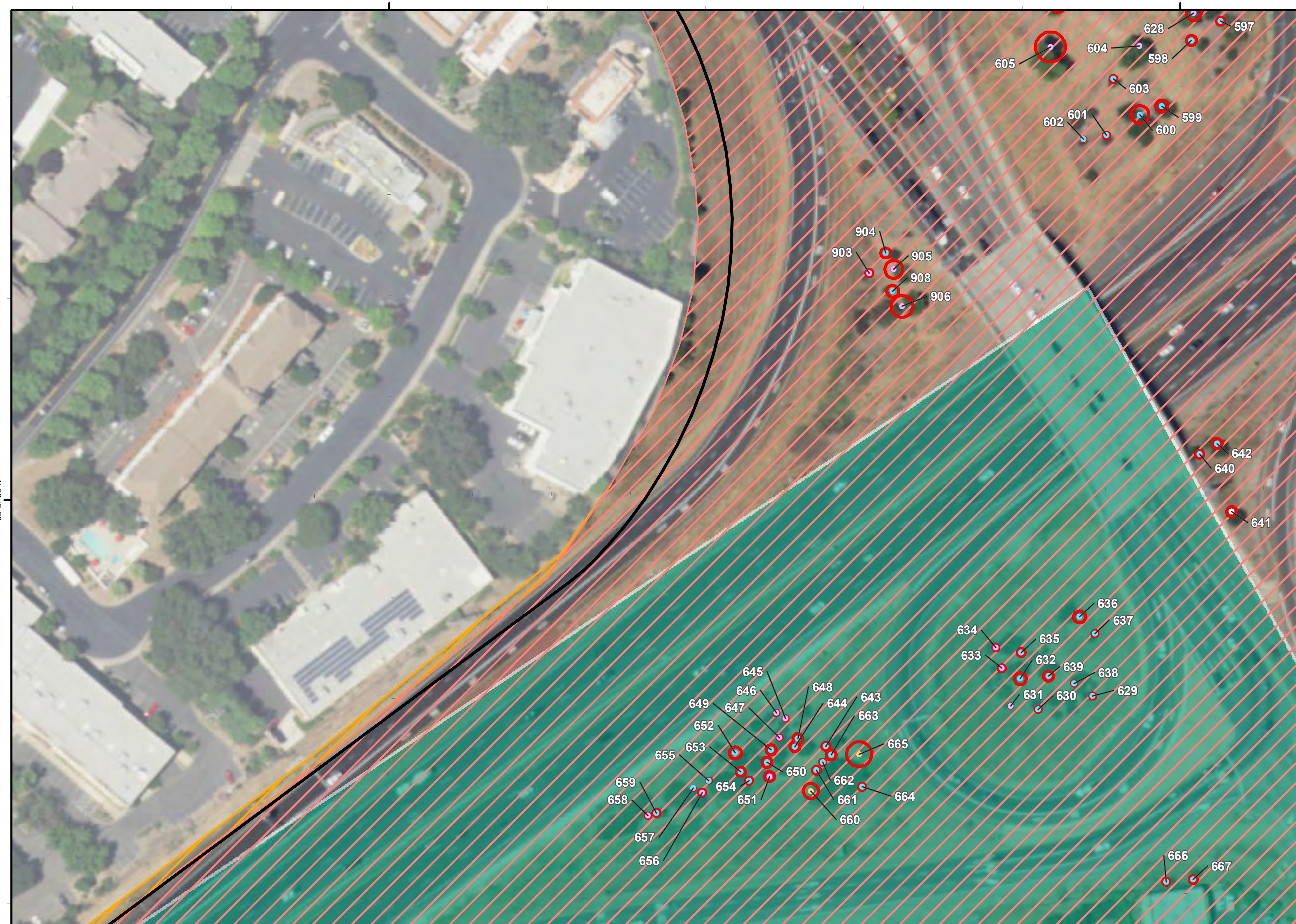
Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: \\PDCCITRDSGIS1\Projects_1\County_of_Sacramento\c000529_15_HazelAve\Cmaps\doc\BioArborist_Report_Att1_2018.mxd; Author: ; Date: 5/2/2018

Figure 10
Impacts on Protected Trees - Alternatives 1 and 1A
NES

Hazel Avenue/U.S. 50 Interchange Project
April 2018
Sheet 7 of 16



Legend

Project Boundary

City of Rancho Cordova (within Project Area)

Tree Type

Heritage (Native Oak)

Native Tree

Native Oak

Nonnative Tree

Canopy Impact

No Impact

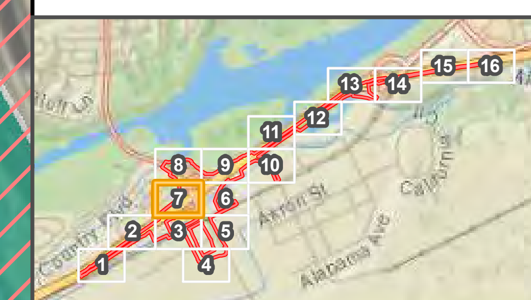
Permanent Impact

Temporary Impact

Impact Areas

Permanent Impact

Temporary Impact



0 50 100
Feet
1 inch = 100 feet

N

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: \\PDCCITRDSGIS1\Projects_1\County_of_Sacramento\00529_15_HazelAve\Cmapdoc\Bio\Arborist_Report__Alt1_2018.mxd; Author: ; Date: 5/2/2018

Figure 10
Impacts on Protected Trees - Alternatives 1 and 1A
NES

121°13'10"W

121°13'0"W

38°38'0"N

Hazel Avenue/U.S. 50 Interchange Project
April 2018
Sheet 8 of 16

Legend

- Project Boundary
- City of Rancho Cordova (within Project Area)

Tree Type

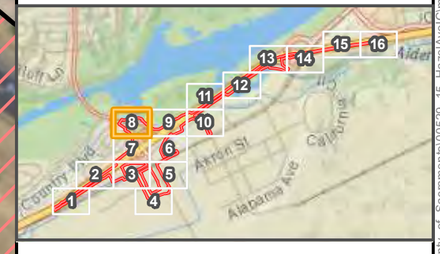
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

N

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: \\PDC\CITRDS\GIS\Projects_1\County_of_Sacramento\100529_15_HazelAve\Cmapdoc\BioArborist_Report__Alt1_2018.mxd; Author: ; Date: 5/2/2018

Figure 10
Impacts on Protected Trees - Alternatives 1 and 1A
NES

121°12'50"W

38°38'0"N

Hazel Avenue/U.S. 50 Interchange Project
April 2018
Sheet 9 of 16

Legend

- Project Boundary
- City of Rancho Cordova (within Project Area)

Tree Type

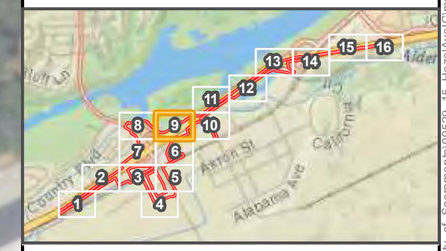
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

N

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: \\PDCIITRDStGIS1\Projects_1\County_of_Sacramento\100529_15_HazelAve\Cmaps\doc\BioArborist_Report_Alt1_2018.mxd; Author: ; Date: 5/2/2018

Figure 10
Impacts on Protected Trees - Alternatives 1 and 1A
NES

121°12'40"W

121°12'30"W

38°36'0"N

Hazel Avenue/U.S. 50 Interchange Project
April 2018
Sheet 10 of 16

Legend

- Project Boundary
- City of Rancho Cordova (within Project Area)

Tree Type

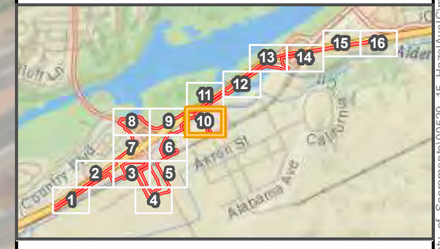
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: \\PDC\TRDS\GIS1\Projects_1\County_of_Sacramento\100529_15_HazelAve\Cfmaptoc\Bio\Arborist_Report__Alt1_2018.mxd; Author: ; Date: 5/2/2018

Figure 10
Impacts on Protected Trees - Alternatives 1 and 1A
NES

121°12'40"W

121°12'30"W

38°38'10"N

876

875

874

873

Hazel Avenue/U.S. 50 Interchange Project
April 2018
Sheet 11 of 16

Legend

- Project Boundary
- City of Rancho Cordova (within Project Area)

Tree Type

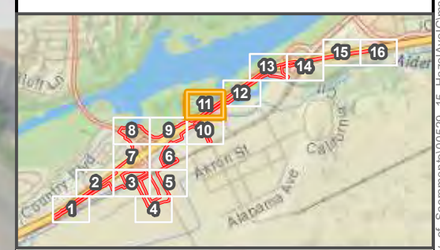
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

N

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: \\PDCCITRDSGIS1\Projects_1\County_of_Sacramento\d0100529_15_HazelAve\CIP\mapdoc\Bio\Arborist_Report_Att1_2018.mxd; Author: ; Date: 5/2/2018

Figure 10
Impacts on Protected Trees - Alternatives 1 and 1A
NES

121°12'20"W

121°12'10"W

38°38'10"N

929
928
927
926
925
915
5b
923
917
918
919
920
921
922
914
913
912
911
910
909

Hazel Avenue/U.S. 50 Interchange Project
April 2018
Sheet 12 of 16

Legend

- Project Boundary
- City of Rancho Cordova (within Project Area)

Tree Type

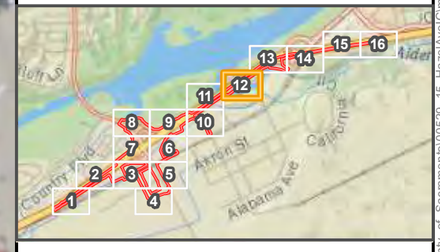
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

N

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: \\PDCCITRDSclS1\Projects_1\County_of_Sacramento\v00529_15_HazelAve\Cmaps\cdcBioArborist_Report_Alt1_2018.mxd; Author: ; Date: 5/2/2018

Figure 10
Impacts on Protected Trees - Alternatives 1 and 1A
NES

121°12'10"W

121°12'0"W

38°38'20"N

Hazel Avenue/U.S. 50 Interchange Project
April 2018
Sheet 13 of 16

Legend

- Project Boundary
- City of Rancho Cordova (within Project Area)

Tree Type

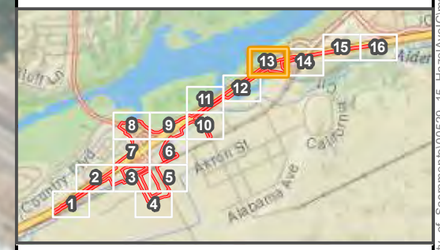
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: \\PDCCITRDSclS1\Projects_1\County_of_Sacramento\v00529_15_HazelAve\Cmaps\doc\BioArborist_Report__Alt1_2018.mxd; Author: ; Date: 5/2/2018

Figure 10
Impacts on Protected Trees - Alternatives 1 and 1A
NES

121°11'50"W

38°38'20"N

Hazel Avenue/U.S. 50 Interchange Project
April 2018
Sheet 14 of 16

Legend

- Project Boundary
- City of Rancho Cordova (within Project Area)

Tree Type

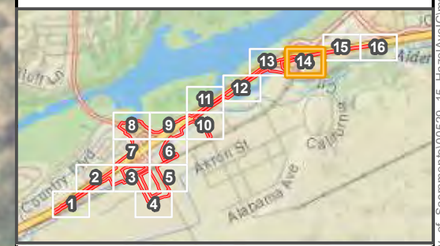
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

N

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: \\PDC\CTRDS\GIS\Projects_1\County_of_Sacramento\100529_15_HazelAve\Cmapdoc\BioArborist_Report__Att1_2018.mxd; Author: ; Date: 5/2/2018

Figure 10
Impacts on Protected Trees - Alternatives 1 and 1A
NES

121°11'40"W

121°11'30"W

38°38'30"N

Inaccesible area (3)

Hazel Avenue/U.S. 50 Interchange Project
April 2018
Sheet 15 of 16

Legend

- Project Boundary
- City of Rancho Cordova (within Project Area)

Tree Type

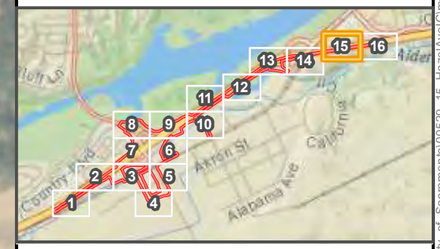
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: \\PDCIT\RDSGIS1\Projects_1\County_of_Sacramento\600529_15_HazelAve\CimeapdocBIo\Arborist_Report_Alt1_2018.mxd; Author: ; Date: 5/2/2018

Figure 10
Impacts on Protected Trees - Alternatives 1 and 1A
NES



Hazel Avenue/U.S. 50 Interchange Project
April 2018
Sheet 16 of 16

Legend

- Project Boundary
- City of Rancho Cordova (within Project Area)

Tree Type

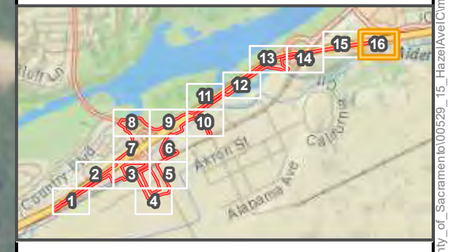
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: \\PDCCITRDSclS1\Projects_1\County_of_Sacramento\v00529_15_HazelAve\Cmaps\cc\BioArborist_Report__Alt1_2018.mxd; Author: ; Date: 5/2/2018

Figure 10
Impacts on Protected Trees - Alternatives 1 and 1A
NES

121°13'40"W

121°13'30"W

38°37'30"N

Hazel Avenue/U.S. 50 Interchange Project
April 2018
Sheet 1 of 16

Legend

- Project Boundary
- City of Rancho Cordova (within Project Area)

Tree Type

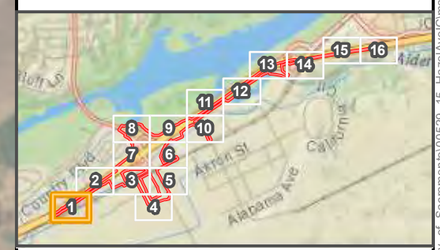
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

N

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: \\PDCCITRDSGIS1\Projects_1\County_of_Sacramento\100529_15_HazelAve\CimapsDoc\BioArborist_Report_Alt2_2018.mxd; Author: ; Date: 5/2/2018

Figure 11
Impacts on Protected Trees - Alternative 2
NES

121°13'30"W

121°13'20"W

38°37'40"N

Hazel Avenue/U.S. 50 Interchange Project
April 2018
Sheet 2 of 16

Legend

- Project Boundary
- City of Rancho Cordova (within Project Area)

Tree Type

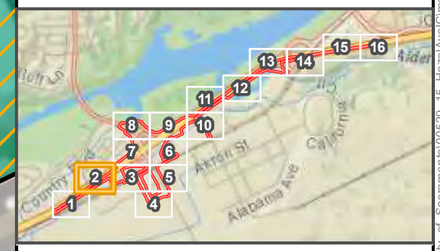
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: \\PDCIITRDSGIS1\Projects_1\County_of_Sacramento\v00529_15_HazelAve\Cmnepdoc\BioArborist_Report_Alt2_2018.mxd; Author: ; Date: 5/2/2018

Figure 11
Impacts on Protected Trees - Alternative 2
NES



Hazel Avenue/U.S. 50 Interchange Project
April 2018
Sheet 3 of 16

Legend

- Project Boundary
- City of Rancho Cordova (within Project Area)

Tree Type

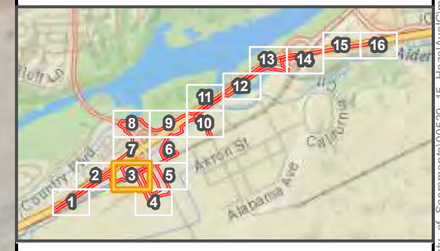
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: \\PDCCITRDSGIS1\Projects_1\County_of_Sacramento\100529_15_HazelAve\Dmaps\doc\BioArborist_Report_Alt2_2018.mxd; Author: ; Date: 5/2/2018

Figure 11
Impacts on Protected Trees - Alternative 2
NES

121°13'0"W

121°12'50"W

38°37'30"N

Inaccesible area (2)

Hazel Avenue/U.S. 50 Interchange Project
April 2018
Sheet 4 of 16

Legend

- Project Boundary
- City of Rancho Cordova (within Project Area)

Tree Type

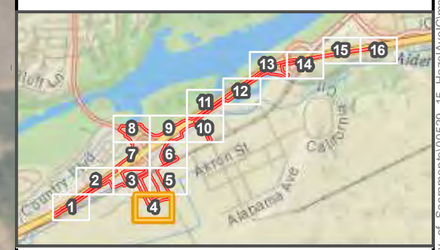
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

N

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: \\PDCCITRDSGIS1\Projects_1\County_of_Sacramento\100529_15_HazelAve\CimapsDoc\BioArborist_Report_Alt2_2018.mxd; Author: ; Date: 5/2/2018

Figure 11
Impacts on Protected Trees - Alternative 2
NES

121°12'50"W

38°37'40"N

668 669 1243 670 671 672 673 674 675 676 677 678 679 680 681 682 683 684 685 686 687

Inaccesible area (2)

Hazel Avenue/U.S. 50 Interchange Project
April 2018
Sheet 5 of 16

Legend

- Project Boundary
- City of Rancho Cordova (within Project Area)

Tree Type

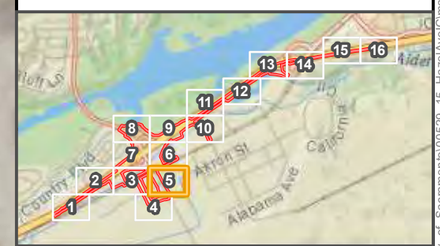
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

N

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: \\PDOCIT\RDSGIS1\Projects_1\County_of_Sacramento\100529_15_HazelAve\CimapsDoc\BioArborist_Report_Alt2_2018.mxd; Author: ; Date: 5/2/2018

Figure 11
Impacts on Protected Trees - Alternative 2
NES

121°12'50"W

38°37'50"N

Hazel Avenue/U.S. 50 Interchange Project
April 2018
Sheet 6 of 16

Legend

- Project Boundary
- City of Rancho Cordova (within Project Area)

Tree Type

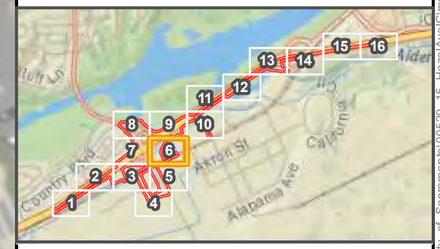
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: \\PDC01\TRDSGIS1\Projects_1\County_of_Sacramento\600529_15_HazelAve\CimeppdocBio\Arborist_Report_Alt2_2018.mxd; Author: ; Date: 5/2/2018

Figure 11
Impacts on Protected Trees - Alternative 2
NES

121°13'10"W

121°13'0"W

38°37'50"N

Hazel Avenue/U.S. 50 Interchange Project
April 2018
Sheet 7 of 16

Legend

- Project Boundary
- City of Rancho Cordova (within Project Area)

Tree Type

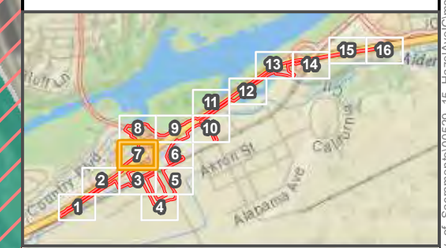
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: \\PDCCITRDSGIS1\Projects_1\County_of_Sacramento\b100529_15_HazelAve\Cmep\doc\BioAr\botnist_Report_Alt2_2018.mxd; Author: ; Date: 5/2/2018

Figure 11
Impacts on Protected Trees - Alternative 2
NES

121°13'10"W

121°13'0"W

38°38'0"N

Hazel Avenue/U.S. 50 Interchange Project
April 2018
Sheet 8 of 16

Legend

- Project Boundary
- City of Rancho Cordova (within Project Area)

Tree Type

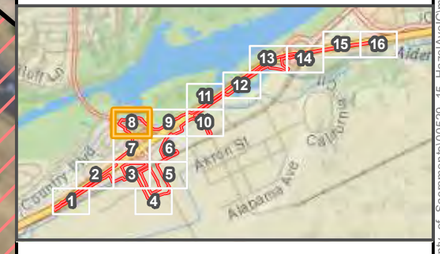
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

N

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: \\PDC\CITRDS\GIS\Projects_1\County_of_Sacramento\100529_15_HazelAve\Cimapdoc\Bio\Arborist_Report_Alt2_2018.mxd; Author: ; Date: 5/2/2018

Figure 11
Impacts on Protected Trees - Alternative 2
NES

121°12'50"W

38°38'0"N

Hazel Avenue/U.S. 50 Interchange Project
April 2018
Sheet 9 of 16

Legend

- Project Boundary
- City of Rancho Cordova (within Project Area)

Tree Type

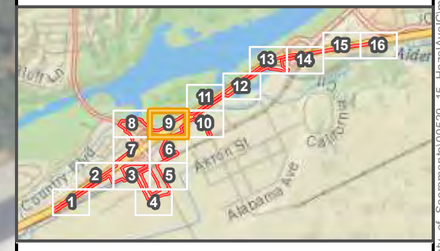
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

N

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: \\PDCCITRDSGIS1\Projects_1\County_of_Sacramento\d000529_15_HazelAve\Dmapdoc\BioArborist_Report_Alt2_2018.mxd; Author: ; Date: 5/2/2018

Figure 11
Impacts on Protected Trees - Alternative 2
NES

121°12'40"W

121°12'30"W

38°36'0"N

Hazel Avenue/U.S. 50 Interchange Project
April 2018
Sheet 10 of 16

Legend

- Project Boundary
- City of Rancho Cordova (within Project Area)

Tree Type

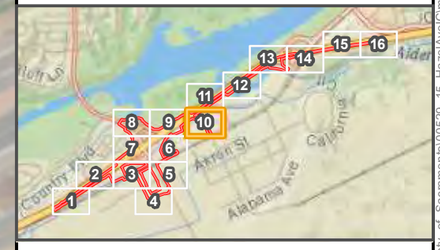
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: \\PDOCHTRDSGIS1\Projects_1\County_of_Sacramento\100529_15_HazelAve\Cmapdoc\Bio\Arborist_Report_Att2_2018.mxd; Author: ; Date: 5/2/2018

Figure 11
Impacts on Protected Trees - Alternative 2
NES

121°12'40"W

121°12'30"W

38°38'10"N

873

874

875

876

Hazel Avenue/U.S. 50 Interchange Project
April 2018
Sheet 11 of 16

Legend

- Project Boundary
- City of Rancho Cordova (within Project Area)

Tree Type

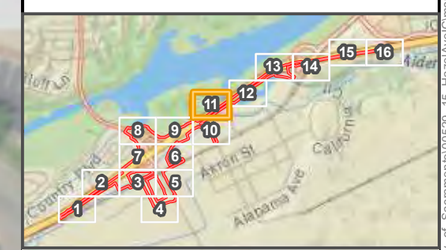
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

N

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: \\PDOCIT\RDSGIS1\Projects_1\County_of_Sacramento\100529_15_HazelAve\CImaps\doc\BioArborist_Report_Alt2_2018.mxd; Author: ; Date: 5/2/2018

Figure 11
Impacts on Protected Trees - Alternative 2
NES

121°12'20"W

121°12'10"W

38°38'10"N

929
928
927
926
925
923
915
5b
917
918
919
920
921
922
914
913
912
911
910
909

Hazel Avenue/U.S. 50 Interchange Project
April 2018
Sheet 12 of 16

Legend

Project Boundary

City of Rancho Cordova (within Project Area)

Tree Type

Heritage (Native Oak)

Native Tree

Native Oak

Nonnative Tree

Canopy Impact

No Impact

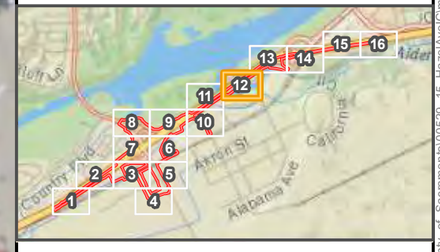
Permanent Impact

Temporary Impact

Impact Areas

Permanent Impact

Temporary Impact



0 50 100
Feet
1 inch = 100 feet

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: \\PDC\ITRD\GIS\1\Projects_1\County_of_Sacramento\v000529_15_HazelAve\Cmnp\doc\BioArborist_Report_Alt2_2018.mxd; Author: ; Date: 5/2/2018

Figure 11
Impacts on Protected Trees - Alternative 2
NES

121°12'10"W

121°12'0"W

38°38'20"N

Hazel Avenue/U.S. 50 Interchange Project
April 2018
Sheet 13 of 16

Legend

- Project Boundary
- City of Rancho Cordova (within Project Area)

Tree Type

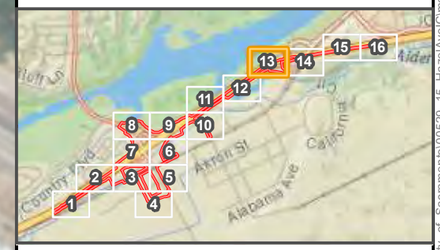
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: \\PDCCITRDSclS1\Projects_1\County_of_Sacramento\v00529_15_HazelAve\Cmep\doc\BioArborist_Report_Alt2_2018.mxd; Author: ; Date: 5/2/2018

Figure 11
Impacts on Protected Trees - Alternative 2
NES

121°11'50"W

38°36'20"N

Hazel Avenue/U.S. 50 Interchange Project
April 2018
Sheet 14 of 16

Legend

- Project Boundary
- City of Rancho Cordova (within Project Area)

Tree Type

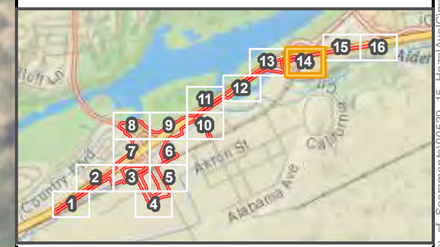
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

N

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: \\PDOC\TRDS\GIS \Projects_1\County_of_Sacramento\100529_15_HazelAve\Cmapdoc\Bio\Arborist_Report_Alt2_2018.mxd; Author: ; Date: 5/2/2018

Figure 11
Impacts on Protected Trees - Alternative 2
NES

121°11'40"W

121°11'30"W

38°38'30"N

Inaccesible area (3)

Hazel Avenue/U.S. 50 Interchange Project
April 2018
Sheet 15 of 16

Legend

- Project Boundary
- City of Rancho Cordova (within Project Area)

Tree Type

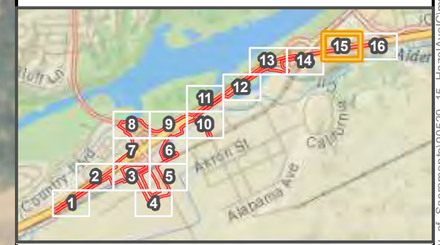
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

N

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: \\P\DOCITRDSds1\Projects_1\County_of_Sacramento\v100529_15_HazelAve\Cmapdoc\BioArborist_Report_Alt2_2018.mxd; Author: ; Date: 5/2/2018

Figure 11
Impacts on Protected Trees - Alternative 2
NES



Hazel Avenue/U.S. 50 Interchange Project
April 2018
Sheet 16 of 16

Legend

- Project Boundary
- City of Rancho Cordova (within Project Area)

Tree Type

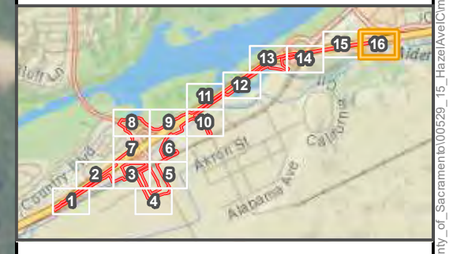
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: \\PDCCITRDSclS1\Projects_1\County_of_Sacramento\v00529_15_HazelAve\Cmnpdoc\BioArborist_Report_Alt2_2018.mxd; Author: ; Date: 5/2/2018

Figure 11
Impacts on Protected Trees - Alternative 2
NES

Appendix B Database Searches and Species Lists

Selected Elements by Common Name

California Department of Fish and Wildlife

California Natural Diversity Database

Query Criteria: Quad IS (Carmichael (3812153) OR Buffalo Creek (3812152) OR Citrus Heights (3812163) OR Clarksville (3812161) OR Folsom (3812162) OR Folsom SE (3812151))
 AND Taxonomic Group IS (Fish OR Amphibians OR Reptiles OR Birds OR Mammals OR Mollusks OR Arachnids OR Crustaceans OR Insects)

Hazel Avenue/US 50 Interchange Project

Species	Element Code	Federal Status	State Status	Global Rank	State Rank	Rare Plant Rank/CDFW SSC or FP
American badger *Taxidea taxus*	AMAJF04010	None	None	G5	S3	SSC
An andrenid bee *Andrena subapasta*	IIHYM35210	None	None	G1G2	S1S2	
bald eagle *Haliaeetus leucocephalus*	ABNKC10010	Delisted	Endangered	G5	S3	FP
bank swallow *Riparia riparia*	ABPAU08010	None	Threatened	G5	S2	
Blennosperma vernal pool andrenid bee *Andrena blennospermatis*	IIHYM35030	None	None	G2	S2	
burrowing owl *Athene cunicularia*	ABNSB10010	None	None	G4	S3	SSC
California black rail *Laterallus jamaicensis coturniculus*	ABNME03041	None	Threatened	G3G4T1	S1	FP
California linderiella *Linderiella occidentalis*	ICBRA06010	None	None	G2G3	S2S3	
California red-legged frog *Rana draytonii*	AAABH01022	Threatened	None	G2G3	S2S3	SSC
Cooper's hawk *Accipiter cooperii*	ABNKC12040	None	None	G5	S4	WL
double-crested cormorant *Phalacrocorax auritus*	ABNFD01020	None	None	G5	S4	WL
ferruginous hawk *Buteo regalis*	ABNKC19120	None	None	G4	S3S4	WL
foothill yellow-legged frog *Rana boylii*	AAABH01050	None	Candidate Threatened	G3	S3	SSC
giant gartersnake *Thamnophis gigas*	ARADB36150	Threatened	Threatened	G2	S2	
golden eagle *Aquila chrysaetos*	ABNKC22010	None	None	G5	S3	FP
grasshopper sparrow *Ammodramus savannarum*	ABPBXA0020	None	None	G5	S3	SSC
great blue heron *Ardea herodias*	ABNGA04010	None	None	G5	S4	
great egret *Ardea alba*	ABNGA04040	None	None	G5	S4	

Species	Element Code	Federal Status	State Status	Global Rank	State Rank	Rare Plant Rank/CDFW SSC or FP
hairy water flea *Dumontia oregonensis*	ICBRA23010	None	None	G1G3	S1	
merlin *Falco columbarius*	ABNKD06030	None	None	G5	S3S4	WL
midvalley fairy shrimp *Branchinecta mesovallensis*	ICBRA03150	None	None	G2	S2S3	
North American porcupine *Erethizon dorsatum*	AMAFJ01010	None	None	G5	S3	
pallid bat *Antrozous pallidus*	AMACC10010	None	None	G5	S3	SSC
Ricksecker's water scavenger beetle *Hydrochara rickseckeri*	IICOL5V010	None	None	G2?	S2?	
silver-haired bat *Lasionycteris noctivagans*	AMACC02010	None	None	G5	S3S4	
steelhead - Central Valley DPS *Oncorhynchus mykiss irideus pop. 11*	AFCHA0209K	Threatened	None	G5T2Q	S2	
Swainson's hawk *Buteo swainsoni*	ABNKC19070	None	Threatened	G5	S3	
tricolored blackbird *Agelaius tricolor*	ABPBXB0020	None	Candidate Endangered	G2G3	S1S2	SSC
valley elderberry longhorn beetle *Desmocerus californicus dimorphus*	IICOL48011	Threatened	None	G3T2	S2	
vernal pool fairy shrimp *Branchinecta lynchi*	ICBRA03030	Threatened	None	G3	S3	
vernal pool tadpole shrimp *Lepidurus packardi*	ICBRA10010	Endangered	None	G4	S3S4	
western pond turtle *Emys marmorata*	ARAAD02030	None	None	G3G4	S3	SSC
western spadefoot *Spea hammondii*	AAABF02020	None	None	G3	S3	SSC
white-tailed kite *Elanus leucurus*	ABNKC06010	None	None	G5	S3S4	FP

Record Count: 34

Selected Elements by Scientific Name

California Department of Fish and Wildlife

California Natural Diversity Database

Query Criteria: Quad IS (Carmichael (3812153) OR Buffalo Creek (3812152) OR Citrus Heights (3812163) OR Clarksville (3812161) OR Folsom (3812162) OR Folsom SE (3812151))
 AND Taxonomic Group IS (Dune OR Scrub OR Herbaceous OR Marsh OR Riparian OR Woodland OR Forest OR Alpine OR Inland Waters OR Marine OR Estuarine OR Riverine OR Palustrine OR Ferns OR Gymnosperms OR Monocots OR Dicots OR Lichens OR Bryophytes)

Hazel Avenue/US 50 Interchange Project

Selected Elements by Scientific Name

California Department of Fish and Wildlife

California Natural Diversity Database

Species	Element Code	Federal Status	State Status	Global Rank	State Rank	Rare Plant Rank/CDFW SSC or FP
Ceanothus roderickii Pine Hill ceanothus	PDRHA04190	Endangered	Rare	G1	S1	1B.1
Chlorogalum grandiflorum Red Hills soaproot	PMLIL0G020	None	None	G3	S3	1B.2
Clarkia biloba ssp. brandegeeae Brandegee's clarkia	PDONA05053	None	None	G4G5T4	S4	4.2
Crocanthemum suffrutescens Bisbee Peak rush-rose	PDCIS020F0	None	None	G2?Q	S2?	3.2
Downingia pusilla dwarf downingia	PDCAM060C0	None	None	GU	S2	2B.2
Eryngium pinnatisectum Tuolumne button-celery	PDAPI0Z0P0	None	None	G2	S2	1B.2
Fremontodendron decumbens Pine Hill flannelbush	PDSTE03030	Endangered	Rare	G1	S1	1B.2
Fritillaria agrestis stinkbells	PMLIL0V010	None	None	G3	S3	4.2
Galium californicum ssp. sierrae El Dorado bedstraw	PDRUB0N0E7	Endangered	Rare	G5T1	S1	1B.2
Gratiola heterosepala Boggs Lake hedge-hyssop	PDSCR0R060	None	Endangered	G2	S2	1B.2
Juncus leiospermus var. ahartii Ahart's dwarf rush	PMJUN011L1	None	None	G2T1	S1	1B.2
Legenere limosa legenere	PDCAM0C010	None	None	G2	S2	1B.1
Navarretia myersii ssp. myersii pincushion navarretia	PDPLM0C0X1	None	None	G2T2	S2	1B.1
Northern Hardpan Vernal Pool Northern Hardpan Vernal Pool	CTT44110CA	None	None	G3	S3.1	
Northern Volcanic Mud Flow Vernal Pool Northern Volcanic Mud Flow Vernal Pool	CTT44132CA	None	None	G1	S1.1	
Orcuttia tenuis slender Orcutt grass	PMPOA4G050	Threatened	Endangered	G2	S2	1B.1
Orcuttia viscida Sacramento Orcutt grass	PMPOA4G070	Endangered	Endangered	G1	S1	1B.1
Packera layneae Layne's ragwort	PDAST8H1V0	Threatened	Rare	G2	S2	1B.2
Sagittaria sanfordii Sanford's arrowhead	PMALI040Q0	None	None	G3	S3	1B.2
Valley Needlegrass Grassland Valley Needlegrass Grassland	CTT42110CA	None	None	G3	S3.1	
Wyethia reticulata El Dorado County mule ears	PDAST9X0D0	None	None	G2	S2	1B.2

Record Count: 21

CNPS Inventory of Rare and Endangered Plants – July 11, 2018

Scientific Name	Common Name	Blooming Period	Status
Balsamorhiza macrolepis	big-scale balsamroot	Mar-Jun	-/-/1B.2
Calystegia stebbinsii	Stebbins' morning-glory	Apr-Jul	FE/CE/1B.1
Carex xerophila	chaparral sedge	Mar-Jun	-/-/1B.2
Ceanothus roderickii	Pine Hill ceanothus	Apr-Jun	FE/CE/1B.1
Chlorogalum grandiflorum	Red Hills soaproot	May-Jun	-/-/1B.2
Chloropyron molle ssp. hispidum	hispid bird's-beak	Jun-Sep	-/-/1B.1
Downingia pusilla	dwarf downingia	Mar-May	-/-/2B.2
Eryngium pinnatisectum	Tuolumne button-celery	May-Aug	-/-/1B.2
Fremontodendron decumbens	Pine Hill flannelbush	Apr-Jul	FE/CR/1B.2
Galium californicum ssp. sierrae	El Dorado bedstraw	May-Jun	FE/CR/1B.2
Gratiola heterosepala	Boggs Lake hedge-hyssop	Apr-Aug	-/CE/1B.2
Juncus leiospermus var. ahartii	Ahart's dwarf rush	Mar-May	-/-/1B.2
Juncus leiospermus var. leiospermus	Red Bluff dwarf rush	Mar-Jun	-/-/1B.1
Legenere limosa	legenere	Apr-Jun	-/-/1B.1
Navarretia myersii ssp. myersii	pincushion navarretia	Apr-May	-/-/1B.1
Orcuttia tenuis	slender Orcutt grass	May-Sep(Oct)	FT/CE/1B.1
Orcuttia viscida	Sacramento Orcutt grass	Apr-Jul(Sep)	FE/CE/1B.1
Packera layneae	Layne's ragwort	Apr-Aug	FT/CE/1B.2
Sagittaria sanfordii	Sanford's arrowhead	May-Oct(Nov)	-/-/1B.2
Wyethia reticulata	El Dorado County mule ears	Apr-Aug	-/-/1B.2

Federal
FE = listed as endangered under the federal Endangered Species Act.
FT = listed as Threatened under the federal Endangered Species Act
– = no listing.
State
CE = listed as endangered under the California Endangered Species Act.
CT = listed as Threatened under the California Endangered Species Act
CR = listed as Rare under the California Endangered Species Act
– = no listing.
California Native Plant Society (CNPS) California Rare Plant Rank
1B = List 1B species: rare, threatened, or endangered in California and elsewhere.
2B = List 2B species: rare, threatened, or endangered in California but more common elsewhere.
3 = List 3 species: more information is needed about this plant.
0.1 = seriously endangered in California.
0.2 = fairly endangered in California.

From: Lukkarila, Michele K@DOT
To: "nmfswcrca.specieslist@noaa.gov"
Subject: Caltrans EA 3E380 Hazel Ave Interchange Project
Date: Tuesday, July 10, 2018 7:52:00 AM

Quad Name **Folsom**

Quad Number **38121-F2**

ESA Anadromous Fish

SONCC Coho ESU (T) -

CCC Coho ESU (E) -

CC Chinook Salmon ESU (T) -

CVSR Chinook Salmon ESU (T) - **X**

SRWR Chinook Salmon ESU (E) -

NC Steelhead DPS (T) -

CCC Steelhead DPS (T) -

SCCC Steelhead DPS (T) -

SC Steelhead DPS (E) -

CCV Steelhead DPS (T) - **X**

Eulachon (T) -

sDPS Green Sturgeon (T) -

ESA Anadromous Fish Critical Habitat

SONCC Coho Critical Habitat -

CCC Coho Critical Habitat -

CC Chinook Salmon Critical Habitat -

CVSR Chinook Salmon Critical Habitat -

SRWR Chinook Salmon Critical Habitat -

NC Steelhead Critical Habitat -

CCC Steelhead Critical Habitat -

SCCC Steelhead Critical Habitat -

SC Steelhead Critical Habitat -

CCV Steelhead Critical Habitat - **X**

Eulachon Critical Habitat -

sDPS Green Sturgeon Critical Habitat -

ESA Marine Invertebrates

Range Black Abalone (E) -

Range White Abalone (E) -

ESA Marine Invertebrates Critical Habitat

Black Abalone Critical Habitat -

ESA Sea Turtles

East Pacific Green Sea Turtle (T) -

Olive Ridley Sea Turtle (T/E) -

Leatherback Sea Turtle (E) -

North Pacific Loggerhead Sea Turtle (E) -

ESA Whales

Blue Whale (E) -

Fin Whale (E) -

Humpback Whale (E) -

Southern Resident Killer Whale (E) -

North Pacific Right Whale (E) -

Sei Whale (E) -

Sperm Whale (E) -

ESA Pinnipeds

Guadalupe Fur Seal (T) -

Steller Sea Lion Critical Habitat -

Essential Fish Habitat

Coho EFH -

Chinook Salmon EFH - **X**

Groundfish EFH -

Coastal Pelagics EFH -

Highly Migratory Species EFH -

MMPA Species (See list at left)

ESA and MMPA Cetaceans/Pinnipeds

See list at left and consult the NMFS Long Beach office

562-980-4000

MMPA Cetaceans -

MMPA Pinnipeds -

Michele Lukkarila

Associate Environmental Planner/Biologist
D3/NR Environmental Planning
CA Dept. of Transportation
703 B. St.
Marysville, CA 95901
(530)741-4239

From: NMFSWCRCA Specieslist - NOAA Service Account
To: Lukkarila, Michele K@DOT
Subject: Re: Caltrans EA 3E380 Hazel Ave Interchange Project
Date: Tuesday, July 10, 2018 7:52:22 AM

Receipt of this message confirms that NMFS has received your email to nmfswcrca.specieslist@noaa.gov. If you are a federal agency (or representative) and have followed the steps outlined on the California Species List Tools web page (http://www.westcoast.fisheries.noaa.gov/maps_data/california_species_list_tools.html), you have generated an official Endangered Species Act species list.

Messages sent to this email address are not responded to directly. For project specific questions, please contact your local NMFS office.

Northern California/Klamath (Arcata) 707-822-7201

North-Central Coast (Santa Rosa) 707-387-0737

Southern California (Long Beach) 562-980-4000

California Central Valley (Sacramento) 916-930-3600

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish And Wildlife Office
Federal Building
2800 Cottage Way, Room W-2605
Sacramento, CA 95825-1846
Phone: (916) 414-6600 Fax: (916) 414-6713

In Reply Refer To:
Consultation Code: 08ESMF00-2016-SLI-1181
Event Code: 08ESMF00-2018-E-07791
Project Name: US 50/Hazel Avenue Interchange Project

July 10, 2018

Subject: Updated list of threatened and endangered species that may occur in your proposed project location, and/or may be affected by your proposed project

To Whom It May Concern:

The enclosed species list identifies threatened, endangered, proposed and candidate species, as well as proposed and final designated critical habitat, under the jurisdiction of the U.S. Fish and Wildlife Service (Service) that may occur within the boundary of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the Service under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

Please follow the link below to see if your proposed project has the potential to affect other species or their habitats under the jurisdiction of the National Marine Fisheries Service:

http://www.nwr.noaa.gov/protected_species/species_list/species_lists.html

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Please feel free to contact us if you need more current information or assistance regarding the potential impacts to federally proposed, listed, and candidate species and federally designated and proposed critical habitat. Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally as desired. The Service recommends that verification be completed by visiting the ECOS-IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through the ECOS-IPaC system by completing the same process used to receive the enclosed list.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the Act and its implementing regulations (50 CFR 402 *et seq.*), Federal agencies are required to utilize their authorities to carry out programs for the conservation of threatened and endangered species and to determine whether projects may affect threatened and endangered species and/or designated critical habitat.

A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2)(c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.

If a Federal agency determines, based on the Biological Assessment or biological evaluation, that listed species and/or designated critical habitat may be affected by the proposed project, the agency is required to consult with the Service pursuant to 50 CFR 402. In addition, the Service recommends that candidate species, proposed species and proposed critical habitat be addressed within the consultation. More information on the regulations and procedures for section 7 consultation, including the role of permit or license applicants, can be found in the "Endangered Species Consultation Handbook" at:

http://www.fws.gov/endangered/esa-library/pdf/TOC-GLOS.PDF

Please be aware that bald and golden eagles are protected under the Bald and Golden Eagle Protection Act (16 U.S.C. 668 *et seq.*), and projects affecting these species may require development of an eagle conservation plan (http://www.fws.gov/windenergy/eagle_guidance.html). Additionally, wind energy projects should follow the wind energy guidelines (http://www.fws.gov/windenergy/) for minimizing impacts to migratory birds and bats.

Guidance for minimizing impacts to migratory birds for projects including communications towers (e.g., cellular, digital television, radio, and emergency broadcast) can be found at: http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/towers.htm; http://www.towerkill.com; and http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/comtow.html.

We appreciate your concern for threatened and endangered species. The Service encourages Federal agencies to include conservation of threatened and endangered species into their project planning to further the purposes of the Act. Please include the Consultation Tracking Number in the header of this letter with any request for consultation or correspondence about your project that you submit to our office.

Attachment(s):

- Official Species List

Official Species List

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action".

This species list is provided by:

Sacramento Fish And Wildlife Office
Federal Building
2800 Cottage Way, Room W-2605
Sacramento, CA 95825-1846
(916) 414-6600

Project Summary

Consultation Code: 08ESMF00-2016-SLI-1181

Event Code: 08ESMF00-2018-E-07791

Project Name: US 50/Hazel Avenue Interchange Project

Project Type: TRANSPORTATION

Project Description: Modify interchange and extend Hazel Avenue.

Project Location:

Approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/place/38.631672622086185N121.21614875411532W



Counties: Sacramento, CA

Endangered Species Act Species

There is a total of 10 threatened, endangered, or candidate species on this species list.

Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species.

IPaC does not display listed species or critical habitats under the sole jurisdiction of NOAA Fisheries[1], as USFWS does not have the authority to speak on behalf of NOAA and the Department of Commerce.

See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

---

1. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

Reptiles

NAME	STATUS
Giant Garter Snake *Thamnophis gigas* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/4482	Threatened

Amphibians

NAME	STATUS
California Red-legged Frog *Rana draytonii* There is **final** critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/2891	Threatened
California Tiger Salamander *Ambystoma californiense* Population: U.S.A. (Central CA DPS) There is **final** critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/2076	Threatened

Fishes

NAME	STATUS
Delta Smelt *Hypomesus transpacificus*	Threatened

There is **final** critical habitat for this species. Your location is outside the critical habitat.
Species profile: https://ecos.fws.gov/ecp/species/321

Insects

NAME	STATUS
Valley Elderberry Longhorn Beetle *Desmocerus californicus dimorphus*	Threatened

There is **final** critical habitat for this species. Your location is outside the critical habitat.
Species profile: https://ecos.fws.gov/ecp/species/7850
Habitat assessment guidelines:
https://ecos.fws.gov/ipac/guideline/assessment/population/436/office/11420.pdf

Crustaceans

NAME	STATUS
Conservancy Fairy Shrimp *Branchinecta conservatio*	Endangered

There is **final** critical habitat for this species. Your location is outside the critical habitat.
Species profile: https://ecos.fws.gov/ecp/species/8246

Vernal Pool Fairy Shrimp *Branchinecta lynchi*	Threatened

There is **final** critical habitat for this species. Your location is outside the critical habitat.
Species profile: https://ecos.fws.gov/ecp/species/498

Vernal Pool Tadpole Shrimp *Lepidurus packardi*	Endangered

There is **final** critical habitat for this species. Your location is outside the critical habitat.
Species profile: https://ecos.fws.gov/ecp/species/2246

Flowering Plants

NAME	STATUS
Sacramento Orcutt Grass *Orcuttia viscida*	Endangered

There is **final** critical habitat for this species. Your location is outside the critical habitat.
Species profile: https://ecos.fws.gov/ecp/species/5507

Slender Orcutt Grass *Orcuttia tenuis*	Threatened

There is **final** critical habitat for this species. Your location is outside the critical habitat.
Species profile: https://ecos.fws.gov/ecp/species/1063

Critical habitats

THERE ARE NO CRITICAL HABITATS WITHIN YOUR PROJECT AREA UNDER THIS OFFICE'S JURISDICTION.

Appendix C Representative Photographs



Photo 1. Fremont cottonwood-oak woodland and annual grassland at the Aerojet property.



Photo 2. Ponded portion of Alder Creek with emergent wetland at edges.



Photo 3. Seasonal wetland within the interchange, looking southeast.



Photo 4. Seasonal wetland within the interchange, looking northwest.



Photo 5. Close up of season wetland within the interchange.



Photo 6. First of four potential seasonal wetlands at the Aerojet property.



Photo 7. Second of four potential seasonal wetlands at the Aerojet property.



Photo 8. Third of four potential seasonal wetlands at the Aerojet property.



Photo 9. Fourth of four potential seasonal wetlands at the Aerojet property.



Photo 10. Grassland and ditch south of Highway 50 near the Folsom Boulevard Exit.



Photo 11. Elderberry #1.



Photo 12. Potential exit hole at elderberry #1.



Photo 13. Elderberry #2.



Photo 14. Potential exit hole at elderberry #2.



Photo 15. Elderberry #3.



Photo 16. Potential exit hole at elderberry #3.



Photo 17. Elderberry #4.

Appendix D Species Observed in the Biological Study Area

Appendix D Plant and Animal Species Observed during Field Surveys

Table D-1. Plant Species Observed in the Biological Study Area

Scientific Name	Common Name
Acmispon americanus var. *americanus* [*Lotus purshianus*]	Spanish lotus
Aesculus californica	Buckeye
Aira caryophyllea	Silver hairgrass
Alnus rhombifolia	White alder
Amsinckia menziesii	Small flowered fiddleneck
*Avena barbata**	Slender wild oat
*Avena fatua**	Wild oat
Azolla filiculoides	American water fern
Baccharis pilularis	Coyote brush
*Brassica nigra**	Black mustard
*Bromus diandrus**	Ripgut brome
*Bromus hordeaceus**	Soft chess
Bromus madritensis ssp. *madritensis*	Foxtail chess
Bromus madritensis ssp. *rubens**	Red brome
*Carduus pycnocephalus**	Italian thistle
Castilleja attenuata	Valley tassels
Ceanothus lemmonii	Lemmon's ceanothus
*Centaurea melitensis**	Maltese star thistle
*Centaurea solstitialis**	Yellow star-thistle
Centaurium tenuiflorum	Slender centaury
Centromadia fitchii	Spikeweed
Cercis occidentalis	Redbud
Chlorogalum pomeridianum var. *pomeridianum*	Common soaproot
*Cirsium arvense**	Bull thistle
Clarkia unguiculata	Elegant clarkia
Claytonia perfoliata	Miner's lettuce
*Conium maculatum**	Poison hemlock
*Convolvulus arvensis**	Bindweed
*Cortaderia jubata**	Pampas grass
Cyperus eragrostis	Tall flatsedge
Dichelostemma capitatum spp. *capitatum*	Blue dicks
Epilobium brachycarpum	Annual fireweed
Erigeron canadensis	Canada horseweed
Erodium botrys	Big heronbill
*Erodium cicutarium**	Red stemmed filaree
Eschscholzia californica	California poppy
Eucalyptus sp.	Eucalyptus
Festuca [*Vulpia*] *myuros**	Rattail six weeks grass
Festuca perennis [*Lolium perenne*]*	Italian ryegrass
*Ficus carica**	Edible fig
*Foeniculum vulgare**	Sweet fennel
Frangula californica	Coffeeberry
Fremontodendron californicum	California flannelbush

Scientific Name	Common Name
Galium aparine	Common bedstraw
*Geranium dissectum**	Cut leaved geranium
Geranium molle	Dove's foot geranium
Heterotheca grandiflora	Telegraph weed
Holocarpha virgata ssp. *virgata*	Narrow tarplant
Hordeum marinum ssp. *gussoneanum**	Mediterranean barley
Hordeum murinum ssp. *leporinum**	Foxtail barley
*Hypochaeris glabra**	Smooth cat's ear
*Iris pseudacorus**	Water iris
Juncus effusus ssp. *pacificus*	Pacific rush
Kickxia spuria	Fluellin
Lactuca serriola	Prickly lettuce
Leontodon saxatilis ssp. *longirostris*	Hawkbit
Ludwigia peploides ssp. *peploides*	Floating water primrose
Lupinus bicolor	Bicolor lupine
Lupinus nanus	Sky lupine
Lythrum hyssopifolia [*hyssopifolium*]*	Hyssop loosestrife
*Marrubium vulgare**	White horehound
*Medicago polymorpha**	Bur clover
Melilotus indicus	Yellow sweetclover
Oxalis corniculata	Yellow sorrel
Persicaria hydropiperoides	Knotweed
Petrorhagia dubia	Pink grass
*Phalaris aquatica**	Harding grass
Phoradendron leucarpum	American mistletoe
Pinus sabiniana	California foothill pine
*Plantago lanceolata**	English plantain
*Polypogon monspeliensis**	Rabbitsfoot grass
Populus fremontii ssp. *fremontii*	Fremont cottonwood
Prunus sp.	Cherry
Quercus lobata	Valley oak
Quercus wislizeni	Interior live oak
*Raphanus sativus**	Wild radish
*Rubus armeniacus**	Himalayan blackberry
Rubus ursinus	California blackberry
*Rumex crispus**	Curly dock
Salix exigua	Sandbar willow
Salix gooddingii	Black willow
Sambucus nigra ssp. *caerulea*	Blue elderberry
Schoenoplectus acutus	Tule
Senecio vulgaris	Old man of spring
*Silybum marianum**	Milk-thistle
Stellaria media	Chickweed
Stipa pulchra	Purple needlegrass
Toxicodendron diversilobum	Poison-oak
Trifolium dubium	Suckling clover
*Trifolium hirtum**	Rose clover
Verbena bonariensis	Purpletop vervain
Vicia sativa ssp. *nigra*	Common vetch
Vicia tetrasperma	Four seeded vetch
Vicia villosa	Hairy vetch

Scientific Name	Common Name
* Species identified as invasive by California Department of Food and Agriculture and/or the California Invasive Plant Council	

Table D-2. Animal Species Observed in or Near the Biological Study Area

Common Name*	Scientific Name
Western pond turtle	*Actinemys marmorata*
Western fence lizard	*Sceloporus occidentalis*
Canada goose	*Branta canadensis*
Mallard	*Anas platyrhynchos*
Turkey vulture	*Cathartes aura*
Swainson's hawk	*Buteo swainsoni*
Red-tailed hawk	*Buteo jamaicensis*
Killdeer	*Falco sparverius*
Mourning dove	*Zenaida macroura*
Anna's hummingbird	*Calypte anna*
Acorn woodpecker	*Melanerpes formicivorus*
Nuttall's woodpecker	*Picoides nuttallii*
Black phoebe	*Sayornis nigricans*
Western scrub jay	*Aphelocoma californica*
Yellow-billed magpie	*Pica nuttalli*
American crow	*Corvus brachyrhynchos*
Cliff swallow	*Petrochelidon pyrrhonota*
American robin	*Turdus migratorius*
Northern mockingbird	*Mimus polyglottos*
European starling	*Sturnus vulgaris*
Red-winged blackbird	*Agelaius phoeniceus*
Brewer's blackbird	*Euphagus cyanocephalus*
House finch	*Carpodacus mexicanus*
Black-tailed deer	*Odocoileus hemionus*
*Species are listed in taxonomic order	

Appendix E Delineation of Potential Waters of the United States

Bound Separately

Hazel Avenue/U.S. 50 Interchange Project



Aquatic Resources Delineation

Hazel Avenue/U.S. 50 Interchange Project

Sacramento County

03-SAC-50-PM 15.1/17.5

Federal Project No.: EA 03-3E380/E-FIS 0300020439

County Control Number 2011-70062

October 2018

ICF

Aquatic Resources Delineation

Hazel Avenue/U.S. 50 Interchange Project

Sacramento County

03-SAC-50-PM 15.1/17.5

Federal Project No.: EA 03-3E380/E-FIS 0300020439

County Control Number 2011-70062

October 2018

Prepared for: Sacramento County
Office of Planning and Environmental Review
827 7th Street, Room 225
Sacramento, CA 95814

Contact: Marianne Biner, Senior Environmental Analyst
916-874-7520

Prepared By: ICF, Sacramento Office
630 K Street, Suite 400
Sacramento, CA 95814

Contact: Lisa Webber, Botanist/Wetland Ecologist
916-737-3000

ICF. 2018. Aquatic Resources Delineation. Hazel Avenue/U.S. 50 Interchange Project. October. (ICF 00529.15) Sacramento, CA. Prepared for Sacramento County Office of Planning and Environmental Review, Sacramento, CA.

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List of Abbreviated Terms

AMSL	above mean sea level
APNs	assessor parcel numbers
Caltrans	California Department of Transportation
CFR	Code of Federal Regulations
City	City of Rancho Cordova
County	County of Sacramento
CWA	federal Clean Water Act
GPS	global positioning system
JD	jurisdictional determination
OHWM	ordinary high water mark
proposed project	proposed Hazel Avenue/U.S. 50 Interchange Project
TNW	traditional navigable water
USACE	U.S. Army Corps of Engineers
US 50	U.S. 50

Aquatic Resources Delineation

Summary

This report presents the results of a delineation of potential wetlands and non-wetland waters of the United States conducted for the proposed Hazel Avenue/U.S Route (US) 50 Interchange Project (proposed project) between US 50 post miles 15.1 and 17.5 (Figure 1). The delineation area encompasses approximately 98 acres. The project is proposed by the County of Sacramento (County), in cooperation with the California Department of Transportation (Caltrans) and the City of Rancho Cordova (City).

ICF botanist/wetland ecologist Lisa Webber conducted fieldwork on April 6 and 21, 2016, using the routine onsite determination method described in the *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987) and incorporating the supplemental procedures and wetland indicators provided in the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Arid West Region* (U.S. Army Corps of Engineers 2008). OHWM indicators for non-wetland waters of the United States were identified according to U.S. Army Corps of Engineers (USACE) Regulatory Guidance Letter No. 05-05 (*Ordinary High Water Mark Identification*) (U.S. Army Corps of Engineers 2005) and *A Field Guide to the Identification of the Ordinary High Water Mark (OHWM) in the Arid West Region of the Western United States* (Lichvar and McColley 2008) The delineation was conducted to assist Sacramento County (the project applicant) in identifying the types and extents of wetlands and non-wetland waters subject to USACE regulation under Section 404 of the federal Clean Water Act (CWA).

This report was prepared to support the submission of a preliminary jurisdictional determination (JD) to USACE Sacramento District (RGL 16-01) (U.S. Army Corps of Engineers 2016). All wetland boundaries are preliminary and subject to verification by USACE Sacramento District.

A total of 0.91 acre of wetlands and non-wetland waters of the United States were identified in the delineation area: 0.22 acre of wetlands and 0.69 acres of non-wetland waters (Table 1 and Appendix A).

Table 1. Summary of Wetlands and Non-Wetland Waters of the United States Identified in the Delineation Area

Wetlands and Non-Wetland Waters	Area (acres)
Wetlands	
Seasonal wetland	0.02
Emergent wetland	0.20
Non-Wetland Waters	
Ephemeral drainage	0.001
Perennial drainage	0.42
Perennial drainage (culverted)	0.14
Ditch	0.13
Total	**0.91**

Introduction

This report presents the results of a delineation of potential wetlands and non-wetland waters of the United States conducted for the proposed project to improve the Hazel Avenue/US 50 interchange in Sacramento County, California (Figure 1). The County, in cooperation with Caltrans and the City, proposes to modify the existing Hazel Avenue/US 50 interchange, and extend and grade-separate Hazel Avenue over Folsom Boulevard and the Sacramento Placerville Transportation Corridor Joint Powers Authority rail corridor. Hazel Avenue would be extended further south to a proposed intersection with the future Atlanta Street (a new roadway that will be constructed as part of the Easton Place development). The proposed project also includes:

- Construction of a portion of an eastbound transition auxiliary lane on US 50 from Hazel Avenue through the Folsom Boulevard Overcrossing, also known as the Natoma Overhead.
- The modification of the existing Aerojet Road off-ramp from US 50.
- Reconstruction of the westbound loop on-ramp.
- Reconstruction of the eastbound diagonal off-ramp, and both eastbound on-ramps.
- Eastbound on- and off-ramp auxiliary lanes, from west of the Hazel Avenue to the eastbound off-ramp, and from the loop on-ramp extending to the Folsom Boulevard interchange.
- Roadway improvements constructed along approximately 2,300 feet of Folsom Boulevard. Improvements include sidewalks, street lighting, and landscaping along the north side of Folsom Boulevard, and landscaping and lighting along the south.

The project is in Sacramento County at the interchange of Hazel Avenue and US 50. The project area is bounded along Hazel Avenue by the Tributary Point/westbound US 50 off-ramp intersection to the north, and extends approximately 1,000 feet south of Folsom Boulevard to a future intersection within the Easton Place development. The project limits along US 50 begin approximately 3,200 feet west of the existing Hazel Avenue Overcrossing, and extend 2,500 feet east of the Natoma Overhead. Improvements along Folsom Boulevard would extend from approximately 1,200 feet west of the Hazel Avenue intersection to 900 feet to the east.

The delineation area comprises the proposed interchange improvement area for three alternatives, including the potential staging areas, as well as additional area surrounding the construction footprint.

The delineation was conducted in support of a preliminary JD and to assist the County in identifying the types and extents of wetlands and non-wetland waters subject to USACE regulation under Section 404 of the CWA. All jurisdictional boundaries and determinations presented in this report are preliminary and subject to verification by USACE Sacramento District. The delineation report is intended to comply with USACE Sacramento District guidelines and the South Pacific Division map standards.

Appendices to this report are listed below.

- Appendix A: Aquatic Resources Delineation
- Appendix B: Routine Wetland Delineation Data Forms
- Appendix C: Representative Photographs
- Appendix D: Soil Survey Map and Information
- Appendix E: Plant Species Observed in the Delineation Area
- Appendix F: WETS Table
- Appendix G: Assessor Parcel Numbers in the Delineation Area
- Appendix H: Aquatic Resources Spreadsheet (This table also will be provided to the USACE Sacramento District as a separate Excel file.)

Contact Information

Contact information for the County's contact person and the ICF botanist/wetland ecologist is provided below.

Sacramento County

Office of Planning and Environmental Review
827 7th Street, Room 225
Sacramento, CA 95814
Office: 916/874-7520
Contact: Marianne Biner, Senior Environmental Analyst

binerm@saccounty.net

ICF

ICF
630 K Street, Suite 400
Sacramento, CA 95814
Office: 916/231-7669
Contact: Lisa Webber, Senior Botanist/Wetland Ecologist

lisa.webber@icf.com

Driving Directions

To reach the delineation area from downtown Sacramento, travel east on Interstate 80 to US 50 and proceed east on US 50 for 16 miles. Take exit 21 for Hazel Avenue to reach the western boundary of the delineation area.

Site Description and Location

The 98-acre delineation area is entirely within Sacramento County on US 50 from the Hazel Avenue interchange to the Folsom Boulevard interchange (Figure 1). The delineation area includes the Hazel Avenue interchange, short sections of Folsom Boulevard and Nimbus Road south of the interchange, a portion of the property at the southwest corner of Folsom Boulevard and Nimbus Road, an approximately 1-mile segment of eastbound US 50, and the right-of-way (ROW) along this segment on the south side of US 50.

The delineation area is within the Folsom 7.5-minute U.S. Geological Survey quadrangle in an unnamed section of Township 9 north, Range 7 east. The western end of the delineation area is at 38°37'30"N/121°13'37"W, and the eastern end is at 38°38'22"N/121°11'58"W. The assessor parcel numbers (APNs) in the delineation area are listed in Appendix G.

The delineation area is relatively level, with elevations ranging from approximately 110 to 150 feet above mean sea level (AMSL). Land uses in the delineation area and the surrounding area are primarily commercial and recreational properties.

Existing Conditions

Landscape Setting

Hydrology

The delineation area is in the Lower American River watershed hydrologic unit (hydrologic unit code 18020111) (U.S. Environmental Protection Agency 2016). Alder Creek is the only perennial drainage in the delineation area and crosses underneath US 50. Alder Creek drains north to Lake Natoma, which is approximately 0.7 mile upstream of the Nimbus Dam. Lake Natoma is part of the American River, a traditional navigable water (TNW).

Precipitation and Growing Season

The mean annual precipitation in the delineation area is approximately 22.21 inches, which typically consists entirely of rainfall (Appendix F). As of the April 6, 2016, field survey, the precipitation to date was 22.99 inches at the Chicago Weather Station (elevation of 210 feet), which is approximately 2.5 miles northwest of the delineation area. The most recent rainfall prior to the April 6, 2016, field survey was on March 22, 2016, and total precipitation for the water year was 20.67 inches at that time. An additional 0.56 inch fell prior to the April 21, 2016, field

survey, increasing the total precipitation to 21.23 inches as of April 21, 2016 (California Department of Water Resources 2016).

The climate in the delineation area is characterized by hot, dry summers and cool, moist winters. Climate data were obtained from the WETS tables prepared by the Natural Resources Conservation Service (Appendix F). The National Weather Service cooperative weather station closest to the delineation area is the Represa station (CA7370), approximately 4.5 miles northeast of the delineation area at an elevation of 295 feet AMSL. Climate data from this weather station do not include temperature data. The next closest station is the Sacramento 5 ESE station (CA271), which indicates an average temperature of 63.3°F, with an average range from a minimum of 51.3°F to a maximum of 75.2°F. The WETS tables do not provide median dates of 28°F air temperatures from which to estimate the length of the growing season; however, extended periods of freezing weather are very rare, and the growing season is essentially year-round.

Vegetation

The delineation area is within the Sacramento Valley subregion of the California Floristic Province (Baldwin et al. 2012:41). The delineation area supports two wetland plant communities (seasonal wetland and emergent wetland) and five non-wetland plant communities (annual grassland, planted oak woodland, Fremont cottonwood-oak woodland, valley foothill riparian woodland, and developed/landscaped). A list of plant species identified during the delineation fieldwork is presented in Appendix E. Common and scientific plant names are taken from the *Jepson Manual* (Baldwin et al. 2012).

Seasonal Wetland

Seasonal wetlands are normally inundated during the winter and early spring but are dry by late spring. The seasonal wetlands in the BSA consist of features that occur in swales created to carry runoff within the cloverleaf loops of the Hazel Avenue/US 50 interchange and are not naturally occurring features. These wetlands support few native plants species. Dominant species in the seasonal wetlands include Mediterranean barley (*Hordeum marinum* var. *gussoneanum*), Italian ryegrass (*Festuca perennis*), and hyssop loosestrife (*Lythrum hyssopifolia*).

Emergent Wetland

Emergent wetland occurs at the edges of open water in Alder Creek below valley foothill riparian woodland vegetation and the ordinary high water mark (OHWM) of the creek. Dominant species in this community include white alder saplings (*Alnus rhombifolia*), tall flatsedge (*Cyperus eragrostis*), Pacific rush (*Juncus effusus* ssp. *pacificus*), tule (*Schoenoplectus acutus*), California blackberry (*Rubus ursinus*), curly dock (*Rumex crispus*), and floating water primrose (*Ludwigia peploides* ssp. *peploides*).

Annual Grassland

Annual grassland occurs throughout the delineation area within the US 50 ROW and south of Folsom Boulevard. Dominant species in this community include annual grasses, such as wild oat

(*Avena fatua*), ripgut brome (*Bromus diandrus*), soft chess (*Bromus hordeaceus*), wall barley (*Hordeum murinum*), and perennial ryegrass (*Festuca perennis*) and native and nonnative forbs, such as dwarf brodiaea (*Brodiaea nana*), Italian thistle (*Carduus pycnocephalus*), elegant clarkia (*Clarkia unguiculata*), heron's bill (*Erodium botrys* and *E. cicutarium*), hawkbit (*Leontodon saxatilis*), milk thistle (*Silybum marianum*), hairy clover (*Trifolium hirtum*), and hairy vetch (*Vicia villosa*). This plant community also contains a blue elderberry shrub cluster (*Sambucus mexicana* ssp. *caerulea*)..

Planted Oak Woodland

The interchange cloverleaf areas are planted with native trees and shrubs found in oak woodlands, such as interior live oak (*Quercus wislizeni*), valley oak (*Q. lobata*), buckeye (*Aesculus californica*), Lemmon's ceanothus (*Ceanothus lemmonii*), coffeeberry (*Frangula californica*), California flannelbush (*Fremontodendron californicum*), and Fremont cottonwood, with annual grassland species in the understory. This plant community also contains blue elderberry shrub clusters.

Fremont Cottonwood-Oak Woodland

The proposed jughandle road area, located south of Folsom Boulevard, supports Fremont cottonwood-oak woodland. The overstory of this woodland is dominated by interior live oak, Fremont cottonwood (*Populus fremontii* ssp. *fremontii*), and willows (*Salix* spp.). The understory includes smaller willows, coyote brush (*Baccharis pilularis*), poison-oak (*Toxicodendron diversilobum*), and annual grasses and forbs. Blue elderberry shrubs also occur in this area.

Valley Foothill Riparian Woodland

Valley foothill riparian woodland occurs on the banks of Alder Creek above its OHWM. Dominant species in this community include willow (*Salix* spp.), white alder, and California blackberry (*Rubus ursinus*). Outside the delineation area, California foothill pine (*Pinus sabiniana*) and interior live oak also occur in valley foothill riparian woodland.

Developed/Landscaped

Vegetation in developed/landscaped areas consists of planted vegetation associated with businesses. Species used for landscaping are primarily nonnative trees, shrubs, and herbaceous flowers.

Soil Map Units

The delineation area contains six soil map units (Natural Resources Conservation Service 2015). These soil map units are shown in Appendix D, and the summarized descriptions of each unit, including hydric components, are listed in Table 2.

Table 2. Soil Map Units in the Delineation Area

Soil Map Unit	Map Symbol	Drainage Class	Landform	Typical Profile	Hydric Component (C)	Hydric Criteria[a]
Natomas loam, 0 to 2 percent slopes	181	Well drained	Terraces	loam over clay loam over stratified gravelly coarse sandy loam to sandy loam	–	–
Natomas-Xerorthents, dredge tailings complex, 0 to 50 percent slopes	182	Well drained	Terraces	loam over clay loam over stratified gravelly coarse sandy loam to sandy loam	Unnamed, slickens on terraces	3
Urban land	227	–	–	–	–	–
Urban land-Natomas complex, 0 to 2 percent slopes	228	Somewhat excessively drained	Terraces	loam over clay loam over stratified gravelly coarse sandy loam to sandy loam	–	–
Xerorthents, dredge tailings, 2 to 50 percent slopes	245	Well drained	–	fragmental material	Riverwash in channels Unnamed, slickens in depressions Xerofluvents on flood plains	4 3 4
Xerorthents, dredge tailings-Urban land complex, 0 to 2 percent slopes	246	Somewhat excessively drained	–	fragmental material	Unnamed, slickens in depressions	3
Water	247	–	–	–	–	–

Source: Natural Resources Conservation Service 2015.

[a] Hydric Criteria:

3 Soils that are frequently ponded for long or very long duration during the growing season.

4 Map unit components that are frequently flooded for long duration or very long duration during the growing season.

Delineation Methods

ICF botanist/wetland ecologist Lisa Webber conducted fieldwork for the delineation on April 6 and May 31, 2016. The delineation was conducted in accordance with the guidance provided in the 1987 *U.S. Army Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987:53–69), the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Arid West Region* (U.S. Army Corps of Engineers 2008), and 33 Code of Federal Regulations [CFR] 328.3(e) and 329.11(a)(1). The OHWM indicators were identified according to U.S. Army Corps of Engineers' Regulatory Guidance Letter No. 05-05 (U.S. Army Corps of Engineers 2005).

Data for wetlands and non-wetland waters were collected to support a preliminary JD approach during the permitting phase. USACE Sacramento District issued a Regulatory Guidance Letter

(16-01) regarding local processing procedures for JDs (U.S. Army Corps of Engineers 2016). The preliminary JD approach is intended to streamline the permitting process for applicants seeking USACE permit authorizations or JDs.

Six data point locations were evaluated in the accessible parts of the delineation area. A Trimble GeoXT global positioning system (GPS) unit, typically accurate to less than 1 horizontal meter, was used to record the locations of jurisdictional boundaries, data points, and other pertinent features, such as culverts, wherever possible. The GPS data were downloaded and corrected in the office using the nearest available base-station data before being superimposed onto recent (2014) 1 inch = 200 feet color orthorectified aerial photographs to generate the delineation map.

Aquatic Resources

A total of 0.91 acre of wetlands and non-wetland waters were identified in the delineation area: seasonal wetland (0.02 acre), emergent wetland (0.20 acre), ephemeral drainage (0.001 acre), perennial drainage (0.56 acre), and ditch (0.13 acre).

The delineation map in Appendix A illustrates the locations of all mapped features. Table 3 lists each feature by number and identifies its type, acreage, and map sheet number. In accordance with the preliminary JD approach, all mapped features were interpreted to fall within USACE jurisdiction under CWA Section 404. Table 3 provides a reference to features for which there are corresponding data forms in Appendix B and photographs included in Appendix C.

Table 3. Mapped Features with Data Forms and Photographs

Feature Number[a]	Feature Type	Acreage	Map Sheet Number[a]	Data Form[b]	Photograph Number[c]
SW-1	Seasonal wetland	0.01	3	--	--
SW-2	Seasonal wetland	0.01	3	DP-4w	1-4
EW-1	Emergent wetland	0.03	4	--	5
EW-2	Emergent wetland	0.0002	4	DP-2w	5
ED-1	Ephemeral drainage	0.001	3	--	--
ED-2	Ephemeral drainage	0.0004	5	--	--
PD-1	Perennial drainage	0.42	4	--	5 and 6
PDC-1	Perennial drainage (culverted)	0.14	4	--	6
D-1	Ditch		4 and 5	--	--

[a] As shown in Appendix A.
[b] Data forms are in Appendix B.
[c] Photographs are in Appendix C.

Wetlands

Seasonal Wetland

Two seasonal wetlands (SW-1 and SW-2) were mapped in the delineation area southwest of the westbound US 50 off-ramp. SW-1 is in a swale at the base of the off-ramp slope, and SW-2 is at

the outlet of a culvert at the base of the off-ramp slope. Both features support similar seasonal wetland vegetation. The representative data point for seasonal wetlands is documented on data form DP-4W for SW-2 (Appendix B). Dominant plant species observed in the seasonal wetlands were nonnative, including Mediterranean barley [FAC], perennial ryegrass [FAC], and hyssop loosestrife [OBL]. Associated species observed included curly dock [FAC], burclover (*Medicago polymorpha*) [NI], slender wild oat (*Avena barbata*) [NI], and a non-blooming tarweed that is presumably an upland species. The vegetation in seasonal wetlands met the federal wetland criterion for hydrophytic vegetation.

Soil at the data point location met the redox depressions (F8) hydric soil indicator, based on a 4-inch-thick layer in the upper 12 inches of the soil pit that had 10% prominent redox concentrations in the matrix and a matrix color of 7.5YR 4/6. Soil examined upslope of SW-2 did not exhibit redox features.

The seasonal wetlands were dry when field surveys were conducted. Positive indicators of wetland hydrology in seasonal wetland SW-2 were wetland drainage patterns (B10) and FAC-neutral test (D5). SW-2 is in a depression at the base of a slope that receives runoff from surrounding slopes via a culvert under the US 50 off-ramp.

Emergent Wetland

Two areas of emergent wetland (EW-1 and EW-2) were mapped on the banks of Alder Creek in the delineation area. EW-1 is on the southwest bank, and EW-2 is on the northeast bank of the creek. Both emergent wetlands support similar vegetation, although EW-1 supports more cover of California blackberry than does EW-2. The representative data point for emergent wetlands is documented on data form DP-2W for EW-2 (Appendix B). Emergent wetlands support herbaceous wetland species, including tall flatsedge [FACW], Pacific rush [FACW], tule [OBL], California blackberry [FAC], curly dock [FAC], and floating water primrose [OBL]. The vegetation in emergent wetlands met the federal wetland criterion for hydrophytic vegetation.

Soil in EW-2 is a thin layer over dredge tailings, but has a matrix value of 2 and a chroma of 1. The top layer of soil is 0.5 inch of decaying organic material; the next layer consists of 1.5 inches of loam, with dredge tailing cobbles beneath. The soil is a problematic hydric soil most similar to recently deposited vegetated sand and gravel bars within floodplains. The area sampled also appears to be flooded in most years according to Google Earth aerial imagery.

Positive indicators of wetland hydrology in EW-2 were the presence of a high water table (A2) and soil saturation to the surface (A3).

Non-Wetland Waters

Ephemeral Drainage

A 20-foot-long segment of ephemeral drainage (ED-1) crosses the delineation area east of Alder Creek. This drainage extends south from the edge of US 50 to Alder Creek. The drainage supports annual grassland vegetation and is approximately 1 foot wide at the OHWM. The

OHWM was identified on the basis of visual indicators: a break in the bank slope and the destruction of terrestrial vegetation.

An ephemeral drainage (ED-2) connects a roadside ditch (D-1) to Alder Creek (PD-1). The drainage supports annual grassland vegetation and is approximately 3.5 feet wide at the OHWM. The OHWM was identified on the basis of visual indicators: a break in the bank slope and the destruction of terrestrial vegetation.

Perennial Drainage

The delineation area contains one perennial drainage, Alder Creek (PD-1), which connects to Lake Natoma on the north side of US 50. Alder Creek flows under US 50 through a box culvert that is beneath a Mechanically Stabilized Earth (MSE) wall. As a result of the MSE, the water in Alder Creek backs up at the US 50 crossing, creating a pond-like area with mostly stagnant water. An emergent wetland fringe is present on both sides of the creek. Alder Creek is approximately 150-200 feet wide at the OHWM within the delineation area. The OHWM of the creek was identified on the basis of visual indicators: the destruction of terrestrial vegetation and a change in the plant community.

Jurisdictional Ditches

The delineation area contains four jurisdictional ditches: three drainage ditches that were previously verified as waters of the United States, and a constructed roadside ditch that was delineated by ICF.

The three drainage ditches were delineated and verified (SPK-2004-00515) for the Glenborough at Easton and Easton Place Project. The three ditches are south of Folsom Boulevard on property owned by Aerojet Corporation. These three verified ditches are included on the delineation map in Appendix A for information only; their fill has been permitted by the USACE Sacramento District.

The constructed roadside ditch (D-1) extends from the east end of the delineation area to Alder Creek. This ditch supports annual grassland vegetation and receives runoff from US 50 and the interchange loop at Folsom Boulevard. The ditch averages 3 feet wide at the OHWM that was identified on the basis of a break in the bank slope and the destruction of terrestrial vegetation. This ditch connects to Alder Creek via ED-2 and EW-2.

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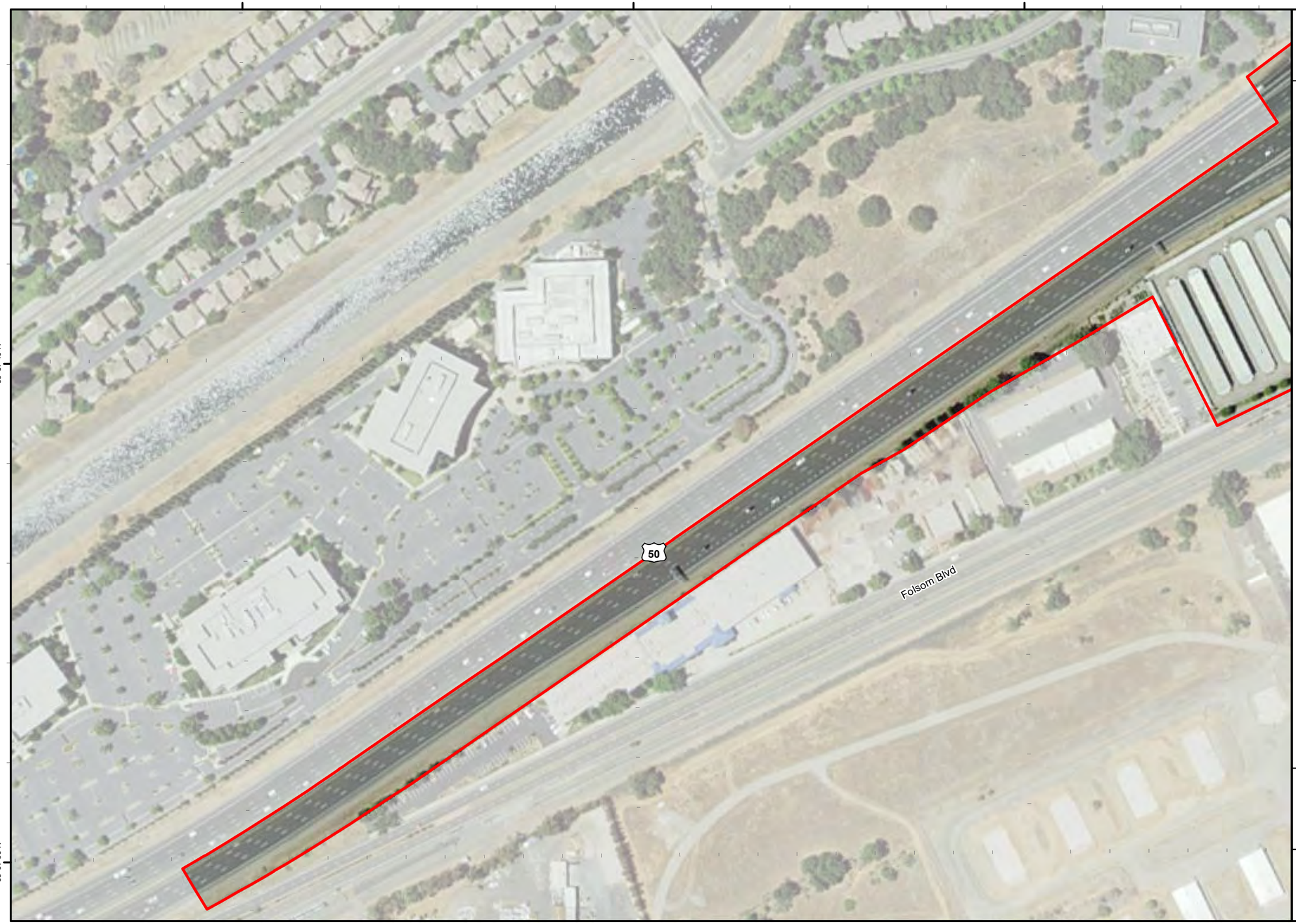
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Appendix A Aquatic Resources Delineation



Hazel Avenue / U.S. 50 Interchange Project
August 2018
Sheet 1 of 6

Legend

- Biological Study Area (98 Acres)
- Data Points (dp)
- Culverts
- Feature Boundaries Outside Delineation Area

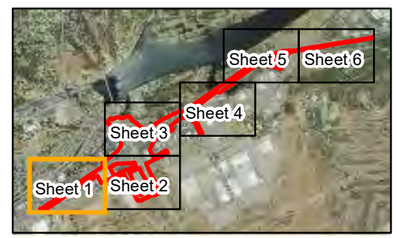
Wetlands

- Emergent Wetland - 0.20 acre
- Seasonal Wetland - 0.02 acre

Non-wetland Waters

- Ephemeral Drainage - 0.001 acre
- Perennial Drainage - 0.42 acre
- Perennial Drainage (Culverted) - 0.14 acre
- Ditch - 0.13 acre
- Ditch - Previously Delineated (SPK-2004-00515)

w = Average Width



0 50 100 200
Feet

1 inch = 200 feet

Notes:
Base Map Source: ICF and ECORP
Imagery Source: NAIP 2014
USGS Topo Quad: Folsom and Buffalo Creek
PLSS: Rio De Los Americanos Land Grant

Prepared By: ICF International
Delineated By: L. Webber
Delineation Date: April 6, May 31, and September 2, 2016
Drawn By: A. Angier

Path: \\PDCOITRDSGIS1\Projects_1\County_of_Sacramento\000529_15_HazelAve\Cmaps\doc\Bio\Aquatic_Resources_20180822.mxd; Author: ; Date: 8/22/2018

Appendix A
Delineation of Potential Waters of the United States, Including Wetlands

121°13'10"W

121°13'0"W

121°12'50"W

38°37'40"N

38°37'30"N

50

Folsom Blvd

Nimbus Rd

Hazel Avenue / U.S. 50 Interchange Project
August 2018
Sheet 2 of 6

Legend

- Biological Study Area (98 Acres)
- Data Points (dp)
- Culverts
- Feature Boundaries Outside Delineation Area

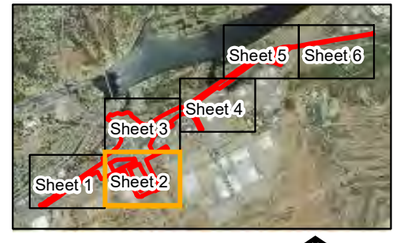
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0 50 100 200
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121°13'10"W
121°13'0"W
121°12'50"W
38°38'0"N
38°37'50"N
dp-6u
dp-3u
dp-4w
dp-5u
SW-2
SW-1
ED-1, w=3.5'
Hazel Ave
50
Folsom Blvd

Hazel Avenue / U.S. 50 Interchange Project
August 2018
Sheet 3 of 6

Legend

- Biological Study Area (98 Acres)
- Data Points (dp)
- Culverts
- Feature Boundaries Outside Delineation Area

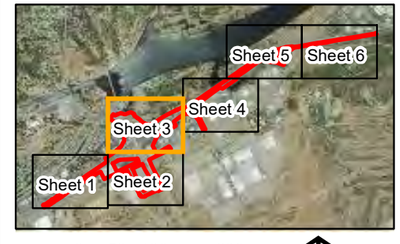
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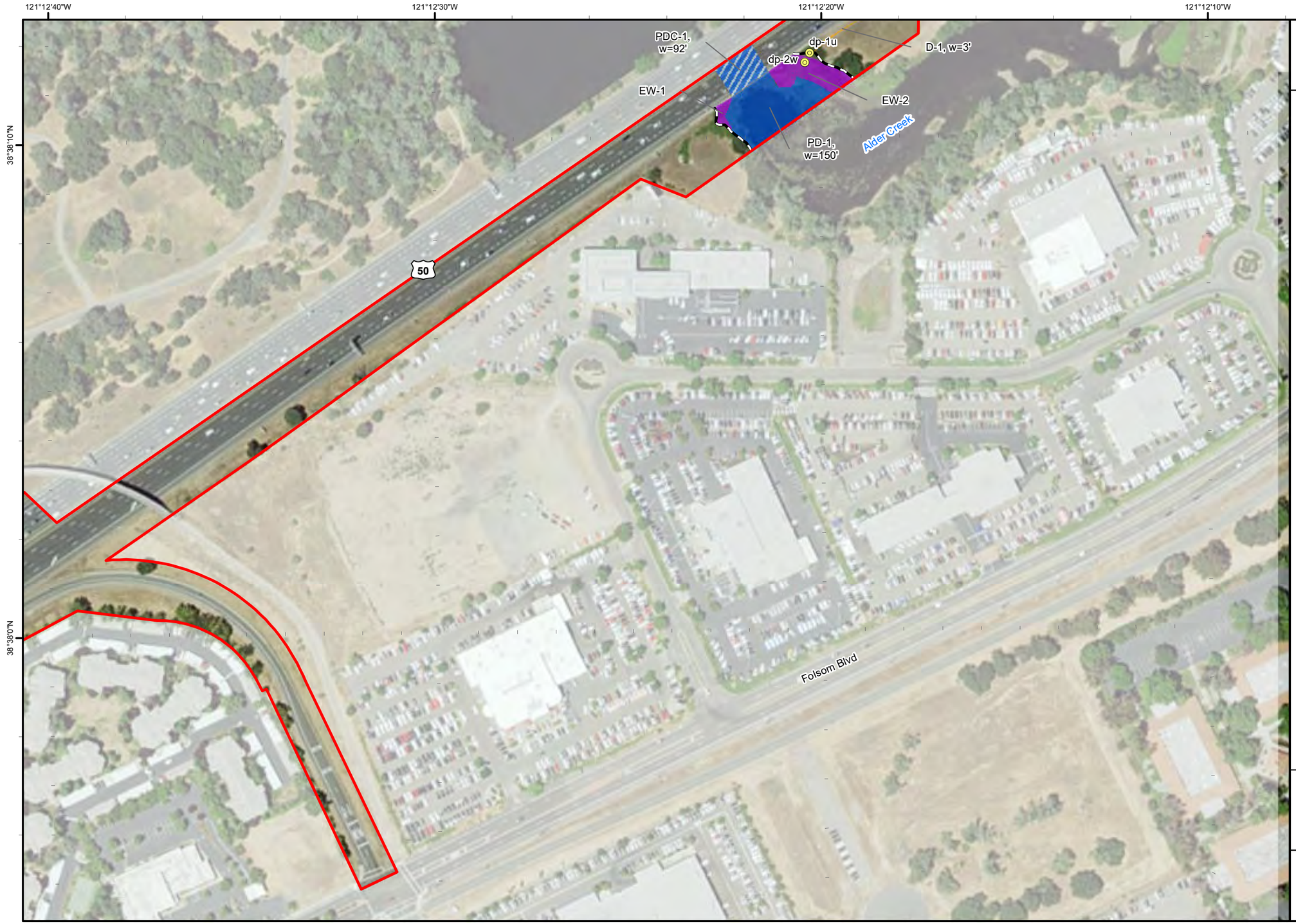


0 50 100 200
Feet
1 inch = 200 feet

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Hazel Avenue / U.S. 50 Interchange Project
August 2018
Sheet 4 of 6

Legend

- Biological Study Area (98 Acres)
- Data Points (dp)
- Culverts
- Feature Boundaries Outside Delineation Area

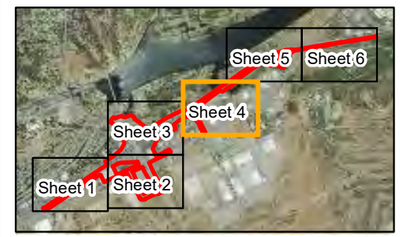
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0 50 100 200
Feet
1 inch = 200 feet

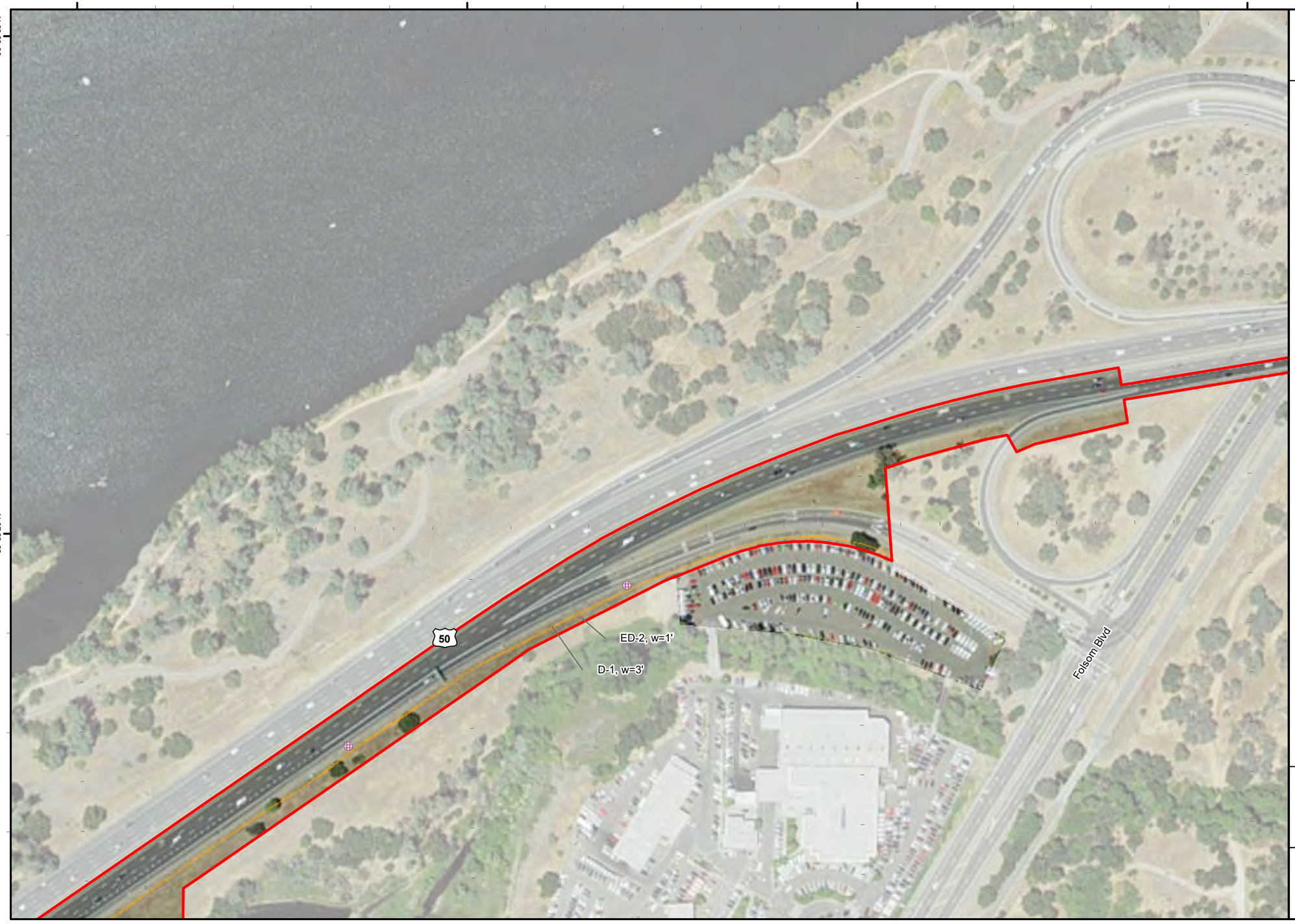
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Appendix A
Delineation of Potential Waters of the United States, Including Wetlands

121°12'20"W
121°12'10"W
121°12'0"W
121°11'50"W
38°38'30"N
38°38'20"N



Hazel Avenue / U.S. 50 Interchange Project
August 2018
Sheet 5 of 6

Legend

- Biological Study Area (98 Acres)
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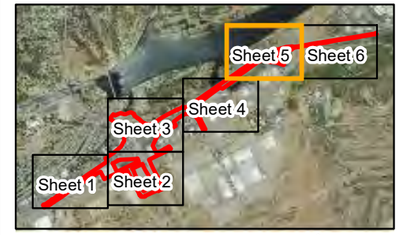
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w = Average Width



0 50 100 200
Feet
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Notes:

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Hazel Avenue / U.S. 50 Interchange Project
August 2018
Sheet 6 of 6

Legend

- Biological Study Area (98 Acres)
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- Feature Boundaries Outside Delineation Area

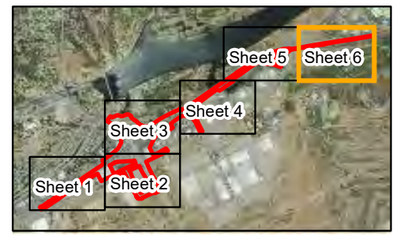
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Appendix A
Delineation of Potential Waters of the United States, Including Wetlands

Appendix B Routine Wetland Delineation Data Forms

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: SR50/Hazel Ave. City/County: Sac. Sampling Date: 4-6-16
Applicant/Owner: County of Sac. State: CA Sampling Point: DP-14
Investigator(s): Webber Section, Township, Range: Unnamed S, T 9N, R7E
Landform (hillslope, terrace, etc.): terrace Local relief (concave, convex, none): none Slope (%): 1%
Subregion (LRR): Mediterranean California (LRR C) Lat: Long: Datum:
Soil Map Unit Name: Natomas loam, 0-2% slopes (181) NWI Classification:
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No (If no, explain in Remarks.)
Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes X No ____
Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X No	**Is the Sampled Area within a Wetland?**	**Yes** ____ **No** X
Hydric Soil Present?	Yes ____ No X		
Wetland Hydrology Present?	Yes ____ No ?		

Remarks: Within OHWM of Alder Creek, east bank. Site is in upper part of OHWM, near the edge of a wetland fringe.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: 20')			
1. Alnus rhombifolia	80	Y	FACW
2.			
3.			
4.			
	80 =Total Cover		
Sapling/Shrub Stratum (Plot size: 20')			
1. Rubus armeniacus	5	N	FAC
2.			
3.			
4.			
5.			
	5 =Total Cover		
Herb Stratum (Plot size: 5')			
1. Juncus effusus	20	Y	FACW
2. Geranium dissectum	5	N	—
3. Schoenoplectus acutus	5	N	OBL
4.			
5.			
6.			
7.			
8.			
	30 =Total Cover		
Woody Vine Stratum (Plot size: ____)			
1.			
2.			
	____ =Total Cover		

% Bare Ground in Herb Stratum 70 % Cover of Biotic Crust 0

Dominance Test worksheet:
Number of Dominant Species That Are OBL, FACW, or FAC: ____ (A)
Total Number of Dominant Species Across All Strata: ____ (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: ____ (A/B)

Prevalence Index Worksheet:

Total % Cover of:	Multiply by:
OBL species ____	x1 = ____
FACW species ____	x2 = ____
FAC species ____	x3 = ____
FACU species ____	x4 = ____
UPL species ____	x5 = ____
Column Totals: ____ (A)	____ (B)

Prevalence Index = B/A = ____

Hydrophytic Vegetation Indicators:
X Dominance Test is >50%
____ Prevalence Index is ≤3.0[1]
____ Morphological Adaptationd[1] (Provide supporting data in Remarks or on a separate sheet)
____ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes X No ____

Remarks:

SOIL

Sampling Point: DP-4

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-2	2.5YR 3/2	100					1	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (**LRR C**)
- ___ 1 cm Muck (A9) (**LRR D**)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (**LRR C**)
- ___ 2 cm Muck (A10) (**LRR B**)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: Shovel refusal @ 2" - dredge tailings

Depth (inches): _____

Hydric Soil Present? Yes _____ No X

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1) (**Nonriverine**)
- ___ Sediment Deposits (B2) (**Nonriverine**)
- ___ Drift Deposits (B3) (**Nonriverine**)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (**Riverine**)
- ___ Sediment Deposits (B2) (**Riverine**)
- ___ Drift Deposits (B3) (**Riverine**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes _____ No X Depth (inches): none

Water Table Present? Yes _____ No X Depth (inches): none to 2"

Saturation Present? (includes capillary fringe) Yes _____ No X Depth (inches): none to 2"

Wetland Hydrology Present? Yes _____ No ?

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: Point is w/in ottawa / floodplain. Does not likely remain inundated for a long enough period to meet wetland hydrology criterion.

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: SR 50/Hazel Ave City/County: Sacramento Sampling Date: 4-6-16
Applicant/Owner: County of Sacramento State: CA Sampling Point: DP-2W
Investigator(s): Webster Section, Township, Range: unnamed S, T9N, R7E
Landform (hillslope, terrace, etc.): terrace Local relief (concave, convex, none): none Slope (%): 0
Subregion (LRR): Mediterranean California (LRR C) Lat: Long: Datum:
Soil Map Unit Name: Natomas loam, 0-2% slopes (181 NWI Classification:
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No (If no, explain in Remarks.)
Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes X No ____
Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X No	**Is the Sampled Area within a Wetland?**	**Yes** X **No**
Hydric Soil Present?	Yes X No		
Wetland Hydrology Present?	Yes X No		

Remarks: Point is in emergent wetland fringe of Alder Ct.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size:)			
1.			
2.			
3.			
4.			
	=Total Cover		
Sapling/Shrub Stratum (Plot size:)			
1.			
2.			
3.			
4.			
5.			
	=Total Cover		
Herb Stratum (Plot size: 5')			
1. Schoenoplectus acutus	40	Y	OBL
2. Ludwigia peploides	15	Y	OBL
3. Juncus effusus ssp. pacificus	5	N	FACW
4.			
5.			
6.			
7.			
8.			
	60 =Total Cover		
Woody Vine Stratum (Plot size:)			
1.			
2.			
	=Total Cover		

% Bare Ground in Herb Stratum 40 % Cover of Biotic Crust 30

Dominance Test worksheet:
Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)
Total Number of Dominant Species Across All Strata: 2 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index Worksheet:

Total % Cover of:	Multiply by:
OBL species	x1 =
FACW species	x2 =
FAC species	x3 =
FACU species	x4 =
UPL species	x5 =
Column Totals: (A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:
____ Dominance Test is >50%
____ Prevalence Index is ≤3.0[1]
____ Morphological Adaptationd[1] (Provide supporting data in Remarks or on a separate sheet)
____ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes X No

Remarks: Dead wood over ~30% of plot.

SOIL

Sampling Point: DP-2w

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-0.5								decaying layer of litter
0.5-2	10YR 3/1	100					1	small rocks

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (**LRR C**)
- ___ 1 cm Muck (A9) (**LRR D**)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (**LRR C**)
- ___ 2 cm Muck (A10) (**LRR B**)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- X Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: Shovel refusal at 2" - dredger tailings

Depth (inches): ___

Hydric Soil Present? Yes X No ___

Remarks: Meets the vegetated sand & gravel bars within floodplains, most similar to recently deposited soils. This area appears flooded on aerial imagery in most years.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- X High Water Table (A2)
- X Saturation (A3)
- ___ Water Marks (B1) (**Nonriverine**)
- ___ Sediment Deposits (B2) (**Nonriverine**)
- ___ Drift Deposits (B3) (**Nonriverine**)
- ___ Surface Soil Cracks (B6)
- X Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (**Riverine**)
- ___ Sediment Deposits (B2) (**Riverine**)
- ___ Drift Deposits (B3) (**Riverine**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ___ No X Depth (inches): none

Water Table Present? Yes X No ___ Depth (inches): at surface

Saturation Present? (includes capillary fringe) Yes X No ___ Depth (inches): " "

Wetland Hydrology Present? Yes X No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: SR50/Hazel Ave. City/County: Sacramento Sampling Date: 5-31-16
Applicant/Owner: County of Sac, State: CA Sampling Point: DP-34
Investigator(s): Webber Section, Township, Range: unnamed S, T9N, R7E
Landform (hillslope, terrace, etc.): — Local relief (concave, convex, none): none Slope (%): <1%
Subregion (LRR): Mediterranean California (LRR C) Lat: Long: Datum:
Soil Map Unit Name: Urban Land (227) NWI Classification:
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No (If no, explain in Remarks.)
Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes X No ____
Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ____ No X	**Is the Sampled Area within a Wetland?**	**Yes** ____ **No** X
Hydric Soil Present?	Yes ____ No X		
Wetland Hydrology Present?	Yes ____ No X		

Remarks: Site is near mouth of culvert in the off-ramp.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: 20')			
1. Populus fremontii	5	N	FAC
2.			
3.			
4.			
	5 =Total Cover		
Sapling/Shrub Stratum (Plot size: 20')			
1. Baccharis pilularis	5	N	—
2.			
3.			
4.			
5.			
	5 =Total Cover		
Herb Stratum (Plot size: 5')			
1. Hordeum marinum var. gussoneanum	60	Y	FAC
2. Festuca perennis	25	Y	FAC
3. Avena barbata	5	N	—
4. Geranium dissectum	5	N	—
5. Bromus hordeaceus	5	N	—
6.			
7.			
8.			
	100 =Total Cover		
Woody Vine Stratum (Plot size: ____)			
1.			
2.			
	=Total Cover		

% Bare Ground in Herb Stratum Ø % Cover of Biotic Crust ____

Dominance Test worksheet:
Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)
Total Number of Dominant Species Across All Strata: 2 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index Worksheet:

Total % Cover of:		Multiply by:
OBL species	____ x1 =	
FACW species	____ x2 =	
FAC species	90 x3 =	270
FACU species	____ x4 =	
UPL species	20 x5 =	100
Column Totals:	110 (A)	370 (B)

Prevalence Index = B/A = 3.4

Hydrophytic Vegetation Indicators:
____ Dominance Test is >50%
____ Prevalence Index is ≤3.0[1]
____ Morphological Adaptationd[1] (Provide supporting data in Remarks or on a separate sheet)
____ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ____ No X

Remarks:

SOIL

Sampling Point: DP-34

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-1								bark layer
1-4	10YR 3/4	100					cl	few rocks

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (**LRR C**)
- ___ 1 cm Muck (A9) (**LRR D**)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (**LRR C**)
- ___ 2 cm Muck (A10) (**LRR B**)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: Shovel refusal @ 4" - rock fill

Depth (inches): ___

Hydric Soil Present? Yes ___ No X

Remarks: Area is within constructed interchange, and is likely composed of fill.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1) (**Nonriverine**)
- ___ Sediment Deposits (B2) (**Nonriverine**)
- ___ Drift Deposits (B3) (**Nonriverine**)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (**Riverine**)
- ___ Sediment Deposits (B2) (**Riverine**)
- ___ Drift Deposits (B3) (**Riverine**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ___ No X Depth (inches): none

Water Table Present? Yes ___ No X Depth (inches): none to 4"

Saturation Present? (includes capillary fringe) Yes ___ No X Depth (inches): none to 4"

Wetland Hydrology Present? Yes ___ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: Slight depressional area near culvert. No other evidence of wetland hydrology

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: SR 50/Hazel Ave. City/County: Sacramento Sampling Date: 5-31-16
Applicant/Owner: County of Sacramento State: CA Sampling Point: DP-4w
Investigator(s): Webber Section, Township, Range: unnamed S, T9N, R7E
Landform (hillslope, terrace, etc.): — Local relief (concave, convex, none): none Slope (%): <1%
Subregion (LRR): Mediterranean California (LRR C) Lat: Long: Datum:
Soil Map Unit Name: Urban Land (227) NWI Classification:
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No (If no, explain in Remarks.)
Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes X No ____
Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X No	**Is the Sampled Area within a Wetland?**	**Yes** X **No**
Hydric Soil Present?	Yes X No		
Wetland Hydrology Present?	Yes X No		

Remarks: Site is in a depression at base of roadside slope, at freeway off ramp.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ____)			
1.			
2.			
3.			
4.			
	=Total Cover		
Sapling/Shrub Stratum (Plot size: ____)			
1.			
2.			
3.			
4.			
5.			
	=Total Cover		
Herb Stratum (Plot size: 5')			
1. Hordeum marinum var. gussoneanum	45	Y	FAC
2. Festuca perennis	20	Y	FAC
3. Lythrum hyssopifolia	15	Y	OBL
4. Rumex crispus	15	Y	FAC
5. tarweed (not blooming)	2	N	—
6. Medicago polymorpha	1	N	—
7. Avena barbata	2	N	—
8.			
	100 =Total Cover		
Woody Vine Stratum (Plot size: ____)			
1.			
2.			
	=Total Cover		

% Bare Ground in Herb Stratum 5 % Cover of Biotic Crust 0

Dominance Test worksheet:
Number of Dominant Species That Are OBL, FACW, or FAC: 4 (A)
Total Number of Dominant Species Across All Strata: 4 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index Worksheet:

Total % Cover of:	Multiply by:
OBL species ____	x1 = ____
FACW species ____	x2 = ____
FAC species ____	x3 = ____
FACU species ____	x4 = ____
UPL species ____	x5 = ____
Column Totals: ____ (A)	____ (B)

Prevalence Index = B/A = ____

Hydrophytic Vegetation Indicators:
X Dominance Test is >50%
____ Prevalence Index is ≤3.0[1]
____ Morphological Adaptationd[1] (Provide supporting data in Remarks or on a separate sheet)
____ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes X No ____

Remarks:

SOIL

Sampling Point: DP-4W

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-4	7.5YR 4/6	90	7.5YR 2/1	10		M	sicl	
4-20	7.5YR 4/6	100					sicl	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (**LRR C**)
- ___ 1 cm Muck (A9) (**LRR D**)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- X Redox Depressions (F8)
- ___ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (**LRR C**)
- ___ 2 cm Muck (A10) (**LRR B**)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes X No ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1) (**Nonriverine**)
- ___ Sediment Deposits (B2) (**Nonriverine**)
- ___ Drift Deposits (B3) (**Nonriverine**)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (**Riverine**)
- ___ Sediment Deposits (B2) (**Riverine**)
- ___ Drift Deposits (B3) (**Riverine**)
- X Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- X FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ___ No X Depth (inches): none

Water Table Present? Yes ___ No X Depth (inches): none to 20"

Saturation Present? (includes capillary fringe) Yes ___ No X Depth (inches): none to 20"

Wetland Hydrology Present? Yes X No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: Site is a depressional swale that receives runoff through a culvert under the freeway offramp. Other end of culvert drains a hillslope.

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: SR50/Hazel Ave. City/County: Sacramento Sampling Date: 5-31-16
Applicant/Owner: County of Sacramento State: CA Sampling Point: DP-5u
Investigator(s): Webber Section, Township, Range: unnamed S, T 9N, R7E
Landform (hillslope, terrace, etc.): — Local relief (concave, convex, none): none Slope (%): 10
Subregion (LRR): Mediterranean California (LRR C) Lat: Long: Datum:
Soil Map Unit Name: Urban Land (227) NWI Classification:
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No (If no, explain in Remarks.)
Are Vegetation X, Soil , or Hydrology significantly disturbed? Are "Normal Circumstances" present? Yes X No
Are Vegetation , Soil , or Hydrology naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X No	**Is the Sampled Area within a Wetland?**	**Yes** **No** X
Hydric Soil Present?	Yes No X		
Wetland Hydrology Present?	Yes No X		

Remarks: Upslope of DP-4w. Vegetation was mowed for maintenance—site is in adjacent to freeway offramp.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size:)			
1.			
2.			
3.			
4.			
=Total Cover			
Sapling/Shrub Stratum (Plot size:)			
1.			
2.			
3.			
4.			
5.			
=Total Cover			
Herb Stratum (Plot size: 5')			
1. Hordeum marinum var. guss.	90	y	FAC
2. Medicago polymorpha	1	n	FACU
3. Centaurea solstitialis	5	n	—
4. Trifolium hirtum	1	n	—
5. Festuca perennis	2	n	FAC
6.			
7.			
8.			
100 =Total Cover			
Woody Vine Stratum (Plot size:)			
1.			
2.			
=Total Cover			

% Bare Ground in Herb Stratum 0 % Cover of Biotic Crust

Dominance Test worksheet:
Number of Dominant Species That Are OBL, FACW, or FAC: (A)
Total Number of Dominant Species Across All Strata: (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: (A/B)

Prevalence Index Worksheet:

Total % Cover of:	Multiply by:
OBL species x1 =	
FACW species x2 =	
FAC species x3 =	
FACU species x4 =	
UPL species x5 =	
Column Totals: (A)	(B)
Prevalence Index = B/A =	

Hydrophytic Vegetation Indicators:
Dominance Test is >50%
Prevalence Index is ≤3.0[1]
Morphological Adaptationd[1] (Provide supporting data in Remarks or on a separate sheet)
Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes X No

Remarks: Veg. mowed.

SOIL

Sampling Point: DP-5y

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Redox Features Type[1]	Redox Features Loc[2]	Texture	Remarks
0-8	7.5YR 4/6	100					sicl	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (**LRR C**)
- ___ 1 cm Muck (A9) (**LRR D**)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (**LRR C**)
- ___ 2 cm Muck (A10) (**LRR B**)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: shovel refusal at 8"

Depth (inches): 8"

Hydric Soil Present? Yes ___ No X

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1) (**Nonriverine**)
- ___ Sediment Deposits (B2) (**Nonriverine**)
- ___ Drift Deposits (B3) (**Nonriverine**)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (**Riverine**)
- ___ Sediment Deposits (B2) (**Riverine**)
- ___ Drift Deposits (B3) (**Riverine**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ___ No X Depth (inches): none

Water Table Present? Yes ___ No X Depth (inches): none to 8"

Saturation Present? (includes capillary fringe) Yes ___ No X Depth (inches): none to 8"

Wetland Hydrology Present? Yes ___ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: On slope, no hydrologic indicators

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: SR 50/Hazel Ave. City/County: Sac Sampling Date: 9-2-16
Applicant/Owner: County of Sacramento State: CA Sampling Point: DP-6u
Investigator(s): Webber Section, Township, Range: unnamed S, T9N, R7E
Landform (hillslope, terrace, etc.): terrace Local relief (concave, convex, none): none Slope (%): 1%
Subregion (LRR): Mediterranean California (LRR C) Lat: Long: Datum:
Soil Map Unit Name: Urban land-Natomas complex, 0-2% slopes NWI Classification: —
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No (If no, explain in Remarks.)
Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes X No
Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes ____ No X
Hydric Soil Present? Yes ____ No X
Wetland Hydrology Present? Yes ____ No X
Is the Sampled Area within a Wetland? Yes ____ No X

Remarks: Site is in a basin, near a culvert outlet, at the base of a road embankment

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ____)			
1.			
2.			
3.			
4.			
	____ =Total Cover		
Sapling/Shrub Stratum (Plot size: ____)			
1.			
2.			
3.			
4.			
5.			
	____ =Total Cover		
Herb Stratum (Plot size: 5')			
1. Festuca perennis	30	y	FAC
2. Avena fatua	10	n	—
3. Centaurea solstitialis	20	y	—
4. Vicia sp.	15	y	—
5. Rumex crispus	3	n	FAC
6. Hordeum murinum var. gussoneanum	3	n	FAC
7. Lythrum hyssopifolia	1	n	OBL
8. Trifolium dubium	1	n	UPL
Trifolium hirtum	1	n	—
	95 =Total Cover		
Woody Vine Stratum (Plot size: ____)			
1.			
2.			
Madia sp.	1	n	—
	____ =Total Cover		
% Bare Ground in Herb Stratum 5	% Cover of Biotic Crust Ø		

Dominance Test worksheet:
Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)
Total Number of Dominant Species Across All Strata: 3 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 33% ~~#DIV/0!~~ (A/B)

Prevalence Index Worksheet:

Total % Cover of:		Multiply by:
OBL species	____ x1 =	
FACW species	____ x2 =	
FAC species	____ x3 =	
FACU species	____ x4 =	
UPL species	____ x5 =	
Column Totals:	____ (A)	____ (B)

Prevalence Index = B/A = ____

Hydrophytic Vegetation Indicators:
____ Dominance Test is >50%
____ Prevalence Index is ≤3.0[1]
____ Morphological Adaptationd[1] (Provide supporting data in Remarks or on a separate sheet)
____ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ____ No X

Remarks: Bare ground is covered in cobbles

SOIL

Sampling Point: DP-64

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Redox Features Type[1]	Redox Features Loc[2]	Texture	Remarks
0-4	10YR 3/4	100					cl	roots + cobbles
4-12	10YR 3/4	100					cl	cobbles, some broken glass

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (**LRR C**)
- ___ 1 cm Muck (A9) (**LRR D**)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (**LRR C**)
- ___ 2 cm Muck (A10) (**LRR B**)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: cobble

Depth (inches): 12

Hydric Soil Present? Yes ___ No X

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1) (**Nonriverine**)
- ___ Sediment Deposits (B2) (**Nonriverine**)
- ___ Drift Deposits (B3) (**Nonriverine**)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (**Riverine**)
- ___ Sediment Deposits (B2) (**Riverine**)
- ___ Drift Deposits (B3) (**Riverine**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ___ No X Depth (inches): none@surface

Water Table Present? Yes ___ No X Depth (inches): 7 12

Saturation Present? (includes capillary fringe) Yes ___ No X Depth (inches): 7 12

Wetland Hydrology Present? Yes ___ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: No evidence of wetland hydrology

Appendix C Representative Photographs



Photo 1. Seasonal wetland SW-2, looking south



Photo 2. Seasonal wetland SW-2, looking north



Photo 3. Seasonal wetland vegetation



Photo 4. Culvert connecting to seasonal wetland SW-2



Photo 5. Alder Creek with fringe of emergent wetland, looking west



Photo 6. Alder Creek at US 50 bridge

Appendix D Soil Survey Map and Information

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Sacramento County, California

US 50/Hazel Avenue Interchange



March 23, 2016

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (http://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the

individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

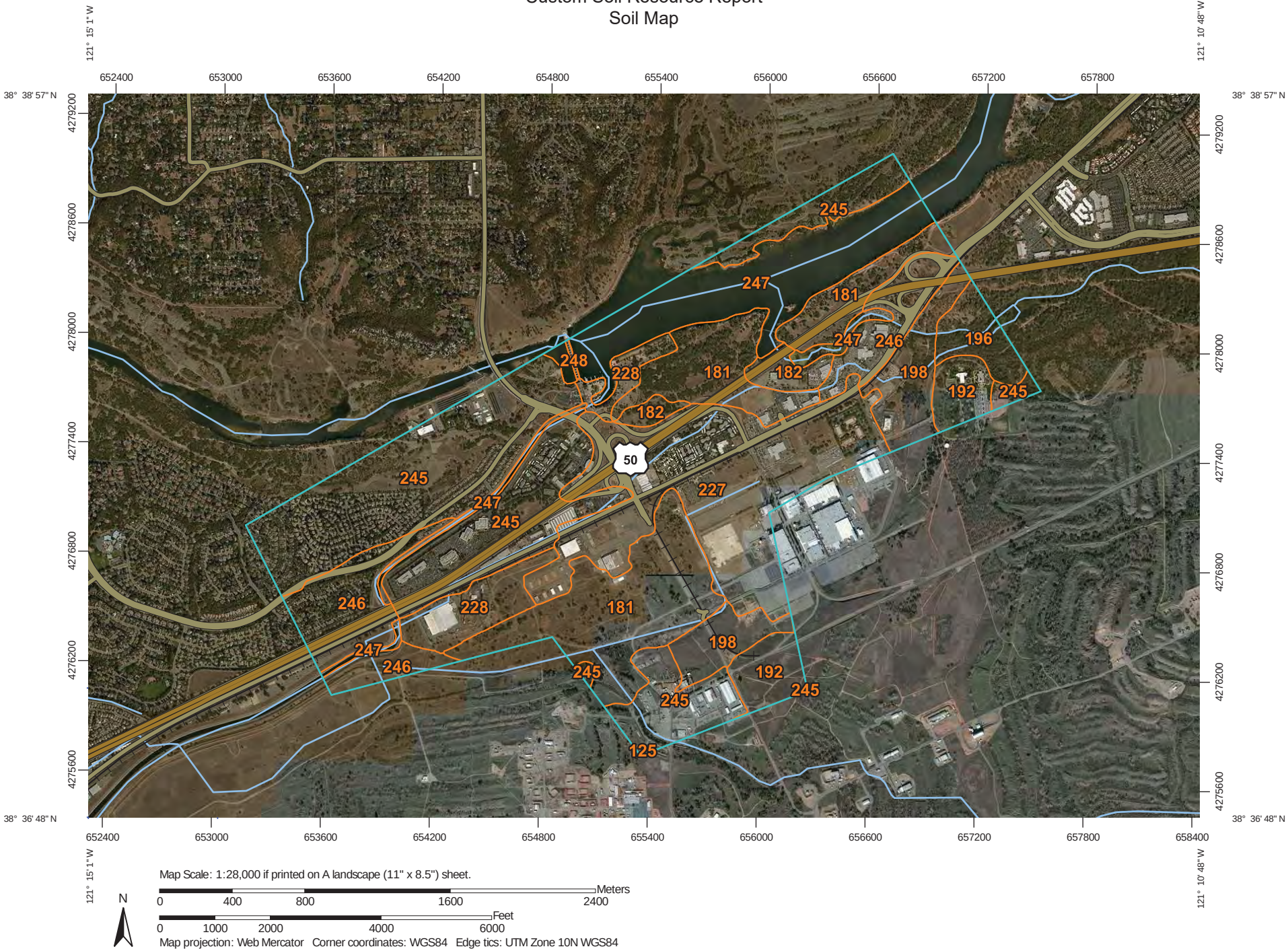
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map



MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Sacramento County, California
Survey Area Data: Version 14, Sep 14, 2015

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Aug 15, 2011—Oct 24, 2013

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Sacramento County, California (CA067)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
125	Corning complex, 0 to 8 percent slopes	0.5	0.0%
181	Natomas loam, 0 to 2 percent slopes	282.2	17.1%
182	Natomas-Xerorthents, dredge tailings complex, 0 to 50 percent slopes	28.8	1.7%
192	Red Bluff loam, 2 to 5 percent slopes	59.9	3.6%
196	Red Bluff-Xerorthents, dredge tailings, complex, 2 to 50 percent slopes	35.8	2.2%
198	Redding gravelly loam, 0 to 8 percent slopes	92.9	5.6%
227	Urban land	292.7	17.7%
228	Urban land-Natomas complex, 0 to 2 percent slopes	69.3	4.2%
245	Xerorthents, dredge tailings, 2 to 50 percent slopes	452.9	27.4%
246	Xerorthents, dredge tailings-Urban land complex, 0 to 2 percent slopes	146.5	8.9%
247	Water	189.0	11.4%
248	Dam	1.1	0.1%
Totals for Area of Interest		**1,651.6**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be

made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Sacramento County, California

125—Corning complex, 0 to 8 percent slopes

Map Unit Setting

National map unit symbol: hhm0
Elevation: 80 to 1,000 feet
Mean annual precipitation: 16 to 30 inches
Mean annual air temperature: 61 to 63 degrees F
Frost-free period: 250 to 280 days
Farmland classification: Not prime farmland

Map Unit Composition

Corning and similar soils: 45 percent
Corning and similar soils: 40 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Corning

Setting

Landform: Terraces
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Gravelly alluvium

Typical profile

H1 - 0 to 28 inches: gravelly loam
H2 - 28 to 47 inches: gravelly clay loam
H3 - 47 to 62 inches: stratified gravelly sandy loam to gravelly clay loam

Properties and qualities

Slope: 2 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 5.5 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: D
Ecological site: GRAVELLY LOAMY (R017XD090CA)

Description of Corning

Setting

Landform: Terraces
Landform position (two-dimensional): Toeslope

Landform position (three-dimensional): Tread
Microfeatures of landform position: Swales
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Gravelly alluvium

Typical profile
H1 - 0 to 20 inches: gravelly sandy loam
H2 - 20 to 32 inches: clay
H3 - 32 to 60 inches: stratified gravelly sandy loam to gravelly clay loam

Properties and qualities
Slope: 0 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 4.9 inches)

Interpretive groups
Land capability classification (irrigated): 2e
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: D
Ecological site: GRAVELLY LOAMY INTERMOUND (R017XD091CA)

Minor Components

Creviscreek
Percent of map unit: 4 percent

Hicksville
Percent of map unit: 4 percent

Redding
Percent of map unit: 4 percent

Unnamed, steeper slopes
Percent of map unit: 3 percent

181—Natomas loam, 0 to 2 percent slopes

Map Unit Setting
National map unit symbol: hhnt
Elevation: 50 to 180 feet
Mean annual precipitation: 17 to 23 inches
Mean annual air temperature: 61 to 63 degrees F
Frost-free period: 275 to 300 days

Farmland classification: Prime farmland if irrigated

Map Unit Composition

Natomas and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Natomas

Setting

Landform: Terraces
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

H1 - 0 to 17 inches: loam
H2 - 17 to 33 inches: loam
H3 - 33 to 78 inches: clay loam
H4 - 78 to 84 inches: stratified gravelly coarse sandy loam to sandy loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 10.3 inches)

Interpretive groups

Land capability classification (irrigated): 1
Land capability classification (nonirrigated): 3c
Hydrologic Soil Group: C

Minor Components

Americanos

Percent of map unit: 5 percent

Kimball

Percent of map unit: 4 percent

San joaquin

Percent of map unit: 4 percent

Unnamed, brown subsoil

Percent of map unit: 2 percent

182—Natomas-Xerorthents, dredge tailings complex, 0 to 50 percent slopes

Map Unit Setting

National map unit symbol: hhnv
Elevation: 0 to 2,500 feet
Mean annual precipitation: 17 to 23 inches
Mean annual air temperature: 61 to 63 degrees F
Frost-free period: 275 to 300 days
Farmland classification: Not prime farmland

Map Unit Composition

Natomas and similar soils: 45 percent
Xerorthents and similar soils: 40 percent
Unnamed, slickens: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Natomas

Setting

Landform: Terraces
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

H1 - 0 to 17 inches: loam
H2 - 17 to 33 inches: loam
H3 - 33 to 78 inches: clay loam
H4 - 78 to 84 inches: stratified gravelly coarse sandy loam to sandy loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 10.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3c
Hydrologic Soil Group: C

Description of Xerorthents

Setting

Landform: Terraces
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mine spoil or earthy fill

Typical profile

H1 - 0 to 60 inches: variable

Properties and qualities

Slope: 2 to 50 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 0.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e

Description of Unnamed, Slickens

Setting

Landform: Terraces
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s

192—Red Bluff loam, 2 to 5 percent slopes

Map Unit Setting

National map unit symbol: hhp5
Elevation: 200 to 800 feet
Mean annual precipitation: 30 inches
Mean annual air temperature: 63 degrees F
Frost-free period: 250 to 280 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Red bluff and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Red Bluff

Setting

Landform: Terraces
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

H1 - 0 to 8 inches: loam
H2 - 8 to 25 inches: clay loam
H3 - 25 to 43 inches: clay loam
H4 - 43 to 68 inches: gravelly clay loam

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C
Ecological site: LOAMY (R017XD045CA)

Minor Components

Redding

Percent of map unit: 7 percent

Xerorthents

Percent of map unit: 7 percent

Unnamed

Percent of map unit: 2 percent
Landform: Depressions

Unnamed, steeper slopes

Percent of map unit: 2 percent

Unnamed, hardpan soil

Percent of map unit: 2 percent

196—Red Bluff-Xerorthents, dredge tailings, complex, 2 to 50 percent slopes

Map Unit Setting

National map unit symbol: hhp9
Elevation: 0 to 2,500 feet
Mean annual precipitation: 30 inches
Mean annual air temperature: 63 degrees F
Frost-free period: 250 to 280 days
Farmland classification: Not prime farmland

Map Unit Composition

Red bluff and similar soils: 45 percent
Xerorthents,, dredge tailings, and similar soils: 40 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Red Bluff

Setting

Landform: Terraces
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

H1 - 0 to 8 inches: loam
H2 - 8 to 25 inches: clay loam
H3 - 25 to 43 inches: clay loam
H4 - 43 to 68 inches: gravelly clay loam

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C
Ecological site: LOAMY (R017XD045CA)

Description of Xerorthents,, Dredge Tailings

Setting

Landform: Terraces
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mine spoil or earthy fill

Typical profile

H1 - 0 to 60 inches: variable

Properties and qualities

Slope: 2 to 50 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 0.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e

Minor Components

Hicksville

Percent of map unit: 4 percent

Unnamed

Percent of map unit: 2 percent
Landform: Depressions

Corning

Percent of map unit: 2 percent

Hicksville

Percent of map unit: 2 percent

Redding

Percent of map unit: 2 percent

Unnamed

Percent of map unit: 1 percent
Landform: Depressions

Unnamed, hardpan below 40 inches

Percent of map unit: 1 percent

Unnamed, steeper slopes

Percent of map unit: 1 percent

198—Redding gravelly loam, 0 to 8 percent slopes

Map Unit Setting

National map unit symbol: hhpc
Elevation: 100 to 1,500 feet
Mean annual precipitation: 14 to 25 inches
Mean annual air temperature: 61 to 63 degrees F
Frost-free period: 230 to 320 days
Farmland classification: Not prime farmland

Map Unit Composition

Redding and similar soils: 75 percent
Minor components: 25 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Redding

Setting

Landform: Terraces
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Gravelly alluvium

Typical profile

H1 - 0 to 7 inches: gravelly loam
H2 - 7 to 20 inches: gravelly loam
H3 - 20 to 28 inches: gravelly clay loam
H4 - 28 to 66 inches: indurated

Properties and qualities

Slope: 0 to 8 percent
Depth to restrictive feature: 28 to 66 inches to duripan
Natural drainage class: Moderately well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 2.9 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: C
Ecological site: GRAVELLY LOAMY (R017XD090CA)

Minor Components

Corning
Percent of map unit: 4 percent

Hicksville
Percent of map unit: 4 percent

Keyes
Percent of map unit: 4 percent

Pardee
Percent of map unit: 4 percent

Xerorthents
Percent of map unit: 4 percent

Unnamed
Percent of map unit: 1 percent
Landform: Depressions

Durixeralfs
Percent of map unit: 1 percent

Xerarents
Percent of map unit: 1 percent

Unnamed, hardpan below 40 inches
Percent of map unit: 1 percent

Unnamed, steeper slopes
Percent of map unit: 1 percent

227—Urban land

Map Unit Composition
Urban land: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Urban Land

Typical profile
H1 - 0 to 6 inches: variable

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8

228—Urban land-Natomas complex, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: hhqb
Elevation: 50 to 180 feet
Mean annual precipitation: 17 to 23 inches
Mean annual air temperature: 61 to 63 degrees F
Frost-free period: 275 to 300 days
Farmland classification: Not prime farmland

Map Unit Composition

Urban land: 45 percent
Natomas and similar soils: 40 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Urban Land

Typical profile

H1 - 0 to 6 inches: variable

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8

Description of Natomas

Setting

Landform: Terraces
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

H1 - 0 to 17 inches: loam
H2 - 17 to 33 inches: loam
H3 - 33 to 78 inches: clay loam
H4 - 78 to 84 inches: stratified gravelly coarse sandy loam to sandy loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 10.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3c
Hydrologic Soil Group: C

Minor Components

Americanos

Percent of map unit: 4 percent

Kimball

Percent of map unit: 4 percent

San joaquin

Percent of map unit: 3 percent

Xerarents

Percent of map unit: 3 percent

Unnamed, clayey subsoil

Percent of map unit: 1 percent

245—Xerorthents, dredge tailings, 2 to 50 percent slopes

Map Unit Setting

National map unit symbol: hhqw
Elevation: 80 to 400 feet
Mean annual precipitation: 18 to 20 inches
Mean annual air temperature: 61 degrees F
Frost-free period: 250 to 300 days
Farmland classification: Not prime farmland

Map Unit Composition

Xerorthents, dredge tailings, and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Xerorthents, Dredge Tailings

Setting

Parent material: Mine spoil or earthy fill

Typical profile

H1 - 0 to 60 inches: fragmental material

Properties and qualities

Slope: 2 to 50 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Runoff class: Low

Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 1.2 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8s
Hydrologic Soil Group: A

Minor Components

Natomas
Percent of map unit: 2 percent

Red bluff
Percent of map unit: 2 percent

Rossmoor
Percent of map unit: 2 percent

Riverwash
Percent of map unit: 1 percent
Landform: Channels

Unnamed, slickens
Percent of map unit: 1 percent
Landform: Depressions

Xerofluvents
Percent of map unit: 1 percent
Landform: Flood plains
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread

Redding
Percent of map unit: 1 percent

246—Xerorthents, dredge tailings-Urban land complex, 0 to 2 percent slopes

Map Unit Setting
National map unit symbol: hhqx
Elevation: 80 to 400 feet
Mean annual precipitation: 18 to 20 inches
Mean annual air temperature: 61 degrees F
Frost-free period: 250 to 300 days
Farmland classification: Not prime farmland

Map Unit Composition
Xerorthents, dredge tailings, and similar soils: 45 percent

Urban land: 40 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Xerorthents, Dredge Tailings

Setting
Parent material: Mine spoil or earthy fill

Typical profile
H1 - 0 to 60 inches: fragmental material

Properties and qualities
Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 1.2 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8s
Hydrologic Soil Group: A

Description of Urban Land

Typical profile
H1 - 0 to 6 inches: variable

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8

Minor Components

Unnamed, slickens
Percent of map unit: 5 percent
Landform: Depressions

Americano
Percent of map unit: 5 percent

Natomas
Percent of map unit: 5 percent

247—Water

Map Unit Composition

Water: 100 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Water

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 8

248—Dam

Map Unit Composition

Dam: 100 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Soil Information for All Uses

Soil Reports

The Soil Reports section includes various formatted tabular and narrative reports (tables) containing data for each selected soil map unit and each component of each unit. No aggregation of data has occurred as is done in reports in the Soil Properties and Qualities and Suitabilities and Limitations sections.

The reports contain soil interpretive information as well as basic soil properties and qualities. A description of each report (table) is included.

Land Classifications

This folder contains a collection of tabular reports that present a variety of soil groupings. The reports (tables) include all selected map units and components for each map unit. Land classifications are specified land use and management groupings that are assigned to soil areas because combinations of soil have similar behavior for specified practices. Most are based on soil properties and other factors that directly influence the specific use of the soil. Example classifications include ecological site classification, farmland classification, irrigated and nonirrigated land capability classification, and hydric rating.

Hydric Soils (US 50/Hazel Avenue Interchange)

This table lists the map unit components that are rated as hydric soils in the survey area. This list can help in planning land uses; however, onsite investigation is recommended to determine the hydric soils on a specific site (National Research Council, 1995; Hurt and others, 2002).

The three essential characteristics of wetlands are hydrophytic vegetation, hydric soils, and wetland hydrology (Cowardin and others, 1979; U.S. Army Corps of Engineers, 1987; National Research Council, 1995; Tiner, 1985). Criteria for all of the characteristics must be met for areas to be identified as wetlands. Undrained hydric soils that have natural vegetation should support a dominant population of ecological wetland plant species. Hydric soils that have been converted to other uses should be capable of being restored to wetlands.

Hydric soils are defined by the National Technical Committee for Hydric Soils (NTCHS) as soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part

(Federal Register, 1994). These soils, under natural conditions, are either saturated or inundated long enough during the growing season to support the growth and reproduction of hydrophytic vegetation.

The NTCHS definition identifies general soil properties that are associated with wetness. In order to determine whether a specific soil is a hydric soil or nonhydric soil, however, more specific information, such as information about the depth and duration of the water table, is needed. Thus, criteria that identify those estimated soil properties unique to hydric soils have been established (Federal Register, 2002). These criteria are used to identify map unit components that normally are associated with wetlands. The criteria used are selected estimated soil properties that are described in "Soil Taxonomy" (Soil Survey Staff, 1999) and "Keys to Soil Taxonomy" (Soil Survey Staff, 2006) and in the "Soil Survey Manual" (Soil Survey Division Staff, 1993).

If soils are wet enough for a long enough period of time to be considered hydric, they should exhibit certain properties that can be easily observed in the field. These visible properties are indicators of hydric soils. The indicators used to make onsite determinations of hydric soils are specified in "Field Indicators of Hydric Soils in the United States" (Hurt and Vasilas, 2006).

Hydric soils are identified by examining and describing the soil to a depth of about 20 inches. This depth may be greater if determination of an appropriate indicator so requires. It is always recommended that soils be excavated and described to the depth necessary for an understanding of the redoximorphic processes. Then, using the completed soil descriptions, soil scientists can compare the soil features required by each indicator and specify which indicators have been matched with the conditions observed in the soil. The soil can be identified as a hydric soil if at least one of the approved indicators is present.

Map units that are dominantly made up of hydric soils may have small areas, or inclusions, of nonhydric soils in the higher positions on the landform, and map units dominantly made up of nonhydric soils may have inclusions of hydric soils in the lower positions on the landform.

The criteria for hydric soils are represented by codes in the table (for example, 2). Definitions for the codes are as follows:

1. All Histels except for Folistels, and Histosols except for Folists.
2. Soils in Aquic suborders, great groups, or subgroups, Albolls suborder, Historthels great group, Histoturbels great group, Pachic subgroups, or Cumulic subgroups that:
    A. Based on the range of characteristics for the soil series, will at least in part meet one or more Field Indicators of Hydric Soils in the United States, or
    B. Show evidence that the soil meets the definition of a hydric soil;
3. Soils that are frequently ponded for long or very long duration during the growing season.
    A. Based on the range of characteristics for the soil series, will at least in part meet one or more Field Indicators of Hydric Soils in the United States, or
    B. Show evidence that the soil meets the definition of a hydric soil;
4. Map unit components that are frequently flooded for long duration or very long duration during the growing season that:
    A. Based on the range of characteristics for the soil series, will at least in part meet one or more Field Indicators of Hydric Soils in the United States, or
    B. Show evidence that the soil meets the definition of a hydric soil;

Hydric Condition: Food Security Act information regarding the ability to grow a commodity crop without removing woody vegetation or manipulating hydrology.

References:
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Federal Register. September 18, 2002. Hydric soils of the United States.
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Report—Hydric Soils (US 50/Hazel Avenue Interchange)

Hydric Soils–Sacramento County, California				
Map symbol and map unit name	**Component**	**Percent of map unit**	**Landform**	**Hydric criteria**
125—Corning complex, 0 to 8 percent slopes				
	Corning	40	Terraces	3
182—Natomas-Xerorthents, dredge tailings complex, 0 to 50 percent slopes				
	Unnamed, slickens	15	Terraces	3
192—Red Bluff loam, 2 to 5 percent slopes				
	Unnamed	2	Depressions	3
196—Red Bluff-Xerorthents, dredge tailings, complex, 2 to 50 percent slopes				
	Unnamed	2	Depressions	3
	Unnamed	1	Depressions	3
198—Redding gravelly loam, 0 to 8 percent slopes				
	Unnamed	1	Depressions	3

Hydric Soils–Sacramento County, California				
Map symbol and map unit name	**Component**	**Percent of map unit**	**Landform**	**Hydric criteria**
245—Xerorthents, dredge tailings, 2 to 50 percent slopes				
	Riverwash	1	Channels	4
	Unnamed, slickens	1	Depressions	3
	Xerofluvents	1	Flood plains	4
246—Xerorthents, dredge tailings-Urban land complex, 0 to 2 percent slopes				
	Unnamed, slickens	5	Depressions	3

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Appendix E Plant Species Observed in the Delineation Area

Plant Species Observed in the Delineation Area

Scientific Name	Common Name	Wetland Indicator Status[2]
Acmispon americanus var. *americanus* [*Lotus purshianus*]	Spanish lotus	UPL
Aesculus californica	Buckeye	NI
Aira caryophyllea	Silver hairgrass	FACU
Alnus rhombifolia	White alder	FACW
Amsinckia menziesii	Small flowered fiddleneck	NI
*Avena barbata**	Slender wild oat	NI
*Avena fatua**	Wild oat	NI
Azolla filiculoides	American water fern	OBL
Baccharis pilularis	Coyote brush	NI
*Brassica nigra**	Black mustard	NI
*Bromus diandrus**	Ripgut brome	NI
*Bromus hordeaceus**	Soft chess	FACU
Bromus madritensis ssp. *madritensis*	Foxtail chess	UPL
Bromus madritensis ssp. *rubens**	Red brome	UPL
*Carduus pycnocephalus**	Italian thistle	NI
Castilleja attenuata	Valley tassels	NI
Ceanothus lemmonii	Lemmon's ceanothus	NI
*Centaurea melitensis**	Maltese star thistle	NI
*Centaurea solstitialis**	Yellow star-thistle	NI
Centaurium tenuiflorum	Slender centaury	FACW
Centromadia fitchii	Spikeweed	FACU
Cercis occidentalis	Redbud	NI
Chlorogalum pomeridianum var. *pomeridianum*	Common soaproot	NI
*Cirsium arvense**	Bull thistle	FACU
Clarkia unguiculata	Elegant clarkia	NI
Claytonia perfoliata	Miner's lettuce	FAC
*Conium maculatum**	Poison hemlock	FACW
*Convolvulus arvensis**	Bindweed	NI
*Cortaderia jubata**	Pampas grass	FACU
Cyperus eragrostis	Tall flatsedge	FACW
Dichelostemma capitatum spp. *capitatum*	Blue dicks	FACU
Epilobium brachycarpum	Annual fireweed	NI
Erigeron canadensis	Canada horseweed	FACU
Erodium botrys	Big heronbill	FACU

Scientific Name	Common Name	Wetland Indicator Status[2]
*Erodium cicutarium**	Red stemmed filaree	NI
Eschscholzia californica	California poppy	NI
Eucalyptus sp.	Eucalyptus	Undetermined
Festuca [*Vulpia*] *myuros**	Rattail six weeks grass	FACU
Festuca perennis [*Lolium perenne*]*	Italian ryegrass	FAC
*Ficus carica**	Edible fig	FACU
*Foeniculum vulgare**	Sweet fennel	NI
Frangula californica	Coffeeberry	NI
Fremontodendron californicum	California flannelbush	NI
Galium aparine	Common bedstraw	FACU
*Geranium dissectum**	Cut leaved geranium	NI
Geranium molle	Dove's foot geranium	NI
Heterotheca grandiflora	Telegraph weed	NI
Holocarpha virgata ssp. *virgata*	Narrow tarplant	NI
Hordeum marinum ssp. *gussoneanum*	Mediterranean barley	FAC
Hordeum murinum ssp. *leporinum**	Foxtail barley	FACU
*Hypochaeris glabra**	Smooth cat's ear	NI
*Iris pseudacorus**	Water iris	OBL
Juncus effusus ssp. *pacificus*	Pacific rush	FACW
Kickxia spuria	Fluellin	NI
Lactuca serriola	Prickly lettuce	FACU
Leontodon saxatilis ssp. *longirostris*	Hawkbit	FACU
Ludwigia peploides ssp. *peploides**	Floating water primrose	OBL
Lupinus bicolor	Bicolor lupine	NI
Lupinus nanus	Sky lupine	NI
Lythrum hyssopifolia [*hyssopifolium*]*	Hyssop loosestrife	OBL
*Marrubium vulgare**	White horehound	FACU
*Medicago polymorpha**	Bur clover	FACU
Melilotus indicus	Yellow sweetclover	FACU
Oxalis corniculata	Yellow sorrel	FACU
Persicaria hydropiperoides	Knotweed	OBL
Petrorhagia dubia	Pink grass	NI
Phalaris aquatica	Harding grass	FACU
Phoradendron leucarpum	American mistletoe	NI
Pinus sabiniana	California foothill pine	NI
*Plantago lanceolata**	English plantain	FAC
*Polypogon monspeliensis**	Rabbitsfoot grass	FACW
Populus fremontii ssp. *fremontii*[2]	Fremont cottonwood	FAC
Prunus sp.	Cherry	Undetermined
Quercus lobata	Valley oak	FACU
Quercus wislizeni	Interior live oak	NI
*Raphanus sativus**	Wild radish	NI

Scientific Name	Common Name	Wetland Indicator Status[2]
Rubus ursinus	California blackberry	FAC
*Rumex crispus**	Curly dock	FAC
Salix exigua	Narrowleaf willow	FACW
Salix gooddingii	Black willow	FACW
Sambucus nigra ssp. *caerulea*	Blue elderberry	FACU
Schoenoplectus acutus	Tule	OBL
Senecio vulgaris	Old man of spring	FACU
*Silybum marianum**	Milk-thistle	NI
Stellaria media	Chickweed	FACU
Stipa pulchra	Purple needlegrass	NI
Toxicodendron diversilobum	Poison oak	FACU
Trifolium dubium	Suckling clover	UPL
*Trifolium hirtum**	Rose clover	NI
Verbena bonariensis	Purpletop vervain	FACW
Vicia sativa ssp. *nigra*	Common vetch	FACU
Vicia tetrasperma	Four seeded vetch	NI
Vicia villosa	Hairy vetch	NI

1 Scientific names follow The National Wetland Plant List: 2016 Wetland Ratings (Lichvar et al. 2016). Names in [ ] are from Baldwin et al. 2012.

2 Wetland indicator status ratings and definitions are from Lichvar et al. 2012

- OBL (Obligate Wetland Plants)—Almost always occur in wetlands.
- FACW (Facultative Wetland Plants)—Usually occur in wetlands, but may occur in non-wetlands.
- FAC (Facultative Plants)—Occur in wetlands and nonwetlands.
- FACU (Facultative Upland Plants)—Usually occur in non-wetlands, but may occur in wetlands.
- UPL (Upland Plants)—Almost never occur in wetlands.
- NI (No Indicator) —Species is not included on the National Wetland Plant List.
- Undetermined—cannot be assigned an indicator status because plant could not be identified to species.

* Species identified as invasive by the California Department of Food and Agriculture and/or the California Invasive Plant Council

Appendix F WETS Tables

USDA Field Office Climate Data

WETS Station : REPRESA, CA7370 Creation Date: 04/13/2016
Latitude: 3842 Longitude: 12110 Elevation: 00295
State FIPS/County(FIPS): 06067 County Name: Sacramento
Start yr. - 1971 End yr. - 2000

Month	Temperature (Degrees F.) avg daily max	avg daily min	Precipitation (Inches) avg	avg	30% chance will have less than	more than	avg # of days w/.1 or more	avg total snow fall
January				4.08	1.68	4.96	7	0.0
February				3.93	1.81	4.80	7	0.0
March				3.81	1.59	4.68	7	0.0
April				1.55	0.77	1.91	3	0.0
May				0.81	0.06	0.94	2	0.0
June				0.26	0.00	0.34	1	0.0
July				0.10	NA	NA	0	0.0
August				0.12	0.00	0.02	0	0.0
September				0.45	0.00	0.47	1	0.0
October				1.25	0.40	1.55	3	0.0
November				2.92	1.08	3.52	5	0.0
December				2.93	1.37	3.62	5	0.0
Annual	-----	-----	-----	------	16.84	25.88	--	----
Average				------	------	------	--	----
Average	-----	-----	-----	22.21	------	------	41	0.0

GROWING SEASON DATES

Probability	Temperature: 24 F or higher	28 F or higher	32 F or higher
	Beginning and Ending Dates Growing Season Length		
50 percent *			
70 percent *			

* Percent chance of the growing season occurring between the Beginning and Ending dates.

total 1893-2012 prcp

Station : CA7370, REPRESA
Unit = inches

yr	jan	feb	mar	apr	may	jun	jul	aug	sep	oct	nov	dec	annl
93			7.40	2.00	1.28	0.00	0.00	0.00	0.70	0.26	3.81	2.35	17.80
94	4.71	5.53	0.65	0.56	2.80	1.10			0.65	2.75	0.90	12.56	32.21
95	11.36	2.64	2.50	2.26	1.83			0.00	1.45	0.07	1.98	1.95	26.04
96	9.07	0.22	4.46	6.54	1.62			0.55	0.35	0.82	M5.83	1.80	31.26
97	4.38	8.99	4.95	0.71	0.35	0.00		0.18	0.10	2.61	1.11	2.04	25.42
98	0.79	4.31	0.30	0.45	1.53	0.35			0.24	0.88	1.87	2.62	13.34
99	5.41	0.04	M7.85	0.74	1.12	0.43		0.04	0.00	6.39	5.52	4.39	31.93
0	5.00	1.16	2.73	3.12	1.72	0.00	0.00		0.25	2.26	4.37	1.63	22.24
1	5.01	6.93	0.56	3.63	0.67	0.00	0.00	0.03	1.15	3.02	3.77	1.88	26.65
2	0.99	8.78	3.68	1.78	1.25	0.06	0.00	0.00	0.00	1.97	2.16	4.75	25.42
3	5.77	1.64	8.13	1.04	0.00	0.00	0.00	0.00	0.00	0.19	6.42	1.83	25.02
4	1.15	8.33	8.55	2.13	0.30	0.00	0.00	0.09	3.10	3.41	2.94	2.03	32.03
5	3.34	2.84	M0.98	1.96	2.42			0.00	0.00		1.89	1.29	14.72
6	9.01	M6.25	M1.46	2.45	3.08	1.14		M0.00	0.92		1.77	13.53	39.61
7	6.31	5.31	12.39	1.13	0.70	1.06			0.05	M0.39	M0.31	M6.47	34.12
8	M4.92	3.33	0.96	0.33	1.50	0.14			0.04	1.18	1.53	3.85	17.78
9	14.96	7.44	2.92		M0.00	0.19	0.00	0.00	0.10	1.38	3.47	5.64	36.10
10	4.88	3.23	3.87	0.60	0.07	0.04	0.00	0.00	0.74	0.79	0.72	3.36	18.30
11	20.35	M2.17	5.77	0.83	M0.48	0.04	0.00		0.00	M0.22	0.89	1.56	32.31
12	4.63	0.38	3.36	3.61	1.66	0.57	0.03	0.00	1.10	1.03	1.98	0.96	19.31
13	4.02	0.34	2.07	1.14	1.08	0.00	0.00		0.00	0.16	3.77	M8.52	21.10
14	11.45	4.48	0.75	0.25	1.56	1.04	0.00	0.00	0.00	1.27	0.40	5.85	27.05
15	6.53	8.47	2.28	0.72	5.38	0.00			0.00	0.00	1.30	7.12	31.80
16	11.08	5.62	1.48	0.00	0.07	0.00	0.00	0.00	0.00	0.75	M2.04	3.90	24.94
17	M1.73	M6.82	M1.37	M1.68	0.33				M0.32		M0.80	1.21	14.26
18	M1.11	4.67	M5.88	0.96	M0.09				M0.70	M0.32	2.54	M2.61	18.88
19	M2.18	M9.79	M2.87	M0.83					M0.34	M0.28	M0.29	M4.92	21.50
20	M0.99	M0.82	M7.10	M2.18		M0.16		M0.07	M0.02	M3.44	M5.33	M7.31	27.42
21	M9.12	1.51	M3.51	M0.29	1.57					M0.44	M1.49	M6.57	24.50
22	M3.57	M6.40	M3.03	M1.18	M1.47			0.00	0.00	0.69	M4.73	M9.26	30.33
23	M3.82	M0.64	M0.35	M5.31	M0.55	M0.15		M0.00	M0.86	M0.68	M0.70	1.58	14.64
24	2.80	M2.19	2.02	M0.62	M0.09					3.25	2.19	5.90	19.06
25	1.45	8.06	2.12	M1.66	2.17	0.02			0.13	0.30	1.67	2.20	19.78
26	4.64	7.61	0.08	6.55	0.77			0.00		2.31	7.81	1.63	31.40
27	4.67	7.02	3.81	1.78	0.36	0.58	0.00	0.00	0.00	1.51	3.30	3.54	26.57
28	1.77	2.31	7.25	1.64	0.05	0.09	0.00	0.00	0.00	0.09	3.96	2.84	20.00
29	2.20	2.91	2.64	1.11	0.00	2.24		0.00	0.00	0.12	0.00	5.85	17.07
30	6.23	1.93	3.74	2.20	0.22	0.00	0.00	0.00	0.21	0.40	2.38	1.31	18.62
31	3.16	2.87	1.65	0.30	1.14	0.98	0.00	0.00	0.00	1.29	2.57	8.69	22.65
32	2.01	3.24	0.68	1.31	1.18	0.00	0.00	0.00	0.00	0.00	1.03	2.90	12.35
33	5.58	1.77	3.30	0.00	1.74	0.00	0.00	0.00	0.08	2.43	0.00	10.39	25.29
34	1.30	4.91	0.14	0.37	0.51	0.36	0.00	0.00	0.08	1.84	3.61	2.53	15.65
35	8.02	2.81	3.52	6.02	0.25	0.00	0.00	0.00	0.00	2.17	1.18	2.39	26.36
36	5.98	10.76	1.62	1.76	0.60	0.21	0.00	0.00	0.01	0.58	0.00	3.08	24.60
37	4.01	6.02	7.82	1.83	0.12	0.50	0.00	0.00	0.00	1.45	3.46	2.65	27.86
38	3.84	7.69	4.28	1.45	0.68	0.00	0.00		0.01	1.90	0.60	1.16	21.61
39	2.00	1.76	3.59	0.10	0.99	0.00	0.00	0.00	0.81	0.87	0.10	1.80	12.02
40	12.01	8.17	4.94	2.50	0.24	0.00	0.00	0.00	0.00	1.05	1.58	8.62	39.11
41	4.76	7.97	2.31	3.77	1.10	0.00	0.00	0.00	0.00	0.79	1.21	6.48	28.39
42	6.15	3.70	2.99	5.49	1.83	0.00	0.00	0.00	0.06	0.01	4.24	3.11	27.58

43	4.63	2.53	6.29	2.29	0.42	0.00	0.00	0.00	0.00	0.43	1.10	2.70	20.39
44	3.38	8.23	M1.65	1.79	0.54	0.30	0.00	0.00	0.00	2.21	4.99	2.33	25.42
45	0.69	4.95	2.38	0.62	2.40	0.10	0.00	0.00	0.00	2.46	3.13	6.94	23.67
46	0.77	2.07	3.27	0.05	0.53	0.00	0.00	0.00	0.46	0.62	3.31	1.80	12.88
47	0.62	2.05	3.50	0.50	0.16	0.39	0.00	0.00	0.00	3.28	1.45	1.16	13.11
48	0.99	1.86	3.41	3.32	2.68	0.00	0.00	0.00	0.00	0.34	1.14	3.95	17.69
49	M0.13	M1.14	8.77	0.00	0.33	0.00	0.00	0.00	0.10	0.02	1.07	2.56	14.12
50	M5.83	M2.67	3.63	1.16	0.66	0.03	0.00	0.00	0.31	2.88	7.46	4.75	29.38
51	4.02	2.57	1.26	0.73	1.56	0.00	0.00	0.00	0.00	1.85	3.61	5.89	21.49
52	M9.12	2.71	4.93	1.11	0.09	0.42	0.00	0.00	0.22	0.00	2.56	7.02	28.18
53	4.06	0.25	1.57	4.02	1.52	0.83	0.00	0.00	0.00	0.57	2.37	1.39	16.58
54	3.80	3.25	4.93	2.50	0.38	0.93	0.00	0.33	0.00	0.07	2.86	6.58	25.63
55	3.51	1.52	0.25	2.78	0.53	0.00	0.00	0.00	0.43	0.69	1.84	11.44	22.99
56	8.13	2.61	0.07	1.61	2.99	M0.02	0.00	0.00	0.63	2.10	0.03	0.40	18.59
57	2.70	4.16	3.88	2.41	3.89	0.00	0.00	0.00	M0.23	1.81	0.94	3.12	23.14
58	5.31	7.49	7.58	4.85	0.96	1.20	0.00	0.00	0.30	0.27	0.39	0.66	29.01
59	5.31	4.77	0.95	2.09	0.01	0.00	0.00	0.00	1.93	0.00	0.00	1.11	16.17
60	3.83	3.54	2.44	1.50	0.72	0.00	0.00	0.00	0.02	0.00	5.02	1.33	18.40
61	2.81	1.61	3.48	1.05	0.43	0.00	0.00	M0.00	M0.26	0.29	3.14	1.63	14.70
62	1.65	8.61	1.88	0.57	0.10	0.01	0.04	0.23	0.03	8.80	0.59	2.44	24.95
63	2.83	1.89	4.30	4.69	1.05	0.05	0.00	0.00	0.16	1.96	5.68	0.27	22.88
64	3.23	0.52	1.76	0.28	1.05	0.28	0.00	0.22	0.00	1.82	4.26	7.01	20.43
65	2.91	0.79	2.33	3.45	0.01	0.00	0.02	0.44	0.00	0.24	4.29	3.82	18.30
66	2.45	1.99	0.62	0.70	0.30	0.00	0.06	0.00	0.03	0.00	7.13	3.49	16.77
67	8.58	0.55	4.52	4.42	0.71	0.38	0.00	0.00	0.06	0.23	1.94	1.24	22.63
68	3.71	3.19	2.84	0.47	0.76	0.24	0.00	0.22	0.01	0.81	3.87	3.69	19.81
69	11.54	6.81	1.19	2.18	0.02	0.35	0.00	0.00		0.93	1.80	4.56	29.38
70	7.00	1.68	1.91	0.23	0.00	0.65	0.00	0.00	0.00	1.39	8.13	4.25	25.24
71	1.36	0.26	M3.01	0.45	0.96	0.22	0.00	0.00	0.12	0.60	1.46	5.75	14.19
72	0.69	2.23	0.44	2.52	0.43	0.19	0.00	0.00	1.42	1.12	5.29	2.38	16.71
73	8.10	5.81	3.62	0.70	0.01	0.00	0.00	0.00	0.19	2.29	7.11	4.60	32.43
74	4.49	1.67	4.26	1.74	0.00	0.45	1.96	0.00	0.00	1.67	1.25	2.34	19.83
75	0.83	4.65	M5.81	1.65	0.00	0.11	0.00	0.59	0.00	2.29	0.77	0.78	17.48
76	0.39	1.58	0.63	1.25	0.00	0.05	0.00	1.57	1.33	0.00	0.58	0.24	7.62
77	1.13	0.90	1.01	0.37	1.07	0.00	0.01	0.00	0.43	0.12	1.74	4.22	11.00
78	9.66	3.81	6.37	3.76	0.00	0.16	0.00	0.00	0.79	0.00	4.06	1.01	29.62
79	5.59	5.15	2.47	1.14	0.24	0.00	0.14	0.00	0.00	2.32	2.07	3.96	23.08
80	M6.64	7.21	4.00	M0.93	0.46	0.06	0.80	0.00	0.00			1.88	21.98
81	M5.15	1.18	4.79	0.64	0.37	0.00	0.00	0.00	0.40	2.31	7.32		22.16
82	3.10	3.40	8.26	3.15	0.00	0.32	0.00	0.00	1.97	4.05	6.99	4.11	35.35
83	5.64	7.83	9.19	5.24	0.36	0.00	0.00	0.22	M2.09	1.13	7.72	7.11	46.53
84	0.31	2.24	1.86	0.73	0.10	0.21	0.00	0.17	0.12	1.83	5.68	1.87	15.12
85	0.74	2.02	3.08	0.00	0.00	0.30	0.00	0.18	0.70	0.96	4.60	2.51	15.09
86	3.95	8.68	4.91	1.07	0.23	0.00	0.00	0.00	0.97	0.29	0.33	1.42	21.85
87	2.29		4.64	0.46	M0.97	0.00	0.00	0.00	0.00	0.44	2.67	3.39	14.86
88	3.12	0.79	0.00	3.48	0.47	0.26	0.00	0.00	0.00	0.02	2.81	2.78	13.73
89	M0.73	1.51	8.77	0.42	0.16	0.83	0.00	0.34	2.40	2.49	1.72	0.00	19.37
90	3.29	2.79	0.98	0.87	2.86	0.00	0.00	0.00	0.00		1.33	1.42	13.54
91	0.65	M2.09	10.97	0.31	0.34	0.43	0.00	0.25	0.00	1.82	0.71	2.77	20.34
92	1.78	6.86	2.39	2.13	0.00	0.33	0.00	0.00	0.00	2.37	0.47	7.39	23.72
93	8.33	5.48	3.53	1.00	1.38	1.46	0.00	0.00	0.00	0.77	2.83	2.68	27.46
94	1.41	3.85	0.44	1.36	1.10	0.00	0.00	0.00	0.12	0.57	4.78	1.47	15.10
95	12.71	0.68	10.35	2.42	2.42	1.09	0.00	0.00	0.00	0.00	0.03	2.89	32.59
96	3.52	5.28	M1.97	3.16	2.56	0.16	0.00	0.01	0.00	1.32	2.22	8.00	28.20
97	9.78	M0.41	0.23	0.76	0.29	0.79	0.00	0.28	0.00	1.29	3.92	2.70	20.45
98	7.60	12.05	3.21	3.26	4.82	0.10	0.00	0.00	0.19	0.71	4.22	0.96	37.12
99	3.34	5.37	1.48	0.74	0.25	0.10	0.00	0.07	0.00	0.25	2.14	0.21	13.95
0	5.77	8.99	1.48	1.06	2.52	0.30	0.00	0.00	0.18	3.76	0.47	0.68	25.21
1	3.78	0.00	2.12	2.64	0.00	0.10	0.00	0.00	0.45	0.38	3.26	7.48	20.21
2	0.21	0.57	2.75	0.43	0.55	0.00	0.00	0.00	0.00	0.00	0.15	M5.81	10.47

3	3.61	1.76	1.69	4.83	0.89	0.00	0.00	0.29	0.00	0.30	1.46	5.07	19.90
4	2.31	4.85	0.69	0.38	0.00	0.00	0.00	0.00	0.00	2.91	1.62	4.69	17.45
5	M3.26	2.10	3.94	2.09	2.37	0.77	0.00	0.00	0.50	0.21		M10.18	25.42
6	3.27	1.11	M5.54	M5.46	0.14	0.00	0.00	0.00	0.00	0.22	0.68	2.64	19.06
7	0.00	9.18	0.00	0.00	0.00	0.00	0.00	0.00	0.73	M0.78	0.00	1.84	12.53
8	14.38	10.40	M2.63		0.44	0.00	0.00		0.00	0.30	1.20	2.35	31.70
9	3.40	3.68	M3.42	0.00	0.48	0.00	0.00	0.00	0.00	0.00	0.57	M7.48	19.03
10	5.03	3.19	1.61	2.70	1.39	0.07	0.00	0.00	0.00	1.96	3.97	5.04	24.96
11	M1.67	M5.99	M6.32	M0.10	M1.45	M1.13			0.00	M2.27	M2.29	M0.34	21.56
12	M2.98	M0.83											3.81

Product generated by ACIS - NOAA Regional Climate Centers.

USDA Field Office Climate Data

WETS Station : SACRAMENTO 5 ESE, CA271 Creation Date: 06/23/2016
Latitude: 3833 Longitude: 12125 Elevation: 00038
State FIPS/County(FIPS): 06067 County Name: Sacramento
Start yr. - 1971 End yr. - 2000

	Temperature (Degrees F.)			Precipitation (Inches)				
					30% chance will have		avg # of days w/.1 or more	avg total snow fall
Month	avg daily max	avg daily min	avg	avg	less than	more than		
January	55.1	41.3	48.2	4.18	1.79	5.10	7	0.0
February	62.2	44.7	53.5	3.77	1.59	4.59	7	0.0
March	67.0	47.1	57.1	3.15	1.39	3.84	7	0.0
April	73.9	49.5	61.7	1.17	0.59	1.43	3	0.0
May	81.6	54.1	67.9	0.60	0.03	0.63	1	0.0
June	88.8	58.4	73.6	0.18	0.00	0.21	1	0.0
July	93.8	60.9	77.4	0.05	0.00	0.00	0	0.0
August	92.5	60.8	76.7	0.05	0.00	0.00	0	0.0
September	88.6	59.0	73.8	0.37	0.00	0.37	1	0.0
October	79.2	53.6	66.4	1.00	0.32	1.21	2	0.0
November	64.2	45.9	55.1	2.59	0.97	3.16	5	0.0
December	55.0	40.4	47.7	2.76	1.22	3.40	5	0.0
Annual	-----	-----	-----	------	15.40	22.98	--	----
Average	75.2	51.3	63.3	------	------	------	--	----
Average	-----	-----	-----	19.87	------	------	38	0.0

GROWING SEASON DATES

	Temperature		
Probability	24 F or higher	28 F or higher	32 F or higher
	Beginning and Ending Dates Growing Season Length		
50 percent *			
70 percent *			

* Percent chance of the growing season occurring between the Beginning and Ending dates.

total 1877-2016 prcp

Station : CA271, SACRAMENTO 5 ESE
------- Unit = inches

yr	jan	feb	mar	apr	may	jun	jul	aug	sep	oct	nov	dec	annl
77							M0.00	0.00	0.00	0.73	1.07	1.43	3.23
78	9.26	8.04	3.09	1.07	0.17	0.00	0.00	0.00	0.29	0.55	0.51	0.47	23.45
79	3.18	3.89	4.88	2.56	1.30	0.13	0.00	0.00	0.00	0.88	2.05	3.41	22.28
80	1.64	1.83	1.70	M14.20	0.76	0.00	0.00	0.00	0.00	0.00	0.05	11.81	31.99
81	6.14	5.06	1.37	1.64	0.00	0.50	0.00	0.00	0.30	0.55	1.88	3.27	20.71
82	1.89	2.40	3.78	1.99	0.35	0.10	0.00	M0.00	0.57	2.63	3.22	1.13	18.06
83	2.23	1.11	3.70	0.67	2.85	0.00	0.00	0.00	0.90	0.97	0.61	0.44	13.48
84	3.43	4.46	8.14	4.32	0.06	1.45	0.00	0.00	0.60	2.01	0.00	10.45	34.92
85	2.16	0.49	0.08	0.68	0.00	0.11	0.00	0.00	0.08	0.02	11.34	5.76	20.72
86	7.95	0.29	2.68	4.08	0.07	0.00	M0.00	0.00	0.00	0.68	0.21	2.18	18.14
87	1.12	6.28	0.94	2.53	0.00	0.00	0.00	0.00	0.02	0.00	0.45	2.09	13.43
88	4.81	0.57	3.04	0.10	0.40	0.08	0.00	0.00	0.55	0.00	4.28	M4.61	18.44
89	0.15	0.33	6.25	0.26	3.25	0.25	0.00	0.00	0.00	6.02	3.15	7.82	27.48
90	6.62	4.06	3.00	1.33	1.80	0.00	0.00	0.00	0.80	M0.00	0.00	6.68	24.29
91	0.53	6.61	1.78	2.04	0.66	0.05	0.00	0.00	0.10	0.10	0.48	3.28	15.63
92	1.78	2.84	3.02	1.20	2.38	0.00	M0.00	0.00	0.18	0.70	3.34	4.90	20.34
93	3.27	2.66	3.51	1.08	1.05	0.00	0.00	0.00	0.22	0.12	2.92	1.76	16.59
94	4.17	3.92	0.74	M0.34	1.70	0.46	0.00	0.00	0.88	1.06	0.48	8.86	22.61
95	8.42	1.84	1.20	0.86	0.51	0.00	0.04	0.00	1.26	0.17	1.54	1.54	17.38
96	9.76	0.09	2.57	5.34	0.66	0.00	0.00	0.20	0.31	0.55	3.56	1.76	24.80
97	3.66	4.15	2.54	0.25	0.30	0.04	0.00	0.01	0.16	1.96	0.61	1.64	15.32
98	0.98	3.19	0.04	0.28	1.50	0.14	0.00	0.00	0.36	0.64	0.61	2.30	10.04
99	3.94	0.04	6.02	0.10	0.54	0.49	0.00	0.02	0.00	4.46	2.62	2.91	21.14
0	3.54	0.32	1.61	1.88	2.88	0.00	0.00	0.00	0.06	1.74	4.50	1.38	17.91
1	3.70	5.32	M0.48	2.23	0.80	0.00	0.00	0.00	0.56	1.56	2.68	1.19	18.52
2	0.95	6.52	1.99	1.36	0.45	0.01	0.00	0.00	0.00	1.67	M1.96	2.91	17.82
3	3.05	1.70	4.81	0.46	0.00	0.00	0.00	0.00	0.00	0.12	3.44	1.12	14.70
4	0.45	5.26	5.43	1.02	0.03	0.00	0.00	0.07	3.62	1.86	2.05	1.20	20.99
5	3.34	2.47	3.75	1.18	2.45	0.00	0.00	0.00	0.03	0.00	1.20	0.56	14.98
6	6.63	3.02	8.45	1.21	2.24	0.59	0.00	0.00	0.20	0.00	0.99	7.37	30.70
7	4.63	2.37	7.28	0.25	0.10	0.85	0.00	0.00	0.00	1.20	0.04	M2.71	19.43
8	3.84	2.75	0.42	0.08	0.54	0.00	0.00	0.00	0.05	0.26	1.23	2.04	11.21
9	9.65	6.53	1.84	0.00	0.00	0.03	0.00	0.00	0.21	1.27	1.32	3.87	24.72
10	1.48	0.83	3.06	0.11	0.03	0.00	0.00	0.00	0.20	0.28	0.17	1.62	7.78
11	12.72	1.88	4.30	0.66	0.03	0.12	0.00	0.00	0.00	0.18	0.15	1.07	21.11
12	2.74	0.23	1.97	1.69	0.94	0.58	0.00	0.00	1.25	0.58	0.80	0.23	11.01
13	2.52	0.16	1.34	0.53	0.51	0.11	0.00	0.01	0.00	0.13	4.58	4.40	14.29
14	5.97	2.96	0.59	0.70	0.50	0.60	0.00	0.00	0.00	0.82	0.47	3.44	16.05
15	3.76	M4.26	1.20	0.50	2.75	0.00	0.00	0.01	0.00	0.00	0.83	4.42	17.73
16	9.35	2.45	1.06	0.06	0.10	0.01	0.07	0.00	0.16	0.79	0.49	3.73	18.27
17	1.30	4.97	0.70	0.62	0.12	0.00	0.00	0.00	0.51	M0.00	0.25	0.45	8.92
18	0.97	3.36	4.00	1.06	0.01	0.00	M0.00	0.00	3.58		1.84	1.70	16.52
19	1.77	M6.15	1.50	0.11	0.01	0.00	0.00	0.00	0.53	0.01	M0.36	2.22	12.66
20	0.29	0.81	3.27	1.36	0.00	0.05	0.00	0.00	0.01	1.29	3.39	4.32	14.79
21	4.61	0.54	1.45	0.39	0.75	0.05	0.00	0.00	0.00	0.80	1.09	3.81	13.49
22	2.16	4.18	1.29	0.40	0.43	0.00	0.00	0.00	0.00	0.72	3.03	6.12	18.33
23	2.05	0.30	0.43	2.87	0.08	0.09	0.00	0.00	0.50	0.58	0.62	0.94	8.46
24	1.80	2.00	M0.65	0.30	0.06	0.00	0.00	0.00	0.00	2.10	1.59	3.63	12.13
25	1.02	4.45	1.14	1.61	2.11	0.05	0.01	0.01	0.02	0.00	1.13	1.50	13.05
26	3.20	5.52	0.05	4.25	0.36	0.00	0.00	0.00	0.00	2.14	4.48	0.58	20.58

27	2.30	4.99	1.01	M1.47	0.21	0.57	0.00	0.00	0.01	1.45	1.81	M0.58	14.40
28	1.17	1.38	3.39	0.78	0.02	0.04	0.00	0.00	0.00	0.15	2.98	2.66	12.57
29	0.88	1.44	0.78	M0.44	0.04	1.02	0.00	M0.00	0.00	0.15	0.00	4.06	8.81
30	3.65	1.62	2.86	0.94	0.34	0.00	0.00	0.00	0.29	0.47	1.11	0.56	11.84
31	2.50	1.35	1.14	0.05	0.67	0.29	0.00	0.00	0.00	0.18	1.30	6.84	14.32
32	1.09	1.76	0.34	0.76	0.30	0.00	0.00	0.00	0.00	0.00	0.36	2.11	6.72
33	2.85	0.95	1.44	0.03	0.30	0.08	0.00	0.00	0.03	0.66	0.00	5.74	12.08
34	1.33	2.97	0.13	0.16	0.26	0.30	0.00	0.00	0.01	0.45	2.61	2.50	10.72
35	4.81	1.97	2.93	5.81	0.01	0.00	0.00	0.00	0.00	1.22	0.77	2.18	19.70
36	3.80	8.59	1.33	1.69	0.68	0.27	0.00	0.00	0.00	0.35	0.03	2.62	19.36
37	2.92	6.18	6.37	1.10	0.01	0.18	0.00	0.00	0.00	0.87	2.69	4.06	24.38
38	3.50	8.24	3.92	1.51	0.04	0.00	0.00	0.00	0.30	1.29	0.88	0.71	20.39
39	1.91	1.06	2.42	0.25	0.92	0.00	0.00	0.00	0.35	0.45	0.07	1.15	8.58
40	7.98	9.25	4.22	0.68	0.92	0.00	0.00	0.00	0.01	0.93	1.32	M7.67	32.98
41	5.78	5.40	2.86	4.76	1.35	0.02	0.00	0.00	0.00	0.86	1.17	6.29	28.49
42	4.68	2.98	3.31	4.58	1.07	0.00	0.00	0.00	0.03	0.27	2.22	3.16	22.30
43	7.04	1.26	3.60	1.91	0.14	0.35	0.00	0.00	0.00	0.16	0.62	2.02	17.10
44	3.08	7.27	1.42	1.66	0.83	0.52	0.00	0.00	0.00	1.39	3.54	2.31	22.02
45	1.82	4.49	2.83	0.08	0.55	0.05	0.00	0.00	0.00	2.53	1.60	5.07	19.02
46	0.77	0.90	1.94	0.06	0.61	0.00	0.00	0.00	0.04	0.75	2.42	1.56	9.05
47	0.60	2.34	3.28	0.15	0.17	0.28	0.00	0.00	0.00	2.60	1.02	0.64	11.08
48	0.51	0.88	3.68	M2.72	2.91	0.01	0.00	0.00	0.10	1.45	0.59	4.88	17.73
49	1.47	1.91	4.15	0.00	0.32	0.00	0.00	0.01	0.03	0.14	1.10	1.90	11.03
50	4.41	3.27	2.00	1.03	0.37	0.05	0.01	0.00	0.62	2.35	5.50	4.72	24.33
51	2.45	1.57	0.84	0.85	0.64	0.00	0.00	0.00	0.25	1.33	3.18	5.11	16.22
52	8.65	1.65	4.50	1.41	0.05	0.45	0.01	0.00	0.05	0.00	2.04	7.27	26.08
53	3.51	0.21	1.42	2.69	0.52	0.61	0.00	0.67	0.00	0.18	1.79	0.56	12.16
54	3.26	3.70	3.29	1.88	0.21	0.00	0.00	0.35	0.00	0.02	3.35	4.93	20.99
55	3.14	1.33	0.37	2.75	0.67	0.01	0.00	0.00	0.95	0.57	1.16	12.20	23.15
56	7.58	2.43	0.03	1.86	0.96	0.00	0.00	0.00	0.84	1.32	0.06	0.22	15.30
57	2.47	4.18	2.23	1.66	1.78	0.00	0.00	0.00	1.35	1.35	0.33	3.07	18.42
58	5.38	9.13	5.93	4.41	0.72	0.27	0.00	0.02	0.12	0.42	0.16	0.72	27.28
59	4.62	3.64	0.46	0.30	0.00	0.00	0.00	0.00	1.54	0.00	0.01	1.28	11.85
60	3.25	2.91	1.62	1.26	0.41	0.00	0.00	0.00	0.00	0.00	4.38	0.70	14.53
61	3.11	1.19	2.02	0.49	0.13	0.02	0.00	0.01	0.17	0.03	2.96	1.44	11.57
62	0.95	7.60	1.84	0.19	0.06	0.01	0.00	0.13	0.11	6.85	0.40	1.74	19.88
63	3.65	1.75	3.56	3.43	0.64	0.02	0.00	0.00	0.35	1.27	3.92	0.38	18.97
64	3.35	0.19	0.83	0.16	0.18	0.41	0.01	0.06	0.00	1.55	2.64	5.69	15.07
65	3.66	0.48	1.61	2.97	0.07	0.00	0.00	0.59	0.00	0.11	3.25	2.89	15.63
66	2.11	1.58	0.22	0.59	0.24	0.00	0.09	0.00	0.05	0.00	5.48	3.33	13.69
67	7.94	0.40	4.15	3.85	0.12	0.68	0.00	0.00	0.04	0.26	1.25	0.94	19.63
68	3.34	1.97	2.42	0.40	0.32	0.23	0.00	0.08	0.00	0.68	2.74	3.10	15.28
69	8.90	7.61	1.13	1.32	0.09	0.01	0.00	0.00	0.03	0.80	0.81	5.36	26.06
70	7.05	1.45	1.83	0.14	0.00	0.24	0.00	0.00	0.00	0.95	7.44	3.73	22.83
71	1.10	0.33	2.34	0.54	0.94	0.05	0.00	0.00	0.00	0.27	0.88	4.84	11.29
72	1.07	1.15	0.37	1.27	0.34	0.15	0.00	0.00	0.99	1.70	5.08	2.25	14.37
73	7.29	6.47	2.89	0.41	0.06	0.00	0.00	0.00	0.44	1.56	6.69	3.05	28.86
74	3.80	1.57	3.72	1.34	0.00	0.66	0.90	0.01	0.00	1.22	0.86	3.42	17.50
75	1.15	5.16	4.73	1.10	0.00	0.00	0.02	0.16	0.00	2.32	0.40	0.30	15.34
76	0.37	1.49	0.61	1.53	0.00	0.05	0.00	0.57	0.81	0.00	0.62	0.62	6.67
77	1.36	1.10	1.33	0.36	0.76	0.00	0.01	0.00	0.55	0.27	2.00	3.65	11.39
78	9.61	2.77	4.24	2.26	0.00	0.00	0.00	0.00	0.37	0.01	3.45	0.87	23.58
79	5.81	5.24	2.67	0.88	0.09	0.00	0.22	0.00	0.01	1.79	1.66	3.96	22.33
80	5.33	8.08	2.19	1.04	0.47	0.04	0.31	0.00	0.00	0.04	0.26	2.25	20.01
81	4.97	1.00	3.55	0.71	0.34	0.00	0.00	0.00	0.32	2.64	7.13	3.91	24.57
82	5.40	2.90	6.87	3.36	0.00	0.17	0.00	0.00	1.54	2.69	5.83	3.44	32.20
83	5.54	5.28	8.30	4.36	0.23	0.28	0.00	0.01	0.61	0.53	5.83	6.65	37.62
84	0.23	1.52	1.47	0.44	0.01	0.10	0.00	0.08	0.08	1.87	5.46	1.75	13.01
85	1.07	1.85	2.79	0.11	0.02	0.14	0.00	0.01	0.71	0.69	4.64	3.19	15.22
86	4.88	10.30	4.23	1.02	0.08	0.00	0.00	0.00	0.80	0.33	0.22	1.30	23.16

87	2.55	3.77	3.57	0.26	0.01	0.00	0.00	0.00	0.00	1.30	3.22	3.75	18.43
88	3.61	0.74	0.31	1.46	0.75	0.23	0.01	0.00	0.00	0.22	2.08	3.32	12.73
89	0.70	1.38	6.73	0.39	0.04	0.26	0.00	0.37	3.15	1.47	1.26	0.00	15.75
90	5.49	3.14	1.16	0.75	2.61	0.00	0.00	0.00	0.00	0.28	0.56	1.66	15.65
91	0.37	3.18	7.48	0.38	0.26	0.56	0.00	0.01	0.05	1.22	0.32	2.04	15.87
92	1.68	6.89	3.32	0.93	0.00	0.22	0.00	0.00	0.00	1.26	0.38	6.23	20.91
93	9.37	5.11	2.43	0.75	1.23	0.94	0.00	0.00	0.00	0.43	2.70	2.04	25.00
94	2.16	3.17	0.07	0.80	1.65	0.00	0.00	0.00	0.00	0.45	3.96	3.54	15.80
95	12.35	0.19	7.84	1.90	1.01	0.53	0.01	0.00	0.00	0.00	0.00	5.14	28.97
96	3.30	6.09	2.30	1.93	2.22	0.00	0.00	0.00	0.00	0.76	1.49	5.83	23.92
97	7.68	0.26	0.58	0.28	0.35	0.53	0.00	0.21	0.18	1.01	4.67	2.64	18.39
98	6.79	9.43	2.55	1.44	3.04	0.29	0.00	0.00	0.30	0.81	3.60	0.65	28.90
99	2.86	4.54	1.46	0.94	0.08	0.03	0.00	0.00	0.00	0.13	1.75	0.03	11.82
0	7.20	8.93	2.26	2.05	1.36	0.03	0.00	0.00	0.17	2.57	0.76	0.55	25.88
1	4.48	4.79	2.15	1.70	0.00	0.14	0.00	0.00	0.33	0.35	2.33	5.99	22.26
2	2.23	1.04	2.85	0.15	1.81	0.00	0.00	0.00	0.00	0.00	2.00	5.85	15.93
3	1.13	1.08	1.95	2.75	1.23	0.00	0.00	0.34	0.00	0.27	1.64	4.35	14.74
4	2.07	4.84	0.49	0.11	0.08	0.00	0.00	0.00	1.93	3.09	2.76	4.13	19.50
5	3.69	2.52	3.55	0.86	1.31	0.69	0.00	0.00	0.10	0.16	0.90	9.47	23.25
6	3.07	2.07	6.02	3.42	0.42	0.00	0.00	0.00	0.00	0.21	1.03	3.12	19.36
7	0.07	5.17	0.50	1.42	0.43	0.00	0.01	0.00	0.08	0.93	0.98	3.35	12.94
8	7.42	1.83	0.12	0.01	0.04	0.00	0.00	0.00	0.00	0.75	2.22	1.75	14.14
9	1.48	5.06	1.83	1.61	1.30	0.47	0.00	0.00	0.19	3.42	0.36	3.16	18.88
10	4.75	2.28	1.95	2.60	0.84	0.00	0.00	0.00	0.05	1.75	2.65	5.52	22.39
11	1.36	3.88	7.00	0.08	1.40	1.14	0.00	0.00	0.00	1.72	0.87	0.07	17.52
12	2.52	0.94	4.45	2.65	0.00	0.01	0.00	0.00	0.00	1.28	4.33	6.46	22.64
13	1.06	0.26	1.59	0.58	0.57	0.31	0.00	0.00	0.55	0.00	0.82	0.38	6.12
14	0.20	4.49	1.93	1.97	0.01	0.00	0.02	0.00	0.54	0.37	1.28	7.63	18.44
15	0.01	2.28	0.16	1.82	0.19	0.07	0.00	0.00	0.00	0.44	1.35	1.83	8.15
16	5.79	0.85	4.64	1.48	0.59	M0.00							13.35

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Appendix G Assessor Parcel Numbers in the Delineation Area

Assessor Parcel Numbers in the Delineation Area

Parcel	Property Owner
069-0160-005	Hansen Family Revocable Trust Attention: John Hansen 2201 Francisco Drive 140 205 El Dorado Hills, CA 95762
069-0160-006	Norman W/Dolores A Moniz Family Revocable Trust 5515 Kenneth Avenue Fair Oaks, CA 95628
069-0160-007	Norman W/Dolores A Moniz Family Revocable Trust 5515 Kenneth Avenue Fair Oaks, CA 95628
069-0160-008	Park Chang No/Park Woong Ja 9909 Portofino Oak Lane Fair Oaks, CA 95628
069-0160-015	Forest Robert J/Forest Sarah D P.O. Box 877 Mendocino, CA 95460
069-0160-019	Prestige Hospitality Incorporated Attention: Mitul Tundavia 8160 Barton Road Granite Bay, CA 95746
069-0160-020	Ichiban Samurai Incorporated Attention: Young Hu Shin 12251 Folsom Boulevard Rancho Cordova, CA 95742
069-0160-014	Steve/Julie Ryan Family 1996 Revocable Trust 12303 Folsom Boulevard

Parcel	Property Owner
	Rancho Cordova, CA 95742
069-0160-011	Sacramento Metropolitan Fire District 10545 Armstrong Avenue, Suite 200 Mather, CA 95655
069-0160-012	Folsom Twin Invs LLC 12399 Folsom Boulevard Rancho Cordova, CA 95742
069-0050-013	Conrad Ethan 1300 National Drive, Suite 100 Sacramento, CA 95834
069-0050-014	Conrad Ethan 1300 National Drive, Suite 100 Sacramento, CA 95834
069-0050-085	Property owner information was not available.
069-0050-107	Property owner information was not available.
072-0231-125	Aerojet Rocketdyne, Inc Attention: Easton Dev Company P.O. Box 13222 Sacramento, CA 95813
072-0231-079	APN: 072-3360-002 Easton Development Company LLC P.O. Box 13222 Sacramento, CA 95813
Source: Sacramento County Assessor's Office, September 22, 2016	

Appendix H Aquatic Resources Spreadsheet

Waters_Name	State	Cowardin_Code	HGM_Code	Meas_Type	Amount	Units	Waters_Type	Latitude	Longitude	Local_Waterway	Similarly_Situated	Adjcent_Waters_Sbjct_33USC1344	OHWM_Chg_In_Plant_Community	OHWM_Bed_And_Banks	OHWM_Break_In_Slope	OHWM_Destr_Of_Terrestrial_Veg	Func_Ill_Pollutant_Management	Func_V_Runoff_Storage
SW-1	CALIFORNIA	PEM	DEPRESS	Area	0.01	ACRE	A8OWB	38.6322672	-121.2151075	Alder Creek and Lake Natoma	NO	NO					YES	YES
SW-2	CALIFORNIA	PEM	DEPRESS	Area	0.01	ACRE	A8OWB	38.63234503	-121.216164	Alder Creek and Lake Natoma	NO	NO					YES	YES
EW-1	CALIFORNIA	PEM	RIVERINE	Area	0.03	ACRE	A6BWB	38.63625816	-121.2062703	Alder Creek and Lake Natoma								
EW-2	CALIFORNIA	PEM	RIVERINE	Area	0.0002	ACRE	A6BWB	38.63647821	-121.2056483	Alder Creek and Lake Natoma								
ED-1	CALIFORNIA	R4	RIVERINE	Area	0.001	ACRE	A8OOHWM	38.63076567	-121.2178977	Alder Creek and Lake Natoma	NO	NO			YES	YES	YES	YES
ED-2	CALIFORNIA	R4	RIVERINE	Area	0.0004	ACRE	A6N1OHWM	38.63839334	-121.2019974	Alder Creek and Lake Natoma					YES	YES		
PD-1	CALIFORNIA	R2	RIVERINE	Area	0.42	ACRE	A5	38.63628587	-121.2059269	Alder Creek and Lake Natoma			YES	YES		YES		
PDC-1	CALIFORNIA	R2	RIVERINE	Area	0.14	ACRE	A5	38.63649835	-121.2061386	Alder Creek and Lake Natoma			YES	YES		YES		

Memorandum

Date:	September 7, 2017
Prepared for:	Marianne Biner, Senior Planner, Sacramento County
Prepared by:	Renee Richardson, ISA–Certified Arborist
Subject:	Tree Survey: Hazel Avenue/U.S. 50 Interchange Project

Introduction

The County of Sacramento, in cooperation with Caltrans and the City of Rancho Cordova, proposes to modify the existing U.S. 50/Hazel Avenue interchange, and extend and grade-separate Hazel Avenue over Folsom Boulevard and the Sacramento Placerville Transportation Corridor Joint Powers Authority (SPTC-JPA) rail corridor. Hazel Avenue will be extended further south to a proposed intersection with the future Atlanta Street (a new roadway that will be constructed as part of the Easton Place development). The project also includes:

- Construction of a portion of an eastbound transition auxiliary lane on U.S. 50 from Hazel Avenue through the Folsom Boulevard Overcrossing, also known as the Natoma Overhead.
- The modification of the existing Aerojet Road off-ramp from U.S. 50.
- Reconstruction of the westbound loop on-ramp.
- Reconstruction of the eastbound diagonal off-ramp, and both eastbound on-ramps.
- Eastbound on- and off-ramp auxiliary lanes, from west of the Hazel Avenue to the eastbound off-ramp, and from the loop on-ramp extending to the Folsom Boulevard interchange.
- Roadway improvements constructed along approximately 2,300 feet of Folsom Boulevard. Improvements include sidewalks, street lighting, and landscaping along the north side of Folsom Boulevard, and landscaping and lighting along the south.

The project is located in the County of Sacramento at the interchange of Hazel Avenue and U.S. 50. The project area is bounded along Hazel Avenue by the Tributary Point/westbound off-ramp intersection to the north, and extends approximately 1000’ south of Folsom Boulevard to a future intersection within the proposed Easton Place development. The project limits along U.S. 50 begin approximately 3200’ west of the existing Hazel Avenue Overcrossing, and extend 2500’ east of the Natoma Overhead. Improvements along Folsom Boulevard will extend from approximately 1200’ west of the Hazel Avenue intersection to 900’ to the east. Construction of the project is anticipated to last 24 months and conclude in year 2020.

This memorandum describes and inventories all accessible tree resources, within the project boundary, which meet the regulatory threshold established by Sacramento County’s Tree

Preservation Ordinance (SCC 480 § 1, 1981.). This memorandum does not provide a tree risk assessment.

Methods of Survey

An ICF International Society of Arboriculture (ISA) - certified arborist inventoried and assessed trees on July 17, 18 and 31, 2017. The arborist survey methods followed standard professional practices. All tree location data were collected with a global positioning system unit. All accessible trees within the defined areas of project disturbance and greater than 4 inches in DBH (defined as the diameter of a tree measured at 4.5 feet above ground level on the high side of the tree) were surveyed. Inaccessible tree areas are identified in Figure 1 (located at the end of this memorandum). Each tree was assigned an individual number, and an aluminum tree tag was attached to each tree for identification. If trees had existing tags, the tags were left on the trees and the number assigned to them was recorded. The location of the tree, species, health, vigor, structure, height, dripline radius, and the DBH of each tree was recorded. The measurement from the trunk to the end of the longest lateral limb was measured determine the radius of the canopy.

Tree health and structure were rated as good, fair, or poor. Where conditions were between ratings of good and fair or fair and poor, intermediate ratings of fair-good and fair-poor were given. Tables 1 and 2 provide a general definition of the assessment criteria ratings.

Table 1. Tree Rating Guidelines, Tree Health and Vigor

Rating	Tree Health and Vigor
Good	Overall appearance of the tree is exemplary of the species. No visible wounds or defects, or completely healed. Crown root area displays no signs of wood deterioration. Bark missing from less than 10% of trunk circumference. Trunk does not show any signs of wood decay, cracking, or deterioration. Foliage is exemplary of the species, no sprout growth observed, evenly distributed, and free of pests. No signs of disease symptoms or pests observed. Current annual twig growth is greater than expected for the species. Buds are normal size, viable, abundant, and uniform throughout canopy. Little to no evidence of stress or nutrient deficiency.
Fair	Overall appearance of the tree is representative of the species. Wounds actively healing, but not completely healed. Crown root area displays minor signs of wood deterioration. Bark missing from more than 10%, but less than 30% of trunk circumference. Trunk does not show any signs of wood decay, cracking, or deterioration. Foliage is representative of the species, some sprout growth observed, foliage is unevenly distributed yet balanced across whole tree, or only a minor pest problem observed. Disease symptoms or pests observed create an intermittent or temporary nuisance. Current annual twig growth is as expected for the species. Buds are of normal size and viable, but are somewhat sparse or irregular throughout the canopy. Some evidence of minor stress or nutrient deficiency observed.
Poor	Overall appearance of the tree deviates from species representative. Wounds not healing vigorously or are showing signs of decay. Crown root area decayed over more than 30% of tree's cross section. Bark missing from more than 30% of trunk circumference. Trunk shows signs of wood decay, cracking, or deterioration. Foliage deviates from species representative, sprout growth observed, foliage is unevenly distributed, or pest infestation observed. Disease symptoms or pests observed threaten the health and wellbeing of host and/or adjacent trees. Current annual twig growth is less than expected for the species. Buds are few, or not viable, or sparse, or irregular throughout the canopy. Evidence of stress or nutrient deficiency observed.

Table 2. Tree Rating Guidelines, Tree Structure and Form

Rating	Tree Structure and Form
Good	Tree structure has a low potential for failure. Ample space for tree to grow to mature size characteristic of the species. No visible root defects or damage from roots to infrastructure observed. No anchor roots exposed. Trunk appears solid and free of cavities, decay, or hollowness. No bark inclusion observed. Canopy is full and balanced. Single leader, branch attachment solid, and angle of branch attachment exemplary. No dead limbs observed, all limbs free of defects, and limbs are not overburdened.
Fair	Tree structure has a moderate potential for failure. Adequate space available for tree to grow to a size representative of the species. Roots abutting infrastructure, displacing built objects from normal alignment. Some anchor root exposure. Trunk displays some signs of minor deterioration, but structurally still solid and in process of healing. Bark inclusion observed only on minor branches and away from posing threats to health, safety, and welfare to the public. Canopy is slightly lacking or unbalanced. Leader not clearly defined, but not missing; branch attachment characteristic of species. One minor dead limb observed, but solidly attached, other limbs free of defects, limbs only slightly overburdened.
Poor	Tree structure has a high potential for failure. Inadequate space available for tree to grow to a size representative of the species. Roots lifting sidewalks or built objects from normal grade, extensive portions of root system cut, decay of root crown in excess of 30%, or root zone subject to overwatering. Anchor roots exposed. Trunk decay is affecting 30% or more of the trunk cross section, healing process slow or not evident, or crack observed. Unequal weight distribution within tree structure due to trunk lean. Bark inclusion at branches, involving main trunk, or posing a threat to health, safety, or welfare of the public. Canopy is lacking or unbalanced, or concentrated in the upper one-third of the tree. Double leader or no leader observed, a branch observed nearly as large as trunk, narrow angles of branch attachment, multiple limb attachments, or attachments of limbs not characteristic of species, or decay observed at branch attachment. More than one dead limb observed, a wound in limb observed greater than 30% of cross section, limbs overburdened, or multiple branches sprouting from cuts.

Survey Results

A total of 472 trees were identified within the Project boundary. 327 of those trees were California natives and 241 were native oak species. Table 3 provides an overview of the tree species found on site and their associated numbers. Table 4, located at the end of this memorandum, provides the survey data collected for each specific tree identified. Figure 1, which follows Table 4, identifies the location of each inventoried tree in relation to the Project boundary and the impact areas, by alternative.

Table 3. Project Trees

Native Tree Species				Nonnative Tree Species					
	Total		Total		Total		Total		Total
Arroyo willow (*Salix lasiolepis*)	6	Fremont cottonwood (*Populus fremontii*)	29	Ash tree (Fraxinus sp.)	1	Chinese privet (*Ligustrum sinense*)	4	Pine (*Pine sp.*)	1
Buckeye (Aesculus californica)	5	Gray pine (*Pinus sabiniana*)	10	Black locust (*Robinia pseudoacacia*)	4	Chinese tallowtree (*Triadicasebifera*)	41	Small-leaved lime (*Tilia cordata*)	7
California black walnut (*Juglans hindsii)*	6	Interior live oak (*Quercus wislizeni*)	132	Bradford pear (*Pyrus calleryana*)	17	Crape myrtle (*Lagerstroemia sp.)*	7	Sweet gum (*Liquid ambarstyraciflua*)	11
California Sycamore (*Platanus racemosa*)	4	Valley oak (*Quercus lobata*)	87	Chinese elm (*Ulmus parvifolia*)	2	Eucalyptus (*Eucalyptus sp.*)	1	Tree of Heaven (*Ailanthus altissima*)	25
Coast live oak (*Quercus agrifolia*)	22	Western redbud (*Cercis occidentalis*)	25	Chinese Hackberry (*Celtis sinensis*)	3	Olive (*Olea europaea*)	1	Walnut (*Juglans sp.)*	1

The larger percentage of the trees within the Project boundary were found to be in fair to good health. 27 of the trees within the Project boundary were found to be in fair-poor to poor health. The same was found to be true with the structural ratings of the tree. 409 trees were found to have fair to good structure and 63 were found to have fair-poor or poor structure.

Trees with a fair to fair-poor health or vigor rating have the potential to improve over time with positive changes to the environment or site conditions. Human involvement using various tree care techniques may also improve the health or vigor of these trees. Trees with a fair-poor or poor structure rating typically decline further over time, increasing the chances of tree failure. For this reason, trees with a fair-poor or poor rating may need to be removed or considered for removal if they are located in areas with targets or potential targets. Targets are people, vehicles, structures, or any other object potentially subject to damage from a falling limb or tree. The trees with poor ratings were typically found in clusters and effected by similar issues within the group. Trees adjacent to the freeway typically had lower health and structural ratings than those found within the landscaped areas of the Project.

Mitigation

Preliminary impact boundaries for Alternative 1(1 and 1A, combined on one map) and Alternative 2 indicate both temporary and permanent impacts on regulated trees (see Figure 1 and the end of this

memorandum). Regulated trees that are affected will require mitigation based on the regulating body. Some trees are regulated by more than one entity, which should be considered when determining mitigation requirements. Trees temporarily affected will require pruning or special avoidance measures during the construction process of the Project to avoid impacts. Of the temporarily affected trees, a few select individuals are likely to incur impacts that could be considered severe, depending on site conditions encountered and construction activities. If great care is not exercised during construction, these trees are at greatest risk of becoming permanently affected. Methods to avoid this risk are provided later in this memo.

The Project falls under the jurisdiction of two regulatory agencies: the County of Sacramento and the City of Rancho Cordova. 68 of the 472 trees were found to be within the City of Rancho Cordova. Tree removal or other impacts will require prior authorization either through permit issuance or documentation of permit condition compliance, as directed by each regulatory agency.

Both the City of Rancho Cordova and the County of Sacramento have a documented interest in the preservation of native oak trees and even more specifically, in the preservation of Heritage trees. Heritage trees are defined as any California oak tree growing on any land in Sacramento County, including privately owned land, with a trunk sixty inches or greater in girth (circumference) measured four and one-half feet above the ground" (SCC 480 § 1, 1981.). A total of 37 trees were found on the Project boundaries which meet this criterion (9 *Quercus agrifolia*, 13 *Quercus wislizeni*, 15 *Quercus lobata*). The greatest concentration of these trees can be found directly adjacent to US 50, north to northeast of Rocket Circle, in the parking lot of Cattleman's Restaurant.

The County of Sacramento and City of Rancho Cordova will determine which trees will require mitigation under their respective tree preservation policies. The required mitigation may be on an inch-per-inch replacement basis. This means that for each inch DBH of tree removed, the project must replace 1 inch. A newly planted 15-gallon tree will replace 1-inch DBH, a 24-inch box tree will replace 2 inches, and a 36-inch box tree will replace 3 inches. Mitigation on-site may not be feasible or desirable and may require instead payment of a cash contribution based upon the cost of purchasing, planting, irrigating, and maintaining the required mitigation trees.

Best Management Practices

Temporarily affected trees could experience severe harm to their long-term health and survivability if best management practices (BMPs) are not closely adhered to during construction. Injured trees or trees adversely affected by construction activities may begin to slowly or imperceptibly decline posing risks to targets. It is critical to document construction activity around these trees and note changes to construction methods and trees during the construction process. Trees subjected to manipulation of roots and limbs during the construction process should be monitored for 5 years after construction completion to manage potential risk and ensure the safety of the public.

Tree Protection Zone

The tree protection zone for all trees is the dripline radius plus 1 foot. The project design engineer should include this information on grading, demolition, and layout plans. In some instances, the tree protection fencing must be placed within the regulated tree protection zone to allow for construction trenching and equipment access. For all other instances, the fenced area should define

the tree protection zone. The fencing should remain in place throughout the course of the project and cannot be moved without approval in accordance with regulatory permit requirements.

In areas where trees are growing in open space, the contractor should install fencing to the extent of the tree protection zone. In areas where trees are growing near a curb, paved street, or along an existing driveway or paved area, tree-protective fencing should be installed along the pavement edge. Tree-protection fencing must be a minimum 5-foot-tall chain link, or substitute, fence that conforms to the tree preservation ordinance requirements of the County of Sacramento or the City of Rancho Cordova, as applicable. The location of the fencing should be indicated on the project design engineer's grading plans and must be erected before demolition, grading, or any other construction activity begins.

Prohibited Activities

The following activities are prohibited throughout the course of the project within the tree protection zone.

- Storage or parking of vehicles, building materials, refuse, or excavated soil material.
- Use, access, or parking of heavy equipment, such as backhoes, tractors, and other heavy vehicles and equipment.
- Dumping of poisonous chemicals or materials or chemicals or materials with unknown properties that could be deleterious to tree health, such as paint, petroleum products, concrete or stucco mix, or dirty water.
- The use of tree trunks for winch support, anchorage, power poles, sign posts, or any other function.
- Drainage changes, grade changes, and soil disturbance.

General Best Management Practices

The following activities are allowed in the tree protection zone on a temporary basis if it is necessary for the contractor to access the tree protection zone with equipment.

- Mulching with wood chips spread to a 4- to 6-inch depth over the tree protection zone for access by construction workers or light equipment. Wood chips shall be 2-inch untreated, unpainted, nondyed wood material. Wood chips must be removed once equipment passage is completed for project work.
- Trenching, excavation, or boring within the tree protection zone, though it may require preconstruction approval pending conditions of the permits.

An arborist should conduct the required inspections of construction sites containing regulated trees where activities need to occur within the tree protection zone. The inspections will verify all work was done in accordance with this report, local ordinances, and BMPs. With these measures in place and BMPs strictly adhered to, mitigation measures (compensation plantings) will not be required for temporarily affected trees.

Pruning Best Management Practices

Prior to commencing work, some individual trees will need to be pruned to allow clearance for construction vehicles and equipment. If a branch or root greater than 2 inches in diameter is damaged, the branch or root should be cut clean. Pruning must be performed by, or under the direction of, a certified arborist, qualified tree care specialists, or certified tree worker. All cuts must be made clean and to the bark collar of the closest joint on the branch allowing for the clearance. ISA pruning guidelines shall be followed.

Grading Best Management Practices

It is anticipated the project will require grading and result in changes to existing grades. If a change of grade greater than 2 inches over 10% or more of the protected zone occurs, the activity will result in likely death or decline of any affected tree and will be considered a permanent impact. Therefore, grading within the driplines of protected trees is not recommended.

Completely avoiding fill within a protected zone is not always possible. Where fill must occur within a protected zone, a root aeration system can help mitigate the effect of soil fill over the roots of an affected tree. Root aeration systems should be implemented when any fill occurs in the protected zone to avoid death of the root systems.

Root aeration systems include installation of a 3-inch-diameter perforated polyvinyl chloride (PVC) pipe wrapped in engineering fabric at approximately 5 feet on center spacing within the protected zone area of fill. The pipes should be placed on the existing soil surface, extend the full length of the fill, and daylight to the extent of fill on both sides if possible. At the limits of grading, a 90-degree PVC elbow should be placed on the pipe terminus and a PVC drain cover will be placed on the end. In areas of soil fill within protected zones where the final grade is not paved, vertical mulching should be employed. Four-inch-diameter cardboard tubes should be placed at 3 feet on center triangularly spaced. The tube should extend from the surface of the existing grade to the surface of the new fill grade. The tube should be filled with organic mulch, including wood chips, shredded bark, or pine needles.

Pavement Best Management Practices

Pavement and the underlying aggregate should be removed with care. If tree roots are found in the aggregate, the aggregate should be removed by hand. The pavement and aggregate layers should be replaced with soil, but the soil depth should not exceed the original finish grade of the pavement surface. The soil should not be overly compacted but gently tamped by hand or wheel roll to 85% compaction.

Pouring asphalt paving over or near tree roots is not recommended as the heat from the fresh asphalt can burn and damage the roots. Asphalt will also eventually suffocate the roots. Damaged tree roots can slowly decay and eventually could lead to structural instability and failure. If tree roots are found within planned pavement cross sections, the project design engineer is encouraged to consider the use of permeable concrete pavers units in lieu of asphalt to eliminate the possibility of burning and suffocating roots.

Trenching Best Management Practices

To avoid causing permanent impacts on tree resources, the contractor should consider excavating trenches near tree protection zones by hand digging or using pneumatic air excavation technology. If either method is used, tree roots are exposed, and if the trench is in direct sunlight, the exposed roots should be wrapped and covered with damp burlap. Roots should be kept moist and sheltered from ultraviolet light. Trenches should not be excavated when temperatures are in excess of 90 degrees Fahrenheit. Trenching should be avoided for new curb installation within driplines of trees; instead, alternate curb design should be installed that does not require trenching or minimize trenching.

The contractor should also consider passing any new pipe or utility lines under or around tree roots. Permanent impacts can be avoided if roots 2 inches in diameter or larger are not cut or disturbed at any time. If roots smaller than 2 inches in diameter are injured or cannot be avoided by new utility pipe, the root should be cut clean at the next joint and cut repaired. Once the trench has been excavated, the pipe should be installed immediately, backfilled with soil, and soaked with uncontaminated water within the same workday.

Table 4. Tree Survey Data

Tree Tag Number	City of Rancho Cordova	County of Sacramento	Connotation	Species Name Common (Scientific)	Cumulative DBH	Diameter at Breast Height of Individual Trunks (inches)					Dripline Radius (feet)	Height (feet	Health	Vigor	Structure	Comments
						1	2	3	4	Additional						
1	No	Yes	Heritage Tree	Valley oak (Quercus lobata)	43.7	26.6	17.1	0	0	0	35	55	Good	Good	Good	
4	No	Yes	Heritage Tree	Valley oak (Quercus lobata)	20.7	20.7	0	0	0	0	30	45	Good	Good	Good	
5	No	Yes	Heritage Tree	Interior live oak (Quercus wislizeni)	22.8	9.8	10.6	0	2.4	0	25	40	Good	Good	Good	
5	No	Yes	Nonnative Tree	Chinese elm (Ulmus parvifolia)	23.4	23.4	0	0	0	0	15	30	Good	Fair	Fair	
6	No	Yes	Heritage Tree	Valley oak (Quercus lobata)	37.8	37.8	0	0	0	0	30	50	Good	Good	Good	
6	No	Yes	Heritage Tree	Coast live oak (Quercus agrifolia)	34.6	34.6	0	0	0	0	20	45	Good	Good	Fair-Poor	Stable structure but codominant trunk was removed
8	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	14.2	14.2	0	0	0	0	25	45	Good	Good	Fair	
9	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	12.2	12.2	0	0	0	0	25	40	Good	Good	Fair	
12	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	12.6	12.6	0	0	0	0	20	45	Good	Fair	Fair	
12	No	Yes	Heritage Tree	Coast live oak (Quercus agrifolia)	33.5	33.5	0	0	0	0	35	50	Good	Good	Fair	The tree has large broken branches growing on slope not straight
15	No	Yes	Nonnative Tree	Bradford pear (Pyrus calleryana)	9.8	9.8	0	0	0	0	15	18	Good	Good	Good	
19	No	Yes	Heritage Tree	Valley oak (Quercus lobata)	21.9	21.9	0	0	0	0	25	45	Good	Good	Good	
29	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	16.1	16.1	0	0	0	0	32	45	Good	Good	Fair-Poor	The tree is heavily weighted to one side
33	No	Yes	Heritage Tree	Interior live oak (Quercus wislizeni)	37.9	15.2	15	7.7	0	0	30	38	Good	Good	Good	
38	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	10.2	10.2	0	0	0	0	20	38	Good	Good	Good	
40	No	Yes	Heritage Tree	Interior live oak (Quercus wislizeni)	39.6	13	9.1	17.5	0	0	35	45	Good	Good	Good	

Table 4. Con't.

Tree Tag Number	City of Rancho Cordova	County of Sacramento	Connotation	Species Name Common (Scientific)	Cumulative DBH	Diameter at Breast Height of Individual Trunks (inches)					Dripline Radius (feet)	Height (feet	Health	Vigor	Structure	Comments
						1	2	3	4	Additional						
41	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	16.1	16.1	0	0	0	0	30	45	Good	Good	Good	
42	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	11	11	0	0	0	0	25	30	Good	Good	Fair-Poor	The tree has broken branches and is heavily weighted to one side
43	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	11.8	11.8	0	0	0	0	32	28	Good	Good	Fair-Poor	The tree is heavily weighted to one side
44	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	15.4	15.4	0	0	0	0	10	25	Good	Fair	Fair	
46	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	12	12	0	0	0	0	18	25	Good	Fair	Fair	The tree is weighted to one side
47	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	14.4	14.4	0	0	0	0	0	25	Fair	Poor	Poor	The tree has decay on 2\3 of trunk and insect infestation
67	No	Yes	Heritage Tree	Interior live oak (Quercus wislizeni)	56.9	20.1	36.8	0	0	0	35	45	Fair	Fair	Fair	The tree has decay on one trunk and an insect infestation
68	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	13.8	13.8	0	0	0	0	35	45	Good	Good	Good	
80	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	11.8	11.8	0	0	0	0	20	25	Good	Fair	Fair	
81	No	Yes	Heritage Tree	Interior live oak (Quercus wislizeni)	25.9	10.2	15.7	0	0	0	25	25	Fair-Poor	Fair-Poor	Fair-Poor	The tree is tethered to neighbor, has cankers, mushrooms and an insect infestation
83	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	9.4	9.4	0	0	0	0	15	25	Good	Fair	Fair	
85	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	18.9	18.9	0	0	0	0	30	40	Good	Good	Good	
86	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	15.7	15.7	0	0	0	0	30	45	Good	Fair	Fair	The canopy of this tree appears reduced
501	No	Yes	Nonnative Tree	Olive (Olea europaea)	28.8	3.9	4.3	4.3	5.1	3,4.1,4.1,3.5,4,3,4	11	13	Fair	Fair	Fair	The tree has broken branches and is heavily weighted to one side

Table 4. Con't.

Tree Tag Number	City of Rancho Cordova	County of Sacramento	Connotation	Species Name Common (Scientific)	Cumulative DBH	Diameter at Breast Height of Individual Trunks (inches)					Dripline Radius (feet)	Height (feet	Health	Vigor	Structure	Comments
						1	2	3	4	Additional						
502	No	Yes	Nonnative Tree	Crape myrtle (Lagerstroemia sp.)	13.2	2	2.4	1.6	2.4	1.6,1.6,1.6	6	9	Good	Fair	Fair	
503	No	Yes	Native Tree	California sycamore (Platanus racemosa)	7.7	7.7	0	0	0	0	10	20	Good	Good	Good	
504	No	Yes	Native Tree	California sycamore (Platanus racemosa)	5.9	5.9	0	0	0	0	10	15	Good	Good	Good	
505	No	Yes	Native Tree	California sycamore (Platanus racemosa)	5.9	5.9	0	0	0	0	8	15	Good	Fair	Fair	Tree is leaning and much smaller than the adjacent trees and
506	No	Yes	Native Tree	California sycamore (Platanus racemosa)	2.2	2.2	0	0	0	0	4	10	Fair	Fair	Fair	Tree is much smaller than the adjacent trees
507	No	Yes	Heritage Tree	Interior live oak (Quercus wislizeni)	22.4	4.9	5.1	5.7	4.3	2.4	12	20	Good	Fair	Fair	
508	No	Yes	Native Tree	Western redbud (Cercis occidentalis)	12.6	2	2	1.6	1	1,1,1,1,3	7	9	Fair	Fair	Fair	The tree has broken branches and a heavily reduced canopy
509	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	15.3	2.8	3.1	3.1	3.9	2.4	8	12	Good	Good	Good	
510	No	Yes	Native Tree	Western redbud (Cercis occidentalis)	14.8	1.6	2	2	1.2	2,2,2,2	5	7	Fair	Fair	Fair	This tree has a shrubby growth form with a reduced canopy
511	No	Yes	Native Tree	Buckeye (Aesculus californica)	6	2	2	2	0	0	4	5	Fair	Fair-Poor	Fair	
512	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	10.2	4.9	5.3	0	0	0	7	20	Good	Fair	Fair	Codominant trunks
513	No	Yes	Nonnative Tree	Bradford pear (Pyrus calleryana)	13	1.6	1.8	1.6	1.6	1.6,1.4,1.4,2	6	10	Good	Fair	Fair	Young tree
514	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	12.3	3.9	4.9	3.5	0	0	8	13	Good	Fair	Fair	Codominant trunks
515	No	Yes	Native Tree	Fremont cottonwood (Populus fremontii)	44.9	13.8	13	18.1	0	0	25	35	Fair-Poor	Fair	Fair-Poor	The tree is infested with insects on the dominant trunk and has heavy sucker production
516	No	Yes	Native Tree	Western redbud (Cercis occidentalis)	11	2	2	2	1	Many 1' branches	5	8	Fair	Fair	Fair	This tree has a shrubby growth form with a reduced canopy

Table 4. Con't.

Tree Tag Number	City of Rancho Cordova	County of Sacramento	Connotation	Species Name Common (Scientific)	Cumulative DBH	Diameter at Breast Height of Individual Trunks (inches)					Dripline Radius (feet)	Height (feet	Health	Vigor	Structure	Comments
						1	2	3	4	Additional						
517	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	8.4	2	2	2.8	1.6	0	7	15	Good	Fair	Fair	
518	No	Yes	Nonnative Tree	Bradford pear (Pyrus calleryana)	5	2.8	2.2	0	0	0	5	15	Good	Fair	Fair	Young tree with codominant trunks.
519	No	Yes	Nonnative Tree	Bradford pear (Pyrus calleryana)	5.5	5.5	0	0	0	0	15	25	Good	Good	Good	
520	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	13.7	2.6	2.4	2.2	3.5	3	13	15	Good	Fair	Fair	
521	No	Yes	Heritage Tree	Interior live oak (Quercus wislizeni)	30.3	5.3	3.7	4.1	5.1	5.9,3.1,3.1	20	30	Good	Good	Good	The trunk of this tree are girdling at the base. Tree appears healthy otherwise
522	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	2.2	2.2	0	0	0	0	4	10	Fair-Poor	Fair-Poor	Poor	The tree has fallen over and the trees roots are exposed
523	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	3.9	3.9	0	0	0	0	12	20	Fair	Fair-Poor	Fair	The canopy of this tree appears reduced and suckers are being produced on the trunk
524	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	6.3	6.3	0	0	0	0	10	20	Good	Fair	Fair	
525	No	Yes	Nonnative Tree	Chinese tallowtree (Triadica sebifera)	3.5	3.5	0	0	0	0	6	10	Good	Fair	Fair	
526	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	7.3	2.6	3.5	1.2	0	0	5	15	Good	Fair	Fair	Codominant trunks
527	No	Yes	Nonnative Tree	Bradford pear (Pyrus calleryana)	5.7	3.3	2.4	0	0	0	12	15	Good	Good	Good	
528	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	9.6	5.5	4.1	0	0	0	6	20	Good	Fair	Fair	Codominant trunks
529	No	Yes	Native Tree	Fremont cottonwood (Populus fremontii)	20.2	6.3	6.3	4.1	3.5	0	12	20	Good	Fair	Good	
530	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	9.7	4.9	2.4	2.4	0	0	6	20	Good	Fair	Fair	

Table 4. Con't.

Tree Tag Number	City of Rancho Cordova	County of Sacramento	Connotation	Species Name Common (Scientific)	Cumulative DBH	Diameter at Breast Height of Individual Trunks (inches)					Dripline Radius (feet)	Height (feet	Health	Vigor	Structure	Comments
						1	2	3	4	Additional						
531	No	Yes	Native Tree	Western redbud (Cercis occidentalis)	11.6	2	2	2	1.2	2,1.2,1.2	5	10	Good	Fair	Fair	This tree has had many branches removed at the base.
532	No	Yes	Native Tree	Western redbud (Cercis occidentalis)	8.3	3.5	2.4	2.4	0	0	6	8	Good	Fair	Fair	
533	No	Yes	Nonnative Tree	Chinese tallowtree (Triadica sebifera)	4.8	1.8	1	1	1	0	5	7	Good	Fair	Fair	
534	No	Yes	Native Tree	Fremont cottonwood (Populus fremontii)	10.8	10.8	0	0	0	0	20	35	Good	Good	Good	
535	No	Yes	Native Tree	Fremont cottonwood (Populus fremontii)	7.6	3.7	3.9	0	0	0	8	20	Good	Fair	Fair	
536	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	3.4	2	1.4	0	0	0	7	7	Good	Fair	Fair	Young tree
537	No	Yes	Native Tree	Fremont cottonwood (Populus fremontii)	6.7	6.7	0	0	0	0	6	22	Fair	Fair-Poor	Fair-Poor	The tree has a dead codominant trunk and reduced canopy
538	No	Yes	Heritage Tree	Interior live oak (Quercus wislizeni)	51.1	10.4	17.3	23.4	0	0	40	45	Good	Good	Fair-Poor	The tree is heavily weighted to one side
539	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	18.3	18.3	0	0	0	0	25	45	Good	Good	Good	This tree has had many large branches removed.
540	No	Yes	Native Tree	Fremont cottonwood (Populus fremontii)	18.7	9.6	9.1	0	0	0	15	40	Fair	Fair	Fair	Sucker production on trunk
541	No	Yes	Nonnative Tree	Bradford pear (Pyrus calleryana)	4.9	4.9	0	0	0	0	13	35	Good	Good	Good	
542	No	Yes	Native Tree	Fremont cottonwood (Populus fremontii)	29.9	7.1	8.3	9.4	5.1	0	25	40	Good	Fair	Fair	Sucker production on trunk
543	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	18.6	4.3	3.9	3.9	6.5	0	12	23	Good	Good	Good	
544	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	14.8	6.7	8.1	0	0	0	12	35	Good	Good	Good	

Table 4. Con't.

Tree Tag Number	City of Rancho Cordova	County of Sacramento	Connotation	Species Name Common (Scientific)	Cumulative DBH	Diameter at Breast Height of Individual Trunks (inches)					Dripline Radius (feet)	Height (feet	Health	Vigor	Structure	Comments
						1	2	3	4	Additional						
545	No	Yes	Native Tree	Western redbud (Cercis occidentalis)	11.6	1.2	1.2	1.2	2	2,2,2	8	10	Good	Good	Good	
546	No	Yes	Native Tree	Western redbud (Cercis occidentalis)	14	2	2	2	2	2,2,2,2,1,1,1,1,1,2	6	8	Good	Fair	Good	
547	No	Yes	Native Tree	Western redbud (Cercis occidentalis)	14	2	2	2	2	2,2,2	3	7	Good	Fair	Good	Young tree
548	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	18.9	5.7	5.7	7.5	0	0	8	30	Good	Fair	Good	
549	No	Yes	Nonnative Tree	Bradford pear (Pyrus calleryana)	3.9	3.9	0	0	0	0	8	25	Good	Good	Fair	
550	No	Yes	Nonnative Tree	Bradford pear (Pyrus calleryana)	3.5	3.5	0	0	0	0	6	25	Good	Good	Fair	
551	No	Yes	Nonnative Tree	Chinese tallowtree (Triadica sebifera)	8.6	4.7	3.9	0	0	0	8	20	Good	Good	Good	
552	No	Yes	Nonnative Tree	Bradford pear (Pyrus calleryana)	5.9	2.8	3.1	0	0	0	6	15	Fair	Fair-Poor	Fair-Poor	One of the tree codominant trunks is dead.
553	No	Yes	Nonnative Tree	Pine (Pine sp.)	6.1	6.1	0	0	0	0	5	15	Good	Good	Good	
554	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	14.5	3.5	4.7	4.9	1.4	0	8	30	Good	Good	Good	
555	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	14.6	3.5	2	2.4	2.4	4.3	10	15	Good	Good	Fair	Codominant trunks
556	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	11.8	2.4	1.6	3.9	3.9	0	7	10	Good	Fair	Fair	
557	No	Yes	Nonnative Tree	Bradford pear (Pyrus calleryana)	7.5	2.8	3.1	1.6	0	0	5	12	Good	Good	Fair	
558	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	7.6	2.8	2.4	2.4	0	0	6	10	Good	Fair	Fair	

Table 4. Con't.

Tree Tag Number	City of Rancho Cordova	County of Sacramento	Connotation	Species Name Common (Scientific)	Cumulative DBH	Diameter at Breast Height of Individual Trunks (inches)					Dripline Radius (feet)	Height (feet	Health	Vigor	Structure	Comments
						1	2	3	4	Additional						
559	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	12.8	6.1	6.7	0	0	0	8	25	Good	Fair	Fair	
560	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	7.8	3.9	3.9	0	0	0	10	13	Good	Fair	Fair	
561	No	Yes	Native Tree	Western redbud (Cercis occidentalis)	12.8	2	1.2	2.8	1.2	2.4,1.6,1.6	6	10	Good	Good	Fair	
562	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	10	5.3	4.7	0	0	0	10	20	Good	Good	Good	
563	No	Yes	Heritage Tree	Interior live oak (Quercus wislizeni)	28.9	3.3	3.5	4.7	5.3	3.5,4.3,4.3	15	23	Good	Good	Good	
564	No	Yes	Native Tree	Buckeye (Aesculus californica)	8	2	1	1	1	Many 1' branches	3	6	Fair	Fair	Fair	
565	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	11.6	6.7	4.9	0	0	0	10	15	Good	Good	Fair	Codominant trunks
566	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	6.9	6.9	0	0	0	0	7	18	Good	Good	Good	
567	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	7.6	3.9	3.7	0	0	0	6	15	Fair-Poor	Fair-Poor	Good	Leaves appear to have a powdery mildew
568	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	10.2	3.7	2.6	3.9	0	0	10	15	Good	Fair	Fair	
569	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	14.7	3	1.4	3	2.6	4.7	10	10	Good	Fair	Fair	
570	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	12.5	5.1	3.9	3.5	0	0	10	15	Good	Fair	Fair	
571	No	Yes	Heritage Tree	Valley oak (Quercus lobata)	20.7	7.3	6.1	7.3	0	0	15	30	Good	Good	Fair	Codominant trunks
572	No	Yes	Native Tree	Western redbud (Cercis occidentalis)	9	2	2	1	1	Many 1' branches	4	6	Good	Fair	Fair	This tree has a shrubby growth form
573	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	5.9	5.9	0	0	0	0	6	25	Good	Good	Fair	

Table 4. Con't.

Tree Tag Number	City of Rancho Cordova	County of Sacramento	Connotation	Species Name Common (Scientific)	Cumulative DBH	Diameter at Breast Height of Individual Trunks (inches)					Dripline Radius (feet)	Height (feet	Health	Vigor	Structure	Comments
						1	2	3	4	Additional						
574	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	8.8	3.9	4.9	0	0	0	8	20	Good	Good	Fair	
575	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	3.3	3.3	0	0	0	0	5	15	Good	Fair	Fair	
576	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	5.3	5.3	0	0	0	0	5	18	Good	Fair	Fair	
577	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	2.6	2.6	0	0	0	0	4	7	Good	Fair	Fair	Tree is much smaller than the adjacent trees
578	No	Yes	Native Tree	Western redbud (Cercis occidentalis)	11.6	1.6	2	2	2	Many 1' branches	6	9	Good	Good	Good	
579	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	5.9	5.9	0	0	0	0	0	35	Fair	Good	Fair	
580	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	7.3	7.3	0	0	0	0	10	20	Good	Good	Good	
581	No	Yes	Native Tree	Western redbud (Cercis occidentalis)	10	2	2	2	1	1,1	8	10	Good	Good	Good	
582	No	Yes	Nonnative Tree	Chinese privet (Ligustrum sinense)	4	4	0	0	0	0	0	0	Good	Good	Good	A large polygon of small, recruiting trees
583	No	Yes	Nonnative Tree	Chinese privet (Ligustrum sinense)	0	0	0	0	0	0	20	35	Good	Good	Good	A 3ft diameter polygon of small, recruiting privet trees
585	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	17.9	4.7	5.5	5.1	2.6	0	15	25	Good	Good	Good	
586	No	Yes	Heritage Tree	Valley oak (Quercus lobata)	19.1	3.9	4.7	3.1	3.1	4.3	20	30	Good	Good	Good	
587	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	8.9	3.1	2.8	3	0	0	8	20	Good	Good	Good	
588	No	Yes	Native Tree	Fremont cottonwood (Populus fremontii)	0	0	0	0	0	0	10	25	Fair	Fair	Fair	This tree has a extensive sucker production

Table 4. Con't.

Tree Tag Number	City of Rancho Cordova	County of Sacramento	Connotation	Species Name Common (Scientific)	Cumulative DBH	Diameter at Breast Height of Individual Trunks (inches)					Dripline Radius (feet)	Height (feet	Health	Vigor	Structure	Comments
						1	2	3	4	Additional						
589	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	7.6	4.1	3.5	0	0	0	0	0	Good	Good	Good	
590	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	4.9	4.9	0	0	0	0	7	20	Good	Good	Good	
591	No	Yes	Native Tree	Buckeye (Aesculus californica)	9.2	2	1.2	1.2	1.2	Many 1' branches	4	10	Good	Fair	Good	
592	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	15.1	5.7	5.5	3.9	0	0	25	30	Good	Fair	Fair	Codominant trunks
593	No	Yes	Native Tree	Fremont cottonwood (Populus fremontii)	6.1	6.1	0	0	0	0	10	18	Fair	Fair	Fair	The canopy of this tree appears reduced and suckers are being produced on the trunk
594	No	Yes	Heritage Tree	Interior live oak (Quercus wislizeni)	20.4	3.9	5.7	4.7	6.1	0	12	0	Good	Good	Good	
595	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	10.2	4.9	5.3	0	0	0	12	18	Good	Fair	Fair	
596	No	Yes	Native Tree	Fremont cottonwood (Populus fremontii)	8.5	8.5	0	0	0	0	10	18	Fair	Fair-Poor	Fair-Poor	The canopy of this tree appears reduced and suckers are being produced on the trunk
597	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	11	4.7	6.3	0	0	0	8	18	Good	Fair	Good	
598	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	7	3.3	3.7	0	0	0	10	15	Good	Fair	Fair	
599	No	Yes	Heritage Tree	Interior live oak (Quercus wislizeni)	21.8	3.7	5.5	2.6	4.7	5.3	12	20	Good	Good	Fair	
600	No	Yes	Heritage Tree	Valley oak (Quercus lobata)	24.4	6.1	5.9	5.9	6.5	0	18	25	Good	Good	Fair	
601	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	9.1	3.1	3	3	0	0	6	12	Good	Fair	Fair	
602	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	3.7	3.7	0	0	0	0	4	12	Fair	Fair	Fair	The canopy of this tree appears reduced
603	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	5.9	5.9	0	0	0	0	7	15	Good	Fair	Fair	

Table 4. Con't.

Tree Tag Number	City of Rancho Cordova	County of Sacramento	Connotation	Species Name Common (Scientific)	Cumulative DBH	Diameter at Breast Height of Individual Trunks (inches)					Dripline Radius (feet)	Height (feet	Health	Vigor	Structure	Comments
						1	2	3	4	Additional						
604	No	Yes	Native Tree	Fremont cottonwood (Populus fremontii)	54.8	10.2	8.3	8.7	8.7	6.3,6.3,6.3	0	0	Good	Good	Good	The tree has heavy sucker production and the ground around the tree is heavily infested with insects
605	No	Yes	Native Tree	Fremont cottonwood (Populus fremontii)	24.8	13.8	11	0	0	0	30	45	Good	Fair	Fair	This tree has sucker production and a large trunk was cut at the base
606	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	12.2	5.3	6.9	0	0	0	15	23	Good	Fair	Fair	
607	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	7.8	3.9	3.9	0	0	0	5	13	Good	Fair	Fair	
608	No	Yes	Nonnative Tree	Walnut (Juglans sp.)	3	3	0	0	0	0	6	10	Fair	Poor	Poor	This tree is uncharateristic of the species; shrubby growth form, thin canopy, curling leaves.
609	No	Yes	Native Tree	Buckeye (Aesculus californica)	6	2	2	2	0	0	4	6	Good	Fair-Poor	Fair	The tree is heavily weighted to one side
610	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	11.2	6.1	5.1	0	0	0	8	20	Good	Good	Good	
611	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	14.3	4.7	4.7	4.9	0	0	15	20	Good	Fair	Fair	Sucker production on trunk
612	No	Yes	Native Tree	Western redbud (Cercis occidentalis)	11	2	2	2	2	Many 1' branches	0	0	Good	Good	Good	
613	No	Yes	Native Tree	Western redbud (Cercis occidentalis)	11.2	1.2	1.6	1.2	2	1.2,2,2	8	10	Good	Good	Good	
614	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	11	5.5	5.5	0	0	0	15	25	Good	Fair	Fair	
615	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	8.6	4.1	4.5	0	0	0	7	18	Good	Fair	Fair	
616	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	9.2	4.7	4.5	0	0	0	8	23	Good	Good	Fair	Codominant trunks
617	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	7.1	7.1	0	0	0	0	10	0	Good	Fair	Fair	
618	No	Yes	Native Oak	Valley oak (Quercus lobata)	7.8	3.9	3.9	0	0	0	7	18	Fair	Fair	Fair-Poor	Codominant trunks and sucker production

Table 4. Con't.

Tree Tag Number	City of Rancho Cordova	County of Sacramento	Connotation	Species Name Common (Scientific)	Cumulative DBH	Diameter at Breast Height of Individual Trunks (inches)					Dripline Radius (feet)	Height (feet	Health	Vigor	Structure	Comments
						1	2	3	4	Additional						
			Tree													
619	No	Yes	Native Tree	Fremont cottonwood (Populus fremontii)	22.8	10.6	12.2	0	0	0	20	40	Good	Good	Fair	Codominant trunks and sucker production
620	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	4.9	4.9	0	0	0	0	6	18	Good	Fair	Fair	
621	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	11.8	4.5	4.3	3	0	0	12	12	Good	Fair	Fair-Poor	This tree has has fused limbs and many browning leaves
622	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	14	6.7	7.3	0	0	0	10	15	Good	Fair	Fair	Codominant trunks
623	No	Yes	Native Tree	Fremont cottonwood (Populus fremontii)	19.6	9.6	10	0	0	0	18	35	Good	Good	Fair	Codominant trunks and sucker production
624	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	12.4	3.9	2.2	3.1	1.2	2	12	10	Good	Fair	Fair	
625	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	4.4	3	1.4	0	0	0	5	10	Good	Fair	Fair	
626	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	11.4	4.3	4.5	2.6	0	0	8	12	Good	Fair	Fair	
627	No	Yes	Native Tree	Fremont cottonwood (Populus fremontii)	22.8	10.2	12.6	0	0	0	18	35	Good	Good	Fair	Codominant trunks and sucker production
628	No	Yes	Native Tree	Fremont cottonwood (Populus fremontii)	18.1	18.1	0	0	0	0	15	25	Fair	Fair	Fair	The canopy of this tree appears reduced and suckers are being produced on the trunk
629	Yes	Yes	Native Oak Tree	Valley oak (Quercus lobata)	4.3	4.3	0	0	0	0	6	13	Good	Fair	Fair	
630	Yes	Yes	Native Oak Tree	Valley oak (Quercus lobata)	7.1	4.1	3	0	0	0	6	10	Good	Fair	Fair	
631	Yes	Yes	Native Tree	Western redbud (Cercis occidentalis)	10	2	2	2	1	Many 1' branches	4	7	Fair	Fair	Fair	The canopy of this tree appears reduced
632	Yes	Yes	Heritage Tree	Valley oak (Quercus lobata)	21.2	5.7	4.7	4.5	6.3	0	12	18	Fair	Fair	Fair	The leaves of this tree have are slightly discolored and appear to have a powdery mildew.

Table 4. Con't.

Tree Tag Number	City of Rancho Cordova	County of Sacramento	Connotation	Species Name Common (Scientific)	Cumulative DBH	Diameter at Breast Height of Individual Trunks (inches)					Dripline Radius (feet)	Height (feet	Health	Vigor	Structure	Comments
						1	2	3	4	Additional						
633	Yes	Yes	Native Tree	Western redbud (Cercis occidentalis)	14	2	2	2	2	Many 1' branches	7	7	Fair	Fair	Fair	The canopy of this tree appears reduced
634	Yes	Yes	Native Tree	Western redbud (Cercis occidentalis)	13.2	2	2	1.2	2	Many 1' branches	6	7	Good	Fair	Good	The canopy of this tree appears reduced
635	Yes	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	14.9	3.1	2.6	2	3.9	3.3	8	17	Good	Fair	Fair	This tree has a shrubby growth form
636	Yes	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	14.9	3.5	5.3	6.1	0	0	12	17	Good	Fair	Fair	
637	Yes	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	7	1	1	1	1	Many 1' branches	6	6	Good	Good	Fair-Poor	This tree has a shrubby growth form
638	Yes	Yes	Native Oak Tree	Valley oak (Quercus lobata)	4.8	2.2	2.6	0	0	0	5	15	Fair	Fair	Fair-Poor	Codominant trunks and broken limbs
639	Yes	Yes	Native Oak Tree	Valley oak (Quercus lobata)	7.9	7.9	0	0	0	0	10	20	Fair	Fair	Fair	Leaves appear to have a powdery mildew and a large amount of galls are present
640	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	12.6	2.8	4.3	1.2	3.1	1.2	8	15	Good	Good	Fair-Poor	This tree has a shrubby growth form
641	No	Yes	Heritage Tree	Interior live oak (Quercus wislizeni)	27.2	3.9	4.9	2.4	5.5	3.5,3.5,3.5,3,2	10	12	Good	Good	Fair-Poor	This tree has a shrubby growth form
642	No	Yes	Heritage Tree	Interior live oak (Quercus wislizeni)	21.7	2.8	3.1	3.9	3.9	2.4,2.8,2.8	10	12	Good	Good	Fair-Poor	This tree has a shrubby growth form
643	Yes	Yes	Native Oak Tree	Valley oak (Quercus lobata)	14.7	4.7	6.3	3.7	0	0	8	23	Good	Good	Fair	
644	Yes	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	17.8	2.4	3.9	4.3	2	2,1.6,1.6	10	12	Good	Good	Good	
645	Yes	Yes	Native Tree	Western redbud (Cercis occidentalis)	8	2	1	1	1	Many 1' branches	5	7	Good	Good	Good	
646	Yes	Yes	Native Tree	Western redbud (Cercis occidentalis)	8	2	1	1	1	Many 1' branches	5	8	Good	Good	Good	
647	Yes	Yes	Native Tree	Western redbud (Cercis occidentalis)	8.2	1.2	2	1	1	1	5	7	Good	Good	Good	

Table 4. Con't.

Tree Tag Number	City of Rancho Cordova	County of Sacramento	Connotation	Species Name Common (Scientific)	Cumulative DBH	Diameter at Breast Height of Individual Trunks (inches)					Dripline Radius (feet)	Height (feet	Health	Vigor	Structure	Comments
						1	2	3	4	Additional						
648	Yes	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	11.8	3.9	4.7	1.6	1.6	0	10	10	Good	Fair	Fair	This tree and the neighboring trees create a good visual buffer
649	Yes	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	13.4	3.9	2.4	2.4	4.7	0	10	15	Good	Good	Fair	
650	Yes	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	16.6	2.4	2.4	2.4	3.1	3.1,1.6,1.6	10	12	Good	Good	Fair	This tree has a shrubby growth form
651	Yes	Yes	Native Tree	Buckeye (Aesculus californica)	20.6	3.9	4.7	2.4	2.4	Many 2-3' branches	10	9	Good	Good	Good	
652	Yes	Yes	Heritage Tree	Interior live oak (Quercus wislizeni)	20.2	2.4	2.4	4.7	3.1	2,2.8,2.8	12	15	Good	Good	Fair	This tree has a shrubby growth form
653	Yes	Yes	Native Oak Tree	Valley oak (Quercus lobata)	6.1	6.1	0	0	0	0	9	20	Good	Fair	Fair	
654	Yes	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	10	2	1.6	1.6	1.2	Many 1' branches	7	12	Good	Fair	Fair	This tree has a shrubby growth form
655	Yes	Yes	Native Oak Tree	Valley oak (Quercus lobata)	11.6	2.8	3.5	3.3	2	0	5	12	Good	Fair	Fair	
656	Yes	Yes	Native Tree	Western redbud (Cercis occidentalis)	12.4	2	1.2	1.2	2	Many 1' branches	7	13	Good	Good	Good	
657	Yes	Yes	Native Oak Tree	Valley oak (Quercus lobata)	3.9	3.9	0	0	0	0	4	12	Fair	Fair	Fair	
658	Yes	Yes	Native Tree	Western redbud (Cercis occidentalis)	12	2	2	2	2	2,1,1	5	8	Good	Good	Fair	
659	Yes	Yes	Native Oak Tree	Valley oak (Quercus lobata)	8	4.1	3.9	0	0	0	7	15	Fair	Fair	Fair	
660	Yes	Yes	Nonnative Tree	Chinese privet (Ligustrum sinense)	27	3.5	5.5	4.7	2.4	3.1,3.9,3.9	15	15	Good	Good	Fair	
661	Yes	Yes	Native Oak Tree	Valley oak (Quercus lobata)	5.5	3.1	2.4	0	0	0	8	23	Good	Fair	Fair	
662	Yes	Yes	Native Oak	Valley oak (Quercus lobata)	6.7	4.7	2	0	0	0	6	22	Good	Fair	Fair	

Table 4. Con't.

Tree Tag Number	City of Rancho Cordova	County of Sacramento	Connotation	Species Name Common (Scientific)	Cumulative DBH	Diameter at Breast Height of Individual Trunks (inches)					Dripline Radius (feet)	Height (feet	Health	Vigor	Structure	Comments
						1	2	3	4	Additional						
			Tree													
663	Yes	Yes	Native Oak Tree	Valley oak (Quercus lobata)	12.8	4.5	3.7	1.8	2.8	0	10	20	Good	Fair	Fair	
664	Yes	Yes	Native Oak Tree	Valley oak (Quercus lobata)	7	3.1	3.9	0	0	0	7	18	Good	Fair	Fair	
665	Yes	Yes	Nonnative Tree	Chinese privet (Ligustrum sinense)	26.6	5.5	3.1	4.7	3.1	2.4,3.9,3.9	25	22	Good	Good	Good	
666	Yes	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	6.3	3.1	1.6	1.6	0	0	7	12	Good	Fair	Fair-Poor	This tree has a shrubby growth form
667	Yes	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	9	1.6	1.2	1.2	2	Many 1' branches	8	8	Good	Fair	Fair-Poor	This tree has a shrubby growth form
668	Yes	Yes	Native Oak Tree	Valley oak (Quercus lobata)	17.7	17.7	0	0	0	0	20	30	Good	Fair	Good	Large tree wth many suckers and leaf discoloration
669	Yes	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	4.7	4.7	0	0	0	0	10	18	Good	Good	Fair-Poor	This tree has a shrubby growth form
670	Yes	Yes	Nonnative Tree	Chinese Hackberry (Celtis sinensis)	11	11	0	0	0	0	15	25	Fair	Fair	Good	The canopy of this tree appears reduced
671	Yes	Yes	Nonnative Tree	Chinese Hackberry (Celtis sinensis)	9.4	9.4	0	0	0	0	8	12	Good	Good	Good	
672	Yes	Yes	Nonnative Tree	Chinese tallowtree (Triadica sebifera)	16.1	16.1	0	0	0	0	18	23	Good	Good	Good	This tree has some broken branches
673	Yes	Yes	Nonnative Tree	Chinese tallowtree (Triadica sebifera)	9.3	9.3	0	0	0	0	12	15	Fair	Fair	Good	The canopy of this tree appears reduced
674	Yes	Yes	Native Tree	Western redbud (Cercis occidentalis)	8.9	8.9	0	0	0	0	16	15	Good	Good	Good	
675	Yes	Yes	Native Tree	Western redbud (Cercis occidentalis)	7.1	7.1	0	0	0	0	10	12	Good	Fair	Fair	
676	Yes	Yes	Nonnative	Chinese tallowtree (Triadica	9.1	9.1	0	0	0	0	8	13	Good	Fair	Fair	

Table 4. Con't.

Tree Tag Number	City of Rancho Cordova	County of Sacramento	Connotation	Species Name Common (Scientific)	Cumulative DBH	Diameter at Breast Height of Individual Trunks (inches)					Dripline Radius (feet)	Height (feet	Health	Vigor	Structure	Comments
						1	2	3	4	Additional						
			Tree	sebifera)												
677	No	Yes	Nonnative Tree	Bradford pear (Pyrus calleryana)	15.2	15.2	0	0	0	0	15	15	Good	Good	Good	
678	Yes	Yes	Nonnative Tree	Chinese tallowtree (Triadica sebifera)	7.3	7.3	0	0	0	0	7	12	Good	Fair	Fair	
679	Yes	Yes	Nonnative Tree	Chinese tallowtree (Triadica sebifera)	8.9	8.9	0	0	0	0	8	18	Fair	Fair	Fair	The canopy of this tree appears reduced
680	Yes	Yes	Nonnative Tree	Chinese tallowtree (Triadica sebifera)	10.6	10.6	0	0	0	0	7	12	Fair	Fair	Fair	The canopy of this tree appears reduced
681	Yes	Yes	Nonnative Tree	Chinese tallowtree (Triadica sebifera)	7.3	7.3	0	0	0	0	12	15	Good	Good	Fair-Poor	The tree has broken branches and is heavily weighted to one side
682	No	Yes	Nonnative Tree	Bradford pear (Pyrus calleryana)	14.8	14.8	0	0	0	0	15	18	Good	Good	Good	
683	Yes	Yes	Nonnative Tree	Chinese tallowtree (Triadica sebifera)	6.3	6.3	0	0	0	0	5	10	Fair-Poor	Fair-Poor	Fair-Poor	This tree has a reduced canopy, sucker production, and a large wound at the base
684	Yes	Yes	Nonnative Tree	Chinese tallowtree (Triadica sebifera)	11.6	11.6	0	0	0	0	10	20	Good	Good	Good	
685	Yes	Yes	Nonnative Tree	Chinese tallowtree (Triadica sebifera)	16.2	5.5	2	2	3.9	2.8	10	15	Good	Good	Fair-Poor	This tree has a shrubby growth form
686	Yes	Yes	Nonnative Tree	Chinese tallowtree (Triadica sebifera)	10	2	2	2	2	2	6	7	Good	Good	Fair-Poor	This tree has a shrubby growth form
687	Yes	Yes	Nonnative Tree	Chinese tallowtree (Triadica sebifera)	13.2	2	1.2	2	2	2,2,2	5	8	Fair-Poor	Fair	Fair-Poor	This tree has a shrubby growth form, reduced canopy and yellowing leaves
688	No	Yes	Nonnative Tree	Small-leaved lime (Tilia cordata)	7.7	7.7	0	0	0	0	10	18	Good	Good	Good	
690	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	13.8	13.8	0	0	0	0	18	28	Good	Good	Good	
691	No	Yes	Nonnative	Chinese tallowtree (Triadica	19.3	19.3	0	0	0	0	20	40	Good	Good	Good	

Table 4. Con't.

Tree Tag Number	City of Rancho Cordova	County of Sacramento	Connotation	Species Name Common (Scientific)	Cumulative DBH	Diameter at Breast Height of Individual Trunks (inches)					Dripline Radius (feet)	Height (feet	Health	Vigor	Structure	Comments
						1	2	3	4	Additional						
			Tree	sebifera)												
692	No	Yes	Nonnative Tree	Chinese tallowtree (Triadica sebifera)	17.5	17.5	0	0	0	0	20	38	Good	Good	Good	
693	No	Yes	Native Oak Tree	Coast live oak (Quercus agrifolia)	14.2	14.2	0	0	0	0	25	30	Good	Good	Good	
694	No	Yes	Heritage Tree	Coast live oak (Quercus agrifolia)	24.4	24.4	0	0	0	0	25	32	Good	Good	Good	
695	No	Yes	Native Oak Tree	Coast live oak (Quercus agrifolia)	16.1	16.1	0	0	0	0	25	30	Good	Good	Good	
696	No	Yes	Native Oak Tree	Coast live oak (Quercus agrifolia)	18.1	18.1	0	0	0	0	20	35	Good	Good	Good	
697	No	Yes	Native Oak Tree	Coast live oak (Quercus agrifolia)	11.2	11.2	0	0	0	0	15	28	Good	Good	Good	
698	No	Yes	Native Oak Tree	Coast live oak (Quercus agrifolia)	17.3	17.3	0	0	0	0	20	25	Good	Good	Good	
699	No	Yes	Native Oak Tree	Coast live oak (Quercus agrifolia)	10.6	10.6	0	0	0	0	20	15	Good	Good	Fair-Poor	The tree is heavily weighted to one side and has codominant trunks.
700	Yes	Yes	Nonnative Tree	Chinese Hackberry (Celtis sinensis)	16.3	16.3	0	0	0	0	25	32	Good	Good	Good	
701	Yes	Yes	Nonnative Tree	Small-leaved lime (Tilia cordata)	12	12	0	0	0	0	10	28	Poor	Poor	Fair	Mushrooms are on the trunk of this tree, the bark is dessicated and canopy is bare
702	Yes	Yes	Nonnative Tree	Small-leaved lime (Tilia cordata)	11.6	11.6	0	0	0	0	10	28	Poor	Poor	Fair	Mushrooms are on the trunk of this tree, the bark is dessicated and the leaves are starting to drop
703	Yes	Yes	Nonnative Tree	Small-leaved lime (Tilia cordata)	13.4	13.4	0	0	0	0	10	30	Fair	Fair	Fair	The leaves of this tree are starting to drop
704	Yes	Yes	Nonnative Tree	Small-leaved lime (Tilia cordata)	16.4	8.1	8.3	0	0	0	12	27	Fair-Poor	Fair-Poor	Fair	Mushrooms are on the trunk of this tree and the leaves are starting to drop
705	Yes	Yes	Nonnative Tree	Small-leaved lime (Tilia cordata)	10.4	3.1	4.9	2.4	0	0	8	15	Poor	Poor	Fair-Poor	Mushrooms are on the trunk of this tree, the bark is dessicated and canopy is bare

Table 4. Con't.

Tree Tag Number	City of Rancho Cordova	County of Sacramento	Connotation	Species Name Common (Scientific)	Cumulative DBH	Diameter at Breast Height of Individual Trunks (inches)					Dripline Radius (feet)	Height (feet	Health	Vigor	Structure	Comments
						1	2	3	4	Additional						
706	Yes	Yes	Nonnative Tree	Small-leaved lime (Tilia cordata)	8.3	8.3	0	0	0	0	8	18	Poor	Poor	Fair-Poor	The bark is dessicated and the canopy is bare
707	No	Yes	Nonnative Tree	Crape myrtle (Lagerstroemia sp.)	16.9	16.9	0	0	0	0	25	30	Good	Good	Good	
708	Yes	Yes	Native Oak Tree	Coast live oak (Quercus agrifolia)	10	3.9	1.6	3.1	1.4	0	15	10	Good	Fair	Fair-Poor	
709	Yes	Yes	Nonnative Tree	Crape myrtle (Lagerstroemia sp.)	17.6	2.4	2.8	2	2.4	2.4,2.8,2.8	15	15	Good	Good	Fair	This tree has a shrubby growth form
711	Yes	Yes	Native Tree	California black walnut (Juglans hindsii)	20.1	4.7	3.1	3.9	2.4	2,2,2	20	12	Good	Good	Fair	This tree has a shrubby growth form
712	Yes	Yes	Native Tree	California black walnut (Juglans hindsii)	22.7	7.3	7.3	8.1	0	0	20	18	Good	Fair	Fair	
713	Yes	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	18.1	10.2	7.9	0	0	0	20	25	Good	Fair	Fair-Poor	The tree has grown over a fence and codominant trunks
714	Yes	Yes	Native Tree	California black walnut (Juglans hindsii)	11.2	11.2	0	0	0	0	15	25	Good	Fair	Fair	
715	No	Yes	Nonnative Tree	Crape myrtle (Lagerstroemia sp.)	4.9	4.9	0	0	0	0	12	18	Good	Good	Good	
716	No	Yes	Nonnative Tree	Crape myrtle (Lagerstroemia sp.)	5.3	5.3	0	0	0	0	12	18	Good	Good	Good	
717	No	Yes	Heritage Tree	Coast live oak (Quercus agrifolia)	21.3	21.3	0	0	0	0	25	30	Good	Good	Good	
718	No	Yes	Native Oak Tree	Coast live oak (Quercus agrifolia)	18.5	18.5	0	0	0	0	25	30	Good	Good	Good	
719	No	Yes	Nonnative Tree	Chinese tallowtree (Triadica sebifera)	14	14	0	0	0	0	12	22	Good	Good	Good	
720	No	Yes	Nonnative Tree	Chinese tallowtree (Triadica sebifera)	18.1	18.1	0	0	0	0	15	30	Good	Fair	Good	Sucker production on one side of the trunk near wound
721	No	Yes	Native Oak	Coast live oak (Quercus agrifolia)	18.5	18.5	0	0	0	0	25	27	Good	Good	Good	

Table 4. Con't.

Tree Tag Number	City of Rancho Cordova	County of Sacramento	Connotation	Species Name Common (Scientific)	Cumulative DBH	Diameter at Breast Height of Individual Trunks (inches)					Dripline Radius (feet)	Height (feet	Health	Vigor	Structure	Comments
						1	2	3	4	Additional						
			Tree													
722	No	Yes	Heritage Tree	Coast live oak (Quercus agrifolia)	25.2	25.2	0	0	0	0	30	30	Good	Good	Good	
723	No	Yes	Heritage Tree	Coast live oak (Quercus agrifolia)	23.6	23.6	0	0	0	0	25	30	Good	Good	Good	
724	No	Yes	Nonnative Tree	Crape myrtle (Lagerstroemia sp.)	22.1	3.7	3.5	3.5	3.5	3.1,2.4,2.4,2,2,3	10	22	Good	Good	Good	
725	No	Yes	Nonnative Tree	Chinese tallowtree (Triadica sebifera)	17.9	17.9	0	0	0	0	20	45	Good	Good	Good	
726	No	Yes	Nonnative Tree	Sweet gum (Liquidambar styraciflua)	8.7	8.7	0	0	0	0	15	30	Good	Fair	Fair	
727	No	Yes	Nonnative Tree	Sweet gum (Liquidambar styraciflua)	9.4	9.4	0	0	0	0	12	30	Good	Good	Good	
728	No	Yes	Nonnative Tree	Sweet gum (Liquidambar styraciflua)	7.3	7.3	0	0	0	0	7	25	Fair	Fair	Fair-Poor	
729	No	Yes	Nonnative Tree	Sweet gum (Liquidambar styraciflua)	8.5	8.5	0	0	0	0	10	20	Good	Fair	Fair	
730	No	Yes	Nonnative Tree	Sweet gum (Liquidambar styraciflua)	8.1	8.1	0	0	0	0	10	20	Good	Fair	Fair	
731	No	Yes	Nonnative Tree	Sweet gum (Liquidambar styraciflua)	12.2	12.2	0	0	0	0	15	25	Good	Good	Good	
732	No	Yes	Nonnative Tree	Chinese tallowtree (Triadica sebifera)	16.5	16.5	0	0	0	0	20	28	Good	Good	Good	
733	No	Yes	Nonnative Tree	Chinese tallowtree (Triadica sebifera)	13	13	0	0	0	0	18	23	Good	Good	Good	
734	No	Yes	Nonnative Tree	Bradford pear (Pyrus calleryana)	9.8	9.8	0	0	0	0	15	18	Good	Good	Good	
735	No	Yes	Nonnative Tree	Crape myrtle (Lagerstroemia sp.)	5.3	5.3	0	0	0	0	5	12	Good	Good	Good	
736	No	Yes	Nonnative	Crape myrtle (Lagerstroemia sp.)	4.7	4.7	0	0	0	0	5	10	Good	Good	Good	

Table 4. Con't.

Tree Tag Number	City of Rancho Cordova	County of Sacramento	Connotation	Species Name Common (Scientific)	Cumulative DBH	Diameter at Breast Height of Individual Trunks (inches)					Dripline Radius (feet)	Height (feet	Health	Vigor	Structure	Comments
						1	2	3	4	Additional						
			Tree													
737	No	Yes	Nonnative Tree	Crape myrtle (Lagerstroemia sp.)	4.9	4.9	0	0	0	0	5	12	Good	Good	Good	
738	No	Yes	Nonnative Tree	Bradford pear (Pyrus calleryana)	12.4	12.4	0	0	0	0	20	15	Good	Fair	Fair-Poor	The tree has large broken branches one side
739	No	Yes	Nonnative Tree	Bradford pear (Pyrus calleryana)	13	13	0	0	0	0	15	20	Good	Good	Fair	
740	No	Yes	Nonnative Tree	Bradford pear (Pyrus calleryana)	12.2	12.2	0	0	0	0	15	18	Good	Good	Good	
741	No	Yes	Nonnative Tree	Chinese tallowtree (Triadica sebifera)	12	12	0	0	0	0	18	45	Good	Good	Fair	
742	No	Yes	Nonnative Tree	Chinese tallowtree (Triadica sebifera)	16.1	16.1	0	0	0	0	20	38	Good	Good	Good	
743	No	Yes	Nonnative Tree	Chinese tallowtree (Triadica sebifera)	21.7	21.7	0	0	0	0	25	38	Good	Good	Good	
744	No	Yes	Nonnative Tree	Chinese tallowtree (Triadica sebifera)	18.3	18.3	0	0	0	0	20	35	Good	Good	Good	
745	No	Yes	Nonnative Tree	Chinese tallowtree (Triadica sebifera)	20.9	20.9	0	0	0	0	25	35	Good	Good	Good	
746	No	Yes	Nonnative Tree	Crape myrtle (Lagerstroemia sp.)	6.1	6.1	0	0	0	0	12	12	Good	Good	Good	
747	No	Yes	Nonnative Tree	Sweet gum (Liquidambar styraciflua)	15.2	15.2	0	0	0	0	25	40	Good	Good	Good	
748	No	Yes	Nonnative Tree	Sweet gum (Liquidambar styraciflua)	16.3	16.3	0	0	0	0	20	40	Good	Good	Fair	
749	No	Yes	Nonnative Tree	Sweet gum (Liquidambar styraciflua)	14.8	14.8	0	0	0	0	20	40	Good	Good	Fair	
750	No	Yes	Nonnative	Sweet gum (Liquidambar	11.4	11.4	0	0	0	0	18	40	Good	Good	Fair	

Table 4. Con't.

Tree Tag Number	City of Rancho Cordova	County of Sacramento	Connotation	Species Name Common (Scientific)	Cumulative DBH	Diameter at Breast Height of Individual Trunks (inches)					Dripline Radius (feet)	Height (feet	Health	Vigor	Structure	Comments
						1	2	3	4	Additional						
			Tree	styraciflua)												
751	No	Yes	Nonnative Tree	Sweet gum (Liquidambar styraciflua)	14.8	14.8	0	0	0	0	18	45	Good	Good	Good	
752	No	Yes	Nonnative Tree	Chinese tallowtree (Triadica sebifera)	26.7	18.7	2	2	1	Many 1' branches	25	43	Good	Good	Fair	
753	No	Yes	Nonnative Tree	Crape myrtle (Lagerstroemia sp.)	3.5	3.5	0	0	0	0	10	12	Good	Good	Good	
754	No	Yes	Nonnative Tree	Crape myrtle (Lagerstroemia sp.)	7.7	7.7	0	0	0	0	12	23	Good	Good	Good	
755	No	Yes	Nonnative Tree	Ash tree (Fraxinus sp.)	35.3	7.1	6.9	3.7	5.1	4.7,3.9,3.9	20	23	Good	Good	Good	
756	No	Yes	Nonnative Tree	Chinese tallowtree (Triadica sebifera)	11.8	11.8	0	0	0	0	18	25	Good	Good	Fair	
757	No	Yes	Native Oak Tree	Coast live oak (Quercus agrifolia)	17.5	17.5	0	0	0	0	25	45	Good	Good	Good	
758	No	Yes	Nonnative Tree	Chinese tallowtree (Triadica sebifera)	7.7	7.7	0	0	0	0	25	30	Good	Fair	Fair	
759	No	Yes	Nonnative Tree	Chinese tallowtree (Triadica sebifera)	7.9	7.9	0	0	0	0	25	30	Good	Fair	Fair	
760	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	14.2	14.2	0	0	0	0	18	30	Good	Fair	Fair	
761	No	Yes	Native Oak Tree	Coast live oak (Quercus agrifolia)	16.9	16.9	0	0	0	0	20	45	Good	Good	Good	
762	No	Yes	Heritage Tree	Coast live oak (Quercus agrifolia)	38.2	38.2	0	0	0	0	30	50	Good	Good	Good	
763	No	Yes	Heritage Tree	Coast live oak (Quercus agrifolia)	28.3	28.3	0	0	0	0	35	50	Good	Good	Good	
764	No	Yes	Heritage Tree	Coast live oak (Quercus agrifolia)	33.9	33.9	0	0	0	0	35	50	Good	Good	Good	
765	No	Yes	Heritage Tree	Interior live oak (Quercus wislizeni)	23.6	23.6	0	0	0	0	30	45	Good	Good	Fair-Poor	The tree is heavily weighted to one side

Table 4. Con't.

Tree Tag Number	City of Rancho Cordova	County of Sacramento	Connotation	Species Name Common (Scientific)	Cumulative DBH	Diameter at Breast Height of Individual Trunks (inches)					Dripline Radius (feet)	Height (feet	Health	Vigor	Structure	Comments
						1	2	3	4	Additional						
766	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	16.3	16.3	0	0	0	0	18	45	Good	Good	Fair	
767	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	16.3	16.3	0	0	0	0	20	40	Good	Good	Fair	
768	No	Yes	Heritage Tree	Interior live oak (Quercus wislizeni)	34.1	34.1	0	0	0	0	30	45	Good	Fair	Fair-Poor	The tree has large wounds and peeling bark
769	No	Yes	Heritage Tree	Interior live oak (Quercus wislizeni)	20.7	20.7	0	0	0	0	25	42	Good	Good	Good	
770	No	Yes	Heritage Tree	Valley oak (Quercus lobata)	19.1	19.1	0	0	0	0	28	42	Good	Good	Fair-Poor	The tree is heavily weighted to one side
771	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	14.4	14.4	0	0	0	0	30	40	Good	Good	Fair-Poor	The tree is weighted to one side
772	No	Yes	Heritage Tree	Interior live oak (Quercus wislizeni)	32.3	32.3	0	0	0	0	30	50	Good	Good	Good	
773	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	14.2	14.2	0	0	0	0	25	40	Good	Good	Fair-Poor	The tree is heavily weighted to one side
774	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	15.4	15.4	0	0	0	0	28	50	Good	Good	Good	
775	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	10.4	10.4	0	0	0	0	25	23	Good	Fair	Fair-Poor	The tree has wounds, broken branches, and is heavily weighted to one side
776	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	16.3	16.3	0	0	0	0	20	45	Fair-Poor	Fair	Fair-Poor	The tree has decay on one side, mushrooms growing on trunk, and an insect infestation
777	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	12.2	12.2	0	0	0	0	20	45	Good	Good	Good	
778	No	Yes	Heritage Tree	Valley oak (Quercus lobata)	26	26	0	0	0	0	25	45	Good	Good	Good	
779	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	17.9	17.9	0	0	0	0	25	55	Good	Good	Good	
781	No	Yes	Heritage Tree	Valley oak (Quercus lobata)	23.6	23.6	0	0	0	0	30	50	Good	Good	Good	
782	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	11.8	11.8	0	0	0	0	15	40	Good	Good	Good	

Table 4. Con't.

Tree Tag Number	City of Rancho Cordova	County of Sacramento	Connotation	Species Name Common (Scientific)	Cumulative DBH	Diameter at Breast Height of Individual Trunks (inches)					Dripline Radius (feet)	Height (feet	Health	Vigor	Structure	Comments
						1	2	3	4	Additional						
783	No	Yes	Heritage Tree	Valley oak (Quercus lobata)	36.2	36.2	0	0	0	0	30	60	Good	Good	Good	
784	No	Yes	Nonnative Tree	Crape myrtle (Lagerstroemia sp.)	20.6	3.5	17.1	0	0	0	8	12	Good	Good	Good	
785	No	Yes	Nonnative Tree	Crape myrtle (Lagerstroemia sp.)	3.5	3.5	0	0	0	0	7	12	Good	Good	Good	
786	No	Yes	Nonnative Tree	Crape myrtle (Lagerstroemia sp.)	5.9	5.9	0	0	0	0	10	18	Good	Good	Fair	
787	No	Yes	Nonnative Tree	Crape myrtle (Lagerstroemia sp.)	5.5	5.5	0	0	0	0	7	12	Good	Good	Fair	
788	No	Yes	Nonnative Tree	Crape myrtle (Lagerstroemia sp.)	5.5	5.5	0	0	0	0	10	20	Good	Fair	Fair	
789	No	Yes	Nonnative Tree	Crape myrtle (Lagerstroemia sp.)	6.3	6.3	0	0	0	0	8	12	Good	Good	Good	
790	No	Yes	Heritage Tree	Valley oak (Quercus lobata)	31.1	31.1	0	0	0	0	25	50	Good	Good	Good	
791	No	Yes	Heritage Tree	Valley oak (Quercus lobata)	23.4	23.4	0	0	0	0	25	45	Fair	Fair	Fair	The canopy of this tree appears reduced and most of the leaves are browning
792	No	Yes	Nonnative Tree	Chinese tallowtree (Triadica sebifera)	12.4	12.4	0	0	0	0	18	35	Good	Good	Good	
793	No	Yes	Nonnative Tree	Chinese tallowtree (Triadica sebifera)	8.7	8.7	0	0	0	0	15	28	Good	Fair	Fair	
794	No	Yes	Nonnative Tree	Chinese tallowtree (Triadica sebifera)	16.5	16.5	0	0	0	0	20	40	Good	Good	Good	
794	No	Yes	Nonnative Tree	Chinese tallowtree (Triadica sebifera)	10.8	10.8	0	0	0	0	15	25	Good	Good	Good	
796	No	Yes	Nonnative Tree	Chinese tallowtree (Triadica sebifera)	9.8	9.8	0	0	0	0	22	23	Good	Good	Fair	
797	No	Yes	Nonnative Tree	Chinese tallowtree (Triadica sebifera)	11.6	11.6	0	0	0	0	15	25	Good	Good	Good	

Table 4. Con't.

Tree Tag Number	City of Rancho Cordova	County of Sacramento	Connotation	Species Name Common (Scientific)	Cumulative DBH	Diameter at Breast Height of Individual Trunks (inches)					Dripline Radius (feet)	Height (feet	Health	Vigor	Structure	Comments
						1	2	3	4	Additional						
798	No	Yes	Nonnative Tree	Chinese tallowtree (Triadica sebifera)	10.8	10.8	0	0	0	0	18	25	Good	Good	Fair	
799	No	Yes	Nonnative Tree	Chinese tallowtree (Triadica sebifera)	12.8	12.8	0	0	0	0	18	25	Good	Good	Fair	
800	No	Yes	Nonnative Tree	Chinese tallowtree (Triadica sebifera)	12.4	12.4	0	0	0	0	20	25	Good	Good	Fair	
801	No	Yes	Nonnative Tree	Chinese tallowtree (Triadica sebifera)	8.5	8.5	0	0	0	0	12	20	Good	Fair	Fair	
802	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	11	11	0	0	0	0	25	25	Good	Fair	Fair	
803	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	15.7	15.7	0	0	0	0	25	30	Good	Good	Fair	The roots of this tree are girdling at the base. Tree appears healthy otherwise
804	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	4.5	4.5	0	0	0	0	8	20	Good	Fair	Fair	
805	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	7.9	7.9	0	0	0	0	12	23	Good	Good	Good	
806	No	Yes	Nonnative Tree	Crape myrtle (Lagerstroemia sp.)	3.9	3.9	0	0	0	0	8	15	Good	Fair	Fair	
807	No	Yes	Nonnative Tree	Crape myrtle (Lagerstroemia sp.)	3.9	3.9	0	0	0	0	6	15	Good	Fair	Fair	
808	No	Yes	Nonnative Tree	Crape myrtle (Lagerstroemia sp.)	5.7	5.7	0	0	0	0	7	25	Good	Good	Fair	
809	No	Yes	Nonnative Tree	Crape myrtle (Lagerstroemia sp.)	4.3	4.3	0	0	0	0	7	18	Good	Good	Fair	
810	No	Yes	Nonnative Tree	Crape myrtle (Lagerstroemia sp.)	4.3	4.3	0	0	0	0	7	18	Good	Good	Fair	
811	No	Yes	Nonnative Tree	Crape myrtle (Lagerstroemia sp.)	5.1	5.1	0	0	0	0	12	18	Good	Good	Fair	

Table 4. Con't.

Tree Tag Number	City of Rancho Cordova	County of Sacramento	Connotation	Species Name Common (Scientific)	Cumulative DBH	Diameter at Breast Height of Individual Trunks (inches)					Dripline Radius (feet)	Height (feet	Health	Vigor	Structure	Comments
						1	2	3	4	Additional						
812	No	Yes	Nonnative Tree	Crape myrtle (Lagerstroemia sp.)	5.1	5.1	0	0	0	0	8	20	Good	Fair	Fair	
813	No	Yes	Nonnative Tree	Crape myrtle (Lagerstroemia sp.)	3.9	3.9	0	0	0	0	8	15	Good	Fair	Fair	
814	No	Yes	Nonnative Tree	Crape myrtle (Lagerstroemia sp.)	5.5	5.5	0	0	0	0	8	18	Good	Good	Fair	
815	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	16.1	16.1	0	0	0	0	20	28	Good	Fair	Fair-Poor	
816	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	17.7	17.7	0	0	0	0	20	30	Good	Fair	Fair	
817	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	18.9	18.9	0	0	0	0	20	40	Good	Fair	Fair	
818	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	15.3	8.7	3.3	3.3	0	0	15	45	Good	Fair	Fair	
819	No	Yes	Native Tree	California black walnut (Juglans hindsii)	3.1	3.1	0	0	0	0	10	10	Good	Fair-Poor	Fair-Poor	
820	No	Yes	Native Tree	California black walnut (Juglans hindsii)	11.3	5.7	2.8	2.8	0	0	15	25	Good	Fair	Fair-Poor	Small walnut with multiple leaders.
821	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	3.9	3.9	0	0	0	0	10	12	Good	Fair	Fair	This tree has a shrubby growth form
822	No	Yes	Heritage Tree	Interior live oak (Quercus wislizeni)	24.8	24.8	0	0	0	0	35	40	Good	Fair	Fair	The tree is weighted to one side
823	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	13.8	13.8	0	0	0	0	40	50	Good	Good	Good	
824	No	Yes	Heritage Tree	Valley oak (Quercus lobata)	29.7	29.7	0	0	0	0	35	50	Good	Good	Good	
825	No	Yes	Heritage Tree	Interior live oak (Quercus wislizeni)	33.8	16.5	17.3	0	0	0	25	45	Good	Fair	Fair	
826	No	Yes	Heritage Tree	Interior live oak (Quercus wislizeni)	33.3	33.3	0	0	0	0	30	50	Good	Fair	Fair	
827	No	Yes	Native Oak	Valley oak (Quercus lobata)	9.1	9.1	0	0	0	0	15	28	Good	Fair	Fair	

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Tree Tag Number	City of Rancho Cordova	County of Sacramento	Connotation	Species Name Common (Scientific)	Cumulative DBH	Diameter at Breast Height of Individual Trunks (inches)					Dripline Radius (feet)	Height (feet	Health	Vigor	Structure	Comments
						1	2	3	4	Additional						
			Tree													
828	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	8.7	8.7	0	0	0	0	10	20	Good	Fair	Fair	
829	No	Yes	Heritage Tree	Interior live oak (Quercus wislizeni)	19.7	19.7	0	0	0	0	20	35	Good	Fair	Fair	
830	No	Yes	Heritage Tree	Interior live oak (Quercus wislizeni)	34.6	34.6	0	0	0	0	30	40	Good	Good	Good	
831	No	Yes	Heritage Tree	Valley oak (Quercus lobata)	28.5	28.5	0	0	0	0	30	50	Good	Good	Good	
832	No	Yes	Heritage Tree	Valley oak (Quercus lobata)	33.1	33.1	0	0	0	0	35	45	Good	Good	Good	
833	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	3	3	0	0	0	0	8	10	Fair	Fair	Fair	
834	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	3.1	3.1	0	0	0	0	8	12	Fair	Fair	Fair	
835	No	Yes	Native Tree	Arroyo willow (Salix lasiolepis)	6.9	6.9	0	0	0	0	8	12	Fair	Fair	Fair	
836	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	3.1	3.1	0	0	0	0	6	15	Fair	Fair	Fair	
837	No	Yes	Native Tree	Fremont cottonwood (Populus fremontii)	43.5	12	17.7	7.9	5.9	0	20	20	Fair	Fair	Fair-Poor	The primary trunk is growing around a fence, has sucker production and is covered in vines.
838	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	14.5	4.7	3.9	0	5.9	0	20	15	Fair-Poor	Fair	Fair-Poor	This tree has dead decaying trunks, sucker production, and is covered in vines
839	No	Yes	Nonnative Tree	Black locust (Robinia pseudoacacia)	7.9	7.9	0	0	0	0	20	25	Fair	Fair	Fair-Poor	The tree is supported by fence and covered in vines
840	No	Yes	Native Tree	Fremont cottonwood (Populus fremontii)	13.8	13.8	0	0	0	0	15	30	Fair	Fair	Fair	
841	No	Yes	Nonnative Tree	Black locust (Robinia pseudoacacia)	7.3	7.3	0	0	0	0	20	30	Fair	Fair	Fair	The trees are growing in a cluster on the slope near the freeway
842	No	Yes	Nonnative Tree	Black locust (Robinia pseudoacacia)	18.5	5.5	5.9	7.1	0	0	20	25	Fair	Fair	Fair	The trees are growing in a cluster on the slope near the freeway
843	No	Yes	Nonnative	Black locust (Robinia pseudoacacia)	0	0	0	0	0	0	20	25	Fair	Fair	Fair	The trees are growing in a cluster on the slope near the freeway

Table 4. Con't.

Tree Tag Number	City of Rancho Cordova	County of Sacramento	Connotation	Species Name Common (Scientific)	Cumulative DBH	Diameter at Breast Height of Individual Trunks (inches)					Dripline Radius (feet)	Height (feet	Health	Vigor	Structure	Comments
						1	2	3	4	Additional						
			Tree													
844	No	Yes	Nonnative Tree	Tree of Heaven (Ailanthus altissima)	0	0	0	0	0	0	20	25	Good	Good	Fair	From this point, to the corner of Folsom, is a polygon of recruiting Ailanthus altissima trees
844	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	5.1	5.1	0	0	0	0	15	15	Fair-Poor	Fair	Fair	The roots of this tree have been uplifted. The tree is leaning as result. The tree has cankers
845	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	3.5	3.5	0	0	0	0	8	12	Fair	Fair	Fair	
846	No	Yes	Nonnative Tree	Bradford pear (Pyrus calleryana)	5.5	5.5	0	0	0	0	12	20	Good	Good	Fair	
847	No	Yes	Native Tree	Fremont cottonwood (Populus fremontii)	25.9	15.7	5.5	4.7	0	0	20	30	Good	Good	Fair	
848	No	Yes	Native Tree	Fremont cottonwood (Populus fremontii)	5.1	5.1	0	0	0	0	7	20	Fair	Fair	Fair	The canopy of this tree appears reduced and suckers are being produced on the trunk
849	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	5.7	5.7	0	0	0	0	8	23	Good	Fair	Fair	
850	No	Yes	Nonnative Tree	Tree of Heaven (Ailanthus altissima)	8.1	8.1	0	0	0	0	20	30	Good	Good	Fair	
851	No	Yes	Nonnative Tree	Tree of Heaven (Ailanthus altissima)	8.7	8.7	0	0	0	0	15	30	Good	Good	Fair	
852	No	Yes	Nonnative Tree	Tree of Heaven (Ailanthus altissima)	13.4	4.3	9.1	0	0	0	20	30	Good	Fair	Fair	This tree has peeiling bark around canker
853	No	Yes	Nonnative Tree	Tree of Heaven (Ailanthus altissima)	9.1	9.1	0	0	0	0	20	20	Fair-Poor	Fair	Fair	This tree has peeiling bark around canker and an insect infestation
854	No	Yes	Nonnative Tree	Tree of Heaven (Ailanthus altissima)	6.9	6.9	0	0	0	0	15	30	Good	Fair	Fair	
855	No	Yes	Nonnative Tree	Tree of Heaven (Ailanthus altissima)	11.2	11.2	0	0	0	0	20	30	Fair	Fair	Fair	This tree has peeiling bark around canker
856	No	Yes	Nonnative	Tree of Heaven (Ailanthus altissima)	16.5	16.5	0	0	0	0	25	30	Fair-	Fair-Poor	Fair	This tree has peeiling bark around canker and an insect infestation

Table 4. Con't.

Tree Tag Number	City of Rancho Cordova	County of Sacramento	Connotation	Species Name Common (Scientific)	Cumulative DBH	Diameter at Breast Height of Individual Trunks (inches)					Dripline Radius (feet)	Height (feet	Health	Vigor	Structure	Comments
						1	2	3	4	Additional						
			Tree										Poor			
857	No	Yes	Nonnative Tree	Tree of Heaven (Ailanthus altissima)	15	15	0	0	0	0	20	30	Good	Fair	Fair	
858	No	Yes	Nonnative Tree	Tree of Heaven (Ailanthus altissima)	12.8	12.8	0	0	0	0	20	30	Fair	Fair	Fair	The tree has healed cankers and codominant trunks
859	No	Yes	Nonnative Tree	Tree of Heaven (Ailanthus altissima)	15	15	0	0	0	0	15	30	Fair	Fair	Fair	Codominant trunks with peeking bark around healed cankers
860	No	Yes	Nonnative Tree	Tree of Heaven (Ailanthus altissima)	8.3	8.3	0	0	0	0	15	30	Good	Fair	Good	
861	No	Yes	Nonnative Tree	Tree of Heaven (Ailanthus altissima)	28.9	19.1	9.8	0	0	0	20	30	Fair-Poor	Fair-Poor	Fair-Poor	This tree has deep cankers, peeling bark, and weeping sap
862	No	Yes	Nonnative Tree	Tree of Heaven (Ailanthus altissima)	11	11	0	0	0	0	20	25	Fair	Fair	Fair	This tree has peeiling bark with weeping sap
863	No	Yes	Nonnative Tree	Tree of Heaven (Ailanthus altissima)	10	10	0	0	0	0	18	25	Good	Fair	Fair	
864	No	Yes	Nonnative Tree	Tree of Heaven (Ailanthus altissima)	13.4	13.4	0	0	0	0	20	30	Good	Fair	Fair	Codominant trunks
865	No	Yes	Nonnative Tree	Tree of Heaven (Ailanthus altissima)	13	13	0	0	0	0	25	30	Good	Good	Good	
866	No	Yes	Nonnative Tree	Tree of Heaven (Ailanthus altissima)	14.6	14.6	0	0	0	0	25	30	Good	Fair	Fair	Codominant trunks
867	No	Yes	Nonnative Tree	Tree of Heaven (Ailanthus altissima)	8.5	8.5	0	0	0	0	25	30	Good	Good	Good	
868	No	Yes	Nonnative Tree	Tree of Heaven (Ailanthus altissima)	16.1	16.1	0	0	0	0	25	30	Good	Good	Fair	
869	No	Yes	Nonnative Tree	Tree of Heaven (Ailanthus altissima)	14.6	7.1	7.5	0	0	0	25	28	Good	Fair	Fair	Codominant trunks
870	No	Yes	Nonnative	Tree of Heaven (Ailanthus altissima)	14.2	14.2	0	0	0	0	25	28	Good	Fair	Fair	

Table 4. Con't.

Tree Tag Number	City of Rancho Cordova	County of Sacramento	Connotation	Species Name Common (Scientific)	Cumulative DBH	Diameter at Breast Height of Individual Trunks (inches)					Dripline Radius (feet)	Height (feet	Health	Vigor	Structure	Comments
						1	2	3	4	Additional						
			Tree													
871	No	Yes	Nonnative Tree	Tree of Heaven (Ailanthus altissima)	28.9	15.9	13	0	0	0	25	28	Fair	Fair-Poor	Fair-Poor	The tree has fused codominant trunks, peeling bark and cankers at base
872	No	Yes	Heritage Tree	Valley oak (Quercus lobata)	21.3	21.3	0	0	0	0	20	30	Good	Good	Good	
873	No	Yes	Heritage Tree	Interior live oak (Quercus wislizeni)	27.6	27.6	0	0	0	0	45	30	Good	Fair	Fair-Poor	The tree is heavily weighted to one side
874	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	7.6	2.8	2.4	2.4	0	0	10	12	Good	Fair	Fair	
875	No	Yes	Heritage Tree	Valley oak (Quercus lobata)	24.8	24.8	0	0	0	0	25	30	Good	Good	Good	
876	No	Yes	Native Tree	Arroyo willow (Salix lasiolepis)	44.7	7.5	7.1	7.9	8.7	8.7,2.4,2.4	30	25	Good	Fair	Fair	
877	No	Yes	Native Tree	Fremont cottonwood (Populus fremontii)	7.1	7.1	0	0	0	0	6	23	Fair	Fair-Poor	Fair-Poor	The canopy of this tree appears reduced, vines cover the trunk and suckers are being produced
878	No	Yes	Native Tree	Fremont cottonwood (Populus fremontii)	8.5	8.5	0	0	0	0	8	25	Fair	Fair-Poor	Fair-Poor	The canopy of this tree appears reduced, vines cover the trunk and suckers are being produced
879	No	Yes	Native Tree	Fremont cottonwood (Populus fremontii)	38.8	17.3	7.1	14.4	0	0	30	38	Fair	Good	Fair	
880	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	14.2	6.3	2.8	3.1	2	0	12	15	Good	Fair	Fair	Sucker production on trunk
881	No	Yes	Native Tree	Arroyo willow (Salix lasiolepis)	16.6	13.8	2.8	0	0	0	20	20	Good	Fair	Fair	The ground around the tree is heavily infested with flying insects
882	No	Yes	Native Tree	Arroyo willow (Salix lasiolepis)	46	15.7	15.7	11.8	2.8	0	25	25	Good	Fair	Fair	The ground around the tree is heavily infested with flying insects
883	No	Yes	Native Tree	Fremont cottonwood (Populus fremontii)	8.7	8.7	0	0	0	0	18	25	Good	Fair	Fair	The ground around the tree is heavily infested with flying insects
884	No	Yes	Native Tree	Arroyo willow (Salix lasiolepis)	17.8	15	0	0	2.8	0	18	25	Good	Fair	Fair	The ground around the tree is heavily infested with flying insects
885	No	Yes	Native Tree	Fremont cottonwood (Populus fremontii)	13	13	0	0	0	0	18	25	Good	Fair	Fair	
886	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	11.8	11.8	0	0	0	0	20	20	Good	Fair	Fair	

Table 4. Con't.

Tree Tag Number	City of Rancho Cordova	County of Sacramento	Connotation	Species Name Common (Scientific)	Cumulative DBH	Diameter at Breast Height of Individual Trunks (inches)					Dripline Radius (feet)	Height (feet	Health	Vigor	Structure	Comments
						1	2	3	4	Additional						
887	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	10.4	10.4	0	0	0	0	20	25	Good	Fair	Fair	
888	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	9.4	9.4	0	0	0	0	25	25	Good	Fair	Fair	
889	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	6.7	6.7	0	0	0	0	20	23	Good	Fair	Fair	
890	No	Yes	Nonnative Tree	Tree of Heaven (Ailanthus altissima)	3.9	3.9	0	0	0	0	12	18	Good	Good	Good	
891	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	4.7	4.7	0	0	0	0	12	18	Good	Fair	Fair	
892	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	5.1	5.1	0	0	0	0	8	18	Good	Fair	Fair	
893	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	8.9	8.9	0	0	0	0	8	10	Good	Fair	Fair	
894	No	Yes	Nonnative Tree	Tree of Heaven (Ailanthus altissima)	3.7	3.7	0	0	0	0	8	22	Good	Fair	Fair	
895	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	7.3	7.3	0	0	0	0	20	20	Good	Fair	Fair	
896	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	3.9	3.9	0	0	0	0	7	12	Good	Fair	Fair	
897	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	6.3	6.3	0	0	0	0	8	12	Good	Fair	Fair	This tree has a shrubby growth form
898	No	Yes	Native Tree	Arroyo willow (Salix lasiolepis)	3.5	3.5	0	0	0	0	8	12	Good	Fair	Fair	The canopy of this tree appears reduced
899	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	7.1	7.1	0	0	0	0	10	18	Good	Fair	Fair	The canopy of this tree appears reduced
900	No	Yes	Native Tree	Fremont cottonwood (Populus fremontii)	11.8	11.8	0	0	0	0	10	23	Good	Fair	Fair	The canopy of this tree appears reduced
901	No	Yes	Native Oak	Interior live oak (Quercus wislizeni)	7.1	7.1	0	0	0	0	12	20	Good	Fair	Fair	

Table 4. Con't.

Tree Tag Number	City of Rancho Cordova	County of Sacramento	Connotation	Species Name Common (Scientific)	Cumulative DBH	Diameter at Breast Height of Individual Trunks (inches)					Dripline Radius (feet)	Height (feet	Health	Vigor	Structure	Comments
						1	2	3	4	Additional						
			Tree													
902	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	6.3	6.3	0	0	0	0	15	25	Good	Fair	Fair	
903	No	Yes	Native Tree	Western redbud (Cercis occidentalis)	11	2	2	2	2	Many 1' branches	7	10	Good	Fair	Fair	
904	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	10.5	3.1	3.5	3.9	0	0	10	15	Good	Fair	Fair	This tree has a shrubby growth form
905	No	Yes	Native Tree	Fremont cottonwood (Populus fremontii)	19.6	4.7	5.5	3.9	3.1	2.4	18	18	Good	Fair	Fair	Sucker production on trunk
906	No	Yes	Native Tree	Fremont cottonwood (Populus fremontii)	37.4	8.3	9.4	6.3	6.3	7.1	22	30	Good	Fair	Fair	Sucker production on trunk
908	No	Yes	Heritage Tree	Valley oak (Quercus lobata)	19.7	2.8	3.5	0	6.3	7.1	12	15	Good	Fair	Fair	This tree has a shrubby growth form
909	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	16.5	16.5	0	0	0	0	25	25	Good	Fair	Fair	The tree has large, healed, wounds and is weighted to one side
910	No	Yes	Native Tree	Arroyo willow (Salix lasiolepis)	18.9	13	5.9	0	0	0	10	25	Good	Fair	Fair	
911	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	10.8	5.7	5.1	0	0	0	10	30	Good	Fair	Fair	The tree is leaning
912	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	10.6	10.6	0	0	0	0	20	20	Good	Good	Good	
913	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	3.9	3.9	0	0	0	0	10	15	Good	Fair	Fair	
914	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	12.9	5.1	4.3	3.5	0	0	18	20	Good	Fair	Fair	
915	No	Yes	Nonnative Tree	Chinese elm (Ulmus parvifolia)	14.5	5.1	3.1	3.9	2.4	0	15	30	Good	Fair	Fair	
917	No	Yes	Native Oak Tree	Coast live oak (Quercus agrifolia)	15	8.7	3.9	0	2.4	0	14	20	Good	Fair	Fair	
918	No	Yes	Heritage Tree	Interior live oak (Quercus wislizeni)	24.8	7.1	6.3	5.1	3.9	2.4	20	35	Good	Fair	Fair	

Table 4. Con't.

Tree Tag Number	City of Rancho Cordova	County of Sacramento	Connotation	Species Name Common (Scientific)	Cumulative DBH	Diameter at Breast Height of Individual Trunks (inches)					Dripline Radius (feet)	Height (feet	Health	Vigor	Structure	Comments
						1	2	3	4	Additional						
919	No	Yes	Heritage Tree	Interior live oak (Quercus wislizeni)	39.1	7.5	2.4	2.4	6.3	6.3,7.1,7.1	20	35	Good	Fair	Fair	
920	No	Yes	Heritage Tree	Interior live oak (Quercus wislizeni)	26.8	7.1	8.7	11	0	0	20	40	Good	Fair	Fair	
921	No	Yes	Native Oak Tree	Coast live oak (Quercus agrifolia)	5.1	5.1	0	0	0	0	10	20	Good	Fair	Fair	
922	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	18.5	5.1	3.9	5.5	2	2	10	20	Good	Fair	Fair	
923	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	4.8	1.6	1.6	1.6	0	0	6	15	Good	Fair	Fair	
925	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	17.7	11.8	2.4	3.5	0	0	30	20	Good	Fair	Fair	
926	No	Yes	Native Tree	Fremont cottonwood (Populus fremontii)	23.6	23.6	0	0	0	0	20	25	Good	Fair	Fair	
927	No	Yes	Heritage Tree	Interior live oak (Quercus wislizeni)	41.2	7.9	6.7	3.9	5.9	9.8,3.5,3.5	30	20	Good	Fair	Fair	This tree has a shrubby growth form
928	No	Yes	Heritage Tree	Interior live oak (Quercus wislizeni)	24	9.8	7.9	6.3	0	0	20	25	Good	Fair	Fair	The tree is covered in poison oak
929	No	Yes	Heritage Tree	Interior live oak (Quercus wislizeni)	77.1	15.7	15.7	12.6	5.9	9.8,8.7,8.7	30	28	Good	Good	Good	
930	No	Yes	Heritage Tree	Interior live oak (Quercus wislizeni)	50	34.3	15.7	0	0	0	25	28	Good	Good	Good	
931	No	Yes	Nonnative Tree	Eucalyptus (Eucalyptus sp.)	32.6	23.6	4.3	3.1	1.6	0	18	35	Good	Fair	Fair	
932	No	Yes	Native Oak Tree	Valley oak (Quercus lobata)	5.3	5.3	0	0	0	0	7	12	Good	Fair	Fair	
933	No	Yes	Native Tree	Gray pine (Pinus sabiniana)	66.9	37.8	29.1	0	0	0	30	40	Fair-Poor	Poor	Poor	This tree has significant fire damage
934	No	Yes	Native Tree	Gray pine (Pinus sabiniana)	18.9	18.9	0	0	0	0	30	45	Fair-Poor	Poor	Poor	This tree has significant fire damage
935	No	Yes	Native Tree	Gray pine (Pinus sabiniana)	14.6	14.6	0	0	0	0	30	45	Fair-Poor	Poor	Poor	This tree has significant fire damage

Table 4. Con't.

Tree Tag Number	City of Rancho Cordova	County of Sacramento	Connotation	Species Name Common (Scientific)	Cumulative DBH	Diameter at Breast Height of Individual Trunks (inches)					Dripline Radius (feet)	Height (feet	Health	Vigor	Structure	Comments
						1	2	3	4	Additional						
936	No	Yes	Native Tree	Gray pine (Pinus sabiniana)	16.9	16.9	0	0	0	0	30	45	Fair-Poor	Poor	Poor	This tree has significant fire damage
937	No	Yes	Native Tree	Gray pine (Pinus sabiniana)	0	0	0	0	0	0	30	45	Fair-Poor	Poor	Poor	This tree is covered in poison oak and has significant fire damage
938	No	Yes	Native Tree	Gray pine (Pinus sabiniana)	0	0	0	0	0	0	30	45	Fair-Poor	Poor	Poor	This tree is covered in poison oak and has significant fire damage
939	No	Yes	Heritage Tree	Interior live oak (Quercus wislizeni)	20.4	16.7	3.7	0	0	0	25	15	Good	Fair	Fair	
940	No	Yes	Heritage Tree	Interior live oak (Quercus wislizeni)	28.3	24.4	3.9	0	0	0	35	30	Good	Good	Good	
941	No	Yes	Heritage Tree	Interior live oak (Quercus wislizeni)	43	8.1	8.3	10.2	8.9	7.5	25	25	Good	Good	Good	
942	No	Yes	Native Tree	Gray pine (Pinus sabiniana)	0	0	0	0	0	0	30	45	Fair-Poor	Poor	Poor	This tree is covered in poison oak and has significant fire damage
943	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	4.9	4.9	0	0	0	0	18	25	Good	Fair	Fair	The tree is covered in poison oak
944	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	4	4	0	0	0	0	18	25	Good	Fair	Fair	The tree is covered in poison oak
945	No	Yes	Native Oak Tree	Interior live oak (Quercus wislizeni)	5	5	0	0	0	0	18	25	Good	Fair	Fair	The tree is covered in poison oak
946	No	Yes	Native Tree	Gray pine (Pinus sabiniana)	0	0	0	0	0	0	30	45	Fair-Poor	Poor	Poor	This tree is covered in poison oak and has significant fire damage
947	No	Yes	Native Tree	Gray pine (Pinus sabiniana)	0	0	0	0	0	0	30	45	Fair-Poor	Poor	Poor	This tree is covered in poison oak and has significant fire damage
948	No	Yes	Native Tree	Gray pine (Pinus sabiniana)	0	0	0	0	0	0	30	45	Fair-Poor	Poor	Poor	This tree is covered in poison oak and has significant fire damage
12438	Yes	Yes	Native Oak Tree	Valley oak (Quercus lobata)	16.1	16.1	0	0	0	0	25	30	Good	Good	Good	Existing tag was left on the tree.

121°13'40"W

121°13'30"W

38°37'30"N

Hazel Avenue/U.S. 50 Interchange Project
August 2017
Sheet 1 of 16

Legend

- Project Boundary
- Rancho Cordova City Boundary

Tree Type

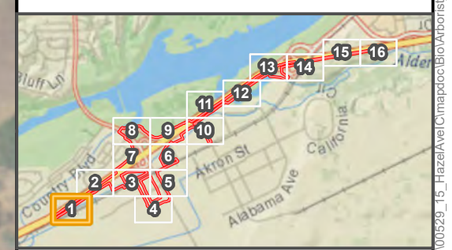
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

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Figure 1
Tree Inventory and Impact Map - Alternative 1
Arborist Report

121°13'30"W

121°13'20"W

38°37'40"N

Hazel Avenue/U.S. 50 Interchange Project
August 2017
Sheet 2 of 16

Legend

- Project Boundary
- Rancho Cordova City Boundary

Tree Type

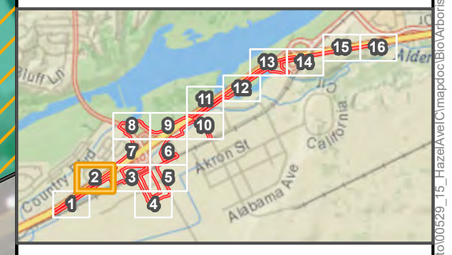
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

N

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

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ICF

Figure 1
Tree Inventory and Impact Map - Alternative 1
Arborist Report

121°13'10"W

121°13'0"W

38°37'40"N

Inaccessible area (1)

708 709 711 712 713 714

700 701 702 703 704 705 706 707

Hazel Avenue/U.S. 50 Interchange Project
August 2017
Sheet 3 of 16

Legend

- Project Boundary
- Rancho Cordova City Boundary

Tree Type

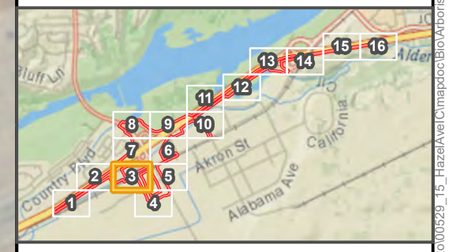
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

N

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: K:\Projects_1\County_of_Sacramento\000529_15_HazelAve\Cmapdoc\BioArborist_Report_20170920.mxd; Author: ; Date: 9/20/2017

ICF

Figure 1
Tree Inventory and Impact Map - Alternative 1
Arborist Report

121°13'0"W

121°12'50"W

38°37'30"N

Inaccesible area (2)

Hazel Avenue/U.S. 50 Interchange Project
August 2017
Sheet 4 of 16

Legend

- Project Boundary
- Rancho Cordova City Boundary

Tree Type

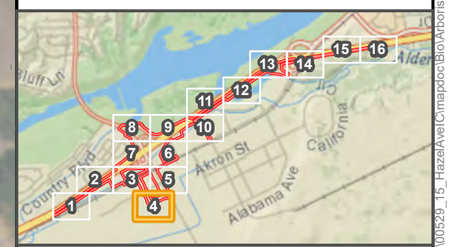
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

N

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: K:\Projects_1\County_of_Sacramento\00529_15_HazelAve\Cmapdoc\BioArborist_Report_2017\8\07\20.mxd; Author: ; Date: 9/20/2017

ICF

Figure 1
Tree Inventory and Impact Map - Alternative 1
Arborist Report

121°12'50"W

38°37'40"N

668
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1243
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687
Inaccesible area (2)

Hazel Avenue/U.S. 50 Interchange Project
August 2017
Sheet 5 of 16

Legend

- Project Boundary
- Rancho Cordova City Boundary

Tree Type

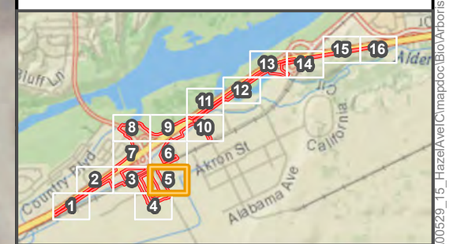
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

N

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: K:\Projects_1\County_of_Sacramento\00529_15_HazelAve\Cmapdoc\Bio\Arborist_Report_2017\090720.mxd; Author: ; Date: 9/20/2017

ICF

Figure 1
Tree Inventory and Impact Map - Alternative 1
Arborist Report

121°12'50"W

38°37'50"N

Hazel Avenue/U.S. 50 Interchange Project
August 2017
Sheet 6 of 16

Legend

- Project Boundary
- Rancho Cordova City Boundary

Tree Type

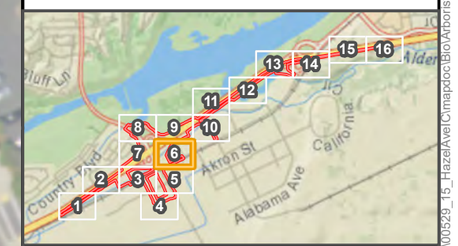
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: K:\Projects_1\County_of_Sacramento\000529_15_HazelAve\Cmapdoc\Bio\Arborist_Report_20170907\20.mxd; Author: ; Date: 9/20/2017

Figure 1
Tree Inventory and Impact Map - Alternative 1
Arborist Report

121°13'10"W

121°13'0"W

38°37'50"N

Hazel Avenue/U.S. 50 Interchange Project
August 2017
Sheet 7 of 16

Legend

- Project Boundary
- Rancho Cordova City Boundary

Tree Type

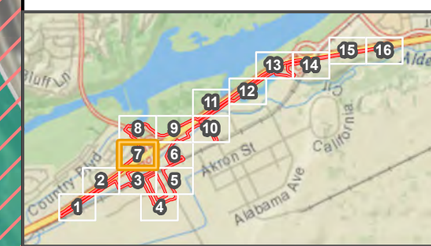
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

N

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: K:\Projects_1\County_of_Sacramento\00529_15_HazelAve\Cmapdoc\BioArborist_Report_2017\090720.mxd; Author: ; Date: 9/20/2017

Figure 1
Tree Inventory and Impact Map - Alternative 1
Arborist Report

121°13'10"W

121°13'0"W

38°38'0"N

Hazel Avenue/U.S. 50 Interchange Project
August 2017
Sheet 8 of 16

Legend

- Project Boundary
- Rancho Cordova City Boundary

Tree Type

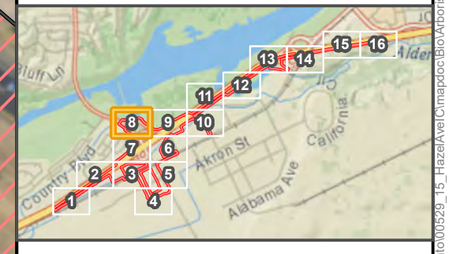
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: K:\Projects_1\County_of_Sacramento\00529_15_HazelAve\Cmapdoc\BioArborist_Report_2017\09\20.mxd; Author: ; Date: 9/20/2017

Figure 1
Tree Inventory and Impact Map - Alternative 1
Arborist Report

121°12'50"W

38°38'0"N

Hazel Avenue/U.S. 50 Interchange Project
August 2017
Sheet 9 of 16

Legend

- Project Boundary
- Rancho Cordova City Boundary

Tree Type

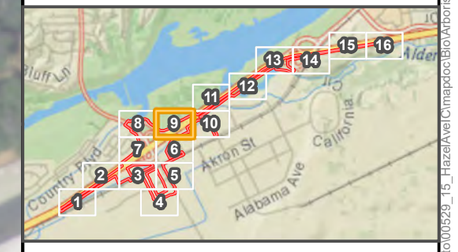
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: K:\Projects_1\County_of_Sacramento\000529_15_HazelAve\Compdoc\Bio\Arborist_Report_20170920.mxd; Author: ; Date: 9/20/2017

Figure 1
Tree Inventory and Impact Map - Alternative 1
Arborist Report

121°12'40"W

121°12'30"W

38°36'0"N

Hazel Avenue/U.S. 50 Interchange Project
August 2017
Sheet 10 of 16

Legend

- Project Boundary
- Rancho Cordova City Boundary

Tree Type

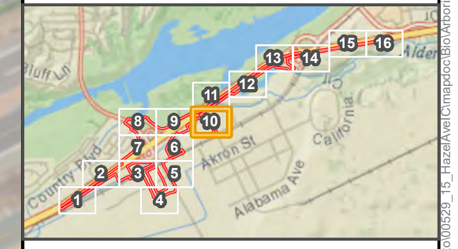
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: K:\Projects_1\County_of_Sacramento\000529_15_HazelAvel\Mapdoc\Bio\Arborist_Report_2017\09\20.mxd; Author: ; Date: 9/20/2017

Figure 1
Tree Inventory and Impact Map - Alternative 1
Arborist Report

121°12'40"W

121°12'30"W

38°38'10"N

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Hazel Avenue/U.S. 50 Interchange Project
August 2017
Sheet 11 of 16

Legend

- Project Boundary
- Rancho Cordova City Boundary

Tree Type

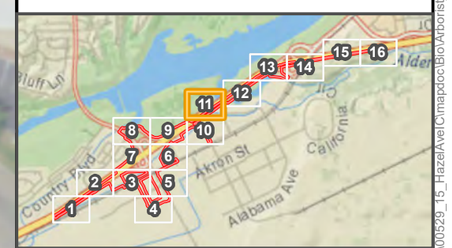
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: K:\Projects_1\County_of_Sacramento\00529_15_HazelAve\Cmapdoc\BioArborist_Report_2017\09\20.mxd; Author: ; Date: 9/20/2017

Figure 1
Tree Inventory and Impact Map - Alternative 1
Arborist Report

121°12'20"W

121°12'10"W

38°38'10"N

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Hazel Avenue/U.S. 50 Interchange Project
August 2017
Sheet 12 of 16

Legend

- Project Boundary
- Rancho Cordova City Boundary

Tree Type

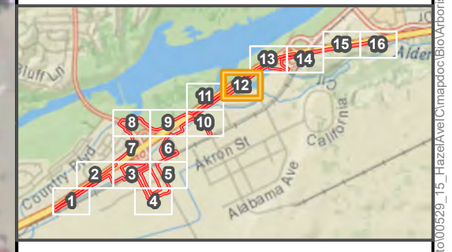
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: K:\Projects_1\County_of_Sacramento\000529_15_HazelAve\Cmapdoc\Bio\Arborist_Report_2017\080720.mxd; Author: ; Date: 9/20/2017

ICF

Figure 1
Tree Inventory and Impact Map - Alternative 1
Arborist Report

121°12'10"W

121°12'0"W

38°38'20"N

932

931

930

Hazel Avenue/U.S. 50 Interchange Project
August 2017
Sheet 13 of 16

Legend

- Project Boundary
- Rancho Cordova City Boundary

Tree Type

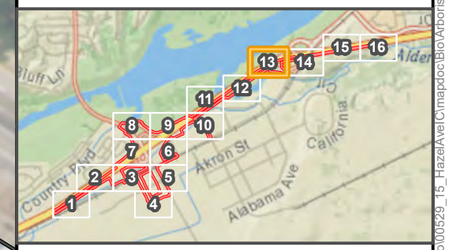
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

N

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: K:\Projects_1\County_of_Sacramento\000529_15_Hazel\Arc\Mapdoc\Bio\Arborist_Report_20170907\20.mxd; Author: ; Date: 9/20/2017

ICF

Figure 1
Tree Inventory and Impact Map - Alternative 1
Arborist Report

121°11'50"W

38°38'20"N

Hazel Avenue/U.S. 50 Interchange Project
August 2017
Sheet 14 of 16

Legend

- Project Boundary
- Rancho Cordova City Boundary

Tree Type

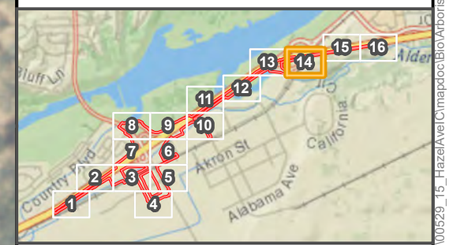
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

N

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: K:\Projects_1\County_of_Sacramento\00529_15_HazelAve\Comapdoc\BioArborist_Report_2017\080720.mxd; Author: ; Date: 9/20/2017

ICF

Figure 1
Tree Inventory and Impact Map - Alternative 1
Arborist Report

121°11'40"W

121°11'30"W

38°38'30"N



Hazel Avenue/U.S. 50 Interchange Project
August 2017
Sheet 15 of 16

Legend

- Project Boundary
- Rancho Cordova City Boundary

Tree Type

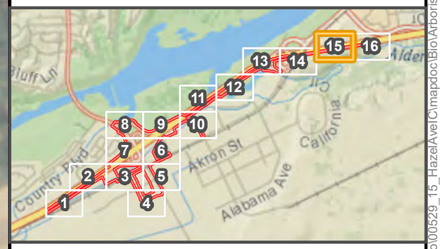
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: K:\Projects_1\County_of_Sacramento\000529_15_HazelAve\Cmapdoc\Bio\Arborist_Report_20170807\20.mxd; Author: ; Date: 9/20/2017

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Figure 1
Tree Inventory and Impact Map - Alternative 1
Arborist Report



Hazel Avenue/U.S. 50 Interchange Project
August 2017
Sheet 16 of 16

Legend

- Project Boundary
- Rancho Cordova City Boundary

Tree Type

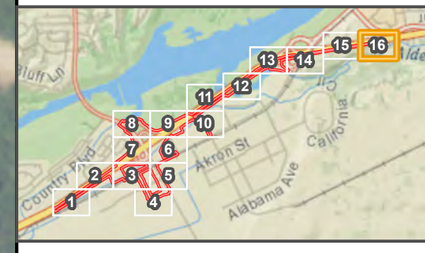
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: K:\Projects_1\County_of_Sacramento\000529_15_HazelAve\Cmapdoc\Bio\Arborist_Report_20170907\20.mxd; Author: ; Date: 9/20/2017

Figure 1
Tree Inventory and Impact Map - Alternative 1
Arborist Report

121°13'40"W

121°13'30"W

38°37'30"N

Hazel Avenue/U.S. 50 Interchange Project
August 2017
Sheet 1 of 16

Legend

- Project Boundary
- Rancho Cordova City Boundary

Tree Type

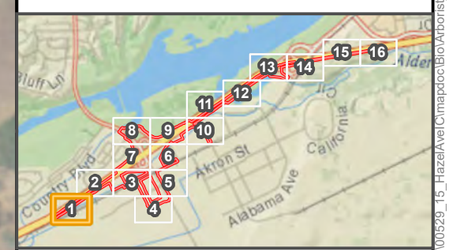
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

N

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: K:\Projects_1\County_of_Sacramento\00529_15_HazelAve\Cmapdoc\BioArborist_Report_2017\09\20.mxd, Author: , Date: 9/20/2017

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Figure 1
Tree Inventory and Impact Map - Alternative 2
Arborist Report

121°13'30"W

121°13'20"W

38°37'40"N

Hazel Avenue/U.S. 50 Interchange Project
August 2017
Sheet 2 of 16

Legend

- Project Boundary
- Rancho Cordova City Boundary

Tree Type

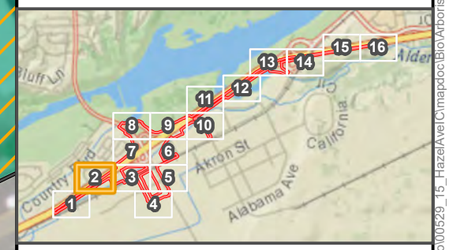
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

N

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: K:\Projects_1\County_of_Sacramento\000529_15_Hazel\Arb\Cmapdoc\Bio\Arborist_Report_20170920.mxd; Author: ; Date: 9/20/2017

ICF

Figure 1
Tree Inventory and Impact Map - Alternative 2
Arborist Report

121°13'10"W

121°13'0"W

38°37'40"N

Inaccessible area (1)

700 701 702 703 704 705 706 707 708 709 711 712 713 714

Hazel Avenue/U.S. 50 Interchange Project
August 2017
Sheet 3 of 16

Legend

- Project Boundary
- Rancho Cordova City Boundary

Tree Type

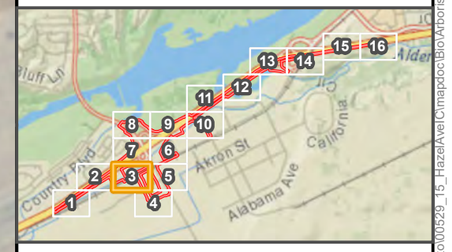
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

N

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: K:\Projects_1\County_of_Sacramento\000529_15_HazelAve\Cmapdoc\BioArborist_Report_20170907\20.mxd; Author: ; Date: 9/20/2017

ICF

Figure 1
Tree Inventory and Impact Map - Alternative 2
Arborist Report

121°13'0"W

121°12'50"W

38°37'30"N

Inaccesible area (2)

Hazel Avenue/U.S. 50 Interchange Project
August 2017
Sheet 4 of 16

Legend

- Project Boundary
- Rancho Cordova City Boundary

Tree Type

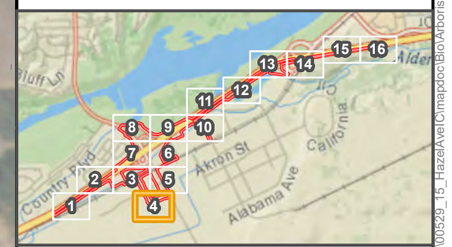
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

N

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: K:\Projects_1\County_of_Sacramento\00529_15_HazelAve\Cmapdoc\BioArborist_Report_2017\8\07\20.mxd; Author: ; Date: 9/20/2017

ICF

Figure 1
Tree Inventory and Impact Map - Alternative 2
Arborist Report

121°12'50"W

38°37'40"N

668
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Inaccesible area (2)

Hazel Avenue/U.S. 50 Interchange Project
August 2017
Sheet 5 of 16

Legend

- Project Boundary
- Rancho Cordova City Boundary

Tree Type

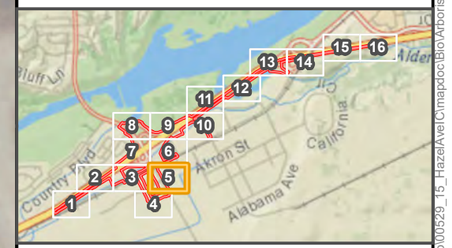
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: K:\Projects_1\County_of_Sacramento\00529_15_HazelAve\Cmapdoc\Bio\Arborist_Report_2017\090720.mxd; Author: ; Date: 9/20/2017

Figure 1
Tree Inventory and Impact Map - Alternative 2
Arborist Report

121°12'50"W

38°37'50"N

Hazel Avenue/U.S. 50 Interchange Project
August 2017
Sheet 6 of 16

Legend

- Project Boundary
- Rancho Cordova City Boundary

Tree Type

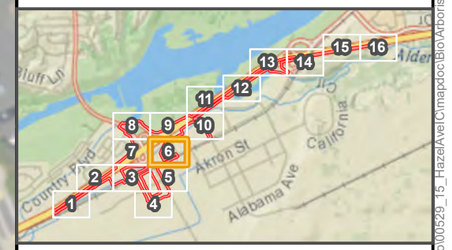
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: K:\Projects_1\County_of_Sacramento\00529_15_Hazel\Arel\Cmapdoc\Bio\Arborist_Report_2017\080720.mxd; Author: ; Date: 9/20/2017

Figure 1
Tree Inventory and Impact Map - Alternative 2
Arborist Report

121°13'10"W

121°13'0"W

38°37'50"N

Hazel Avenue/U.S. 50 Interchange Project
August 2017
Sheet 7 of 16

Legend

- Project Boundary
- Rancho Cordova City Boundary

Tree Type

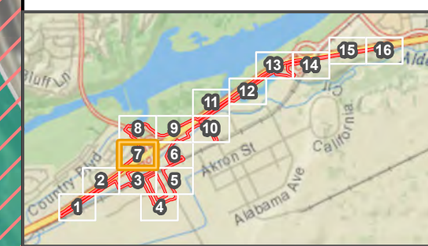
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: K:\Projects_1\County_of_Sacramento\00529_15_HazelAve\Cmapdoc\BioArborist_Report_2017\080720.mxd; Author: ; Date: 9/20/2017

Figure 1
Tree Inventory and Impact Map - Alternative 2
Arborist Report

121°13'10"W

121°13'0"W

38°38'0"N

Hazel Avenue/U.S. 50 Interchange Project
August 2017
Sheet 8 of 16

Legend

- Project Boundary
- Rancho Cordova City Boundary

Tree Type

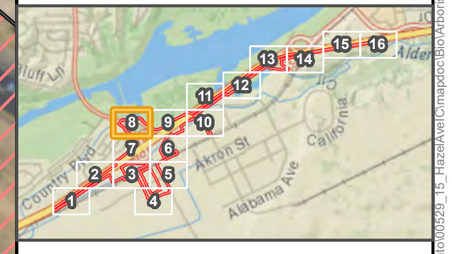
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: K:\Projects_1\County_of_Sacramento\00529_15_HazelAve\Cmapdoc\BioArborist_Report_2017\080720.mxd; Author: ; Date: 9/20/2017

Figure 1
Tree Inventory and Impact Map - Alternative 2
Arborist Report

121°12'50"W

38°38'0"N

Hazel Avenue/U.S. 50 Interchange Project
August 2017
Sheet 9 of 16

Legend

- Project Boundary
- Rancho Cordova City Boundary

Tree Type

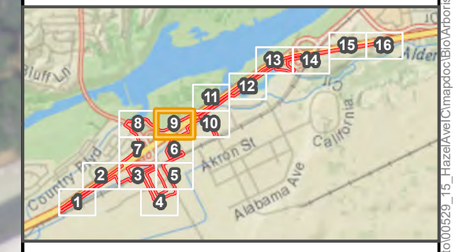
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- Temporary Impact

Impact Areas

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- Temporary Impact



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Notes:

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Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: K:\Projects_1\County_of_Sacramento\000529_15_HazelAve\Cmapdoc\Bio\Arborist_Report_20170920.mxd; Author: ; Date: 9/20/2017

Figure 1
Tree Inventory and Impact Map - Alternative 2
Arborist Report

121°12'40"W

121°12'30"W

38°36'0"N

Hazel Avenue/U.S. 50 Interchange Project
August 2017
Sheet 10 of 16

Legend

- Project Boundary
- Rancho Cordova City Boundary

Tree Type

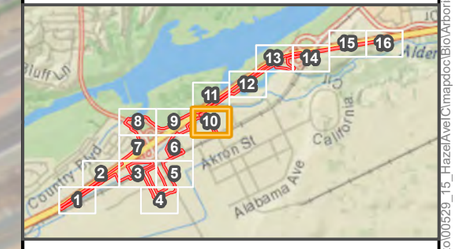
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- Nonnative Tree

Canopy Impact

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- Temporary Impact

Impact Areas

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- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

N

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: K:\Projects_1\County_of_Sacramento\00529_15_HazelAve\Cmapdoc\Bio\Arborist_Report_2017\09\20.mxd; Author: ; Date: 9/20/2017

ICF

Figure 1
Tree Inventory and Impact Map - Alternative 2
Arborist Report

121°12'40"W

121°12'30"W

38°38'10"N

873

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Hazel Avenue/U.S. 50 Interchange Project
August 2017
Sheet 11 of 16

Legend

- Project Boundary
- Rancho Cordova City Boundary

Tree Type

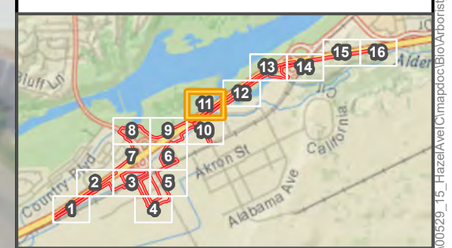
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- Native Oak
- Nonnative Tree

Canopy Impact

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Impact Areas

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- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

N

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: K:\Projects_1\County_of_Sacramento\000529_15_HazelAve\Cmaps\doc\BioArborist_Report_2017\09\20.mxd; Author: ; Date: 9/20/2017

ICF

Figure 1
Tree Inventory and Impact Map - Alternative 2
Arborist Report

121°12'20"W

121°12'10"W

38°38'10"N

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5b
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909

Hazel Avenue/U.S. 50 Interchange Project
August 2017
Sheet 12 of 16

Legend

- Project Boundary
- Rancho Cordova City Boundary

Tree Type

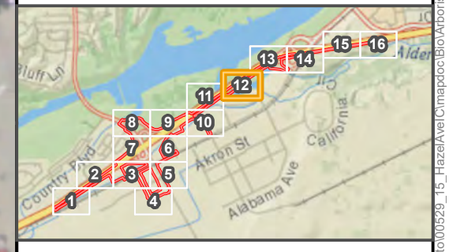
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- Nonnative Tree

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Impact Areas

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Feet
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Drawn By: Hunter Watkins (916) 231-9577

Path: K:\Projects_1\County_of_Sacramento\000529_15_HazelAve\Cmapdoc\Bio\Arborist_Report_2017\080720.mxd; Author: ; Date: 9/20/2017

Figure 1
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Arborist Report

121°12'10"W

121°12'0"W

38°38'20"N

Hazel Avenue/U.S. 50 Interchange Project
August 2017
Sheet 13 of 16

Legend

- Project Boundary
- Rancho Cordova City Boundary

Tree Type

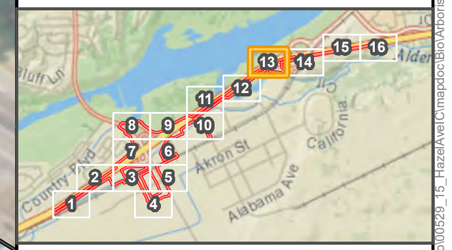
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: K:\Projects_1\County_of_Sacramento\000529_15_Hazel\Arc\Mapdoc\Bio\Arborist_Report_20170907\20.mxd; Author: ; Date: 9/20/2017

Figure 1
Tree Inventory and Impact Map - Alternative 2
Arborist Report

121°11'50"W

38°38'20"N

Hazel Avenue/U.S. 50 Interchange Project
August 2017
Sheet 14 of 16

Legend

- Project Boundary
- Rancho Cordova City Boundary

Tree Type

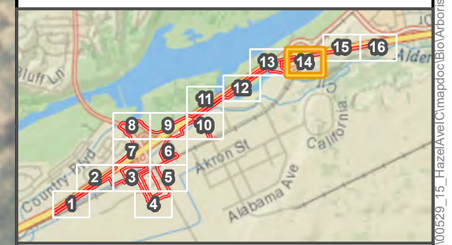
- Heritage (Native Oak)
- Native Tree
- Native Oak
- Nonnative Tree

Canopy Impact

- No Impact
- Permanent Impact
- Temporary Impact

Impact Areas

- Permanent Impact
- Temporary Impact



0 50 100
Feet
1 inch = 100 feet

N

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: K:\Projects_1\County_of_Sacramento\000529_15_HazelAve\Comapdoc\BioArborist_Report_2017\080720.mxd; Author: ; Date: 9/20/2017

ICF

Figure 1
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Arborist Report

121°11'40"W

121°11'30"W

38°38'30"N



Hazel Avenue/U.S. 50 Interchange Project
August 2017
Sheet 15 of 16

Legend

- Project Boundary
- Rancho Cordova City Boundary

Tree Type

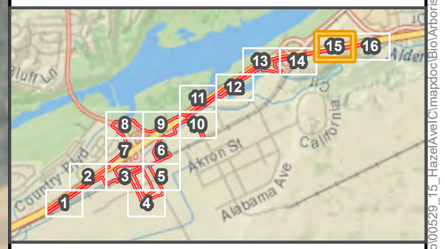
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0 50 100
Feet
1 inch = 100 feet

Notes:

Tree Information Source: ICF
Imagery Source: NAIP 2016
Drawn By: Hunter Watkins (916) 231-9577

Path: K:\Projects_1\County_of_Sacramento\000529_15_HazelAve\Cmapdoc\Bio\Arborist_Report_20170807\20.mxd; Author: ; Date: 9/20/2017

Figure 1
Tree Inventory and Impact Map - Alternative 2
Arborist Report



Hazel Avenue/U.S. 50 Interchange Project
August 2017
Sheet 16 of 16

Legend

- Project Boundary
- Rancho Cordova City Boundary

Tree Type

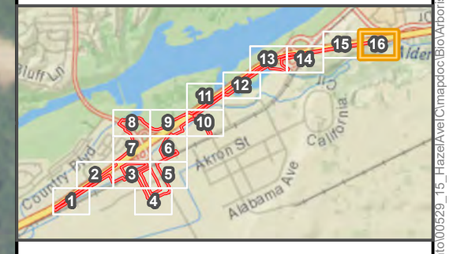
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Figure 1
Tree Inventory and Impact Map - Alternative 2
Arborist Report

Hazel Avenue/U.S. 50 Interchange Project



Biological Assessment

Hazel Avenue/U.S. 50 Interchange Project

Sacramento County

03-SAC-50-PM 15.1/17.5

Federal Project No.: EA 03-3E380/E-FIS 0300020439

County Control Number 2011-70062

February 2019

Caltrans

CALIFORNIA DEPARTMENT OF TRANSPORTATION

Biological Assessment

Hazel Avenue/U.S. 50 Interchange Project

Sacramento County

03-SAC-50-PM 15.1/17.5

Federal Project No.: EA 03-3E380/E-FIS 0300020439

County Control Number 2011-70062

February 2019

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Approved By: Julia K. Green Date: 2/13/19

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California Department of Transportation, District 3-North Region

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List of Abbreviated Terms

BA	biological assessment
Basin Plans	Water Quality Control Basin Plans
BMP	best management practice
BSA	biological study area
Cal-IPC	California Invasive Plant Council
Caltrans	California Department of Transportation
CDFA	California Department of Food and Agriculture
CDFW	California Department of Fish and Wildlife
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CFGC	California Fish and Game Code
CFR	Code of Federal Regulations
CNDDB	California Natural Diversity Database
CNPPA	California Native Plant Protection Act
CNPS	California Native Plant Society
County	County of Sacramento
CWA	Clean Water Act
dbh	diameter at breast height
EFH	essential fish habitat
EIR	Environmental Impact Report
EO	Executive Order
EPA	U.S. Environmental Protection Agency
FESA	federal Endangered Species Act
FHWA	Federal Highway Administration
FR	Federal Register
HOV	high-occupancy vehicle
IpaC	Information, Planning, and Consultation
ISAC	Invasive Species Advisory Committee
LSAA	Lake or Streambed Alteration Agreement
MBTA	Migratory Bird Treaty Act
MOU	memorandum of understanding
MSA	Management and Conservation Act
MSE	Mechanically Stabilized Earth
NCCP	Natural Community Conservation Plan
NEPA	National Environmental Policy Act
NISC	National Invasive Species Council
NMFS	National Marine Fisheries Service
NPDES	Pollutant Discharge Elimination System

OHWM	ordinary high water mark
Porter-Cologne Act	Porter-Cologne Water Quality Control Act
ROW	right-of-way
RWQCB	Regional Water Control Board
SACOG	Sacramento Area Council of Governments
SPCC	spill prevention control and countermeasure
SPTC-JPA	Sacramento Placerville Transportation Corridor Joint Powers Authority
State Water Board	State Water Resources Control Board
SWPPP	stormwater pollution prevention plan
TNW	traditional navigable water
U.S.C.	United States Code
UPRR	Union Pacific Railroad
US 50	U.S. Route
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WDR	waste discharge requirement

Chapter 1 Introduction

The purpose of this biological assessment (BA) is to provide technical information and review the proposed action in sufficient detail to determine to what extent the proposed action may affect federally threatened, endangered, or proposed threatened or endangered species. The California Department of Transportation (Caltrans), as assigned by the Federal Highway Administration (FHWA), has prepared this BA under its assumption of responsibility at 23 United States Code (U.S.C.) 327(a)(2)(A). This BA was also prepared in accordance with 50 Code of Federal Regulations (CFR) 402, legal requirements found in Section 7 (a)(2) of the federal Endangered Species Act (FESA) (16 U.S.C. 1536(c)), and FHWA and Caltrans regulation, policy, and guidance, with the following objectives:

- Provide the best available information to the U.S. Fish and Wildlife Service (USFWS) about the species and habitats addressed in this BA and how they may be affected by the proposed action.
- Determine whether the species addressed in this BA are likely to be adversely affected by the proposed action.
- Determine if designated or proposed critical habitat would be adversely modified by the proposed action.
- Describe conservation measures for the proposed action that would avoid or minimize potential effects on these species and their habitats.
- Provide information to determine whether formal consultation with USFWS is necessary.

1.1 Purpose and Need of the Proposed Action

The County of Sacramento (County), in cooperation with Caltrans and the City of Rancho Cordova, is proposing the Hazel Avenue/U.S. Route (US 50) Interchange Project (proposed action) to modify the existing interchange as well as extend and grade separate Hazel Avenue over Folsom Boulevard and the Sacramento-Placerville Transportation Corridor Joint Powers Authority (SPTC-JPA) rail corridor. The primary purpose of the proposed action is to reduce congestion, improve traffic operations, accommodate travel demand from planned and approved developments, and improve the safety of all modes of travel, including bicycle and pedestrian. The proposed action is needed to relieve congestion at the interchange and accommodate the planned and approved developments identified by the adopted Sacramento County General Plan and the Sacramento Area Council of Governments (SACOG) Regional Transportation Plan.

1.2 Threatened, Endangered, and Proposed Threatened or Endangered Species and Critical Habitat

An official list of federally listed threatened, endangered, and proposed to be listed as threatened or endangered species with the potential to occur in the vicinity of the proposed action was obtained from the Information, Planning, and Consultation (IPaC) System website for the action

area on October 16, 2018 (Appendix A). The following 10 federally endangered and threatened species were on the USFWS species list and considered for inclusion in this BA:

- Slender Orcutt grass (*Orcuttia tenuis*)—threatened.
- Sacramento Orcutt grass (*Orcuttia viscida*)—endangered.
- Conservancy fairy shrimp (*Branchinecta conservatio*)—endangered.
- Vernal pool fairy shrimp (*Branchinecta lynchi*)—threatened.
- Vernal pool tadpole shrimp (*Lepidurus packardi*)—endangered.
- Valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*)—threatened
- Delta smelt (*Hypomesus transpacificus*)—threatened.
- California tiger salamander (*Ambystoma californiense*)—threatened.
- California red-legged frog (*Rana draytonii*)—threatened.
- Giant gartersnake (*Thamnophis gigas*)—threatened.

The official species list did not identify designated critical habitat for any federally listed species within the action area.

1.2.1 Species Requiring Consultation

Of the 10 federally listed species considered for inclusion in this BA, two species (vernal pool fairy shrimp and valley elderberry longhorn beetle) are known or have the potential to occur in the action area. Implementation of best management practices (BMPs) and avoidance and minimization measures (AMMs) would avoid effects on vernal pool fairy shrimp. Therefore, the only species requiring consultation is valley elderberry longhorn beetle.

Construction of the proposed action would result in the removal of three elderberry shrubs that provide suitable habitat for, and are potentially occupied by, valley elderberry longhorn beetle. The shrubs are located within non-riparian habitat and would be transplanted to a USFWS approved conservation bank. No other direct or indirect effects on elderberry shrubs would occur in the action area as a result of the proposed action.

Federally listed species from the USFWS list, their statuses, and the effect determinations for the proposed action are summarized in Table 1-1.

Table 1-1. Effect Determinations for Federally Listed Species

Common Name	Scientific Name	Status	Effect Determination	Rationale
Slender Orcutt grass	*Orcuttia tenuis*	Threatened	No effect	No vernal pools in the action area.
Sacramento Orcutt grass	*Orcuttia viscida*	Endangered	No effect	No vernal pools in the action area.
Conservancy fairy shrimp	*Branchinecta conservatio*	Endangered	No effect	There are no large, deep vernal pools that would support this species in the action area.
Vernal pool fairy shrimp	*Branchinecta lynchi*	Threatened	No effect	Indirect effects (changes in hydrology and degradation of habitat) on seasonal wetlands in the action area could result from the proposed action but would be avoided through implementation of BMPs and AMMs (discussed in Chapter 5).
Vernal pool tadpole shrimp	*Lepidurus packardi*	Endangered	No effect	There are no vernal or seasonal pools in the action area that are deep enough or capable of holding water long enough to support this species.
Valley elderberry longhorn beetle	*Desmocerus californicus dimorphus*	Threatened	Likely to adversely affect	Elderberry shrubs that provide habitat for the beetle would be directly affected.
Delta smelt	*Hypomesus transpacificus*	Threatened	No effect	The action area is outside the known range of this species.
California tiger salamander	*Ambystoma californiense*	Threatened	No effect	There are no ponds, lakes, or vernal pools of adequate size and depth that provide suitable aquatic habitat in or adjacent to the action area. The majority of the action area is located between a freeway and dense development and does not provide connectivity to other areas with suitable aquatic habitat. As such, there is also no suitable upland habitat in the action area.
California red-legged frog	*Rana draytonii*	Threatened	No effect	The action area is not within the current range of the species (U.S. Fish and Wildlife Service 2002) and Lake Natoma is a barrier to dispersal from the north and west. The nearest documented occurrence is at Folsom Lake, approximately 9.5 miles from the action area and there are many roads and substantial residential development between this location and the action area. The next closest known record is approximately 20 miles southeast of the action area in Amador County (California Department of Fish and Wildlife 2018a).
Giant garter snake	*Thamnophis gigas*	Threatened	No effect	There are no sloughs, canals, rice fields, or freshwater marshes that provide suitable habitat. Although the ponded area of Alder Creek at US 50 provides appropriate conditions, the remainder of the creek has a rocky substrate, is predominantly shaded, and does not connect to other suitable habitat.

1.2.2 Critical Habitat

Critical habitat is defined in Section 3(5)A of the FESA as the specific areas within the geographical area occupied by a species on which are found physical or biological features essential to the conservation of the species and that may require special management considerations or protection (15 USC 1632A).

Except for giant gartersnake, final critical habitat has been designated for all of the federally listed species on the USFWS species list for the proposed action. The action area, however, is not located within designated critical habitat for any of these species. Accordingly, critical habitat is not discussed further in this BA.

1.3 Consultation History

Pursuant to the FESA, Caltrans must consult with USFWS with regard to any proposed actions that may affect the continued existence of a federally listed species. To date, Caltrans has had no coordination with USFWS regarding the proposed action.

1.4 Authorities and Discretion

Project documentation is being prepared in compliance with both the California Environmental Quality Act (CEQA) and the National Environmental Policy Act (NEPA). Caltrans is the lead agency under NEPA. The County of Sacramento is the lead agency under CEQA. The City of Rancho Cordova is a responsible agency under CEQA.

This section summarizes the federal law under which the action is regulated.

1.4.1 Federal Endangered Species Act

The FESA of 1973, and subsequent amendments, provide regulations for the conservation of endangered and threatened species and the ecosystems on which they depend. USFWS (with jurisdiction over plants, wildlife, and resident fish) and the National Marine Fisheries Service (NMFS) (with jurisdiction over anadromous fish and marine fish and mammals) oversee the FESA. Section 7 of the FESA mandates all federal agencies to consult with USFWS and NMFS if they determine that a proposed project may affect a listed species or destroy or adversely modify designated critical habitat. Section 7 requirements do not apply to nonfederal actions. A Clean Water Act (CWA) Section 404 permit from the U.S. Army Corps of Engineers (USACE) would be required for project construction. Consequently, consultation under Section 7 for effects on federally listed species will be required. Under Section 7, the federal lead agency must obtain incidental take authorization or a letter of concurrence stating that the proposed project is not likely to adversely affect federally listed species.

Section 9 of the FESA prohibits the take of any fish or wildlife species listed as endangered, including the destruction of habitat that prevents the species' recovery. *Take* is defined as any action or attempt to hunt, harm, harass, pursue, shoot, wound, capture, kill, trap, or collect a species. Section 9 prohibitions also apply to threatened species, unless a special rule has been defined with regard to take at the time of listing. Under Section 9 of the FESA, the take prohibition applies only to wildlife and fish species. However, Section 9 does prohibit the unlawful removal and possession, or malicious damage or destruction, of any endangered plant from federal land. Section 9 prohibits acts to remove, cut, dig up, damage, or destroy an endangered plant species in nonfederal areas in knowing violation of any state law or in the course of criminal trespass. Candidate species and species proposed for or under petition for listing receive no protection under Section 9.

1.5 Description of the Proposed Action

1.5.1 Location

The proposed action is located in the northeastern portion of Sacramento County, at the interchange of Hazel Avenue and US 50 (Appendix B, Figure 1). The project area is bounded along Hazel Avenue by the Tributary Point/westbound off-ramp intersection to the north, extending approximately 1,000 feet south of Folsom Boulevard to a future intersection within the Easton Project: Easton Place and Glenborough at Easton developments (Appendix B, Figure 1). The project limits along US 50 begin approximately 3,200 feet west of the existing Hazel Avenue overcrossing and extend 2,500 feet east of the Natoma overhead. Improvements along Folsom Boulevard would extend from approximately 1,200 feet west of the Hazel Avenue intersection to 900 feet to the east.

1.5.2 Project Summary

The County of Sacramento, in cooperation with Caltrans and the City of Rancho Cordova, proposes to modify the existing Hazel Avenue/US 50 interchange as well as extend and grade separate Hazel Avenue over Folsom Boulevard and the SPTC-JPA rail corridor. Hazel Avenue would be extended south to a proposed intersection with the future Atlanta Street (a new roadway that would be constructed as part of the Easton Project: Easton Place and Glenborough at Easton development). The proposed action also includes:

- Construction of a portion of an eastbound transition auxiliary lane on US 50 from Hazel Avenue to the Folsom Boulevard overcrossing, also known as the Natoma overhead.
- Modification of the existing Aerojet Road off-ramp from US 50.
- Reconstruction of the westbound loop on-ramp.
- Reconstruction of the eastbound diagonal off-ramp and both eastbound on-ramps.
- Construction of eastbound on- and off-ramp auxiliary lanes, from west of the Hazel Avenue to the eastbound off-ramp and from the loop on-ramp to the Folsom Boulevard interchange.

- Roadway improvements along approximately 2,300 feet of Folsom Boulevard, including sidewalks, street lighting, and landscaping along the north side of Folsom Boulevard and landscaping and lighting along the south.

1.5.3 Roadway Modifications

- Construction of a portion of an eastbound transition auxiliary lane on US 50 from Hazel Avenue to the Folsom Boulevard overcrossing, also known as the Natoma overhead.
- Modification of the existing Aerojet Road off-ramp from US 50.
- Reconstruction of the westbound loop on-ramp, with the ramp intersection shifted north toward the westbound off-ramp terminus, thereby increasing storage lengths. The ramp would be metered with two lanes (one mixed-use lane and one high-occupancy vehicle [HOV] bypass) and a squared-up pedestrian-friendly entrance.
- Reconstruction of the eastbound diagonal off-ramp to conform with the new Hazel Avenue profile and accommodate the Aerojet Road ramp divergence.
- Reconstruction of the eastbound diagonal on-ramp to conform with the new Hazel Avenue profile. The ramp would be metered with two lanes, one mixed flow and one HOV bypass.
- Reconstruction of the eastbound loop on-ramp to conform with the new Hazel Avenue profile. The ramp would be metered with two lanes, one mixed flow and one HOV bypass. A tie-back wall at the abutment of the overcrossing is proposed to maximize the opening through the structure. The loop ramp would develop an additional lane on US 50 that would continue on to the Folsom Boulevard interchange.
- Construction of eastbound on- and off-ramp auxiliary lanes on US 50, from west of the Hazel Avenue to the eastbound off-ramp and from the loop on-ramp to the Folsom Boulevard interchange.
- Modification of traffic signals and installation of safety lighting at the ramp intersections. A new signalized intersection and at-grade railroad crossing would be constructed for the jughandle.
- Maintenance of pedestrian access on the east side of Hazel Avenue, with 6-foot-wide sidewalks (however, the existing sidewalk on the overcrossing would remain 5 feet wide). Bicyclists may use the County-standard 7-foot shoulders. It is expected that pedestrians and bicyclists would continue to use the nearby bikeway and pedestrian overcrossing as the primary means for crossing US 50.
- Construction of roadway improvements along approximately 2,300 feet of Folsom Boulevard. Improvements would include removal of the existing signalized intersection with Hazel Avenue and installation of sidewalks, street lighting, and landscaping along the north side of Folsom Boulevard and landscaping and lighting along the south.

1.5.4 Transition Lane to Folsom Boulevard/US 50 Interchange

As indicated in Caltrans' 2009 Corridor System Management Plan, eastbound US 50 is shown as having one HOV lane and three mixed-flow lanes to Hazel Avenue as the Concept Facility. Additionally, eastbound US 50 is shown as having one HOV lane and three mixed-flow lanes across Folsom Boulevard as the Ultimate Facility. The proposed action would accommodate these future facility improvements; would conform to the approved Caltrans project at the Folsom Boulevard/US 50 interchange, some of which occurred in 2017; and would then restripe the third mixed-flow lane through the Folsom Boulevard/US 50 interchange.

A mixed-flow lane must be added because it was determined in the traffic analysis for the proposed action, as well as studies for adjacent projects, that the additional eastbound lane on US 50 through the Folsom Boulevard interchange is needed for operations. Accommodating this mixed-flow lane would require the eastbound loop on-ramp to extend its auxiliary lane to the Folsom Boulevard/US 50 eastbound off-ramp. This would require widening and a new structure over Alder Creek.

Alder Creek currently flows under US 50 through a box culvert (Br. No. 24-0033). A mechanically stabilized earth (MSE) wall (Br. No. 24-0372) is above the culvert. A new bridge would be required to widen US 50 over Alder Creek. The new bridge is necessary because there is insufficient lateral space to construct an adjacent MSE wall on top of the culvert and because the creek maintains a high operating water level.

1.5.5 Railroad Overhead

Hazel Avenue would be extended and grade separated over Folsom Boulevard and the SPTC-JPA rail corridor. Currently there is one light-rail track on the north side of the Union Pacific Railroad (UPRR) tracks. Sacramento Regional Transit plans to add another track at this location in the future; when the addition occurs, the existing UPRR track would be relocated south to accommodate the second light-rail track. The proposed design meets the requirements for all three tracks.

A temporary vertical clearance of 21 feet, 6 inches and permanent vertical clearance of 24 feet have been accounted for in the layout for the Hazel Avenue overhead. The vertical clearance provided would accommodate the overhead catenary system for the light rail.

1.5.6 L-9 Interchange with Viaduct Connector

A modified type L-9 interchange configuration would provide a viaduct connection to Aerojet Road (Appendix B, Figure 2). A Caltrans Type L-9 interchange indicates a ramp configuration that includes a diagonal off-ramp, a diagonal on-ramp, and a loop on-ramp.

Hazel Avenue would be grade separated over Folsom Boulevard and the SPTC-JPA rail corridor and extend south to a proposed intersection with the future Atlanta Street. The existing at-grade intersection of Hazel Avenue and Folsom Boulevard would be removed, sidewalks would be

extended across the former intersection, and the lanes would be re-striped to remove left-turn lanes.

The location of the departure point of the existing Aerojet Road off-ramp from US 50 would be moved to join with the eastbound Hazel Avenue off-ramp. The eastbound Hazel Avenue off-ramp would split and introduce a direct viaduct ramp over Hazel Avenue to carry eastbound off-ramp traffic to Aerojet Road and Folsom Boulevard. The off-ramp divergence from US 50 would be shifted approximately 830 feet to the east to provide decision sight distance before the Aerojet Road split. The two-lane off-ramp would widen to five lanes at the ramp terminal intersection, with three left-turn lanes and two right-turn lanes. Retaining walls and barriers placed at the proposed right-of-way (ROW) would minimize acquisition. The eastbound off-ramp would also have an auxiliary lane prior to the exit.

The Aerojet Road viaduct would land adjacent to the eastbound diagonal on-ramp and then turn southerly to conform to Folsom Boulevard along its existing alignment. Retaining walls are proposed between the viaduct and the diagonal on-ramp to accommodate the grade difference as well as to the outside of the ramp after the viaduct lands to minimize ROW acquisitions. Retaining walls are also proposed along Aerojet Road as it approaches the horizontal curve toward Folsom Boulevard to accommodate the grade difference between the ramp and mainline and minimize ROW acquisition.

The existing Hazel Avenue overcrossing of US 50 would be widened on the west side to accommodate eight lanes (three through lanes and one freeway-only lane in both directions). The existing raised concrete median across the structure would be removed, and the roadway would be re-striped with a 6-foot-wide striped median. The existing sidewalk and barrier on the east side of the structure would remain.

1.5.7 ROW and Utilities

ROW acquisition is anticipated from parcels in the southwest quadrant of the interchange. It is anticipated that 12 parcels would be affected by the improvements, including full acquisition and demolition of structures at the Chevron gas station (APN 069-0160-012) and Cattlemen's restaurant (APN 069-0060-085). The viaduct structure is proposed to cross over the northern portion of the Nimbus Winery parking lot (APN 069-0050-013) on an aerial easement to allow parking below the structure and minimize project effects on the business.

The acquisition needs are preliminary and would need to be finalized during the ROW process and final design of the proposed action. It is anticipated that gas lines, overhead electric lines, underground electric lines, fiber optic cables, water lines, sewer lines, and storm drain lines would need to be relocated. The potential for project effects on other unknown utilities also exists.

1.5.8 Construction Schedule

Construction of the project is anticipated to last 24 months, beginning in 2021 and concluding in 2023.

1.6 Define Action Area

The project area is bounded along Hazel Avenue by the Tributary Point/westbound off-ramp intersection to the north, extending approximately 1,000 feet south of Folsom Boulevard to a future intersection within the Easton Project: Easton Place and Glenborough at Easton developments (Appendix B, Figure 1). The project limits along US 50 begin approximately 3,200 feet west of the existing Hazel Avenue overcrossing and extend 2,500 feet east of the Natoma overhead. Improvements along Folsom Boulevard would extend from approximately 1,200 feet west of the Hazel Avenue intersection to 900 feet to the east.

The action area consists of the project area, as described above, as well as a 100-foot buffer area around the project area, which was included to assess potential effects on valley elderberry longhorn beetle. Additionally, the action area includes a 250-foot buffer on the west, south, and east sides of the jughandle area off of Folsom Boulevard for potential indirect effects on vernal pool branchiopod habitat. This area is depicted as the "Indirect Effects Assessment Area for Branchiopods" in Figure 3 in Appendix B. Other than the vernal pool branchiopod indirect effects assessment area and elderberry shrubs within 100 feet of the project area boundary, effects from the proposed action (i.e., project-related ground-disturbing construction, staging, or access activities) are expected to be contained within the project footprint.

1.7 Conservation Measures

1.7.1 Project Design Modifications for Avoidance and Minimization

Three alternatives were considered for construction. Alternative 1 was chosen as the proposed action, which affected one fewer elderberry shrubs than one of the other alternatives (Alternative 2) that were considered. Additionally, an AMM was added to the project that requires that water conveyance systems to be designed and constructed to maintain hydrology and prevent contaminants from entering suitable vernal pool branchiopod habitat (AMM 4).

1.7.2 Best Management Practices, Avoidance and Minimization Measures, and Compensatory Mitigation

1.7.2.1 Best Management Practices

The following BMPs are relevant to federally listed species and would be implemented as part of the proposed action.

BMP 1: Protect Water Quality and Prevent Erosion and Sedimentation in Wetlands and Drainages

BMP 2: Avoid and Minimize the Spread of Invasive Plant Species during Project Construction

1.7.2.2 Avoidance and Minimization Measures

The following AMMs and would be implemented to avoid and minimize potential effects of the proposed action on listed species.

AMM 1: Install Orange Construction Fencing between the Construction Area and Adjacent Sensitive Biological Resources

AMM 2: Retain a Qualified Biologist to Conduct Monitoring during Construction in Sensitive Habitats

AMM 3: Conduct Environmental Awareness Training for Construction Employees

AMM 4: Design and Implement Water Conveyance Systems that Maintain the Hydrology of and Prevent Contaminants from Entering Suitable Vernal Pool Branchiopod Habitat

AMM 5: Fence Elderberry Shrubs to Be Protected

1.7.2.3 Compensatory Mitigation

The following measure would be implemented to compensate for effects on valley elderberry longhorn beetle.

Compensate for Direct Effects on Valley Elderberry Longhorn Beetle and Its Habitat

1.8 Interrelated and Interdependent Actions

The proposed action is interrelated with the Easton Project: Easton Place and Glenborough at Easton developments. The proposed action has independent utility but would not be necessary if not for the Easton Project, which requires improvements at the Hazel Avenue/US 50 interchange to mitigate traffic impacts (County of Sacramento Department of Environmental Review and Assessment 2008). While the proposed action would provide additional capacity that would benefit other approved and planned development in Sacramento County, development of the Easton Project is dependent on the Hazel Avenue/US 50 interchange modifications. Because the effects of the Easton Project on federally listed species were analyzed in a separate Section 7 consultation (81420-2010-F-0714-1), the effects of the Easton Project are not included in this BA.

Chapter 2 Study Methods

2.1 Summary

Potential biological resource issues associated with the proposed action were identified through a review of existing information and field surveys. Information obtained from the following surveys was used to identify habitat for, and assess potential effects on, federally listed species in the action area:

- General habitat evaluation to determine whether suitable habitat exists for special-status plant and animal species.
- Botanical field surveys to map land cover types, including natural communities, and survey for special-status plant species.
- Delineation of waters of the United States and waters of the State.
- Elderberry shrub (*Sambucus* sp.) and valley elderberry longhorn beetle surveys.

To prepare for the field surveys, biologists reviewed existing resource information related to the proposed action to evaluate whether federally listed species or their habitats could occur in the action area. The sources listed below were reviewed.

- California Native Plant Society's (CNPS's) online *Inventory of Rare and Endangered Plants of California* records search of the Buffalo Creek, Carmichael, Citrus Heights, Clarksville, Folsom, and Folsom SE U.S. Geological Survey (USGS) 7.5-minute quadrangles (California Native Plant Society 2016).
- California Natural Diversity Database (CNDDB) records search of the Buffalo Creek, Carmichael, Citrus Heights, Clarksville, Folsom, and Folsom SE USGS 7.5-minute quadrangles (California Department of Fish and Wildlife 2016).
- USFWS's list of endangered and threatened species that may occur in or be affected by the proposed action (U.S. Fish and Wildlife Service 2016).
- Lists of plants identified as noxious weeds or invasive plants by the U.S. Department of Agriculture (USDA) (U.S. Department of Agriculture, Natural Resources Conservation Service 2012), the California Department of Food and Agriculture (CDFA) (California Department of Food and Agriculture 2016), and the California Invasive Plant Council (Cal-IPC) (2016).
- Soil map unit descriptions for the project area (U.S. Department of Agriculture, Natural Resources Conservation Service 2015).

An updated USFWS (2018) species list from the IPaC website, a list of threatened and endangered species for the Folsom USGS 7.5-minute quadrangle from NMFS's California Species List Tools website (National Marine Fisheries Service 2018), and recent versions of the CNDDB (California Department of Fish and Wildlife 2018b) and CNPS inventory (California Native Plant Society 2018) were obtained and included in Appendix A.

2.2 Personnel and Survey Dates

ICF biologists conducted biological surveys of accessible parcels in the action area in April 2016, May 2016, and July 2017 (Table 2-1).

Table 2-1. Biological Survey Personnel and Dates

Survey Type	Survey Date	Surveyors
Natural community mapping and botanical surveys	April 6 and May 31, 2016	Lisa Webber, ICF botanist/wetland ecologist, 25 years of experience
Habitat-based assessment for special-status animal species	April 6 and May 31, 2016	Jennifer Haire, ICF wildlife biologist, 20 years of experience
Aquatic resources delineation (waters of the United States and waters of the State)	April 6 and May 31, 2016	Lisa Webber
Elderberry shrub and valley elderberry longhorn beetle surveys	May 31, 2016	Jennifer Haire
Arborist survey	July 17, 18, and 31, 2017	Renee Richardson, certified arborist, 10 years of experience

2.3 Survey Methods

Methods for the natural community (land cover type) mapping, botanical surveys, habitat-based assessment for special-status species, aquatic resources delineation, and elderberry shrub and valley elderberry longhorn beetle surveys are described below. Figure 3 in Appendix B shows the project area and action area boundaries. Appendix C provides representative photographs of elderberry shrubs and valley elderberry longhorn beetle exit holes.

2.3.1 Natural Community Mapping and Botanical and Arborist Surveys

ICF botanist and wetland ecologist Lisa Webber identified and mapped land cover types and natural communities in the project area on April 6 and May 31, 2016. Ms. Webber also conducted botanical surveys in the project area on these dates. The surveys coincided with the identification periods of special-status plants identified as having potential to occur in the project region. Ms. Webber walked or visually surveyed all of the project area and compiled a list of all plant species observed (Appendix D).

ICF biologist and International Society of Arboriculture–certified arborist Renee Richardson inventoried and assessed all trees in the project area on July 17, 18, and 31, 2017. All accessible trees in the project area that were greater than 4 inches in dbh (defined as the diameter of a tree measured at 4.5 feet above ground level on the high side of the tree) were assigned an individual number and tagged. The location of each tree was recorded with a global positioning system unit; species, health, vigor, structure, height, dripline radius, and the dbh of each tree were also recorded.

2.3.2 Habitat-Based Assessment for Special-Status Animal Species

ICF wildlife biologist Jennifer Haire conducted a reconnaissance-level field survey of the action area on April 6 and May 31, 2016. This survey focused on evaluating natural communities in the project area and determining their suitability for special-status animal species. Ms. Haire walked or visually surveyed all of the project area, making notes on the types and suitability of habitat present and recording any wildlife species observed (Appendix D). Ms. Haire also surveyed a 250-foot buffer on the west, south, and east sides of the jughandle area off of Folsom Boulevard for vernal pool branchiopod habitat in order to assess potential indirect effects on vernal pool branchiopods. She also looked for elderberry shrubs within 100 feet of the project area, except for the portion of the action area that is east of the Folsom Auto Mall (where only restriping would occur and there would be no ground disturbance), in order to assess indirect effects on valley elderberry longhorn beetle.

The assessment for the potential for special-status fish in the vicinity of the project area was based on a reconnaissance-level field survey of the project area on June 11, 2016, conducted by ICF fish biologist Jeff Kozlowski. Mr. Kozlowski observed aquatic habitats in the project area and vicinity of Lake Natomas on the north side of US 50.

2.3.3 Delineation of Aquatic Resources (Waters of the United States/Waters of the State)

Ms. Webber conducted delineation fieldwork in the project area on April 6 and May 31, 2016. The delineation was conducted using the routine on-site determination methods described in the *U.S. Army Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987) and the supplemental procedures and wetland indicators provided in the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Arid West Region* (U.S. Army Corps of Engineers 2008).

Other waters of the United States were mapped and delineated in the field in accordance with indicators and guidance in USACE Regulatory Guidance Letter No. 05-05, dated December 7, 2005 (U.S. Army Corps of Engineers 2005), and *A Field Guide to the Identification of the Ordinary High Water Mark (OHWM) in the Arid West Region* (Lichvar and McColley 2008). Methods and standards conform to the USACE Sacramento District's *Minimum Standards for Acceptance of Aquatic Resources Delineation Reports* (U.S. Army Corps of Engineers 2016a) and *Revised Map and Drawing Standards for the Pacific Division Regulatory Program Delineations* (U.S. Army Corps of Engineers 2016b). The delineation report is included as Appendix E.

2.3.4 Elderberry Shrub and Valley Elderberry Longhorn Beetle Surveys

Ms. Haire mapped the locations of elderberry shrubs, which provide habitat for valley elderberry longhorn beetle, on May 31, 2016. Surveys for the presence of valley elderberry longhorn beetle and their exit holes were conducted at four elderberry shrubs within the project footprint that may be affected by the proposed action. Surveys were conducted in accordance with the

Conservation Guidelines for the Valley Elderberry Longhorn Beetle (U.S. Fish and Wildlife Service 1999) since this was the current guidance at the time of the surveys. The shrub height, canopy area, number of stems, and stem diameters were estimated or measured for each shrub. One additional elderberry shrub is located within the project footprint but was not surveyed because impacts on and mitigation for this shrub have already been accounted for during the permitting process for the Easton Project: Easton Place and Glenborough at Easton. Eight elderberry shrubs within 100 feet of the project footprint were not surveyed because they are not expected to be directly affected by the proposed action (see discussion in Chapter 5).

2.4 Resource Agency Coordination and Professional Contacts

2.4.1 U.S. Fish and Wildlife Service

On April 4, 2016, Ms. Haire obtained a list of threatened and endangered species for the proposed action from the USFWS Sacramento Field Office through the IPaC website (U.S. Fish and Wildlife Service 2016). On March 31, 2017, September 25, 2017, March 2, 2018, July 10, 2018, and October 16, 2018, Ms. Haire obtained updated lists of threatened and endangered species from the IPaC website. The most recent version of the species list (U.S. Fish and Wildlife Service 2018) is included in Appendix A.

On April 7, 2017, Mr. Kozlowski obtained a list of threatened and endangered species for the Folsom USGS 7.5-minute quadrangle from NMFS's California Species List Tools website (National Marine Fisheries Service 2017). Caltrans biologist Michelle Lukkarila obtained an updated list from the NMFS website on July 10, 2018 (National Marine Fisheries Service 2018). Ms. Tina Sorvari, of ICF, obtained an updated list from the NMFS website on October 17, 2018. The most recent version of the species list (National Marine Fisheries Service 2018) is included in Appendix A.

To date, there has been no coordination between Caltrans and USFWS regarding the proposed action.

2.4.2 ECORP Consulting

On April 28, 2016, Debra Sykes of ECORP Consulting provided a map of biological resources identified during surveys for the Easton Project: Glenborough at Easton and Easton Place developments, which overlaps with the portion of the proposed action that is on Aerojet property. ECORP is Aerojet's consultant and has done previous biological survey work for the Easton Project: Glenborough at Easton and Easton Place development. On June 14, 2016, Ms. Sykes also provided ICF with the following information from the Easton Project: Glenborough at Easton and Easton Place development:

- USACE 404 permit.
- USFWS biological opinion.
- A map showing the portions of the project where required mitigation had been completed.

2.5 Limitations that May Influence Results

There were no limitations on the natural community, botanical, or special-status species habitat assessment; aquatic resources delineation; or elderberry shrub and valley elderberry longhorn beetle surveys that would influence the results presented in this BA.

Chapter 3 Results: Environmental Baseline

The environmental baseline describes the setting in which the proposed action would occur and the effects from past and present federal, state, and private actions; proposed federal projects with completed Section 7 consultations; and contemporaneous state or private actions with consultation in progress. The environmental baseline also considers non-permitted actions (i.e., other nonfederal actions occurring within the action area).

3.1 Habitat Conditions in the Action Area

The proposed action is located in Sacramento County (Appendix B, Figure 1). The topography of the action area is relatively level, with elevations ranging from approximately 110 to 150 feet above mean sea level. Land uses in the action area and surrounding area are primarily commercial and recreational (Appendix B, Figure 3). A portion of the action area abuts Aerojet property, which is an undeveloped area adjacent to the project area. Most of the action area has a relatively high level of historical and ongoing disturbance. The action area is within the geographic and elevation range of vernal pool fairy shrimp and valley elderberry longhorn beetle.

3.2 Summary of Environmental Baseline

The following sections (3.3 through 3.9) provide a summary of the environmental baseline in the action area. Development of the sections was based on the results of field surveys (described in Chapter 2) as well as background information related to land use, soils, hydrology, and biological resources derived from multiple sources, including the USDA, Natural Resources Conservation Service (2015); U.S. Environmental Protection Agency (2016); CNPS (2018); California Department of Fish and Wildlife (2018a, 2018b); USDA, Natural Resources Conservation Service (2012); and Cal-IPC (2006). The sections describe existing physical and biological conditions within the action area. Representative photographs of the action area are provided in Appendix C.

3.3 Description of the Action Area

3.3.1 Physical Conditions

The following seven soil map units (U.S. Department of Agriculture, Natural Resources Conservation Service 2015) are located in the project area (these are shown in Figure 1 of the delineation report [Appendix E]).

- Natomas loam, 0% – 2% slopes.

- Natomas-Xerorthents, dredge tailings complex, 0% – 50% slopes.
- Urban land.
- Urban land-Natomas complex, 0% – 2% slopes.
- Xerorthents, dredge tailings, 2% – 50% slopes.
- Xerorthents, dredge tailings – Urban land complex, 0% – 2% slopes.
- Water.

The action area is in the Upper American River watershed hydrologic unit (hydrologic unit code 18020111) (U.S. Environmental Protection Agency 2016). Alder Creek is the only perennial drainage in the action area. Alder Creek drains north under US 50 to Lake Natoma, which is approximately 0.7 mile upstream of Nimbus Dam. Lake Natoma is part of the American River, a traditional navigable water (TNW).

3.3.2 Biological Conditions

This section describes the four land cover types in which elderberry shrubs are present. There are a total of 11 land cover types in the project area, which are shown in Figure 3 in Appendix B.

Fremont Cottonwood-Oak Woodland

The proposed jughandle road area south of Folsom Boulevard supports Fremont cottonwood-oak woodland (Appendix C, Photo 1). The overstory is dominated by interior live oak, Fremont cottonwood (*Populus fremontii* ssp. *fremontii*), and willows (*Salix* spp.). The understory includes small willows, coyote brush (*Baccharis pilularis*), poison-oak (*Toxicodendron diversilobum*), and annual grasses and forbs. Blue elderberry shrubs (*Sambucus nigra* ssp. *caerulea*) occur in this area (Appendix B, Figure 3).

Planted Oak Woodland

The areas between the US 50 on-ramps and off-ramps are planted with native trees and shrubs found in oak woodlands such as interior live oak, valley oak, buckeye (*Aesculus californica*), Lemmon's ceanothus (*Ceanothus lemmonii*), coffeeberry (*Frangula californica*), California flannelbush (*Fremontodendron californicum*), and Fremont cottonwood, with annual grassland species in the understory. Two mature interior live oak trees and a large elderberry cluster located between the US 50 westbound off-ramp to Hazel Avenue and the westbound loop on-ramp and a large elderberry cluster adjacent to the US 50 eastbound Hazel Avenue off-ramp appear to be older than the planted trees and shrubs and may have been extant on the site prior to construction of the ramps (Appendix B, Figure 3).

Annual Grassland

Annual grassland occurs throughout the project area within the US 50 ROW and south of Folsom Boulevard. Areas mapped as annual grassland in the existing Hazel Avenue/US 50 interchange

and the area south of Folsom Boulevard support primarily nonnative weedy species (Appendix C, Photo 1). Dominant species in this community include annual grasses such as wild oat (*Avena fatua*), ripgut brome (*Bromus diandrus*), soft chess (*B. hordeaceus*), foxtail barley (*Hordeum murinum* ssp. *leporinum*), and perennial ryegrass. Typical forbs in annual grassland in the project area are Italian thistle (*Carduus pycnocephalus*), heron's bill (*Erodium botrys* and *E. cicutarium*), hawkbit (*Leontodon saxatilis* ssp. *longirostris*), milk thistle (*Silybum marianum*), hairy clover (*Trifolium hirtum*), and hairy vetch (*Vicia villosa*). The annual grassland on both sides of Alder Creek also supports some native forbs, including elegant clarkia (*Clarkia unguiculata*) and dwarf brodiaea (*Brodiaea nana*). Scattered native trees such as Fremont cottonwood, interior live oak, valley oak, and California foothill pine also occur in areas mapped as annual grassland. A blue elderberry shrub cluster also occurs in annual grassland along US 50 (Appendix B. Figure 3).

Developed and Landscaped

Developed and landscaped land cover types are discussed together because they are similar from a wildlife habitat-value standpoint. These cover types comprise the largest portion of the project area. Developed areas largely consist of hardscape, including buildings, parking lots, driveways, and sidewalks. Native vegetation has been removed or replaced with grass lawns and ornamental plantings. The landscaping adjacent to developed facilities consists of shade and street trees, hedges and shrubs, lawns, and gardens. The growth of vegetation in this land cover type is typically managed by trimming or mowing. Blue elderberries are located within areas that were mapped as developed and landscaped (Appendix B, Figure 3).

3.3.2.2 Invasive Plant Species

Invasive plant species include species designated as federal noxious weeds by USDA, species listed by CDFA, and invasive plants identified by Cal-IPC. Invasive plants displace native species, change ecosystem processes, alter plant community structure, and lower wildlife habitat quality (California Invasive Plant Council 2006:1). Road, highway, and related construction projects are some of the principal dispersal pathways for invasive plants and their propagules. Table 3-1 lists the invasive plant species identified by CDFA and Cal-IPC that are known to occur in the project area (California Department of Food and Agriculture 2016; California Invasive Plant Council 2016). No plant species designated as federal noxious weeds (U.S. Department of Agriculture, Natural Resources Conservation Service 2012) have been identified in the project area. Invasive plant species occur in all plant communities in the project area but are more prevalent in annual grassland.

Table 3-1. Invasive Plant Species Identified in the Project Area

Species	CDFA	Cal-IPC
Slender wild oat (*Avena barbata*)	–	Moderate
Wild oat (*Avena fatua*)	–	Moderate
Black mustard (*Brassica nigra*)	–	Moderate
Common mustard (*Brassica rapa*)	–	Limited
Ripgut brome (*Bromus diandrus*)	–	Moderate
Soft chess (*Bromus hordeaceus*)	–	Limited
Red brome (*Bromus madritensis* ssp. *rubens*)	–	High
Italian thistle (*Carduus pycnocephalus*)	C	Moderate
Maltese star thistle (*Centaurea melitensis*)	C	Moderate
Yellow star-thistle (*Centaurea solstitialis*)	C	High
Canada thistle (*Cirsium arvense*)	B	Moderate
Poison-hemlock (*Conium maculatum*)	–	Moderate
Bindweed (*Convolvulus arvensis*)	C	–
Pampas grass (*Cortaderia jubata*)	–	High
Red-stemmed filaree (*Erodium cicutarium*)	–	Limited
Rattail fescue (*Festuca myuros*)		Moderate
Italian ryegrass (*Festuca perennis*)	–	Moderate
Edible fig (*Ficus carica*)	–	Moderate
Sweet fennel (*Foeniculum vulgare*)	–	High
Cutleaf geranium (*Geranium dissectum*)	–	Limited
Mediterranean barley (*Hordeum marinum* var. *gussoneanum*)	–	Moderate
Foxtail barley (*Hordeum murinum* ssp. *leporinum*)	–	Moderate
Smooth cat's-ear (*Hypochaeris glabra*)	–	Limited
Water iris (*Iris pseudacorus*)	–	Limited
Hyssop loosestrife (*Lythrum hyssopifolia*)	–	Limited
Horehound (*Marrubium vulgare*)	–	Limited
California burclover (*Medicago polymorpha*)	–	Limited
Harding grass (*Phalaris aquatica*)	–	Moderate
English plantain (*Plantago lanceolata*)	–	Limited
Rabbitsfoot grass (*Polypogon monspeliensis*)	–	Limited
Wild radish (*Raphanus sativus*)	–	Limited
Himalayan blackberry (*Rubus armeniacus*)	–	High
Curly dock (*Rumex crispus*)	–	Limited
Milk thistle (*Silybum marianum*)	–	Limited
Rose clover (*Trifolium hirtum*)	–	Moderate

Note: The California Department of Agriculture (CDFA) and California Invasive Plant Council (Cal-IPC) lists assign ratings that reflect the CDFA and Cal-IPC views of the statewide importance of the pest, likelihood that eradication or control efforts would be successful, and present distribution of the pest in the state. These ratings are guidelines that indicate the most appropriate action to take against a pest under general circumstances. The Cal-IPC species list is more inclusive than the CDFA list.

The **CDFA categories** indicated in the table are defined as follows:

B: Eradication, containment, control, or other holding action at the discretion of the county agricultural commissioner.

C: State-endorsed holding action and eradication only when found in a nursery; action to retard spread outside nurseries at the discretion of the county agricultural commissioner.

The **Cal-IPC categories** indicated in the table are defined as follows:

High: Species with severe ecological impacts, high rates of dispersal and establishment, and usually widely distributed.

Moderate: Species with substantial and apparent ecological impacts, moderate to high rates of dispersal, establishment dependent on disturbance, and limited to widespread distribution.

Limited: Species with minor ecological impacts, low to moderate rates of invasion, limited distribution, and locally persistent and problematic.

Chapter 4 Federally Listed Species in the Action Area

4.1 Federally Listed Species

The only federally listed species that is known to occur, or may occur, in the action area and may be affected by the project is valley elderberry longhorn beetle. As described in Chapter 1, no federally proposed species were identified on the USFWS species list, and there is no designated critical habitat in the action area.

This chapter describes the pertinent life history and distribution information for valley elderberry longhorn beetle, as well as the status of the species in the action area.

4.1.1 Valley Elderberry Longhorn Beetle

4.1.1.1 Status and Distribution

Valley elderberry longhorn beetle is federally listed as threatened. The presumed historical range and current range of valley elderberry longhorn beetle is the Central Valley from Tehama County south to Fresno County (79 *Federal Register* [FR] 55881–55884). The majority of beetles have been documented below 500 feet in elevation (U.S. Fish and Wildlife Service 2017:4). Valley elderberry longhorn beetle is dependent on its host plant, elderberry, which is a common component of riparian corridors and adjacent upland areas in the Central Valley (Barr 1991:5).

4.1.1.2 Habitat and Biology

Valley elderberry longhorn beetle has four life stages: egg, larva, pupa, and adult. Females deposit eggs on or adjacent to the host elderberry. Egg production varies; females have been observed to lay between 16 and 180 eggs. Eggs hatch within a few days of being deposited. Larvae emerge and bore into the woody stems of the host plant, creating a long feeding gallery in the pith. The larvae feed on the pith for 1 to 2 years. When a larva is ready to pupate, it chews an exit hole and then plugs it with frass. The larva then retreats into the feeding gallery and constructs a pupal chamber from wood and frass. The larvae metamorphose between December and April; the pupal stage lasts about a month. The adult remains in the pupal chamber for several weeks after metamorphosis and then emerges from the chamber through the exit hole. Adults emerge between mid-March and mid-June, which corresponds with elderberry flowering. Adults feed on elderberry leaves and mate within the elderberry canopy (Talley et al. 2006a:7–9).

4.1.1.3 Reasons for Decline

The decline of valley elderberry longhorn beetle is attributed primarily to the loss of its riparian habitat (45 FR 52803). Agricultural and urban developments have resulted in a nearly 90%

reduction in historic riparian ecosystems in the Central Valley (Katibah et al. 1984:26–28). Since 1900, an estimated 65% of potential valley elderberry longhorn beetle habitat (elderberry savannah and riparian woodland) has been removed throughout the Central Valley, including 87% of riparian habitat, which is most likely the most densely populated habitat for the beetle. Riparian habitat decreased 48% between 1960 and 1990. From 1980, when the beetle was listed, to the present, the rate of agricultural conversion has slowed, but rates of urban, suburban, and associated development have increased (Talley et al. 2006a:21–22). Colonization of elderberry shrubs by Argentine ants (*Linepithema humile*) and potential predation of beetle eggs by the ants may also contribute to the decline of valley elderberry longhorn beetle (Huxel 2000:84).

4.1.1.4 Occurrence in the Action Area

There are 10 CNDDB records for valley elderberry longhorn beetle within 5 miles of the action area (California Department of Fish and Wildlife 2018b). The closest record abuts the project area east of the US 50 westbound off-ramp and north of US 50 between Lake Natoma and the freeway. Adult beetles and exit holes were observed at this location in 1987 (California Department of Fish and Wildlife 2018b). Five elderberry shrubs/clusters (#s 1, 2, 3, 4, and 5) are present in the project area (Appendix B, Figure 3). Three of these shrubs (#s 1, 2, and 3) are located along US 50 or between on- and off-ramps in the project area. Two elderberry shrubs (#s 4 and 5) are located in the jughandle off of Folsom Boulevard in the project area.

Eight additional elderberry shrubs are located within 100 feet of the project area. Six of the elderberry shrubs/clusters (#s 6–11) within 100 feet of the project area are located along Folsom Boulevard on Aerojet property in the vernal pool branchiopod indirect effects assessment area. The two other shrubs within 100 feet of the project area are south of Folsom Boulevard and east of Nimbus Road (#12) and next to the Cattlemen's Restaurant parking lot (#13) (Appendix B, Figure 3).

Surveys for valley elderberry longhorn beetle exit holes, stem counts, and stem diameter measurements were conducted for the four shrubs (#s 1–4) that could be affected by the proposed action; the results of the surveys are shown in Table 4-1. None of these shrubs are located within riparian habitat. Appendix E contains photographs of the four shrubs and representative photographs of observed potential exit holes.

Table 4-1. Results of Surveys of Elderberry Shrubs in the Project Area that May Be Affected by the Proposed Action

Elderberry Number	Riparian (Y/N)	Exit Holes (Y/N)	Number of Stems ≥ 1" and ≤ 3"	Number of Stems > 3" and < 5"	Number of Stems ≥ 5"	Total Number of Stems
1	N	Y	21	8	7	35
2	N	Y	22	0	5	27
3	N	Y	0	0	1	1
4	N	N	0	2	0	2
Total			**43**	**10**	**13**	**65**

Chapter 5 Effects of the Proposed Action

5.1 Deconstruct Action

This section deconstructs the proposed action into activities and conditions that would result in direct and indirect effects on valley elderberry longhorn beetle.

5.1.1 Construction Scenario

Three elderberry shrubs, which provide habitat for valley elderberry longhorn beetle habitat, would be removed and transplanted to a USFWS-approved conservation bank prior to the start of construction activities. These three shrubs would not be further affected by construction activities. Because there would be no soil disturbance within 20 feet of eight elderberry shrubs/clusters that are within 100 feet of the project area, construction activities would not directly affect these shrubs. No indirect effects are anticipated to occur on elderberry shrubs that are within 100 feet of the project area.

5.1.2 Sequencing and Schedule

The proposed action is expected to take 2 years (2021–2023) to construct. Direct effects on valley elderberry longhorn beetle and its habitat could occur early in the sequencing of the proposed action or part way through the proposed action, depending on the location and sequence of construction. Three elderberry shrubs would be removed and transported to a USFWS-approved conservation area between November 1, 2020, and mid-February 2021 or between November 1, 2021, and mid-February 2022 (these are the timeframes within the construction schedule when elderberry shrubs should be transplanted) (U.S. Fish and Wildlife Service 2017).

Work would generally be conducted in the order below, but some activities could occur at the same time in different locations within the project area.

- Install fencing to delineate construction area and protect biologically sensitive areas.
- Mobilize equipment and materials to staging areas.
- Relocate utilities.
- To the extent feasible, clear vegetation and debris from work areas (October 1 through January 31 to minimize impacts on nesting birds and September 15 through October 30 to minimize impacts on roosting bats).
- Construct improvements.

5.1.3 Stressors from Project Actions

Stressors induce an adverse response in an organism by any physical, chemical, or biological alteration of the environment (or resource) that can lead to a response from the individual. Stressors can act directly on an individual or indirectly through effects on a resource.

5.1.3.1 Valley Elderberry Longhorn Beetle

The following stressors from the proposed action could induce an adverse response from valley elderberry longhorn beetle:

- Disturbance of valley elderberry longhorn beetle larvae or pupae that are within the elderberry shrub stems when the shrubs are transplanted.
- Reduced population and less opportunity for genetic exchange in the action area from the removal and relocation of potentially occupied habitat.
- Loss of subsequent generations of elderberry beetles if the transplanted elderberry shrubs do not survive at the conservation area.

5.1.4 Project Operation and Maintenance

The proposed action does not include any operational or maintenance activities. Areas within the Caltrans ROW would be maintained similar to existing conditions.

5.2 Exposure to Stressors from the Action and Response to Exposure

Exposures are defined as the interaction of the species, their resources, and the stressors that result from the project action. Exposure is the result of the co-occurrence of the species and its resources and any stressors resulting from the action. The exposure analysis identifies the effects of the action that would most likely overlap with the species' presence in the action area.

The following sections summarize direct and indirect effects on valley elderberry longhorn beetle that could result from the proposed action. BMPs described in Chapter 1 and AMMs and compensatory mitigation described in Section 5.5 would avoid, minimize, and compensate for potential effects on listed species.

5.2.1 Valley Elderberry Longhorn Beetle

5.2.1.1 Direct Effects

Direct effects on valley elderberry longhorn beetle would consist of removing three elderberry shrubs that are located in non-riparian habitat. Construction of the proposed action would result

in the removal of elderberry #1 (because of the embankment for the loop ramp), elderberry #3 (because of construction of the auxiliary lane between Hazel Avenue and the Folsom Boulevard interchange), and elderberry #4 (because of construction of the new intersection and at-grade railroad crossing for the jughandle) (Appendix B, Figure 4). Elderberry #2 would not need to be removed, but disturbance could occur within 20 feet of its dripline (see discussion below). Impacts on and mitigation for elderberry #5 have already been accounted for during the permitting process for the Easton Project: Easton Place and Glenborough at Easton. As such, effects on this shrub have already been permitted and mitigated. No effects from the proposed action would occur. Elderberry #5 is not discussed further.

Relocation of the three elderberry shrubs could result in the disturbance of valley elderberry longhorn beetle larvae or pupae that are within the elderberry shrubs when they are transplanted. The removal of these shrubs could also reduce the population of valley elderberry longhorn beetle in the action area. Subsequent generations of elderberry beetles could also be lost if the transplanted elderberry shrubs do not survive at the conservation area. These potential effects would be compensated through compensatory mitigation discussed below.

Ground disturbance within 20 feet of an elderberry shrub's dripline could result in disturbance of roots. Root damage could result in stress or reduced vigor of elderberry shrubs. Ground disturbance could occur within 20 feet of elderberry #2 (Appendix B, Figure 4, Sheet 3). This shrub would be fenced and protected during construction (see AMM 5). Fencing the shrub would minimize the potential for disturbance of the shrub and root damage.

There would be no soil disturbance within 20 feet of the eight elderberry shrubs/clusters that are within 100 feet of the project area (Appendix B, Figure 4). The roots of the six shrubs (#s 6-11) along Folsom Boulevard on the Aerojet property would not be affected because railroad tracks are located between the work area on Folsom Boulevard and the elderberry shrubs, and no work would occur on the south side of the tracks. The other two shrubs (#12 and #13) are located more than 20 feet from work areas. Therefore, there would be no direct impacts on the eight elderberry shrubs/clusters within 100 feet of the project area.

5.2.1.2 Indirect Impacts

Potential indirect effects on eight elderberry shrubs/clusters within 100 feet of the project area were considered. Potential indirect effects on valley elderberry longhorn beetle that were considered were altered hydrology, exposure to dust, loss of connectivity to adjacent habitat, increased lighting, and disturbance from operations and maintenance activities. Each of these potential indirect effects is discussed below.

Altered Hydrology

A reduction in water to elderberry shrubs as a result of altered of hydrology from changes in topography or compaction of soil could result in reduced shrub vigor/vitality and an associated decrease in shoot, leaf, and flower production that could ultimately reduce the ability of the shrubs to provide habitat for valley elderberry longhorn beetle. Because elderberry #s 5–12 are in flat areas with moderate amounts of pavement next to or near them, changes in the hydrology for these shrubs from altered topography or increased paved surface are unlikely to occur.

Elderberry #13 would most likely not be affected by changes in topography and the increased paved surface from the proposed action because it is approximately 80 feet from the project area, in a low area adjacent to the Cattlemen's Restaurant parking lot.

Dust

Ground-disturbing activities during construction of the proposed action could result in dust becoming airborne and settling on elderberries within 100 feet of the project area. Exposure of elderberries shrubs to dust is most likely limited under current conditions because surrounding areas are paved or vegetated. Dust control measures would most likely be required to meet air quality standards and minimize the amount of dust generated during construction. Additionally, according to Talley et al. (2006b), in an experiment along the American River Parkway, conditions for elderberry shrubs related to dust from nearby trails and roads (paved and dirt) did not affect the presence of valley elderberry longhorn beetle. Additional work by Talley and Holyoak (2009) found no effect on elderberries from dust accumulations. Because dust has not been found to greatly affect elderberry shrubs and because dust control measures would most likely be implemented during construction, this indirect effect is not expected to affect the beetle.

Loss of Connectivity to Adjacent Habitat

Loss of connectivity between elderberry shrubs may result when elderberries or associated vegetation is removed. Removal of such vegetation could result in gaps in vegetation that are too wide for valley elderberry longhorn beetle to travel across because of their fairly limited movement distances (Talley et al. 2006a), resulting in separation of individuals or a reduction in the possibility of colonization of adjacent areas. Removal of associated vegetation may result in an altered habitat structure or microclimate that could affect behaviors of the beetle in response to these changes in unforeseen ways (U.S. Fish and Wildlife Service 2003).

Although more research is needed, valley elderberry longhorn beetle has been observed to fly 1 mile or more in contiguous or fairly contiguous habitat, and exit holes have been observed on isolated shrubs that are a minimum of 0.25 mile from the next nearest elderberry (Arnold pers. comm.). Within the American River Basin, evidence suggests that local beetle movements are farther within the riparian corridor (141 +/-144 feet) than in the adjacent non-riparian scrub (82 +/-52 feet) (average +/-1 standard deviation nearest neighbor distances between recent exit holes), illustrating that valley elderberry longhorn beetle population extents may also be habitat specific (Talley et al. 2006a).

The removal of three elderberry shrubs would result in a greater distance between existing shrubs. It is possible that the removal of these shrubs could result in the isolation of a beetle population or greater dispersal distances between shrubs. A search for all elderberry shrubs in the project vicinity was not conducted; the distances between mapped elderberry shrubs within 100 feet of the project area are shown in Table 5-1. The distances between the shrubs are within the observed flight distance of the beetle (i.e., 1 mile), and therefore, movement between the shrubs is possible. However, developed areas and the busy interstate may preclude the beetle from flying between some of the elderberry shrubs in and within 100 feet of the project area. As such, loss of connectivity of habitat is not expected to be an indirect effect on valley elderberry longhorn beetle.

Table 5-1. Distances (Miles) to Nearest Mapped Elderberry Shrubs within 100-Feet of the Project Area

Elderberry Number	1	2	3	4–11	12	13
1	0	0.19	0.43	0.11	0.36	0.31
2	0.19	0.0	0.6	0.22	0.21	0.22
3	0.43	0.6	0.0	0.43	0.58	0.23
4–11	0.11	0.22	0.43	0.0	0.21	0.47
12	0.36	0.21	0.58	0.21	0.0	0.22
13	0.31	0.22	0.23	0.47	0.22	0.0

5.3 Effects of the Action

Effect is a description of the manner in which the action may affect any listed species or critical habitat and an analysis of any cumulative effect (50 CFR 402.02). The effect of the action is the consequence (behavioral, physical, or physiological) of a response to a stressor.

5.3.1 Valley Elderberry Longhorn Beetle

The proposed action would result in the removal and relocation of three elderberry shrubs from the action area to a USFWS-approved conservation area. The relocation of the shrubs could result in the disturbance of valley elderberry longhorn beetle larvae or pupae that are within the elderberry shrubs when they are transplanted. Relocation of three elderberry shrubs could also reduce the population of valley elderberry longhorn beetle in the action area. Subsequent generations of elderberry beetles could also be lost if the transplanted elderberry shrubs do not survive at the conservation area. Compensation for direct effects on valley elderberry longhorn beetle would be provided through implementation of the compensatory mitigation described below.

As discussed above, the proposed action would not have other direct or indirect effects on other elderberry shrubs in the action area. BMPs and AMMs 3 and 5 would ensure that elderberry shrubs in the action area would be protected and not disturbed by the proposed action.

5.4 Best Management Practices, Avoidance and Minimization Measures, and Compensation Proposal

5.4.1 Best Management Practices

BMP 1: Protect Water Quality and Prevent Erosion and Sedimentation in Wetlands and Drainages

The County will ensure that the construction specifications include the water quality protection and erosion and sediment control BMPs listed below, which are based on standard

County/Caltrans requirements, to minimize construction-related contaminants and mobilization of sediment in wetlands and drainages, including Alder Creek, in and adjacent to the project area. The BMPs will be selected to achieve maximum sediment removal, representing the best available technology that is economically achievable, subject to review and approval by the County. The County will perform routine inspections of the construction area to verify the BMPs are properly implemented and maintained. The County will notify contractors immediately if there is a noncompliance issue and will require compliance.

The BMPs will include, but are not limited to, the following practices:

- Ensure that equipment used in and around drainages is in good working order and free of dripping or leaking engine fluids. All vehicle maintenance will be performed at least 100 feet from all drainages. Any necessary equipment washing will be carried out where the water cannot flow into drainages.
- Prepare and implement a hazardous material spill prevention control and countermeasure (SPCC) plan before construction begins that will minimize the potential for, and the effects of, spills of hazardous or toxic substances during construction. The SPCC plan will include storage and containment procedures to prevent and respond to spills and identify the parties responsible for monitoring the spill response. The SPCC plan will also include the following stipulations:
  - Prevent raw cement, concrete or concrete washings, asphalt, paint or other coating material, oil or other petroleum products, or any other substances that could be hazardous to aquatic life from contaminating the soil or entering watercourses.
  - Clean up all spills immediately according to the SPCC plan.
  - Avoid operation of vehicles and equipment in flowing water.
  - Provide areas located outside all stream OHWMs for staging and storing equipment, materials, fuels, lubricants, solvents, and other possible contaminants.
  - Ensure that areas where equipment is refueled or lubricated are storm-proofed to prevent contaminants from being discharged to the streams. Pump contaminated water to a holding tank for proper disposal.
- The County will review and approve the contractor's hazardous materials SPCC plan before allowing construction to begin.
- Prohibit the following types of materials from being rinsed or washed into the roads, shoulder areas, or gutters: concrete, solvents and adhesives, thinners, paints, fuels, sawdust, dirt, gasoline, asphalt and concrete saw slurry, and heavily chlorinated water.
- Dispose of any surplus concrete rubble, asphalt, or other rubble from construction at a local landfill.
- Prepare and implement an erosion and sediment control plan for the proposed action. The plan will include the following provisions and protocols:
  - Runoff from disturbed areas will be made to conform to the water quality requirements of the waste discharge permit issued by the Central Valley RWQCB.

  - Temporary erosion control measures, such as sandbagged silt fences, will be applied throughout construction of the proposed action and be removed after the working area is stabilized, or as directed by the engineer. Soil exposure will be minimized through use of temporary BMPs, groundcover, and stabilization measures. Exposed dust-producing surfaces will be sprinkled daily, if necessary, until wet; this measure will be controlled to avoid producing runoff. Paved roads will be swept daily following construction activities.
  - The contractor will conduct periodic maintenance of erosion and sediment control measures.
  - An appropriate seed mix of native species will be planted on disturbed areas upon completion of construction.
  - Cover or apply nontoxic soil stabilizers to inactive construction areas (previously graded areas inactive for 10 days or more) that could contribute sediment to waterways.
  - Enclose and cover exposed stockpiles of dirt or other loose, granular construction materials that could contribute sediment to waterways. Material stockpiles will be located in non-traffic areas only. Side slopes will not be steeper than 2:1. All stockpile areas will be surrounded by a filter fabric fence and interceptor dike.
  - Contain soil and filter runoff from disturbed areas by berms, vegetated filters, silt fencing, straw wattle, plastic sheeting, catch basins, or other means necessary to prevent the escape of sediment from the disturbed area.
  - Use other temporary erosion control measures (such as silt fences, staked straw bales/wattles, silt/sediment basins and traps, check dams, geofabric, sandbag dikes, and temporary revegetation or other ground cover) to control erosion from disturbed areas as necessary.
  - Avoid earth or organic material from being deposited or placed where it may be directly carried into drainages.
- Minimize the extent of all areas requiring clearing, grading, revegetation, and recontouring.
- Grade areas following construction to minimize surface erosion.
- Cover bare areas with mulch and revegetate all cleared areas.

The County will also obtain a CWA Section 404 permit from USACE and Section 401 water quality certification from the Central Valley RWQCB, which may contain additional BMPs and measures to ensure the protection of water quality.

BMP 2: Avoid and Minimize the Spread of Invasive Plant Species during Project Construction

The County will require its contractor to avoid and minimize the introduction of new invasive plants and the spread of invasive plants previously documented in the project area. BMPs that may be used, though not limited to, include the following:

- Retain all fill material on-site to prevent the spread of invasive plants to uninfested areas.

- Use a weed-free source for project materials (e.g., straw wattles for erosion control that are weed-free or contain less than 1% weed seed).
- Prevent invasive plant contamination of project materials during transport and when stockpiling (e.g., by covering soil stockpiles with a heavy-duty, contractor-grade tarpaulin).
- Use native plant stock during revegetation.
- Revegetate or mulch disturbed soils within 30 days of completion of ground-disturbing activities to reduce the likelihood of invasive plant establishment.

The goal for implementation of these BMPs is to minimize the disturbance and transport of soil and vegetation to the greatest extent feasible to complete the work. Detailed information about implementing these BMPs is available in the Cal-IPC publication *Preventing the Spread of Invasive Plants: Best Management Practices for Transportation and Utility Corridors* (California Invasive Plant Council 2012).

5.4.2 Avoidance and Minimization Measures

AMM 1: Install Orange Construction Fencing between the Construction Area and Adjacent Sensitive Biological Resources

The County and/or its contractor will install orange construction fencing between the construction area and adjacent sensitive biological resources. Sensitive biological resources that occur adjacent to the construction area that could be directly affected by the project include natural communities of special concern; valley elderberry longhorn beetle and western pond turtle habitats; nest sites of Swainson's hawk and other migratory birds; roosting bats; and protected trees to be avoided.

Barrier fencing around sensitive areas will be installed as one of the first orders of work prior to equipment staging. Before construction begins, the construction contractor will work with the project engineer and a resource specialist to identify the locations for the orange construction fencing and place stakes around the sensitive resource sites to indicate these locations. The protected areas will be designated as environmentally sensitive areas, clearly identified on the construction plans, and described in the specifications. The exception to this condition is where construction barrier fencing overlaps with erosion control fencing and must be secured to prevent sediment runoff. Barrier fencing will be installed before construction activities are initiated, maintained throughout the construction period, and removed after completion of construction.

AMM 2: Retain a Qualified Biologist to Conduct Monitoring during Construction in Sensitive Habitats

The County will retain a qualified biologist to monitor construction activities once a week. The purpose of the monitoring is to ensure that avoidance and minimization measures are properly implemented to protect sensitive biological resources and the project complies with all applicable permit requirements and agency conditions of approval. The biologist will inspect the fencing around environmentally sensitive areas regularly and communicate any issues to the resident engineer or construction foreman. The contractor will be responsible for maintaining the fence

during construction and ensuring that no construction personnel, equipment, or runoff/sediment from the construction area enters environmentally sensitive areas. The monitor will complete weekly monitoring reports, and a final monitoring report will be prepared at the end of each construction season that will be submitted to the County and other overseeing agencies (i.e., CDFW, USFWS, USACE), if required

AMM 3: Conduct Environmental Awareness Training for Construction Employees

The County will retain a qualified biologist to conduct environmental awareness training for construction crews before project implementation. The awareness training will be provided to all construction personnel and brief them on the need to avoid effects on sensitive biological resources (e.g., native trees, natural communities of special concern, special-status species habitats in and adjacent to the construction area). The education program will include a brief review of the special-status species with the potential to occur in the BSA, including their life history, habitat requirements, and photographs of the species. The training will identify the portions of the BSA in which the species may occur as well as their legal status and protection. The program also will cover the restrictions and guidelines that must be followed by all construction personnel to reduce or avoid effects on these species during project implementation. This will include the steps to be taken if a sensitive species is found within the construction area (e.g., notifying the crew foreman, who will call a designated biologist). In addition, construction employees will be educated about the importance of controlling and preventing the spread of invasive plant infestations. An environmental awareness handout that describes and illustrates sensitive resources to be avoided during project construction and identifies all relevant permit conditions will be provided to each crew member. The crew foreman will be responsible for ensuring that crew members adhere to the guidelines and restrictions. Education programs will be conducted for appropriate new personnel as they are brought on the job during the construction period.

AMM 4: Design and Implement Water Conveyance Systems that Maintain the Hydrology of and Prevent Contaminants from Entering Suitable Vernal Pool Branchiopod Habitat

Concentrated flow conveyance systems identified for the proposed action may include roadside ditches, biofiltration swales, curb and gutters, dikes, overside drains, and culverts. Water conveyance systems surrounding suitable vernal pool branchiopod habitat in the project area will be evaluated, designed, and installed to maintain the existing hydrology of four seasonal wetlands that provide potential habitat for vernal pool branchiopods.

AMM 5: Fence Elderberry Shrubs to Be Protected

Elderberry shrubs/clusters within 100 feet of the construction area that will not be removed will be protected during construction. A qualified biologist (i.e., with elderberry/valley elderberry longhorn beetle experience) will mark the elderberry shrubs and clusters that will be protected during construction. Orange construction barrier fencing will be placed at the edge of the buffer areas established for each shrub or cluster. The buffer area distances will be proposed by the biologist and approved by USFWS. No construction activities will be permitted in the buffer zone, other than those activities necessary to erect the fencing. Signs will be posted along fencing for the duration of construction and contain the following information:

This area is habitat of the valley elderberry longhorn beetle, a threatened species, and must not be disturbed. This species is protected by the Endangered Species Act of 1973, as amended. Violators are subject to prosecution, fines, and imprisonment.

Temporary fences around the elderberry shrubs will be installed as the first order of work. Temporary fences will be furnished, constructed, maintained, and later removed as shown on the plans, as specified in the special provisions, and as directed by the project engineer. Temporary fencing will be 4 feet tall, commercial-quality woven polypropylene, and orange in color.

Buffer area fences around elderberry shrubs will be inspected periodically by a qualified biologist until project construction is complete or until the fences are removed, as approved by the biological monitor and the resident engineer. The contractor will be responsible for maintaining the buffer area fences around elderberry shrubs throughout construction. If required, biological inspection reports will be provided to the County and USFWS.

5.4.3 Compensatory Mitigation

Compensatory mitigation for valley elderberry longhorn beetle is described below.

Compensate for Direct Effects on Valley Elderberry Longhorn Beetle and its Habitat

Before construction begins, the County will compensate for direct effects on valley elderberry longhorn beetle by transplanting shrubs that cannot be avoided to a USFWS-approved conservation bank. The County will also purchase credits at the approved conservation bank in accordance with ratios shown in Table 5-2.

Table 5-2. Compensation for Direct Effects on Elderberry Shrubs

Number of Elderberry Shrubs	Compensation Ratio (non-riparian)	Number of Conservation Credits Required
3	1:1	3

The relocation of the elderberry shrubs will be conducted according to USFWS-approved procedures outlined in the *Framework for Assessing Impacts to the Valley Elderberry Longhorn Beetle* (U.S. Fish and Wildlife Service 2017). Elderberry shrubs within the project construction area that cannot be avoided will be transplanted during the plant's dormant phase (November through the first 2 weeks of February). A qualified biological monitor will remain on-site while the shrubs are being transplanted.

5.5 Effects of Interrelated and Interdependent Actions

Interrelated actions are actions that are part of a larger action and depend on the larger action for their justification (i.e., this project would not occur "but for" a larger project) (50 CFR 402.02). Interrelated actions are typically associated with the proposed action. Interrelated actions are those that are part of a larger action and depend on the larger action for their justification.

Interdependent actions are actions having no independent utility apart from the proposed action (50 CFR 402.02).

As described in Chapter 1, the proposed action is interrelated with the Easton Project: Easton Place and Glenborough at Easton. Development of the Easton Project is dependent on the Hazel Avenue/US 50 interchange modifications because the Final Environmental Impact Report for the Easton Project identified specific roadway improvements as mitigation measures to reduce the traffic impacts that would results from that project (County of Sacramento Department of Environmental Review and Assessment 2008). The Easton Project would also result in effects on valley elderberry longhorn beetle and its habitat. However, the effects of the Easton Project have already been assessed and accounted for during the permitting process under a separate Section 7 consultation (81420-2010-F-0714-1), and are therefore not analyzed in this BA.

5.6 Cumulative Effects

Cumulative effects include the effects of future state, tribal, local, or private actions that are reasonably certain to occur in the action area described in this BA. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to Section 7 of the FESA.

Implementation of the proposed action would result in the removal of suitable and possibly occupied (i.e., because of the presence of potential exit holes) valley elderberry longhorn beetle habitat. The removal of the habitat would contribute to the cumulative loss of habitat for the beetle in the region. However, with implementation of BMPs and protective measures (AMMs 3 and 5) that ensure that elderberry shrubs within 100 feet of the project area are protected, and with compensation for three elderberries that would be removed, the project's contribution to effects on valley elderberry longhorn beetle would not be cumulatively considerable.

5.7 Determinations

A likely to adversely affect determination was made for valley elderberry longhorn beetle. This determination was made because the proposed action would result in the removal of three elderberry shrubs that provide suitable habitat for, and may be occupied by, valley elderberry longhorn beetle. Relocation of the three elderberry shrubs could result in the disturbance of valley elderberry longhorn beetle larvae or pupae that are within the elderberry shrubs when they are transplanted. The removal of these shrubs could also reduce the population of valley elderberry longhorn beetle in the action area. Subsequent generations of elderberry beetles could also be lost if the transplanted elderberry shrubs do not survive at the conservation area. These potential effects would be compensated through transplanting the three elderberry shrubs during the shrub's dormant period to a USFWS-approved conservation bank and purchasing three conservation credits from the approved bank.

Chapter 6 References

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6.2 Personal Communication

Arnold, Richard A., Ph.D. Entomologist. Entomological Consulting Services Ltd., Pleasant Hill, CA. August 22 and 23, 2011–written comments on the draft supplemental biological assessment for PG&E's Valley Elderberry Longhorn Beetle Conservation Program.

Appendix A Database Searches and Species Lists

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish And Wildlife Office
Federal Building
2800 Cottage Way, Room W-2605
Sacramento, CA 95825-1846
Phone: (916) 414-6600 Fax: (916) 414-6713

In Reply Refer To: October 16, 2018
Consultation Code: 08ESMF00-2016-SLI-1181
Event Code: 08ESMF00-2019-E-00347
Project Name: US 50/Hazel Avenue Interchange Project

Subject: Updated list of threatened and endangered species that may occur in your proposed project location, and/or may be affected by your proposed project

To Whom It May Concern:

The enclosed species list identifies threatened, endangered, proposed and candidate species, as well as proposed and final designated critical habitat, under the jurisdiction of the U.S. Fish and Wildlife Service (Service) that may occur within the boundary of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the Service under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

Please follow the link below to see if your proposed project has the potential to affect other species or their habitats under the jurisdiction of the National Marine Fisheries Service:

http://www.nwr.noaa.gov/protected_species/species_list/species_lists.html

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Please feel free to contact us if you need more current information or assistance regarding the potential impacts to federally proposed, listed, and candidate species and federally designated and proposed critical habitat. Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally as desired. The Service recommends that verification be completed by visiting the ECOS-IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through the ECOS-IPaC system by completing the same process used to receive the enclosed list.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the Act and its implementing regulations (50 CFR 402 *et seq.*), Federal agencies are required to utilize their authorities to carry out programs for the conservation of threatened and endangered species and to determine whether projects may affect threatened and endangered species and/or designated critical habitat.

A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2)(c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.

If a Federal agency determines, based on the Biological Assessment or biological evaluation, that listed species and/or designated critical habitat may be affected by the proposed project, the agency is required to consult with the Service pursuant to 50 CFR 402. In addition, the Service recommends that candidate species, proposed species and proposed critical habitat be addressed within the consultation. More information on the regulations and procedures for section 7 consultation, including the role of permit or license applicants, can be found in the "Endangered Species Consultation Handbook" at:

http://www.fws.gov/endangered/esa-library/pdf/TOC-GLOS.PDF

Please be aware that bald and golden eagles are protected under the Bald and Golden Eagle Protection Act (16 U.S.C. 668 *et seq.*), and projects affecting these species may require development of an eagle conservation plan (http://www.fws.gov/windenergy/eagle_guidance.html). Additionally, wind energy projects should follow the wind energy guidelines (http://www.fws.gov/windenergy/) for minimizing impacts to migratory birds and bats.

Guidance for minimizing impacts to migratory birds for projects including communications towers (e.g., cellular, digital television, radio, and emergency broadcast) can be found at: http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/towers.htm; http://www.towerkill.com; and http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/comtow.html.

We appreciate your concern for threatened and endangered species. The Service encourages Federal agencies to include conservation of threatened and endangered species into their project planning to further the purposes of the Act. Please include the Consultation Tracking Number in the header of this letter with any request for consultation or correspondence about your project that you submit to our office.

Attachment(s):

- Official Species List

Official Species List

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action".

This species list is provided by:

Sacramento Fish And Wildlife Office
Federal Building
2800 Cottage Way, Room W-2605
Sacramento, CA 95825-1846
(916) 414-6600

Project Summary

Consultation Code: 08ESMF00-2016-SLI-1181

Event Code: 08ESMF00-2019-E-00347

Project Name: US 50/Hazel Avenue Interchange Project

Project Type: TRANSPORTATION

Project Description: Modify interchange and extend Hazel Avenue.

Project Location:

Approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/place/38.631672622086185N121.21614875411532W



Counties: Sacramento, CA

Endangered Species Act Species

There is a total of 10 threatened, endangered, or candidate species on this species list.

Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species.

IPaC does not display listed species or critical habitats under the sole jurisdiction of NOAA Fisheries[1], as USFWS does not have the authority to speak on behalf of NOAA and the Department of Commerce.

See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

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1. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

Reptiles

NAME	STATUS
Giant Garter Snake *Thamnophis gigas* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/4482	Threatened

Amphibians

NAME	STATUS
California Red-legged Frog *Rana draytonii* There is **final** critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/2891	Threatened
California Tiger Salamander *Ambystoma californiense* Population: U.S.A. (Central CA DPS) There is **final** critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/2076	Threatened

Fishes

NAME	STATUS
Delta Smelt *Hypomesus transpacificus*	Threatened

There is **final** critical habitat for this species. Your location is outside the critical habitat.
Species profile: https://ecos.fws.gov/ecp/species/321

Insects

NAME	STATUS
Valley Elderberry Longhorn Beetle *Desmocerus californicus dimorphus*	Threatened

There is **final** critical habitat for this species. Your location is outside the critical habitat.
Species profile: https://ecos.fws.gov/ecp/species/7850
Habitat assessment guidelines:
https://ecos.fws.gov/ipac/guideline/assessment/population/436/office/11420.pdf

Crustaceans

NAME	STATUS
Conservancy Fairy Shrimp *Branchinecta conservatio*	Endangered

There is **final** critical habitat for this species. Your location is outside the critical habitat.
Species profile: https://ecos.fws.gov/ecp/species/8246

Vernal Pool Fairy Shrimp *Branchinecta lynchi*	Threatened

There is **final** critical habitat for this species. Your location is outside the critical habitat.
Species profile: https://ecos.fws.gov/ecp/species/498

Vernal Pool Tadpole Shrimp *Lepidurus packardi*	Endangered

There is **final** critical habitat for this species. Your location is outside the critical habitat.
Species profile: https://ecos.fws.gov/ecp/species/2246

Flowering Plants

NAME	STATUS
Sacramento Orcutt Grass *Orcuttia viscida*	Endangered

There is **final** critical habitat for this species. Your location is outside the critical habitat.
Species profile: https://ecos.fws.gov/ecp/species/5507

Slender Orcutt Grass *Orcuttia tenuis*	Threatened

There is **final** critical habitat for this species. Your location is outside the critical habitat.
Species profile: https://ecos.fws.gov/ecp/species/1063

Critical habitats

THERE ARE NO CRITICAL HABITATS WITHIN YOUR PROJECT AREA UNDER THIS OFFICE'S JURISDICTION.

Sorvari, Tina

Subject: FW: Federal Highway Administration – California Division, Hazel Avenue/U.S. Route 50 Interchange Project

Hello- I am requesting an ESA species list. Please see below. Thank you.

Federal Agency: Federal Highway Administration – California Division
Federal Agency Address: 650 Capitol Mall, Suite 4-100, Sacramento, CA 95814 4708
Non-Federal Agency Representative: California Department of Transportation
Non-Federal Agency Representative Address: 703 B Street, Marysville, CA 95901
Project Name: Hazel Avenue/U.S. Route 50 Interchange Project

Point-of-Contact Tina Sorvari – ICF 916-231-9738 tina.sorvari@icf.com

Quad Name **Folsom**
Quad Number **38121-F2**

ESA Anadromous Fish

SONCC Coho ESU (T) -
CCC Coho ESU (E) -
CC Chinook Salmon ESU (T) -
CVSR Chinook Salmon ESU (T) - **X**
SRWR Chinook Salmon ESU (E) -
NC Steelhead DPS (T) -
CCC Steelhead DPS (T) -
SCCC Steelhead DPS (T) -
SC Steelhead DPS (E) -
CCV Steelhead DPS (T) - **X**
Eulachon (T) -
sDPS Green Sturgeon (T) -

ESA Anadromous Fish Critical Habitat

SONCC Coho Critical Habitat -
CCC Coho Critical Habitat -
CC Chinook Salmon Critical Habitat -
CVSR Chinook Salmon Critical Habitat -
SRWR Chinook Salmon Critical Habitat -
NC Steelhead Critical Habitat -
CCC Steelhead Critical Habitat -
SCCC Steelhead Critical Habitat -

SC Steelhead Critical Habitat -
CCV Steelhead Critical Habitat - X
Eulachon Critical Habitat -
sDPS Green Sturgeon Critical Habitat -

ESA Marine Invertebrates

Range Black Abalone (E) -
Range White Abalone (E) -

ESA Marine Invertebrates Critical Habitat

Black Abalone Critical Habitat -

ESA Sea Turtles

East Pacific Green Sea Turtle (T) -
Olive Ridley Sea Turtle (T/E) -
Leatherback Sea Turtle (E) -
North Pacific Loggerhead Sea Turtle (E) -

ESA Whales

Blue Whale (E) -
Fin Whale (E) -
Humpback Whale (E) -
Southern Resident Killer Whale (E) -
North Pacific Right Whale (E) -
Sei Whale (E) -
Sperm Whale (E) -

ESA Pinnipeds

Guadalupe Fur Seal (T) -
Steller Sea Lion Critical Habitat -

Essential Fish Habitat

Coho EFH -
Chinook Salmon EFH - X
Groundfish EFH -
Coastal Pelagics EFH -
Highly Migratory Species EFH -

MMPA Species (See list at left)

ESA and MMPA Cetaceans/Pinnipeds
See list at left and consult the NMFS Long Beach office
562-980-4000

MMPA Cetaceans -
MMPA Pinnipeds -

Sorvari, Tina

From: NMFSWCRCA Specieslist - NOAA Service Account <nmfswcrca.specieslist+canned.response@noaa.gov>
Sent: Wednesday, October 17, 2018 10:51 AM
To: Sorvari, Tina
Subject: Re: Federal Highway Administration – California Division, Hazel Avenue/U.S. Route 50 Interchange Project

Receipt of this message confirms that NMFS has received your email to nmfswcrca.specieslist@noaa.gov. If you are a federal agency (or representative) and have followed the steps outlined on the California Species List Tools web page (http://www.westcoast.fisheries.noaa.gov/maps_data/california_species_list_tools.html), you have generated an official Endangered Species Act species list.

Messages sent to this email address are not responded to directly. For project specific questions, please contact your local NMFS office.

Northern California/Klamath (Arcata) 707-822-7201

North-Central Coast (Santa Rosa) 707-387-0737

Southern California (Long Beach) 562-980-4000

California Central Valley (Sacramento) 916-930-3600

Selected Elements by Scientific Name

California Department of Fish and Wildlife

California Natural Diversity Database

Query Criteria: Quad IS (Carmichael (3812153) OR Buffalo Creek (3812152) OR Citrus Heights (3812163) OR Clarksville (3812161) OR Folsom (3812162) OR Folsom SE (3812151))
 AND Taxonomic Group IS (Dune OR Scrub OR Herbaceous OR Marsh OR Riparian OR Woodland OR Forest OR Alpine OR Inland Waters OR Marine OR Estuarine OR Riverine OR Palustrine OR Ferns OR Gymnosperms OR Monocots OR Dicots OR Lichens OR Bryophytes)

Hazel Avenue/US 50 Interchange Project

Selected Elements by Scientific Name

California Department of Fish and Wildlife

California Natural Diversity Database

Species	Element Code	Federal Status	State Status	Global Rank	State Rank	Rare Plant Rank/CDFW SSC or FP
Ceanothus roderickii Pine Hill ceanothus	PDRHA04190	Endangered	Rare	G1	S1	1B.1
Chlorogalum grandiflorum Red Hills soaproot	PMLIL0G020	None	None	G3	S3	1B.2
Clarkia biloba ssp. brandegeeae Brandegee's clarkia	PDONA05053	None	None	G4G5T4	S4	4.2
Crocanthemum suffrutescens Bisbee Peak rush-rose	PDCIS020F0	None	None	G2?Q	S2?	3.2
Downingia pusilla dwarf downingia	PDCAM060C0	None	None	GU	S2	2B.2
Eryngium pinnatisectum Tuolumne button-celery	PDAPI0Z0P0	None	None	G2	S2	1B.2
Fremontodendron decumbens Pine Hill flannelbush	PDSTE03030	Endangered	Rare	G1	S1	1B.2
Fritillaria agrestis stinkbells	PMLIL0V010	None	None	G3	S3	4.2
Galium californicum ssp. sierrae El Dorado bedstraw	PDRUB0N0E7	Endangered	Rare	G5T1	S1	1B.2
Gratiola heterosepala Boggs Lake hedge-hyssop	PDSCR0R060	None	Endangered	G2	S2	1B.2
Juncus leiospermus var. ahartii Ahart's dwarf rush	PMJUN011L1	None	None	G2T1	S1	1B.2
Legenere limosa legenere	PDCAM0C010	None	None	G2	S2	1B.1
Navarretia myersii ssp. myersii pincushion navarretia	PDPLM0C0X1	None	None	G2T2	S2	1B.1
Northern Hardpan Vernal Pool Northern Hardpan Vernal Pool	CTT44110CA	None	None	G3	S3.1	
Northern Volcanic Mud Flow Vernal Pool Northern Volcanic Mud Flow Vernal Pool	CTT44132CA	None	None	G1	S1.1	
Orcuttia tenuis slender Orcutt grass	PMPOA4G050	Threatened	Endangered	G2	S2	1B.1
Orcuttia viscida Sacramento Orcutt grass	PMPOA4G070	Endangered	Endangered	G1	S1	1B.1
Packera layneae Layne's ragwort	PDAST8H1V0	Threatened	Rare	G2	S2	1B.2
Sagittaria sanfordii Sanford's arrowhead	PMALI040Q0	None	None	G3	S3	1B.2
Valley Needlegrass Grassland Valley Needlegrass Grassland	CTT42110CA	None	None	G3	S3.1	
Wyethia reticulata El Dorado County mule ears	PDAST9X0D0	None	None	G2	S2	1B.2

Record Count: 21

Selected Elements by Common Name

California Department of Fish and Wildlife

California Natural Diversity Database

Query Criteria: Quad IS (Carmichael (3812153) OR Buffalo Creek (3812152) OR Citrus Heights (3812163) OR Clarksville (3812161) OR Folsom (3812162) OR Folsom SE (3812151))
 AND Taxonomic Group IS (Fish OR Amphibians OR Reptiles OR Birds OR Mammals OR Mollusks OR Arachnids OR Crustaceans OR Insects)

Hazel Avenue/US 50 Interchange Project

Species	Element Code	Federal Status	State Status	Global Rank	State Rank	Rare Plant Rank/CDFW SSC or FP
American badger *Taxidea taxus*	AMAJF04010	None	None	G5	S3	SSC
An andrenid bee *Andrena subapasta*	IIHYM35210	None	None	G1G2	S1S2	
bald eagle *Haliaeetus leucocephalus*	ABNKC10010	Delisted	Endangered	G5	S3	FP
bank swallow *Riparia riparia*	ABPAU08010	None	Threatened	G5	S2	
Blennosperma vernal pool andrenid bee *Andrena blennospermatis*	IIHYM35030	None	None	G2	S2	
burrowing owl *Athene cunicularia*	ABNSB10010	None	None	G4	S3	SSC
California black rail *Laterallus jamaicensis coturniculus*	ABNME03041	None	Threatened	G3G4T1	S1	FP
California linderiella *Linderiella occidentalis*	ICBRA06010	None	None	G2G3	S2S3	
California red-legged frog *Rana draytonii*	AAABH01022	Threatened	None	G2G3	S2S3	SSC
Cooper's hawk *Accipiter cooperii*	ABNKC12040	None	None	G5	S4	WL
double-crested cormorant *Phalacrocorax auritus*	ABNFD01020	None	None	G5	S4	WL
ferruginous hawk *Buteo regalis*	ABNKC19120	None	None	G4	S3S4	WL
foothill yellow-legged frog *Rana boylii*	AAABH01050	None	Candidate Threatened	G3	S3	SSC
giant gartersnake *Thamnophis gigas*	ARADB36150	Threatened	Threatened	G2	S2	
golden eagle *Aquila chrysaetos*	ABNKC22010	None	None	G5	S3	FP
grasshopper sparrow *Ammodramus savannarum*	ABPBXA0020	None	None	G5	S3	SSC
great blue heron *Ardea herodias*	ABNGA04010	None	None	G5	S4	
great egret *Ardea alba*	ABNGA04040	None	None	G5	S4	

Species	Element Code	Federal Status	State Status	Global Rank	State Rank	Rare Plant Rank/CDFW SSC or FP
hairy water flea *Dumontia oregonensis*	ICBRA23010	None	None	G1G3	S1	
merlin *Falco columbarius*	ABNKD06030	None	None	G5	S3S4	WL
midvalley fairy shrimp *Branchinecta mesovallensis*	ICBRA03150	None	None	G2	S2S3	
North American porcupine *Erethizon dorsatum*	AMAFJ01010	None	None	G5	S3	
pallid bat *Antrozous pallidus*	AMACC10010	None	None	G5	S3	SSC
Ricksecker's water scavenger beetle *Hydrochara rickseckeri*	IICOL5V010	None	None	G2?	S2?	
silver-haired bat *Lasionycteris noctivagans*	AMACC02010	None	None	G5	S3S4	
steelhead - Central Valley DPS *Oncorhynchus mykiss irideus pop. 11*	AFCHA0209K	Threatened	None	G5T2Q	S2	
Swainson's hawk *Buteo swainsoni*	ABNKC19070	None	Threatened	G5	S3	
tricolored blackbird *Agelaius tricolor*	ABPBXB0020	None	Candidate Endangered	G2G3	S1S2	SSC
valley elderberry longhorn beetle *Desmocerus californicus dimorphus*	IICOL48011	Threatened	None	G3T2	S2	
vernal pool fairy shrimp *Branchinecta lynchi*	ICBRA03030	Threatened	None	G3	S3	
vernal pool tadpole shrimp *Lepidurus packardi*	ICBRA10010	Endangered	None	G4	S3S4	
western pond turtle *Emys marmorata*	ARAAD02030	None	None	G3G4	S3	SSC
western spadefoot *Spea hammondii*	AAABF02020	None	None	G3	S3	SSC
white-tailed kite *Elanus leucurus*	ABNKC06010	None	None	G5	S3S4	FP

Record Count: 34

CNPS California Native Plant Society

Inventory of Rare and Endangered Plants

Plant List

20 matches found. *Click on scientific name for details*

Search Criteria

Found in Quads 3812163, 3812162, 3812161, 3812153 3812152 and 3812151;

Modify Search Criteria | Export to Excel | Modify Columns | Modify Sort | Display Photos

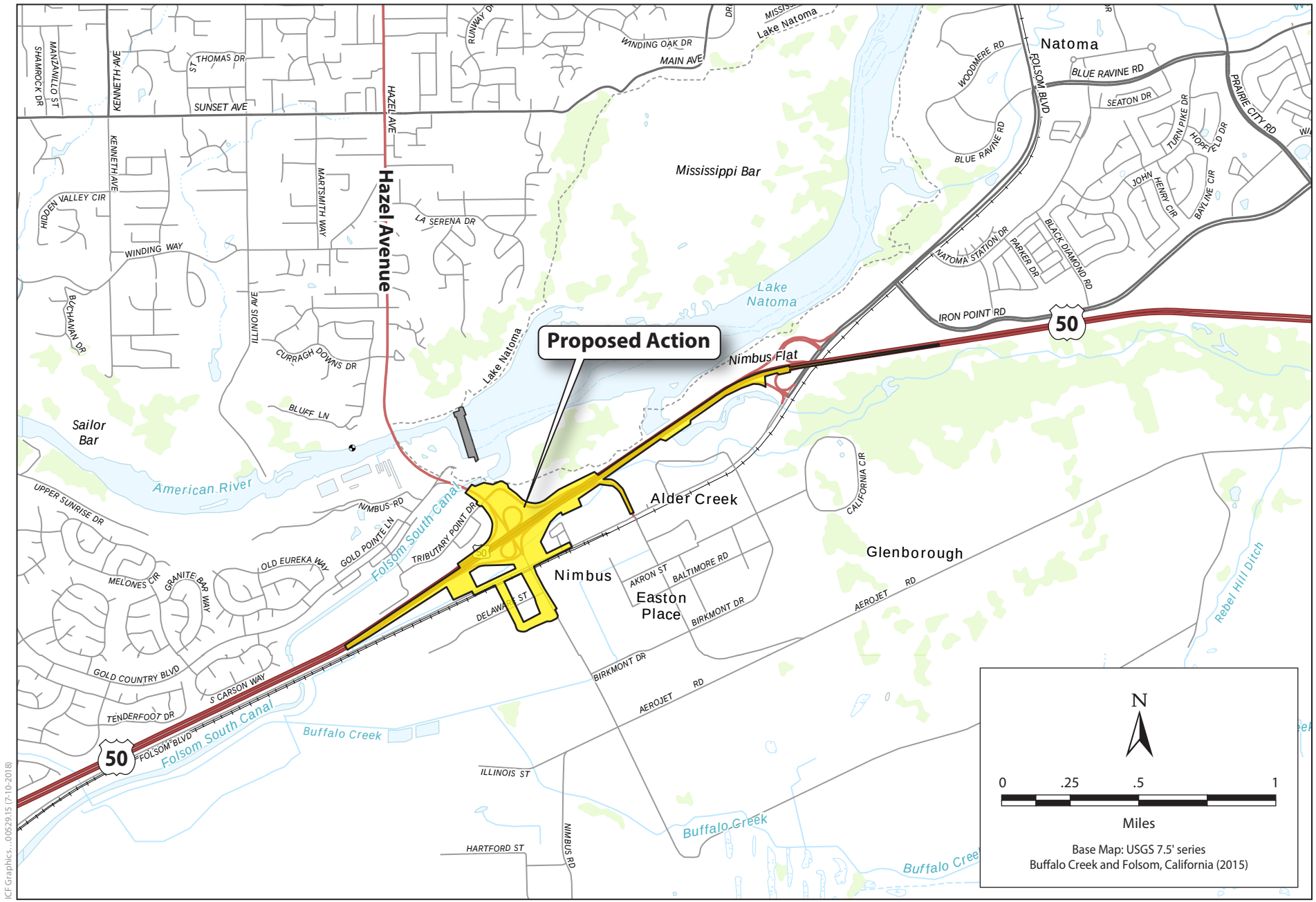
Scientific Name	Common Name	Family	Lifeform	Blooming Period	CA Rare Plant Rank	State Rank	Global Rank
Calandrinia breweri	Brewer's calandrinia	Montiaceae	annual herb	(Jan)Mar-Jun	4.2	S4	G4
Ceanothus roderickii	Pine Hill ceanothus	Rhamnaceae	perennial evergreen shrub	Apr-Jun	1B.1	S1	G1
Chlorogalum grandiflorum	Red Hills soaproot	Agavaceae	perennial bulbiferous herb	May-Jun	1B.2	S3	G3
Clarkia biloba ssp. brandegeeae	Brandegee's clarkia	Onagraceae	annual herb	May-Jul	4.2	S4	G4G5T4
Crocanthemum suffrutescens	Bisbee Peak rush-rose	Cistaceae	perennial evergreen shrub	Apr-Aug	3.2	S2?	G2?Q
Downingia pusilla	dwarf downingia	Campanulaceae	annual herb	Mar-May	2B.2	S2	GU
Eriophyllum jepsonii	Jepson's woolly sunflower	Asteraceae	perennial herb	Apr-Jun	4.3	S3	G3
Eryngium pinnatisectum	Tuolumne button-celery	Apiaceae	annual / perennial herb	May-Aug	1B.2	S2	G2
Fremontodendron decumbens	Pine Hill flannelbush	Malvaceae	perennial evergreen shrub	Apr-Jul	1B.2	S1	G1
Fritillaria agrestis	stinkbells	Liliaceae	perennial bulbiferous herb	Mar-Jun	4.2	S3	G3
Galium californicum ssp. sierrae	El Dorado bedstraw	Rubiaceae	perennial herb	May-Jun	1B.2	S1	G5T1
Gratiola heterosepala	Boggs Lake hedge-hyssop	Plantaginaceae	annual herb	Apr-Aug	1B.2	S2	G2
Juncus leiospermus var. ahartii	Ahart's dwarf rush	Juncaceae	annual herb	Mar-May	1B.2	S1	G2T1
Legenere limosa	legenere	Campanulaceae	annual herb	Apr-Jun	1B.1	S2	G2
Navarretia myersii ssp. myersii	pincushion navarretia	Polemoniaceae	annual herb	Apr-May	1B.1	S2	G2T2
Orcuttia tenuis	slender Orcutt grass	Poaceae	annual herb	May-Sep(Oct)	1B.1	S2	G2
Orcuttia viscida	Sacramento Orcutt grass	Poaceae	annual herb	Apr-Jul(Sep)	1B.1	S1	G1
Packera layneae	Layne's ragwort	Asteraceae	perennial herb	Apr-Aug	1B.2	S2	G2
Sagittaria sanfordii	Sanford's arrowhead	Alismataceae	perennial rhizomatous herb (emergent)	May-Oct(Nov)	1B.2	S3	G3
Wyethia reticulata	El Dorado County mule ears	Asteraceae	perennial herb	Apr-Aug	1B.2	S2	G2

Suggested Citation

California Native Plant Society, Rare Plant Program. 2018. Inventory of Rare and Endangered Plants of California (online edition, v8-03 0.39). Website http://www.rareplants.cnps.org [accessed 17 October 2018].

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Appendix B Figures



ICF Graphics...00529.15 (7-10-2018)

Figure 1
Location of the Proposed Action



Figure 2
Components of the Proposed Action
U.S. 50/Hazel Avenue Interchange Project

121°13'40"W

121°13'30"W

121°13'20"W

38°37'40"N

38°37'30"N

50

Folsom Blvd

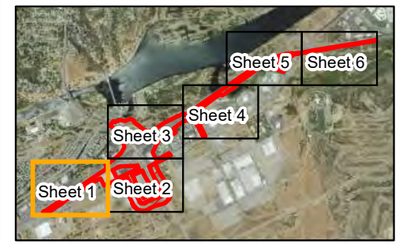
Hazel Avenue / U.S. 50 Interchange Project
January 2019
Sheet 1 of 6

Legend

- Project Area
- Action Area

Landcover

- Annual Grassland
- Developed
- Landscaped



0 50 100 200
Feet

1 inch = 200 feet

Notes:

Base Map Source: ICF and ECORP
Imagery Source: NAIP 2014
USGS Topo Quad: Folsom and Buffalo Creek
PLSS: Rio De Los Americanos Land Grant

Prepared By: ICF International
Delineated By: L. Webber
Delineation Date: May 31. 2016
Drawn By: A. Angier

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Figure 3
Action Area and Land Cover Types in the Project Area

121°13'10"W
121°13'0"W
121°12'50"W
38°37'40"N
38°37'30"N
50
Folsom Blvd
Nimbus Rd
1
4
5
6
7
8
9
10
11
12
See Inset
Inset Map

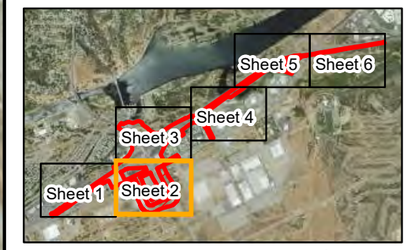
Hazel Avenue / U.S. 50 Interchange Project
January 2019
Sheet 2 of 6

Legend

- Project Area
- Indirect Effects Assessment Area for Branchiopods
- Action Area
- Elderberry Shrub

Landcover

- Annual Grassland
- Developed
- Ditch
- Landscaped
- Fremont Cottonwood-Oak Woodland
- Planted Oak Woodland
- Seasonal Wetland



0 50 100 200
Feet
1 inch = 200 feet

Notes:
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Imagery Source: NAIP 2014
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PLSS: Rio De Los Americanos Land Grant

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Delineated By: L. Webber
Delineation Date: May 31. 2016
Drawn By: A. Angier

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Figure 3
Action Area and Land Cover Types in the Project Area

121°13'10"W
121°13'0"W
121°12'50"W
38°38'0"N
38°37'50"N
Hazel Ave
Folsom Blvd
50
2
13

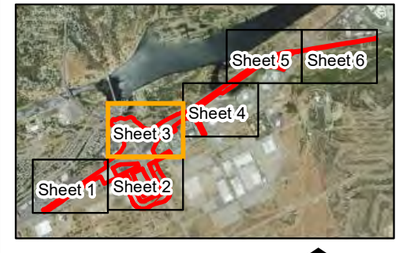
Hazel Avenue / U.S. 50 Interchange Project
January 2019
Sheet 3 of 6

Legend

- Project Area
- Action Area
- Elderberry Shrub

Landcover

- Annual Grassland
- Developed
- Ephemeral Drainage
- Landscaped
- Planted Oak Woodland
- Seasonal Wetland



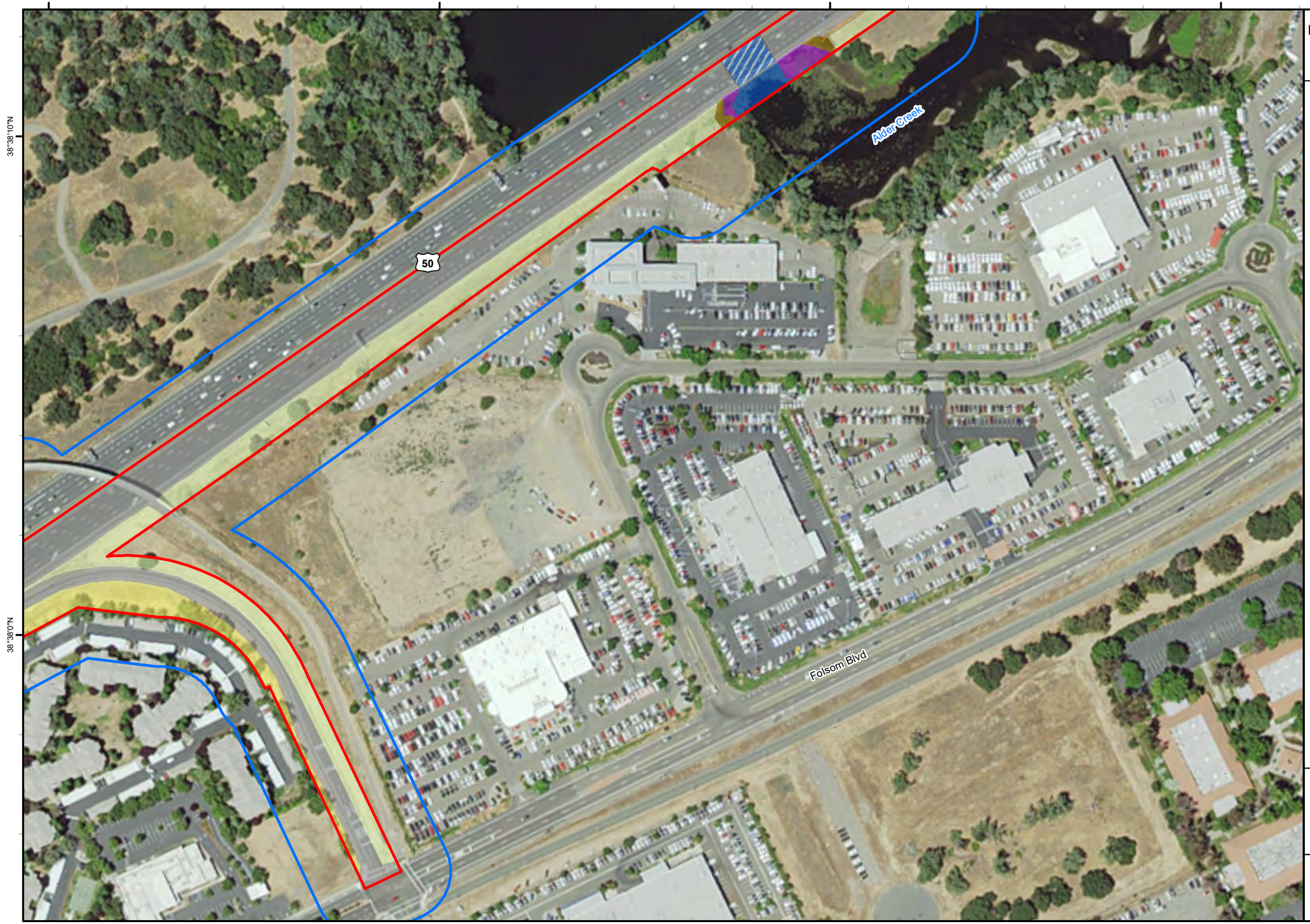
0 50 100 200
Feet
1 inch = 200 feet

Notes:
Base Map Source: ICF and ECORP
Imagery Source: NAIP 2014
USGS Topo Quad: Folsom and Buffalo Creek
PLSS: Rio De Los Americanos Land Grant

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Delineated By: L. Webber
Delineation Date: May 31. 2016
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Figure 3
Action Area and Land Cover Types in the Project Area



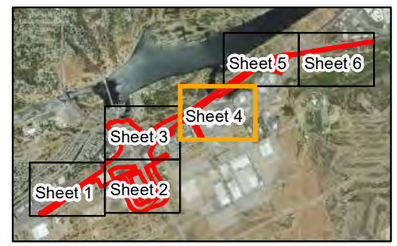
Hazel Avenue / U.S. 50 Interchange Project
January 2019
Sheet 4 of 6

Legend

- Project Area
- Action Area

Landcover

- Annual Grassland
- Developed
- Ditch
- Emergent Wetland
- Landscaped
- Perennial Drainage
- Perennial Drainage (Culverted)
- Valley Foothill Riparian



0 50 100 200
Feet

1 inch = 200 feet

Notes:

Base Map Source: ICF and ECORP
Imagery Source: NAIP 2014
USGS Topo Quad: Folsom and Buffalo Creek
PLSS: Rio De Los Americanos Land Grant

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Drawn By: A. Angier

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Figure 3
Action Area and Land Cover Types in the Project Area

121°12'20"W
121°12'10"W
121°12'0"W
121°11'50"W
38°38'30"N
38°38'20"N
50
Folsom Blvd
3

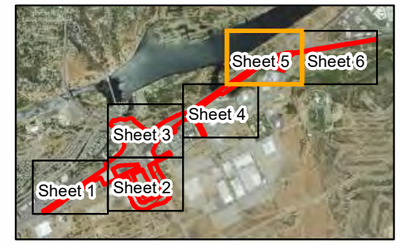
Hazel Avenue / U.S. 50 Interchange Project
January 2019
Sheet 5 of 6

Legend

- Project Area
- Action Area
- Elderberry Shrub

Landcover

- Annual Grassland
- Developed
- Ditch
- Ephemeral Drainage



0 50 100 200
Feet
1 inch = 200 feet

Notes:
Base Map Source: ICF and ECORP
Imagery Source: NAIP 2014
USGS Topo Quad: Folsom and Buffalo Creek
PLSS: Rio De Los Americanos Land Grant

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Drawn By: A. Angier

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Figure 3
Action Area and Land Cover Types in the Project Area

121°11'40"W

121°11'30"W

121°11'20"W

38°38'30"N

38°38'20"N

Hazel Avenue / U.S. 50 Interchange Project
January 2019
Sheet 6 of 6

Legend

- Project Area
- Action Area

Landcover

- Annual Grassland
- Developed



0 50 100 200
Feet

1 inch = 200 feet

Notes:

Base Map Source: ICF and ECORP
Imagery Source: NAIP 2014
USGS Topo Quad: Folsom and Buffalo Creek
PLSS: Rio De Los Americanos Land Grant

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Figure 3
Action Area and Land Cover Types in the Project Area

121°13'40"W

121°13'30"W

121°13'20"W

38°37'40"N

38°37'30"N

50

Folsom Blvd

Hazel Avenue / U.S. 50 Interchange Project
January 2019
Sheet 1 of 6

Legend

Project Area

Action Area

Proposed Action

Limits of Permanent Disturbance

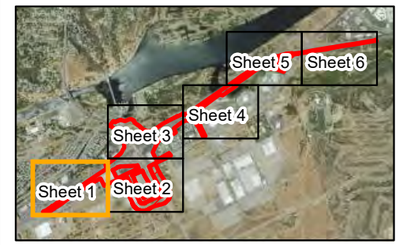
Limits of Temporary Disturbance

Landcover

Annual Grassland

Developed

Landscaped



0 50 100 200

Feet

1 inch = 200 feet

Notes:

Base Map Source: ICF and ECORP
Imagery Source: NAIP 2014
USGS Topo Quad: Folsom and Buffalo Creek
PLSS: Rio De Los Americanos Land Grant

Prepared By: ICF International
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Delineation Date: May 31. 2016
Drawn By: A. Angier

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Figure 4
Effects of the Proposed Action

121°13'10"W
121°13'0"W
121°12'50"W
38°37'40"N
38°37'30"N
50
Folsom Blvd
Nimbus Rd
1
4
5
6
7
8
9
10
11
12

Hazel Avenue / U.S. 50 Interchange Project
January 2019
Sheet 2 of 6

Legend

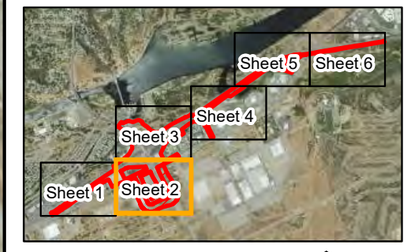
- Project Area
- Action Area

Proposed Action

- Limits of Permanent Disturbance
- Limits of Temporary Disturbance
- Elderberry Shrub

Landcover

- Annual Grassland
- Developed
- Ditch
- Landscaped
- Fremont Cottonwood-Oak Woodland
- Planted Oak Woodland
- Seasonal Wetland



0 50 100 200
Feet
1 inch = 200 feet

Notes:
Base Map Source: ICF and ECORP
Imagery Source: NAIP 2014
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Figure 4
Effects of the Proposed Action

121°13'10"W
121°13'0"W
121°12'50"W
38°38'0"N
38°37'50"N
Hazel Ave
Folsom Blvd
50
This elderberry will be fenced and protected with orange construction barrier fencing during construction (see Conservation Measure 3)
2
13

Hazel Avenue / U.S. 50 Interchange Project
January 2019
Sheet 3 of 6

Legend

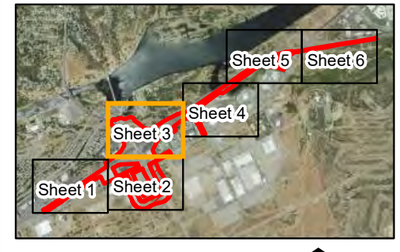
- Project Area
- Action Area

Proposed Action

- Limits of Permanent Disturbance
- Limits of Temporary Disturbance
- Elderberry Shrub

Landcover

- Annual Grassland
- Developed
- Ephemeral Drainage
- Landscaped
- Planted Oak Woodland
- Seasonal Wetland



0 50 100 200
Feet
1 inch = 200 feet

Notes:
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Figure 4
Effects of the Proposed Action

121°12'40"W
121°12'30"W
121°12'20"W
121°12'10"W
38°38'10"N
38°38'0"N
50
Alder Creek
Folsom Blvd

Hazel Avenue / U.S. 50 Interchange Project
January 2019
Sheet 4 of 6

Legend

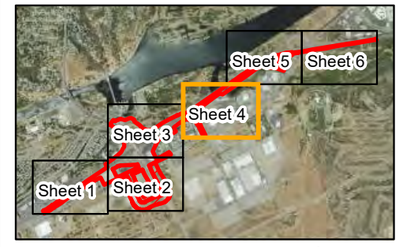
- Project Area
- Action Area

Proposed Action

- Limits of Permanent Disturbance
- Limits of Temporary Disturbance

Landcover

- Annual Grassland
- Developed
- Ditch
- Emergent Wetland
- Landscaped
- Perennial Drainage
- Perennial Drainage (Culverted)
- Valley Foothill Riparian



0 50 100 200
Feet
1 inch = 200 feet

Notes:

Base Map Source: ICF and ECORP
Imagery Source: NAIP 2014
USGS Topo Quad: Folsom and Buffalo Creek
PLSS: Rio De Los Americanos Land Grant

Prepared By: ICF International
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Figure 4
Effects of the Proposed Action

121°12'20"W
121°12'10"W
121°12'0"W
121°11'50"W
38°38'30"N
38°38'20"N
50
Folsom Blvd
3

Hazel Avenue / U.S. 50 Interchange Project
January 2019
Sheet 5 of 6

Legend

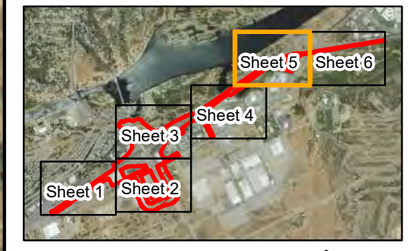
Project Area
Action Area

Proposed Action

Limits of Permanent Disturbance
Limits of Temporary Disturbance
Elderberry Shrub

Landcover

Annual Grassland
Developed
Ditch
Ephemeral Drainage



0 50 100 200
Feet
1 inch = 200 feet

Notes:
Base Map Source: ICF and ECORP
Imagery Source: NAIP 2014
USGS Topo Quad: Folsom and Buffalo Creek
PLSS: Rio De Los Americanos Land Grant

Prepared By: ICF International
Delineated By: L. Webber
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Figure 4
Effects of the Proposed Action

121°11'40"W

121°11'30"W

121°11'20"W

38°38'30"N

38°38'20"N

Hazel Avenue / U.S. 50 Interchange Project
January 2019
Sheet 6 of 6

Legend

- Project Area
- Action Area

Proposed Action

- Limits of Permanent Disturbance

Landcover

- Annual Grassland
- Developed



0 50 100 200
Feet

1 inch = 200 feet

Notes:

Base Map Source: ICF and ECORP
Imagery Source: NAIP 2014
USGS Topo Quad: Folsom and Buffalo Creek
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Figure 4
Effects of the Proposed Action

Appendix C Representative Photographs of Elderberry Shrubs and Potential Valley Elderberry Longhorn Beetle Exit Holes



Photo 1. Elderberry #1.



Photo 2. Potential exit hole at elderberry #1.

Graphics ... 00529.15 (10/19/18) AB

Appendix C
Representative Photographs of Elderberry Shrubs and Potential Valley Elderberry Longhorn Beetle Exit Holes



Photo 3. Elderberry #2.



Photo 4. Potential exit hole at elderberry #2.

Graphics ... 00529.15 (10/19/18) AB

Appendix C
Representative Photographs of Elderberry Shrubs and Potential Valley Elderberry Longhorn Beetle Exit Holes



Photo 5. Elderberry #3.



Photo 6. Potential exit hole at elderberry #3.

Graphics ... 00529.15 (10/19/18) AB

Appendix C
Representative Photographs of Elderberry Shrubs and Potential Valley Elderberry Longhorn Beetle Exit Holes



Photo 7. Elderberry #4.

Graphics ... 00529.15 (10/19/18) AB

Appendix C
Representative Photographs of Elderberry Shrubs and Potential Valley Elderberry Longhorn Beetle Exit Holes

Appendix D Plant and Animal Species Observed during Field Surveys

Appendix D Plant and Animal Species Observed during Field Surveys

Table D-1. Plant Species Observed in the Biological Study Area

Scientific Name	Common Name
Acmispon americanus var. *americanus* [*Lotus purshianus*]	Spanish lotus
Aesculus californica	Buckeye
Aira caryophyllea	Silver hairgrass
Alnus rhombifolia	White alder
Amsinckia menziesii	Small flowered fiddleneck
*Avena barbata**	Slender wild oat
*Avena fatua**	Wild oat
Azolla filiculoides	American water fern
Baccharis pilularis	Coyote brush
*Brassica nigra**	Black mustard
*Bromus diandrus**	Ripgut brome
*Bromus hordeaceus**	Soft chess
Bromus madritensis ssp. *madritensis*	Foxtail chess
Bromus madritensis ssp. *rubens**	Red brome
*Carduus pycnocephalus**	Italian thistle
Castilleja attenuata	Valley tassels
Ceanothus lemmonii	Lemmon's ceanothus
*Centaurea melitensis**	Maltese star thistle
*Centaurea solstitialis**	Yellow star-thistle
Centaurium tenuiflorum	Slender centaury
Centromadia fitchii	Spikeweed
Cercis occidentalis	Western redbud
Chlorogalum pomeridianum var. *pomeridianum*	Common soaproot
*Cirsium arvense**	Bull thistle
Clarkia unguiculata	Elegant clarkia
Claytonia perfoliata	Miner's lettuce
*Conium maculatum**	Poison hemlock
*Convolvulus arvensis**	Bindweed
*Cortaderia jubata**	Pampas grass
Cyperus eragrostis	Tall flatsedge
Dichelostemma capitatum spp. *capitatum*	Blue dicks
Epilobium brachycarpum	Annual fireweed
Erigeron canadensis	Canada horseweed
Erodium botrys	Big heronbill
*Erodium cicutarium**	Red stemmed filaree
Eschscholzia californica	California poppy
Eucalyptus sp.	Eucalyptus
Festuca [*Vulpia*] *myuros**	Rattail six weeks grass
Festuca perennis [*Lolium perenne*]*	Italian ryegrass
*Ficus carica**	Edible fig

Scientific Name	Common Name
*Foeniculum vulgare**	Sweet fennel
Frangula californica	Coffeeberry
Fremontodendron californicum	California flannelbush
Galium aparine	Common bedstraw
*Geranium dissectum**	Cut leaved geranium
Geranium molle	Dove's foot geranium
Heterotheca grandiflora	Telegraph weed
Holocarpha virgata ssp. *virgata*	Narrow tarplant
Hordeum marinum ssp. *gussoneanum**	Mediterranean barley
Hordeum murinum ssp. *leporinum**	Foxtail barley
*Hypochaeris glabra**	Smooth cat's ear
*Iris pseudacorus**	Water iris
Juglans hindsii	California black walnut
Juncus effusus ssp. *pacificus*	Pacific rush
Kickxia spuria	Fluellin
Lactuca serriola	Prickly lettuce
Leontodon saxatilis ssp. *longirostris*	Hawkbit
Ludwigia peploides ssp. *peploides*	Floating water primrose
Lupinus bicolor	Bicolor lupine
Lupinus nanus	Sky lupine
Lythrum hyssopifolia [*hyssopifolium*]*	Hyssop loosestrife
*Marrubium vulgare**	White horehound
*Medicago polymorpha**	Bur clover
Melilotus indicus	Yellow sweetclover
Oxalis corniculata	Yellow sorrel
Persicaria hydropiperoides	Knotweed
Petrorhagia dubia	Pink grass
*Phalaris aquatica**	Harding grass
Phoradendron leucarpum	American mistletoe
Pinus sabiniana	Gray pine
*Plantago lanceolata**	English plantain
Platanus racemosa	California sycamore
*Polypogon monspeliensis**	Rabbitsfoot grass
Populus fremontii ssp. *fremontii*	Fremont cottonwood
Prunus sp.	Cherry
Quercus agrifolia	Coast live oak
Quercus lobata	Valley oak
Quercus wislizeni	Interior live oak
*Raphanus sativus**	Wild radish
*Rubus armeniacus**	Himalayan blackberry
Rubus ursinus	California blackberry
*Rumex crispus**	Curly dock
Salix exigua	Sandbar willow
Salix lasiolepis	Arroyo willow
Sambucus nigra ssp. *caerulea*	Blue elderberry
Schoenoplectus acutus	Tule
Senecio vulgaris	Old man of spring

Scientific Name	Common Name
*Silybum marianum**	Milk-thistle
Stellaria media	Chickweed
Stipa pulchra	Purple needlegrass
Toxicodendron diversilobum	Poison-oak
Trifolium dubium	Suckling clover
*Trifolium hirtum**	Rose clover
Verbena bonariensis	Purpletop vervain
Vicia sativa ssp. *nigra*	Common vetch
Vicia tetrasperma	Four seeded vetch
Vicia villosa	Hairy vetch

* Species identified as invasive by California Department of Food and Agriculture and/or the California Invasive Plant Council

Table D-2. Animal Species Observed in or Near the Biological Study Area

Common Name*	Scientific Name
Western pond turtle	*Actinemys marmorata*
Western fence lizard	*Sceloporus occidentalis*
Canada goose	*Branta canadensis*
Mallard	*Anas platyrhynchos*
Turkey vulture	*Cathartes aura*
Swainson's hawk	*Buteo swainsoni*
Red-tailed hawk	*Buteo jamaicensis*
Killdeer	*Falco sparverius*
Mourning dove	*Zenaida macroura*
Anna's hummingbird	*Calypte anna*
Acorn woodpecker	*Melanerpes formicivorus*
Nuttall's woodpecker	*Picoides nuttallii*
Black phoebe	*Sayornis nigricans*
Western scrub jay	*Aphelocoma californica*
Yellow-billed magpie	*Pica nuttalli*
American crow	*Corvus brachyrhynchos*
Cliff swallow	*Petrochelidon pyrrhonota*
American robin	*Turdus migratorius*
Northern mockingbird	*Mimus polyglottos*
European starling	*Sturnus vulgaris*
Red-winged blackbird	*Agelaius phoeniceus*
Brewer's blackbird	*Euphagus cyanocephalus*
House finch	*Carpodacus mexicanus*
Black-tailed deer	*Odocoileus hemionus*

* Species are listed in taxonomic order

Appendix E Aquatic Resources Delineation

Hazel Avenue/U.S. 50 Interchange Project



Aquatic Resources Delineation

Hazel Avenue/U.S. 50 Interchange Project

Sacramento County

03-SAC-50-PM 15.1/17.5

Federal Project No.: EA 03-3E380/E-FIS 0300020439

County Control Number 2011-70062

October 2018

ICF

Aquatic Resources Delineation

Hazel Avenue/U.S. 50 Interchange Project

Sacramento County

03-SAC-50-PM 15.1/17.5

Federal Project No.: EA 03-3E380/E-FIS 0300020439

County Control Number 2011-70062

October 2018

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List of Abbreviated Terms

AMSL	above mean sea level
APNs	assessor parcel numbers
Caltrans	California Department of Transportation
CFR	Code of Federal Regulations
City	City of Rancho Cordova
County	County of Sacramento
CWA	federal Clean Water Act
GPS	global positioning system
JD	jurisdictional determination
OHWM	ordinary high water mark
proposed project	proposed Hazel Avenue/U.S. 50 Interchange Project
TNW	traditional navigable water
USACE	U.S. Army Corps of Engineers
US 50	U.S. 50

Aquatic Resources Delineation

Summary

This report presents the results of a delineation of potential wetlands and non-wetland waters of the United States conducted for the proposed Hazel Avenue/U.S Route (US) 50 Interchange Project (proposed project) between US 50 post miles 15.1 and 17.5 (Figure 1). The delineation area encompasses approximately 98 acres. The project is proposed by the County of Sacramento (County), in cooperation with the California Department of Transportation (Caltrans) and the City of Rancho Cordova (City).

ICF botanist/wetland ecologist Lisa Webber conducted fieldwork on April 6 and 21, 2016, using the routine onsite determination method described in the *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987) and incorporating the supplemental procedures and wetland indicators provided in the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Arid West Region* (U.S. Army Corps of Engineers 2008). OHWM indicators for non-wetland waters of the United States were identified according to U.S. Army Corps of Engineers (USACE) Regulatory Guidance Letter No. 05-05 (*Ordinary High Water Mark Identification*) (U.S. Army Corps of Engineers 2005) and *A Field Guide to the Identification of the Ordinary High Water Mark (OHWM) in the Arid West Region of the Western United States* (Lichvar and McColley 2008) The delineation was conducted to assist Sacramento County (the project applicant) in identifying the types and extents of wetlands and non-wetland waters subject to USACE regulation under Section 404 of the federal Clean Water Act (CWA).

This report was prepared to support the submission of a preliminary jurisdictional determination (JD) to USACE Sacramento District (RGL 16-01) (U.S. Army Corps of Engineers 2016). All wetland boundaries are preliminary and subject to verification by USACE Sacramento District.

A total of 0.91 acre of wetlands and non-wetland waters of the United States were identified in the delineation area: 0.22 acre of wetlands and 0.69 acres of non-wetland waters (Table 1 and Appendix A).

Table 1. Summary of Wetlands and Non-Wetland Waters of the United States Identified in the Delineation Area

Wetlands and Non-Wetland Waters	Area (acres)
Wetlands	
Seasonal wetland	0.02
Emergent wetland	0.20
Non-Wetland Waters	
Ephemeral drainage	0.001
Perennial drainage	0.42
Perennial drainage (culverted)	0.14
Ditch	0.13
Total	**0.91**

Introduction

This report presents the results of a delineation of potential wetlands and non-wetland waters of the United States conducted for the proposed project to improve the Hazel Avenue/US 50 interchange in Sacramento County, California (Figure 1). The County, in cooperation with Caltrans and the City, proposes to modify the existing Hazel Avenue/US 50 interchange, and extend and grade-separate Hazel Avenue over Folsom Boulevard and the Sacramento Placerville Transportation Corridor Joint Powers Authority rail corridor. Hazel Avenue would be extended further south to a proposed intersection with the future Atlanta Street (a new roadway that will be constructed as part of the Easton Place development). The proposed project also includes:

- Construction of a portion of an eastbound transition auxiliary lane on US 50 from Hazel Avenue through the Folsom Boulevard Overcrossing, also known as the Natoma Overhead.
- The modification of the existing Aerojet Road off-ramp from US 50.
- Reconstruction of the westbound loop on-ramp.
- Reconstruction of the eastbound diagonal off-ramp, and both eastbound on-ramps.
- Eastbound on- and off-ramp auxiliary lanes, from west of the Hazel Avenue to the eastbound off-ramp, and from the loop on-ramp extending to the Folsom Boulevard interchange.
- Roadway improvements constructed along approximately 2,300 feet of Folsom Boulevard. Improvements include sidewalks, street lighting, and landscaping along the north side of Folsom Boulevard, and landscaping and lighting along the south.

The project is in Sacramento County at the interchange of Hazel Avenue and US 50. The project area is bounded along Hazel Avenue by the Tributary Point/westbound US 50 off-ramp intersection to the north, and extends approximately 1,000 feet south of Folsom Boulevard to a future intersection within the Easton Place development. The project limits along US 50 begin approximately 3,200 feet west of the existing Hazel Avenue Overcrossing, and extend 2,500 feet east of the Natoma Overhead. Improvements along Folsom Boulevard would extend from approximately 1,200 feet west of the Hazel Avenue intersection to 900 feet to the east.

The delineation area comprises the proposed interchange improvement area for three alternatives, including the potential staging areas, as well as additional area surrounding the construction footprint.

The delineation was conducted in support of a preliminary JD and to assist the County in identifying the types and extents of wetlands and non-wetland waters subject to USACE regulation under Section 404 of the CWA. All jurisdictional boundaries and determinations presented in this report are preliminary and subject to verification by USACE Sacramento District. The delineation report is intended to comply with USACE Sacramento District guidelines and the South Pacific Division map standards.

Appendices to this report are listed below.

- Appendix A: Aquatic Resources Delineation
- Appendix B: Routine Wetland Delineation Data Forms
- Appendix C: Representative Photographs
- Appendix D: Soil Survey Map and Information
- Appendix E: Plant Species Observed in the Delineation Area
- Appendix F: WETS Table
- Appendix G: Assessor Parcel Numbers in the Delineation Area
- Appendix H: Aquatic Resources Spreadsheet (This table also will be provided to the USACE Sacramento District as a separate Excel file.)

Contact Information

Contact information for the County's contact person and the ICF botanist/wetland ecologist is provided below.

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Driving Directions

To reach the delineation area from downtown Sacramento, travel east on Interstate 80 to US 50 and proceed east on US 50 for 16 miles. Take exit 21 for Hazel Avenue to reach the western boundary of the delineation area.

Site Description and Location

The 98-acre delineation area is entirely within Sacramento County on US 50 from the Hazel Avenue interchange to the Folsom Boulevard interchange (Figure 1). The delineation area includes the Hazel Avenue interchange, short sections of Folsom Boulevard and Nimbus Road south of the interchange, a portion of the property at the southwest corner of Folsom Boulevard and Nimbus Road, an approximately 1-mile segment of eastbound US 50, and the right-of-way (ROW) along this segment on the south side of US 50.

The delineation area is within the Folsom 7.5-minute U.S. Geological Survey quadrangle in an unnamed section of Township 9 north, Range 7 east. The western end of the delineation area is at 38°37'30"N/121°13'37"W, and the eastern end is at 38°38'22"N/121°11'58"W. The assessor parcel numbers (APNs) in the delineation area are listed in Appendix G.

The delineation area is relatively level, with elevations ranging from approximately 110 to 150 feet above mean sea level (AMSL). Land uses in the delineation area and the surrounding area are primarily commercial and recreational properties.

Existing Conditions

Landscape Setting

Hydrology

The delineation area is in the Lower American River watershed hydrologic unit (hydrologic unit code 18020111) (U.S. Environmental Protection Agency 2016). Alder Creek is the only perennial drainage in the delineation area and crosses underneath US 50. Alder Creek drains north to Lake Natoma, which is approximately 0.7 mile upstream of the Nimbus Dam. Lake Natoma is part of the American River, a traditional navigable water (TNW).

Precipitation and Growing Season

The mean annual precipitation in the delineation area is approximately 22.21 inches, which typically consists entirely of rainfall (Appendix F). As of the April 6, 2016, field survey, the precipitation to date was 22.99 inches at the Chicago Weather Station (elevation of 210 feet), which is approximately 2.5 miles northwest of the delineation area. The most recent rainfall prior to the April 6, 2016, field survey was on March 22, 2016, and total precipitation for the water year was 20.67 inches at that time. An additional 0.56 inch fell prior to the April 21, 2016, field

survey, increasing the total precipitation to 21.23 inches as of April 21, 2016 (California Department of Water Resources 2016).

The climate in the delineation area is characterized by hot, dry summers and cool, moist winters. Climate data were obtained from the WETS tables prepared by the Natural Resources Conservation Service (Appendix F). The National Weather Service cooperative weather station closest to the delineation area is the Represa station (CA7370), approximately 4.5 miles northeast of the delineation area at an elevation of 295 feet AMSL. Climate data from this weather station do not include temperature data. The next closest station is the Sacramento 5 ESE station (CA271), which indicates an average temperature of 63.3°F, with an average range from a minimum of 51.3°F to a maximum of 75.2°F. The WETS tables do not provide median dates of 28°F air temperatures from which to estimate the length of the growing season; however, extended periods of freezing weather are very rare, and the growing season is essentially year-round.

Vegetation

The delineation area is within the Sacramento Valley subregion of the California Floristic Province (Baldwin et al. 2012:41). The delineation area supports two wetland plant communities (seasonal wetland and emergent wetland) and five non-wetland plant communities (annual grassland, planted oak woodland, Fremont cottonwood-oak woodland, valley foothill riparian woodland, and developed/landscaped). A list of plant species identified during the delineation fieldwork is presented in Appendix E. Common and scientific plant names are taken from the *Jepson Manual* (Baldwin et al. 2012).

Seasonal Wetland

Seasonal wetlands are normally inundated during the winter and early spring but are dry by late spring. The seasonal wetlands in the BSA consist of features that occur in swales created to carry runoff within the cloverleaf loops of the Hazel Avenue/US 50 interchange and are not naturally occurring features. These wetlands support few native plants species. Dominant species in the seasonal wetlands include Mediterranean barley (*Hordeum marinum* var. *gussoneanum*), Italian ryegrass (*Festuca perennis*), and hyssop loosestrife (*Lythrum hyssopifolia*).

Emergent Wetland

Emergent wetland occurs at the edges of open water in Alder Creek below valley foothill riparian woodland vegetation and the ordinary high water mark (OHWM) of the creek. Dominant species in this community include white alder saplings (*Alnus rhombifolia*), tall flatsedge (*Cyperus eragrostis*), Pacific rush (*Juncus effusus* ssp. *pacificus*), tule (*Schoenoplectus acutus*), California blackberry (*Rubus ursinus*), curly dock (*Rumex crispus*), and floating water primrose (*Ludwigia peploides* ssp. *peploides*).

Annual Grassland

Annual grassland occurs throughout the delineation area within the US 50 ROW and south of Folsom Boulevard. Dominant species in this community include annual grasses, such as wild oat

(*Avena fatua*), ripgut brome (*Bromus diandrus*), soft chess (*Bromus hordeaceus*), wall barley (*Hordeum murinum*), and perennial ryegrass (*Festuca perennis*) and native and nonnative forbs, such as dwarf brodiaea (*Brodiaea nana*), Italian thistle (*Carduus pycnocephalus*), elegant clarkia (*Clarkia unguiculata*), heron's bill (*Erodium botrys* and *E. cicutarium*), hawkbit (*Leontodon saxatilis*), milk thistle (*Silybum marianum*), hairy clover (*Trifolium hirtum*), and hairy vetch (*Vicia villosa*). This plant community also contains a blue elderberry shrub cluster (*Sambucus mexicana* ssp. *caerulea*)..

Planted Oak Woodland

The interchange cloverleaf areas are planted with native trees and shrubs found in oak woodlands, such as interior live oak (*Quercus wislizeni*), valley oak (*Q. lobata*), buckeye (*Aesculus californica*), Lemmon's ceanothus (*Ceanothus lemmonii*), coffeeberry (*Frangula californica*), California flannelbush (*Fremontodendron californicum*), and Fremont cottonwood, with annual grassland species in the understory. This plant community also contains blue elderberry shrub clusters.

Fremont Cottonwood-Oak Woodland

The proposed jughandle road area, located south of Folsom Boulevard, supports Fremont cottonwood-oak woodland. The overstory of this woodland is dominated by interior live oak, Fremont cottonwood (*Populus fremontii* ssp. *fremontii*), and willows (*Salix* spp.). The understory includes smaller willows, coyote brush (*Baccharis pilularis*), poison-oak (*Toxicodendron diversilobum*), and annual grasses and forbs. Blue elderberry shrubs also occur in this area.

Valley Foothill Riparian Woodland

Valley foothill riparian woodland occurs on the banks of Alder Creek above its OHWM. Dominant species in this community include willow (*Salix* spp.), white alder, and California blackberry (*Rubus ursinus*). Outside the delineation area, California foothill pine (*Pinus sabiniana*) and interior live oak also occur in valley foothill riparian woodland.

Developed/Landscaped

Vegetation in developed/landscaped areas consists of planted vegetation associated with businesses. Species used for landscaping are primarily nonnative trees, shrubs, and herbaceous flowers.

Soil Map Units

The delineation area contains six soil map units (Natural Resources Conservation Service 2015). These soil map units are shown in Appendix D, and the summarized descriptions of each unit, including hydric components, are listed in Table 2.

Table 2. Soil Map Units in the Delineation Area

Soil Map Unit	Map Symbol	Drainage Class	Landform	Typical Profile	Hydric Component (C)	Hydric Criteria[a]
Natomas loam, 0 to 2 percent slopes	181	Well drained	Terraces	loam over clay loam over stratified gravelly coarse sandy loam to sandy loam	–	–
Natomas-Xerorthents, dredge tailings complex, 0 to 50 percent slopes	182	Well drained	Terraces	loam over clay loam over stratified gravelly coarse sandy loam to sandy loam	Unnamed, slickens on terraces	3
Urban land	227	–	–	–	–	–
Urban land-Natomas complex, 0 to 2 percent slopes	228	Somewhat excessively drained	Terraces	loam over clay loam over stratified gravelly coarse sandy loam to sandy loam	–	–
Xerorthents, dredge tailings, 2 to 50 percent slopes	245	Well drained	–	fragmental material	Riverwash in channels Unnamed, slickens in depressions Xerofluvents on flood plains	4 3 4
Xerorthents, dredge tailings-Urban land complex, 0 to 2 percent slopes	246	Somewhat excessively drained	–	fragmental material	Unnamed, slickens in depressions	3
Water	247	–	–	–	–	–

Source: Natural Resources Conservation Service 2015.

[a] Hydric Criteria:

3 Soils that are frequently ponded for long or very long duration during the growing season.

4 Map unit components that are frequently flooded for long duration or very long duration during the growing season.

Delineation Methods

ICF botanist/wetland ecologist Lisa Webber conducted fieldwork for the delineation on April 6 and May 31, 2016. The delineation was conducted in accordance with the guidance provided in the 1987 *U.S. Army Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987:53–69), the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Arid West Region* (U.S. Army Corps of Engineers 2008), and 33 Code of Federal Regulations [CFR] 328.3(e) and 329.11(a)(1). The OHWM indicators were identified according to U.S. Army Corps of Engineers' Regulatory Guidance Letter No. 05-05 (U.S. Army Corps of Engineers 2005).

Data for wetlands and non-wetland waters were collected to support a preliminary JD approach during the permitting phase. USACE Sacramento District issued a Regulatory Guidance Letter

(16-01) regarding local processing procedures for JDs (U.S. Army Corps of Engineers 2016). The preliminary JD approach is intended to streamline the permitting process for applicants seeking USACE permit authorizations or JDs.

Six data point locations were evaluated in the accessible parts of the delineation area. A Trimble GeoXT global positioning system (GPS) unit, typically accurate to less than 1 horizontal meter, was used to record the locations of jurisdictional boundaries, data points, and other pertinent features, such as culverts, wherever possible. The GPS data were downloaded and corrected in the office using the nearest available base-station data before being superimposed onto recent (2014) 1 inch = 200 feet color orthorectified aerial photographs to generate the delineation map.

Aquatic Resources

A total of 0.91 acre of wetlands and non-wetland waters were identified in the delineation area: seasonal wetland (0.02 acre), emergent wetland (0.20 acre), ephemeral drainage (0.001 acre), perennial drainage (0.56 acre), and ditch (0.13 acre).

The delineation map in Appendix A illustrates the locations of all mapped features. Table 3 lists each feature by number and identifies its type, acreage, and map sheet number. In accordance with the preliminary JD approach, all mapped features were interpreted to fall within USACE jurisdiction under CWA Section 404. Table 3 provides a reference to features for which there are corresponding data forms in Appendix B and photographs included in Appendix C.

Table 3. Mapped Features with Data Forms and Photographs

Feature Number[a]	Feature Type	Acreage	Map Sheet Number[a]	Data Form[b]	Photograph Number[c]
SW-1	Seasonal wetland	0.01	3	--	--
SW-2	Seasonal wetland	0.01	3	DP-4w	1-4
EW-1	Emergent wetland	0.03	4	--	5
EW-2	Emergent wetland	0.0002	4	DP-2w	5
ED-1	Ephemeral drainage	0.001	3	--	--
ED-2	Ephemeral drainage	0.0004	5	--	--
PD-1	Perennial drainage	0.42	4	--	5 and 6
PDC-1	Perennial drainage (culverted)	0.14	4	--	6
D-1	Ditch		4 and 5	--	--

[a] As shown in Appendix A.
[b] Data forms are in Appendix B.
[c] Photographs are in Appendix C.

Wetlands

Seasonal Wetland

Two seasonal wetlands (SW-1 and SW-2) were mapped in the delineation area southwest of the westbound US 50 off-ramp. SW-1 is in a swale at the base of the off-ramp slope, and SW-2 is at

the outlet of a culvert at the base of the off-ramp slope. Both features support similar seasonal wetland vegetation. The representative data point for seasonal wetlands is documented on data form DP-4W for SW-2 (Appendix B). Dominant plant species observed in the seasonal wetlands were nonnative, including Mediterranean barley [FAC], perennial ryegrass [FAC], and hyssop loosestrife [OBL]. Associated species observed included curly dock [FAC], burclover (*Medicago polymorpha*) [NI], slender wild oat (*Avena barbata*) [NI], and a non-blooming tarweed that is presumably an upland species. The vegetation in seasonal wetlands met the federal wetland criterion for hydrophytic vegetation.

Soil at the data point location met the redox depressions (F8) hydric soil indicator, based on a 4-inch-thick layer in the upper 12 inches of the soil pit that had 10% prominent redox concentrations in the matrix and a matrix color of 7.5YR 4/6. Soil examined upslope of SW-2 did not exhibit redox features.

The seasonal wetlands were dry when field surveys were conducted. Positive indicators of wetland hydrology in seasonal wetland SW-2 were wetland drainage patterns (B10) and FAC-neutral test (D5). SW-2 is in a depression at the base of a slope that receives runoff from surrounding slopes via a culvert under the US 50 off-ramp.

Emergent Wetland

Two areas of emergent wetland (EW-1 and EW-2) were mapped on the banks of Alder Creek in the delineation area. EW-1 is on the southwest bank, and EW-2 is on the northeast bank of the creek. Both emergent wetlands support similar vegetation, although EW-1 supports more cover of California blackberry than does EW-2. The representative data point for emergent wetlands is documented on data form DP-2W for EW-2 (Appendix B). Emergent wetlands support herbaceous wetland species, including tall flatsedge [FACW], Pacific rush [FACW], tule [OBL], California blackberry [FAC], curly dock [FAC], and floating water primrose [OBL]. The vegetation in emergent wetlands met the federal wetland criterion for hydrophytic vegetation.

Soil in EW-2 is a thin layer over dredge tailings, but has a matrix value of 2 and a chroma of 1. The top layer of soil is 0.5 inch of decaying organic material; the next layer consists of 1.5 inches of loam, with dredge tailing cobbles beneath. The soil is a problematic hydric soil most similar to recently deposited vegetated sand and gravel bars within floodplains. The area sampled also appears to be flooded in most years according to Google Earth aerial imagery.

Positive indicators of wetland hydrology in EW-2 were the presence of a high water table (A2) and soil saturation to the surface (A3).

Non-Wetland Waters

Ephemeral Drainage

A 20-foot-long segment of ephemeral drainage (ED-1) crosses the delineation area east of Alder Creek. This drainage extends south from the edge of US 50 to Alder Creek. The drainage supports annual grassland vegetation and is approximately 1 foot wide at the OHWM. The

OHWM was identified on the basis of visual indicators: a break in the bank slope and the destruction of terrestrial vegetation.

An ephemeral drainage (ED-2) connects a roadside ditch (D-1) to Alder Creek (PD-1). The drainage supports annual grassland vegetation and is approximately 3.5 feet wide at the OHWM. The OHWM was identified on the basis of visual indicators: a break in the bank slope and the destruction of terrestrial vegetation.

Perennial Drainage

The delineation area contains one perennial drainage, Alder Creek (PD-1), which connects to Lake Natoma on the north side of US 50. Alder Creek flows under US 50 through a box culvert that is beneath a Mechanically Stabilized Earth (MSE) wall. As a result of the MSE, the water in Alder Creek backs up at the US 50 crossing, creating a pond-like area with mostly stagnant water. An emergent wetland fringe is present on both sides of the creek. Alder Creek is approximately 150-200 feet wide at the OHWM within the delineation area. The OHWM of the creek was identified on the basis of visual indicators: the destruction of terrestrial vegetation and a change in the plant community.

Jurisdictional Ditches

The delineation area contains four jurisdictional ditches: three drainage ditches that were previously verified as waters of the United States, and a constructed roadside ditch that was delineated by ICF.

The three drainage ditches were delineated and verified (SPK-2004-00515) for the Glenborough at Easton and Easton Place Project. The three ditches are south of Folsom Boulevard on property owned by Aerojet Corporation. These three verified ditches are included on the delineation map in Appendix A for information only; their fill has been permitted by the USACE Sacramento District.

The constructed roadside ditch (D-1) extends from the east end of the delineation area to Alder Creek. This ditch supports annual grassland vegetation and receives runoff from US 50 and the interchange loop at Folsom Boulevard. The ditch averages 3 feet wide at the OHWM that was identified on the basis of a break in the bank slope and the destruction of terrestrial vegetation. This ditch connects to Alder Creek via ED-2 and EW-2.

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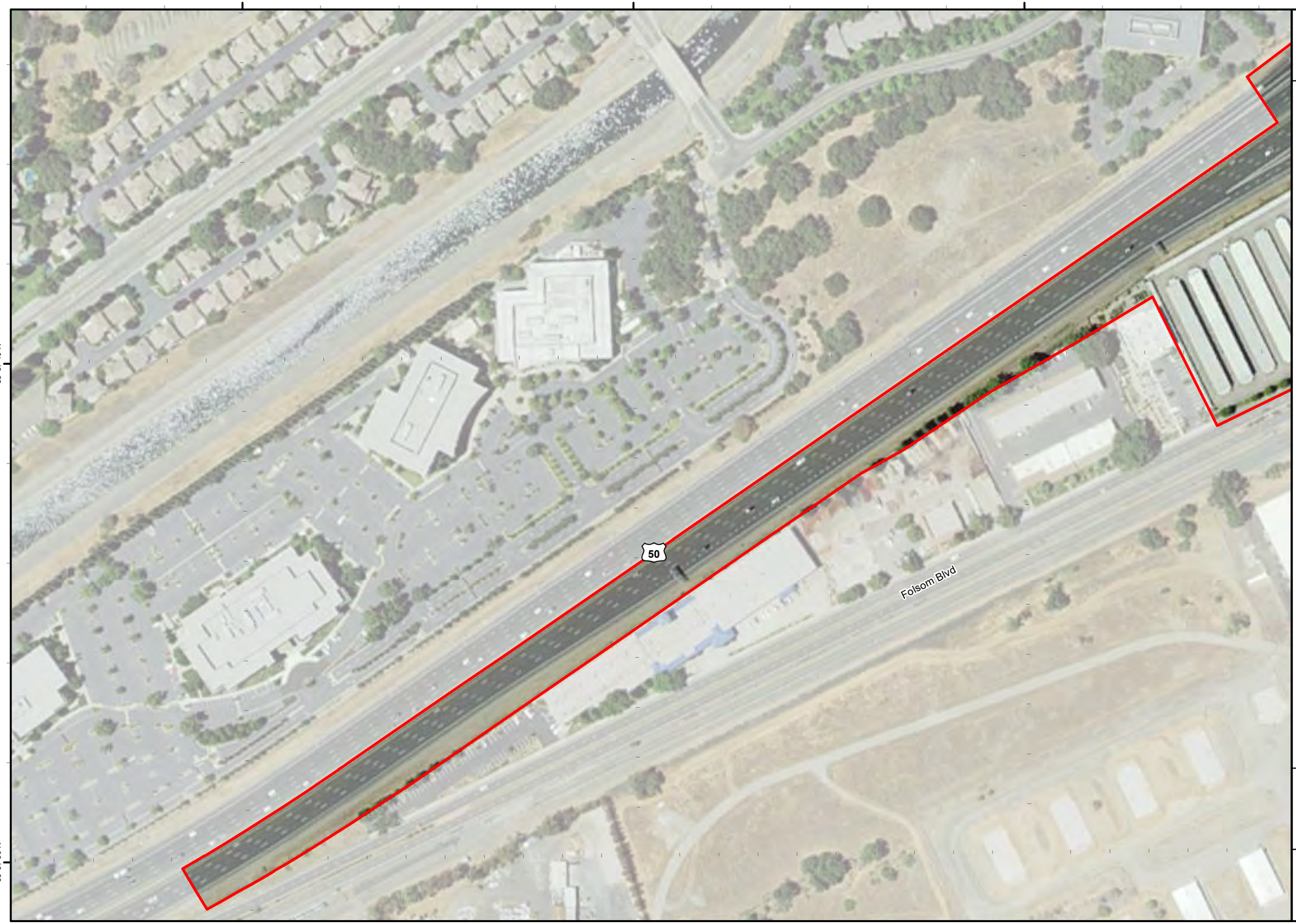
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Appendix A Aquatic Resources Delineation



Hazel Avenue / U.S. 50 Interchange Project
August 2018
Sheet 1 of 6

Legend

- Biological Study Area (98 Acres)
- Data Points (dp)
- Culverts
- Feature Boundaries Outside Delineation Area

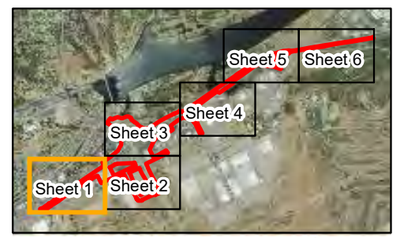
Wetlands

- Emergent Wetland - 0.20 acre
- Seasonal Wetland - 0.02 acre

Non-wetland Waters

- Ephemeral Drainage - 0.001 acre
- Perennial Drainage - 0.42 acre
- Perennial Drainage (Culverted) - 0.14 acre
- Ditch - 0.13 acre
- Ditch - Previously Delineated (SPK-2004-00515)

w = Average Width



0 50 100 200
Feet

1 inch = 200 feet

Notes:
Base Map Source: ICF and ECORP
Imagery Source: NAIP 2014
USGS Topo Quad: Folsom and Buffalo Creek
PLSS: Rio De Los Americanos Land Grant

Prepared By: ICF International
Delineated By: L. Webber
Delineation Date: April 6, May 31, and September 2, 2016
Drawn By: A. Angier

Path: \\PDCOITRDSGIS1\Projects_1\County_of_Sacramento\000529_15_HazelAve\Cmaps\doc\Bio\Aquatic_Resources_20180822.mxd; Author: ; Date: 8/22/2018

Appendix A
Delineation of Potential Waters of the United States, Including Wetlands

121°13'10"W

121°13'0"W

121°12'50"W

38°37'40"N

38°37'30"N

50

Folsom Blvd

Nimbus Rd

Hazel Avenue / U.S. 50 Interchange Project
August 2018
Sheet 2 of 6

Legend

- Biological Study Area (98 Acres)
- Data Points (dp)
- Culverts
- Feature Boundaries Outside Delineation Area

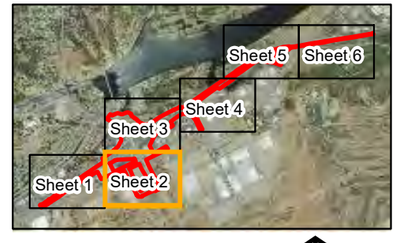
Wetlands

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Non-wetland Waters

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- Perennial Drainage (Culverted) - 0.14 acre
- Ditch - 0.13 acre
- Ditch - Previously Delineated (SPK-2004-00515)

w = Average Width



0 50 100 200
Feet

1 inch = 200 feet

Notes:

Base Map Source: ICF and ECORP
Imagery Source: NAIP 2014
USGS Topo Quad: Folsom and Buffalo Creek
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Prepared By: ICF International
Delineated By: L. Webber
Delineation Date: April 6, May 31, and September 2, 2016
Drawn By: A. Angier

Path: \\PDOCHRDSGIS1\Projects_1\County_of_Sacramento\00529_15_HazelAveIO\mapdoc\Bio\Aquatic_Resources_20180822.mxd; Author: ; Date: 8/22/2018

121°13'10"W
121°13'0"W
121°12'50"W
38°38'0"N
38°37'50"N
dp-6u
dp-3u
dp-4w
dp-5u
SW-2
SW-1
ED-1, w=3.5'
Hazel Ave
50
Folsom Blvd

Hazel Avenue / U.S. 50 Interchange Project
August 2018
Sheet 3 of 6

Legend

- Biological Study Area (98 Acres)
- Data Points (dp)
- Culverts
- Feature Boundaries Outside Delineation Area

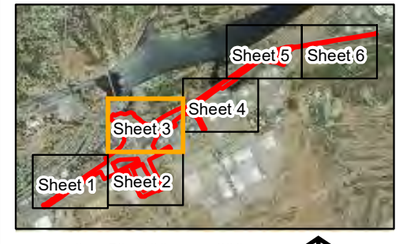
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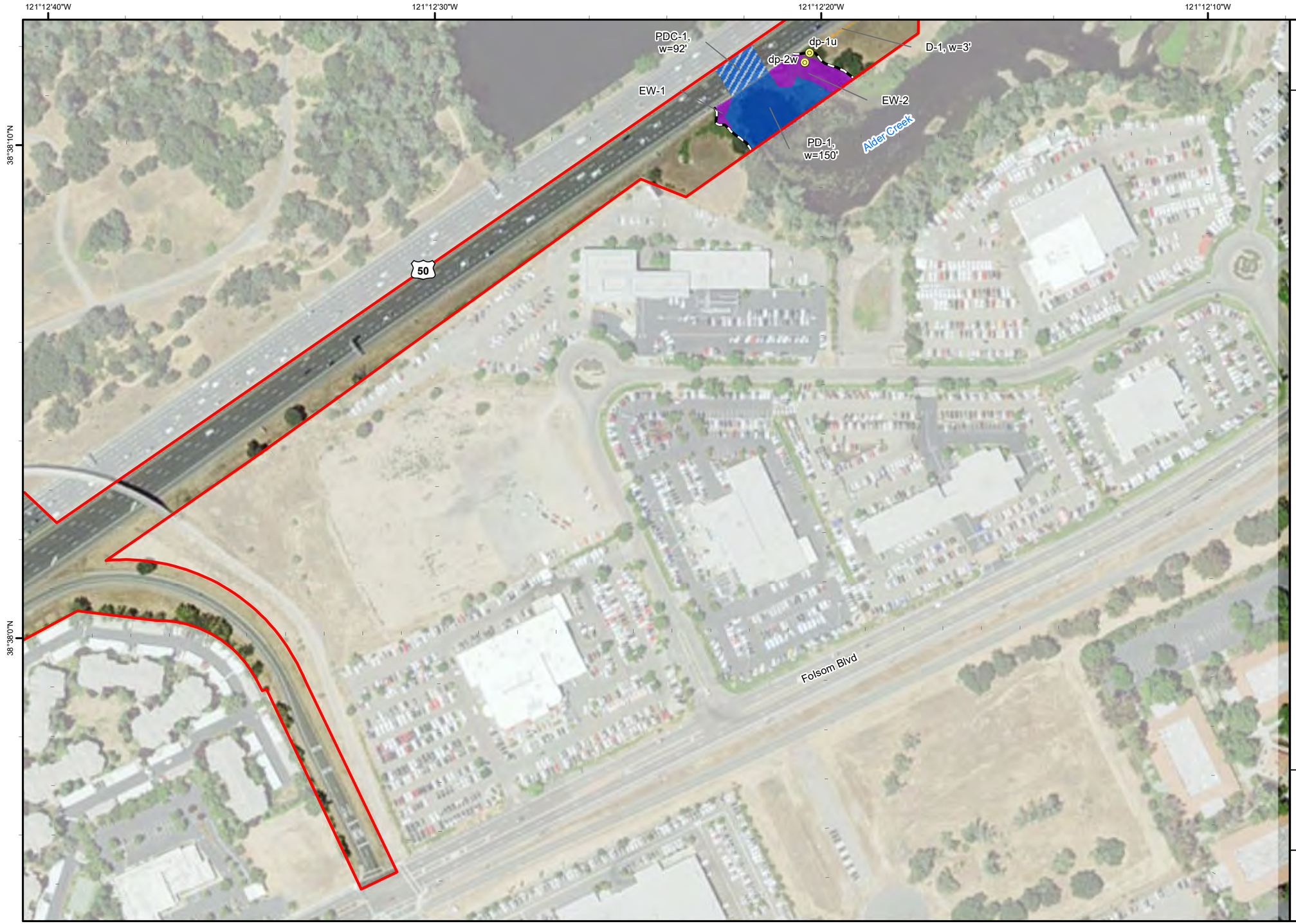


0 50 100 200
Feet
1 inch = 200 feet

Notes:
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Imagery Source: NAIP 2014
USGS Topo Quad: Folsom and Buffalo Creek
PLSS: Rio De Los Americanos Land Grant

Prepared By: ICF International
Delineated By: L. Webber
Delineation Date: April 6, May 31, and September 2, 2016
Drawn By: A. Angier

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Hazel Avenue / U.S. 50 Interchange Project
August 2018
Sheet 4 of 6

Legend

- Biological Study Area (98 Acres)
- Data Points (dp)
- Culverts
- Feature Boundaries Outside Delineation Area

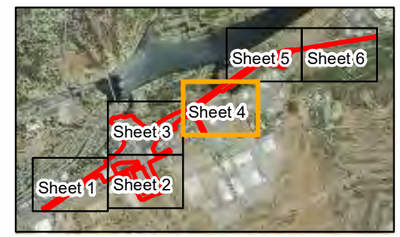
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- Perennial Drainage (Culverted) - 0.14 acre
- Ditch - 0.13 acre
- Ditch - Previously Delineated (SPK-2004-00515)

w = Average Width



0 50 100 200
Feet
1 inch = 200 feet

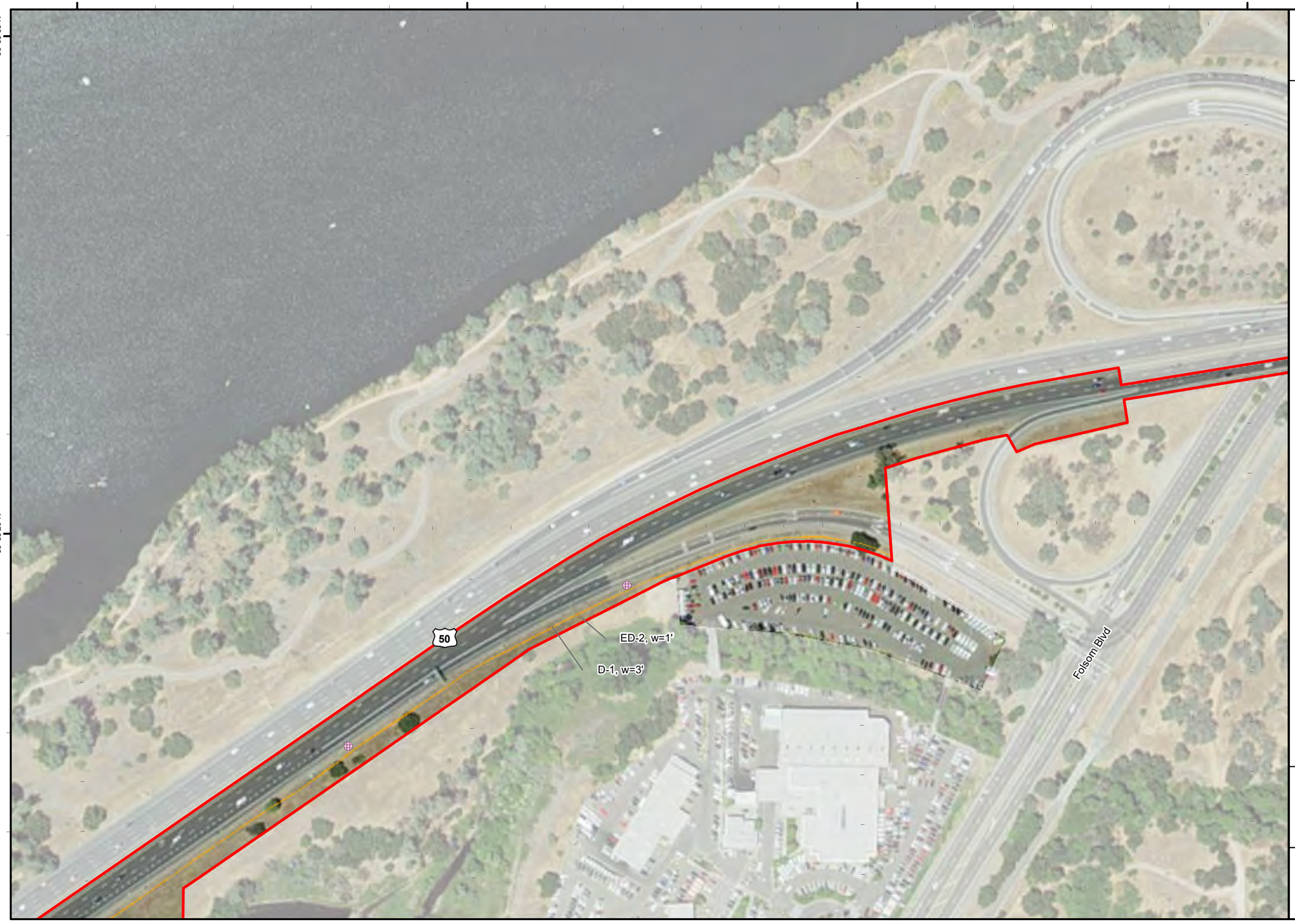
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Delineation Date: April 6, May 31, and September 2, 2016
Drawn By: A. Angier

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Appendix A
Delineation of Potential Waters of the United States, Including Wetlands

121°12'20"W
121°12'10"W
121°12'0"W
121°11'50"W
38°38'30"N
38°38'20"N



Hazel Avenue / U.S. 50 Interchange Project
August 2018
Sheet 5 of 6

Legend

- Biological Study Area (98 Acres)
- Data Points (dp)
- Culverts
- Feature Boundaries Outside Delineation Area

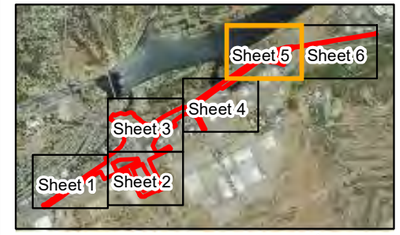
Wetlands

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- Perennial Drainage (Culverted) - 0.14 acre
- Ditch - 0.13 acre
- Ditch - Previously Delineated (SPK-2004-00515)

w = Average Width



0 50 100 200
Feet
1 inch = 200 feet

Notes:

Base Map Source: ICF and ECORP
Imagery Source: NAIP 2014
USGS Topo Quad: Folsom and Buffalo Creek
PLSS: Rio De Los Americanos Land Grant

Prepared By: ICF International
Delineated By: L. Webber
Delineation Date: April 6, May 31, and September 2, 2016
Drawn By: A. Angier

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Hazel Avenue / U.S. 50 Interchange Project
August 2018
Sheet 6 of 6

Legend

- Biological Study Area (98 Acres)
- Data Points (dp)
- Culverts
- Feature Boundaries Outside Delineation Area

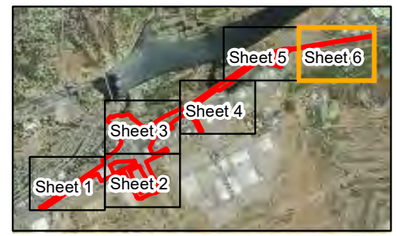
Wetlands

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Non-wetland Waters

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w = Average Width



0 50 100 200
Feet

1 inch = 200 feet

Notes:

Base Map Source: ICF and ECORP
Imagery Source: NAIP 2014
USGS Topo Quad: Folsom and Buffalo Creek
PLSS: Rio De Los Americanos Land Grant

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Appendix A
Delineation of Potential Waters of the United States, Including Wetlands

Appendix B Routine Wetland Delineation Data Forms

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: SR50/Hazel Ave. City/County: Sac. Sampling Date: 4-6-16
Applicant/Owner: County of Sac. State: CA Sampling Point: DP-14
Investigator(s): Webber Section, Township, Range: Unnamed S, T 9N, R7E
Landform (hillslope, terrace, etc.): terrace Local relief (concave, convex, none): none Slope (%): 1%
Subregion (LRR): Mediterranean California (LRR C) Lat: Long: Datum:
Soil Map Unit Name: Natomas loam, 0-2% slopes (181) NWI Classification:
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No (If no, explain in Remarks.)
Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes X No ____
Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X No	**Is the Sampled Area within a Wetland?**	**Yes** ____ **No** X
Hydric Soil Present?	Yes ____ No X		
Wetland Hydrology Present?	Yes ____ No ?		

Remarks: Within OHWM of Alder Creek, east bank. Site is in upper part of OHWM, near the edge of a wetland fringe.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: 20')			
1. Alnus rhombifolia	80	Y	FACW
2.			
3.			
4.			
	80 =Total Cover		
Sapling/Shrub Stratum (Plot size: 20')			
1. Rubus armeniacus	5	N	FAC
2.			
3.			
4.			
5.			
	5 =Total Cover		
Herb Stratum (Plot size: 5')			
1. Juncus effusus	20	Y	FACW
2. Geranium dissectum	5	N	—
3. Schoenoplectus acutus	5	N	OBL
4.			
5.			
6.			
7.			
8.			
	30 =Total Cover		
Woody Vine Stratum (Plot size: ____)			
1.			
2.			
	____ =Total Cover		

% Bare Ground in Herb Stratum 70 % Cover of Biotic Crust 0

Dominance Test worksheet:
Number of Dominant Species That Are OBL, FACW, or FAC: ____ (A)
Total Number of Dominant Species Across All Strata: ____ (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: ____ (A/B)

Prevalence Index Worksheet:

Total % Cover of:	Multiply by:
OBL species ____	x1 = ____
FACW species ____	x2 = ____
FAC species ____	x3 = ____
FACU species ____	x4 = ____
UPL species ____	x5 = ____
Column Totals: ____ (A)	____ (B)

Prevalence Index = B/A = ____

Hydrophytic Vegetation Indicators:
X Dominance Test is >50%
____ Prevalence Index is ≤3.0[1]
____ Morphological Adaptationd[1] (Provide supporting data in Remarks or on a separate sheet)
____ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes X No ____

Remarks:

SOIL

Sampling Point: DP-4

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-2	2.5YR 3/2	100					1	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (**LRR C**)
- ___ 1 cm Muck (A9) (**LRR D**)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (**LRR C**)
- ___ 2 cm Muck (A10) (**LRR B**)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: Shovel refusal @ 2" - dredge tailings

Depth (inches): _____

Hydric Soil Present? Yes _____ No X

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1) (**Nonriverine**)
- ___ Sediment Deposits (B2) (**Nonriverine**)
- ___ Drift Deposits (B3) (**Nonriverine**)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (**Riverine**)
- ___ Sediment Deposits (B2) (**Riverine**)
- ___ Drift Deposits (B3) (**Riverine**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes _____ No X Depth (inches): none

Water Table Present? Yes _____ No X Depth (inches): none to 2"

Saturation Present? (includes capillary fringe) Yes _____ No X Depth (inches): none to 2"

Wetland Hydrology Present? Yes _____ No ?

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: Point is w/in ottawa / floodplain. Does not likely remain inundated for a long enough period to meet wetland hydrology criterion.

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: SR 50/Hazel Ave City/County: Sacramento Sampling Date: 4-6-16
Applicant/Owner: County of Sacramento State: CA Sampling Point: DP-2W
Investigator(s): Webster Section, Township, Range: unnamed S, T9N, R7E
Landform (hillslope, terrace, etc.): terrace Local relief (concave, convex, none): none Slope (%): 0
Subregion (LRR): Mediterranean California (LRR C) Lat: Long: Datum:
Soil Map Unit Name: Natomas loam, 0-2% slopes (181 NWI Classification:
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No (If no, explain in Remarks.)
Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes X No ____
Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X No	**Is the Sampled Area within a Wetland?**	**Yes** X **No**
Hydric Soil Present?	Yes X No		
Wetland Hydrology Present?	Yes X No		

Remarks: Point is in emergent wetland fringe of Alder Ct.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size:)			
1.			
2.			
3.			
4.			
	=Total Cover		
Sapling/Shrub Stratum (Plot size:)			
1.			
2.			
3.			
4.			
5.			
	=Total Cover		
Herb Stratum (Plot size: 5')			
1. Schoenoplectus acutus	40	Y	OBL
2. Ludwigia peploides	15	Y	OBL
3. Juncus effusus ssp. pacificus	5	N	FACW
4.			
5.			
6.			
7.			
8.			
	60 =Total Cover		
Woody Vine Stratum (Plot size:)			
1.			
2.			
	=Total Cover		

% Bare Ground in Herb Stratum 40 % Cover of Biotic Crust 30

Dominance Test worksheet:
Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)
Total Number of Dominant Species Across All Strata: 2 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index Worksheet:

Total % Cover of:	Multiply by:
OBL species	x1 =
FACW species	x2 =
FAC species	x3 =
FACU species	x4 =
UPL species	x5 =
Column Totals: (A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:
____ Dominance Test is >50%
____ Prevalence Index is ≤3.0[1]
____ Morphological Adaptationd[1] (Provide supporting data in Remarks or on a separate sheet)
____ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes X No

Remarks: Dead wood over ~30% of plot.

SOIL

Sampling Point: DP-2w

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-0.5								decaying layer of litter
0.5-2	10YR 3/1	100					1	small rocks

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (**LRR C**)
- ___ 1 cm Muck (A9) (**LRR D**)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (**LRR C**)
- ___ 2 cm Muck (A10) (**LRR B**)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- X Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: Shovel refusal at 2" - dredger tailings

Depth (inches): ___

Hydric Soil Present? Yes X No ___

Remarks: Meets the vegetated sand & gravel bars within floodplains, most similar to recently deposited soils. This area appears flooded on aerial imagery in most years.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- X High Water Table (A2)
- X Saturation (A3)
- ___ Water Marks (B1) (**Nonriverine**)
- ___ Sediment Deposits (B2) (**Nonriverine**)
- ___ Drift Deposits (B3) (**Nonriverine**)
- ___ Surface Soil Cracks (B6)
- X Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (**Riverine**)
- ___ Sediment Deposits (B2) (**Riverine**)
- ___ Drift Deposits (B3) (**Riverine**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ___ No X Depth (inches): none

Water Table Present? Yes X No ___ Depth (inches): at surface

Saturation Present? (includes capillary fringe) Yes X No ___ Depth (inches): " "

Wetland Hydrology Present? Yes X No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: SR50/Hazel Ave. City/County: Sacramento Sampling Date: 5-31-16
Applicant/Owner: County of Sac, State: CA Sampling Point: DP-34
Investigator(s): Webber Section, Township, Range: unnamed S, T9N, R7E
Landform (hillslope, terrace, etc.): — Local relief (concave, convex, none): none Slope (%): <1%
Subregion (LRR): Mediterranean California (LRR C) Lat: Long: Datum:
Soil Map Unit Name: Urban Land (227) NWI Classification:
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No (If no, explain in Remarks.)
Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes X No ____
Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ____ No X	**Is the Sampled Area within a Wetland?**	**Yes** ____ **No** X
Hydric Soil Present?	Yes ____ No X		
Wetland Hydrology Present?	Yes ____ No X		

Remarks: Site is near mouth of culvert in the off-ramp.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: 20')			
1. Populus fremontii	5	N	FAC
2.			
3.			
4.			
	5 =Total Cover		
Sapling/Shrub Stratum (Plot size: 20')			
1. Baccharis pilularis	5	N	—
2.			
3.			
4.			
5.			
	5 =Total Cover		
Herb Stratum (Plot size: 5')			
1. Hordeum marinum var. gussoneanum	60	Y	FAC
2. Festuca perennis	25	Y	FAC
3. Avena barbata	5	N	—
4. Geranium dissectum	5	N	—
5. Bromus hordeaceus	5	N	—
6.			
7.			
8.			
	100 =Total Cover		
Woody Vine Stratum (Plot size: ____)			
1.			
2.			
	=Total Cover		

% Bare Ground in Herb Stratum Ø % Cover of Biotic Crust ____

Dominance Test worksheet:
Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)
Total Number of Dominant Species Across All Strata: 2 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index Worksheet:

Total % Cover of:		Multiply by:
OBL species	____ x1 =	
FACW species	____ x2 =	
FAC species	90 x3 =	270
FACU species	____ x4 =	
UPL species	20 x5 =	100
Column Totals:	110 (A)	370 (B)

Prevalence Index = B/A = 3.4

Hydrophytic Vegetation Indicators:
____ Dominance Test is >50%
____ Prevalence Index is ≤3.0[1]
____ Morphological Adaptationd[1] (Provide supporting data in Remarks or on a separate sheet)
____ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ____ No X

Remarks:

SOIL

Sampling Point: DP-34

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-1								bark layer
1-4	10YR 3/4	100					cl	few rocks

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (**LRR C**)
- ___ 1 cm Muck (A9) (**LRR D**)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (**LRR C**)
- ___ 2 cm Muck (A10) (**LRR B**)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: Shovel refusal @ 4" - rock fill

Depth (inches): ___

Hydric Soil Present? Yes ___ No X

Remarks: Area is within constructed interchange, and is likely composed of fill.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1) (**Nonriverine**)
- ___ Sediment Deposits (B2) (**Nonriverine**)
- ___ Drift Deposits (B3) (**Nonriverine**)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (**Riverine**)
- ___ Sediment Deposits (B2) (**Riverine**)
- ___ Drift Deposits (B3) (**Riverine**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ___ No X Depth (inches): none

Water Table Present? Yes ___ No X Depth (inches): none to 4"

Saturation Present? (includes capillary fringe) Yes ___ No X Depth (inches): none to 4"

Wetland Hydrology Present? Yes ___ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: Slight depressional area near culvert. No other evidence of wetland hydrology

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: SR 50/Hazel Ave. City/County: Sacramento Sampling Date: 5-31-16
Applicant/Owner: County of Sacramento State: CA Sampling Point: DP-4w
Investigator(s): Webber Section, Township, Range: unnamed S, T9N, R7E
Landform (hillslope, terrace, etc.): — Local relief (concave, convex, none): none Slope (%): <1%
Subregion (LRR): Mediterranean California (LRR C) Lat: Long: Datum:
Soil Map Unit Name: Urban Land (227) NWI Classification:
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No (If no, explain in Remarks.)
Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes X No ____
Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X No	**Is the Sampled Area within a Wetland?**	**Yes** X **No**
Hydric Soil Present?	Yes X No		
Wetland Hydrology Present?	Yes X No		

Remarks: Site is in a depression at base of roadside slope, at freeway off ramp.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ____)			
1.			
2.			
3.			
4.			
	=Total Cover		
Sapling/Shrub Stratum (Plot size: ____)			
1.			
2.			
3.			
4.			
5.			
	=Total Cover		
Herb Stratum (Plot size: 5')			
1. Hordeum marinum var. gussoneanum	45	Y	FAC
2. Festuca perennis	20	Y	FAC
3. Lythrum hyssopifolia	15	Y	OBL
4. Rumex crispus	15	Y	FAC
5. tarweed (not blooming)	2	N	—
6. Medicago polymorpha	1	N	—
7. Avena barbata	2	N	—
8.			
	100 =Total Cover		
Woody Vine Stratum (Plot size: ____)			
1.			
2.			
	=Total Cover		

% Bare Ground in Herb Stratum 5 % Cover of Biotic Crust 0

Dominance Test worksheet:
Number of Dominant Species That Are OBL, FACW, or FAC: 4 (A)
Total Number of Dominant Species Across All Strata: 4 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index Worksheet:

Total % Cover of:	Multiply by:
OBL species ____	x1 = ____
FACW species ____	x2 = ____
FAC species ____	x3 = ____
FACU species ____	x4 = ____
UPL species ____	x5 = ____
Column Totals: ____ (A)	____ (B)

Prevalence Index = B/A = ____

Hydrophytic Vegetation Indicators:
X Dominance Test is >50%
____ Prevalence Index is ≤3.0[1]
____ Morphological Adaptationd[1] (Provide supporting data in Remarks or on a separate sheet)
____ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes X No ____

Remarks:

SOIL

Sampling Point: DP-4W

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-4	7.5YR 4/6	90	7.5YR 2/1	10		M	sicl	
4-20	7.5YR 4/6	100					sicl	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (**LRR C**)
- ___ 1 cm Muck (A9) (**LRR D**)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- X Redox Depressions (F8)
- ___ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (**LRR C**)
- ___ 2 cm Muck (A10) (**LRR B**)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes X No ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1) (**Nonriverine**)
- ___ Sediment Deposits (B2) (**Nonriverine**)
- ___ Drift Deposits (B3) (**Nonriverine**)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (**Riverine**)
- ___ Sediment Deposits (B2) (**Riverine**)
- ___ Drift Deposits (B3) (**Riverine**)
- X Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- X FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ___ No X Depth (inches): none

Water Table Present? Yes ___ No X Depth (inches): none to 20"

Saturation Present? (includes capillary fringe) Yes ___ No X Depth (inches): none to 20"

Wetland Hydrology Present? Yes X No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: Site is a depressional swale that receives runoff through a culvert under the freeway offramp. Other end of culvert drains a hillslope.

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: SR50/Hazel Ave. City/County: Sacramento Sampling Date: 5-31-16
Applicant/Owner: County of Sacramento State: CA Sampling Point: DP-5u
Investigator(s): Webber Section, Township, Range: unnamed S, T 9N, R7E
Landform (hillslope, terrace, etc.): — Local relief (concave, convex, none): none Slope (%): 10
Subregion (LRR): Mediterranean California (LRR C) Lat: Long: Datum:
Soil Map Unit Name: Urban Land (227) NWI Classification:
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No (If no, explain in Remarks.)
Are Vegetation X, Soil , or Hydrology significantly disturbed? Are "Normal Circumstances" present? Yes X No
Are Vegetation , Soil , or Hydrology naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X No	**Is the Sampled Area within a Wetland?**	**Yes** **No** X
Hydric Soil Present?	Yes No X		
Wetland Hydrology Present?	Yes No X		

Remarks: Upslope of DP-4w. Vegetation was mowed for maintenance—site is in adjacent to freeway offramp.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size:)			
1.			
2.			
3.			
4.			
=Total Cover			
Sapling/Shrub Stratum (Plot size:)			
1.			
2.			
3.			
4.			
5.			
=Total Cover			
Herb Stratum (Plot size: 5')			
1. Hordeum marinum var. guss.	90	y	FAC
2. Medicago polymorpha	1	n	FACU
3. Centaurea solstitialis	5	n	—
4. Trifolium hirtum	1	n	—
5. Festuca perennis	2	n	FAC
6.			
7.			
8.			
100 =Total Cover			
Woody Vine Stratum (Plot size:)			
1.			
2.			
=Total Cover			

% Bare Ground in Herb Stratum 0 % Cover of Biotic Crust

Dominance Test worksheet:
Number of Dominant Species That Are OBL, FACW, or FAC: (A)
Total Number of Dominant Species Across All Strata: (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: (A/B)

Prevalence Index Worksheet:

Total % Cover of:	Multiply by:
OBL species x1 =	
FACW species x2 =	
FAC species x3 =	
FACU species x4 =	
UPL species x5 =	
Column Totals: (A)	(B)
Prevalence Index = B/A =	

Hydrophytic Vegetation Indicators:
Dominance Test is >50%
Prevalence Index is ≤3.0[1]
Morphological Adaptationd[1] (Provide supporting data in Remarks or on a separate sheet)
Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes X No

Remarks: Veg. mowed.

SOIL

Sampling Point: DP-5y

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Redox Features Type[1]	Redox Features Loc[2]	Texture	Remarks
0-8	7.5YR 4/6	100					sicl	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (**LRR C**)
- ___ 1 cm Muck (A9) (**LRR D**)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (**LRR C**)
- ___ 2 cm Muck (A10) (**LRR B**)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: shovel refusal at 8"

Depth (inches): 8"

Hydric Soil Present? Yes ___ No X

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1) (**Nonriverine**)
- ___ Sediment Deposits (B2) (**Nonriverine**)
- ___ Drift Deposits (B3) (**Nonriverine**)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (**Riverine**)
- ___ Sediment Deposits (B2) (**Riverine**)
- ___ Drift Deposits (B3) (**Riverine**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ___ No X Depth (inches): none

Water Table Present? Yes ___ No X Depth (inches): none to 8"

Saturation Present? (includes capillary fringe) Yes ___ No X Depth (inches): none to 8"

Wetland Hydrology Present? Yes ___ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: On slope, no hydrologic indicators

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: SR 50/Hazel Ave. City/County: Sac Sampling Date: 9-2-16
Applicant/Owner: County of Sacramento State: CA Sampling Point: DP-6u
Investigator(s): Webber Section, Township, Range: unnamed S, T9N, R7E
Landform (hillslope, terrace, etc.): terrace Local relief (concave, convex, none): none Slope (%): 1%
Subregion (LRR): Mediterranean California (LRR C) Lat: Long: Datum:
Soil Map Unit Name: Urban land-Natomas complex, 0-2% slopes NWI Classification: —
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No (If no, explain in Remarks.)
Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes X No
Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes ____ No X
Hydric Soil Present? Yes ____ No X
Wetland Hydrology Present? Yes ____ No X
Is the Sampled Area within a Wetland? Yes ____ No X

Remarks: Site is in a basin, near a culvert outlet, at the base of a road embankment

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ____)			
1.			
2.			
3.			
4.			
	____ =Total Cover		
Sapling/Shrub Stratum (Plot size: ____)			
1.			
2.			
3.			
4.			
5.			
	____ =Total Cover		
Herb Stratum (Plot size: 5')			
1. Festuca perennis	30	y	FAC
2. Avena fatua	10	n	—
3. Centaurea solstitialis	20	y	—
4. Vicia sp.	15	y	—
5. Rumex crispus	3	n	FAC
6. Hordeum murinum var. gussoneanum	3	n	FAC
7. Lythrum hyssopifolia	1	n	OBL
8. Trifolium dubium	1	n	UPL
Trifolium hirtum	1	n	—
	95 =Total Cover		
Woody Vine Stratum (Plot size: ____)			
1.			
2.			
Madia sp.	1	n	—
	____ =Total Cover		
% Bare Ground in Herb Stratum 5	% Cover of Biotic Crust Ø		

Dominance Test worksheet:
Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)
Total Number of Dominant Species Across All Strata: 3 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 33% ~~#DIV/0!~~ (A/B)

Prevalence Index Worksheet:

Total % Cover of:		Multiply by:
OBL species	____ x1 =	
FACW species	____ x2 =	
FAC species	____ x3 =	
FACU species	____ x4 =	
UPL species	____ x5 =	
Column Totals:	____ (A)	____ (B)

Prevalence Index = B/A = ____

Hydrophytic Vegetation Indicators:
____ Dominance Test is >50%
____ Prevalence Index is ≤3.0[1]
____ Morphological Adaptationd[1] (Provide supporting data in Remarks or on a separate sheet)
____ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ____ No X

Remarks: Bare ground is covered in cobbles

SOIL

Sampling Point: DP-64

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Redox Features Type[1]	Redox Features Loc[2]	Texture	Remarks
0-4	10YR 3/4	100					cl	roots + cobbles
4-12	10YR 3/4	100					cl	cobbles, some broken glass

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (**LRR C**)
- ___ 1 cm Muck (A9) (**LRR D**)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (**LRR C**)
- ___ 2 cm Muck (A10) (**LRR B**)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: cobble

Depth (inches): 12

Hydric Soil Present? Yes ___ No X

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1) (**Nonriverine**)
- ___ Sediment Deposits (B2) (**Nonriverine**)
- ___ Drift Deposits (B3) (**Nonriverine**)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (**Riverine**)
- ___ Sediment Deposits (B2) (**Riverine**)
- ___ Drift Deposits (B3) (**Riverine**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ___ No X Depth (inches): none@surface

Water Table Present? Yes ___ No X Depth (inches): 7 12

Saturation Present? (includes capillary fringe) Yes ___ No X Depth (inches): 7 12

Wetland Hydrology Present? Yes ___ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: No evidence of wetland hydrology

Appendix C Representative Photographs



Photo 1. Seasonal wetland SW-2, looking south



Photo 2. Seasonal wetland SW-2, looking north



Photo 3. Seasonal wetland vegetation



Photo 4. Culvert connecting to seasonal wetland SW-2



Photo 5. Alder Creek with fringe of emergent wetland, looking west



Photo 6. Alder Creek at US 50 bridge

Appendix D Soil Survey Map and Information

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Sacramento County, California

US 50/Hazel Avenue Interchange



March 23, 2016

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (http://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the

individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

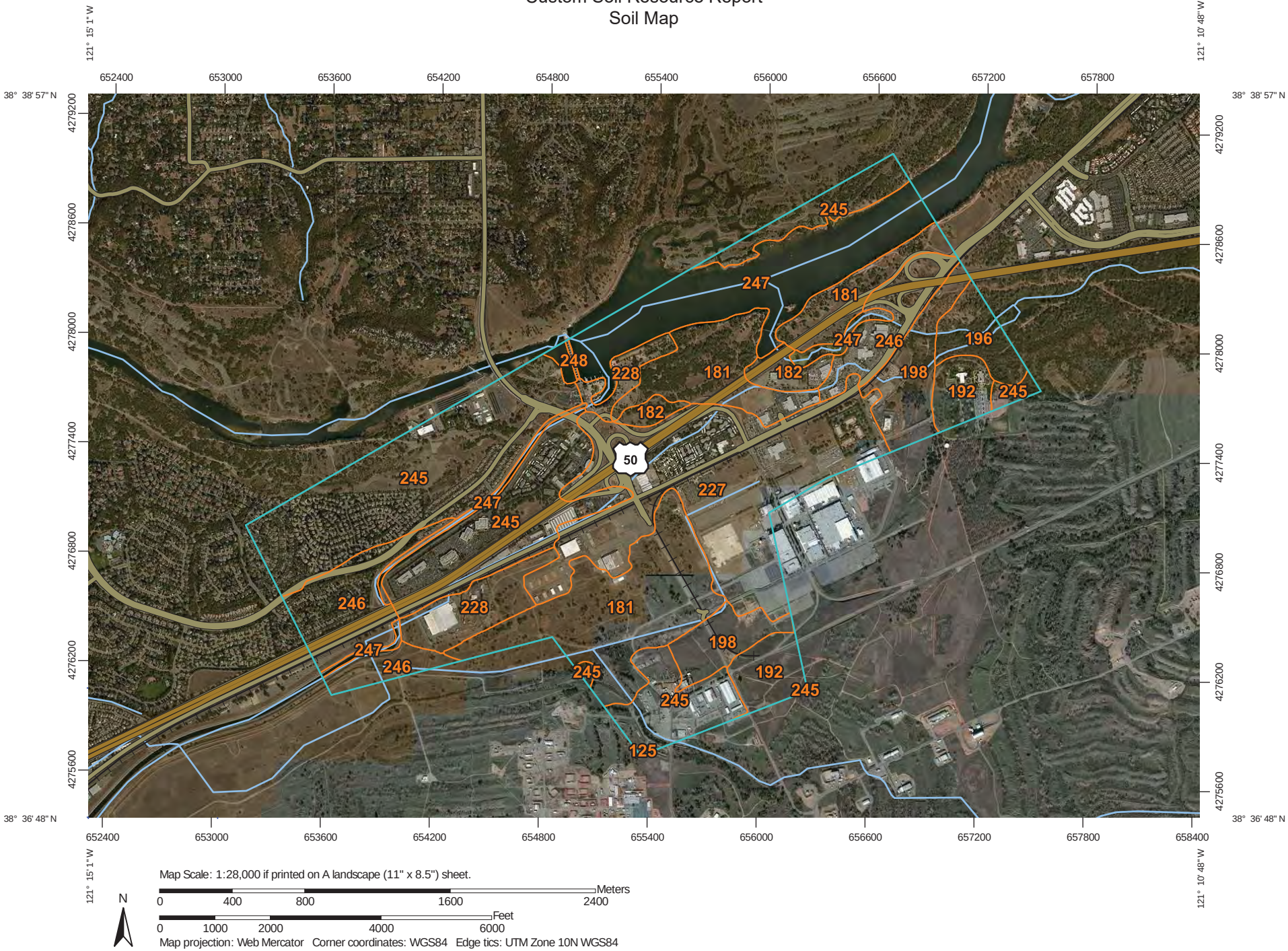
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map



MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Sacramento County, California
Survey Area Data: Version 14, Sep 14, 2015

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Aug 15, 2011—Oct 24, 2013

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Sacramento County, California (CA067)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
125	Corning complex, 0 to 8 percent slopes	0.5	0.0%
181	Natomas loam, 0 to 2 percent slopes	282.2	17.1%
182	Natomas-Xerorthents, dredge tailings complex, 0 to 50 percent slopes	28.8	1.7%
192	Red Bluff loam, 2 to 5 percent slopes	59.9	3.6%
196	Red Bluff-Xerorthents, dredge tailings, complex, 2 to 50 percent slopes	35.8	2.2%
198	Redding gravelly loam, 0 to 8 percent slopes	92.9	5.6%
227	Urban land	292.7	17.7%
228	Urban land-Natomas complex, 0 to 2 percent slopes	69.3	4.2%
245	Xerorthents, dredge tailings, 2 to 50 percent slopes	452.9	27.4%
246	Xerorthents, dredge tailings-Urban land complex, 0 to 2 percent slopes	146.5	8.9%
247	Water	189.0	11.4%
248	Dam	1.1	0.1%
Totals for Area of Interest		**1,651.6**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be

made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Sacramento County, California

125—Corning complex, 0 to 8 percent slopes

Map Unit Setting

National map unit symbol: hhm0
Elevation: 80 to 1,000 feet
Mean annual precipitation: 16 to 30 inches
Mean annual air temperature: 61 to 63 degrees F
Frost-free period: 250 to 280 days
Farmland classification: Not prime farmland

Map Unit Composition

Corning and similar soils: 45 percent
Corning and similar soils: 40 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Corning

Setting

Landform: Terraces
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Gravelly alluvium

Typical profile

H1 - 0 to 28 inches: gravelly loam
H2 - 28 to 47 inches: gravelly clay loam
H3 - 47 to 62 inches: stratified gravelly sandy loam to gravelly clay loam

Properties and qualities

Slope: 2 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 5.5 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: D
Ecological site: GRAVELLY LOAMY (R017XD090CA)

Description of Corning

Setting

Landform: Terraces
Landform position (two-dimensional): Toeslope

Landform position (three-dimensional): Tread
Microfeatures of landform position: Swales
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Gravelly alluvium

Typical profile
H1 - 0 to 20 inches: gravelly sandy loam
H2 - 20 to 32 inches: clay
H3 - 32 to 60 inches: stratified gravelly sandy loam to gravelly clay loam

Properties and qualities
Slope: 0 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 4.9 inches)

Interpretive groups
Land capability classification (irrigated): 2e
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: D
Ecological site: GRAVELLY LOAMY INTERMOUND (R017XD091CA)

Minor Components

Creviscreek
Percent of map unit: 4 percent

Hicksville
Percent of map unit: 4 percent

Redding
Percent of map unit: 4 percent

Unnamed, steeper slopes
Percent of map unit: 3 percent

181—Natomas loam, 0 to 2 percent slopes

Map Unit Setting
National map unit symbol: hhnt
Elevation: 50 to 180 feet
Mean annual precipitation: 17 to 23 inches
Mean annual air temperature: 61 to 63 degrees F
Frost-free period: 275 to 300 days

Farmland classification: Prime farmland if irrigated

Map Unit Composition

Natomas and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Natomas

Setting

Landform: Terraces
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

H1 - 0 to 17 inches: loam
H2 - 17 to 33 inches: loam
H3 - 33 to 78 inches: clay loam
H4 - 78 to 84 inches: stratified gravelly coarse sandy loam to sandy loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 10.3 inches)

Interpretive groups

Land capability classification (irrigated): 1
Land capability classification (nonirrigated): 3c
Hydrologic Soil Group: C

Minor Components

Americanos

Percent of map unit: 5 percent

Kimball

Percent of map unit: 4 percent

San joaquin

Percent of map unit: 4 percent

Unnamed, brown subsoil

Percent of map unit: 2 percent

182—Natomas-Xerorthents, dredge tailings complex, 0 to 50 percent slopes

Map Unit Setting

National map unit symbol: hhnv
Elevation: 0 to 2,500 feet
Mean annual precipitation: 17 to 23 inches
Mean annual air temperature: 61 to 63 degrees F
Frost-free period: 275 to 300 days
Farmland classification: Not prime farmland

Map Unit Composition

Natomas and similar soils: 45 percent
Xerorthents and similar soils: 40 percent
Unnamed, slickens: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Natomas

Setting

Landform: Terraces
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

H1 - 0 to 17 inches: loam
H2 - 17 to 33 inches: loam
H3 - 33 to 78 inches: clay loam
H4 - 78 to 84 inches: stratified gravelly coarse sandy loam to sandy loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 10.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3c
Hydrologic Soil Group: C

Description of Xerorthents

Setting

Landform: Terraces
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mine spoil or earthy fill

Typical profile

H1 - 0 to 60 inches: variable

Properties and qualities

Slope: 2 to 50 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 0.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e

Description of Unnamed, Slickens

Setting

Landform: Terraces
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s

192—Red Bluff loam, 2 to 5 percent slopes

Map Unit Setting

National map unit symbol: hhp5
Elevation: 200 to 800 feet
Mean annual precipitation: 30 inches
Mean annual air temperature: 63 degrees F
Frost-free period: 250 to 280 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Red bluff and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Red Bluff

Setting

Landform: Terraces
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

H1 - 0 to 8 inches: loam
H2 - 8 to 25 inches: clay loam
H3 - 25 to 43 inches: clay loam
H4 - 43 to 68 inches: gravelly clay loam

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C
Ecological site: LOAMY (R017XD045CA)

Minor Components

Redding

Percent of map unit: 7 percent

Xerorthents

Percent of map unit: 7 percent

Unnamed

Percent of map unit: 2 percent
Landform: Depressions

Unnamed, steeper slopes

Percent of map unit: 2 percent

Unnamed, hardpan soil

Percent of map unit: 2 percent

196—Red Bluff-Xerorthents, dredge tailings, complex, 2 to 50 percent slopes

Map Unit Setting

National map unit symbol: hhp9
Elevation: 0 to 2,500 feet
Mean annual precipitation: 30 inches
Mean annual air temperature: 63 degrees F
Frost-free period: 250 to 280 days
Farmland classification: Not prime farmland

Map Unit Composition

Red bluff and similar soils: 45 percent
Xerorthents,, dredge tailings, and similar soils: 40 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Red Bluff

Setting

Landform: Terraces
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

H1 - 0 to 8 inches: loam
H2 - 8 to 25 inches: clay loam
H3 - 25 to 43 inches: clay loam
H4 - 43 to 68 inches: gravelly clay loam

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C
Ecological site: LOAMY (R017XD045CA)

Description of Xerorthents,, Dredge Tailings

Setting

Landform: Terraces
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mine spoil or earthy fill

Typical profile

H1 - 0 to 60 inches: variable

Properties and qualities

Slope: 2 to 50 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 0.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e

Minor Components

Hicksville

Percent of map unit: 4 percent

Unnamed

Percent of map unit: 2 percent
Landform: Depressions

Corning

Percent of map unit: 2 percent

Hicksville

Percent of map unit: 2 percent

Redding

Percent of map unit: 2 percent

Unnamed

Percent of map unit: 1 percent
Landform: Depressions

Unnamed, hardpan below 40 inches

Percent of map unit: 1 percent

Unnamed, steeper slopes

Percent of map unit: 1 percent

198—Redding gravelly loam, 0 to 8 percent slopes

Map Unit Setting

National map unit symbol: hhpc
Elevation: 100 to 1,500 feet
Mean annual precipitation: 14 to 25 inches
Mean annual air temperature: 61 to 63 degrees F
Frost-free period: 230 to 320 days
Farmland classification: Not prime farmland

Map Unit Composition

Redding and similar soils: 75 percent
Minor components: 25 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Redding

Setting

Landform: Terraces
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Gravelly alluvium

Typical profile

H1 - 0 to 7 inches: gravelly loam
H2 - 7 to 20 inches: gravelly loam
H3 - 20 to 28 inches: gravelly clay loam
H4 - 28 to 66 inches: indurated

Properties and qualities

Slope: 0 to 8 percent
Depth to restrictive feature: 28 to 66 inches to duripan
Natural drainage class: Moderately well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 2.9 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: C
Ecological site: GRAVELLY LOAMY (R017XD090CA)

Minor Components

Corning
Percent of map unit: 4 percent

Hicksville
Percent of map unit: 4 percent

Keyes
Percent of map unit: 4 percent

Pardee
Percent of map unit: 4 percent

Xerorthents
Percent of map unit: 4 percent

Unnamed
Percent of map unit: 1 percent
Landform: Depressions

Durixeralfs
Percent of map unit: 1 percent

Xerarents
Percent of map unit: 1 percent

Unnamed, hardpan below 40 inches
Percent of map unit: 1 percent

Unnamed, steeper slopes
Percent of map unit: 1 percent

227—Urban land

Map Unit Composition
Urban land: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Urban Land

Typical profile
H1 - 0 to 6 inches: variable

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8

228—Urban land-Natomas complex, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: hhqb
Elevation: 50 to 180 feet
Mean annual precipitation: 17 to 23 inches
Mean annual air temperature: 61 to 63 degrees F
Frost-free period: 275 to 300 days
Farmland classification: Not prime farmland

Map Unit Composition

Urban land: 45 percent
Natomas and similar soils: 40 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Urban Land

Typical profile

H1 - 0 to 6 inches: variable

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8

Description of Natomas

Setting

Landform: Terraces
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

H1 - 0 to 17 inches: loam
H2 - 17 to 33 inches: loam
H3 - 33 to 78 inches: clay loam
H4 - 78 to 84 inches: stratified gravelly coarse sandy loam to sandy loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 10.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3c
Hydrologic Soil Group: C

Minor Components

Americanos

Percent of map unit: 4 percent

Kimball

Percent of map unit: 4 percent

San joaquin

Percent of map unit: 3 percent

Xerarents

Percent of map unit: 3 percent

Unnamed, clayey subsoil

Percent of map unit: 1 percent

245—Xerorthents, dredge tailings, 2 to 50 percent slopes

Map Unit Setting

National map unit symbol: hhqw
Elevation: 80 to 400 feet
Mean annual precipitation: 18 to 20 inches
Mean annual air temperature: 61 degrees F
Frost-free period: 250 to 300 days
Farmland classification: Not prime farmland

Map Unit Composition

Xerorthents, dredge tailings, and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Xerorthents, Dredge Tailings

Setting

Parent material: Mine spoil or earthy fill

Typical profile

H1 - 0 to 60 inches: fragmental material

Properties and qualities

Slope: 2 to 50 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Runoff class: Low

Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 1.2 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8s
Hydrologic Soil Group: A

Minor Components

Natomas
Percent of map unit: 2 percent

Red bluff
Percent of map unit: 2 percent

Rossmoor
Percent of map unit: 2 percent

Riverwash
Percent of map unit: 1 percent
Landform: Channels

Unnamed, slickens
Percent of map unit: 1 percent
Landform: Depressions

Xerofluvents
Percent of map unit: 1 percent
Landform: Flood plains
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread

Redding
Percent of map unit: 1 percent

246—Xerorthents, dredge tailings-Urban land complex, 0 to 2 percent slopes

Map Unit Setting
National map unit symbol: hhqx
Elevation: 80 to 400 feet
Mean annual precipitation: 18 to 20 inches
Mean annual air temperature: 61 degrees F
Frost-free period: 250 to 300 days
Farmland classification: Not prime farmland

Map Unit Composition
Xerorthents, dredge tailings, and similar soils: 45 percent

Urban land: 40 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Xerorthents, Dredge Tailings

Setting
Parent material: Mine spoil or earthy fill

Typical profile
H1 - 0 to 60 inches: fragmental material

Properties and qualities
Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 1.2 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8s
Hydrologic Soil Group: A

Description of Urban Land

Typical profile
H1 - 0 to 6 inches: variable

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8

Minor Components

Unnamed, slickens
Percent of map unit: 5 percent
Landform: Depressions

Americano
Percent of map unit: 5 percent

Natomas
Percent of map unit: 5 percent

247—Water

Map Unit Composition

Water: 100 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Water

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 8

248—Dam

Map Unit Composition

Dam: 100 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Soil Information for All Uses

Soil Reports

The Soil Reports section includes various formatted tabular and narrative reports (tables) containing data for each selected soil map unit and each component of each unit. No aggregation of data has occurred as is done in reports in the Soil Properties and Qualities and Suitabilities and Limitations sections.

The reports contain soil interpretive information as well as basic soil properties and qualities. A description of each report (table) is included.

Land Classifications

This folder contains a collection of tabular reports that present a variety of soil groupings. The reports (tables) include all selected map units and components for each map unit. Land classifications are specified land use and management groupings that are assigned to soil areas because combinations of soil have similar behavior for specified practices. Most are based on soil properties and other factors that directly influence the specific use of the soil. Example classifications include ecological site classification, farmland classification, irrigated and nonirrigated land capability classification, and hydric rating.

Hydric Soils (US 50/Hazel Avenue Interchange)

This table lists the map unit components that are rated as hydric soils in the survey area. This list can help in planning land uses; however, onsite investigation is recommended to determine the hydric soils on a specific site (National Research Council, 1995; Hurt and others, 2002).

The three essential characteristics of wetlands are hydrophytic vegetation, hydric soils, and wetland hydrology (Cowardin and others, 1979; U.S. Army Corps of Engineers, 1987; National Research Council, 1995; Tiner, 1985). Criteria for all of the characteristics must be met for areas to be identified as wetlands. Undrained hydric soils that have natural vegetation should support a dominant population of ecological wetland plant species. Hydric soils that have been converted to other uses should be capable of being restored to wetlands.

Hydric soils are defined by the National Technical Committee for Hydric Soils (NTCHS) as soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part

(Federal Register, 1994). These soils, under natural conditions, are either saturated or inundated long enough during the growing season to support the growth and reproduction of hydrophytic vegetation.

The NTCHS definition identifies general soil properties that are associated with wetness. In order to determine whether a specific soil is a hydric soil or nonhydric soil, however, more specific information, such as information about the depth and duration of the water table, is needed. Thus, criteria that identify those estimated soil properties unique to hydric soils have been established (Federal Register, 2002). These criteria are used to identify map unit components that normally are associated with wetlands. The criteria used are selected estimated soil properties that are described in "Soil Taxonomy" (Soil Survey Staff, 1999) and "Keys to Soil Taxonomy" (Soil Survey Staff, 2006) and in the "Soil Survey Manual" (Soil Survey Division Staff, 1993).

If soils are wet enough for a long enough period of time to be considered hydric, they should exhibit certain properties that can be easily observed in the field. These visible properties are indicators of hydric soils. The indicators used to make onsite determinations of hydric soils are specified in "Field Indicators of Hydric Soils in the United States" (Hurt and Vasilas, 2006).

Hydric soils are identified by examining and describing the soil to a depth of about 20 inches. This depth may be greater if determination of an appropriate indicator so requires. It is always recommended that soils be excavated and described to the depth necessary for an understanding of the redoximorphic processes. Then, using the completed soil descriptions, soil scientists can compare the soil features required by each indicator and specify which indicators have been matched with the conditions observed in the soil. The soil can be identified as a hydric soil if at least one of the approved indicators is present.

Map units that are dominantly made up of hydric soils may have small areas, or inclusions, of nonhydric soils in the higher positions on the landform, and map units dominantly made up of nonhydric soils may have inclusions of hydric soils in the lower positions on the landform.

The criteria for hydric soils are represented by codes in the table (for example, 2). Definitions for the codes are as follows:

1. All Histels except for Folistels, and Histosols except for Folists.
2. Soils in Aquic suborders, great groups, or subgroups, Albolls suborder, Historthels great group, Histoturbels great group, Pachic subgroups, or Cumulic subgroups that:
    A. Based on the range of characteristics for the soil series, will at least in part meet one or more Field Indicators of Hydric Soils in the United States, or
    B. Show evidence that the soil meets the definition of a hydric soil;
3. Soils that are frequently ponded for long or very long duration during the growing season.
    A. Based on the range of characteristics for the soil series, will at least in part meet one or more Field Indicators of Hydric Soils in the United States, or
    B. Show evidence that the soil meets the definition of a hydric soil;
4. Map unit components that are frequently flooded for long duration or very long duration during the growing season that:
    A. Based on the range of characteristics for the soil series, will at least in part meet one or more Field Indicators of Hydric Soils in the United States, or
    B. Show evidence that the soil meets the definition of a hydric soil;

Hydric Condition: Food Security Act information regarding the ability to grow a commodity crop without removing woody vegetation or manipulating hydrology.

References:
Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.
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National Research Council. 1995. Wetlands: Characteristics and boundaries.
Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18.
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Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service. U.S. Department of Agriculture Handbook 436.
Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.
United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

Report—Hydric Soils (US 50/Hazel Avenue Interchange)

Hydric Soils–Sacramento County, California				
Map symbol and map unit name	**Component**	**Percent of map unit**	**Landform**	**Hydric criteria**
125—Corning complex, 0 to 8 percent slopes				
	Corning	40	Terraces	3
182—Natomas-Xerorthents, dredge tailings complex, 0 to 50 percent slopes				
	Unnamed, slickens	15	Terraces	3
192—Red Bluff loam, 2 to 5 percent slopes				
	Unnamed	2	Depressions	3
196—Red Bluff-Xerorthents, dredge tailings, complex, 2 to 50 percent slopes				
	Unnamed	2	Depressions	3
	Unnamed	1	Depressions	3
198—Redding gravelly loam, 0 to 8 percent slopes				
	Unnamed	1	Depressions	3

Hydric Soils–Sacramento County, California				
Map symbol and map unit name	**Component**	**Percent of map unit**	**Landform**	**Hydric criteria**
245—Xerorthents, dredge tailings, 2 to 50 percent slopes				
	Riverwash	1	Channels	4
	Unnamed, slickens	1	Depressions	3
	Xerofluvents	1	Flood plains	4
246—Xerorthents, dredge tailings-Urban land complex, 0 to 2 percent slopes				
	Unnamed, slickens	5	Depressions	3

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American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

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Federal Register. July 13, 1994. Changes in hydric soils of the United States.

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United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

Appendix E Plant Species Observed in the Delineation Area

Plant Species Observed in the Delineation Area

Scientific Name	Common Name	Wetland Indicator Status[2]
Acmispon americanus var. *americanus* [*Lotus purshianus*]	Spanish lotus	UPL
Aesculus californica	Buckeye	NI
Aira caryophyllea	Silver hairgrass	FACU
Alnus rhombifolia	White alder	FACW
Amsinckia menziesii	Small flowered fiddleneck	NI
*Avena barbata**	Slender wild oat	NI
*Avena fatua**	Wild oat	NI
Azolla filiculoides	American water fern	OBL
Baccharis pilularis	Coyote brush	NI
*Brassica nigra**	Black mustard	NI
*Bromus diandrus**	Ripgut brome	NI
*Bromus hordeaceus**	Soft chess	FACU
Bromus madritensis ssp. *madritensis*	Foxtail chess	UPL
Bromus madritensis ssp. *rubens**	Red brome	UPL
*Carduus pycnocephalus**	Italian thistle	NI
Castilleja attenuata	Valley tassels	NI
Ceanothus lemmonii	Lemmon's ceanothus	NI
*Centaurea melitensis**	Maltese star thistle	NI
*Centaurea solstitialis**	Yellow star-thistle	NI
Centaurium tenuiflorum	Slender centaury	FACW
Centromadia fitchii	Spikeweed	FACU
Cercis occidentalis	Redbud	NI
Chlorogalum pomeridianum var. *pomeridianum*	Common soaproot	NI
*Cirsium arvense**	Bull thistle	FACU
Clarkia unguiculata	Elegant clarkia	NI
Claytonia perfoliata	Miner's lettuce	FAC
*Conium maculatum**	Poison hemlock	FACW
*Convolvulus arvensis**	Bindweed	NI
*Cortaderia jubata**	Pampas grass	FACU
Cyperus eragrostis	Tall flatsedge	FACW
Dichelostemma capitatum spp. *capitatum*	Blue dicks	FACU
Epilobium brachycarpum	Annual fireweed	NI
Erigeron canadensis	Canada horseweed	FACU
Erodium botrys	Big heronbill	FACU

Scientific Name	Common Name	Wetland Indicator Status[2]
*Erodium cicutarium**	Red stemmed filaree	NI
Eschscholzia californica	California poppy	NI
Eucalyptus sp.	Eucalyptus	Undetermined
Festuca [*Vulpia*] *myuros**	Rattail six weeks grass	FACU
Festuca perennis [*Lolium perenne*]*	Italian ryegrass	FAC
*Ficus carica**	Edible fig	FACU
*Foeniculum vulgare**	Sweet fennel	NI
Frangula californica	Coffeeberry	NI
Fremontodendron californicum	California flannelbush	NI
Galium aparine	Common bedstraw	FACU
*Geranium dissectum**	Cut leaved geranium	NI
Geranium molle	Dove's foot geranium	NI
Heterotheca grandiflora	Telegraph weed	NI
Holocarpha virgata ssp. *virgata*	Narrow tarplant	NI
Hordeum marinum ssp. *gussoneanum*	Mediterranean barley	FAC
Hordeum murinum ssp. *leporinum**	Foxtail barley	FACU
*Hypochaeris glabra**	Smooth cat's ear	NI
*Iris pseudacorus**	Water iris	OBL
Juncus effusus ssp. *pacificus*	Pacific rush	FACW
Kickxia spuria	Fluellin	NI
Lactuca serriola	Prickly lettuce	FACU
Leontodon saxatilis ssp. *longirostris*	Hawkbit	FACU
Ludwigia peploides ssp. *peploides**	Floating water primrose	OBL
Lupinus bicolor	Bicolor lupine	NI
Lupinus nanus	Sky lupine	NI
Lythrum hyssopifolia [*hyssopifolium*]*	Hyssop loosestrife	OBL
*Marrubium vulgare**	White horehound	FACU
*Medicago polymorpha**	Bur clover	FACU
Melilotus indicus	Yellow sweetclover	FACU
Oxalis corniculata	Yellow sorrel	FACU
Persicaria hydropiperoides	Knotweed	OBL
Petrorhagia dubia	Pink grass	NI
Phalaris aquatica	Harding grass	FACU
Phoradendron leucarpum	American mistletoe	NI
Pinus sabiniana	California foothill pine	NI
*Plantago lanceolata**	English plantain	FAC
*Polypogon monspeliensis**	Rabbitsfoot grass	FACW
Populus fremontii ssp. *fremontii*[2]	Fremont cottonwood	FAC
Prunus sp.	Cherry	Undetermined
Quercus lobata	Valley oak	FACU
Quercus wislizeni	Interior live oak	NI
*Raphanus sativus**	Wild radish	NI

Scientific Name	Common Name	Wetland Indicator Status[2]
Rubus ursinus	California blackberry	FAC
*Rumex crispus**	Curly dock	FAC
Salix exigua	Narrowleaf willow	FACW
Salix gooddingii	Black willow	FACW
Sambucus nigra ssp. *caerulea*	Blue elderberry	FACU
Schoenoplectus acutus	Tule	OBL
Senecio vulgaris	Old man of spring	FACU
*Silybum marianum**	Milk-thistle	NI
Stellaria media	Chickweed	FACU
Stipa pulchra	Purple needlegrass	NI
Toxicodendron diversilobum	Poison oak	FACU
Trifolium dubium	Suckling clover	UPL
*Trifolium hirtum**	Rose clover	NI
Verbena bonariensis	Purpletop vervain	FACW
Vicia sativa ssp. *nigra*	Common vetch	FACU
Vicia tetrasperma	Four seeded vetch	NI
Vicia villosa	Hairy vetch	NI

1 Scientific names follow The National Wetland Plant List: 2016 Wetland Ratings (Lichvar et al. 2016). Names in [ ] are from Baldwin et al. 2012.

2 Wetland indicator status ratings and definitions are from Lichvar et al. 2012

- OBL (Obligate Wetland Plants)—Almost always occur in wetlands.
- FACW (Facultative Wetland Plants)—Usually occur in wetlands, but may occur in non-wetlands.
- FAC (Facultative Plants)—Occur in wetlands and nonwetlands.
- FACU (Facultative Upland Plants)—Usually occur in non-wetlands, but may occur in wetlands.
- UPL (Upland Plants)—Almost never occur in wetlands.
- NI (No Indicator) —Species is not included on the National Wetland Plant List.
- Undetermined—cannot be assigned an indicator status because plant could not be identified to species.

* Species identified as invasive by the California Department of Food and Agriculture and/or the California Invasive Plant Council

Appendix F WETS Tables

USDA Field Office Climate Data

WETS Station : REPRESA, CA7370 Creation Date: 04/13/2016
Latitude: 3842 Longitude: 12110 Elevation: 00295
State FIPS/County(FIPS): 06067 County Name: Sacramento
Start yr. - 1971 End yr. - 2000

Month	Temperature (Degrees F.) avg daily max	avg daily min	Precipitation (Inches) avg	avg	30% chance will have less than	more than	avg # of days w/.1 or more	avg total snow fall
January				4.08	1.68	4.96	7	0.0
February				3.93	1.81	4.80	7	0.0
March				3.81	1.59	4.68	7	0.0
April				1.55	0.77	1.91	3	0.0
May				0.81	0.06	0.94	2	0.0
June				0.26	0.00	0.34	1	0.0
July				0.10	NA	NA	0	0.0
August				0.12	0.00	0.02	0	0.0
September				0.45	0.00	0.47	1	0.0
October				1.25	0.40	1.55	3	0.0
November				2.92	1.08	3.52	5	0.0
December				2.93	1.37	3.62	5	0.0
Annual	-----	-----	-----	------	16.84	25.88	--	----
Average				------	------	------	--	----
Average	-----	-----	-----	22.21	------	------	41	0.0

GROWING SEASON DATES

Probability	Temperature: 24 F or higher	28 F or higher	32 F or higher
	Beginning and Ending Dates Growing Season Length		
50 percent *			
70 percent *			

* Percent chance of the growing season occurring between the Beginning and Ending dates.

total 1893-2012 prcp

Station : CA7370, REPRESA
Unit = inches

yr	jan	feb	mar	apr	may	jun	jul	aug	sep	oct	nov	dec	annl
93			7.40	2.00	1.28	0.00	0.00	0.00	0.70	0.26	3.81	2.35	17.80
94	4.71	5.53	0.65	0.56	2.80	1.10			0.65	2.75	0.90	12.56	32.21
95	11.36	2.64	2.50	2.26	1.83			0.00	1.45	0.07	1.98	1.95	26.04
96	9.07	0.22	4.46	6.54	1.62			0.55	0.35	0.82	M5.83	1.80	31.26
97	4.38	8.99	4.95	0.71	0.35	0.00		0.18	0.10	2.61	1.11	2.04	25.42
98	0.79	4.31	0.30	0.45	1.53	0.35			0.24	0.88	1.87	2.62	13.34
99	5.41	0.04	M7.85	0.74	1.12	0.43		0.04	0.00	6.39	5.52	4.39	31.93
0	5.00	1.16	2.73	3.12	1.72	0.00	0.00		0.25	2.26	4.37	1.63	22.24
1	5.01	6.93	0.56	3.63	0.67	0.00	0.00	0.03	1.15	3.02	3.77	1.88	26.65
2	0.99	8.78	3.68	1.78	1.25	0.06	0.00	0.00	0.00	1.97	2.16	4.75	25.42
3	5.77	1.64	8.13	1.04	0.00	0.00	0.00	0.00	0.00	0.19	6.42	1.83	25.02
4	1.15	8.33	8.55	2.13	0.30	0.00	0.00	0.09	3.10	3.41	2.94	2.03	32.03
5	3.34	2.84	M0.98	1.96	2.42			0.00	0.00		1.89	1.29	14.72
6	9.01	M6.25	M1.46	2.45	3.08	1.14		M0.00	0.92		1.77	13.53	39.61
7	6.31	5.31	12.39	1.13	0.70	1.06			0.05	M0.39	M0.31	M6.47	34.12
8	M4.92	3.33	0.96	0.33	1.50	0.14			0.04	1.18	1.53	3.85	17.78
9	14.96	7.44	2.92		M0.00	0.19	0.00	0.00	0.10	1.38	3.47	5.64	36.10
10	4.88	3.23	3.87	0.60	0.07	0.04	0.00	0.00	0.74	0.79	0.72	3.36	18.30
11	20.35	M2.17	5.77	0.83	M0.48	0.04	0.00		0.00	M0.22	0.89	1.56	32.31
12	4.63	0.38	3.36	3.61	1.66	0.57	0.03	0.00	1.10	1.03	1.98	0.96	19.31
13	4.02	0.34	2.07	1.14	1.08	0.00	0.00		0.00	0.16	3.77	M8.52	21.10
14	11.45	4.48	0.75	0.25	1.56	1.04	0.00	0.00	0.00	1.27	0.40	5.85	27.05
15	6.53	8.47	2.28	0.72	5.38	0.00			0.00	0.00	1.30	7.12	31.80
16	11.08	5.62	1.48	0.00	0.07	0.00	0.00	0.00	0.00	0.75	M2.04	3.90	24.94
17	M1.73	M6.82	M1.37	M1.68	0.33				M0.32		M0.80	1.21	14.26
18	M1.11	4.67	M5.88	0.96	M0.09				M0.70	M0.32	2.54	M2.61	18.88
19	M2.18	M9.79	M2.87	M0.83					M0.34	M0.28	M0.29	M4.92	21.50
20	M0.99	M0.82	M7.10	M2.18		M0.16		M0.07	M0.02	M3.44	M5.33	M7.31	27.42
21	M9.12	1.51	M3.51	M0.29	1.57					M0.44	M1.49	M6.57	24.50
22	M3.57	M6.40	M3.03	M1.18	M1.47			0.00	0.00	0.69	M4.73	M9.26	30.33
23	M3.82	M0.64	M0.35	M5.31	M0.55	M0.15		M0.00	M0.86	M0.68	M0.70	1.58	14.64
24	2.80	M2.19	2.02	M0.62	M0.09					3.25	2.19	5.90	19.06
25	1.45	8.06	2.12	M1.66	2.17	0.02			0.13	0.30	1.67	2.20	19.78
26	4.64	7.61	0.08	6.55	0.77			0.00		2.31	7.81	1.63	31.40
27	4.67	7.02	3.81	1.78	0.36	0.58	0.00	0.00	0.00	1.51	3.30	3.54	26.57
28	1.77	2.31	7.25	1.64	0.05	0.09	0.00	0.00	0.00	0.09	3.96	2.84	20.00
29	2.20	2.91	2.64	1.11	0.00	2.24		0.00	0.00	0.12	0.00	5.85	17.07
30	6.23	1.93	3.74	2.20	0.22	0.00	0.00	0.00	0.21	0.40	2.38	1.31	18.62
31	3.16	2.87	1.65	0.30	1.14	0.98	0.00	0.00	0.00	1.29	2.57	8.69	22.65
32	2.01	3.24	0.68	1.31	1.18	0.00	0.00	0.00	0.00	0.00	1.03	2.90	12.35
33	5.58	1.77	3.30	0.00	1.74	0.00	0.00	0.00	0.08	2.43	0.00	10.39	25.29
34	1.30	4.91	0.14	0.37	0.51	0.36	0.00	0.00	0.08	1.84	3.61	2.53	15.65
35	8.02	2.81	3.52	6.02	0.25	0.00	0.00	0.00	0.00	2.17	1.18	2.39	26.36
36	5.98	10.76	1.62	1.76	0.60	0.21	0.00	0.00	0.01	0.58	0.00	3.08	24.60
37	4.01	6.02	7.82	1.83	0.12	0.50	0.00	0.00	0.00	1.45	3.46	2.65	27.86
38	3.84	7.69	4.28	1.45	0.68	0.00	0.00		0.01	1.90	0.60	1.16	21.61
39	2.00	1.76	3.59	0.10	0.99	0.00	0.00	0.00	0.81	0.87	0.10	1.80	12.02
40	12.01	8.17	4.94	2.50	0.24	0.00	0.00	0.00	0.00	1.05	1.58	8.62	39.11
41	4.76	7.97	2.31	3.77	1.10	0.00	0.00	0.00	0.00	0.79	1.21	6.48	28.39
42	6.15	3.70	2.99	5.49	1.83	0.00	0.00	0.00	0.06	0.01	4.24	3.11	27.58

43	4.63	2.53	6.29	2.29	0.42	0.00	0.00	0.00	0.00	0.43	1.10	2.70	20.39
44	3.38	8.23	M1.65	1.79	0.54	0.30	0.00	0.00	0.00	2.21	4.99	2.33	25.42
45	0.69	4.95	2.38	0.62	2.40	0.10	0.00	0.00	0.00	2.46	3.13	6.94	23.67
46	0.77	2.07	3.27	0.05	0.53	0.00	0.00	0.00	0.46	0.62	3.31	1.80	12.88
47	0.62	2.05	3.50	0.50	0.16	0.39	0.00	0.00	0.00	3.28	1.45	1.16	13.11
48	0.99	1.86	3.41	3.32	2.68	0.00	0.00	0.00	0.00	0.34	1.14	3.95	17.69
49	M0.13	M1.14	8.77	0.00	0.33	0.00	0.00	0.00	0.10	0.02	1.07	2.56	14.12
50	M5.83	M2.67	3.63	1.16	0.66	0.03	0.00	0.00	0.31	2.88	7.46	4.75	29.38
51	4.02	2.57	1.26	0.73	1.56	0.00	0.00	0.00	0.00	1.85	3.61	5.89	21.49
52	M9.12	2.71	4.93	1.11	0.09	0.42	0.00	0.00	0.22	0.00	2.56	7.02	28.18
53	4.06	0.25	1.57	4.02	1.52	0.83	0.00	0.00	0.00	0.57	2.37	1.39	16.58
54	3.80	3.25	4.93	2.50	0.38	0.93	0.00	0.33	0.00	0.07	2.86	6.58	25.63
55	3.51	1.52	0.25	2.78	0.53	0.00	0.00	0.00	0.43	0.69	1.84	11.44	22.99
56	8.13	2.61	0.07	1.61	2.99	M0.02	0.00	0.00	0.63	2.10	0.03	0.40	18.59
57	2.70	4.16	3.88	2.41	3.89	0.00	0.00	0.00	M0.23	1.81	0.94	3.12	23.14
58	5.31	7.49	7.58	4.85	0.96	1.20	0.00	0.00	0.30	0.27	0.39	0.66	29.01
59	5.31	4.77	0.95	2.09	0.01	0.00	0.00	0.00	1.93	0.00	0.00	1.11	16.17
60	3.83	3.54	2.44	1.50	0.72	0.00	0.00	0.00	0.02	0.00	5.02	1.33	18.40
61	2.81	1.61	3.48	1.05	0.43	0.00	0.00	M0.00	M0.26	0.29	3.14	1.63	14.70
62	1.65	8.61	1.88	0.57	0.10	0.01	0.04	0.23	0.03	8.80	0.59	2.44	24.95
63	2.83	1.89	4.30	4.69	1.05	0.05	0.00	0.00	0.16	1.96	5.68	0.27	22.88
64	3.23	0.52	1.76	0.28	1.05	0.28	0.00	0.22	0.00	1.82	4.26	7.01	20.43
65	2.91	0.79	2.33	3.45	0.01	0.00	0.02	0.44	0.00	0.24	4.29	3.82	18.30
66	2.45	1.99	0.62	0.70	0.30	0.00	0.06	0.00	0.03	0.00	7.13	3.49	16.77
67	8.58	0.55	4.52	4.42	0.71	0.38	0.00	0.00	0.06	0.23	1.94	1.24	22.63
68	3.71	3.19	2.84	0.47	0.76	0.24	0.00	0.22	0.01	0.81	3.87	3.69	19.81
69	11.54	6.81	1.19	2.18	0.02	0.35	0.00	0.00		0.93	1.80	4.56	29.38
70	7.00	1.68	1.91	0.23	0.00	0.65	0.00	0.00	0.00	1.39	8.13	4.25	25.24
71	1.36	0.26	M3.01	0.45	0.96	0.22	0.00	0.00	0.12	0.60	1.46	5.75	14.19
72	0.69	2.23	0.44	2.52	0.43	0.19	0.00	0.00	1.42	1.12	5.29	2.38	16.71
73	8.10	5.81	3.62	0.70	0.01	0.00	0.00	0.00	0.19	2.29	7.11	4.60	32.43
74	4.49	1.67	4.26	1.74	0.00	0.45	1.96	0.00	0.00	1.67	1.25	2.34	19.83
75	0.83	4.65	M5.81	1.65	0.00	0.11	0.00	0.59	0.00	2.29	0.77	0.78	17.48
76	0.39	1.58	0.63	1.25	0.00	0.05	0.00	1.57	1.33	0.00	0.58	0.24	7.62
77	1.13	0.90	1.01	0.37	1.07	0.00	0.01	0.00	0.43	0.12	1.74	4.22	11.00
78	9.66	3.81	6.37	3.76	0.00	0.16	0.00	0.00	0.79	0.00	4.06	1.01	29.62
79	5.59	5.15	2.47	1.14	0.24	0.00	0.14	0.00	0.00	2.32	2.07	3.96	23.08
80	M6.64	7.21	4.00	M0.93	0.46	0.06	0.80	0.00	0.00			1.88	21.98
81	M5.15	1.18	4.79	0.64	0.37	0.00	0.00	0.00	0.40	2.31	7.32		22.16
82	3.10	3.40	8.26	3.15	0.00	0.32	0.00	0.00	1.97	4.05	6.99	4.11	35.35
83	5.64	7.83	9.19	5.24	0.36	0.00	0.00	0.22	M2.09	1.13	7.72	7.11	46.53
84	0.31	2.24	1.86	0.73	0.10	0.21	0.00	0.17	0.12	1.83	5.68	1.87	15.12
85	0.74	2.02	3.08	0.00	0.00	0.30	0.00	0.18	0.70	0.96	4.60	2.51	15.09
86	3.95	8.68	4.91	1.07	0.23	0.00	0.00	0.00	0.97	0.29	0.33	1.42	21.85
87	2.29		4.64	0.46	M0.97	0.00	0.00	0.00	0.00	0.44	2.67	3.39	14.86
88	3.12	0.79	0.00	3.48	0.47	0.26	0.00	0.00	0.00	0.02	2.81	2.78	13.73
89	M0.73	1.51	8.77	0.42	0.16	0.83	0.00	0.34	2.40	2.49	1.72	0.00	19.37
90	3.29	2.79	0.98	0.87	2.86	0.00	0.00	0.00	0.00		1.33	1.42	13.54
91	0.65	M2.09	10.97	0.31	0.34	0.43	0.00	0.25	0.00	1.82	0.71	2.77	20.34
92	1.78	6.86	2.39	2.13	0.00	0.33	0.00	0.00	0.00	2.37	0.47	7.39	23.72
93	8.33	5.48	3.53	1.00	1.38	1.46	0.00	0.00	0.00	0.77	2.83	2.68	27.46
94	1.41	3.85	0.44	1.36	1.10	0.00	0.00	0.00	0.12	0.57	4.78	1.47	15.10
95	12.71	0.68	10.35	2.42	2.42	1.09	0.00	0.00	0.00	0.00	0.03	2.89	32.59
96	3.52	5.28	M1.97	3.16	2.56	0.16	0.00	0.01	0.00	1.32	2.22	8.00	28.20
97	9.78	M0.41	0.23	0.76	0.29	0.79	0.00	0.28	0.00	1.29	3.92	2.70	20.45
98	7.60	12.05	3.21	3.26	4.82	0.10	0.00	0.00	0.19	0.71	4.22	0.96	37.12
99	3.34	5.37	1.48	0.74	0.25	0.10	0.00	0.07	0.00	0.25	2.14	0.21	13.95
0	5.77	8.99	1.48	1.06	2.52	0.30	0.00	0.00	0.18	3.76	0.47	0.68	25.21
1	3.78	0.00	2.12	2.64	0.00	0.10	0.00	0.00	0.45	0.38	3.26	7.48	20.21
2	0.21	0.57	2.75	0.43	0.55	0.00	0.00	0.00	0.00	0.00	0.15	M5.81	10.47

3	3.61	1.76	1.69	4.83	0.89	0.00	0.00	0.29	0.00	0.30	1.46	5.07	19.90
4	2.31	4.85	0.69	0.38	0.00	0.00	0.00	0.00	0.00	2.91	1.62	4.69	17.45
5	M3.26	2.10	3.94	2.09	2.37	0.77	0.00	0.00	0.50	0.21		M10.18	25.42
6	3.27	1.11	M5.54	M5.46	0.14	0.00	0.00	0.00	0.00	0.22	0.68	2.64	19.06
7	0.00	9.18	0.00	0.00	0.00	0.00	0.00	0.00	0.73	M0.78	0.00	1.84	12.53
8	14.38	10.40	M2.63		0.44	0.00	0.00		0.00	0.30	1.20	2.35	31.70
9	3.40	3.68	M3.42	0.00	0.48	0.00	0.00	0.00	0.00	0.00	0.57	M7.48	19.03
10	5.03	3.19	1.61	2.70	1.39	0.07	0.00	0.00	0.00	1.96	3.97	5.04	24.96
11	M1.67	M5.99	M6.32	M0.10	M1.45	M1.13			0.00	M2.27	M2.29	M0.34	21.56
12	M2.98	M0.83											3.81

Product generated by ACIS - NOAA Regional Climate Centers.

USDA Field Office Climate Data

WETS Station : SACRAMENTO 5 ESE, CA271 Creation Date: 06/23/2016
Latitude: 3833 Longitude: 12125 Elevation: 00038
State FIPS/County(FIPS): 06067 County Name: Sacramento
Start yr. - 1971 End yr. - 2000

	Temperature (Degrees F.)			Precipitation (Inches)				
					30% chance will have		avg # of days w/.1 or more	avg total snow fall
Month	avg daily max	avg daily min	avg	avg	less than	more than		
January	55.1	41.3	48.2	4.18	1.79	5.10	7	0.0
February	62.2	44.7	53.5	3.77	1.59	4.59	7	0.0
March	67.0	47.1	57.1	3.15	1.39	3.84	7	0.0
April	73.9	49.5	61.7	1.17	0.59	1.43	3	0.0
May	81.6	54.1	67.9	0.60	0.03	0.63	1	0.0
June	88.8	58.4	73.6	0.18	0.00	0.21	1	0.0
July	93.8	60.9	77.4	0.05	0.00	0.00	0	0.0
August	92.5	60.8	76.7	0.05	0.00	0.00	0	0.0
September	88.6	59.0	73.8	0.37	0.00	0.37	1	0.0
October	79.2	53.6	66.4	1.00	0.32	1.21	2	0.0
November	64.2	45.9	55.1	2.59	0.97	3.16	5	0.0
December	55.0	40.4	47.7	2.76	1.22	3.40	5	0.0
Annual	-----	-----	-----	------	15.40	22.98	--	----
Average	75.2	51.3	63.3	------	------	------	--	----
Average	-----	-----	-----	19.87	------	------	38	0.0

GROWING SEASON DATES

	Temperature		
Probability	24 F or higher	28 F or higher	32 F or higher
	Beginning and Ending Dates Growing Season Length		
50 percent *			
70 percent *			

* Percent chance of the growing season occurring between the Beginning and Ending dates.

total 1877-2016 prcp

Station : CA271, SACRAMENTO 5 ESE
------- Unit = inches

yr	jan	feb	mar	apr	may	jun	jul	aug	sep	oct	nov	dec	annl
77							M0.00	0.00	0.00	0.73	1.07	1.43	3.23
78	9.26	8.04	3.09	1.07	0.17	0.00	0.00	0.00	0.29	0.55	0.51	0.47	23.45
79	3.18	3.89	4.88	2.56	1.30	0.13	0.00	0.00	0.00	0.88	2.05	3.41	22.28
80	1.64	1.83	1.70	M14.20	0.76	0.00	0.00	0.00	0.00	0.00	0.05	11.81	31.99
81	6.14	5.06	1.37	1.64	0.00	0.50	0.00	0.00	0.30	0.55	1.88	3.27	20.71
82	1.89	2.40	3.78	1.99	0.35	0.10	0.00	M0.00	0.57	2.63	3.22	1.13	18.06
83	2.23	1.11	3.70	0.67	2.85	0.00	0.00	0.00	0.90	0.97	0.61	0.44	13.48
84	3.43	4.46	8.14	4.32	0.06	1.45	0.00	0.00	0.60	2.01	0.00	10.45	34.92
85	2.16	0.49	0.08	0.68	0.00	0.11	0.00	0.00	0.08	0.02	11.34	5.76	20.72
86	7.95	0.29	2.68	4.08	0.07	0.00	M0.00	0.00	0.00	0.68	0.21	2.18	18.14
87	1.12	6.28	0.94	2.53	0.00	0.00	0.00	0.00	0.02	0.00	0.45	2.09	13.43
88	4.81	0.57	3.04	0.10	0.40	0.08	0.00	0.00	0.55	0.00	4.28	M4.61	18.44
89	0.15	0.33	6.25	0.26	3.25	0.25	0.00	0.00	0.00	6.02	3.15	7.82	27.48
90	6.62	4.06	3.00	1.33	1.80	0.00	0.00	0.00	0.80	M0.00	0.00	6.68	24.29
91	0.53	6.61	1.78	2.04	0.66	0.05	0.00	0.00	0.10	0.10	0.48	3.28	15.63
92	1.78	2.84	3.02	1.20	2.38	0.00	M0.00	0.00	0.18	0.70	3.34	4.90	20.34
93	3.27	2.66	3.51	1.08	1.05	0.00	0.00	0.00	0.22	0.12	2.92	1.76	16.59
94	4.17	3.92	0.74	M0.34	1.70	0.46	0.00	0.00	0.88	1.06	0.48	8.86	22.61
95	8.42	1.84	1.20	0.86	0.51	0.00	0.04	0.00	1.26	0.17	1.54	1.54	17.38
96	9.76	0.09	2.57	5.34	0.66	0.00	0.00	0.20	0.31	0.55	3.56	1.76	24.80
97	3.66	4.15	2.54	0.25	0.30	0.04	0.00	0.01	0.16	1.96	0.61	1.64	15.32
98	0.98	3.19	0.04	0.28	1.50	0.14	0.00	0.00	0.36	0.64	0.61	2.30	10.04
99	3.94	0.04	6.02	0.10	0.54	0.49	0.00	0.02	0.00	4.46	2.62	2.91	21.14
0	3.54	0.32	1.61	1.88	2.88	0.00	0.00	0.00	0.06	1.74	4.50	1.38	17.91
1	3.70	5.32	M0.48	2.23	0.80	0.00	0.00	0.00	0.56	1.56	2.68	1.19	18.52
2	0.95	6.52	1.99	1.36	0.45	0.01	0.00	0.00	0.00	1.67	M1.96	2.91	17.82
3	3.05	1.70	4.81	0.46	0.00	0.00	0.00	0.00	0.00	0.12	3.44	1.12	14.70
4	0.45	5.26	5.43	1.02	0.03	0.00	0.00	0.07	3.62	1.86	2.05	1.20	20.99
5	3.34	2.47	3.75	1.18	2.45	0.00	0.00	0.00	0.03	0.00	1.20	0.56	14.98
6	6.63	3.02	8.45	1.21	2.24	0.59	0.00	0.00	0.20	0.00	0.99	7.37	30.70
7	4.63	2.37	7.28	0.25	0.10	0.85	0.00	0.00	0.00	1.20	0.04	M2.71	19.43
8	3.84	2.75	0.42	0.08	0.54	0.00	0.00	0.00	0.05	0.26	1.23	2.04	11.21
9	9.65	6.53	1.84	0.00	0.00	0.03	0.00	0.00	0.21	1.27	1.32	3.87	24.72
10	1.48	0.83	3.06	0.11	0.03	0.00	0.00	0.00	0.20	0.28	0.17	1.62	7.78
11	12.72	1.88	4.30	0.66	0.03	0.12	0.00	0.00	0.00	0.18	0.15	1.07	21.11
12	2.74	0.23	1.97	1.69	0.94	0.58	0.00	0.00	1.25	0.58	0.80	0.23	11.01
13	2.52	0.16	1.34	0.53	0.51	0.11	0.00	0.01	0.00	0.13	4.58	4.40	14.29
14	5.97	2.96	0.59	0.70	0.50	0.60	0.00	0.00	0.00	0.82	0.47	3.44	16.05
15	3.76	M4.26	1.20	0.50	2.75	0.00	0.00	0.01	0.00	0.00	0.83	4.42	17.73
16	9.35	2.45	1.06	0.06	0.10	0.01	0.07	0.00	0.16	0.79	0.49	3.73	18.27
17	1.30	4.97	0.70	0.62	0.12	0.00	0.00	0.00	0.51	M0.00	0.25	0.45	8.92
18	0.97	3.36	4.00	1.06	0.01	0.00	M0.00	0.00	3.58		1.84	1.70	16.52
19	1.77	M6.15	1.50	0.11	0.01	0.00	0.00	0.00	0.53	0.01	M0.36	2.22	12.66
20	0.29	0.81	3.27	1.36	0.00	0.05	0.00	0.00	0.01	1.29	3.39	4.32	14.79
21	4.61	0.54	1.45	0.39	0.75	0.05	0.00	0.00	0.00	0.80	1.09	3.81	13.49
22	2.16	4.18	1.29	0.40	0.43	0.00	0.00	0.00	0.00	0.72	3.03	6.12	18.33
23	2.05	0.30	0.43	2.87	0.08	0.09	0.00	0.00	0.50	0.58	0.62	0.94	8.46
24	1.80	2.00	M0.65	0.30	0.06	0.00	0.00	0.00	0.00	2.10	1.59	3.63	12.13
25	1.02	4.45	1.14	1.61	2.11	0.05	0.01	0.01	0.02	0.00	1.13	1.50	13.05
26	3.20	5.52	0.05	4.25	0.36	0.00	0.00	0.00	0.00	2.14	4.48	0.58	20.58

27	2.30	4.99	1.01	M1.47	0.21	0.57	0.00	0.00	0.01	1.45	1.81	M0.58	14.40
28	1.17	1.38	3.39	0.78	0.02	0.04	0.00	0.00	0.00	0.15	2.98	2.66	12.57
29	0.88	1.44	0.78	M0.44	0.04	1.02	0.00	M0.00	0.00	0.15	0.00	4.06	8.81
30	3.65	1.62	2.86	0.94	0.34	0.00	0.00	0.00	0.29	0.47	1.11	0.56	11.84
31	2.50	1.35	1.14	0.05	0.67	0.29	0.00	0.00	0.00	0.18	1.30	6.84	14.32
32	1.09	1.76	0.34	0.76	0.30	0.00	0.00	0.00	0.00	0.00	0.36	2.11	6.72
33	2.85	0.95	1.44	0.03	0.30	0.08	0.00	0.00	0.03	0.66	0.00	5.74	12.08
34	1.33	2.97	0.13	0.16	0.26	0.30	0.00	0.00	0.01	0.45	2.61	2.50	10.72
35	4.81	1.97	2.93	5.81	0.01	0.00	0.00	0.00	0.00	1.22	0.77	2.18	19.70
36	3.80	8.59	1.33	1.69	0.68	0.27	0.00	0.00	0.00	0.35	0.03	2.62	19.36
37	2.92	6.18	6.37	1.10	0.01	0.18	0.00	0.00	0.00	0.87	2.69	4.06	24.38
38	3.50	8.24	3.92	1.51	0.04	0.00	0.00	0.00	0.30	1.29	0.88	0.71	20.39
39	1.91	1.06	2.42	0.25	0.92	0.00	0.00	0.00	0.35	0.45	0.07	1.15	8.58
40	7.98	9.25	4.22	0.68	0.92	0.00	0.00	0.00	0.01	0.93	1.32	M7.67	32.98
41	5.78	5.40	2.86	4.76	1.35	0.02	0.00	0.00	0.00	0.86	1.17	6.29	28.49
42	4.68	2.98	3.31	4.58	1.07	0.00	0.00	0.00	0.03	0.27	2.22	3.16	22.30
43	7.04	1.26	3.60	1.91	0.14	0.35	0.00	0.00	0.00	0.16	0.62	2.02	17.10
44	3.08	7.27	1.42	1.66	0.83	0.52	0.00	0.00	0.00	1.39	3.54	2.31	22.02
45	1.82	4.49	2.83	0.08	0.55	0.05	0.00	0.00	0.00	2.53	1.60	5.07	19.02
46	0.77	0.90	1.94	0.06	0.61	0.00	0.00	0.00	0.04	0.75	2.42	1.56	9.05
47	0.60	2.34	3.28	0.15	0.17	0.28	0.00	0.00	0.00	2.60	1.02	0.64	11.08
48	0.51	0.88	3.68	M2.72	2.91	0.01	0.00	0.00	0.10	1.45	0.59	4.88	17.73
49	1.47	1.91	4.15	0.00	0.32	0.00	0.00	0.01	0.03	0.14	1.10	1.90	11.03
50	4.41	3.27	2.00	1.03	0.37	0.05	0.01	0.00	0.62	2.35	5.50	4.72	24.33
51	2.45	1.57	0.84	0.85	0.64	0.00	0.00	0.00	0.25	1.33	3.18	5.11	16.22
52	8.65	1.65	4.50	1.41	0.05	0.45	0.01	0.00	0.05	0.00	2.04	7.27	26.08
53	3.51	0.21	1.42	2.69	0.52	0.61	0.00	0.67	0.00	0.18	1.79	0.56	12.16
54	3.26	3.70	3.29	1.88	0.21	0.00	0.00	0.35	0.00	0.02	3.35	4.93	20.99
55	3.14	1.33	0.37	2.75	0.67	0.01	0.00	0.00	0.95	0.57	1.16	12.20	23.15
56	7.58	2.43	0.03	1.86	0.96	0.00	0.00	0.00	0.84	1.32	0.06	0.22	15.30
57	2.47	4.18	2.23	1.66	1.78	0.00	0.00	0.00	1.35	1.35	0.33	3.07	18.42
58	5.38	9.13	5.93	4.41	0.72	0.27	0.00	0.02	0.12	0.42	0.16	0.72	27.28
59	4.62	3.64	0.46	0.30	0.00	0.00	0.00	0.00	1.54	0.00	0.01	1.28	11.85
60	3.25	2.91	1.62	1.26	0.41	0.00	0.00	0.00	0.00	0.00	4.38	0.70	14.53
61	3.11	1.19	2.02	0.49	0.13	0.02	0.00	0.01	0.17	0.03	2.96	1.44	11.57
62	0.95	7.60	1.84	0.19	0.06	0.01	0.00	0.13	0.11	6.85	0.40	1.74	19.88
63	3.65	1.75	3.56	3.43	0.64	0.02	0.00	0.00	0.35	1.27	3.92	0.38	18.97
64	3.35	0.19	0.83	0.16	0.18	0.41	0.01	0.06	0.00	1.55	2.64	5.69	15.07
65	3.66	0.48	1.61	2.97	0.07	0.00	0.00	0.59	0.00	0.11	3.25	2.89	15.63
66	2.11	1.58	0.22	0.59	0.24	0.00	0.09	0.00	0.05	0.00	5.48	3.33	13.69
67	7.94	0.40	4.15	3.85	0.12	0.68	0.00	0.00	0.04	0.26	1.25	0.94	19.63
68	3.34	1.97	2.42	0.40	0.32	0.23	0.00	0.08	0.00	0.68	2.74	3.10	15.28
69	8.90	7.61	1.13	1.32	0.09	0.01	0.00	0.00	0.03	0.80	0.81	5.36	26.06
70	7.05	1.45	1.83	0.14	0.00	0.24	0.00	0.00	0.00	0.95	7.44	3.73	22.83
71	1.10	0.33	2.34	0.54	0.94	0.05	0.00	0.00	0.00	0.27	0.88	4.84	11.29
72	1.07	1.15	0.37	1.27	0.34	0.15	0.00	0.00	0.99	1.70	5.08	2.25	14.37
73	7.29	6.47	2.89	0.41	0.06	0.00	0.00	0.00	0.44	1.56	6.69	3.05	28.86
74	3.80	1.57	3.72	1.34	0.00	0.66	0.90	0.01	0.00	1.22	0.86	3.42	17.50
75	1.15	5.16	4.73	1.10	0.00	0.00	0.02	0.16	0.00	2.32	0.40	0.30	15.34
76	0.37	1.49	0.61	1.53	0.00	0.05	0.00	0.57	0.81	0.00	0.62	0.62	6.67
77	1.36	1.10	1.33	0.36	0.76	0.00	0.01	0.00	0.55	0.27	2.00	3.65	11.39
78	9.61	2.77	4.24	2.26	0.00	0.00	0.00	0.00	0.37	0.01	3.45	0.87	23.58
79	5.81	5.24	2.67	0.88	0.09	0.00	0.22	0.00	0.01	1.79	1.66	3.96	22.33
80	5.33	8.08	2.19	1.04	0.47	0.04	0.31	0.00	0.00	0.04	0.26	2.25	20.01
81	4.97	1.00	3.55	0.71	0.34	0.00	0.00	0.00	0.32	2.64	7.13	3.91	24.57
82	5.40	2.90	6.87	3.36	0.00	0.17	0.00	0.00	1.54	2.69	5.83	3.44	32.20
83	5.54	5.28	8.30	4.36	0.23	0.28	0.00	0.01	0.61	0.53	5.83	6.65	37.62
84	0.23	1.52	1.47	0.44	0.01	0.10	0.00	0.08	0.08	1.87	5.46	1.75	13.01
85	1.07	1.85	2.79	0.11	0.02	0.14	0.00	0.01	0.71	0.69	4.64	3.19	15.22
86	4.88	10.30	4.23	1.02	0.08	0.00	0.00	0.00	0.80	0.33	0.22	1.30	23.16

87	2.55	3.77	3.57	0.26	0.01	0.00	0.00	0.00	0.00	1.30	3.22	3.75	18.43
88	3.61	0.74	0.31	1.46	0.75	0.23	0.01	0.00	0.00	0.22	2.08	3.32	12.73
89	0.70	1.38	6.73	0.39	0.04	0.26	0.00	0.37	3.15	1.47	1.26	0.00	15.75
90	5.49	3.14	1.16	0.75	2.61	0.00	0.00	0.00	0.00	0.28	0.56	1.66	15.65
91	0.37	3.18	7.48	0.38	0.26	0.56	0.00	0.01	0.05	1.22	0.32	2.04	15.87
92	1.68	6.89	3.32	0.93	0.00	0.22	0.00	0.00	0.00	1.26	0.38	6.23	20.91
93	9.37	5.11	2.43	0.75	1.23	0.94	0.00	0.00	0.00	0.43	2.70	2.04	25.00
94	2.16	3.17	0.07	0.80	1.65	0.00	0.00	0.00	0.00	0.45	3.96	3.54	15.80
95	12.35	0.19	7.84	1.90	1.01	0.53	0.01	0.00	0.00	0.00	0.00	5.14	28.97
96	3.30	6.09	2.30	1.93	2.22	0.00	0.00	0.00	0.00	0.76	1.49	5.83	23.92
97	7.68	0.26	0.58	0.28	0.35	0.53	0.00	0.21	0.18	1.01	4.67	2.64	18.39
98	6.79	9.43	2.55	1.44	3.04	0.29	0.00	0.00	0.30	0.81	3.60	0.65	28.90
99	2.86	4.54	1.46	0.94	0.08	0.03	0.00	0.00	0.00	0.13	1.75	0.03	11.82
0	7.20	8.93	2.26	2.05	1.36	0.03	0.00	0.00	0.17	2.57	0.76	0.55	25.88
1	4.48	4.79	2.15	1.70	0.00	0.14	0.00	0.00	0.33	0.35	2.33	5.99	22.26
2	2.23	1.04	2.85	0.15	1.81	0.00	0.00	0.00	0.00	0.00	2.00	5.85	15.93
3	1.13	1.08	1.95	2.75	1.23	0.00	0.00	0.34	0.00	0.27	1.64	4.35	14.74
4	2.07	4.84	0.49	0.11	0.08	0.00	0.00	0.00	1.93	3.09	2.76	4.13	19.50
5	3.69	2.52	3.55	0.86	1.31	0.69	0.00	0.00	0.10	0.16	0.90	9.47	23.25
6	3.07	2.07	6.02	3.42	0.42	0.00	0.00	0.00	0.00	0.21	1.03	3.12	19.36
7	0.07	5.17	0.50	1.42	0.43	0.00	0.01	0.00	0.08	0.93	0.98	3.35	12.94
8	7.42	1.83	0.12	0.01	0.04	0.00	0.00	0.00	0.00	0.75	2.22	1.75	14.14
9	1.48	5.06	1.83	1.61	1.30	0.47	0.00	0.00	0.19	3.42	0.36	3.16	18.88
10	4.75	2.28	1.95	2.60	0.84	0.00	0.00	0.00	0.05	1.75	2.65	5.52	22.39
11	1.36	3.88	7.00	0.08	1.40	1.14	0.00	0.00	0.00	1.72	0.87	0.07	17.52
12	2.52	0.94	4.45	2.65	0.00	0.01	0.00	0.00	0.00	1.28	4.33	6.46	22.64
13	1.06	0.26	1.59	0.58	0.57	0.31	0.00	0.00	0.55	0.00	0.82	0.38	6.12
14	0.20	4.49	1.93	1.97	0.01	0.00	0.02	0.00	0.54	0.37	1.28	7.63	18.44
15	0.01	2.28	0.16	1.82	0.19	0.07	0.00	0.00	0.00	0.44	1.35	1.83	8.15
16	5.79	0.85	4.64	1.48	0.59	M0.00							13.35

Product generated by ACIS - NOAA Regional Climate Centers.

Appendix G Assessor Parcel Numbers in the Delineation Area

Assessor Parcel Numbers in the Delineation Area

Parcel	Property Owner
069-0160-005	Hansen Family Revocable Trust Attention: John Hansen 2201 Francisco Drive 140 205 El Dorado Hills, CA 95762
069-0160-006	Norman W/Dolores A Moniz Family Revocable Trust 5515 Kenneth Avenue Fair Oaks, CA 95628
069-0160-007	Norman W/Dolores A Moniz Family Revocable Trust 5515 Kenneth Avenue Fair Oaks, CA 95628
069-0160-008	Park Chang No/Park Woong Ja 9909 Portofino Oak Lane Fair Oaks, CA 95628
069-0160-015	Forest Robert J/Forest Sarah D P.O. Box 877 Mendocino, CA 95460
069-0160-019	Prestige Hospitality Incorporated Attention: Mitul Tundavia 8160 Barton Road Granite Bay, CA 95746
069-0160-020	Ichiban Samurai Incorporated Attention: Young Hu Shin 12251 Folsom Boulevard Rancho Cordova, CA 95742
069-0160-014	Steve/Julie Ryan Family 1996 Revocable Trust 12303 Folsom Boulevard

Parcel	Property Owner
	Rancho Cordova, CA 95742
069-0160-011	Sacramento Metropolitan Fire District 10545 Armstrong Avenue, Suite 200 Mather, CA 95655
069-0160-012	Folsom Twin Invs LLC 12399 Folsom Boulevard Rancho Cordova, CA 95742
069-0050-013	Conrad Ethan 1300 National Drive, Suite 100 Sacramento, CA 95834
069-0050-014	Conrad Ethan 1300 National Drive, Suite 100 Sacramento, CA 95834
069-0050-085	Property owner information was not available.
069-0050-107	Property owner information was not available.
072-0231-125	Aerojet Rocketdyne, Inc Attention: Easton Dev Company P.O. Box 13222 Sacramento, CA 95813
072-0231-079	APN: 072-3360-002 Easton Development Company LLC P.O. Box 13222 Sacramento, CA 95813
Source: Sacramento County Assessor's Office, September 22, 2016	

Appendix H Aquatic Resources Spreadsheet

Waters_Name	State	Cowardin_Code	HGM_Code	Meas_Type	Amount	Units	Waters_Type	Latitude	Longitude	Local_Waterway	Similarly_Situated	Adjcent_Waters_Sbjct_33USC1344	OHWM_Chg_In_Plant_Community	OHWM_Bed_And_Banks	OHWM_Break_In_Slope	OHWM_Destr_Of_Terrestrial_Veg	Func_Ill_Pollutant_Management	Func_V_Runoff_Storage
SW-1	CALIFORNIA	PEM	DEPRESS	Area	0.01	ACRE	A8OWB	38.6322672	-121.2151075	Alder Creek and Lake Natoma	NO	NO					YES	YES
SW-2	CALIFORNIA	PEM	DEPRESS	Area	0.01	ACRE	A8OWB	38.63234503	-121.216164	Alder Creek and Lake Natoma	NO	NO					YES	YES
EW-1	CALIFORNIA	PEM	RIVERINE	Area	0.03	ACRE	A6BWB	38.63625816	-121.2062703	Alder Creek and Lake Natoma								
EW-2	CALIFORNIA	PEM	RIVERINE	Area	0.0002	ACRE	A6BWB	38.63647821	-121.2056483	Alder Creek and Lake Natoma								
ED-1	CALIFORNIA	R4	RIVERINE	Area	0.001	ACRE	A8OOHWM	38.63076567	-121.2178977	Alder Creek and Lake Natoma	NO	NO			YES	YES	YES	YES
ED-2	CALIFORNIA	R4	RIVERINE	Area	0.0004	ACRE	A6N1OHWM	38.63839334	-121.2019974	Alder Creek and Lake Natoma					YES	YES		
PD-1	CALIFORNIA	R2	RIVERINE	Area	0.42	ACRE	A5	38.63628587	-121.2059269	Alder Creek and Lake Natoma			YES	YES		YES		
PDC-1	CALIFORNIA	R2	RIVERINE	Area	0.14	ACRE	A5	38.63649835	-121.2061386	Alder Creek and Lake Natoma			YES	YES		YES		

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
2800 Cottage Way, Suite W-2605
Sacramento, California 95825-1846

In Reply Refer to:
08ESMF00-
2019-F-1386-1

FEB 2 8 2020

Ms. Kelly McNally
Office Chief
California Department of Transportation, District 3
P.O. Box 942873, MS-49
Sacramento, California 94273-0001

Subject: Formal Consultation on the Hazel Avenue/U.S. 50 Interchange Project, Sacramento County, California (Caltrans Fed. ID# 03-3E380)

Dear Ms. McNally:

This letter is in response to the California Department of Transportation's (Caltrans) March 7, 2019, request for initiation of formal consultation with the U.S. Fish and Wildlife Service (Service) on the proposed Hazel Avenue/U.S. 50 Interchange Project (proposed project) in Sacramento County, California. Your request was received by the Service on March 14, 2019. At issue are the proposed project's effects on the federally threatened valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*) (beetle). This response is provided under the authority of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act), and in accordance with the implementing regulations pertaining to interagency cooperation (50 CFR 402).

The federal action on which we are consulting is the Federal Highway Administration (FHWA) funding Caltrans' proposal to modify the existing Hazel Avenue/U.S. Route 50 (U.S. 50) interchange as well as extend and grade Hazel Avenue over Folsom Boulevard and the Sacramento-Placerville Transportation Corridor Joint Powers Authority (SPTC-JPA) rail corridor. The proposed project is needed to relieve congestion at the interchange and accommodate the planned and approved developments identified by the adopted Sacramento County General Plan and the Sacramento Area Council of Governments Regional Transportation Plan. Caltrans has assumed FHWA's responsibilities as the lead agency under the Act for this consultation in accordance with Section 1313, Surface Transportation Project Delivery Program, of the Moving Ahead for Progress in the 21st Century Act (MAP-21) of 2012. The MAP-21 is described in the National Environmental Policy Act assignment Memorandum of Understanding between FHWA and Caltrans (effective March 30, 2017) and codified in 23 U.S.C 327.

Pursuant to 50 CFR 402.12(j), you submitted a biological assessment for our review and requested concurrence with the findings presented therein. These findings conclude that the proposed project may affect, and is likely to adversely affect the beetle. The proposed project is not within designated or proposed critical habitat for the beetle.

In considering your request, we based our evaluation on the following: (1) your March 7, 2019, letter requesting initiation of formal consultation and the attached *Hazel Avenue/U.S. 50 Interchange Project: Biological Assessment* (biological assessment), prepared by Caltrans and received by the Service on March 14, 2019; (2) e-mail and telephone correspondence between the Service and Caltrans; and (3) other information available by the Service.

Consultation History

March 14, 2019: The Service received the March 7, 2019, letter from Caltrans requesting initiation of formal consultation. This date also confirms the receipt of all the complete information in order for consultation to begin.

BIOLOGICAL OPINION

Description of the Proposed Action

The proposed project is located in the northeastern portion of Sacramento County, at the interchange of Hazel Avenue and U.S. 50. The project area is bounded along Hazel Avenue by the Tributary Point/westbound off-ramp intersection to the north, extending approximately 1,000 feet south of Folsom Boulevard. The project limits along U.S. 50 begin approximately 3,200 feet west of the existing Hazel Avenue overcrossing and extend 2,500 feet east of the Natoma overhead. Improvements along Folsom Boulevard will extend from approximately 1,200 feet west of the Hazel Avenue intersection to 900 feet to the east.

The County of Sacramento, in cooperation with Caltrans and the City of Rancho Cordova, proposes to modify the existing Hazel Avenue/U.S. 50 interchange as well as extend and grade Hazel Avenue over Folsom Boulevard and the SPTC-JPA rail corridor. Hazel Avenue will be extended south to a proposed intersection with the future Atlanta Street. Construction of the proposed project is anticipated to last 24 months, beginning in 2021 and concluding in 2023. The proposed project's construction activities include:

Roadway Modifications

- Construction of a portion of an eastbound transition auxiliary lane on U.S. 50 from Hazel Avenue to the Folsom Boulevard overcrossing, also known as the Natoma overhead.

- Modification of the existing Aerojet Road off-ramp from U.S. 50.

- Reconstruction of the westbound loop on-ramp, with the ramp intersection shifted north toward the westbound off-ramp terminus, thereby increasing storage lengths. The ramp will be metered with two lanes (one mixed-use lane and one high-occupancy vehicle [HOV] bypass) and a squared-up pedestrian-friendly entrance.

- Reconstruction of the eastbound diagonal off-ramp to conform with the new Hazel Avenue profile and accommodate the Aerojet Road ramp divergence.

- Reconstruction of the eastbound diagonal on-ramp to conform with the new Hazel Avenue profile. The ramp will be metered with two lanes, one mixed flow and one HOV bypass.

- Reconstruction of the eastbound loop on-ramp to conform with the new Hazel Avenue profile. The ramp will be metered with two lanes, one mixed flow and one HOV bypass. A

tie-back wall at the abutment of the overcrossing is proposed to maximize the opening through the structure. The loop ramp will develop an additional lane on U.S. 50 that will continue on to the Folsom Boulevard interchange.

- Construction of eastbound on- and off-ramp auxiliary lanes on U.S. 50, from west of Hazel Avenue to the eastbound off-ramp and from the loop on-ramp to the Folsom Boulevard interchange.

- Modification of traffic signals and installation of safety lighting at the ramp intersections. A new signalized intersection and at-grade railroad crossing will be constructed for the jughandle.

- Maintenance of pedestrian access on the east side of Hazel Avenue, with 6-foot-wide sidewalks (however, the existing sidewalk on the overcrossing will remain 5 feet wide).

- Construction of roadway improvements along approximately 2,300 feet of Folsom Boulevard. Improvements will include removal of the existing signalized intersection with Hazel Avenue and installation of sidewalks, street lighting, and landscaping along the north side of Folsom Boulevard and landscaping and lighting along the south.

Transition Lane to Folsom Boulevard/U.S. 50 Interchange

As indicated in Caltrans' 2009 Corridor System Management Plan, eastbound U.S. 50 is shown as having one HOV lane and three mixed-flow lanes to Hazel Avenue as the Concept Facility. Additionally, eastbound U.S. 50 is shown as having one HOV lane and three mixed-flow lanes across Folsom Boulevard as the Ultimate Facility. The proposed project will accommodate these future facility improvements; will conform to the approved Caltrans project at the Folsom Boulevard/U.S. 50 interchange; and will then restripe the third mixed-flow lane through the Folsom Boulevard/U.S. 50 interchange.

A mixed-flow lane must be added because it was determined in the traffic analysis for the proposed project that the additional eastbound lane on U.S. 50 through the Folsom Boulevard interchange is needed for operations. Accommodating this mixed-flow lane will require the eastbound loop on-ramp to extend its auxiliary lane to the Folsom Boulevard/US 50 eastbound off-ramp. This will require widening and a new structure over Alder Creek, which currently flows under U.S. 50 through a box culvert. A mechanically stabilized earth (MSE) wall is above the culvert; therefore, a new bridge will be required to widen U.S. 50 over Alder Creek.

L-9 Interchange with Viaduct Connector

A modified type L-9 interchange configuration will provide a viaduct connection to Aerojet Road. A Caltrans Type L-9 interchange indicates a ramp configuration that includes a diagonal off-ramp, a diagonal on-ramp, and a loop on-ramp. The location of the departure point of the existing Aerojet Road off-ramp from U.S. 50 will be moved to join with the eastbound Hazel Avenue off-ramp. The eastbound Hazel Avenue off-ramp will split and introduce a direct viaduct ramp over Hazel Avenue to carry eastbound off-ramp traffic to Aerojet Road and Folsom Boulevard. The off-ramp divergence from U.S. 50 will be shifted approximately 830 feet to the east to provide decision sight distance before the Aerojet Road split. The two-lane off-ramp will widen to five lanes at the ramp terminal intersection, with three left-turn lanes and two right-turn lanes. Retaining walls and

barriers placed at the proposed right-of-way (ROW) will minimize acquisition. The eastbound off-ramp will also have an auxiliary lane prior to the exit.

The Aerojet Road viaduct will land adjacent to the eastbound diagonal on-ramp and then turn to the south to conform to Folsom Boulevard along its existing alignment. Retaining walls are proposed between the viaduct and the diagonal on-ramp to accommodate the grade difference as well as to the outside of the ramp after the viaduct lands to minimize ROW acquisitions. Retaining walls are also proposed along Aerojet Road as it approaches the horizontal curve toward Folsom Boulevard to accommodate the grade difference between the ramp and mainline, as well as minimize ROW acquisition.

The existing Hazel Avenue overcrossing of U.S. 50 will be widened on the west side to accommodate eight lanes (three through lanes and one freeway-only lane in both directions). The existing raised concrete median across the structure will be removed, and the roadway will be re-striped with a 6-foot-wide striped median. The existing sidewalk and barrier on the eastside of the structure will remain.

Thirteen elderberry shrubs (*Sambucus* sp.), the sole host plant for the beetle, occur within the action area of the proposed project. Of the 13 elderberry shrubs, three will be removed and transplanted to a Service-approved beetle conservation bank. The 10 remaining elderberry shrubs will be fenced off from construction activities with a 20 foot buffer from all ground disturbance due to construction activities.

Conservation Measures

In addition to implementing Caltrans' standard BMPs throughout the proposed project for the duration of construction, including erosion and sediment control, the following measures to minimize effects to the beetle are proposed. The purchasing of beetle conservation credits referenced in Conservation Measure #1 pertains to the three elderberry shrubs that will be removed and transplanted. Conservation Measures #2-5 pertain to the remaining 10 elderberry shrubs that will not be removed during construction activities.

1. The three impacted elderberry shrubs will be mitigated for using the *Framework for Assessing Impacts to the Valley Elderberry Longhorn Beetle (Desmocerus californicus dimorphus)* (Service 2017). The three elderberry shrubs will be transplanted to a Service-approved beetle conservation bank in accordance with the framework. These elderberry shrubs will be compensated utilizing shrub-level impact compensation. Mitigation requirements will be satisfied by purchasing three (3) credits from a Service-approved beetle conservation bank.

2. The construction limits will be clearly identified prior to construction and all areas containing elderberry shrubs to be avoided during construction will be fenced or flagged off.

3. Retain a Service-approved biologist to conduct monitoring during construction in sensitive habitats.

4. The Servive-approved biological monitor will conduct environmental awareness training for construction employees.

5. For elderberry shrubs occurring within or immediately adjacent to work locations, 20-foot avoidance buffers will be established around the driplines of the shrubs to help protect the

shrubs and their root zones during project activities. The avoidance buffers will be maintained for the duration of work activities in the area.

Action Area

The action area is defined in 50 CFR § 402.02, as "all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action." For the proposed project, the 98 acre action area encompasses the construction footprint, any areas used for access and staging, as well as the area within 100 feet of these components to account for impacts to the beetle.

Analytical Framework for the Jeopardy Determination

Section 7(a)(2) of the Act requires that federal agencies ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of listed species. "Jeopardize the continued existence of" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR § 402.02).

The jeopardy analysis in this biological opinion considers the effects of the proposed federal action, and any cumulative effects, on the rangewide survival and recovery of the listed species. It relies on four components: (1) the *Status of the Species*, which describes the current rangewide condition of the species, the factors responsible for that condition, and its survival and recovery needs; (2) the *Environmental Baseline*, which analyzes the current condition of the species in the action area without the consequences to the listed species caused by the proposed action, the factors responsible for that condition, and the relationship of the action area to the survival and recovery of the species; (3) the *Effects of the Action*, which determines all consequences to listed species that are caused by the proposed federal action; and (4) the *Cumulative Effects*, which evaluates the effects of future, non-federal activities in the action area on the species. The *Effects of the Action* and *Cumulative Effects* are added to the *Environmental Baseline* and in light of the status of the species, the Service formulates its opinion as to whether the proposed action is likely to jeopardize the continued existence of the listed species.

Status of the Species

For the most recent comprehensive assessment of the species' range-wide status, please refer to the *Withdrawal of the Proposed Rule to Remove the Valley Elderberry Longhorn Beetle from the Federal List of Endangered and Threatened Wildlife* (Service 2014). Threats discussed in the withdrawal continue to act on the beetle, with loss of riparian habitat being the most significant effect. While there continue to be losses of beetle habitat throughout its range, to date no project has proposed a level of effect for which the Service has issued a biological opinion of jeopardy for the beetle.

Environmental Baseline

Environmental baseline refers to the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat

from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline.

The proposed project is located in the northeastern portion of Sacramento County. The topography is relatively level, with elevations ranging from approximately 110 to 150 feet above mean sea level. Land uses in the action area and surrounding area are primarily commercial and recreational with a portion of the action area abutting Aerojet property. Most of the action area has a relatively high level of historical and ongoing disturbance. The action area is in the Upper American River watershed hydrologic unit which includes Alder Creek as the only perennial drainage. Alder Creek drains north under U.S. 50 to Lake Natoma, which is part of the American River riparian corridor.

The action area is within the current range of the beetle. Suitable habitat for the beetle in the form of elderberry shrubs occurs within the action area. There are 13 elderberry shrubs which vary in location from roadside grasslands to areas between on-and off-ramps within the action area. The 13 elderberry shrubs are located in four dominant land cover types within the actions area, which include:

Fremont Cottonwood-Oak Woodland

The proposed jughandle road area south of Folsom Boulevard supports Fremont cottonwood-oak woodland. The overstory is dominated by interior live oak, Fremont cottonwood (*Populus fremontii* ssp. *fremontii*), and willows (*Salix* spp.). The understory includes small willows, coyote brush (*Baccharis pilularis*), poison-oak (*Toxicodendron diversilobum*), and annual grasses and forbs. One elderberry shrub occurs within this area.

Planted Oak Woodland

The areas between the U.S. 50 on-ramps and off-ramps are planted with native trees and shrubs found in oak woodlands such as interior live oak, valley oak, buckeye (*Aesculus californica*), Lemmon's ceanothus (*Ceanothus lemmonii*), coffeeberry (*Frangula californica*), California flannelbush (*Fremontodendron californicum*), and Fremont cottonwood, with annual grassland species in the understory. Two elderberry shrubs are located within this land cover type. One is located between the U.S. 50 wetbound off-ramp to Hazel Avenue and one is located adjacent to the U.S. 50 eastbound Hazel Avenue off-ramp.

Annual Grassland

Annual grasslands occurs throughout the project area within the U.S. 50 ROW and south of Folsom Boulevard. Areas mapped as annual grassland in the existing Hazel Avenue/U.S. 50 interchange and the area south of Folsom Boulevard support primarily nonnative weedy species. Dominant species in this community include annual grasses such as wild oat (*Avena fatua*), ripgut brome (*Bromus diandrus*), soft chess (*B. hordeaceus*), foxtail barley (*Hordeum murinum* ssp. *leporinum*), and perennial ryegrass. Typical forbs in annual grassland in the project area are Italian thistle (*Carduus pycnocephalus*), heron's bill (*Erodium botrys* and *E. cicutarium*), hawkbit (*Leontodon saxatilis* ssp. *longirostris*), milk thistle (*Silybum marianum*), hairy clover (*Trifolium hirtum*), and hairy vetch (*Vicia villosa*). The annual grassland on both sides of Alder Creek also supports some native forbs, including elegant clarkia (*Clarkia unguiculata*) and dwarf brodiaea (*Brodiaea nana*). Scattered native trees such as Fremont cottonwood, interior live oak, valley oak, and California foothill pine also occur in areas mapped as annual grassland. One elderberry shrub is located within this land cover type along U.S. 50.

Developed/Landscaped

These combined land cover types comprise the largest portion of the action area. Developed areas largely consist of hardscape, including buildings, parking lots, driveways, and sidewalks. Native vegetation has been removed or replaced with grass lawns and ornamental plantings. The landscaping adjacent to developed facilities consists of shade and street trees, hedges and shrubs, lawns, and gardens. The growth of vegetation in this land cover type is typically managed by trimming or mowing. Nine elderberry shrubs are within this area of the proposed project.

The American River riparian corridor is approximately 0.10 mile north of the proposed project. This riparian corridor is suitable beetle habitat with multiple recorded occurrences in the California Natural Diversity Database (CNDDB). All 13 elderberry shrubs within the action area of the proposed project are located outside of this riparian corridor, immediately adjacent to U.S. 50 which is a frequently used highway causing ongoing disturbance and dust around these elderberry shrubs due to a continuous flow of vehicles. However, an adult beetle has been observed inhabiting an elderberry shrub immediately adjacent to U.S. 50 approximately 1 mile southwest of the action area of the proposed project (CNDDB 2020).

Due to the fact that the life cycle of the beetle takes one or two years to complete, during which it spends most of its life in the larval stage living within the stems of the elderberry shrubs, it is not possible to know if the elderberry shrubs in the action area are currently inhabited by the beetle. However, the proposed project is within the range of the beetle, the American River riparian corridor is within beetle dispersal distance of the action area, and the beetle is known to occur nearby, it is likely that the beetle may be present in one or more elderberry shrubs.

Effects of the Action

Effects of the action are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action.

Construction activities will result in effects to beetles inhabiting three of the 13 total elderberry shrubs in the action area. All three of these shrubs occur in non-riparian habitat. Removal and relocation of these elderberry shrubs due to construction activities will result in the harm or death of an unknown number of individual beetle larvae inhabiting the stems. Occasionally, elderberry shrub stems are trimmed during transplanting activities in order to facilitate transport and enhance the survival of the transplanted shrub. Trimming may kill or interrupt the beetle's life cycle, whether the beetle is an egg, larva, pupa, or an adult, by equipment hitting/damaging steam and killing a beetle within the steam. Transplantation of these elderberry shrubs that are reasonably likely to be occupied by beetle larvae is expected to adversely affect the beetle because the elderberry shrub may experience stress due to changes in soil, hydrology, microclimate, or associated vegetation; which will in turn will adversely affect the host plant for the beetle and directly attribute to the decline of suitable beetle habitat. The elderberry shrubs may die as a result of transplantation; and branches containing larvae may be cut, broken, or crushed as a result of the transplantation process. Transplanting of elderberry shrubs will occur during their dormant phase, which will reduce effects by increasing the likelihood that the elderberry shrubs will survive the transplanting process and continue to provide habitat to the beetle.

Construction activities will occur within 20 feet of one elderberry shrub dripline which could result in disturbance to the root system. Root damage could result in stress or reduced vigor of the elderberry shrub which in turn will deplete suitable habitat which is reasonably likely to support the beetle. However, the elderberry shrub will be fenced and protected as much as possible during construction activities. Construction access is limited surrounding this elderberry shrub and Caltrans has proposed every effort to avoid this elderberry shrub with the exception that the 20 foot buffer may be encroached if all other alternatives are met. In addition, the elderberry shrub is isolated in a non-riparian habitat located within an already highly disturbed location in between an off-ramp and a loop on-ramp adjacent to the freeway. Therefore, the proposed project is not anticipated to adversely affect this additional elderberry shrub. The remaining nine elderberry shrubs will be avoided due to the proposed conservation measures.

As noted previously in the *Description of the Proposed Action* section, the project proponent has also proposed a set of conservation measures, including the commitment to provide compensatory habitat as a condition of the action. This compensatory habitat is intended to minimize the effect on the species of the proposed project's anticipated incidental take, resulting from the permanent loss of habitat described above. The compensatory habitat proposed will be in the form of beetle conservation credits at a Service-approved bank with a service area that includes the proposed project, as well as transplantation of the three removed elderberry shrubs to a Service-approved location. The survival rate of transplanted elderberry shrubs is estimated to be 72.8% in the first year following shrub relocation (Holyoak et al. 2010). Therefore, it is anticipated that one of the three transplanted elderberry shrubs may not survive in the first year following relocation, and that the remaining two transplanted elderberry shrubs may experience damage to stems either accidentally or from targeted trimming during transplanting activities.

This component of the action will have the effect of protecting and managing lands for the species' conservation in perpetuity. The compensatory lands will provide suitable habitat for breeding, feeding, or sheltering commensurate with or better than habitat lost as a result of the proposed project. Providing this compensatory habitat as part of a relatively large, contiguous block of conserved land may contribute to other recovery efforts for the species. Additionally, if the transplanted elderberry shrub is occupied by both male and female larvae that successfully emerge, beetles can reproduce and colonize unoccupied elderberry shrubs at a conservation bank.

Cumulative Effects

Cumulative effects include the effects of future State, Tribal, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

Conclusion

After reviewing the current status of the beetle, the environmental baseline for the action area, the effects of the proposed Hazel Avenue/U.S. 50 Interchange Project, and the cumulative effects, it is the Service's biological opinion that the Hazel Avenue/U.S. 50 Interchange Project, as proposed, is not likely to jeopardize the continued existence of the beetle. The Service reached this conclusion because the project-related effects to the species, when added to the environmental baseline and analyzed in consideration of all potential cumulative effects, will not rise to the level of precluding recovery or reducing the likelihood of survival of the species based on the following: (1) the 13 elderberry shrubs within the action area, including the three elderberry shrubs that will be removed and transplanted, represent a very small proportion of habitat available throughout the full range of

the beetle; (2) the conservation measures proposed by Caltrans; and (3) the compensatory habitat proposed will ensure that habitat for the species will be protected and managed in perpetuity.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harass is defined by Service regulations at 50 CFR 17.3 as an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Harm is defined by the same regulations as an act which actually kills or injures wildlife. Harm is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavior patterns, including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by Caltrans so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, for the exemption in section 7(o)(2) to apply. Caltrans has a continuing duty to regulate the activity covered by this incidental take statement. If Caltrans (1) fails to assume and implement the terms and conditions or (2) fails to require the applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, Caltrans must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [50 CFR §402.14(i)(3)].

Amount or Extent of Take

The Service anticipates that incidental take of the beetle will be difficult to detect due to the fact that it is not possible to know how many larvae inhabit any one elderberry shrub providing habitat for the beetle. The beetle spends most of its time in the larval stage living within the stems of the elderberry shrub, and the life cycle of the beetle takes one or two years to complete. Beetle larval use of an elderberry shrub is not readily apparent, and in early stages of development beetle larvae can be present in stems that have no evidence of exit holes. The transplanting of the elderberry shrubs could result in harm and mortality to all larvae inhabiting the stems.

All three elderberry shrubs to be removed from the action area will be transplanted to a Service-approved beetle conservation bank with a service area that includes the proposed project. The Service anticipates one of the three transplanted elderberry shrubs may not survive in the first year following relocation, and that the remaining two transplanted elderberry shrubs may experience damage to stems either accidentally or from targeted trimming during transplanting activities. Therefore, the Service is authorizing incidental take to the proposed action as the harm or death of all beetle larvae within the one elderberry shrub anticipated to not survive transplanting, as well as any beetle larvae with stems greater or equal to 1-inch in diameter that may be trimmed or damaged during transplanting on the two remaining shrubs.

Upon implementation of the following *Reasonable and Prudent Measure*, incidental take of the beetle associated with the Hazel Avenue/U.S. 50 Interchange Project will become exempt from the prohibitions described in section 9 of the Act. No other forms of take are exempted under this opinion.

Effect of the Take

In the accompanying biological opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the species.

Reasonable and Prudent Measures

All necessary and appropriate measures to avoid or minimize effects on the beetle resulting from implementation of this project have been incorporated into the project's proposed conservation measures. Therefore, the Service believes the following reasonable and prudent measure is necessary and appropriate to minimize incidental take of the beetle:

1) All conservation measures, as described in the biological assessment and restated here in the *Project Description* section of this biological opinion, shall be fully implemented and adhered to. Further, this reasonable and prudent measure shall be supplemented by the terms and conditions below.

Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the Act, Caltrans must ensure compliance with the following terms and conditions, which implement the reasonable and prudent measure described above. These terms and conditions are nondiscretionary.

1. Caltrans will include full implementation and adherence to the conservation measures as a condition of any permit or contract issued for the project.

2. Caltrans will provide a copy of the completed bill of sale and payment receipt to the Service upon the purchase of beetle conservation credits.

3. In order to monitor whether the amount or extent of incidental take anticipated from implementation of the proposed project is approached or exceeded, Caltrans will adhere to the following reporting requirement. Should this anticipated amount or extent of incidental take be exceeded, Caltrans must immediately reinitiate formal consultation, as per 50 CFR §402.16.

    a. For those components of the action that will result in habitat degradation or modification whereby incidental take in the form of harm is anticipated, Caltrans will provide a precise accounting of the elderberry shrubs impacted to the Service after the completion of construction. This report will also include any information about changes in project implementation that result in habitat disturbance not described in the *Description of the Action* and not analyzed in this biological opinion.

REINITIATION—CLOSING STATEMENT

This concludes formal consultation on the Hazel Avenue/U.S. 50 Interchange Project. As provided in 50 CFR §402.16, reinitiation of consultation is required and shall be requested by the federal

agency or by the Service where discretionary federal involvement or control over the action has been retained or is authorized by law, and:

(a) If the amount or extent of taking specified in the incidental take statement is exceeded;

(b) If new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered;

(c) If the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion; or written concurrence, or

(d) If a new species is listed or critical habitat designated that may be affected by the identified action.

If you have any questions regarding this biological opinion, please contact Adam Stewart, Fish and Wildlife Biologist (adam_stewart@fws.gov) or Kellie Berry, Sacramento Valley Division Chief (kellie_berry@fws.gov), at the letterhead address or at (916) 414-6631.

Sincerely,

Jennifer M. Norris, Ph.D.
Field Supervisor

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COUNTY OF SACRAMENTO

OFFICE OF PLANNING AND ENVIRONMENTAL REVIEW

MITIGATION MONITORING AND REPORTING PROGRAM

CONTROL NUMBER: 2011-70062

NAME: Hazel Avenue/U.S. 50 Interchange Project

LOCATION: The project site is located at the existing Hazel Avenue/US 50 interchange within Sacramento County and the City of Rancho Cordova. The project area is bounded along Hazel Avenue by Tributary Point/westbound off-ramp intersection to the north, and extends approximately 1,000 feet south of Folsom Boulevard to a future intersection within the Easton Place development. The project limits along US 50 begin approximately 3,200 feet west of the existing Hazel Avenue Overcrossing, and extend 2,500 feet east of the Natoma Overhead (post miles 15.1 to 15.4). Improvements along Folsom Boulevard would extend from approximately 1,200 feet west of the Hazel Avenue intersection to 900 feet east of the intersection.

ASSESSOR'S PARCEL NUMBERS: Various

APPLICANT: Sacramento County Department of Transportation (SacDOT)
4111 Branch Center Road
Sacramento, CA 95827
Attention: Tim Stevens

PROJECT DESCRIPTION: The County of Sacramento, in cooperation with Caltrans and the City of Rancho Cordova, proposes to modify the existing Hazel Avenue/US 50 interchange, and extend and grade-separate Hazel Avenue over Folsom Boulevard and the SPTC-JPA rail corridor. Hazel Avenue will be extended south to a proposed intersection with the future Atlanta Street (a new roadway that will be constructed as part of the Easton Place development). The project also includes:

- Construction of a portion of an eastbound auxiliary lane on US 50 from Hazel Avenue to the Folsom Boulevard Overcrossing, also known as the Natoma Overhead.
- The modification of the existing Aerojet Road off-ramp from US 50.
- Reconstruction of the US 50 westbound loop on-ramp.
- Reconstruction of the US 50 eastbound diagonal off-ramp, and both eastbound on-ramps.
- Eastbound US 50 on- and off-ramp auxiliary lanes, from west of the Hazel Avenue eastbound off-ramp, and from the loop on-ramp extending to the Folsom Boulevard interchange.

- Roadway and pedestrian improvements constructed along approximately 2,300 feet of Folsom Boulevard. Improvements include sidewalks, street lighting, and landscaping along the north side of Folsom Boulevard, and landscaping and lighting along the south.

TYPE OF ENVIRONMENTAL DOCUMENT: Final Environmental Impact Report/Environmental Assessment (FEIR/EA)

PREPARED BY: Sacramento County
Office of Planning and Environmental Review
827 7th Street, Room 225
Sacramento, CA 95814

PHONE: (916) 874-6141

MITIGATION MONITORING AND REPORTING PROGRAM

ADOPTED BY: **DATE:**

ATTEST:_____
SECRETARY/CLERK

(Insert name and title of officer)

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PURPOSE AND PROCEDURES

Pursuant to Section 21081.6 of the Public Resources Code and Chapter 20.02 of the Sacramento County Code, a Mitigation Monitoring and Reporting Program has been established for the project entitled Hazel Avenue/U.S. 50 Interchange Project (Control Number: 2011-70062). The project is subject to both the National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA). Avoidance, Minimization, and/or Mitigation Measures (AMMs) in compliance with NEPA are also included in this document along with measures associated with the Incidental Take Permit of the Biological Opinion.

PURPOSE

The purpose of this program is to assure diligent and good faith compliance with the Mitigation Measures which have been recommended in the environmental document, and adopted as part of the project or made conditions of project approval, in order to avoid or mitigate potentially significant effects on the environment.

NOTIFICATION AND COMPLIANCE

It shall be the responsibility of the project applicant/owner to provide written notification to the Environmental Coordinator, in a timely manner, of the completion of each Mitigation Measure as identified on the following pages. The Environmental Coordinator will verify that the project is in compliance with the adopted Mitigation Monitoring and Reporting Program (MMRP). Any non-compliance will be reported to the project applicant/owner, and it shall be the project applicant's/owner's responsibility to rectify the situation by bringing the project into compliance and re-notifying the Environmental Coordinator. Any indication that the project is proceeding without good-faith compliance could result in the imposition of administrative, civil and/or criminal penalties upon the project applicant/owner in accordance with Chapter 20.02 of the Sacramento County Code.

PAYMENT

It shall be the responsibility of the project applicant to reimburse the Planning and Environmental Review Division for all expenses incurred in the implementation of the Mitigation Monitoring and Reporting Program (MMRP), including any necessary enforcement actions.

COMPLETION

Pursuant to Section 20.02.060 of the Sacramento County Code, upon the determination of the Environmental Coordinator that compliance with the terms of the approved Mitigation Monitoring and Reporting Program has been achieved, and that there has been full payment of all fees for the project, the Environmental Coordinator shall record and issue a Program Completion Certificate for the project.

STANDARD PROVISIONS

The project applicant shall submit one copy of all Project Plans and Construction Specifications and/or revisions to the Environmental Coordinator prior to Board approval to advertise Plans and Specifications. If the Environmental Coordinator determines that the Plans are not in full compliance with the adopted MMRP, the Plans shall be returned to the project applicant with a letter specifying the items of non-compliance, and instructing the applicant to revise the Plans, and then resubmit one copy of the revised Plans to the Environmental Coordinator prior to Board approval to advertise.

Additionally, the project applicant shall notify the Environmental Coordinator **no later than 48 hours** prior to the start of construction and no later than 24 hours after its completion. The applicant shall notify the Environmental Coordinator no later than 48 hours prior to any/all Final Inspection(s) by the County of Sacramento.

The project applicant shall notify the Environmental Coordinator of any pre-construction meetings. Upon notification, a determination will be made as to whether or not the Environmental Coordinator will need to attend the meeting.

The project applicant shall comply with the Mitigation Monitoring and Reporting Program for this project, including the payment of 100% of the Planning and Environmental Review Division staff costs, and the costs of any technical consultant services incurred during implementation of that Program.

☐ MITIGATION MEASURE AE-1: MINIMIZE FUGITIVE LIGHT FROM PORTABLE SOURCES USED FOR CONSTRUCTION

At a minimum, the construction contractor will minimize project-related light and glare to the maximum extent feasible, given safety considerations. Color-corrected halide lights will be used. Portable lights will be operated at the lowest allowable wattage and height and will be raised to a height no greater than 20 feet. All lights will be screened and directed downward toward work activities and away from the night sky and roadway users and highway neighbors to the maximum extent possible. Lights will not be directed toward residential land uses after 10 p.m. The number of nighttime lights used will be minimized to the greatest extent possible.

Implementation and Notification (Action by Project Applicant):

1. Comply fully with the above measure.

2. Include the above measure verbatim as a Construction Note and incorporate it into all Plans and Specifications for the project, and submit one copy to the Environmental Coordinator for review and approval prior to the start of any construction work (including clearing and grubbing).

Verification (Action by the Environmental Coordinator):

1. Review the Project Plans prior to the start of construction. Approve Project Plans that are determined to be in compliance with all required mitigation.

2. Monitor compliance during periodic site inspections of the construction work.

3. Participate in any Final Inspection(s) as necessary.

☐ MITIGATION MEASURE PS-1: PREVENT UNAUTHORIZED USE OF STATE PARKS LAND

Construction-related staging, equipment, and worker parking will be kept within the approved project limits. The project boundary adjacent to State Parks Land will be delineated with Environmentally Sensitive Area fencing or other visible means. No unauthorized use of State Parks land will be allowed.

Implementation and Notification (Action by Project Applicant):

1. Comply fully with the above measure.

2. Include the above measure verbatim as a Construction Note and incorporate it into all Plans and Specifications for the project, and submit one copy to the Environmental Coordinator for review and approval prior to the start of any construction work (including clearing and grubbing).

Verification (Action by the Environmental Coordinator):

1. Review the Project Plans prior to the start of construction. Approve Project Plans that are determined to be in compliance with all required mitigation.

2. Monitor compliance during periodic site inspections of the construction work.

3. Participate in any Final Inspection(s) as necessary.

☐ MITIGATION MEASURE AQ-1: IMPLEMENT SMAQMD'S BASIC CONSTRUCTION EMISSION CONTROL PRACTICES (BEST MANAGEMENT PRACTICES

Measures to control and reduce fugitive dust from SMAQMD's Basic Construction Emission Control Practices (Sacramento Metropolitan Air Quality Management District 2017) will be implemented to the extent practicable when the measures have not already been incorporated and do not conflict with requirements of Caltrans' Standard Specifications, Special Provisions, the National Pollutant Discharge Elimination System (NPDES) permit, and the Biological Opinions, Clean Water Act Section 404 permit, Clean Water Act Section 401 Certification, and other permits issued for the project. The project-proponent will implement SMAQMD's basic construction emission control practices, including but not limited to the following measures.

- Water all exposed surfaces two times daily. Exposed surfaces include, but are not limited to soil piles, graded areas, unpaved parking areas, staging areas, and access roads.
- Cover or maintain at least 2 feet of free board space on haul trucks transporting soil, sand, or other loose material on the site. Any haul trucks that would be traveling along freeways or major roadways should be covered.
- Use wet power vacuum street sweepers to remove any visible trackout mud or dirt onto adjacent public roads at least once a day. Use of dry power sweeping is prohibited.
- Limit vehicle speeds on unpaved roads to 15 miles per hour.
- Pave all roadways, driveways, sidewalks, and parking lots as soon as possible. In addition, building pads should be laid as soon as possible after grading unless seeding or soil binders are used.
- Minimize idling time either by shutting equipment off when not in use or reducing the time of idling to 5 minutes (required by California Code of Regulations, Title 13, Sections 2449(d)(3) and 2485). Provide clear signage that posts this requirement for workers at the entrances to the site.
- Maintain all construction equipment in proper working condition according to manufacturer's specifications. The equipment must be checked by a certified mechanic and determine to be running in proper condition before it is operated.

Implementation and Notification (Action by Project Applicant):

1. Comply fully with the above measure.

2. Include the above measure verbatim as a Construction Note and incorporate it into all Plans and Specifications for the project, and submit one copy to the Environmental Coordinator for review and approval prior to the start of any construction work (including clearing and grubbing).

Verification (Action by the Environmental Coordinator):

1. Review the Project Plans prior to the start of construction. Approve Project Plans that are determined to be in compliance with all required mitigation.

2. Monitor compliance during periodic site inspections of the construction work.

3. Participate in any Final Inspection(s) as necessary.

☐ MITIGATION MEASURE AQ-2: UTILIZE MODEL YEAR 2010 OR NEWER ENGINES TO REDUCE CONSTRUCTION-RELATED EMISSIONS FROM ON-ROAD VEHICLES

All on-road trucks will consist of model year 2010 or newer engines. Construction contractors will provide documentation to the County of efforts to secure such a fleet. The contractors will keep a written record of equipment usage during project construction for each piece of equipment and provide the County with annual reports documenting compliance. These reports will be submitted to SMAQMD. In the event Construction contractors cannot secure all 2010 engine model year or newer on-road trucks for the project, an off-site mitigation fee program, as analyzed in the Air Quality Study Report (Volume 3 Technical Studies), or SMAQMD Off-site Construction Mitigation Fee Program shall be implemented.

The reporting plan shall follow SMAQMD's Enhanced On-site Exhaust Controls mitigation language. The plan will have at least two components: an initial report submitted before construction and a final report submitted at the completion of the job, phase or calendar year, as pre-arranged with SMAQMD staff and documented in the approval letter, to demonstrate continued project compliance. Additionally, the below requirements shall be met:

- Submit the initial report at least four (4) business days prior to construction activity using the SMAQMD's Construction Mitigation Tool (http://www.airquality.org/businesses/ceqa-land-use-planning/mitigation)
- Provide project information and construction company information

Include the equipment type, horsepower rating, engine model year, projected hours of use, and the CARB equipment identification number for each piece of equipment in the plan. Incorporate all owned, leased and subcontracted equipment to be used.

Implementation and Notification (Action by Project Applicant):

1. Comply fully with the above measure.

2. Include the above measure verbatim as a Construction Note and incorporate it into all Plans and Specifications for the project, and submit one copy to the Environmental Coordinator for review and approval prior to the start of any construction work (including clearing and grubbing).

Verification (Action by the Environmental Coordinator):

1. Review the Project Plans prior to the start of construction. Approve Project Plans that are determined to be in compliance with all required mitigation.

2. Monitor compliance during periodic site inspections of the construction work.

3. Participate in any Final Inspection(s) as necessary.

☐ MITIGATION MEASURE AQ-3: UTILIZE CLEAN DIESEL-POWERED EQUIPMENT DURING CONSTRUCTION TO CONTROL CONSTRUCTION-RELATED NO_X EMISSIONS

The County will ensure that all off-road diesel-powered equipment used during construction is equipped with EPA Tier 4 Final engines. The County will submit to SMAQMD a comprehensive inventory of all off-road construction equipment, equal to or greater than 50 horsepower, that will be used an aggregate of 8 or more hours during any phase of the construction project. In the event Construction contractors cannot secure all 2010 engine model year or newer on-road trucks and all Tier 4 Final off-road equipment for this entire project, an off-site mitigation fee program, as analyzed in the Air Quality Study Report (Volume 3 Technical Studies), or SMAQMD Off-site Construction Mitigation Fee Program shall be implemented.

The inventory will include the following:

- CARB equipment identification number, equipment type, horsepower rating, engine model year (Tier 4 Final), and projected hours of use for each piece of off-road equipment.
- Current Certificate of Reported Compliance for CARB's In-Use Off-Road Regulation for each construction company working on the project.
- Anticipated construction timeline including start date, and name, phone number and email address of the project manager and on-site foreman.

The construction inventory will be submitted to the SMAQMD at least 4 business days prior to the use of subject equipment. The reporting plan shall comply with the requirements as outlined in Mitigation Measure AQ-2.

Implementation and Notification (Action by Project Applicant):

1. Comply fully with the above measure.

2. Include the above measure verbatim as a Construction Note and incorporate it into all Plans and Specifications for the project, and submit one copy to the Environmental Coordinator for review and approval prior to the start of any construction work (including clearing and grubbing).

Verification (Action by the Environmental Coordinator):

1. Review the Project Plans prior to the start of construction. Approve Project Plans that are determined to be in compliance with all required mitigation.

2. Monitor compliance during periodic site inspections of the construction work.

3. Participate in any Final Inspection(s) as necessary.

☐ MITIGATION MEASURE AQ-4: PREPARE AND IMPLEMENT A LEAD AND ASBESTOS ABATEMENT PLAN

Following the requirements of SMAQMD Rule 902 and Sacramento County Standard Construction Specification Section 12-1.01.C, Task Specific Safety Plan (TSSP), the County or its contractor will prepare a plan for the abatement of asbestos during demolition and removal of structures. The plan will also address abatement of structural lead. The contents of the plan will conform to Federal, State and local regulations regarding preventing environmental exposure and ensuring worker health and safety standards are implemented, including for the proper handling, removal, and disposal of the pollutants.

Implementation and Notification (Action by Project Applicant):

1. Comply fully with the above measure.

2. Include the above measure verbatim as a Construction Note and incorporate it into all Plans and Specifications for the project, and submit one copy to the Environmental Coordinator for review and approval prior to the start of any construction work (including clearing and grubbing).

Verification (Action by the Environmental Coordinator):

1. Review the Project Plans prior to the start of construction. Approve Project Plans that are determined to be in compliance with all required mitigation.

2. Monitor compliance during periodic site inspections of the construction work.

3. Participate in any Final Inspection(s) as necessary.

☐ MITIGATION MEASURE NO-1: APPLY QUIET PAVEMENT OR CONSTRUCT NOISE BARRIER ALONG AEROJET ROAD (FOR ALTERNATIVE 2 ONLY)

The County will implement one of two mitigation options.

Option 1. Apply quiet pavement to the US 50 mainline from just west of Hazel Avenue to 0.25 mile east of Aerojet Road, at a minimum. The pavement will be designed to provide a minimum of 4 dB of noise reduction relative to standard pavement that would otherwise be used. Applying quiet pavement to the off-ramp only and exclusive of US 50 would have no noise-reducing effect. As such, quiet pavement will be applied to both the US 50 mainline and Aerojet Road to achieve the required noise level reduction.

Option 2. Construct a noise barrier at a height of 14 feet along Aerojet Road in the location shown on EIR/EA Figure 2.14-5.

It may not be possible to apply quiet pavement to the US 50 mainline given that it is located within State ROWs and regulated by Caltrans. Therefore, if Option 1 is determined not to be feasible, the County will implement Option 2.

Implementation and Notification (Action by Project Applicant):

1. Comply fully with the above measure.

2. Include the above measure verbatim as a Construction Note and incorporate it into all Plans and Specifications for the project, and submit one copy to the Environmental Coordinator for review and approval prior to the start of any construction work (including clearing and grubbing).

Verification (Action by the Environmental Coordinator):

1. Review the Project Plans prior to the start of construction. Approve Project Plans that are determined to be in compliance with all required mitigation.

2. Monitor compliance during periodic site inspections of the construction work.

3. Participate in any Final Inspection(s) as necessary.

☐ MITIGATION MEASURE NO-2: EMPLOY NOISE-REDUCING CONSTRUCTION PRACTICES DURING CONSTRUCTION

During construction, the contractor will employ best practices to reduce construction noise at noise-sensitive land uses. Where possible, noise levels should not exceed 55 dBA during evening hours (8:00 p.m. to 10:00 p.m.) and 50 dBA during nighttime hours (10:00 p.m. to 6:00 a.m.)

Measures used to limit construction noise include the following.

- Limit noise-generating construction operations to daytime hours.
- Locate stationary equipment (e.g., generators, compressors, cement mixers, idling trucks) as far as possible from noise-sensitive land uses.
- Prevent excessive noise by shutting down idle vehicles or equipment.
- During use of pile drivers, include noise control measures such as pile cushions or noise shrouds.
- Require that all construction equipment powered by gasoline or diesel engines have sound-control devices that are at least as effective as those originally provided by the manufacturer and that all equipment be operated and maintained to minimize noise generation.
- Use noise-reducing enclosures around noise-generating equipment.
- Construct barriers to block sound transmission from construction equipment to noise-sensitive land uses. The barriers will be designed to obstruct the line of sight from the noise-sensitive land uses to on-site construction equipment.

Implementation and Notification (Action by Project Applicant):

1. Comply fully with the above measure.
2. Include the above measure verbatim as a Construction Note and incorporate it into all Plans and Specifications for the project, and submit one copy to the Environmental Coordinator for review and approval prior to the start of any construction work (including clearing and grubbing).

Verification (Action by the Environmental Coordinator):

1. Review the Project Plans prior to the start of construction. Approve Project Plans that are determined to be in compliance with all required mitigation.
2. Monitor compliance during periodic site inspections of the construction work.
3. Participate in any Final Inspection(s) as necessary.

☐ MITIGATION MEASURE NO-3: INITIATE A NOISE CONTROL PLAN FOR MITIGATION OF CONSTRUCTION NOISE DURING EVENING/NIGHTTIME HOURS

A construction noise control plan will be prepared by the County or its contractor that describes the specific methods the contractor will use to minimize construction equipment noise levels at nearby residences. The plan will include provisions for giving advance notification of construction activity schedules to occupants of potentially affected buildings.

Prior to construction, the contractor will make a construction schedule available to residents living in the vicinity of the construction areas, and designate a noise disturbance coordinator. The coordinator will be responsible for responding to complaints regarding construction noise, will determine the cause of the complaint, and will ensure that reasonable measures are implemented to correct the problem when feasible. A contact telephone number for the noise disturbance coordinator will be conspicuously posted on construction site fences and will be included in the notification of the construction schedule.

In the event of complaints by affected residents due to on-site construction noise generated during evening/nighttime hours, the contractor will monitor noise levels intermittently (between 8:00 p.m. and 6:00 a.m.) at or near the residence of the person lodging the complaint. If measured construction noise at the monitor location during nighttime hours exceeds 55 dBA L_{eq} between the hours of 8:00 p.m. to 10:00 p.m. or 50 dBA L_{eq} during nighttime hours (10:00 p.m. to 6:00 a.m.), the construction contractor will implement sound-attenuating mitigation measures where site conditions allow, such as limitations on use of noise-generating equipment or installation of additional temporary barriers or enclosures.

If these measures are ineffective in reducing noise to the identified levels, or site conditions prohibit implementation of the measures, the affected residents will be offered short-term relocation assistance for the duration of the time that nighttime noise levels are expected to exceed the specified levels.

Implementation and Notification (Action by Project Applicant):

1. Comply fully with the above measure.

2. Include the above measure verbatim as a Construction Note and incorporate it into all Plans and Specifications for the project, and submit one copy to the Environmental Coordinator for review and approval prior to the start of any construction work (including clearing and grubbing).

Verification (Action by the Environmental Coordinator):

1. Review the Project Plans prior to the start of construction. Approve Project Plans that are determined to be in compliance with all required mitigation.

2. Monitor compliance during periodic site inspections of the construction work.

3. Participate in any Final Inspection(s) as necessary.

☐ MITIGATION MEASURE HY-1: IMPLEMENT BEST MANAGEMENT PRACTICES TO CONTROL RUNOFF AND DISCHARGE OF POLLUTANTS DURING PROJECT CONSTRUCTION AND OPERATION AND FOLLOW REQUIREMENTS OF PERMITTING AGENCIES AND THE STORMWATER QUALITY DESIGN MANUAL

As part of the final design process prior to project construction, the project engineers will develop and incorporate design features or BMPs into the project design. The features selected will comply with the Sacramento County SQIP and the Sacramento Region SQDM for project areas outside of Caltrans ROW, and Caltrans SWMP and Standard Specifications for project areas within Caltrans ROW. The features will be designed to meet all applicable water quality objectives for surface waters and groundwater contained in the Basin Plan.

For project areas outside of Caltrans ROW, the project engineers will follow the guidance in the SQDM including selecting measures from SQDM Table 3-3, Stormwater Quality Control Measure Selection Matrix, for street/road projects with new impervious areas larger than 5 acres. Measures that could be selected and implemented include source control, hydromodification control, treatment control, and low impact development measures such as vegetated swales, water quality detention basins, and bioretention planters.

The project engineers and construction contractor will ensure compliance with the requirements of Caltrans and County NPDES MS4 permits to control stormwater and non-stormwater discharges associated with project construction activities and discharges within the jurisdiction of each permit. Temporary diversion systems and dewatering operations will be implemented, as appropriate. The controls required by all applicable permits will be implemented to reduce the discharge of pollutants in stormwater discharges to the maximum extent possible, including management practices, control techniques, system design and engineering methods, and other measures as appropriate.

The project engineers and the construction contractor will ensure that the requirements of the County SQIP will be followed to reduce the discharge of pollutants to the MS4. The project engineers and construction contractor will also ensure construction activities and project implementation complies with Section 401 (Water Quality Certification) from the Central Valley Regional Water Quality Control Board and the Section 404 Permit from the Sacramento District U.S. Army Corps of Engineers (USACE).

Implementation and Notification (Action by Project Applicant):

1. Comply fully with the above measure.

2. Include the above measure verbatim as a Construction Note and incorporate it into all Plans and Specifications for the project, and submit one copy to the Environmental Coordinator for review and approval prior to the start of any construction work (including clearing and grubbing).

Verification (Action by the Environmental Coordinator):

1. Review the Project Plans prior to the start of construction. Approve Project Plans that are determined to be in compliance with all required mitigation.

2. Monitor compliance during periodic site inspections of the construction work.

3. Participate in any Final Inspection(s) as necessary.

☐ MITIGATION MEASURE GS-1: PREPARE AND IMPLEMENT A PALEONTOLOGICAL MITIGATION PLAN

A non-standard special provision for paleontology mitigation will be included in the construction contract special provisions section to advise the construction contractor of the requirement to cooperate with paleontological salvage. The following items will be part of the provisions.

- A qualified principal paleontologist, as defined by the Caltrans Standard Environmental Reference, will be retained to prepare and implement a final Paleontological Mitigation Plan (PMP) prior to construction. If the qualified paleontologist is not a licensed professional geologist in the State of California, then a licensed professional geologist will need to be retained to review and approve the PMP prior to construction. The preliminary PMP prepared for the project (California Department of Transportation 2017; provided in Volume 3, *Technical Studies*, or from the project website at http://www.sacdot.com/Pages/Project-Hazel-StatRoute50.aspx) will be updated based on final engineering design and geotechnical information
- The geotechnical investigation conducted to support final engineering design will identify the depth and location of sensitives areas and will be used by the qualified principal paleontologist to identify locations that warrant monitoring for paleontological resources during construction
- The final PMP will list the proposed staff and professional qualifications.
- The qualified principal paleontologist will attend a task order meeting and conduct a site visit to review task order requirements; review plans, maps, initial site reports, and mitigation requirements; review site geology and paleontological sensitivity; prepare a mitigation work plan; and prepare a Code of Safe Practices.
- The qualified principal paleontologist will schedule coordination and supervision for paleontological monitors of any salvage. Monthly progress reports will be prepared for lead agency review and comment.
- The qualified principal paleontologist may designate a paleontological monitor to be present during earthmoving activities. According to preliminary engineering, excavations could occur throughout the proposed project area; therefore, paleontological monitoring is recommended during any earthmoving activities/excavations. The qualified principal paleontologist will identify locations that warrant monitoring during construction
- The paleontological monitor will have a college degree in paleontology or geology and at least 2 years of paleontological monitoring experience or other qualifications described by the Society of Vertebrate Paleontology (2010).
- The qualified principal paleontologist and paleontological monitor will be notified by the resident engineer or lead agency in advance of starting construction activity and will attend any safety training programs for the proposed project. Paleontological monitoring may be full-time during excavation for

undercrossings, in-ground structural elements such as bridge substructures and culverts, and any other project elements requiring deep excavation. If, after 50% of the grading/excavation is completed at a particular location for the proposed project, it can be demonstrated that the level of monitoring should be reduced for that site, the qualified principal paleontologist will amend the mitigation program (Society of Vertebrate Paleontology 2010). If pieces of heavy equipment are in use simultaneously at different locations, each location may be individually monitored.

- The qualified principal paleontologist will meet with the resident engineer and construction contractor at a preconstruction conference to develop an agreed-upon communication plan and to discuss provisions for worker safety. All project personnel will receive paleontological awareness training prior to commencement of work by the qualified principal paleontologist.
- If paleontological resources are discovered during earthmoving activities, the construction crew will immediately cease work within a 60-foot radius of the find and notify the resident engineer and the Sacramento County Office of Planning and Environmental Review. In the event paleontological resources are discovered, fossil specimens will be properly collected and sufficiently documented to be of scientific value.
- The collection and treatment actions described in the PMP will occur during the grading and construction process and after recovery of specimens if fossils are found, including sampling for microfossils, conducting paleomagnetic analysis, identifying and preparing fossils, arranging for a repository, and preparing a final report.

Implementation and Notification (Action by Project Applicant):

1. Comply fully with the above measure.

2. Include the above measure verbatim as a Construction Note and incorporate it into all Plans and Specifications for the project, and submit one copy to the Environmental Coordinator for review and approval prior to the start of any construction work (including clearing and grubbing).

Verification (Action by the Environmental Coordinator):

1. Review the Project Plans prior to the start of construction. Approve Project Plans that are determined to be in compliance with all required mitigation.

2. Monitor compliance during periodic site inspections of the construction work.

3. Participate in any Final Inspection(s) as necessary.

☐ MITIGATION MEASURE BIO-1: INSTALL ORANGE CONSTRUCTION FENCING BETWEEN THE CONSTRUCTION AREA AND ADJACENT SENSITIVE BIOLOGICAL RESOURCES

The County and/or their contractor will install orange construction fencing between the construction area and adjacent sensitive biological resource areas. Sensitive biological resources that occur adjacent to the construction area that could be directly affected by the project include natural communities of special concern; fairy shrimp, valley elderberry longhorn beetle and western pond turtle habitats; nest sites of Swainson's hawk, yellow-breasted chat, tricolored blackbird, song sparrow, and other migratory birds; roosting bats; and protected trees to be avoided.

Barrier fencing around sensitive areas will be installed as one of the first orders of work and prior to equipment staging. Preliminary fencing locations are included in the draft project design drawings and labeled as Environmentally Sensitive Areas. The preliminary fencing locations area also shown on EIR/EA Figure 3-1. The locations of the fencing will be updated or confirmed as part of final design, prior to construction. Before construction begins, the construction contractor will work with the project engineer and a resource specialist to identify the locations for the orange construction fencing, and a resource specialist will place stakes around the sensitive resource sites to indicate these locations. The protected areas will be designated as environmentally sensitive areas and clearly identified on the construction plans and described in the specifications. Barrier fencing will be installed before construction activities are initiated, maintained throughout the construction period, and removed after completion of construction.

Implementation and Notification (Action by Project Applicant):

1. Comply fully with the above measure.

2. Include the above measure verbatim as a Construction Note and incorporate it into all Plans and Specifications for the project, and submit one copy to the Environmental Coordinator for review and approval prior to the start of any construction work (including clearing and grubbing).

Verification (Action by the Environmental Coordinator):

1. Review the Project Plans prior to the start of construction. Approve Project Plans that are determined to be in compliance with all required mitigation.

2. Monitor compliance during periodic site inspections of the construction work.

3. Participate in any Final Inspection(s) as necessary.

☐ MITIGATION MEASURE BIO-2: CONDUCT ENVIRONMENTAL AWARENESS TRAINING FOR CONSTRUCTION EMPLOYEES

The County or their contractor will retain a qualified biologist to conduct environmental awareness training for construction crews before project implementation. The awareness training will be provided to all construction personnel and will brief them on the need to avoid effects on sensitive biological resources (e.g., native trees, natural communities of special concern, and special-status species habitats in and adjacent to the construction area). The education program will include a brief review of the special-status species with the potential to occur in the BSA (including their life history, habitat requirements, and photographs of the species). The training will identify the portions of the BSA in which the species may occur, as well as their legal status and protection. The program also will cover the restrictions and guidelines that must be followed by all construction personnel to reduce or avoid effects on these species during project implementation. This will include the steps to be taken if a sensitive species is found within the construction area (i.e., notifying the crew foreman, who will call a designated biologist). In addition, construction employees will be educated about the importance of controlling and preventing the spread of invasive plant infestations. An environmental awareness handout that describes and illustrates sensitive resources to be avoided during project construction and identifies all relevant permit conditions will be provided to each crew member. The crew foreman will be responsible for ensuring that crew members adhere to the guidelines and restrictions. Education programs will be conducted for appropriate new personnel as they are brought on the job during the construction period.

Implementation and Notification (Action by Project Applicant):

1. Comply fully with the above measure.

2. Include the above measure verbatim as a Construction Note and incorporate it into all Plans and Specifications for the project, and submit one copy to the Environmental Coordinator for review and approval prior to the start of any construction work (including clearing and grubbing).

Verification (Action by the Environmental Coordinator):

1. Review the Project Plans prior to the start of construction. Approve Project Plans that are determined to be in compliance with all required mitigation.

2. Monitor compliance during periodic site inspections of the construction work.

3. Participate in any Final Inspection(s) as necessary.

☐ MITIGATION MEASURE BIO-3: RETAIN A QUALIFIED BIOLOGIST TO CONDUCT MONITORING DURING CONSTRUCTION IN SENSITIVE HABITATS

The County or their contractor will retain a qualified biologist to monitor all construction activities that involve ground disturbance (e.g., vegetation removal, grading, excavation, road construction) within or adjacent to environmentally sensitive areas (e.g., wetlands, streams, riparian vegetation, special-status species habitat, active bird nests, and adjacent areas within 250-feet or where indirect effects are possible). The purpose of the monitoring is to ensure that avoidance and minimization measures are properly implemented to protect sensitive biological resources and to ensure that the project complies with all applicable permit requirements and agency conditions of approval. The biologist will regularly inspect the fencing around environmentally sensitive areas (see EIR/EA Figure 3-1) and will communicate any issues to the resident engineer or construction foreman. The contractor will be responsible for maintaining the fence during construction and ensuring that no construction personnel, equipment, or runoff/sediment from the construction area enters environmentally sensitive areas. The monitor will complete daily logs, and a final monitoring report will be prepared at the end of each construction season that will be submitted to the County and other overseeing agencies (i.e., California Department of Fish and Wildlife [CDFW], U.S. Fish and Wildlife Service [USFWS], and USACE), as appropriate.

Implementation and Notification (Action by Project Applicant):

1. Comply fully with the above measure.

2. Include the above measure verbatim as a Construction Note and incorporate it into all Plans and Specifications for the project, and submit one copy to the Environmental Coordinator for review and approval prior to the start of any construction work (including clearing and grubbing).

Verification (Action by the Environmental Coordinator):

1. Review the Project Plans prior to the start of construction. Approve Project Plans that are determined to be in compliance with all required mitigation.

2. Monitor compliance during periodic site inspections of the construction work.

3. Participate in any Final Inspection(s) as necessary.

☐ MITIGATION MEASURE BIO-4: DESIGN AND IMPLEMENT WATER CONVEYANCE SYSTEMS THAT MAINTAIN HYDROLOGY OF AND PREVENT CONTAMINANTS FROM ENTERING SUITABLE VERNAL POOL BRANCHIOPOD HABITAT

Concentrated flow conveyance systems identified for the proposed project may include roadside ditches, biofiltration swales, curb and gutters, dikes, overside drains, and culverts. Water conveyance systems surrounding suitable vernal pool branchiopod habitat in the project area will be evaluated, designed, and installed to maintain the existing hydrology of the four seasonal wetlands (see EIR/EA Figure 2.16-1, Sheet 2) that provide potential habitat for vernal pool branchiopods.

Implementation and Notification (Action by Project Applicant):

1. Comply fully with the above measure.

2. Include the above measure verbatim as a Construction Note and incorporate it into all Plans and Specifications for the project, and submit one copy to the Environmental Coordinator for review and approval prior to the start of any construction work (including clearing and grubbing).

Verification (Action by the Environmental Coordinator):

1. Review the Project Plans prior to the start of construction. Approve Project Plans that are determined to be in compliance with all required mitigation.

2. Monitor compliance during periodic site inspections of the construction work.

3. Participate in any Final Inspection(s) as necessary.

☐ MITIGATION MEASURE BIO-5: FENCE ELDERBERRY SHRUBS TO BE PROTECTED

Elderberry shrubs/clusters within 165 feet of the construction area that will not be removed will be protected during construction. A qualified biologist (i.e., with elderberry/valley elderberry longhorn beetle experience) will mark the elderberry shrubs and clusters that will be protected during construction. Orange construction barrier fencing will be placed at the edge of the buffer areas established for each shrub or cluster. The buffer area distances will be proposed by the biologist and approved by the U.S. Fish and Wildlife Service (USFWS). No construction activities will be permitted in the buffer zone other than those activities necessary to erect the fencing. Signs will be posted along fencing for the duration of construction and will contain the following information.

This area is habitat of the valley elderberry longhorn beetle, a threatened species, and must not be disturbed. This species is protected by the Endangered Species Act of 1973, as amended. Violators are subject to prosecution, fines, and imprisonment.

Temporary fences around the elderberry shrubs will be installed as the first order of work. Temporary fences will be furnished, constructed, maintained, and later removed, as shown on the plans, as specified in the special provisions, and as directed by the project engineer. Temporary fencing will be 4 feet high, commercial-quality woven polypropylene, and orange in color.

Buffer area fences around elderberry shrubs will be inspected periodically by a qualified biologist until project construction is complete or until the fences are removed, as approved by the biological monitor and the resident engineer. The contractor will be responsible for maintaining the buffer area fences around elderberry shrubs throughout construction. Biological inspection reports will be provided to the County and USFWS.

Implementation and Notification (Action by Project Applicant):

1. Comply fully with the above measure.

2. Include the above measure verbatim as a Construction Note and incorporate it into all Plans and Specifications for the project, and submit one copy to the Environmental Coordinator for review and approval prior to the start of any construction work (including clearing and grubbing).

Verification (Action by the Environmental Coordinator):

1. Review the Project Plans prior to the start of construction. Approve Project Plans that are determined to be in compliance with all required mitigation.

2. Monitor compliance during periodic site inspections of the construction work.

3. Participate in any Final Inspection(s) as necessary.

☐ MITIGATION MEASURE BIO-6: COMPENSATE FOR DIRECT EFFECTS ON VALLEY ELDERBERRY LONGHORN BEETLE AND ITS HABITAT

Before construction begins, the County will compensate for direct effects on valley elderberry longhorn beetle by transplanting shrubs that cannot be avoided to a USFWS-approved conservation bank. The County will also purchase credits at a USWFS-approved conservation bank in accordance with ratios shown in Table 3.15-2 for the alternative that is selected. Compensation ratios shown are for shrub-level impact compensation (U.S. Fish and Wildlife Service 2017).

Table 3.15-2. Compensation for Direct Effects on Elderberry Shrubs by Alternative

Alternative	Number of Elderberry Shrubs Affected	Compensa-tion Ratio (non-riparian)	Number of Conserva-tion Credits Required
1	3	1:1	3
1A	3	1:1	3
2	4	1:1	4

The relocation of the elderberry shrubs will be conducted according to USFWS-approved procedures outlined in the Framework for Assessing Impacts to the Valley Elderberry Longhorn Beetle (U.S. Fish and Wildlife Service 2017). Elderberry shrubs within the the project construction area that cannot be avoided will be transplanted during the plant's dormant phase (November through the first 2 weeks of February). A qualified biological monitor will remain on-site while the shrubs are being transplanted.

Implementation and Notification (Action by Project Applicant):

1. Comply fully with the above measure.

2. Include the above measure verbatim as a Construction Note and incorporate it into all Plans and Specifications for the project, and submit one copy to the Environmental Coordinator for review and approval prior to the start of any construction work (including clearing and grubbing).

Verification (Action by the Environmental Coordinator):

1. Review the Project Plans prior to the start of construction. Approve Project Plans that are determined to be in compliance with all required mitigation.

2. Monitor compliance during periodic site inspections of the construction work.

3. Participate in any Final Inspection(s) as necessary.

☐ MITIGATION MEASURE BIO-7: COMPENSATE FOR THE PERMANENT AND TEMPORARY LOSS OF VALLEY FOOTHILL RIPARIAN WOODLAND

The County will compensate for the permanent and temporary loss of valley foothill riparian habitat (as show on EIR/EA Figures 2.16-2 and 2.16-3, Sheet 4) by planting a minimum of 0.06 acre of valley foothill riparian woodland species (a minimum ratio of 1:1 [1 acre planted for every 1 acre permanently and temporarily affected]) on-site or off-site and/or purchasing mitigation bank credits equivalent to a minimum of 0.06 acre of valley foothill riparian habitat.

On-site compensation will be used to the maximum extent practicable, but off-site compensation and/or purchase of mitigation bank credits may be needed to achieve no net loss of existing in-kind riparian habitat. Each of these options is discussed below.

- Riparian habitat restoration and/or enhancement on-site or off-site should occur in the same year construction is completed. For on-site or off-site plantings, the County will prepare a mitigation planting plan, including a species list and number of each species, planting locations, and maintenance requirements. Plantings will consist of cuttings taken from local plants or plants grown from local material. Planted species for the mitigation plantings will be similar to those in and adjacent to the project area and will include native species, such as white alder (*Alnus rhombifolia*), Fremont cottonwood (*Populus fremontii* ssp. *fremontii*), valley oak (*Quercus lobata*), black walnut (*Juglans hindsii*), Oregon ash (*Fraxinus latifolia*), boxelder (*Acer negundo*), and black willow (*Salix gooddingii*). All plantings will be fitted with exclusion cages or other suitable protection from herbivory until plantings are established. Plantings will be irrigated for up to 3 years or until established. Plantings will be monitored annually for 3 years or as required in the project permits. If 75% of the plants survive at the end of the monitoring period, the revegetation will be considered successful. If the survival criterion is not met at the end of the monitoring period, planting and monitoring will be repeated after mortality causes have been identified and corrected.
- The County will provide written evidence to the resource agencies that compensation has been established through the purchase of mitigation credits. The County will pay the cost of mitigation credits in effect at the time the credits are purchased. Replacement riparian habitat will include tree species that would support nesting Swainson's hawk (*Buteo swainsoni*) (i.e., oak, cottonwood) and will occur within the range of nesting Swainson's hawk within the Sacramento Valley.

Approval of riparian mitigation activities is subject to Notification that would require CDFW-approved compensatory mitigation to offset impacts. Likewise, to the extent offsite credits are utilized, the mitigation should occur at a CDFW-approved mitigation or conservation bank.

Implementation and Notification (Action by Project Applicant):

1. Comply fully with the above measure.

2. Include the above measure verbatim as a Construction Note and incorporate it into all Plans and Specifications for the project, and submit one copy to the Environmental Coordinator for review and approval prior to the start of any construction work (including clearing and grubbing).

Verification (Action by the Environmental Coordinator):

1. Review the Project Plans prior to the start of construction. Approve Project Plans that are determined to be in compliance with all required mitigation.

2. Monitor compliance during periodic site inspections of the construction work.

3. Participate in any Final Inspection(s) as necessary.

☐ MITIGATION MEASURE BIO-8: COMPENSATE FOR LOSS OF WETLANDS AND NON-WETLAND WATERS OF THE UNITED STATES/WATERS OF THE STATE

The County will compensate for the permanent fill of waters of the United States/waters of the State (a direct impact associated with roadway and interchange construction) in two wetland habitat types—emergent wetland and seasonal wetland—and in two non-wetland waters type—perennial drainage and ephemeral drainage. The minimum wetland compensation ratio to ensure no net loss of wetland or drainage functions and values will be 1:1 (1 acre of habitat credit for every 1 acre of permanent impact). The final compensation ratio will be approved by USACE. The County will compensate for permanent loss of wetlands and non-wetland waters through one or more of the following mitigation options:

- Purchase habitat credits from a USACE-approved mitigation bank with service areas for Sacramento County, such as the Cosumnes Floodplain Mitigation Bank or Elsie Gridley Mitigation Bank, and provide written evidence to the resource agencies that compensation has been established through the purchase of mitigation credits. The County will pay the cost of mitigation credits in effect at the time the credits are purchased. The mitigation will be approved by USACE and may be modified during the permitting process.
- Pay into the National Fish and Wildlife Foundation Sacramento District In-Lieu Fee Program.

Temporarily disturbed wetlands and non-wetland waters will be returned to preconstruction condition following construction. The County also will implement the conditions and requirements of State and Federal permits that will be obtained for the proposed project.

Approval of wetland mitigation activities is subject to Notification that would require CDFW-approved compensatory mitigation to offset impacts. Likewise, to the extent offsite credits are utilized, the mitigation should occur at a CDFW-approved mitigation or conservation bank.

Implementation and Notification (Action by Project Applicant):

1. Comply fully with the above measure.

2. Include the above measure verbatim as a Construction Note and incorporate it into all Plans and Specifications for the project, and submit one copy to the Environmental Coordinator for review and approval prior to the start of any construction work (including clearing and grubbing).

Verification (Action by the Environmental Coordinator):

1. Review the Project Plans prior to the start of construction. Approve Project Plans that are determined to be in compliance with all required mitigation.

2. Monitor compliance during periodic site inspections of the construction work.

3. Participate in any Final Inspection(s) as necessary.

☐ MITIGATION MEASURE BIO-9: CONDUCT PRECONSTRUCTION SURVEYS FOR WESTERN POND TURTLE AND MONITOR INITIAL IN WATER WORK

To avoid potential injury or mortality of western pond turtles, the County will retain a qualified wildlife biologist who is CDFW-approved to capture and relocate turtles. The biologist will conduct a preconstruction survey for western pond turtles within 24 hours of the start of construction and will survey Alder Creek and the adjacent riparian and ruderal habitat within the construction area. If in-water work does not start immediately, the biologist will return to the construction site immediately prior to the start of in-water work (i.e., dewatering, vegetation removal, or any other activities in the creek) to conduct another preconstruction survey. The biologist will remain on-site until initial in-water work is complete. If a turtle becomes trapped during initial in-water work, the biologist will relocate the individual to suitable aquatic habitat upstream of the construction area (the area downstream of the construction area is not accessible because of US 50). For the remainder of construction, the biologist will remain on-call in case a turtle is discovered. The construction crew will be instructed to notify the crew foreman, who will contact the biologist if a turtle is found trapped within the construction area. Work in the area where the turtle is trapped will stop until the biologist arrives and removes and relocates the turtle. The biologist will report their activities to the County and CDFW within 1 day of relocating any turtle.

Implementation and Notification (Action by Project Applicant):

1. Comply fully with the above measure.

2. Include the above measure verbatim as a Construction Note and incorporate it into all Plans and Specifications for the project, and submit one copy to the Environmental Coordinator for review and approval prior to the start of any construction work (including clearing and grubbing).

Verification (Action by the Environmental Coordinator):

1. Review the Project Plans prior to the start of construction. Approve Project Plans that are determined to be in compliance with all required mitigation.

2. Monitor compliance during periodic site inspections of the construction work.

3. Participate in any Final Inspection(s) as necessary.

☐ MITIGATION MEASURE BIO-10: RESTORE TEMPORARILY DISTURBED RUDERAL HABITAT

Upon project completion, the County will restore all temporarily disturbed ruderal habitat (1.92 acres under all alternatives) (as shown on EIR/EA Figures 2.16-2 and 2.16-3) to pre-project or better conditions. To the extent feasible, native grasses and forbs will be used to reseed disturbed areas.

Implementation and Notification (Action by Project Applicant):

1. Comply fully with the above measure.
2. Include the above measure verbatim as a Construction Note and incorporate it into all Plans and Specifications for the project, and submit one copy to the Environmental Coordinator for review and approval prior to the start of any construction work (including clearing and grubbing).

Verification (Action by the Environmental Coordinator):

1. Review the Project Plans prior to the start of construction. Approve Project Plans that are determined to be in compliance with all required mitigation.
2. Monitor compliance during periodic site inspections of the construction work.
3. Participate in any Final Inspection(s) as necessary.

☐ MITIGATION MEASURE BIO-11: COMPENSATE FOR THE PERMANENT AND TEMPORARY LOSS OF FREMONT COTTONWOOD-OAK WOODLAND

The County will compensate for the permanent loss of 2.97 acres and temporary loss of 0.19 acres of Fremont cottonwood-oak woodland at a minimum ratio of 1:1 (1 acre planted for every 1 acre permanently affected). The loss of most of the Fremont cottonwood-oak woodland habitat in the project area has been previously mitigated as part of Phase 2 of the Easton Project (County of Sacramento 2008). Figures 2.16-2 and 2.16-3 show the area that has been previously mitigated for Phase 2 of the Easton Project. For the proposed project, compensation would only be required for 0.90 acre of the direct impacts (see Section 2.16, Natural Communities, for further details). As part of the woodland mitigation, compensation may include either compensation for the woodland habitat at a minimum ratio or 1:1 as indicated above and/or compliance with Mitigation Measure BIO-20 and/or Mitigation Measure BIO-21.

Implementation and Notification (Action by Project Applicant):

1. Comply fully with the above measure.

2. Include the above measure verbatim as a Construction Note and incorporate it into all Plans and Specifications for the project, and submit one copy to the Environmental Coordinator for review and approval prior to the start of any construction work (including clearing and grubbing).

Verification (Action by the Environmental Coordinator):

1. Review the Project Plans prior to the start of construction. Approve Project Plans that are determined to be in compliance with all required mitigation.

2. Monitor compliance during periodic site inspections of the construction work.

3. Participate in any Final Inspection(s) as necessary.

☐ MITIGATION MEASURE BIO-12: CONDUCT VEGETATION REMOVAL DURING THE NON-BREEDING SEASON OF NESTING MIGRATORY BIRDS

To the maximum extent feasible, vegetation removal (trees, shrubs, and ground vegetation) will occur during the non-breeding season for most migratory birds (generally between September 16 and January 31). This timing is highly preferable because if an active nest is found during preconstruction surveys in a tree (or other vegetation) that would be removed by project construction, the tree (or other vegetation) cannot be removed until the end of the nesting season, which could delay construction. If vegetation cannot be removed between October and January, or if ground cover re-establishes in areas where vegetation has been removed, the affected area must be surveyed for nesting birds, as discussed in Mitigation Measures BIO-13: Conduct Focused Survey for Nesting Swainson's Hawk and White-Tailed Kite Prior to Construction and BIO-14: Conduct Preconstruction Surveys for Nesting Migratory Birds. To minimize potential impacts on roosting bats, tree trimming and removal should be conducted from September 1 through October 15 (see Mitigation Measure BIO-15: Identify Suitable Roosting Habitat for Bats and Implement Avoidance and Protective Measures). Tree trimming and removal during this timeframe would avoid or minimize impacts on nesting birds and roosting bats.

Implementation and Notification (Action by Project Applicant):

1. Comply fully with the above measure.

2. Include the above measure verbatim as a Construction Note and incorporate it into all Plans and Specifications for the project, and submit one copy to the Environmental Coordinator for review and approval prior to the start of any construction work (including clearing and grubbing).

Verification (Action by the Environmental Coordinator):

1. Review the Project Plans prior to the start of construction. Approve Project Plans that are determined to be in compliance with all required mitigation.

2. Monitor compliance during periodic site inspections of the construction work.

3. Participate in any Final Inspection(s) as necessary.

☐ MITIGATION MEASURE BIO-13A: CONDUCT FOCUSED SURVEYS FOR NESTING WHITE-TAILED KITE PRIOR TO CONSTRUCTION

For each year in which construction, grading, or project-related improvements are to commence between February 1 and September 15, a focused survey for white- tailed kite nests on the site and within 0.25 mile of the site will be conducted by a qualified biologist no greater than 15 days prior to the start of construction work (including clearing and grubbing). If White-tailed kites are found, the qualified Biologist shall develop a species-specific avoidance plan for CDFW review and approval. Any measures approved in the plan will be implemented prior to the start of any ground-disturbing activities. If no active nests are found during the focused survey, nothing further will be required. If a lapse in project-related activities of 14 days or longer occurs, another focused survey is required before Project activities can be reinitiated.

If impacts are identified during the course of the project, project personnel shall fully avoid impacts to the species and immediately notify CDFW if White-tailed kite is detected during Project activities.

Implementation and Notification (Action by Project Applicant):

1. Comply fully with the above measure.

2. Include the above measure verbatim as a Construction Note and incorporate it into all Plans and Specifications for the project, and submit one copy to the Environmental Coordinator for review and approval prior to the start of any construction work (including clearing and grubbing).

Verification (Action by the Environmental Coordinator):

1. Review the Project Plans prior to the start of construction. Approve Project Plans that are determined to be in compliance with all required mitigation.

2. Monitor compliance during periodic site inspections of the construction work.

3. Participate in any Final Inspection(s) as necessary.

☐ MITIGATION MEASURE BIO-13B: CONDUCT FOCUSED SURVEYS FOR NESTING SWAINSON'S HAWK PRIOR TO CONSTRUCTION

If equipment staging, site preparation, grading, excavation or other project-related activities are scheduled during the Swainson's hawk nesting season (typically March 1 through September 15) surveys for active nests of such birds shall be conducted by a qualified biologist in accordance with the typical survey protocol: Recommended Timing and Methodology for Swainson's Hawk Nesting Surveys in California's Central Valley (Swainson's Hawk Technical Advisory Committee 2000). Surveys shall be conducted at the appropriate radius and time periods listed in the survey protocol. Since the project spans over multiple years, if there is a lapse of more than 15 days in construction, a new survey shall be conducted for each nesting season to capture any new Swainson's hawk nests that may be established.

If an active Swainson's hawk nest is found during project surveys, the qualified biologist shall consult with CDFW and demonstrate compliance with CESA. If during consultation it is determined that implementation of the project as proposed may result in take of Swainson's hawk, the project may seek related take authorization as provided by the Fish and Game Code.

Implementation and Notification (Action by Project Applicant):

1. Comply fully with the above measure.

2. Include the above measure verbatim as a Construction Note and incorporate it into all Plans and Specifications for the project, and submit one copy to the Environmental Coordinator for review and approval prior to the start of any construction work (including clearing and grubbing).

Verification (Action by the Environmental Coordinator):

1. Review the Project Plans prior to the start of construction. Approve Project Plans that are determined to be in compliance with all required mitigation.

2. Monitor compliance during periodic site inspections of the construction work.

3. Participate in any Final Inspection(s) as necessary.

☐ MITIGATION MEASURE BIO-14: CONDUCT PRECONSTRUCTION SURVEYS FOR NESTING MIGRATORY BIRDS

In each year in which project activities would occur during the breeding season (generally February 1 through September 15), the County will retain a qualified wildlife biologist with knowledge of the relevant species to conduct nesting surveys 15 days or less before the start of construction. Surveys will include a search of all trees and shrubs, marsh, wetland, manmade structures, and ruderal vegetation that provide suitable nesting habitat in the project area, including staging and stockpile areas. The minimum survey radii surrounding the work area shall be the following: i) 250 feet for passerines: ii) 500 feet for small raptors such as accipiters: iii) 1,000 feet for larger raptors such as buteos. If no active nests are detected during these surveys, no additional measures are required. If a lapse in project-related activities of 14 days or longer occurs, another focused survev will be required before project activities can be reinitiated.

If an active nest is found in the survey area, a no-disturbance buffer will be established with fences or flags around the nest buffer area to avoid disturbance or destruction of the site until the end of the breeding season (September 15) or until after a qualified wildlife biologist determines that the young have fledged and moved out of the project area (this date varies by species). The extent of these buffers will be determined by the biologist in coordination with USFWS and CDFW and will depend on the level of noise or construction disturbance, line-of-sight between the nest and the disturbance, ambient levels of noise and other disturbances, and other topographical or artificial barriers. Suitable buffer distances may vary between species. If nesting birds are showing signs of distress or disruptions to nesting behaviors or the buffer is otherwise not feasible, the qualified wildlife biologist, in coordination with USFWS and CDFW shall determine the appropriate change in response (e.g. buffer increase, temporary construction stop,. etc.) until no further interruptions to breeding behavior are detectable.

Implementation and Notification (Action by Project Applicant):

1. Comply fully with the above measure.

2. Include the above measure verbatim as a Construction Note and incorporate it into all Plans and Specifications for the project, and submit one copy to the Environmental Coordinator for review and approval prior to the start of any construction work (including clearing and grubbing).

Verification (Action by the Environmental Coordinator):

1. Review the Project Plans prior to the start of construction. Approve Project Plans that are determined to be in compliance with all required mitigation.

2. Monitor compliance during periodic site inspections of the construction work.

3. Participate in any Final Inspection(s) as necessary.

☐ MITIGATION MEASURE BIO-15: IDENTIFY SUITABLE ROOSTING HABITAT FOR BATS AND IMPLEMENT AVOIDANCE AND PROTECTIVE MEASURES

To minimize potential impacts on tree-roosting bats, tree trimming and removal should be conducted between September 1 and October 15, which corresponds to a time period when bats have not yet entered torpor or be caring for nonvolant (non-flying) young. Trimming or removing trees during this timeframe would also avoid impacts on nesting birds.

If tree removal or trimming cannot be conducted between September 1 and October 15, qualified biologists will examine trees for suitable bat roosting habitat before tree removal or trimming. High-quality habitat features (e.g., large tree cavities, basal hollows, loose or peeling bark, larger snags, palm trees with intact thatch) will be identified and the area around these features searched for bats and bat signs (e.g., guano, culled insect parts, staining). Riparian woodland and stands of mature broadleaf trees are considered potential habitat for solitary foliage-roosting bat species. Because signs of bat use are not easily found, and trees cannot be completely surveyed for bat roosts, the protective measures listed below will be implemented for trees containing high-quality habitat features.

- Removal or disturbance of trees providing bat roosting habitat will be avoided between April 1 and August 31 (the maternity period) to avoid effects on pregnant females and active maternity roosts (whether colonial or solitary).
- If a maternity roost is found, whether solitary or colonial, that roost will remain undisturbed until September 1 or until a qualified biologist has determined the roost is no longer active.
- Qualified biologists will monitor tree trimming/removal of the habitat. Trees should be trimmed or removed over two consecutive days. The first day (in the afternoon), limbs and branches should be removed by a tree cutter using chainsaws only. Limbs with cavities, crevices or deep bark fissures should be avoided, and only branches or limbs without those features should be removed. On the second day, the entire tree should be removed. Biologists should search downed vegetation for dead and injured bats. The presence of dead or injured bats that are species of special concern will be reported to CDFW. The biologist will prepare a biological monitoring report, which will be provided to the County and CDFW.
- Habitat assessment and survey by a qualified bat biologist
- Examining all suitable habitats prior to project implementation (including tree removal, tree trimming, or other disturbance). BIO-15 should include also habitats in manmade structures (e.g. bridge, culvert, etc.)
- Including development of a Bat Avoidance and Minimization Plan (Bat Plan) in the event that bats are utilizing the Project area during Project activities. The Bat Plan should include 1) Project-specific measures to avoid and minimize impacts to roosting bats in and near the areas that will be disturbed by Project activities 2) monitoring by a qualified bat biologist to oversee bat

behavior and the avoidance and minimizations measures designed to protect nesting/roosting bats 3) exclusion measures for the habitat that will be removed or made inaccessible by the Project and 4) discussion of available alternative habitat (both temporary and permanent).

All appropriate exclusionary measures should be implemented prior to the bridge construction during the period of March 1 to April 15 or August 31 to October 15. Potential avoidance efforts may include exclusionary blocking or filling potential roosting cavities with foam or steel wool, visual monitoring, and staging Project work to avoid bats. If bats are known to use manmade structures, exclusion netting should not be used to avoid entanglement.

Implementation and Notification (Action by Project Applicant):

1. Comply fully with the above measure.

2. Include the above measure verbatim as a Construction Note and incorporate it into all Plans and Specifications for the project, and submit one copy to the Environmental Coordinator for review and approval prior to the start of any construction work (including clearing and grubbing).

Verification (Action by the Environmental Coordinator):

1. Review the Project Plans prior to the start of construction. Approve Project Plans that are determined to be in compliance with all required mitigation.

2. Monitor compliance during periodic site inspections of the construction work.

3. Participate in any Final Inspection(s) as necessary.

☐ MITIGATION MEASURE BIO-16: COMPENSATE FOR THE LOSS OF PROTECTED TREES OUTSIDE OF OAK WOODLAND AND RIPARIAN HABITATS

This measure applies to all native oaks, that have a DBH of at least 6 inches, or if it has multiple trunks of less than 6 inches each, a combined DBH of at least 10 inches.

With the exception of the removed trees that will be compensated for through measures below, all native trees in the project area, all portions of adjacent off-site native trees that have driplines that extend onto the project area, and all off-site native trees that may be affected by utility installation and/or improvements associated with this project, will be preserved and protected based on the County's tree mitigation measures as follows:

1. A circle with a radius measurement from the trunk of the tree to the tip of its longest limb will constitute the dripline protection area of the tree. Limbs must not be cut back in order to change the dripline. The area beneath the dripline is a critical portion of the root zone and defines the minimum protected area of the tree. Removing limbs that make up the dripline does not change the protected area.
2. Chain link fencing or a similar protective barrier will be installed 1 foot outside the driplines of the native trees prior to initiating project construction, in order to avoid damage to the trees and their root system.
3. No signs, ropes, cables (except cables that may be installed by a certified arborist to provide limb support) or any other items will be attached to the native trees.
4. No vehicles, construction equipment, mobile home/office, supplies, materials or facilities will be driven, parked, stockpiled or located within the driplines of the native trees.
5. Any soil disturbance (scraping, grading, trenching, and excavation) is to be avoided within the driplines of the native trees. Where this is necessary, an International Society of Arboriculture (ISA) Certified Arborist will provide specifications for this work, including methods for root pruning, backfill specifications and irrigation management guidelines.
6. All underground utilities and drain or irrigation lines will be routed outside the driplines of native trees. Trenching within protected tree driplines is not permitted. If utility or irrigation lines must encroach upon the dripline, they should be tunneled or bored under the tree under the supervision of an ISA Certified Arborist.
7. If temporary haul or access roads must pass within the driplines of oak trees, a roadbed of 6 inches of mulch or gravel will be created to protect the root zone. The roadbed will be installed from outside of the dripline and while the soil is in a dry condition, if possible. The roadbed material will be replenished as necessary to maintain a 6-inch depth.
8. Drainage patterns on the site will not be modified so that water collects or stands within, or is diverted across, the dripline of oak trees.
9. No sprinkler or irrigation system will be installed in such a manner that it sprays water within the driplines of the oak trees.

10. Tree pruning that may be required for clearance during construction must be performed by an ISA Certified Arborist or Tree Worker and in accordance with the American National Standards Institute A300 pruning standards and the ISA "Tree Pruning Guidelines".

11. Landscaping beneath the oak trees may include non-plant materials such as boulders, decorative rock, wood chips, organic mulch, non-compacted decomposed granite, etc. Landscape materials will be kept 2 feet away from the base of the trunk. The only plant species that will be planted within the driplines of the oak trees are those which are tolerant of the natural semi-arid environs of the trees. Limited drip irrigation approximately twice per summer is recommended for the understory plants.

12. Any fence/wall that will encroach into the dripline protection area of any protected tree will be constructed using grade beam wall panels and posts or piers set no closer than 10 feet on center. Posts or piers will be spaced in such a manner as to maximize the separation between the tree trunks and the posts or piers in order to reduce impacts on the trees.

13. For a project constructing during the months of June, July, August, and September, deep water trees by using a soaker hose (or a garden hose set to a trickle) that slowly applies water to the soil until water has penetrated at least 1 foot in depth. Sprinklers may be used to water deeply by watering until water begins to run off, then waiting at least an hour or two to resume watering (provided that the sprinkler is not wetting the tree's trunk. Deep water every 2 weeks and suspend watering 2 weeks between rain events of 1 inch or more.

Implementation and Notification (Action by Project Applicant):

1. Comply fully with the above measure.

2. Include the above measure verbatim as a Construction Note and incorporate it into all Plans and Specifications for the project, and submit one copy to the Environmental Coordinator for review and approval prior to the start of any construction work (including clearing and grubbing).

Verification (Action by the Environmental Coordinator):

1. Review the Project Plans prior to the start of construction. Approve Project Plans that are determined to be in compliance with all required mitigation.

2. Monitor compliance during periodic site inspections of the construction work.

3. Participate in any Final Inspection(s) as necessary.

☐ MITIGATION MEASURE BIO-17: COMPENSATE FOR THE LOSS OF PROTECTED TREES

Native trees that would be removed in the project area include valley oak, interior live oak, California black walnut, California sycamore, buckeye, and western redbud. Based on preliminary arborist survey data, the removal of up to approximately 1,846 inches DBH of native oak trees (including oaks, sycamore, and walnut) will be compensated for by planting in-kind native trees equivalent to the DBH inches lost, based on the ratios listed below. Buckeye and western redbud will be compensated by planting one individual for each individual removed. Willows and cottonwoods will be replaced based on the loss of canopy and are included in Mitigation Measure BIO-18 along with non-native trees. Final compensation amounts will be determined based on final design, and mitigation requirements will be adjusted to compensate the actual amount removed or encroached upon by over 50 percent of the dripline radius.

Equivalent compensation based on the following ratio is required:

- one 15-gallon tree = 1 inch DBH
- one 24-inch box tree = 2 inches DBH
- one 36-inch box tree = 3 inches DBH

A Replacement Tree Planting Plan will be prepared by a certified arborist or licensed landscape architect and will be submitted to the Environmental Coordinator for approval. The Replacement Tree Planting Plan(s) will include the following minimum elements:

- Species, size and locations of all replacement plantings and < 6-inch DBH trees to be preserved
- Method of irrigation
- If planting in soils with a hardpan/duripan or claypan layer, include the Sacramento County Standard Tree Planting Detail L-1, including the 10-foot-deep boring hole to provide for adequate drainage
- Planting, irrigation, and maintenance schedules;
- Identification of the maintenance entity and a written agreement with that entity to provide care and irrigation of the trees for a 3-year establishment period, and to replace any of the replacement trees that do not survive during that period.

No replacement tree will be planted within 15 feet of the driplines of existing native trees or landmark size trees that are retained on-site, or within 15 feet of a building foundation or swimming pool excavation. The minimum spacing for replacement native trees will be 15 feet on-center.

If tree replacement plantings are demonstrated to the satisfaction of the Environmental Coordinator to be infeasible for any or all trees removed, then compensation will be through payment into the County Tree Preservation Fund. Payment will be made at a

rate of $325.00 per DBH inch removed but not otherwise compensated, or at the prevailing rate at the time payment into the fund is made.

Implementation and Notification (Action by Project Applicant):

1. Comply fully with the above measure.

2. Include the above measure verbatim as a Construction Note and incorporate it into all Plans and Specifications for the project, and submit one copy to the Environmental Coordinator for review and approval prior to the start of any construction work (including clearing and grubbing).

Verification (Action by the Environmental Coordinator):

1. Review the Project Plans prior to the start of construction. Approve Project Plans that are determined to be in compliance with all required mitigation.

2. Monitor compliance during periodic site inspections of the construction work.

3. Participate in any Final Inspection(s) as necessary.

☐ MITIGATION MEASURE BIO-18: REPLACE LOSS OF TREE CANOPY

Removal of non-native tree canopy for the selected alternative shall be mitigated by creation of new tree canopy equivalent to the acreage of non-native tree canopy removed. New tree canopy acreage shall be calculated using the Sacramento County Department of Transportation 15-year shade cover values for tree species. Preference is given to on-site mitigation, but if this is infeasible, then funding shall be contributed to the Sacramento Tree Foundation's Greenprint program in an amount proportional to the tree canopy lost (as determined by the 15-year shade cover calculations for the tree species to be planted through funding, with the cost to be determined by the Sacramento County Tree Foundation).

Implementation and Notification (Action by Project Applicant):

1. Comply fully with the above measure.

2. Include the above measure verbatim as a Construction Note and incorporate it into all Plans and Specifications for the project, and submit one copy to the Environmental Coordinator for review and approval prior to the start of any construction work (including clearing and grubbing).

Verification (Action by the Environmental Coordinator):

1. Review the Project Plans prior to the start of construction. Approve Project Plans that are determined to be in compliance with all required mitigation.

2. Monitor compliance during periodic site inspections of the construction work.

3. Participate in any Final Inspection(s) as necessary.

☐ MITIGATION MEASURE CUL-1: CONDUCT MANDATORY CULTURAL RESOURCES AWARENESS TRAINING FOR CONSTRUCTION PERSONNEL

Before any ground-disturbing work occurs in the project area, a qualified archaeologist will be retained to conduct mandatory contractor/worker cultural resources awareness training for construction personnel. The awareness training will be provided to all construction personnel, including contractors and subcontractors, to brief them on the need to avoid effects on cultural resources adjacent to and within construction areas, their responsibility to report potential resources if observed, and the penalties for not complying with applicable State and Federal laws and permit requirements.

Implementation and Notification (Action by Project Applicant):

1. Comply fully with the above measure.

2. Include the above measure verbatim as a Construction Note and incorporate it into all Plans and Specifications for the project, and submit one copy to the Environmental Coordinator for review and approval prior to the start of any construction work (including clearing and grubbing).

Verification (Action by the Environmental Coordinator):

1. Review the Project Plans prior to the start of construction. Approve Project Plans that are determined to be in compliance with all required mitigation.

2. Monitor compliance during periodic site inspections of the construction work.

3. Participate in any Final Inspection(s) as necessary.

☐ MITIGATION MEASURE CUL-2: MONITOR FOR ARCHAEOLOGICAL RESOURCES DURING INITIAL GROUND DISTURBANCE

A Native American monitor will be retained to monitor all initial ground disturbing activities (e.g., grading, excavation, tree removal). The purpose of the monitoring is to ensure that no unrecorded archaeological resources are affected by the project and to ensure that the project complies with all applicable permit requirements and agency conditions of approval.

Implementation and Notification (Action by Project Applicant):

1. Comply fully with the above measure.

2. Include the above measure verbatim as a Construction Note and incorporate it into all Plans and Specifications for the project, and submit one copy to the Environmental Coordinator for review and approval prior to the start of any construction work (including clearing and grubbing).

Verification (Action by the Environmental Coordinator):

1. Review the Project Plans prior to the start of construction. Approve Project Plans that are determined to be in compliance with all required mitigation.

2. Monitor compliance during periodic site inspections of the construction work.

3. Participate in any Final Inspection(s) as necessary.

☐ MITIGATION MEASURE CUL-3: IMPLEMENT AVOIDANCE AND NOTIFICATION PROCEDURES FOR CULTURAL RESOURCES DISCOVERED DURING CONSTRUCTION

It is Caltrans' policy to avoid cultural resources whenever possible. If cultural materials are discovered during construction, all earthmoving activity within and around the immediate discovery area will be diverted until a qualified archaeologist can assess the nature and significance of the find. All reasonable measures will be implemented to avoid, minimize, or mitigate further harm to the resource. If appropriate, the project proponent will notify Indian tribes or Native American groups that may attach religious or cultural significance to the affected resource.

If human remains are discovered, State Health and Safety Code Section 7050.5 states that further disturbances and activities will cease in any area or nearby area suspected to overlie remains, and the County coroner will be contacted. Pursuant to PRC Section 5097.98, if the remains are thought to be Native American, the coroner will notify the Native American Heritage Commission (NAHC), which will then notify the Most Likely Descendent (MLD). The County will work with the MLD to avoid the remains, and if avoidance is not feasible, to determine the respectful treatment of the remains. Further provisions of PRC Section 5097.98 are to be followed as applicable.

Implementation and Notification (Action by Project Applicant):

1. Comply fully with the above measure.

2. Include the above measure verbatim as a Construction Note and incorporate it into all Plans and Specifications for the project, and submit one copy to the Environmental Coordinator for review and approval prior to the start of any construction work (including clearing and grubbing).

Verification (Action by the Environmental Coordinator):

1. Review the Project Plans prior to the start of construction. Approve Project Plans that are determined to be in compliance with all required mitigation.

2. Monitor compliance during periodic site inspections of the construction work.

3. Participate in any Final Inspection(s) as necessary.

☐ MITIGATION MEASURE CUL-4: INSTALL ORANGE CONSTRUCTION FENCING TO AVOID CULTURALLY SENSITIVE AREAS

Construction-related staging, equipment, and worker parking will be kept within the approved APE boundary. The APE boundaries in the vicinity of areas identified as culturally sensitive by the UAIC as a result of consultation with the lead agencies will be delineated with orange construction fencing or other visible means to ensure complete avoidance.

Implementation and Notification (Action by Project Applicant):

1. Comply fully with the above measure.

2. Include the above measure verbatim as a Construction Note and incorporate it into all Plans and Specifications for the project, and submit one copy to the Environmental Coordinator for review and approval prior to the start of any construction work (including clearing and grubbing).

Verification (Action by the Environmental Coordinator):

1. Review the Project Plans prior to the start of construction. Approve Project Plans that are determined to be in compliance with all required mitigation.

2. Monitor compliance during periodic site inspections of the construction work.

3. Participate in any Final Inspection(s) as necessary.

☐ MITIGATION MEASURE HZ-1: DEVELOP AND IMPLEMENT PLANS TO ADDRESS WORKER HEALTH AND SAFETY

As required by Federal, State, and local regulations, prior to construction, the County will employ a Certified Industrial Hygienist who will prepare a Health and Safety Plan, Lead Compliance Plan, BMP and/or injury and illness prevention plan to address worker safety when working with potentially hazardous materials (e.g., levels of protective personal equipment, emergency action plan, procedures for encountering hazardous materials) including potential ACMs, LBPs, lead or chromium in traffic stripes, aerially deposited lead, and other construction-related materials within the ROW during any soil-disturbing activity.

Implementation and Notification (Action by Project Applicant):

1. Comply fully with the above measure.

2. Include the above measure verbatim as a Construction Note and incorporate it into all Plans and Specifications for the project, and submit one copy to the Environmental Coordinator for review and approval prior to the start of any construction work (including clearing and grubbing).

Verification (Action by the Environmental Coordinator):

1. Review the Project Plans prior to the start of construction. Approve Project Plans that are determined to be in compliance with all required mitigation.

2. Monitor compliance during periodic site inspections of the construction work.

3. Participate in any Final Inspection(s) as necessary.

☐ MITIGATION MEASURE HZ-2: CONDUCT SITE-SPECIFIC ASSESSMENTS AND PREPARE AND IMPLEMENT A WORK PLAN (FOR ALTERNATIVE 1A ONLY)

Prior to construction, the County will conduct additional assessments of soil, groundwater, and building materials within the proposed acquisition area of the parcels described below. In addition, prior to soil and groundwater testing, the County will prepare a work plan that detail testing locations and analytical methods. Testing locations will be similar to proposed excavation locations in order to characterize potentially excavated soils. The plan will incorporate the soil and groundwater data to ensure that soil and groundwater are stored, managed, and disposed of appropriately and in accordance with applicable laws and regulations.

Soil and Groundwater

Assess the Chevron Service Station (APN: 069-0160-012), Nimbus Winery (APN: 069-0050-013), Aerojet Facility (APN: 072-0231-125), and UPRR ROW for possible soil and groundwater contamination. The sampling and testing of surface soils and groundwater at these sites will be analyzed for total petroleum hydrocarbons such as diesel, heavy metals, petroleum hydrocarbons, PAHs, and chlorinated solvents. Drilling for soil and groundwater will be performed by OSHA-trained personnel with appropriate licenses (CFR 1910.120).

If soil and/or groundwater contamination is identified, the County will comply with Federal and State regulations and the Sacramento County CUPA regulatory requirements regarding the handling and disposal of hazardous wastes. These requirements include consultation with the Department of Toxic Substances Control (DTSC) and State Water Resources Control Board and adherence to the SWPPP. The SWPPP requirement of BMPs designed to minimize the release of hazardous materials would help reduce potential impacts. Contaminated soils not reused on-site will be disposed of at a Class I landfill facility.

If groundwater is extracted as part of dewatering, the extracted groundwater will be stored in tanks, and tested for chlorinated solvents, and either sent off-site for recycling or directed to the existing groundwater treatment system at the Aerojet facilities for disposal and treatment. This will be in addition to the pre-characterization of groundwater quality during preconstruction testing.

Asbestos-Containing Materials and Lead-Based Paint

The Cattlemen's Restaurant (APN: 069-0060-085) and Nimbus Winery (APN: 069-0050-013) buildings are likely to contain ACM and LBP in their construction materials. Various bridge components, such as the overpass, could also contain ACM. The County will conduct a hazardous materials survey prior to demolition or significant renovation of Cattlemen's Restaurant, Nimbus Winery, and bridge structures.

If lead or asbestos is found in these buildings or structures, prior to removal or renovation the County will prepare an abatement plan as part of the Task-Specific Safety Plan required under Section 12-1.01.C of the County Standard Construction Specifications. The abatement plan will provide for a California-certified asbestos consultant and California Department of Health Services–certified lead project designer

to prepare hazardous materials specifications for abatement of the ACM and LBP. This specification will be the basis for selecting qualified contractors to perform the proposed asbestos and lead abatement work. The County will retain a California-licensed asbestos abatement contractor to perform the abatement of any asbestos-containing construction materials and LBP deemed potentially hazardous. Abatement of hazardous building materials will be completed prior to any work on these structures.

Implementation and Notification (Action by Project Applicant):

1. Comply fully with the above measure.

2. Include the above measure verbatim as a Construction Note and incorporate it into all Plans and Specifications for the project, and submit one copy to the Environmental Coordinator for review and approval prior to the start of any construction work (including clearing and grubbing).

Verification (Action by the Environmental Coordinator):

1. Review the Project Plans prior to the start of construction. Approve Project Plans that are determined to be in compliance with all required mitigation.

2. Monitor compliance during periodic site inspections of the construction work.

3. Participate in any Final Inspection(s) as necessary.

☐ MITIGATION MEASURE HZ-3: CONDUCT SAMPLING, TESTING, REMOVAL, STORAGE, TRANSPORTATION, AND DISPOSAL OF YELLOW TRAFFIC STRIPING ALONG EXISTING ROADWAYS

The County will sample and test yellow traffic striping scheduled for removal to determine whether lead or chromium is present. All aspects of the project associated with removal, storage, transportation, and disposal will be conducted in strict accordance with appropriate regulations of the California Health and Safety Code Section 1532.1, and Section 13-2.09, Removal of Traffic Stripes and Pavement Markings of the County's Standard Construction Specifications (2017). Section 13-2.09 includes safety requirements such as shielding sandblasting equipment and using a vacuum to ensure grindings are contained. Traffic striping will be disposed of at a Class I disposal facility. The responsibility of implementing this measure will be outlined in the contract between the County and the construction contractor.

Implementation and Notification (Action by Project Applicant):

1. Comply fully with the above measure.

2. Include the above measure verbatim as a Construction Note and incorporate it into all Plans and Specifications for the project, and submit one copy to the Environmental Coordinator for review and approval prior to the start of any construction work (including clearing and grubbing).

Verification (Action by the Environmental Coordinator):

1. Review the Project Plans prior to the start of construction. Approve Project Plans that are determined to be in compliance with all required mitigation.

2. Monitor compliance during periodic site inspections of the construction work.

3. Participate in any Final Inspection(s) as necessary.

☐ MITIGATION MEASURE HZ-4: APPROPRIATELY DISPOSE OF SOILS CONTAMINATED WITH AERIALLY DEPOSITED LEAD

Soils in the project limits along the US 50 corridor identified as having hazardous levels of ADL will be handled and disposed of in accordance with applicable Cal-OSHA requirements including a project-specific worker Health and Safety Plan and Lead Compliance Plan. Cal-OSHA standards regarding lead apply to all construction work where an employee may be exposed to lead and include notification of lead testing results; providing protective clothing and equipment; hazardous materials training; and control measures to contain lead.

Implementation and Notification (Action by Project Applicant):

1. Comply fully with the above measure.

2. Include the above measure verbatim as a Construction Note and incorporate it into all Plans and Specifications for the project, and submit one copy to the Environmental Coordinator for review and approval prior to the start of any construction work (including clearing and grubbing).

Verification (Action by the Environmental Coordinator):

1. Review the Project Plans prior to the start of construction. Approve Project Plans that are determined to be in compliance with all required mitigation.

2. Monitor compliance during periodic site inspections of the construction work.

3. Participate in any Final Inspection(s) as necessary.

☐ NEPA AVOIDANCE, MINIMIZATION, AND MITIGATION MEASURES (AMMS)

☐ A Transportation Management Plan (TMP) would be developed for use during project construction. The TMP would utilize strategies described in Caltrans' Transportation Management Plan Guidelines (TMP Guidelines) (Caltrans 2015), selected in accordance with the scale and scope of the project. The TMP Guidelines identify the general categories of public information, motorist information, incident management, construction strategies, demand management, and alternate routes or detours.

☐ PREVENT UNAUTHORIZED USE OF STATE PARKS LAND

Construction-related staging, equipment, and worker parking will be kept within the approved project limits. The project boundary adjacent to State Parks Land will be delineated with Environmentally Sensitive Area fencing or other visible means. No unauthorized use of State Parks land will be allowed.

☐ MINIMIZE FUGITIVE LIGHT FROM PORTABLE SOURCES USED FOR CONSTRUCTION

At a minimum, the construction contractor will minimize project-related light and glare to the maximum extent feasible, given safety considerations. Color-corrected halide lights will be used, or the latest requirements in Caltrans Standard Specifications will be followed. Portable lights will be operated at the lowest allowable wattage and height and will be raised to a height no greater than 20 feet. All lights will be screened and directed downward toward work activities and away from the night sky and roadway users and highway neighbors to the maximum extent possible. Lights will not be directed toward residential land uses after 10 p.m. The number of nighttime lights used will be minimized to the greatest extent possible.

☐ CONDUCT MANDATORY CULTURAL RESOURCES AWARENESS TRAINING FOR CONSTRUCTION PERSONNEL

Before any ground-disturbing work occurs in the project area, a qualified archaeologist will be retained to conduct mandatory contractor/worker cultural resources awareness training for construction personnel. The awareness training will be provided to all construction personnel, including contractors and subcontractors, to brief them on the need to avoid effects on cultural resources adjacent to and within construction areas, their responsibility to report potential resources if observed, and the penalties for not complying with applicable State and Federal laws and permit requirements.

☐ MONITOR FOR ARCHAEOLOGICAL RESOURCES DURING INITIAL GROUND DISTURBANCE

A Native American monitor will be retained to monitor all initial ground disturbing activities (e.g., grading, excavation, tree removal). The purpose of the monitoring is to ensure that no unrecorded archaeological resources are affected by the project and to ensure that the project complies with all applicable permit requirements and agency conditions of approval. There will be tribal monitors from more than one tribe, depending on the availability of the tribes' monitors at the time of construction. It is County practice to have one paid tribal monitor at a time during construction, with the multiple tribes coordinating on the sharing of monitoring duties.

☐ IMPLEMENT AVOIDANCE AND NOTIFICATION PROCEDURES FOR CULTURAL RESOURCES

It is County and Caltrans' policy to avoid cultural resources whenever possible. If cultural materials are discovered during construction, all earthmoving activity within and around the immediate discovery area will be diverted until a qualified archaeologist can assess the nature and significance of the find. All reasonable measures will be implemented to avoid, minimize, or mitigate further harm to the resource. If appropriate, the project proponent will notify Indian tribes or Native American groups that may attach religious or cultural significance to the affected resource.

If human remains are discovered, State Health and Safety Code Section 7050.5 states that further disturbances and activities shall cease in any area or nearby area suspected to overlie remains, and the county coroner shall be contacted. Additionally, the Caltrans PQS will be contacted if human remains are identified. Pursuant to PRC Section 5097.98, if the remains are thought to be Native American, the coroner will notify the NAHC, which will then notify the Most Likely Descendent (MLD). The County will work with the MLD to avoid the remains, and if avoidance is not feasible, to determine the respectful treatment of the remains. Further provisions of PRC Section 5097.98 are to be followed as applicable.

☐ IMPLEMENT BEST MANAGEMENT PRACTICES TO CONTROL RUNOFF AND DISCHARGE OF POLLUTANTS DURING PROJECT CONSTRUCTION AND OPERATION AND FOLLOW REQUIREMENTS OF PERMITTING AGENCIES AND THE STORMWATER QUALITY DESIGN MANUAL

As part of the final design process prior to project construction, the project engineers will develop and incorporate design features or BMPs into the project design. The features selected will comply with the Sacramento County SQIP and the Sacramento Region SQDM for project areas outside of Caltrans ROW, and Caltrans SWMP and Standard Specifications for project areas within Caltrans

ROW. The features will be designed to meet all applicable water quality objectives for surface waters and groundwater contained in the Basin Plan.

For project areas outside of Caltrans ROW, the project engineers will follow the guidance in the SQDM including selecting measures from SQDM Table 3-3, Stormwater Quality Control Measure Selection Matrix, for street/road projects with new impervious areas larger than 5 acres. Measures that could be selected and implemented include source control, hydromodification control, treatment control, and low impact development measures such as vegetated swales, water quality detention basins, and bioretention planters.

The project engineers and construction contractor will ensure compliance with the requirements of Caltrans and County NPDES MS4 permits to control stormwater and non-stormwater discharges associated with project construction activities and discharges within the jurisdiction of each permit. Temporary diversion systems and dewatering operations will be implemented, as appropriate. The controls required by all applicable permits will be implemented to reduce the discharge of pollutants in stormwater discharges to the maximum extent possible, including management practices, control techniques, system design and engineering methods, and other measures as appropriate.

The project engineers and the construction contractor will ensure that the requirements of the County SQIP will be followed to reduce the discharge of pollutants to the MS4. The project engineers and construction contractor will also ensure construction activities and project implementation complies with Section 401 (Water Quality Certification) from the Central Valley Regional Water Quality Control Board and the Section 404 Permit from the Sacramento District USACE.

☐ IMPLEMENT CALIFORNIA DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATION SECTION 14-7.03

Caltrans Standard Specification 14-7.03 mandates that within their ROW if unanticipated paleontological resources are discovered at the job site, the resources will not be disturbed, and the following actions will occur immediately:

- 1. All work will stop within a 60-foot radius of the discovery
- 2. The area will be secured
- 3. The project Engineer will be notified

Caltrans Standard Specification 14-7.03 also mandates that “if paleontological resources are discovered during construction, the project proponent will investigate the discovery and modify the dimensions of the secured area, if needed. Paleontological resources will not be moved or taken from the job site. Work will not resume within the radius of discovery until authorized.”

☐ PREPARE AND IMPLEMENT A PALEONTOLOGICAL MITIGATION PLAN

A non-standard special provision for paleontology mitigation will be included in the construction contract special provisions section to advise the construction contractor of the requirement to cooperate with paleontological salvage. The following items will be part of the provisions:

- A qualified principal paleontologist, as defined by the Caltrans Standard Environmental Reference, will be retained to prepare and implement a final Paleontological Mitigation Plan (PMP) prior to construction. If the qualified paleontologist is not a licensed professional geologist in the State of California, then a licensed professional geologist will need to be retained to review and approve the PMP prior to construction. The preliminary PMP prepared for the project (California Department of Transportation 2017; provided in Volume 3, *Technical Studies*, or on the project website at http://www.sacdot.com/Pages/Project-Hazel-StateRoute50.aspx) will be updated based on final engineering design and geotechnical information.
- The geotechnical investigation conducted to support final engineering design will identify the depth and location of sensitives areas and will be used by the qualified principal paleontologist to identify locations that warrant monitoring during construction.
- The final PMP will list the proposed staff and professional qualifications.
- The qualified principal paleontologist will attend a task order meeting and conduct a site visit to review task order requirements; review plans, maps, initial site reports, and mitigation requirements; review geotechnical data, site geology and paleontological sensitivity; prepare a mitigation work plan; and prepare a Code of Safe Practices.
- The qualified principal paleontologist will schedule coordination and supervision for paleontological monitors of any salvage. Monthly progress reports will be prepared for lead agency review and comment.
- The qualified principal paleontologist may designate a paleontological monitor to be present during earthmoving activities.
- The paleontological monitor will have a college degree in paleontology or geology and at least 2 years of paleontological monitoring experience or other qualifications described by the Society of Vertebrate Paleontology (2010).
- The qualified principal paleontologist and paleontological monitor will be notified by the resident engineer or lead agency in advance of starting construction activity and will attend any safety training programs for the proposed project. Paleontological monitoring may be full-time during excavation for undercrossings, in-ground structural elements such as bridge substructures and culverts, and any other project elements requiring deep excavation. If, after 50% of the grading/excavation is completed at a particular location for the proposed project, it can be demonstrated that the level of

monitoring should be reduced for that site, the qualified principal paleontologist will amend the mitigation program (Society of Vertebrate Paleontology 2010). If pieces of heavy equipment are in use simultaneously at different locations, each location may be individually monitored.

- The qualified principal paleontologist will meet with the resident engineer and construction contractor at a preconstruction conference to develop an agreed-upon communication plan and to discuss provisions for worker safety. All project personnel will receive paleontological awareness training prior to commencement of work by the qualified principal paleontologist.
- If paleontological resources are discovered during earthmoving activities, the construction crew will immediately cease work within a 60-foot radius of the find and notify the resident engineer and the Sacramento County Office of Planning and Environmental Review. In the event paleontological resources are discovered, fossil specimens will be properly collected and sufficiently documented to be of scientific value.
- The collection and treatment actions described in the PMP will occur during the grading and construction process and after recovery of specimens if fossils are found, including sampling for microfossils, conducting paleomagnetic analysis, identifying and preparing fossils, arranging for a repository, and preparing a final report.

☐ DEVELOP AND IMPLEMENT PLANS TO ADDRESS WORKER HEALTH AND SAFETY

As required by Caltrans, and Federal, State, and local regulations, prior to construction, the County will employ a Certified Industrial Hygienist who will prepare a Health and Safety Plan, Lead Compliance Plan, BMP and/or injury and illness prevention plan to address worker safety when working with potentially hazardous materials (e.g., levels of protective personal equipment, emergency action plan, procedures for encountering hazardous materials) including potential ACMs, LBPs, lead or chromium in traffic stripes, ADL, and other construction-related materials within the ROW during any soil-disturbing activity. The plan will be implemented during construction. The preparation of such a plan is estimated to cost approximately $3,500 and take three weeks to prepare.

☐ CONDUCT SITE-SPECIFIC ASSESSMENTS AND PREPARE AND IMPLEMENT A WORK PLAN

Prior to construction, the County will conduct additional assessments of soil, groundwater, and building materials within the proposed acquisition area of the parcels described below. In addition, prior to soil and groundwater testing, the County will prepare a work plan that detail testing locations and analytical methods. Testing locations will be similar to proposed excavation locations in order to characterize potentially excavated soils. The plan will incorporate the soil and groundwater data to ensure that soil and groundwater are stored, managed,

and disposed of appropriately and in accordance with applicable laws and regulations.

Soil and Groundwater

Assess the Chevron Service Station (APN: 069-0160-012), Nimbus Winery (APN: 069-0050-013), Aerojet Facility (APN: 072-0231-125), and UPRR ROW for possible soil and groundwater contamination. The sampling and testing of surface soils and groundwater at these sites will be analyzed for total petroleum hydrocarbons as diesel, heavy metals, petroleum hydrocarbons, polynuclear aromatic hydrocarbons, and chlorinated solvents. Drilling for soil and groundwater will be performed by OSHA-trained personnel with appropriate license (CFR 1910.120).

If soil and/or groundwater contamination is identified, the County will comply with Federal and State regulations and the Sacramento County CUPA regulatory requirements regarding the handling and disposal of hazardous wastes. These requirements include consultation with the DTSC and SWRQCB and adherence to the SWPPP. The SWPPP requirement of BMPs designed to minimize the release of hazardous materials would help reduce potential impacts. Contaminated soils not reused onsite will be disposed of at a Class I landfill facility.

If groundwater is extracted as part of dewatering, the extracted groundwater will be stored in tanks, and tested for chlorinated solvents, and either sent offsite for recycling or directed to the existing groundwater treatment system at the Aerojet facilities for disposal and treatment. This will be in addition to the pre-characterization of groundwater quality during preconstruction testing.

The estimated cost of collection and testing soil and groundwater within these parcels totals approximately $26,000 and could take up to six weeks. It should be noted that obtaining access to the UPRR parcel could take up to six months.

Asbestos-Containing Materials and Lead-Based Paint

The Cattlemens Restaurant (APN: 069-0060-085) and Nimbus Winery (APN: 069-0050-013) buildings are likely to contain ACM and LBP in their construction materials. Various bridge components, such as the overpass, could also contain ACM. The County will conduct a hazardous materials survey prior to demolition or significant renovation of Cattlemens Restaurant, Nimbus Winery, and bridge structures. If lead or asbestos is found in these buildings or structures, prior to removal or renovation the County will prepare an abatement plan as part of the TSSP required under Section 12-1.01.C of the County Standard Construction Specifications. The abatement plan will provide for a California-certified asbestos consultant and California Department of Health Services–certified lead project designer to prepare hazardous materials specifications for abatement of the ACM and LBP. This specification will be the basis for selecting qualified contractors to

perform the proposed asbestos and lead abatement work. The County will retain a California-licensed asbestos abatement contractor to perform the abatement of any asbestos-containing construction materials and LBP deemed potentially hazardous. Abatement of hazardous building materials will be completed prior to any work on these structures.

The estimated costs for ACM testing of the Cattlemens Restaurant, Nimbus Winery, and the bridge overpass ranges from $10,000 to $12,000 and would take approximately three weeks to complete. Preparation of the abatement plan is estimated to cost $7,000. Abatement by a certified contractor and oversight by certified inspector is estimated at $12,000 per building if ACM/LBP is present and would take approximately 2-3 weeks per structure.

☐ CONDUCT SAMPLING, TESTING, REMOVAL, STORAGE, TRANSPORTATION, AND DISPOSAL OF YELLOW TRAFFIC STRIPING ALONG EXISTING ROADWAYS

The County will sample and test yellow traffic striping scheduled for removal to determine whether lead or chromium is present. All aspects of the project associated with removal, storage, transportation, and disposal will be conducted in strict accordance with appropriate regulations of the California Health and Safety Code Section 1532.1, and Section 13-2.09, *Removal of Traffic Stripes and Pavement Markings* of the County's Standard Construction Specifications (2017). Section 13-2.09 includes safety requirements such as shielding sandblasting equipment and using a vacuum to ensure grindings are contained. Traffic striping will be disposed of at a Class I disposal facility. The responsibility of implementing this measure will be outlined in the contract between the County and the construction contractor.

Testing traffic striping would take approximately 2-3 weeks and cost approximately $2,500. Removal, storage, transport and disposal of traffic striping is estimated to be between $4,000 and $10,000 if hazardous levels of lead and/or chromium are present and would occur as needed during construction.

☐ APPROPRIATELY DISPOSE OF SOILS CONTAMINATED WITH ADL

Soils in the project limits along the US 50 corridor identified as having hazardous levels of ADL will be handled and disposed of in accordance with applicable CalOSHA requirements including a project specific worker Health and Safety Plan and Lead Compliance Plan. CalOSHA standards regarding lead apply to all construction work where an employee may be exposed to lead and include notification of lead testing results; providing protective clothing and equipment; hazardous materials training; and control measures to contain lead.

☐ IMPLEMENT CALIFORNIA DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATION SECTION 14

Construction activities within areas under Caltrans control are subject to requirements found in the *Standard Specifications* (California Department of Transportation 2018). To control the generation of construction-related PM10 emissions, the project proponent will follow the following applicable policies and procedures outlined in Caltrans Standard Specifications. Standard Specification Section 14-9.02, Air Pollution Control, requires compliance with air district rules, regulations, ordinances, and statutes that apply to work performed under the contract, including air pollution control rules, regulations, ordinances, and statutes provided in Government Code Section 11017 (Public Contract Code 10231). Standard Specification Section 10-5 addresses dust control requirements by preventing and alleviating dust by means of Standard Specification Section 18 (applying dust palliatives), Standard Specification Section 13-5 (applying temporary soil stabilization), and Standard Specification Section 13-4.03C(3) (managing material stockpiles). In addition, Standard Specification Section 14-11.04 addresses dust control associated with material containing hazardous waste or contamination.

☐ IMPLEMENT SMAQMD'S BASIC CONSTRUCTION EMISSION CONTROL PRACTICES (BEST MANAGEMENT PRACTICES)

Measures to control and reduce fugitive dust from SMAQMD's Basic Construction Emission Control Practices (Sacramento Metropolitan Air Quality Management District 2017) will be implemented to the extent practicable when the measures have not already been incorporated and do not conflict with requirements of Caltrans' Standard Specifications, Special Provisions, the National Pollutant Discharge Elimination System permit, and the Biological Opinions, Clean Water Act Section 404 permit, Clean Water Act Section 401 Certification, and other permits issued for the project. The project-proponent will implement SMAQMD's basic construction emission control practices, including but not limited to the following measures.

- Water all exposed surfaces two times daily. Exposed surfaces include, but are not limited to soil piles, graded areas, unpaved parking areas, staging areas, and access roads.
- Cover or maintain at least 2 feet of free board space on haul trucks transporting soil, sand, or other loose material on the site. Any haul trucks that would be traveling along freeways or major roadways should be covered.
- Use wet power vacuum street sweepers to remove any visible trackout mud or dirt onto adjacent public roads at least once a day. Use of dry power sweeping is prohibited.
- Limit vehicle speeds on unpaved roads to 15 miles per hour.

- Pave all roadways, driveways, sidewalks, and parking lots as soon as possible. In addition, building pads should be laid as soon as possible after grading unless seeding or soil binders are used.
- Minimize idling time either by shutting equipment off when not in use or reducing the time of idling to 5 minutes (required by 13 CCR 2449(d)(3) and 2485). Provide clear signage that posts this requirement for workers at the entrances to the site.
- Maintain all construction equipment in proper working condition according to manufacturer's specifications. The equipment must be checked by a certified mechanic and determined to be running in proper condition before it is operated.

☐ UTILIZE MODEL YEAR 2010 OR NEWER ENGINES TO REDUCE CONSTRUCTION-RELATED EMISSIONS FROM ON-ROAD VEHICLES

All on-road trucks will consist of model year 2010 or newer engines. Construction contractors will provide documentation to the County of efforts to secure such a fleet. The contractors will keep a written record of equipment usage during project construction for each piece of equipment and provide the County with annual reports documenting compliance. These reports will be submitted to SMAQMD. In the event Construction contractors cannot secure all 2010 engine model year or newer on-road trucks for the project, an off-site mitigation fee program, as analyzed in the Air Quality Study Report (Volume 3 Technical Studies), or SMAQMD Off-site Construction Mitigation Fee Program shall be implemented.

The reporting plan shall follow SMAQMD's Enhanced On-site Exhaust Controls mitigation language. The plan will have at least two components: an initial report submitted before construction and a final report submitted at the completion of the job, phase or calendar year, as pre-arranged with SMAQMD staff and documented in the approval letter, to demonstrate continued project compliance. Additionally, the below requirements shall be met:

- Submit the initial report at least four (4) business days prior to construction activity using the SMAQMD's Construction Mitigation Tool (http://www.airquality.org/businesses/ceqa-land-use-planning/mitigation)
- Provide project information and construction company information

Include the equipment type, horsepower rating, engine model year, projected hours of use, and the CARB equipment identification number for each piece of equipment in the plan. Incorporate all owned, leased and subcontracted equipment to be used.

☐ UTILIZE CLEAN DIESEL-POWERED EQUIPMENT DURING CONSTRUCTION TO CONTROL CONSTRUCTION-RELATED NO_X EMISSIONS

The County will ensure that all off-road diesel-powered equipment used during construction is equipped with EPA Tier 4 Final engines. The County will submit to SMAQMD a comprehensive inventory of all off-road construction equipment, equal to or greater than 50 horsepower, that will be used an aggregate of 8 or more hours during any phase of the construction project. In the event Construction contractors cannot secure all 2010 engine model year or newer on-road trucks and all Tier 4 Final off-road equipment for this entire project, an off-site mitigation fee program, as analyzed in the Air Quality Study Report (Volume 3 Technical Studies), or SMAQMD Off-site Construction Mitigation Fee Program shall be implemented.

The inventory will include the following:

- CARB equipment identification number, equipment type, horsepower rating, engine model year (Tier 4 Final), and projected hours of use for each piece of off-road equipment.
- Current Certificate of Reported Compliance for CARB's In-Use Off-Road Regulation for each construction company working on the project.
- Anticipated construction timeline including start date, and name, phone number and email address of the project manager and on-site foreman.

The construction inventory will be submitted to the SMAQMD at least 4 business days prior to the use of subject equipment. The reporting plan shall comply with the requirements as outlined in Mitigation Measure AQ-2.

☐ MINIMIZE NOISE EFFECTS FROM CONSTRUCTION

Standard Caltrans procedures include implementation of the following measures to minimize the temporary noise effects from construction.

- All equipment will have sound-control devices that are no less effective than those provided on the original equipment. No equipment will have an unmuffled exhaust.
- The construction contractor will implement appropriate additional noise measures, including changing the location of stationary construction equipment, turning off idling equipment, rescheduling construction activity, notifying adjacent residents in advance of construction work, and installing acoustic barriers around stationary construction noise sources.

☐ APPLY QUIET PAVEMENT OR CONSTRUCT NOISE BARRIER ALONG AEROJET ROAD (FOR ALTERNATIVE 2 ONLY)

The County will implement one of two mitigation options.

Option 1. Apply quiet pavement to the US 50 mainline from just west of Hazel Avenue to 0.25 mile east of Aerojet Road, at a minimum. The pavement will be designed to provide a minimum of 4 dB of noise reduction relative to standard pavement that would otherwise be used. Applying quiet pavement to the off-ramp only and exclusive of US 50 would have no noise-reducing effect. As such, quiet pavement will be applied to both the US 50 mainline and Aerojet Road to achieve the required noise level reduction.

Option 2. Construct a noise barrier at a height of 14 feet along Aerojet Road in the location shown on EIR/EA Figure 2.14-5.

It may not be possible to apply quiet pavement to the US 50 mainline given that it is located within State ROWs and regulated by Caltrans. Therefore, if Option 1 is determined not to be feasible, the County will implement Option 2.

☐ NOISE ABATEMENT EVALUATION UNDER 23 CFR 772

☐ INSTALL ORANGE CONSTRUCTION FENCING BETWEEN THE CONSTRUCTION AREA AND ADJACENT SENSITIVE BIOLOGICAL RESOURCES

The County and/or their contractor will install orange construction fencing between the construction area and adjacent sensitive biological resource areas. Sensitive biological resources that occur adjacent to the construction area that could be directly affected by the project include natural communities of special concern; fairy shrimp, valley elderberry longhorn beetle and western pond turtle habitats; nest sites of Swainson's hawk, yellow-breasted chat, tricolored blackbird, song sparrow, and other migratory birds; roosting bats; and protected trees to be avoided.

Barrier fencing around sensitive areas will be installed as one of the first orders of work and prior to equipment staging. Preliminary fencing locations are included in the draft project design drawings and labeled as Environmentally Sensitive Areas. The locations of the fencing will be updated or confirmed as part of final design, prior to construction. Before construction begins, the construction contractor will work with the project engineer and a resource specialist to identify the locations for the orange construction fencing, and will place stakes around the sensitive resource sites to indicate these locations. The protected areas will be designated as environmentally sensitive areas and clearly identified on the construction plans and described in the specifications. Barrier fencing will be installed before construction activities are initiated, maintained throughout the construction period, and removed after completion of construction.

☐ CONDUCT ENVIRONMENTAL AWARENESS TRAINING FOR CONSTRUCTION EMPLOYEES

The County or their contractor will retain a qualified biologist to conduct environmental awareness training for construction crews before project implementation. The awareness training will be provided to all construction personnel and will brief them on the need to avoid effects on sensitive biological resources (e.g., native trees, natural communities of special concern, and special-status species habitats in and adjacent to the construction area). The education program will include a brief review of the special-status species with the potential to occur in the BSA (including their life history, habitat requirements, and photographs of the species). The training will identify the portions of the BSA in which the species may occur, as well as their legal status and protection. The program also will cover the restrictions and guidelines that must be followed by all construction personnel to reduce or avoid effects on these species during project implementation. This will include the steps to be taken if a sensitive species is found within the construction area (i.e., notifying the crew foreman, who will call a designated biologist). In addition, construction employees will be educated about the importance of controlling and preventing the spread of invasive plant infestations. An environmental awareness handout that describes and illustrates sensitive resources to be avoided during project construction and identifies all relevant permit conditions will be provided to each crew member. The crew foreman will be responsible for ensuring that crew members adhere to the guidelines and restrictions. Education programs will be conducted for appropriate new personnel as they are brought on the job during the construction period.

☐ RETAIN A QUALIFIED BIOLOGIST TO CONDUCT MONITORING DURING CONSTRUCTION IN SENSITIVE HABITATS

The County or their contractor will retain a qualified biologist to monitor all construction activities that involve ground disturbance (e.g., vegetation removal, grading, excavation, road construction) within or adjacent to environmentally sensitive areas (e.g., wetlands, streams, riparian vegetation, special-status species habitat, active bird nests, and adjacent areas within 250-feet or where indirect effects are possible). The purpose of the monitoring is to ensure that avoidance and minimization measures are properly implemented to protect sensitive biological resources and to ensure that the project complies with all applicable permit requirements and agency conditions of approval. The biologist will inspect the fencing around environmentally sensitive areas regularly and will communicate any issues to the resident engineer or construction foreman. The contractor will be responsible for maintaining the fence during construction and ensuring that no construction personnel, equipment, or runoff/sediment from the construction area enters environmentally sensitive areas. The monitor will complete daily logs, and a final monitoring report will be prepared at the end of

each construction season that will be submitted to the County and other overseeing agencies (i.e., CDFW, USFWS, and USACE), as appropriate.

☐ PROTECT NATIVE TREES DURING CONSTRUCTION

This measure applies to all native oaks that have a diameter at breast height (dbh) of at least 6 inches, or if it has multiple trunks of less than 6 inches each, a combined dbh of at least 10 inches.

With the exception of the trees slated for removal that will be mitigated for through compensatory measures, all native oak trees in the project area, all portions of adjacent off-site native oak trees that have driplines that extend onto the project area, and all off-site native oak trees that may be impacted by utility installation and/or improvements associated with this project, will be preserved and protected as follows:

1. A circle with a radius measurement from the trunk of the tree to the tip of its longest limb shall constitute the dripline protection area of the tree. Limbs must not be cut back in order to change the dripline. The area beneath the dripline is a critical portion of the root zone and defines the minimum protected area of the tree. Removing limbs which make up the dripline does not change the protected area.
2. Chain link fencing or a similar protective barrier shall be installed one foot outside the driplines of the native trees prior to initiating project construction, in order to avoid damage to the trees and their root system.
3. No signs, ropes, cables (except cables which may be installed by a certified arborist to provide limb support) or any other items shall be attached to the native trees.
4. No vehicles, construction equipment, mobile home/office, supplies, materials or facilities shall be driven, parked, stockpiled or located within the driplines of the native trees.
5. Any soil disturbance (scraping, grading, trenching, and excavation) is to be avoided within the driplines of the native trees. Where this is necessary, an ISA Certified Arborist will provide specifications for this work, including methods for root pruning, backfill specifications and irrigation management guidelines.
6. All underground utilities and drain or irrigation lines shall be routed outside the driplines of native trees. Trenching within protected tree driplines is not permitted. If utility or irrigation lines must encroach upon the dripline, they should be tunneled or bored under the tree under the supervision of an ISA Certified Arborist.
7. If temporary haul or access roads must pass within the driplines of oak trees, a roadbed of six inches of mulch or gravel shall be created to protect the root zone. The roadbed shall be installed from outside of the dripline and while the

soil is in a dry condition, if possible. The roadbed material shall be replenished as necessary to maintain a six-inch depth.

8. Drainage patterns on the site shall not be modified so that water collects or stands within, or is diverted across, the dripline of oak trees.
9. No sprinkler or irrigation system shall be installed in such a manner that it sprays water within the driplines of the oak trees.
10. Tree pruning that may be required for clearance during construction must be performed by an ISA Certified Arborist or Tree Worker and in accordance with the American National Standards Institute (ANSI) A300 pruning standards and the International Society of Arboriculture (ISA) "Tree Pruning Guidelines".
11. Landscaping beneath the oak trees may include non-plant materials such as boulders, decorative rock, wood chips, organic mulch, non-compacted decomposed granite, etc. Landscape materials shall be kept two (2) feet away from the base of the trunk. The only plant species which shall be planted within the driplines of the oak trees are those which are tolerant of the natural semi-arid environs of the trees. Limited drip irrigation approximately twice per summer is recommended for the understory plants.
12. Any fence/wall that will encroach into the dripline protection area of any protected tree shall be constructed using grade beam wall panels and posts or piers set no closer than 10 feet on center. Posts or piers shall be spaced in such a manner as to maximize the separation between the tree trunks and the posts or piers in order to reduce impacts to the trees.
13. For a project constructing during the months of June, July, August, and September, deep water trees by using a soaker hose (or a garden hose set to a trickle) that slowly applies water to the soil until water has penetrated at least one foot in depth. Sprinklers may be used to water deeply by watering until water begins to run off, then waiting at least an hour or two to resume watering (provided that the sprinkler is not wetting the tree's trunk. Deep water every 2 weeks and suspend watering 2 weeks between rain events of 1 inch or more.

☐ COMPENSATE FOR THE PERMANENT AND TEMPORARY LOSS OF FREMONT COTTONWOOD-OAK WOODLAND

The County and/or Easton will compensate for the permanent loss of 2.97 acres and temporary loss of .19 acres of Fremont cottonwood-oak woodland at a minimum ratio of 1:1 (1 acre planted for every 1 acre permanently affected). The loss of most of the Fremont cottonwood-oak woodland habitat in the project area, which is located near the intersection of Folsom Boulevard and Nimbus Road, has been previously mitigated as part of Phase 2 of the Easton Project (County of Sacramento 2008). Figures 2.16-2 and 2.16-3 show the areas of effect and the area that has been previously mitigated for Phase 2 of the Easton Project. For the proposed project, compensation would only be required for 0.90 acre of the direct impacts.

As part of the woodland mitigation, compensation may include either compensation for the woodland habitat at a minimum ratio or 1:1 as indicated above and/or compliance with Mitigation Measure BIO-17 and/or Mitigation Measure BIO-18.

☐ COMPENSATE FOR THE PERMANENT AND TEMPORARY LOSS OF VALLEY FOOTHILL RIPARIAN WOODLAND

The County will compensate for the permanent and temporary loss of valley foothill riparian habitat (see Figures 2.16-2 and 2.16-3, Sheet 4) by planting a minimum of 0.06 acre of valley foothill riparian woodland species (a minimum ratio of 1:1 [1 acre planted for every 1 acre permanently and temporarily affected]) on-site or off-site and/or purchasing mitigation bank credits equivalent to a minimum of 0.06 acre of valley foothill riparian habitat.

On-site compensation will be used to the maximum extent practicable, but off-site compensation and/or purchase of mitigation bank credits may be needed to achieve no net loss of existing in-kind riparian habitat. Each of these options is discussed below.

- Riparian habitat restoration and/or enhancement on-site or off-site should occur in the same year construction is completed. For on-site or off-site plantings, the County will prepare a mitigation planting plan, including a species list and number of each species, planting locations, and maintenance requirements. Plantings will consist of cuttings taken from local plants or plants grown from local material. Planted species for the mitigation plantings will be similar to those in and adjacent to the project area and will include native species, such as white alder, Fremont cottonwood, valley oak, black walnut (*Juglans hindsii*), Oregon ash (*Fraxinus latifolia*), boxelder (*Acer negundo*), and black willow (*Salix gooddingii*). All plantings will be fitted with exclusion cages or other suitable protection from herbivory until plantings are established. Plantings will be irrigated for up to 3 years or until established. Plantings will be monitored annually for 3 years or as required in the project permits. If 75% of the plants survive at the end of the monitoring period, the revegetation will be considered successful. If the survival criterion is not met at the end of the monitoring period, planting and monitoring will be repeated after mortality causes have been identified and corrected.
- The County will provide written evidence to the resource agencies that compensation has been established through the purchase of mitigation credits. The amount to be paid will be the fee that is in effect at the time the fee is paid. Replacement riparian habitat will include tree species that would support nesting Swainson's hawk (i.e., oak, cottonwood) and will occur within the range of nesting Swainson's hawk within the Sacramento Valley.

Approval of riparian mitigation activities is subject to Notification that would require CDFW-approved compensatory mitigation to offset impacts. Likewise, to the

extent offsite credits are utilized, the mitigation should occur at a CDFW-approved mitigation or conservation bank.

☐ COMPENSATE FOR LOSS OF WETLANDS AND NON-WETLAND WATERS OF THE UNITED STATES/WATERS OF THE STATE

The County will compensate for the permanent fill of waters of the United States/waters of the State (a direct impact associated with roadway and interchange construction) in two wetland habitat types, emergent wetland and seasonal wetland, and in two non-wetland waters type, perennial drainage and ephemeral drainage. The minimum wetland compensation ratio to ensure no net loss of wetland or drainage functions and values will be 1:1 (1 acre of habitat credit for every 1 acre of permanent impact). The final compensation ratio will be approved by USACE. The County will compensate for permanent loss of wetlands and non-wetland waters through one or more of the following mitigation options:

- Purchase habitat credits from a USACE-approved mitigation bank with service areas for Sacramento County, such as the Cosumnes Floodplain Mitigation Bank or Elsie Gridley Mitigation Bank, and provide written evidence to the resource agencies that compensation has been established through the purchase of mitigation credits. The amount to be paid will be according to the fee schedule that is in effect at the time the fee is paid. The mitigation will be approved by USACE and may be modified during the permitting process.
- Pay into the National Fish and Wildlife Foundation Sacramento District In-Lieu Fee Program.

Temporarily disturbed wetlands and non-wetland waters will be returned to preconstruction condition following construction. The County also will implement the conditions and requirements of State and Federal permits that will be obtained for the proposed project. Approval of wetland mitigation activities is subject to Notification that would require CDFW-approved compensatory mitigation to offset impacts. Likewise, to the extent offsite credits are utilized, the mitigation should occur at a CDFW-approved mitigation or conservation bank.

☐ IMPLEMENT BMPS TO PROTECT WATER QUALITY AND PREVENT EROSION AND SEDIMENTATION IN DRAINAGES AND WETLANDS

☐ PERFORMANCE OF ONE-TIME PRE-CONSTRUCTION PLANT SURVEY

A one-time pre-construction plant survey shall be performed during the appropriate blooming period for all special-status plant species with potential to occur that may be impacted within the project site. If the survey results are negative, no further action by Permittee is needed. If the survey finds that any special-status plant species are present, Permittee shall consult with CDFW on the appropriate action and the inclusion of any additional measures.

☐ DESIGN AND IMPLEMENT WATER CONVEYANCE SYSTEMS THAT MAINTAIN HYDROLOGY OF AND PREVENT CONTAMINANTS FROM ENTERING SUITABLE VERNAL POOL BRANCHIOPOD HABITAT

Concentrated flow conveyance systems identified for the proposed project may include roadside ditches, biofiltration swales, curb and gutters, dikes, overside drains, and culverts. Water conveyance systems surrounding suitable vernal pool branchiopod habitat in the project area will be evaluated, designed, and installed to maintain the existing hydrology of the four potential seasonal wetlands (see Figure 2.16-1, Sheet 2) that provide potential habitat for vernal pool branchiopods.

☐ CONDUCT PRECONSTRUCTION SURVEYS FOR WESTERN POND TURTLE AND MONITOR INITIAL IN-WATER WORK

To avoid potential injury or mortality of western pond turtles, the County will retain a qualified wildlife biologist who is CDFW-approved to capture and relocate turtles. The biologist will conduct a preconstruction survey for western pond turtles within 24 hours of the start of construction and will survey Alder Creek and the adjacent riparian and ruderal habitat within the construction area. If in-water work does not start immediately, the biologist will return to the construction site immediately prior to the start of in-water work (i.e., dewatering, vegetation removal, or any other activities in the creek) to conduct another preconstruction survey. The biologist will remain on-site until initial in-water work is complete. If a turtle becomes trapped during initial in-water work, the biologist will relocate the individual to suitable aquatic habitat upstream of the construction area (the area downstream of the construction area is not accessible because of US 50). For the remainder of construction, the biologist will remain on-call in case a turtle is discovered. The construction crew will be instructed to notify the crew foreman, who will contact the biologist if a turtle is found trapped within the construction area. Work in the area where the turtle is trapped will stop until the biologist arrives and removes and relocates the turtle. The biologist will report their activities to the County and CDFW within 1 day of relocating any turtle.

☐ RESTORE TEMPORARILY DISTURBED RUDERAL HABITAT

Upon project completion, the County will restore all temporarily disturbed ruderal habitat (1.92 acres under all alternatives) to pre-project or better conditions. To the extent feasible, native grasses and forbs will be used to reseed disturbed areas.

☐ CONDUCT VEGETATION REMOVAL DURING THE NON-BREEDING SEASON OF NESTING MIGRATORY BIRDS

To the maximum extent feasible, vegetation removal (trees, shrubs, and ground vegetation) will occur during the non-breeding season for most migratory birds (generally between September 16 and January 31). This timing is highly preferable because if an active nest is found during preconstruction surveys in a

tree (or other vegetation) that would be removed by project construction, the tree (or other vegetation) cannot be removed until the end of the nesting season, which could delay construction. If vegetation cannot be removed between October and January, or if ground cover re-establishes in areas where vegetation has been removed, the affected area must be surveyed for nesting birds, as discussed in the following measures: *Conduct Focused Surveys for Nesting Swainson's Hawk and White-Tailed Kite Prior to Construction and Implement Protective Measures during Construction,* and *Conduct Preconstruction Surveys for Nesting Migratory Birds.* To minimize potential impacts on roosting bats, tree trimming and removal should be conducted from September 1 through October 15 (see the measure: *Identify Suitable Roosting Habitat for Bats and Implement Avoidance and Protective Measures*). Tree trimming and removal during this timeframe would avoid or minimize impacts on nesting birds and roosting bats.

☐ CONDUCT FOCUSED SURVEY FOR NESTING WHITE-TAILED KITE PRIOR TO CONSTRUCTION

For each year in which construction, grading, or project-related improvements are to commence between February 1 and September 15, a focused survey for white- tailed kite nests on the site and within 0.25 mile of the site will be conducted by a qualified biologist no greater than 15 days prior to the start of construction work (including clearing and grubbing). If White-tailed kites are found, the qualified Biologist shall develop a species-specific avoidance plan for CDFW review and approval. Any measures approved in the plan will be implemented prior to the start of any ground-disturbing activities. If no active nests are found during the focused survey, nothing further will be required. If a lapse in project-related activities of 14 days or longer occurs, another focused survey is required before Project activities can be reinitiated.

If impacts are identified during the course of the project, project personnel shall fully avoid impacts to the species and immediately notify CDFW if White-tailed kite is detected during Project activities.

☐ CONDUCT FOCUSED SURVEY FOR NESTING SWAINSON'S HAWK PRIOR TO CONSTRUCTION

If equipment staging, site preparation, grading, excavation or other project-related activities are scheduled during the Swainson's hawk nesting season (typically March 1 through September 15) surveys for active nests of such birds shall be conducted by a qualified biologist in accordance with the typical survey protocol: Recommended Timing and Methodology for Swainson's Hawk Nesting Surveys in California's Central Valley (Swainson's Hawk Technical Advisory Committee 2000). Surveys shall be conducted at the appropriate radius and time periods listed in the survey protocol. Since the project spans over multiple years, if there is a lapse of more than 15 days in construction, a new survey shall be conducted for each nesting season to capture any new Swainson's hawk nests that may be established.

If an active Swainson's hawk nest is found during project surveys, the qualified biologist shall consult with CDFW and demonstrate compliance with CESA. If during consultation it is determined that implementation of the project as proposed may result in take of Swainson's hawk, the project may seek related take authorization as provided by the Fish and Game Code.

☐ CONDUCT PRECONSTRUCTION SURVEYS FOR NESTING MIGRATORY BIRDS

In each year in which project activities would occur during the breeding season (generally February 1 through September 15), the County will retain a qualified wildlife biologist with knowledge of the relevant species to conduct nesting surveys 15 days or less before the start of construction. Surveys will include a search of all trees and shrubs, marsh, wetland, manmade structures, and ruderal vegetation that provide suitable nesting habitat in the project area, including staging and stockpile areas. The minimum survey radii surrounding the work area shall be the following: i) 250 feet for passerines: ii) 500 feet for small raptors such as accipiters: iii) 1,000 feet for larger raptors such as buteos. If no active nests are detected during these surveys, no additional measures are required. If a lapse in project-related activities of 14 days or longer occurs, another focused survev will be required before project activities can be reinitiated.

If an active nest is found in the survey area, a no-disturbance buffer will be established with fences or flags around the nest buffer area to avoid disturbance or destruction of the site until the end of the breeding season (September 15) or until a qualified wildlife biologist determines that the young have fledged and moved out of the project area (this date varies by species). The extent of these buffers will be determined by the biologist in coordination with USFWS and CDFW and will depend on the level of noise or construction disturbance, line-of-sight between the nest and the disturbance, ambient levels of noise and other disturbances, and other topographical or artificial barriers. Suitable buffer distances may vary between species. If nesting birds are showing signs of distress or disruptions to nesting behaviors or the buffer is otherwise not feasible, the qualified wildlife biologist, in coordination with USFWS and CDFW shall determine the appropriate change in response (e.g. buffer increase, temporary construction stop, etc.) until no further interruptions to breeding behavior are detectable.

☐ IDENTIFY SUITABLE ROOSTING HABITAT FOR BATS AND IMPLEMENT AVOIDANCE AND PROTECTIVE MEASURES

To minimize potential impacts on tree roosting bats, tree trimming and removal should be conducted between September 1 and October 15, which corresponds to a time period when bats have not yet entered torpor or be caring for nonvolant (non-flying) young. Trimming or removing trees during this timeframe would also avoid impacts on nesting birds.

If tree removal or trimming cannot be conducted between September 1 and October 15, qualified biologists will examine trees for suitable bat roosting habitat before tree removal or trimming. High-quality habitat features (e.g., large tree cavities, basal hollows, loose or peeling bark, larger snags, palm trees with intact thatch) will be identified and the area around these features searched for bats and bat signs (e.g., guano, culled insect parts, staining). Riparian woodland and stands of mature broadleaf trees are considered potential habitat for solitary foliage-roosting bat species. Because signs of bat use are not easily found, and trees cannot be completely surveyed for bat roosts, the protective measures listed below will be implemented for trees containing high-quality habitat features.

- Removal or disturbance of trees providing bat roosting habitat will be avoided between April 1 and August 31 (the maternity period) to avoid effects on pregnant females and active maternity roosts (whether colonial or solitary).
- If a maternity roost is found, whether solitary or colonial, that roost will remain undisturbed until September 1 or until a qualified biologist has determined the roost is no longer active.
- Qualified biologists will monitor tree trimming/removal of the habitat. Trees should be trimmed or removed over two consecutive days. The first day (in the afternoon), limbs and branches should be removed by a tree cutter using chainsaws only. Limbs with cavities, crevices or deep bark fissures should be avoided, and only branches or limbs without those features should be removed. On the second day, the entire tree should be removed. Biologists should search downed vegetation for dead and injured bats. The presence of dead or injured bats that are species of special concern will be reported to CDFW. The biologist will prepare a biological monitoring report, which will be provided to the County and CDFW.
- Habitat assessment and survey by a qualified bat biologist
- Examining all suitable habitats prior to project implementation (including tree removal, tree trimming, or other disturbance). BIO-15 should include also habitats in manmade structures (e.g. bridge, culvert, etc.)
- Including development of a Bat Avoidance and Minimization Plan (Bat Plan) in the event that bats are utilizing the Project area during Project activities. The Bat Plan should include 1) Project-specific measures to avoid and minimize impacts to roosting bats in and near the areas that will be disturbed by Project activities 2) monitoring by a qualified bat biologist to oversee bat behavior and the avoidance and minimizations measures designed to protect nesting/roosting bats 3) exclusion measures for the habitat that will be removed or made inaccessible by the Project and 4) discussion of available alternative habitat (both temporary and permanent).

All appropriate exclusionary measures should be implemented prior to the bridge construction during the period of March 1 to April 15 or August 31 to October 15. Potential avoidance efforts may include exclusionary blocking or filling potential roosting cavities with foam or steel wool, visual monitoring,

and staging Project work to avoid bats. If bats are known to use manmade structures, exclusion netting should not be used to avoid entanglement.

☐ FENCE ELDERBERRY SHRUBS TO BE PROTECTED

Elderberry shrubs/clusters within 165 feet of the construction area that will not be removed will be protected during construction. A qualified biologist (i.e., with elderberry/valley elderberry longhorn beetle experience) will mark the elderberry shrubs and clusters that will be protected during construction. Orange construction barrier fencing will be placed at the edge of the buffer areas established for each shrub or cluster. The buffer area distances will be proposed by the biologist and approved by USFWS. No construction activities will be permitted in the buffer zone other than those activities necessary to erect the fencing. Signs will be posted along fencing for the duration of construction and will contain the following information.

> This area is habitat of the valley elderberry longhorn beetle, a threatened species, and must not be disturbed. This species is protected by the Endangered Species Act of 1973, as amended. Violators are subject to prosecution, fines, and imprisonment.

Temporary fences around the elderberry shrubs will be installed as the first order of work. Temporary fences will be furnished, constructed, maintained, and later removed, as shown on the plans, as specified in the special provisions, and as directed by the resident engineer. Temporary fencing will be 4 feet high, commercial-quality woven polypropylene, and orange in color.

Buffer area fences around elderberry shrubs will be inspected periodically by a qualified biologist until project construction is complete or until the fences are removed, as approved by the biological monitor and the resident engineer. The contractor will be responsible for maintaining the buffer area fences around elderberry shrubs throughout construction. Biological inspection reports will be provided to the County and USFWS.

☐ COMPENSATE FOR DIRECT EFFECTS ON VALLEY ELDERBERRY LONGHORN BEETLE AND ITS HABITAT

Before construction begins, the County will compensate for direct effects on valley elderberry longhorn beetle by transplanting shrubs that cannot be avoided to a USFWS-approved conservation bank. The County will also purchase credits at the approved conservation bank in accordance with ratios shown in Table 2.20-9 for the alternative selected. Compensation ratios shown are for shrub-level impact compensation (U.S. Fish and Wildlife Service 2017).

Table 2.20-9. Compensation for Direct Effects on Elderberry Shrubs by Alternative

Alternative	Number of Elderberry Shrubs Effected	Compensation Ratio (Non-Riparian)	Number of Conservation Credits Required

1	3	1:1	3
1A	3	1:1	3
2	4	1:1	4

The relocation of the elderberry shrubs will be conducted according to USFWS-approved procedures outlined in the *Framework for Assessing Impacts to the Valley Elderberry Longhorn Beetle* (U.S. Fish and Wildlife Service 2017). Elderberry shrubs within the project construction area that cannot be avoided will be transplanted during the plant's dormant phase (November through the first 2 weeks of February). A qualified biological monitor will remain on-site while the shrubs are being transplanted.

☐ AVOID AND MINIMIZE THE SPREAD OF INVASIVE PLANT SPECIES DURING PROJECT CONSTRUCTION

The County will require its contractor to avoid and minimize the introduction of new invasive plants and the spread of invasive plants previously documented in the project area. BMPs that may be used, though not limited to, include the following.

- Retain all fill material onsite to prevent the spread of invasive plants to uninfested areas.
- Use a weed-free source for project materials (e.g., straw wattles for erosion control that are weed-free or contain less than 1% weed seed).
- Prevent invasive plant contamination of project materials during transport and when stockpiling (e.g., by covering soil stockpiles with a heavy-duty, contractor-grade tarpaulin).
- Use sterile wheatgrass seed and native plant stock during revegetation.
- Revegetate or mulch disturbed soils within 30 days of completion of ground-disturbing activities to reduce the likelihood of invasive plant establishment.
- Decontaminate project equipment and gear
- Establish a vehicle wash station
- Ensure straw waddles do not contain plastic monofilament netting that may entrap wildlife or fail to degrade

The goal for implementation of these BMPs is to minimize the disturbance and transport of soil and vegetation to the greatest extent feasible to complete the work. Detailed information about implementing these BMPs is available in the Cal-IPC publication *Preventing the Spread of Invasive Plants: Best Management Practices for Transportation and Utility Corridors* (California Invasive Plant Council 2012).

☐ CONSERVATION MEASURES FROM THE BIOLOGICAL OPINION

In addition to implementing Caltrans' standard BMPs throughout the proposed project for the duration of construction, including erosion and sediment control, the following measures to minimize effects to the beetle are proposed. The purchasing of beetle conservation credits referenced in Conservation Measure #1 pertains to the three elderberry shrubs that will be removed and transplanted. Conservation Measures #2-5 pertain to the remaining 10 elderberry shrubs that will not be removed during construction activities.

1. The three impacted elderberry shrubs will be mitigated for using the *Framework for Accessing Impacts to the Valley Elderberry Longhorn Beetle* (*Desmocerus* californicus dimorphus) (Service 2017). The three elderberry shrubs will be transplanted to a Service-approved beetle conservation bank in accordance with the framework. These elderberry shrubs will be compensated utilizing shrub-level impact compensation. Mitigation requirements will be satisfied by purchasing three (3) credits from a Service-approved beetle conservation bank.

2. The construction limits will be clearly identified prior to construction and all areas containing elderberry shrubs to be avoided during construction will be fenced or flagged off.

3. Retain a Service–approved biologist to conduct monitoring during construction in sensitive habitats.

4. The Service-approved biological monitor will conduct environmental awareness training for construction employees.

5. For elderberry shrubs occurring within or immediately adjacent to work locations, 20-foot avoidance buffers will be established around the driplines of the shrub to help protect the shrubs and their root zones during project activities. The avoidance buffers will be maintained for the duration of work activities in the area.

☐ REASONABLE AND PRUDENT MEASURES

All necessary and appropriate measures to avoid or minimize effects on the beetle resulting from implementation of this project have been incorporated into the project's proposed conservation measures. Therefore, the Service believes the following reasonable and prudent measure is necessary and appropriate to minimize incidental take of the beetle:

1.) All conservation measures, as described in the biological assessment and restated here in the *Project Description* section of this biological opinion, shall be fully implemented and adhered to. Further, this reasonable and prudent measure shall be supplemented by the terms and conditions below.

☐ TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the Act, Caltrans must ensure compliance with the following terms and conditions, which implement the reasonable and prudent measure described above. These terms and conditions are nondiscretionary.

1. Caltrans will include full implementation and adherence to the conservation measures as a condition of any permit or contract issued for the project.

2. Caltrans will provide a copy of the completed bill of sale and payment receipt to the Service upon the purchase of beetle conservation credits.

3. In order to monitor whether the amount or extent of incidental take anticipated from implementation of the proposed project is approached or exceeded, Caltrans will adhere to the following reporting requirement. Should this anticipated amount or extent of incidental take be exceeded, Caltrans must immediately reinitiate formal consultation, as per 50 CFR §402.16.

    a. For those components of the action that will result in habitat degradation or modification whereby incidental take in the form of harm is anticipated, Caltrans will provide a precise accounting of the elderberry shrubs impacted to the Service after the completion of construction. This report will also include any information about changes in project implementation that result in habitat disturbance not described in the *Description of the Action* and not analyzed in this biological opinion.