MOJAVE RIVER WATERSHED

Water Quality Management Plan

For:

Tractor Supply Company - Victorville

APN 3106-201-20, 21 & 29

Prepared for:

Durban Development

106 Foster Avenue

Charlotte, NC 28203

(704)319-8346

Prepared by:

Barghausen Consulting Engineers, LLC

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Submittal Date: 7/17/2025

Revision No. and Date: Insert No and Current Revision Date

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Revision No. and Date: Insert No and Current Revision Date

Revision No. and Date: Insert No and Current Revision Date

Final Approval Date:_____

Project Owner's Certification

This Mojave River Watershed Water Quality Management Plan (WQMP) has been prepared for Durban Development by Barghausen Consulting Engineers, LLC. The WQMP is intended to comply with the requirements of the San Bernardino County and the Phase II Small MS4 General Permit for the Mojave River Watershed. The undersigned, while it owns the subject property, is responsible for the implementation of the provisions of this plan and will ensure that this plan is amended as appropriate to reflect up-to-date conditions on the site consistent with the Phase II Small MS4 Permit and the intent of San Bernardino County (unincorporated areas of Phelan, Oak Hills, Spring Valley Lake and Victorville) and the incorporated cities of Hesperia and Victorville and the Town of Apple Valley. Once the undersigned transfers its interest in the property, its successors in interest and the city/county/town shall be notified of the transfer. The new owner will be informed of its responsibility under this WQMP. A copy of the approved WQMP shall be available on the subject site in perpetuity.

"I certify under a penalty of law that the provisions (implementation, operation, maintenance, and funding) of the WQMP have been accepted and that the plan will be transferred to future successors."

Project Data			
Permit/Application Number(s):	PSUB23-00113	Grading Permit Number(s):	
Tract/Parcel Map Number(s):		Building Permit Number(s):	
CUP, SUP, and/or APN (Specify Lot Numbers if Portions of Tract):			3106-201-20, 21 & 22

Owner's Signature			
Owner Name: Stephen Knudsen			
Title			
Company	Durban Development		
Address	106 Foster Avenue, Charlotte, NC 28203		
Email	Stephen.knudsen@durbandevelopment.com		
Telephone #	(704) 319-8346		
Signature		Date	7/17/2025

Preparer's Certification

Project Data			
Permit/Application Number(s):	PSUB23-00113	Grading Permit Number(s):	
Tract/Parcel Map Number(s):		Building Permit Number(s):	
CUP, SUP, and/or APN (Specify Lot Numbers if Portions of Tract):			APN: 3106-201-20, 21 & 22

"The selection, sizing and design of stormwater treatment and other stormwater quality and quantity control measures in this plan were prepared under my oversight and meet the requirements of the California State Water Resources Control Board Order No. 2013-0001-DWQ.

Engineer: Hal P. Grubb, P.E.		PE Stamp Below
Title	Director of Engineering Services	
Company	Barghausen Consulting Engineers, LLC	
Address	18215 72nd Avenue South, Kent, WA 98032	
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Signature		
Date	7/17/2025	7/17/2025

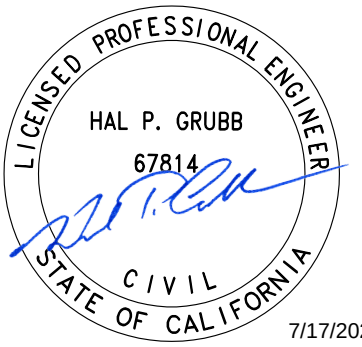


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Section I – Introduction

This WQMP template has been prepared specifically for the Phase II Small MS4 General Permit in the Mojave River Watershed. This location is within the jurisdiction of the Lahontan Regional Water Quality Control Board (LRWQCB). This document should not be confused with the WQMP template for the Santa Ana Phase I area of San Bernardino County.

WQMP preparers must refer to the MS4 Permit for the Mojave Watershed WQMP template and Technical Guidance (TGD) document found at: http://cms.sbcounty.gov/dpw/Land/NPDES.aspx to find pertinent arid region and Mojave River Watershed specific references and requirements.

Section 1 Discretionary Permit(s)

Form 1-1 Project Information

Project Name	Tractor Supply Company - Victorville				
Project Owner Contact Name:	Durban Development				
Mailing Address:	Durban Development 106 Foster Avenue Charlotte, NC 28203	E-mail Address:	Stephen.knudsen@durbandevelopment.com	Telephone:	(704)319-8346
Permit/Application Number(s):	PSUB23-00113	Tract/Parcel Map Number(s):	3106-201-20, 21 & 2		
Additional Information/ Comments:					
Description of Project:	The Project site is located within the City of Victorville north of and abutting Roy Rogers Drive, between Civic Drive and Amargosa Road. Latitude 34.4223°, Longitude -117.3276°.Latitude 34.4223°, Longitude -117.3276°. The proposed development consists of a Tractor Supply Company retail store with an outdoor display area, located on a 3.62-acre site. Improvements include associated parking, drive aisles, and infrastruccture. The site will not receive offsite run-on. All onsite stormwater will sheet flow to on-site catch basins, conveyed to an underground detention pipe system, and treated throug a modular wetland system prior to discharge into the Mojave Drive Channel. This Project is a "Priorty" Project and will require a WQMP.				

Provide summary of Conceptual WQMP conditions (if previously submitted and approved). Attach complete copy.	The WQMP consists of one 3.62-acre DMA. Land coverage breakdown is 0.45 ac of pervious surfaces and 3.18 ac of impervious. Due to the project size being larger than 1 acre, it is subject to hydromodification. BMP treatment, detention, and discharge rate were dependent on the values calculated to meet hydromodification requirements. Stormwater runoff will sheet flow into onsite catchbasins, conveyed through an underground detention pipe system (Vdesign=12150 cf), then treated through a modular wetland (Qdesign = 0.045cfs) prior to discharge into the Mojave Drive Channel.

Section 2 Project Description

2.1 Project Information

The WQMP shall provide the information listed below. The information provided for Conceptual/ Preliminary WQMP should give sufficient detail to identify the major proposed site design and LID BMPs and other anticipated water quality features that impact site planning. Final Project WQMP must specifically identify all BMP incorporated into the final site design and provide other detailed information as described herein.

The purpose of this information is to help determine the applicable development category, pollutants of concern, watershed description, and long term maintenance responsibilities for the project, and any applicable water quality credits. This information will be used in conjunction with the information in Section 3, Site Description, to establish the performance criteria and to select the LID BMP or other BMP for the project or other alternative programs that the project will participate in, which are described in Section 4.

2.1.1 Project Sizing Categorization

If the Project is greater than 5,000 square feet, and not on the excluded list as found on Section 1.4 of the TGD, the Project is a Regulated Development Project.

If the Project is creating and/or replacing greater than 2,500 square feet but less than 5,000 square feet of impervious surface area, then it is considered a Site Design Only project. This criterion is applicable to all development types including detached single family homes that create and/or replace greater than 2,500 square feet of impervious area and are not part of a larger plan of development.

Form 2.1-1 Description of Proposed Project

1 Regulated Development Project Category (Select all that apply):

☒ #1 New development involving the creation of 5,000 ft² or more of impervious surface collectively over entire site	☐ #2 Significant re-development involving the addition or replacement of 5,000 ft² or more of impervious surface on an already developed site	☐ #3 Road Project – any road, sidewalk, or bicycle lane project that creates greater than 5,000 square feet of contiguous impervious surface	☐ #4 LUPs – linear underground/overhead projects that has a discrete location with 5,000 sq. ft. or more new constructed impervious surface

☒ Site Design Only (Project Total Square Feet > 2,500 but < 5,000 sq.ft.) *Will require source control Site Design Measures. Use the "PCMP" Template. Do not use this WQMP Template.*

2 Project Area (ft2):	158,194	**3** Number of Dwelling Units:		**4** SIC Code:	

5 Is Project going to be phased? Yes ☐ No ☒ *If yes, ensure that the WQMP evaluates each phase as a distinct DA, requiring LID BMPs to address runoff at time of completion.*

2.2 Property Ownership/Management

Describe the ownership/management of all portions of the project and site. State whether any infrastructure will transfer to public agencies (City, County, Caltrans, etc.) after project completion. State if a homeowners or property owners association will be formed and be responsible for the long-term maintenance of project stormwater facilities. Describe any lot-level stormwater features that will be the responsibility of individual property owners.

Form 2.2-1 Property Ownership/Management

Describe property ownership/management responsible for long-term maintenance of WQMP stormwater facilities:

Ownership of the project will be held by Durban Development. Long-term maintenance will be the responsibility of the owner.

This includes BMP maintenance, catch basin inspection, storm drain maintenance, efficient irrigation, landscape maintenance, etc. once the property is sold or transferred.

2.3 Potential Stormwater Pollutants

Best Management Practices (BMP) measures for pollutant generating activities and sources shall be designed consistent with recommendations from the CASQA Stormwater BMP Handbook for New Development and Redevelopment (or an equivalent manual). Pollutant generating activities must be considered when determining the overall pollutants of concern for the Project as presented in Form 2.3-1.

Determine and describe expected stormwater pollutants of concern based on land uses and site activities (refer to Table 3-2 in the TGD for WQMP).

Form 2.3-1 Pollutants of Concern

Pollutant	Please check: E=Expected, N=Not Expected		Additional Information and Comments
Pathogens (Bacterial / Virus)	E ☒	N ☐	Potential source- Parking lot and wild birds
Nutrients - Phosphorous	E ☒	N ☐	Potential source - Landscape
Nutrients - Nitrogen	E ☒	N ☐	Potential source - Landscape
Noxious Aquatic Plants	E ☐	N ☒	
Sediment	E ☒	N ☐	Solid materials/suspended solids from land surface are expected in addition to sediments from erosion.
Metals	E ☒	N ☐	Metal pollutants are expected from vehicles circulating the parking lot, including tire wear and brake dust.
Oil and Grease	E ☒	N ☐	Surface area of the parking lot will contribute to pollution from leaking vehicles and grease for production.
Trash/Debris	E ☒	N ☐	Trash and debris pollution from general litter is expected onsite from facility occupants, visitors, and any work that may be performed on the site premises.
Pesticides / Herbicides	E ☒	N ☐	Expected pollutants from maintenance of the site landscape area is expected.
Organic Compounds	E ☒	N ☐	Use of cleaning solvents/chemicals and maintenace of landscape area will contribute to pollution from organic compounds.
Other:	E ☐	N ☐	
Other:	E ☐	N ☐	
Other:	E ☐	N ☐	

Section 3 Site and Watershed Description

Describe the project site conditions that will facilitate the selection of BMPs through an analysis of the physical conditions and limitations of the site and its receiving waters. Identify distinct drainage areas (DA) that collect flow from a portion of the site and describe how runoff from each DA (and sub-watershed Drainage Management Areas (DMAs)) is conveyed to the site outlet(s). Refer to Section 3.2 in the TGD for WQMP. The form below is provided as an example. Then complete Forms 3.2 and 3.3 for each DA on the project site. ***If the project has more than one drainage area for stormwater management, then complete additional versions of these forms for each DA / outlet. A map presenting the DMAs must be included as an appendix to the WQMP document.***

Form 3-1 Site Location and Hydrologic Features

Site coordinates *take GPS measurement at approximate center of site*	Latitude 34.4223°	Longitude -117.3276°	Thomas Bros Map page
1 San Bernardino County climatic region: ☒ Desert			
2 Does the site have more than one drainage area (DA): Yes☐ No☒ *If no, proceed to Form 3-2. If yes, then use this form to show a conceptual schematic describing DMAs and hydrologic feature connecting DMAs to the site outlet(s). An example is provided below that can be modified for proposed project or a drawing clearly showing DMA and flow routing may be attached*			

Conveyance	Briefly describe on-site drainage features to convey runoff that is not retained within a DMA
DA1 DMA C flows to DA1 DMA A	*Ex. Bioretention overflow to vegetated bioswale with 4' bottom width, 5:1 side slopes and bed slope of 0.01. Conveys runoff for 1000' through DMA 1 to existing catch basin on SE corner of property*
DA1 DMA A to Outlet 1	
DA1 DMA B to Outlet 1	
DA2 to Outlet 2	

Form 3-2 Existing Hydrologic Characteristics for Drainage Area 1

For Drainage Area 1's sub-watershed DMA, provide the following characteristics	DMA A	DMA B	DMA C	DMA D
1 DMA drainage area (ft^2)	158,194			
2 Existing site impervious area (ft^2)	1,524			
3 Antecedent moisture condition *For desert areas, use* *http://www.sbcounty.gov/dpw/floodcontrol/pdf/20100412_map.pdf*	2			
4 Hydrologic soil group *Refer to County Hydrology Manual Addendum for Arid Regions – http://www.sbcounty.gov/dpw/floodcontrol/pdf/20100412_addendum.pdf*	B			
5 Longest flowpath length (ft)	282			
6 Longest flowpath slope (ft/ft)	0.4			
7 Current land cover type(s) *Select from Fig C-3 of Hydrology Manual*	Open Bush			
8 Pre-developed pervious area condition: *Based on the extent of wet season vegetated cover good >75%; Fair 50-75%; Poor <50%* ***Attach photos of site to support rating***	Poor cover			

Form 3-2 Existing Hydrologic Characteristics for Drainage Area 1 (use only as needed for additional DMA w/in DA 1)				
For Drainage Area 1's sub-watershed DMA, provide the following characteristics	DMA E	DMA F	DMA G	DMA H
1 DMA drainage area (ft^2)				
2 Existing site impervious area (ft^2)				
3 Antecedent moisture condition *For desert areas, use http://www.sbcounty.gov/dpw/floodcontrol/pdf/20100412_map.pdf*				
4 Hydrologic soil group *County Hydrology Manual Addendum for Arid Regions – http://www.sbcounty.gov/dpw/floodcontrol/pdf/20100412_addendum.pdf*				
5 Longest flowpath length (ft)				
6 Longest flowpath slope (ft/ft)				
7 Current land cover type(s) *Select from Fig C-3 of Hydrology Manual*				
8 Pre-developed pervious area condition: *Based on the extent of wet season vegetated cover good >75%; Fair 50-75%; Poor <50% Attach photos of site to support rating*				

Form 3-3 Watershed Description for Drainage Area

Receiving waters Refer to SWRCB site: http://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2010.shtml	Mojave River
Applicable TMDLs *http://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2010.shtml*	None
303(d) listed impairments *http://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2010.shtml*	Mojave River below lower narrows not listed in the 303d listed waters
Environmentally Sensitive Areas (ESA) *Refer to Watershed Mapping Tool –* *http://sbcounty.permitrack.com/WAP*	Desert Tortoise Habitat, Category 3 Mojave Ground Squirrel
Hydromodification Assessment	☒ Yes *Complete Hydromodification Assessment. Include Forms 4.2-2 through Form 4.2-5 and Hydromodification BMP Form 4.3-9 in submittal* ☐ No

Section 4 Best Management Practices (BMP)

4.1 Source Control BMPs and Site Design BMP Measures

The information and data in this section are required for both Regulated Development and Site Design Only Projects. Source Control BMPs and Site Design BMP Measures are the basis of site-specific pollution management.

4.1.1 Source Control BMPs

Non-structural and structural source control BMP are required to be incorporated into all new development and significant redevelopment projects. Form 4.1-1 and 4.1-2 are used to describe specific source control BMPs used in the WQMP or to explain why a certain BMP is not applicable. Table 7-3 of the TGD for WQMP provides a list of applicable source control BMP for projects with specific types of potential pollutant sources or activities. The source control BMP in this table must be implemented for projects with these specific types of potential pollutant sources or activities.

The preparers of this WQMP have reviewed the source control BMP requirements for new development and significant redevelopment projects. The preparers have also reviewed the specific BMP required for project as specified in Forms 4.1-1 and 4.1-2. All applicable non-structural and structural source control BMP shall be implemented in the project.

The identified list of source control BMPs correspond to the CASQA Stormwater BMP Handbook for New Development and Redevelopment.

Form 4.1-1 Non-Structural Source Control BMPs

Identifier	Name	Check One		Describe BMP Implementation OR, if not applicable, state reason
		Included	Not Applicable	
N1	Education of Property Owners, Tenants and Occupants on Stormwater BMPs	☒	☐	General information will be provided to the owner on housekeeping practices that contribute to the protection of storm water. The property owner and property manager will be familiar with the contents of this document and the BMPs used on the site. The owner will provide education materials to tenants (if applicable) on BMPs and housekeeping practices that contribute to the protection of storm water.
N2	Activity Restrictions	☒	☐	The property owner/manager shall control the discharge of the stormwater pollutants from this site through activity restrictions. Restrictions shall be provided to all new tenants/occupants through lease terms or other mechanisms upon first occupancy of the lease space and annually thereafter. Enforcement of activity restriction shall be on-going during the operation of the project site.
N3	Landscape Management BMPs	☒	☐	The property owner, building operators, and landscape maintenance contractors will practice on-going landscape maintenance BMPs consistent with applicable local ordinances and will regularly inspect the irrigation system for signs of erosion or sediment debris buildup and clean/repair as needed.
N4	BMP Maintenance	☒	☐	The property owner/manager will maintain all post-construction BMPs consistent with the O&M plan described in Section 5 of this document (Form 5-1).
N5	Title 22 CCR Compliance (How development will comply)	☐	☒	N/A
N6	Local Water Quality Ordinances	☒	☐	The owner shall comply with the City of Victorville Stormwater Ordinance through the implementation of BMPs.
N7	Spill Contingency Plan	☒	☐	Building operators shall prepare specific plans based on materials onsite for the cleanup of spills. Plans shall mandate stock piling of cleanup materials, notification of agencies, disposal, documentation, etc. Storage shall comply with Hazmat Regulations and any required contingency plans.

Form 4.1-1 Non-Structural Source Control BMPs				
N8	Underground Storage Tank Compliance	☐	☒	N/A
N9	Hazardous Materials Disclosure Compliance	☐	☒	N/A

Form 4.1-1 Non-Structural Source Control BMPs

Identifier	Name	Check One		Describe BMP Implementation OR, if not applicable, state reason
		Included	Not Applicable	
N10	Uniform Fire Code Implementation	☒	☐	This project will be developed and operated in accordance with Article 80 of the Uniform Fire Code.
N11	Litter/Debris Control Program	☒	☐	The building operator shall prepare and implement an employee training program. This program shall include but not be limited to instructions on spill cleanup, litter control,and material storage procedures.
N12	Employee Training	☒	☐	The property owner/manager shall prepare and implement an employee training program in accordance with California Storm Water Quality Association Standards and BMPs. This program shall be reviewed on a bi-annual basis or with every new edition of the Stormwater Best Management Practice Handbook for Industrial and Commercial. See appendix for all educational material.
N13	Housekeeping of Loading Docks	☐	☒	N/A
N14	Catch Basin Inspection Program	☒	☐	Catch basins shall be inspected visually on a monthly basis; the entire storm drain system shall be inspected and cleaned prior to the start of the rainy season.
N15	Vacuum Sweeping of Private Streets and Parking Lots	☒	☐	Parking areas will be swept regularly using a vacuum-assisted sweeper. Frequency will depend on waste accumulations with a minimum of once per month and prior to the start of the rainy season.
N16	Other Non-structural Measures for Public Agency Projects	☐	☒	N/A
N17	Comply with all other applicable NPDES permits	☒	☐	The developer will comply with the California statewide Construction General Permit during construction and all future occupants of the site shall comply with the requirements of the statewide General Stormwater Permit.

Form 4.1-2 Structural Source Control BMPs

Identifier	Name	Check One		Describe BMP Implementation OR, If not applicable, state reason
		Included	Not Applicable	
S1	Provide storm drain system stencilling and signage (CASQA New Development BMP Handbook SD-13)	☒	☐	All storm drain inlets shall have Stenciling illustrating an anti-dumping message.
S2	Design and construct outdoor material storage areas to reduce pollution introduction (CASQA New Development BMP Handbook SD-34)	☒	☐	Outdoor material storage areas are designed per CASQA standards.
S3	Design and construct trash and waste storage areas to reduce pollution introduction (CASQA New Development BMP Handbook SD-32)	☒	☐	Trash storage areas shall be located away from storm drain inlets. All trash dumpsters/containers will be required to have a lid on at all times to prevent direct precipitation and prevent any rainfall from entering containers.
S4	Use efficient irrigation systems & landscape design, water conservation, smart controllers, and source control (Statewide Model Landscape Ordinance; CASQA New Development BMP Handbook SD-12)	☒	☐	Irrigation systems will be designed to each landscaped area's specific water need. Irrigation controls shall include rain-triggered shutoff devices to prevent irrigation after precipitation.
S5	Finish grade of landscaped areas at a minimum of 1-2 inches below top of curb, sidewalk, or pavement	☒	☐	Landscaped areas shall be below a minimum of 1" to 2" below the top of curb or walk.
S6	Protect slopes and channels and provide energy dissipation (CASQA New Development BMP Handbook SD-10)	☐	☒	N/A
S7	Covered dock areas (CASQA New Development BMP Handbook SD-31)	☐	☒	N/A
S8	Covered maintenance bays with spill containment plans (CASQA New Development BMP Handbook SD-31)	☐	☒	N/A
S9	Vehicle wash areas with spill containment plans (CASQA New Development BMP Handbook SD-33)	☐	☒	N/A
S10	Covered outdoor processing areas (CASQA New Development BMP Handbook SD-36)	☐	☐	N/A

Form 4.1-2 Structural Source Control BMPs

Identifier	Name	Check One		Describe BMP Implementation OR, If not applicable, state reason
		Included	Not Applicable	
S11	Equipment wash areas with spill containment plans (CASQA New Development BMP Handbook SD-33)	☐	☒	N/A
S12	Fueling areas (CASQA New Development BMP Handbook SD-30)	☐	☒	N/A
S13	Hillside landscaping (CASQA New Development BMP Handbook SD-10)	☐	☒	N/A
S14	Wash water control for food preparation areas	☐	☒	N/A
S15	Community car wash racks (CASQA New Development BMP Handbook SD-33)	☐	☒	N/A

4.1.2 Site Design BMPs

As part of the planning phase of a project, the site design practices associated with new LID requirements in the Phase II Small MS4 Permit must be considered. Site design BMP measures can result in smaller Design Capture Volume (DCV) to be managed by both LID and hydromodification control BMPs by reducing runoff generation.

As is stated in the Permit, it is necessary to evaluate site conditions such as soil type(s), existing vegetation and flow paths will influence the overall site design.

Describe site design and drainage plan including:

- A narrative of site design practices utilized or rationale for not using practices
- A narrative of how site plan incorporates preventive site design practices
- Include an attached Site Plan layout which shows how preventative site design practices are included in WQMP

Refer to Section 5.2 of the TGD for WQMP for more details.

Form 4.1-3 Site Design Practices Checklist

Site Design Practices *If yes, explain how preventative site design practice is addressed in project site plan. If no, other LID BMPs must be selected to meet targets*
Minimize impervious areas: Yes ☐ No ☒ Explanation: The existing site is undeveloped; therefore, the projet will increase the impervious areas. A proprietary detention system and modular wetland are proposed to mitigate pollution and increased discharge rates. Landscaping are incorporated
Maximize natural infiltration capacity; Including improvement and maintenance of soil: Yes ☒ No ☐ Explanation: The site will maintain the natural infiltration capacities in proposed landscaped areas.
Preserve existing drainage patterns and time of concentration: Yes ☐ No ☒ Explanation: The existing site is undeveloped; therefore, the project will increase the impervious areas. A proprietary detention system and modular wetland are proposed to mitigate pollution and increase discharge rates.
Disconnect impervious areas. Including rerouting of rooftop drainage pipes to drain stormwater to storage or infiltration BMPs instead of to storm drain : Yes ☐ No ☒ Explanation:
Use of Porous Pavement.: Yes ☐ No ☒ Explanation: This project does not have porous pavement.
Protect existing vegetation and sensitive areas: Yes ☐ No ☐ Explanation: There is no significant existing vegetation and sensitive areas to protect.
Re-vegetate disturbed areas. Including planting and preservation of drought tolerant vegetation. : Yes ☒ No ☐ Explanation: Landscaped areas will be provided.

Minimize unnecessary compaction in stormwater retention/infiltration basin/trench areas: Yes ☒ No ☐ Explanation: Compaction will be minimized to what is required per geotechnical suggestions.
Utilize naturalized/rock-lined drainage swales in place of underground piping or imperviously lined swales: Yes ☐ No ☒ Explanation: Swales are not provided in this project.
Stake off areas that will be used for landscaping to minimize compaction during construction : Yes ☐ No ☒ Explanation: Landscape areas are insufficient to qualify as stake-off areas.
Use of Rain Barrels and Cisterns, Including the use of on-site water collection systems.: Yes ☐ No ☒ Explanation: Not practical to the scope of the project.
Stream Setbacks. Includes a specified distance from an adjacent steam: : Yes ☐ No ☒ Explanation: Project is not adjacent to any streams.

It is noted that, in the Phase II Small MS4 Permit, site design elements for green roofs and vegetative swales are required. Due to the local climatology in the Mojave River Watershed, proactive measures are taken to maximize the amount of drought tolerant vegetation. It is not practical in this region to have green roofs or vegetative swales. As part of site design the project proponent should utilize locally recommended vegetation types for landscaping. Typical landscaping recommendations are found in following local references:

San Bernardino County Special Districts:

Guide to High Desert Landscaping -
http://www.specialdistricts.org/Modules/ShowDocument.aspx?documentid=795

Recommended High-Desert Plants -
http://www.specialdistricts.org/modules/showdocument.aspx?documentid=553

Mojave Water Agency:

Desert Ranch: http://www.mojavewater.org/files/desertranchgardenprototype.pdf

Summertree: http://www.mojavewater.org/files/Summertree-Native-Plant-Brochure.pdf

Thornless Garden: http://www.mojavewater.org/files/thornlessgardenprototype.pdf

Mediterranean Garden: http://www.mojavewater.org/files/mediterraneangardenprototype.pdf

Lush and Efficient Garden: http://www.mojavewater.org/files/lushandefficientgardenprototype.pdf

Alliance for Water Awareness and Conservation (AWAC) outdoor tips – http://hdawac.org/save-outdoors.html

4.2 Treatment BMPs

After implementation and design of both Source Control BMPs and Site Design BMP measures, any remaining runoff from impervious DMAs must be directed to one or more on-site, treatment BMPs (LID or biotreatment) designed to infiltrate, evaportranspire, and/or bioretain the amount of runoff specified in Permit Section E.12.e (ii)(c) Numeric Sizing Criteria for Storm Water Retention and Treatment.

4.2.1 Project Specific Hydrology Characterization

The purpose of this section of the Project WQMP is to establish targets for post-development hydrology based on performance criteria specified in Section E.12.e.ii.c and Section E.12.f of the Phase II Small MS4 Permit. These targets include runoff volume for water quality control (referred to as LID design capture volume), and runoff volume, time of concentration, and peak runoff for protection from hydromodification.

If the project has more than one outlet for stormwater runoff, then complete additional versions of these forms for each DA / outlet.

It is noted that in the Phase II Small MS4 Permit jurisdictions, the LID BMP Design Capture Volume criteria is based on the 2-year rain event. The hydromodification performance criterion is based on the 10-year rain event.

Methods applied in the following forms include:

- For LID BMP Design Capture Volume (DCV), San Bernardino County requires use of the P_6 method (Form 4.2-1) For pre- and post-development hydrologic calculation, San Bernardino County requires the use of the Rational Method (San Bernardino County Hydrology Manual Section D). Forms 4.2-2 through Form 4.2-5 calculate hydrologic variables including runoff volume, time of concentration, and peak runoff from the project site pre- and post-development using the Hydrology Manual Rational Method approach. For projects greater than 640 acres (1.0 mi^2), the Rational Method and these forms should not be used. For such projects, the Unit Hydrograph Method (San Bernardino County Hydrology Manual Section E) shall be applied for hydrologic calculations for hydromodification performance criteria.

Refer to Section 4 in the TGD for WQMP for detailed guidance and instructions.

Form 4.2-1 LID BMP Performance Criteria for Design Capture Volume (DA 1)		
[1] Project area DA 1 (ft^2): 158,194	[2] Imperviousness after applying preventative site design practices (Imp%): 0.88	[3] Runoff Coefficient (Rc): _0.705 *$R_c = 0.858(Imp\%)^{\wedge 3} - 0.78(Imp\%)^{\wedge 2} + 0.774(Imp\%) + 0.04$*
[4] Determine 1-hour rainfall depth for a 2-year return period $P_{2yr\text{-}1hr}$ (in): 0.4445 http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html		
[5] Compute P_6, Mean 6-hr Precipitation (inches): 0.5499 *P_6 = Item 4 * C_1, where C_1 is a function of site climatic region specified in Form 3-1 Item 1 (Desert = 1.2371)*		
[6] Drawdown Rate *Use 48 hours as the default condition. Selection and use of the 24 hour drawdown time condition is subject to approval by the local jurisdiction. The necessary BMP footprint is a function of drawdown time. While shorter drawdown times reduce the performance criteria for LID BMP design capture volume, the depth of water that can be stored is also reduced.*		24-hrs ☐ 48-hrs ☒
[7] Compute design capture volume, DCV (ft^3): 10,045.28 *DCV = 1/12 * [Item 1* Item 3 *Item 5 * C_2], where C_2 is a function of drawdown rate (24-hr = 1.582; 48-hr = 1.963)* *Compute separate DCV for each outlet from the project site per schematic drawn in Form 3-1 Item 2*		

Form 4.2-2 Summary of Hydromodification Assessment (DA 1)

Is the change in post- and pre- condition flows captured on-site? : Yes ☒ No ☐

If "Yes", then complete Hydromodification assessment of site hydrology for 10yr storm event using Forms 4.2-3 through 4.2-5 and insert results below *(Forms 4.2-3 through 4.2-5 may be replaced by computer software analysis based on the San Bernardino County Hydrology Manual- Addendum 1)*

If "No," then proceed to Section 4.3 BMP Selection and Sizing

Condition	Runoff Volume (ft^3)	Time of Concentration (min)	Peak Runoff (cfs)
Pre-developed	[1] 7229.34 *Form 4.2-3 Item 12*	[2] 16.10 *Form 4.2-4 Item 13*	[3] 0.045 *Form 4.2-5 Item 10*
Post-developed	[4] 20372.88 *Form 4.2-3 Item 13*	[5] 8.50 *Form 4.2-4 Item 14*	[6] 1.158 *Form 4.2-5 Item 14*
Difference	[7] *13143.54* *Item 4 – Item 1*	[8] *7.60* *Item 2 – Item 5*	[9] *1.113* *Item 6 – Item 3*
Difference (as % of pre-developed)	[10] *181.8%* *Item 7 / Item 1*	[11] *47.2%* *Item 8 / Item 2*	[12] *2473.33%* *Item 9 / Item 3*

Form 4.2-3 Hydromodification Assessment for Runoff Volume (DA 1)

Weighted Curve Number Determination for: Pre-developed DA	DMA A	DMA B	DMA C	DMA D	DMA E	DMA F	DMA G	DMA H
1a Land Cover type	Op. Brush							
2a Hydrologic Soil Group (HSG)	B							
3a DMA Area, ft^2 *sum of areas of DMA should equal area of DA*	158,194							
4a Curve Number (CN) *use Items 1 and 2 to select the appropriate CN from Appendix C-2 of the TGD for WQMP*	0.76							
Weighted Curve Number Determination for: Post-developed DA	DMA A	DMA B	DMA C	DMA D	DMA E	DMA F	DMA G	DMA H
1b Land Cover type	Grass							
2b Hydrologic Soil Group (HSG)	B							
3b DMA Area, ft^2 *sum of areas of DMA should equal area of DA*	158,194							
4b Curve Number (CN) *use Items 5 and 6 to select the appropriate CN from Appendix C-2 of the TGD for WQMP*	0.933							

5 Pre-Developed area-weighted CN: 76	**7** Pre-developed soil storage capacity, S (in): 3.158 *S = (1000 / Item 5) - 10*	**9** Initial abstraction, I_a (in): 0.632 *I_a = 0.2 * Item 7*
6 Post-Developed area-weighted CN: 93	**8** Post-developed soil storage capacity, S (in): 0.753 *S = (1000 / Item 6) - 10*	**10** Initial abstraction, I_a (in): 0.151 *I_a = 0.2 * Item 8*

11 Precipitation for 10 yr, 24 hr storm (in): 2.25
Go to: http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html

12 Pre-developed Volume (ft^3): 7229.34
*V_{pre} =(1 / 12) * (Item sum of Item 3) * [(Item 11 – Item 9)^2 / ((Item 11 – Item 9 + Item 7)*

13 Post-developed Volume (ft^3): 20372.88
*V_{pre} =(1 / 12) * (Item sum of Item 3) * [(Item 11 – Item 10)^2 / ((Item 11 – Item 10 + Item 8)*

14 Volume Reduction needed to meet hydromodification requirement, (ft^3): 12,124.90
*Vhydro = (Item 13 * 0.95) – Item 12*

Form 4.2-4 Hydromodification Assessment for Time of Concentration (DA 1)

Compute time of concentration for pre and post developed conditions for each DA *(For projects using the Hydrology Manual complete the form below)*

Variables	Pre-developed DA1 *Use additional forms if there are more than 4 DMA*				Post-developed DA1 *Use additional forms if there are more than 4 DMA*			
	DMA A	DMA B	DMA C	DMA D	DMA A	DMA B	DMA C	DMA D
1 Length of flowpath (ft) *Use Form 3-2 Item 5 for pre-developed condition*	389				282			
2 Change in elevation (ft)	7.6				1.42			
3 Slope (ft/ft), *S_o = Item 2 / Item 1*	0.0195				0.00504			
4 Land cover	Open Bush, Poor				Grass, good and Commercial (paved)			
5 Initial DMA Time of Concentration (min) *Appendix C-1 of the TGD for WQMP*	16.1				8.5			
6 Length of conveyance from DMA outlet to project site outlet (ft) *May be zero if DMA outlet is at project site outlet*								
7 Cross-sectional area of channel (ft^2)								
8 Wetted perimeter of channel (ft)								
9 Manning's roughness of channel (n)								
10 Channel flow velocity (ft/sec) *V_{fps} = (1.49 / Item 9) * (Item 7/Item 8)^0.67 * (Item 3)^0.5*								
11 Travel time to outlet (min) *T_t = Item 6 / (Item 10 * 60)*								
12 Total time of concentration (min) *T_c = Item 5 + Item 11*	16.1				8.5			

13 Pre-developed time of concentration (min): 16.1 *Minimum of Item 12 pre-developed DMA*

14 Post-developed time of concentration (min): 8.5 *Minimum of Item 12 post-developed DMA*

15 Additional time of concentration needed to meet hydromodification requirement (min): 6.795 *$T_{C\text{-}Hydro}$ = (Item 13 * 0.95) – Item 14*

Form 4.2-5 Hydromodification Assessment for Peak Runoff (DA 1)

Compute peak runoff for pre- and post-developed conditions

Variables		Pre-developed DA to Project Outlet (*Use additional forms if more than 3 DMA)*			Post-developed DA to Project Outlet (*Use additional forms if more than 3 DMA)*		
		DMA A	DMA B	DMA C	DMA A	DMA B	DMA C
1 Rainfall Intensity for storm duration equal to time of concentration *I_{peak} = 10^(LOG Form 4.2-1 Item 4 - 0.7 LOG Form 4.2-4 Item 5 /60)*		1.807			2.217		
2 Drainage Area of each DMA (Acres) *For DMA with outlet at project site outlet, include upstream DMA (Using example schematic in Form 3-1, DMA A will include drainage from DMA C)*		3.632			3.632		
3 Ratio of pervious area to total area *For DMA with outlet at project site outlet, include upstream DMA (Using example schematic in Form 3-1, DMA A will include drainage from DMA C)*		0.99			0.125		
4 Pervious area infiltration rate (in/hr) *Use pervious area CN and antecedent moisture condition with Appendix C-3 of the TGD for WQMP*		0.421			0.64		
5 Maximum loss rate (in/hr) *F_m = Item 3 * Item 4* *Use area-weighted F_m from DMA with outlet at project site outlet, include upstream DMA (Using example schematic in Form 3-1, DMA A will include drainage from DMA C)*		0.417			0.080		
6 Peak Flow from DMA (cfs) *Q_p =Item 2 * 0.9 * (Item 1 - Item 5)*		0.045			1.158		
7 Time of concentration adjustment factor for other DMA to site discharge point *Form 4.2-4 Item 12 DMA / Other DMA upstream of site discharge point (If ratio is greater than 1.0, then use maximum value of 1.0)*	DMA A	*n/a*			*n/a*		
	DMA B		*n/a*			*n/a*	
	DMA C			*n/a*			*n/a*

8 Pre-developed Q_p at T_c for DMA A: 0.045 *Q_p = Item 6_{DMAA} + [Item 6_{DMAB} * (Item 1_{DMAA} - Item 5_{DMAB})/(Item 1_{DMAB} - Item 5_{DMAB})* Item $7_{DMAA/2}$] + [Item 6_{DMAC} * (Item 1_{DMAA} - Item 5_{DMAC})/(Item 1_{DMAC} - Item 5_{DMAC})* Item $7_{DMAA/3}$]*	**9** Pre-developed Q_p at T_c for DMA B: *Q_p = Item 6_{DMAB} + [Item 6_{DMAA} * (Item 1_{DMAB} - Item 5_{DMAA})/(Item 1_{DMAA} - Item 5_{DMAA})* Item $7_{DMAB/1}$] + [Item 6_{DMAC} * (Item 1_{DMAB} - Item 5_{DMAC})/(Item 1_{DMAC} - Item 5_{DMAC})* Item $7_{DMAB/3}$]*	**10** Pre-developed Q_p at T_c for DMA C: *Q_p = Item 6_{DMAC} + [Item 6_{DMAA} * (Item 1_{DMAC} - Item 5_{DMAA})/(Item 1_{DMAA} - Item 5_{DMAA})* Item $7_{DMAC/1}$] + [Item 6_{DMAB} * (Item 1_{DMAC} - Item 5_{DMAB})/(Item 1_{DMAB} - Item 5_{DMAB})* Item $7_{DMAC/2}$]*
10 Peak runoff from pre-developed condition confluence analysis (cfs): 0.045 *Maximum of Item 8, 9, and 10 (including additional forms as needed)*		
11 Post-developed Q_p at T_c for DMA A: 1.158 *Same as Item 8 for post-developed values*	**12** Post-developed Q_p at T_c for DMA B: *Same as Item 9 for post-developed values*	**13** Post-developed Q_p at T_c for DMA C: *Same as Item 10 for post-developed values*
14 Peak runoff from post-developed condition confluence analysis (cfs): 1.158 *Maximum of Item 11, 12, and 13 (including additional forms as needed)*		

15 Peak runoff reduction needed to meet Hydromodification Requirement (cfs): 1.054 $Q_{p\text{-}hydro}$ *= (Item 14 * 0.95) – Item 10*

4.3 BMP Selection and Sizing

Complete the following forms for each project site DA to document that the proposed treatment (LID/Bioretention) BMPs conform to the project DCV developed to meet performance criteria specified in the Phase II Small MS4 Permit (WQMP Template Section 4.2). For the LID DCV, the forms are ordered according to hierarchy of BMP selection as required by the Phase II Small MS4 Permit (see Section 5.3 in the TGD for WQMP). The forms compute the following for on-site LID BMP:

- Site Design Measures (Form 4.3-2)
- Retention and Infiltration BMPs (Form 4.3-3) or
- Biotreatment BMPs (Form 4.3-4).

> Please note that the selected BMPs may also be used as dual purpose for on-site, hydromodification mitigation and management.

At the end of each form, additional fields facilitate the determination of the extent of mitigation provided by the specific BMP category, allowing for use of the next category of BMP in the hierarchy, if necessary.

The first step in the analysis, using Section 5.3.2 of the TGD for WQMP, is to complete Forms 4.3-1 and 4.3-3) to determine if retention and infiltration BMPs are infeasible for the project. For each feasibility criterion in Form 4.3-1, if the answer is "Yes," provide all study findings that includes relevant calculations, maps, data sources, etc. used to make the determination of infeasibility.

Next, complete Form 4.3-2 to determine the feasibility of applicable Site Design BMPs, and, if their implementation is feasible, the extent of mitigation of the DCV.

If no site constraints exist that would limit the type of BMP to be implemented in a DA, evaluate the use of combinations of LID BMPs, including all applicable Site Design BMPs to maximize on-site retention of the DCV. If no combination of BMP can mitigate the entire DCV, implement the single BMP type, or combination of BMP types, that maximizes on-site retention of the DCV within the minimum effective area.

If the combination of site design, retention and/or infiltration BMPs is unable to mitigate the entire DCV, then the remainder of the volume-based performance criteria that cannot be achieved with site design, retention and/or infiltration BMPs must be managed through biotreatment BMPs. If biotreatment BMPs are used, then they must be sized to provide equivalent effectiveness based on Template Section 4.3.4.

4.3.1 Exceptions to Requirements for Bioretention Facilities

Contingent on a demonstration that use of bioretention or a facility of equivalent effectiveness is infeasible, other types of biotreatment or media filters (such as tree-box-type biofilters or in-vault media filters) may be used for the following categories of Regulated Projects:

1) Projects creating or replacing an acre or less of impervious area, and located in a designated pedestrian-oriented commercial district (i.e., smart growth projects), and having at least 85% of the entire project site covered by permanent structures;

2) Facilities receiving runoff solely from existing (pre-project) impervious areas; and

3) Historic sites, structures or landscapes that cannot alter their original configuration in order to maintain their historic integrity.

Form 4.3-1 Infiltration BMP Feasibility (DA 1)
Feasibility Criterion – Complete evaluation for each DA on the Project Site
[1] Would infiltration BMP pose significant risk for groundwater related concerns? Yes ☐ No ☒ *Refer to Section 5.3.2.1 of the TGD for WQMP*
If Yes, Provide basis: (attach)
[2] Would installation of infiltration BMP significantly increase the risk of geotechnical hazards? Yes ☐ No ☐ (Yes, if the answer to any of the following questions is yes, as established by a geotechnical expert): • The location is less than 50 feet away from slopes steeper than 15 percent • The location is less than ten feet from building foundations or an alternative setback. • A study certified by a geotechnical professional or an available watershed study determines that stormwater infiltration would result in significantly increased risks of geotechnical hazards.
If Yes, Provide basis: (attach)
[3] Would infiltration of runoff on a Project site violate downstream water rights? Yes ☐ No ☐
If Yes, Provide basis: (attach)
[4] Is proposed infiltration facility located on hydrologic soil group (HSG) D soils or does the site geotechnical investigation indicate presence of soil characteristics, which support categorization as D soils? Yes ☐ No ☐
If Yes, Provide basis: (attach)
[5] Is the design infiltration rate, after accounting for safety factor of 2.0, below proposed facility less than 0.3 in/hr (accounting for soil amendments)? Yes ☐ No ☐
If Yes, Provide basis: (attach)
[6] Would on-site infiltration or reduction of runoff over pre-developed conditions be partially or fully inconsistent with watershed management strategies as defined in the WAP, or impair beneficial uses? Yes ☐ No ☐ *See Section 3.5 of the TGD for WQMP and WAP*
If Yes, Provide basis: (attach)
[7] Any answer from Item 1 through Item 3 is "Yes": Yes ☐ No ☐ *If yes, infiltration of any volume is not feasible onsite. Proceed to Form 4.3-4, Selection and Evaluation of Biotreatment BMP.* *If no, then proceed to Item 8 below.* [8] Any answer from Item 4 through Item 6 is "Yes": Yes ☐ No ☐ *If yes, infiltration is permissible but is not required to be considered. Proceed to Form 4.3-2, Site Design BMP.* *If no, then proceed to Item 9, below.* [9] All answers to Item 1 through Item 6 are "No": *Infiltration of the full DCV is potentially feasible, LID infiltration BMP must be designed to infiltrate the full DCV to the MEP.* *Proceed to Form 4.3-2, Site Design BMPs.*

4.3.2 Site Design BMP

Section E.12.e. of the Small Phase II MS4 Permit emphasizes the use of LID preventative measures; and the use of Site Design Measures reduces the portion of the DCV that must be addressed in downstream BMPs. Therefore, all applicable Site Design Measures shall be provided except where they are mutually exclusive

with each other, or with other BMPs. Mutual exclusivity may result from overlapping BMP footprints such that either would be potentially feasible by itself, but both could not be implemented. Please note that while there are no numeric standards regarding the use of Site Design BMPs. If a project cannot feasibly meet BMP sizing requirements or cannot fully address hydromodification, feasibility of all applicable Site Design BMPs must be part of demonstrating that the BMP system has been designed to retain the maximum feasible portion of the DCV. Complete Form 4.3-2 to identify and calculate estimated retention volume from implementing site design BMP. Refer to Section 5.4 in the TGD for more detailed guidance.

Form 4.3-2 Site Design BMPs (DA 1)

1 Implementation of Impervious Area Dispersion BMP (i.e. routing runoff from impervious to pervious areas), excluding impervious areas planned for routing to on-lot infiltration BMP: Yes ☐ No ☒ *If yes, complete Items 2-5; If no, proceed to Item 6*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
2 Total impervious area draining to pervious area (ft^2)			
3 Ratio of pervious area receiving runoff to impervious area			
4 Retention volume achieved from impervious area dispersion (ft^3) *V = Item2 * Item 3 * (0.5/12), assuming retention of 0.5 inches of runoff*			
5 Sum of retention volume achieved from impervious area dispersion (ft^3):	$V_{retention}$ *=Sum of Item 4 for all BMPs*		
6 Implementation of Localized On-lot Infiltration BMPs (e.g. on-lot rain gardens): Yes ☐ No ☒ *If yes, complete Items 7-13 for aggregate of all on-lot infiltration BMP in each DA; If no, proceed to Item 14*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
7 Ponding surface area (ft^2)			
8 Ponding depth (ft) (min. 0.5 ft.)			
9 Surface area of amended soil/gravel (ft^2)			
10 Average depth of amended soil/gravel (ft) (min. 1 ft.)			
11 Average porosity of amended soil/gravel			
12 Retention volume achieved from on-lot infiltration (ft^3) $V_{retention}$ *= (Item 7 *Item 8) + (Item 9 * Item 10 * Item 11)*			
13 Runoff volume retention from on-lot infiltration (ft^3):	$V_{retention}$ *=Sum of Item 12 for all BMPs*		

Form 4.3-2 Site Design BMPs (DA 1)

Form 4.3-2 cont. Site Design BMPs (DA 1)

14 Implementation of Street Trees: Yes ☐ No ☒ *If yes, complete Items 14-18. If no, proceed to Item 19*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
15 Number of Street Trees			
16 Average canopy cover over impervious area (ft^2)			
17 Runoff volume retention from street trees (ft^3) $V_{retention}$ *= Item 15 * Item 16 * (0.05/12) assume runoff retention of 0.05 inches*			
18 Runoff volume retention from street tree BMPs (ft^3):	$V_{retention}$ *= Sum of Item 17 for all BMPs*		
19 Total Retention Volume from Site Design BMPs:	*Sum of Items 5, 13 and 18*		

4.3.3 Infiltration BMPs

Use Form 4.3-3 to compute on-site retention of runoff from proposed retention and infiltration BMPs. Volume retention estimates are sensitive to the percolation rate used, which determines the amount of runoff that can be infiltrated within the specified drawdown time. The infiltration safety factor reduces field measured percolation to account for potential inaccuracy associated with field measurements, declining BMP performance over time, and compaction during construction. Appendix C of the TGD for WQMP provides guidance on estimating an appropriate safety factor to use in Form 4.3-3.

If site constraints limit the use of BMPs to a single type and implementation of retention and infiltration BMPs mitigate no more than 40% of the DCV, then they are considered infeasible and the Project Proponent may evaluate the effectiveness of BMPs lower in the LID hierarchy of use (Section 5.5 of the TGD for WQMP)

If implementation of infiltrations BMPs is feasible as determined using Form 4.3-1, then LID infiltration BMPs shall be implemented to the MEP (section 4.1 of the TGD for WQMP).

4.3.3.1 Allowed Variations for Special Site Conditions

The bioretention system design parameters of this Section may be adjusted for the following special site conditions:

1) Facilities located within 10 feet of structures or other potential geotechnical hazards established by the geotechnical expert for the project may incorporate an impervious cutoff wall between the bioretention facility and the structure or other geotechnical hazard.

2) Facilities with documented high concentrations of pollutants in underlying soil or groundwater, facilities located where infiltration could contribute to a geotechnical hazard, and facilities located on elevated plazas or other structures may incorporate an impervious liner and may locate the underdrain discharge at the bottom of the subsurface drainage/storage layer (this configuration is commonly known as a “flow-through planter”).

3) Facilities located in areas of high groundwater, highly infiltrative soils or where connection of underdrain to a surface drain or to a subsurface storm drain are infeasible, may omit the underdrain.

4) Facilities serving high-risk areas such as fueling stations, truck stops, auto repairs, and heavy industrial sites may be required to provide adequate pretreatment to address pollutants of concern unless these high-risk areas are isolated from storm water runoff or bioretention areas with no chance of spill migration.

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Form 4.3-3 Infiltration LID BMP - including underground BMPs (DA 1)

1 Remaining LID DCV not met by site design BMP (ft^3): 10,045.28 *V_{unmet} = Form 4.2-1 Item 7 - Form 4.3-2 Item19*			
BMP Type *Use columns to the right to compute runoff volume retention from proposed infiltration BMP (select BMP from Table 5-4 in TGD for WQMP) - Use additional forms for more BMPs*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
2 Infiltration rate of underlying soils (in/hr) *See Section 5.4.2 and Appendix C of the TGD for WQMP for minimum requirements for assessment methods*			
3 Infiltration safety factor *See TGD Section 5.4.2 and Appendix D*			
4 Design percolation rate (in/hr) *P_{design} = Item 2 / Item 3*			
5 Ponded water drawdown time (hr) *Copy Item 6 in Form 4.2-1*			
6 Maximum ponding depth (ft) *BMP specific, see Table 5-4 of the TGD for WQMP for BMP design details*			
7 Ponding Depth (ft) *d_{BMP} = Minimum of (1/12*Item 4*Item 5) or Item 6*			
8 Infiltrating surface area, SA_{BMP} (ft^2) *the lesser of the area needed for infiltration of full DCV or minimum space requirements from Table 5.7 of the TGD for WQMP*	128		
9 Amended soil depth, d_{media} (ft) *Only included in certain BMP types, see Table 5-4 in the TGD for WQMP for reference to BMP design details*			
10 Amended soil porosity			
11 Gravel depth, d_{media} (ft) *Only included in certain BMP types, see Table 5-4 of the TGD for WQMP for BMP design details*			
12 Gravel porosity			
13 Duration of storm as basin is filling (hrs) *Typical ~ 3hrs*			
14 Above Ground Retention Volume (ft^3) *$V_{retention}$ = Item 8 * [Item7 + (Item 9 * Item 10) + (Item 11 * Item 12) + (Item 13 * (Item 4 / 12))]*			
15 Underground Retention Volume (ft^3) *Volume determined using manufacturer's specifications and calculations*			
16 Total Retention Volume from LID Infiltration BMPs: *(Sum of Items 14 and 15 for all infiltration BMP included in plan)*			
17 Fraction of DCV achieved with infiltration BMP: % *Retention% = Item 16 / Form 4.2-1 Item 7*			
18 Is full LID DCV retained onsite with combination of hydrologic source control and LID retention/infiltration BMPs? Yes ☐ No ☐ *If yes, demonstrate conformance using Form 4.3-10; If no, then reduce Item 3, Factor of Safety to 2.0 and increase Item 8, Infiltrating Surface Area, such that the portion of the site area used for retention and infiltration BMPs equals or exceeds the minimum effective area thresholds (Table 5-7 of the TGD for WQMP) for the applicable category of development and repeat all above calculations.*			

4.3.4 Biotreatment BMP

Biotreatment BMPs may be considered if the full LID DCV cannot be met by maximizing retention and infiltration. A key consideration when using biotreatment BMP is the effectiveness of the proposed BMP in addressing the pollutants of concern for the project (see Table 5-5 of the TGD for WQMP).

Use Form 4.3-4 to summarize the potential for volume based and/or flow based biotreatment options to biotreat the remaining unmet LID DCV. Biotreatment computations are included as follows:

- Use Form 4.3-5 to compute biotreatment in small volume based biotreatment BMP (e.g. bioretention w/underdrains);
- Use Form 4.3-6 to compute biotreatment in large volume based biotreatment BMP (e.g. constructed wetlands);
- Use Form 4.3-7 to compute sizing criteria for flow-based biotreatment BMP (e.g. bioswales)

Form 4.3-4 Selection and Evaluation of Biotreatment BMP (DA 1)

1 Remaining LID DCV not met by site design , or infiltration, BMP for potential biotreatment (ft^3): 10045.28 *Form 4.2-1 Item 7 - Form 4.3-2 Item 19 – Form 4.3-3 Item 16*	List pollutants of concern *Copy from Form 2.3-1.* Pathogens, nutrients-phosphorous, nutrients - nitrogen, sediment, metals, oil and grease, trash/debris, presticides/herbicides, organic compunds	
2 Biotreatment BMP Selected *(Select biotreatment BMP(s) necessary to ensure all pollutants of concern are addressed through Unit Operations and Processes, described in Table 5-5 of the TGD for WQMP)*	Volume-based biotreatment *Use Forms 4.3-5 and 4.3-6 to compute treated volume*	Flow-based biotreatment *Use Form 4.3-7 to compute treated flow*
	☐ Bioretention with underdrain ☐ Planter box with underdrain ☐ Constructed wetlands ☐ Wet extended detention ☐ Dry extended detention	☐ Vegetated swale ☐ Vegetated filter strip ☒ Proprietary biotreatment
3 Volume biotreated in volume based biotreatment BMP (ft^3): *Form 4.3-5 Item 15 + Form 4.3-6 Item 13*	**4** Compute remaining LID DCV with implementation of volume based biotreatment BMP (ft^3): *Item 1 – Item 3*	**5** Remaining fraction of LID DCV for sizing flow based biotreatment BMP: % *Item 4 / Item 1*
6 Flow-based biotreatment BMP capacity provided (cfs): 0.054 *Use Figure 5-2 of the TGD for WQMP to determine flow capacity required to provide biotreatment of remaining percentage of unmet LID DCV (Item 5), for the project's precipitation zone (Form 3-1 Item 1)*		
7 Metrics for MEP determination: • Provided a WQMP with the portion of site area used for suite of LID BMP equal to minimum thresholds in Table 5-7 of the TGD for WQMP for the proposed category of development: ☐ *If maximized on-site retention BMPs is feasible for partial capture, then LID BMP implementation must be optimized to retain and infiltrate the maximum portion of the DCV possible within the prescribed minimum effective area. The remaining portion of the DCV shall then be mitigated using biotreatment BMP.*		

Form 4.3-5 Volume Based Biotreatment (DA 1) – Bioretention and Planter Boxes with Underdrains

Biotreatment BMP Type *(Bioretention w/underdrain, planter box w/underdrain, other comparable BMP)*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
1 Pollutants addressed with BMP *List all pollutant of concern that will be effectively reduced through specific Unit Operations and Processes described in Table 5-5 of the TGD for WQMP*			
2 Amended soil infiltration rate *Typical ~ 5.0*			
3 Amended soil infiltration safety factor *Typical ~ 2.0*			
4 Amended soil design percolation rate (in/hr) P_{design} *= Item 2 / Item 3*			
5 Ponded water drawdown time (hr) *Copy Item 6 from Form 4.2-1*			
6 Maximum ponding depth (ft) *see Table 5-6 of the TGD for WQMP for reference to BMP design details*			
7 Ponding Depth (ft) d_{BMP} *= Minimum of (1/12 * Item 4 * Item 5) or Item 6*			
8 Amended soil surface area (ft^2)			
9 Amended soil depth (ft) *see Table 5-6 of the TGD for WQMP for reference to BMP design details*			
10 Amended soil porosity, *n*			
11 Gravel depth (ft) *see Table 5-6 of the TGD for WQMP for reference to BMP design details*			
12 Gravel porosity, *n*			
13 Duration of storm as basin is filling (hrs) *Typical ~ 3hrs*			
14 Biotreated Volume (ft^3) $V_{biotreated}$ *= Item 8 * [(Item 7/2) + (Item 9 * Item 10) +(Item 11 * Item 12) + (Item 13 * (Item 4 / 12))]*			
15 Total biotreated volume from bioretention and/or planter box with underdrains BMP: *Sum of Item 14 for all volume-based BMPs included in this form*			

Form 4.3-6 Volume Based Biotreatment (DA 1) – Constructed Wetlands and Extended Detention

Biotreatment BMP Type *Constructed wetlands, extended wet detention, extended dry detention, or other comparable proprietary BMP. If BMP includes multiple modules (E.g. forebay and main basin), provide separate estimates for storage and pollutants treated in each module.*	DA DMA BMP Type		DA DMA BMP Type *(Use additional forms for more BMPs)*	
	Forebay	Basin	Forebay	Basin
1 Pollutants addressed with BMP forebay and basin *List all pollutant of concern that will be effectively reduced through specific Unit Operations and Processes described in Table 5-5 of the TGD for WQMP*				
2 Bottom width (ft)				
3 Bottom length (ft)				
4 Bottom area (ft^2) A_{bottom} = *Item 2 * Item 3*				
5 Side slope (ft/ft)				
6 Depth of storage (ft)				
7 Water surface area (ft^2) $A_{surface}$ =*(Item 2 + (2 * Item 5 * Item 6)) * (Item 3 + (2 * Item 5 * Item 6))*				
8 Storage volume (ft^3) *For BMP with a forebay, ensure fraction of total storage is within ranges specified in BMP specific fact sheets, see Table 5-6 of the TGD for WQMP for reference to BMP design details* V =*Item 6 / 3 * [Item 4 + Item 7 + (Item 4 * Item 7)^0.5]*				
9 Drawdown Time (hrs) *Copy Item 6 from Form 2.1*				
10 Outflow rate (cfs) Q_{BMP} = *(Item* $8_{forebay}$ *+ Item* 8_{basin}*) / (Item 9 * 3600)*				
11 Duration of design storm event (hrs)				
12 Biotreated Volume (ft^3) $V_{biotreated}$ = *(Item* $8_{forebay}$ *+ Item* 8_{basin}*) +(Item 10 * Item 11 * 3600)*				
13 Total biotreated volume from constructed wetlands, extended dry detention, or extended wet detention : *(Sum of Item 12 for all BMP included in plan)*				

Form 4.3-7 Flow Based Biotreatment (DA 1)

Biotreatment BMP Type *Vegetated swale, vegetated filter strip, or other comparable proprietary BMP*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
1 Pollutants addressed with BMP *List all pollutant of concern that will be effectively reduced through specific Unit Operations and Processes described in TGD Table 5-5*	debris, sediments, TSS, dissolved and particulate metals and nutrients including nitrogen and phosphorus species, bacteria, BOD, oxygen demanding substances, organic compounds and hydrocarbons		
2 Flow depth for water quality treatment (ft) *BMP specific, see Table 5-6 of the TGD for WQMP for reference to BMP design details*			
3 Bed slope (ft/ft) *BMP specific, see Table 5-6 of the TGD for WQMP for reference to BMP design details*			
4 Manning's roughness coefficient			
5 Bottom width (ft) b_w = *(Form 4.3-5 Item 6 * Item 4) / (1.49 * Item 2^1.67 * Item 3^0.5)*	8		
6 Side Slope (ft/ft) *BMP specific, see Table 5-6 of the TGD for WQMP for reference to BMP design details*			
7 Cross sectional area (ft^2) *A = (Item 5 * Item 2) + (Item 6 * Item 2^2)*			
8 Water quality flow velocity (ft/sec) *V = Form 4.3-5 Item 6 / Item 7*			
9 Hydraulic residence time (min) *Pollutant specific, see Table 5-6 of the TGD for WQMP for reference to BMP design details*			

10 Length of flow based BMP (ft) *L = Item 8 * Item 9 * 60*	16		
11 Water surface area at water quality flow depth (ft^2) *SA_{top} = (Item 5 + (2 * Item 2 * Item 6)) * Item 10*			

4.3.5 Conformance Summary

Complete Form 4.3-8 to demonstrate how on-site LID DCV is met with proposed site design, infiltration, and/or biotreatment BMP. The bottom line of the form is used to describe the basis for infeasibility determination for on-site LID BMP to achieve full LID DCV, and provides methods for computing remaining volume to be addressed in an alternative compliance plan. If the project has more than one outlet, then complete additional versions of this form for each outlet.

Form 4.3-8 Conformance Summary and Alternative Compliance Volume Estimate (DA 1)

1 Total LID DCV for the Project DA-1 (ft^3): 10045.28 *Copy Item 7 in Form 4.2-1*

2 On-site retention with site design BMP (ft^3): 0 *Copy Item18 in Form 4.3-2*

3 On-site retention with LID infiltration BMP (ft^3): *Copy Item 16 in Form 4.3-3*

4 On-site biotreatment with volume based biotreatment BMP (ft^3): *Copy Item 3 in Form 4.3-4*

5 Flow capacity provided by flow based biotreatment BMP (cfs): *Copy Item 6 in Form 4.3-4*

6 LID BMP performance criteria are achieved if answer to any of the following is "Yes":

- Full retention of LID DCV with site design or infiltration BMP: Yes ☐ No ☒
  If yes, sum of Items 2, 3, and 4 is greater than Item 1
- Combination of on-site retention BMPs for a portion of the LID DCV and volume-based biotreatment BMP that address all pollutants of concern for the remaining LID DCV: Yes ☐ No ☒
  If yes, a) sum of Items 2, 3, 4, and 5 is greater than Item 1, and Items 2, 3 and 4 are maximized; or b) Item 6 is greater than Form 4.3--5 Item 6 and Items 2, 3 and 4 are maximized
- On-site retention and infiltration is determined to be infeasible; therefore biotreatment BMP provides biotreatment for all pollutants of concern for full LID DCV: Yes ☐ No ☒
  If yes, Form 4.3-1 Items 7 and 8 were both checked yes

7 If the LID DCV is not achieved by any of these means, then the project may be allowed to develop an alternative compliance plan. Check box that describes the scenario which caused the need for alternative compliance:

- Combination of Site Design, retention and infiltration, , and biotreatment BMPs provide less than full LID DCV capture: ☐
  Checked yes if Form 4.3-4 Item 7is checked yes, Form 4.3-4 Item 6 is zero, and sum of Items 2, 3, 4, and 5 is less than Item 1. If so, apply water quality credits and calculate volume for alternative compliance, V_{alt} *= (Item 1 – Item 2 – Item 3 – Item 4 – Item 5) * (100 - Form 2.4-1 Item 2)%*

- Facilities, or a combination of facilities, of a different design than in Section E.12.e.(ii)(f) may be permitted if all of the following Phase II Small MS4 General Permit 2013-0001-DWQ 55 February 5, 2013 measures of equivalent effectiveness are demonstrated:
  1) Equal or greater amount of runoff infiltrated or evapotranspired; ☒
  2) Equal or lower pollutant concentrations in runoff that is discharged after biotreatment; ☒
  3) Equal or greater protection against shock loadings and spills; ☒
  4) Equal or greater accessibility and ease of inspection and maintenance. ☒

4.3.6 Hydromodification Control BMP

Use Form 4.3-9 to compute the remaining runoff volume retention, after Site Design BMPs are implemented, needed to address hydromodification, and the increase in time of concentration and decrease in peak runoff necessary to meet targets for protection of waterbodies with a potential hydromodification. Describe the proposed hydromodification treatment control BMP. Section 5.6 of the TGD for WQMP provides additional details on selection and evaluation of hydromodification control BMP.

Form 4.3-9 Hydromodification Control BMPs (DA 1)

1 Volume reduction needed for hydromodification performance criteria (ft^3): 12124.9 *(Form 4.2-2 Item 4 * 0.95) – Form 4.2-2 Item 1*	**2** On-site retention with site design and infiltration, BMP (ft^3): *Sum of Form 4.3-8 Items 2, 3, and 4. Evaluate option to increase implementation of on-site retention in Forms 4.3-2, 4.3-3, and 4.3-4 in excess of LID DCV toward achieving hydromodification volume reduction*
3 Remaining volume for hydromodification volume capture (ft^3): 12124.9 *Item 1 – Item 2*	**4** Volume capture provided by incorporating additional on-site BMPs (ft^3):

5 Is Form 4.2-2 Item 11 less than or equal to 5%: Yes ☐ No ☒

If yes, hydromodification performance criteria is achieved. If no, select one or more mitigation options below:

- Demonstrate increase in time of concentration achieved by proposed LID site design, LID BMP, and additional on-site BMP ☒
- Increase time of concentration by preserving pre-developed flow path and/or increase travel time by reducing slope and increasing cross-sectional area and roughness for proposed on-site conveyance facilities ☐

6 Form 4.2-2 Item 12 less than or equal to 5%: Yes ☐ No ☒

If yes, hydromodification performance criteria is achieved. If no, select one or more mitigation options below:

- Demonstrate reduction in peak runoff achieved by proposed LID site design, LID BMPs, and additional on-site retention BMPs ☒

4.4 Alternative Compliance Plan (if applicable)

Describe an alternative compliance plan (if applicable) for projects not fully able to infiltrate, or biotreat the DCV via on-site LID practices. A project proponent must develop an alternative compliance plan to address the remainder of the LID DCV. Depending on project type some projects may qualify for water quality credits that can be applied to reduce the DCV that must be treated prior to development of an alternative compliance plan (see Form 2.4-1, Water Quality Credits). Form 4.3-9 Item 8 includes instructions on how to apply water quality credits when computing the DCV that must be met through alternative compliance.

Alternative Designs — Facilities, or a combination of facilities, of a different design than in Permit Section E.12.e.(ii)(f) may be permitted if all of the following measures of equivalent effectiveness are demonstrated:

1) Equal or greater amount of runoff infiltrated or evapotranspired;

2) Equal or lower pollutant concentrations in runoff that is discharged after biotreatment;

3) Equal or greater protection against shock loadings and spills;

4) Equal or greater accessibility and ease of inspection and maintenance.

The Project Proponent will need to obtain written approval for an alternative design from the Lahontan Regional Water Board Executive Officer (see Section 6 of the TGD for WQMP).

Alternative Compliance

Due to site ocnstraints, the available footprint is insufficient to implement standard LID BMPs. As an alternative, an ADS underground detention system is proposed to retain a treatment volume of 12,150.44, which will discharge into a modular wetland system for treatment.

The modular wetland system is designed for a discharge flow rate of 0.054 cfs, meeting the minimum required treatment volume and flow rate of 10,045.28 cf and 0.054 cfs as calculated on Form 4.2-1 and Figure 5-2 of the TGD for WQMP.

Refer to Appendix B for the BMP locations and to Appendix G for systems specifications.

Section 5 Inspection and Maintenance Responsibility for Post Construction BMP

All BMPs included as part of the project WQMP are required to be maintained through regular scheduled inspection and maintenance (refer to Section 8, Post Construction BMP Requirements, in the TGD for WQMP). Fully complete Form 5-1 summarizing all BMP included in the WQMP. Attach additional forms as needed. The WQMP shall also include a detailed Operation and Maintenance Plan for all BMP and a Maintenance Agreement. The Maintenance Agreement must also be attached to the WQMP.

Note that at time of Project construction completion, the Maintenance Agreement must be completed, signed, notarized and submitted to the County Stormwater Department

Form 5-1 BMP Inspection and Maintenance (use additional forms as necessary)

BMP	Reponsible Party(s)	Inspection/ Maintenance Activities Required	Minimum Frequency of Activities
Proprietay Biotreatment Unit	Property Owner	Refer to manufacturer's maintenance recommendations for additional detail.	Inspected minimum of every five years. Inspection process per manufacturer maintenance recommendations.
Catch Basin	Property Owner	New basins within the southeastern and southwestern corners of the drive-through lane. An existing basin east of the proposed trash enclosure. Flow is pretreated by the modular wetland downstream of the detention basin. Prior visual inspections, prepare documentation of issues and resolutions for review by appropriate parties. After major maintenance, document major maintenance activities. Ensure to take photographs before and after from the same vantage point.	Perform visual inspections of inlets and outlets and remove accumulated sediment four times per year during wet season, including inspection just before the wet season. Repair structural damage to inlets and outlets as needed.

Proprietay Detention Device	Property Owner	Refer to manufacturer's maintenance recommendations for additional detail.	Inspected minimum of every five years. Inspection process per manufacturer maintenance recommendations.

Section 6 WQMP Attachments

6.1. Site Plan and Drainage Plan

Include a site plan and drainage plan sheet set containing the following minimum information:

- Project location
- Site boundary
- Land uses and land covers, as applicable
- Suitability/feasibility constraints
- Structural Source Control BMP locations
- Site Design Hydrologic Source Control BMP locations
- LID BMP details
- Drainage delineations and flow information
- Drainage connections

6.2 Electronic Data Submittal

Minimum requirements include submittal of PDF exhibits in addition to hard copies. Format must not require specialized software to open. If the local jurisdiction requires specialized electronic document formats (as described in their Local Implementation Plan), this section will describe the contents (e.g., layering, nomenclature, geo-referencing, etc.) of these documents so that they may be interpreted efficiently and accurately.

6.3 Post Construction

Attach all O&M Plans and Maintenance Agreements for BMP to the WQMP.

6.4 Other Supporting Documentation

- BMP Educational Materials
- Activity Restriction – C,C&R's & Lease Agreements

Appendix A

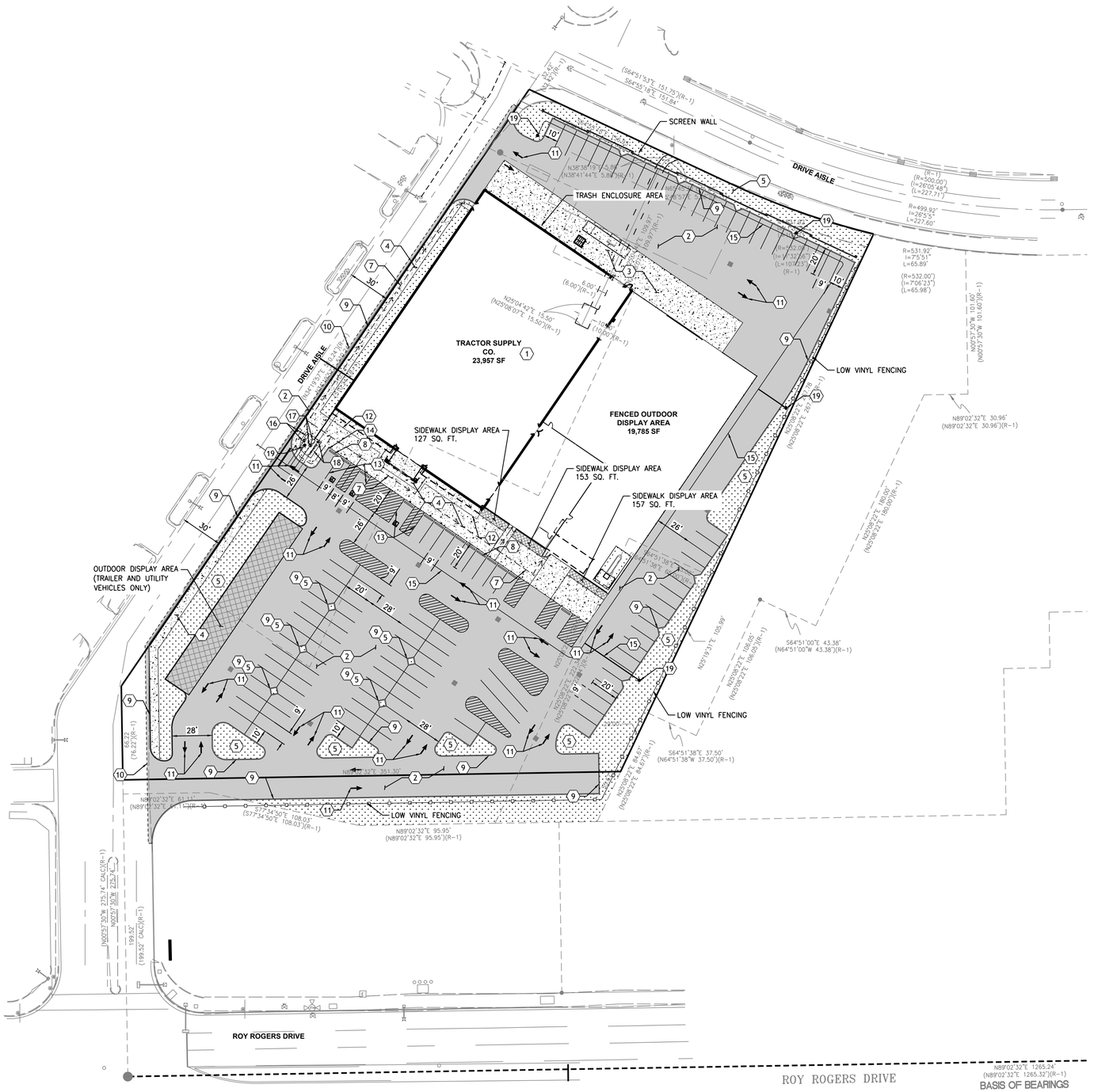


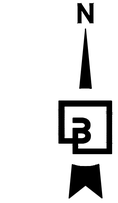
VICINITY MAP

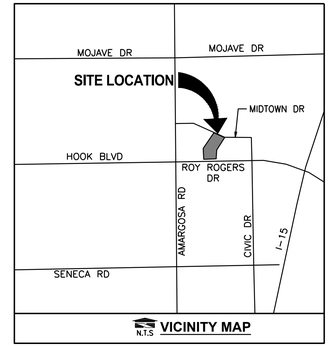
Appendix B

Know what's **below.**
Call before you dig.
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TRACTOR SUPPLY CO. - CITY OF VICTORVILLE, CA
PRELIMINARY SITE PLAN







CONSTRUCTION NOTES:

1. PROPOSED TRACTOR SUPPLY COMPANY BUILDING (TYPE 2 - TILT-UP/SLAB CONSTRUCTION)
2. PROPOSED ASPHALT PAVEMENT.
3. PROPOSED CONCRETE PAVEMENT.
4. PROPOSED CONCRETE SIDEWALK (WIDTH VARIES), TYP.
5. PROPOSED LANDSCAPE AREA, TYP.
6. PROPOSED BOLLARD, TYP.
7. ACCESSIBLE PATH, TYPICAL.
8. PROPOSED WHEEL STOP, TYP.
9. PROPOSED BARRIER CURB, TYP.
10. PROPOSED SAWCUT LIMIT.
11. PROPOSED PAVEMENT MARKING, TYPICAL.
12. PROPOSED AWNING.
13. PROPOSED ADA ACCESSIBLE PARKING SPACE.
14. PROPOSED FLUSH CURB.
15. PROPOSED 8" WATER MAIN
16. PROPOSED METER AND BACKFLOW PREVENTION ASSEMBLY FOR IRRIGATION SERVICE.
17. PROPOSED METER AND BACKFLOW PREVENTION ASSEMBLY FOR DOMESTIC WATER SERVICE.
18. PROPOSED FIRE WATER SERVICE.
19. PROPOSED FIRE HYDRANT.

PROJECT DATA

NAME: TRACTOR SUPPLY CO. - VICTORVILLE, CA

ADDRESS: 15000 ROY ROGERS DRIVE, VICTORVILLE, CA

APN: PARCEL 1: 3106-201-20-0-000
PARCEL 2: 3106-201-21-0-000
PARCEL 3: 3106-201-22-0-000

PROJECT AREA: 158,194 SF (3.63 ACRES)

ZONE: GENERAL COMMERCIAL (C-2)

PROPOSED GROUND COVER SUMMARY:

BUILDINGS:	23,957 SF	(15.1%)
PAVING (CONCRETE, ASPHALT, CURBS):	114,499 SF	(72.4%)
LANDSCAPE:	19,738 SF	(12.5%)
	158,194 SF	(100.0%)

PARKING CALCULATION

TOTAL BUILDING AREA = 23,957 SQ. FT.

PARKING REQUIREMENT = 1 SPACE/200 SQ. FT.

PARKING REQUIRED = 23,957/200 = 120 SPACES

PARKING PROVIDED = 120 SPACES

STANDARD PARKING STALL = 9'X20'

SIDEWALK DISPLAY AREA:

BUILDING AREA:	43,742 SQ. FT
ALLOWED DISPLAY AREA:	1 SQ. FT/100 SQ. FT
SIDEWALK DISPLAY AREA ALLOWED:	437 SQ. FT
SIDEWALK DISPLAY AREA PROVIDED:	437 SQ. FT

SHEET LIST TABLE

SHEET NUMBER	SHEET TITLE
C1.0	PRELIMINARY SITE PLAN
C2.0	PRELIMINARY GRADING AND DRAINAGE PLAN
C2.1	EXISTING DRAINAGE CONDITIONS
C3.0	DEMOLITION AND EROSION CONTROL PLAN
C3.1	EROSION CONTROL DETAILS
C3.2	EROSION CONTROL DETAILS
1 OF 1	COLORED LANDSCAPE EXHIBIT

LEGEND

- BUILDING LINE
- EXISTING CURB TO REMAIN
- PROPOSED CURB
- PROPOSED LANDSCAPING
- PROPOSED ASPHALT
- PROPOSED CONCRETE
- PROPOSED SIDEWALK DISPLAY AREA

Title: PRELIMINARY SITE PLAN
15000 ROY ROGERS DRIVE
CITY OF VICTORVILLE, CA

For: **DURBAN DEVELOPMENT**

HAL P. BARGHAUSEN
72814
CIVIL
STATE OF CALIFORNIA
Not for Construction

Scale: Horizontal N/A Vertical N/A

Designed PJB Drawn PJB Checked MFL Approved HPG Date 7/17/25

Barghausen Consulting Engineers, LLC.
18215 72nd Avenue South
Kent, WA 98032
425.251.6222
barghausen.com

Job Number **23964**
Sheet C1.0

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Know what's **below.**
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TRACTOR SUPPLY CO. - CITY OF VICTORVILLE, CA
PRELIMINARY GRADING AND DRAINAGE PLAN



0 15' 30' 60'
SCALE: 1"=30'

GRADING PLAN LEGEND:

FF - FINISHED FLOOR
ME - MATCH EXISTING
TP - TOP OF PAVEMENT
FSH - FLUSHED
SW - SIDEWALK

PROPOSED CONTOURS
EXISTING CONTOURS
DMA LIMITS

CONSTRUCTION NOTES:

1. PROPOSED 24"X24" CATCH BASIN.
2. PROPOSED CONTECH MODULAR WETLAND SYSTEM.
   FLOW RATE: 0.045 CFS
3. PROPOSED ADS DETENTION PIPE SYSTEM
   REQUIRED VOLUME: 12,124.90 CF
   DESIGN VOLUME: 12,150.44 CF
4. PROPOSED 12" STORM DRAIN PIPE AT A MINIMUM SLOPE OF 0.5%.
5. PROPOSED CONTROL STRUCTURE.
6. PROPOSED CONNECTION TO EXISTING STORM MAIN.

LEGEND

BUILDING LINE
EXISTING CURB TO REMAIN
PROPOSED CURB
PROPOSED LANDSCAPING
PROPOSED ASPHALT
PROPOSED CONCRETE

Title: PRELIMINARY GRADING AND DRAINAGE PLAN
15000 ROY ROGERS DRIVE
CITY OF VICTORVILLE, CA

For: **DURBAN DEVELOPMENT**

LICENSED PROFESSIONAL ENGINEER
HAL P. BARHAUSEN
No. 14814
Not for Construction
CIVIL
STATE OF CALIFORNIA

Scale: Horizontal 1" = 30' Vertical N/A

Designed PJB Drawn PJB Checked MTL Approved HPG Date 7/17/25

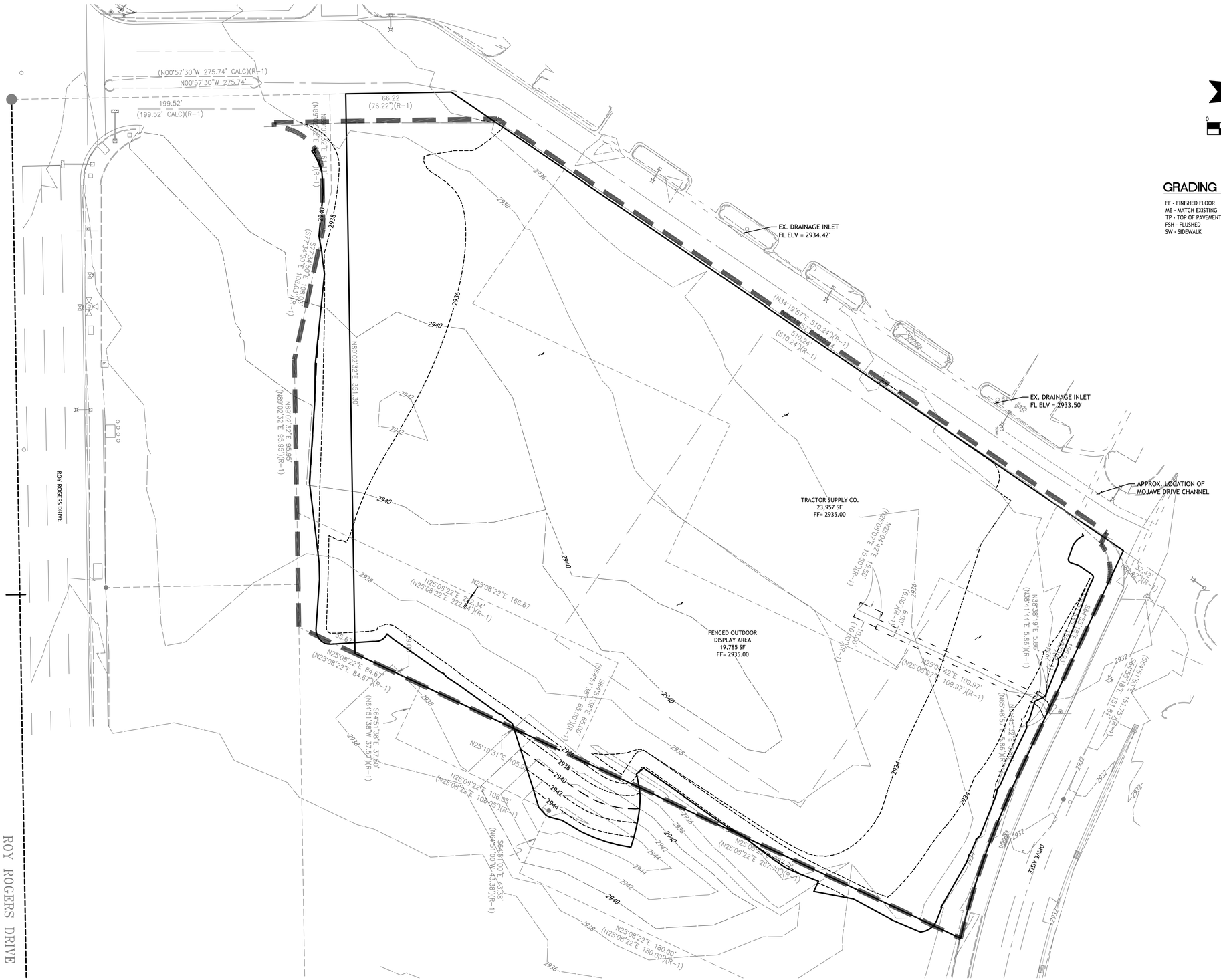
Barghausen Consulting Engineers, LLC.
18215 72nd Avenue South
Kent, WA 98032
425.251.6222 **barghausen.com**

Job Number **23964** Sheet C2.0

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TRACTOR SUPPLY CO. - CITY OF VICTORVILLE, CA
EXISTING DRAINAGE CONDITIONS



SCALE: 1"=30'

GRADING PLAN LEGEND:

FF - FINISHED FLOOR
ME - MATCH EXISTING
TP - TOP OF PAVEMENT
FSH - FLUSHED
SW - SIDEWALK

PROPOSED CONTOURS
EXISTING CONTOURS
DMA LIMITS

LEGEND

- BUILDING LINE
- EXISTING CURB TO REMAIN
- PROPOSED CURB
- PROPOSED LANDSCAPING
- PROPOSED ASPHALT
- PROPOSED CONCRETE

Title: EXISTING DRAINAGE CONDITIONS
15000 ROY ROGERS DRIVE
CITY OF VICTORVILLE, CA

For: **DURBAN DEVELOPMENT**

LICENSED PROFESSIONAL ENGINEER
HAL P. BARBEE
No. 39814
Not for Construction
CIVIL
STATE OF CALIFORNIA

Scale: Horizontal 1" = 30' Vertical N/A

Designed PJB
Drawn PJB
Checked MTL
Approved HPG
Date 7/17/25

Barghausen Consulting Engineers, LLC.
18215 72nd Avenue South
Kent, WA 98032
425.251.6222 **barghausen.com**

Job Number **23964**
Sheet **C2.1**

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Appendix C

NOAA Atlas 14, Volume 6, Version 2
Location name: Victorville, California, USA*
Latitude: 34.5223°, Longitude: -117.3276°
Elevation: 2938 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**1.24** (1.02-1.51)	**1.68** (1.39-2.06)	**2.32** (1.90-2.84)	**2.86** (2.33-3.54)	**3.65** (2.88-4.68)	**4.31** (3.34-5.63)	**5.02** (3.78-6.72)	**5.80** (4.25-7.97)	**6.92** (4.87-9.92)	**7.86** (5.34-11.7)
10-min	**0.882** (0.732-1.08)	**1.21** (0.996-1.48)	**1.66** (1.36-2.03)	**2.05** (1.67-2.54)	**2.62** (2.06-3.35)	**3.09** (2.39-4.04)	**3.59** (2.71-4.81)	**4.15** (3.05-5.71)	**4.96** (3.49-7.11)	**5.63** (3.83-8.36)
15-min	**0.712** (0.588-0.872)	**0.972** (0.800-1.19)	**1.34** (1.10-1.64)	**1.65** (1.35-2.04)	**2.11** (1.67-2.70)	**2.49** (1.92-3.26)	**2.90** (2.19-3.88)	**3.35** (2.46-4.61)	**4.00** (2.82-5.74)	**4.54** (3.09-6.74)
30-min	**0.476** (0.392-0.582)	**0.648** (0.534-0.794)	**0.890** (0.732-1.09)	**1.10** (0.898-1.36)	**1.41** (1.11-1.80)	**1.66** (1.28-2.17)	**1.93** (1.46-2.59)	**2.23** (1.64-3.07)	**2.67** (1.88-3.82)	**3.03** (2.06-4.49)
60-min	**0.276** (0.228-0.338)	**0.376** (0.310-0.461)	**0.517** (0.425-0.635)	**0.639** (0.522-0.792)	**0.817** (0.645-1.05)	**0.964** (0.745-1.26)	**1.12** (0.847-1.50)	**1.30** (0.951-1.78)	**1.55** (1.09-2.22)	**1.76** (1.20-2.61)
2-hr	**0.192** (0.158-0.235)	**0.256** (0.211-0.314)	**0.346** (0.284-0.425)	**0.423** (0.345-0.524)	**0.533** (0.421-0.683)	**0.623** (0.482-0.815)	**0.719** (0.542-0.963)	**0.823** (0.604-1.13)	**0.971** (0.684-1.39)	**1.09** (0.743-1.62)
3-hr	**0.151** (0.125-0.185)	**0.201** (0.166-0.247)	**0.270** (0.222-0.332)	**0.329** (0.268-0.407)	**0.412** (0.325-0.527)	**0.479** (0.370-0.627)	**0.551** (0.415-0.737)	**0.627** (0.460-0.863)	**0.735** (0.518-1.06)	**0.824** (0.560-1.22)
6-hr	**0.102** (0.084-0.125)	**0.135** (0.112-0.166)	**0.181** (0.149-0.222)	**0.219** (0.179-0.271)	**0.273** (0.215-0.349)	**0.315** (0.244-0.412)	**0.360** (0.272-0.482)	**0.407** (0.299-0.561)	**0.474** (0.334-0.680)	**0.527** (0.359-0.783)
12-hr	**0.064** (0.053-0.079)	**0.086** (0.071-0.106)	**0.116** (0.095-0.143)	**0.141** (0.115-0.174)	**0.174** (0.137-0.223)	**0.201** (0.155-0.262)	**0.228** (0.172-0.305)	**0.256** (0.188-0.353)	**0.295** (0.208-0.424)	**0.326** (0.222-0.484)
24-hr	**0.041** (0.037-0.048)	**0.057** (0.050-0.065)	**0.077** (0.068-0.089)	**0.093** (0.082-0.109)	**0.115** (0.098-0.139)	**0.133** (0.110-0.163)	**0.150** (0.122-0.189)	**0.168** (0.133-0.218)	**0.193** (0.146-0.261)	**0.213** (0.155-0.297)
2-day	**0.023** (0.020-0.027)	**0.032** (0.029-0.037)	**0.044** (0.039-0.051)	**0.054** (0.047-0.063)	**0.068** (0.057-0.082)	**0.078** (0.065-0.096)	**0.089** (0.072-0.112)	**0.100** (0.079-0.130)	**0.116** (0.087-0.156)	**0.128** (0.093-0.179)
3-day	**0.017** (0.015-0.019)	**0.023** (0.021-0.027)	**0.032** (0.029-0.037)	**0.040** (0.035-0.046)	**0.050** (0.042-0.060)	**0.058** (0.048-0.071)	**0.066** (0.053-0.083)	**0.075** (0.059-0.097)	**0.086** (0.065-0.117)	**0.096** (0.070-0.134)
4-day	**0.013** (0.012-0.015)	**0.019** (0.016-0.022)	**0.026** (0.023-0.030)	**0.032** (0.028-0.037)	**0.040** (0.034-0.048)	**0.046** (0.038-0.057)	**0.053** (0.043-0.066)	**0.059** (0.047-0.077)	**0.069** (0.052-0.093)	**0.076** (0.055-0.106)
7-day	**0.008** (0.007-0.009)	**0.011** (0.010-0.013)	**0.015** (0.014-0.018)	**0.019** (0.016-0.022)	**0.024** (0.020-0.028)	**0.027** (0.022-0.034)	**0.031** (0.025-0.039)	**0.035** (0.027-0.045)	**0.040** (0.030-0.054)	**0.044** (0.032-0.062)
10-day	**0.006** (0.005-0.007)	**0.008** (0.007-0.009)	**0.011** (0.010-0.013)	**0.014** (0.012-0.016)	**0.017** (0.014-0.021)	**0.020** (0.016-0.024)	**0.022** (0.018-0.028)	**0.025** (0.019-0.032)	**0.028** (0.021-0.039)	**0.031** (0.023-0.044)
20-day	**0.003** (0.003-0.004)	**0.004** (0.004-0.005)	**0.006** (0.006-0.007)	**0.008** (0.007-0.009)	**0.010** (0.008-0.012)	**0.011** (0.009-0.014)	**0.013** (0.010-0.016)	**0.014** (0.011-0.019)	**0.017** (0.012-0.023)	**0.018** (0.013-0.026)
30-day	**0.002** (0.002-0.003)	**0.003** (0.003-0.004)	**0.005** (0.004-0.006)	**0.006** (0.005-0.007)	**0.008** (0.006-0.009)	**0.009** (0.007-0.011)	**0.010** (0.008-0.013)	**0.012** (0.009-0.015)	**0.013** (0.010-0.018)	**0.015** (0.011-0.021)
45-day	**0.002** (0.001-0.002)	**0.002** (0.002-0.003)	**0.004** (0.003-0.004)	**0.005** (0.004-0.005)	**0.006** (0.005-0.007)	**0.007** (0.006-0.009)	**0.008** (0.007-0.011)	**0.010** (0.008-0.013)	**0.012** (0.009-0.016)	**0.013** (0.009-0.018)
60-day	**0.001** (0.001-0.001)	**0.002** (0.002-0.002)	**0.003** (0.003-0.003)	**0.004** (0.003-0.005)	**0.005** (0.004-0.006)	**0.006** (0.005-0.008)	**0.007** (0.006-0.009)	**0.008** (0.007-0.011)	**0.010** (0.008-0.014)	**0.012** (0.008-0.017)

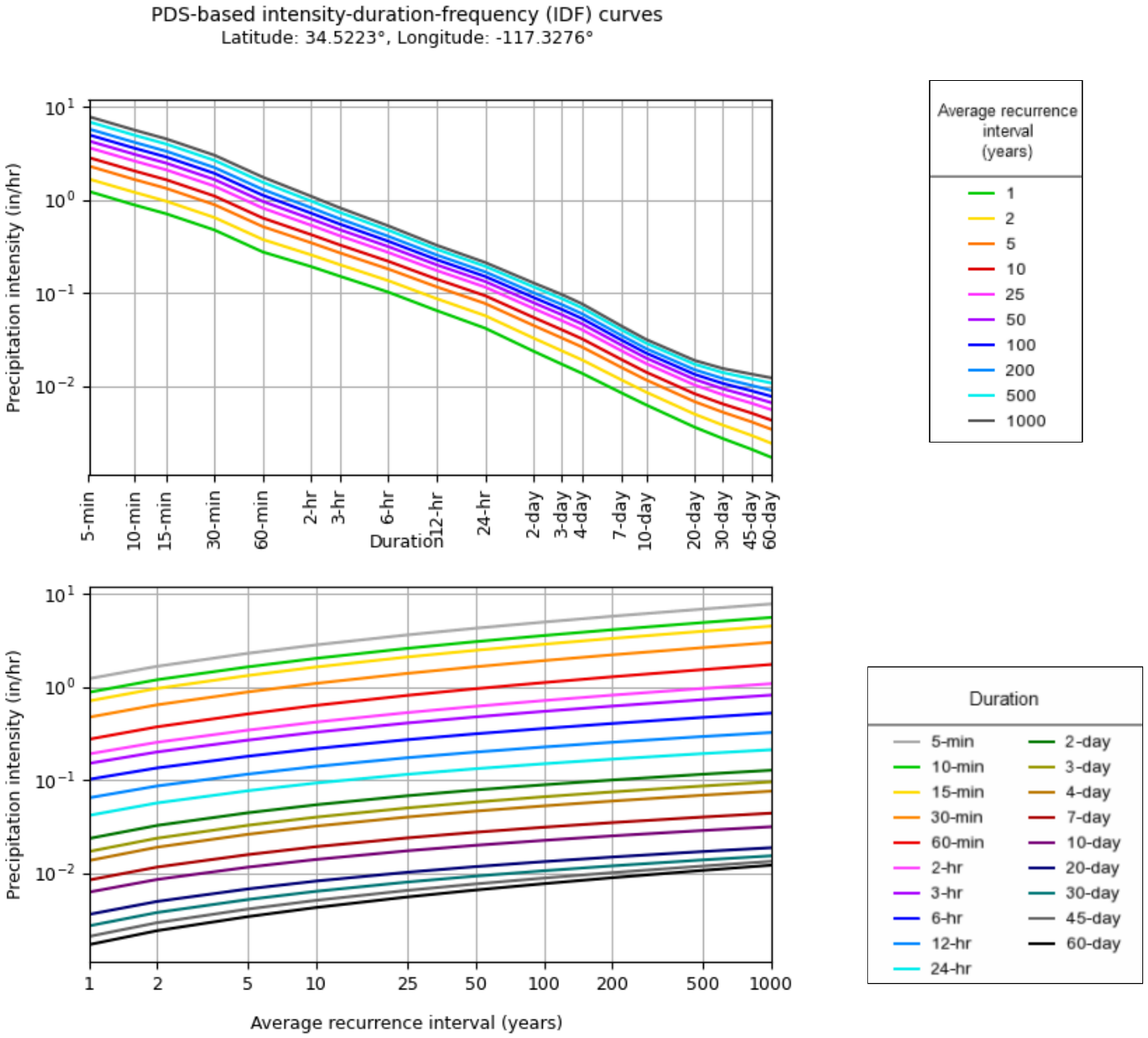
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

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PF graphical



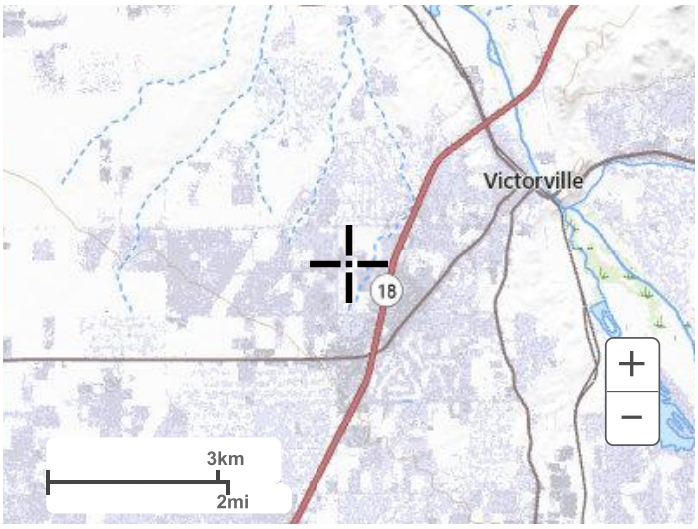
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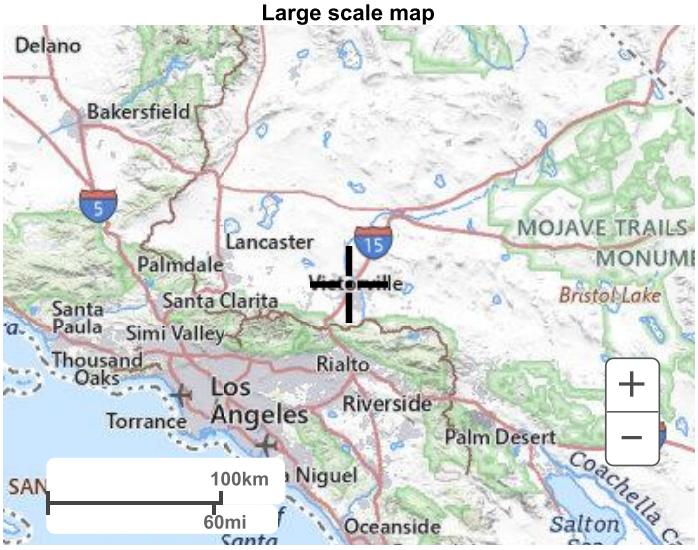
Small scale terrain



Large scale terrain



Large scale map



Large scale aerial



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National Weather Service
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Silver Spring, MD 20910
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NOAA Atlas 14, Volume 6, Version 2
Location name: Victorville, California, USA*
Latitude: 34.5223°, Longitude: -117.3276°
Elevation: 2938 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.103** (0.085-0.126)	**0.140** (0.116-0.172)	**0.193** (0.158-0.237)	**0.238** (0.194-0.295)	**0.304** (0.240-0.390)	**0.359** (0.278-0.469)	**0.418** (0.315-0.560)	**0.483** (0.354-0.664)	**0.577** (0.406-0.827)	**0.655** (0.445-0.972)
10-min	**0.147** (0.122-0.180)	**0.201** (0.166-0.246)	**0.276** (0.227-0.339)	**0.341** (0.278-0.423)	**0.436** (0.344-0.559)	**0.515** (0.398-0.673)	**0.599** (0.452-0.802)	**0.692** (0.508-0.952)	**0.826** (0.582-1.18)	**0.938** (0.639-1.39)
15-min	**0.178** (0.147-0.218)	**0.243** (0.200-0.298)	**0.334** (0.275-0.410)	**0.413** (0.337-0.511)	**0.528** (0.417-0.675)	**0.623** (0.481-0.814)	**0.725** (0.547-0.970)	**0.837** (0.614-1.15)	**0.999** (0.704-1.43)	**1.14** (0.772-1.68)
30-min	**0.238** (0.196-0.291)	**0.324** (0.267-0.397)	**0.445** (0.366-0.547)	**0.551** (0.449-0.682)	**0.704** (0.556-0.901)	**0.830** (0.642-1.08)	**0.967** (0.729-1.29)	**1.12** (0.819-1.54)	**1.33** (0.939-1.91)	**1.51** (1.03-2.25)
60-min	**0.276** (0.228-0.338)	**0.376** (0.310-0.461)	**0.517** (0.425-0.635)	**0.639** (0.522-0.792)	**0.817** (0.645-1.05)	**0.964** (0.745-1.26)	**1.12** (0.847-1.50)	**1.30** (0.951-1.78)	**1.55** (1.09-2.22)	**1.76** (1.20-2.61)
2-hr	**0.384** (0.317-0.470)	**0.513** (0.423-0.629)	**0.692** (0.569-0.850)	**0.846** (0.690-1.05)	**1.07** (0.842-1.37)	**1.25** (0.964-1.63)	**1.44** (1.08-1.93)	**1.65** (1.21-2.26)	**1.94** (1.37-2.79)	**2.19** (1.49-3.24)
3-hr	**0.456** (0.376-0.557)	**0.606** (0.499-0.742)	**0.812** (0.668-0.998)	**0.988** (0.806-1.22)	**1.24** (0.978-1.58)	**1.44** (1.11-1.88)	**1.66** (1.25-2.22)	**1.88** (1.38-2.59)	**2.21** (1.56-3.17)	**2.48** (1.68-3.67)
6-hr	**0.613** (0.506-0.750)	**0.814** (0.671-0.997)	**1.09** (0.893-1.33)	**1.32** (1.07-1.63)	**1.64** (1.29-2.09)	**1.89** (1.46-2.47)	**2.16** (1.63-2.89)	**2.44** (1.79-3.36)	**2.84** (2.00-4.07)	**3.16** (2.15-4.69)
12-hr	**0.781** (0.645-0.955)	**1.05** (0.864-1.28)	**1.40** (1.16-1.72)	**1.70** (1.39-2.10)	**2.10** (1.66-2.69)	**2.42** (1.87-3.16)	**2.75** (2.07-3.68)	**3.09** (2.27-4.26)	**3.56** (2.51-5.11)	**3.93** (2.68-5.84)
24-hr	**1.01** (0.892-1.16)	**1.37** (1.22-1.58)	**1.85** (1.64-2.14)	**2.25** (1.97-2.62)	**2.78** (2.36-3.35)	**3.20** (2.65-3.93)	**3.62** (2.93-4.56)	**4.05** (3.19-5.25)	**4.65** (3.51-6.28)	**5.11** (3.74-7.14)
2-day	**1.14** (1.01-1.31)	**1.57** (1.39-1.81)	**2.15** (1.90-2.48)	**2.62** (2.30-3.06)	**3.28** (2.78-3.94)	**3.78** (3.14-4.65)	**4.30** (3.48-5.42)	**4.84** (3.81-6.27)	**5.58** (4.22-7.54)	**6.16** (4.50-8.61)
3-day	**1.24** (1.10-1.42)	**1.72** (1.52-1.98)	**2.36** (2.09-2.73)	**2.90** (2.54-3.38)	**3.63** (3.08-4.37)	**4.20** (3.49-5.17)	**4.79** (3.88-6.04)	**5.41** (4.26-7.01)	**6.26** (4.73-8.45)	**6.93** (5.06-9.68)
4-day	**1.32** (1.17-1.52)	**1.84** (1.63-2.12)	**2.52** (2.23-2.92)	**3.09** (2.71-3.60)	**3.87** (3.28-4.66)	**4.48** (3.72-5.50)	**5.10** (4.13-6.42)	**5.75** (4.53-7.45)	**6.64** (5.02-8.97)	**7.35** (5.37-10.3)
7-day	**1.42** (1.26-1.64)	**1.96** (1.74-2.26)	**2.67** (2.36-3.09)	**3.25** (2.85-3.79)	**4.04** (3.42-4.86)	**4.65** (3.86-5.71)	**5.27** (4.27-6.63)	**5.90** (4.65-7.65)	**6.78** (5.12-9.15)	**7.46** (5.44-10.4)
10-day	**1.51** (1.34-1.74)	**2.07** (1.83-2.38)	**2.80** (2.47-3.23)	**3.39** (2.97-3.95)	**4.19** (3.55-5.05)	**4.81** (3.99-5.91)	**5.43** (4.40-6.84)	**6.07** (4.78-7.86)	**6.94** (5.24-9.37)	**7.61** (5.56-10.6)
20-day	**1.74** (1.54-2.00)	**2.40** (2.12-2.76)	**3.27** (2.88-3.77)	**3.97** (3.48-4.63)	**4.93** (4.18-5.94)	**5.67** (4.71-6.97)	**6.42** (5.20-8.09)	**7.20** (5.67-9.32)	**8.25** (6.23-11.1)	**9.06** (6.62-12.7)
30-day	**1.96** (1.74-2.26)	**2.74** (2.43-3.16)	**3.77** (3.33-4.36)	**4.63** (4.05-5.39)	**5.81** (4.92-6.99)	**6.73** (5.59-8.28)	**7.68** (6.23-9.68)	**8.68** (6.84-11.2)	**10.0** (7.60-13.6)	**11.1** (8.13-15.5)
45-day	**2.26** (2.01-2.61)	**3.19** (2.83-3.68)	**4.46** (3.94-5.16)	**5.55** (4.86-6.46)	**7.08** (6.00-8.53)	**8.32** (6.90-10.2)	**9.62** (7.79-12.1)	**11.0** (8.67-14.3)	**13.0** (9.80-17.5)	**14.5** (10.6-20.3)
60-day	**2.47** (2.19-2.84)	**3.49** (3.09-4.02)	**4.94** (4.36-5.71)	**6.20** (5.43-7.22)	**8.03** (6.80-9.67)	**9.54** (7.92-11.7)	**11.2** (9.05-14.1)	**12.9** (10.2-16.8)	**15.5** (11.7-20.9)	**17.6** (12.9-24.7)

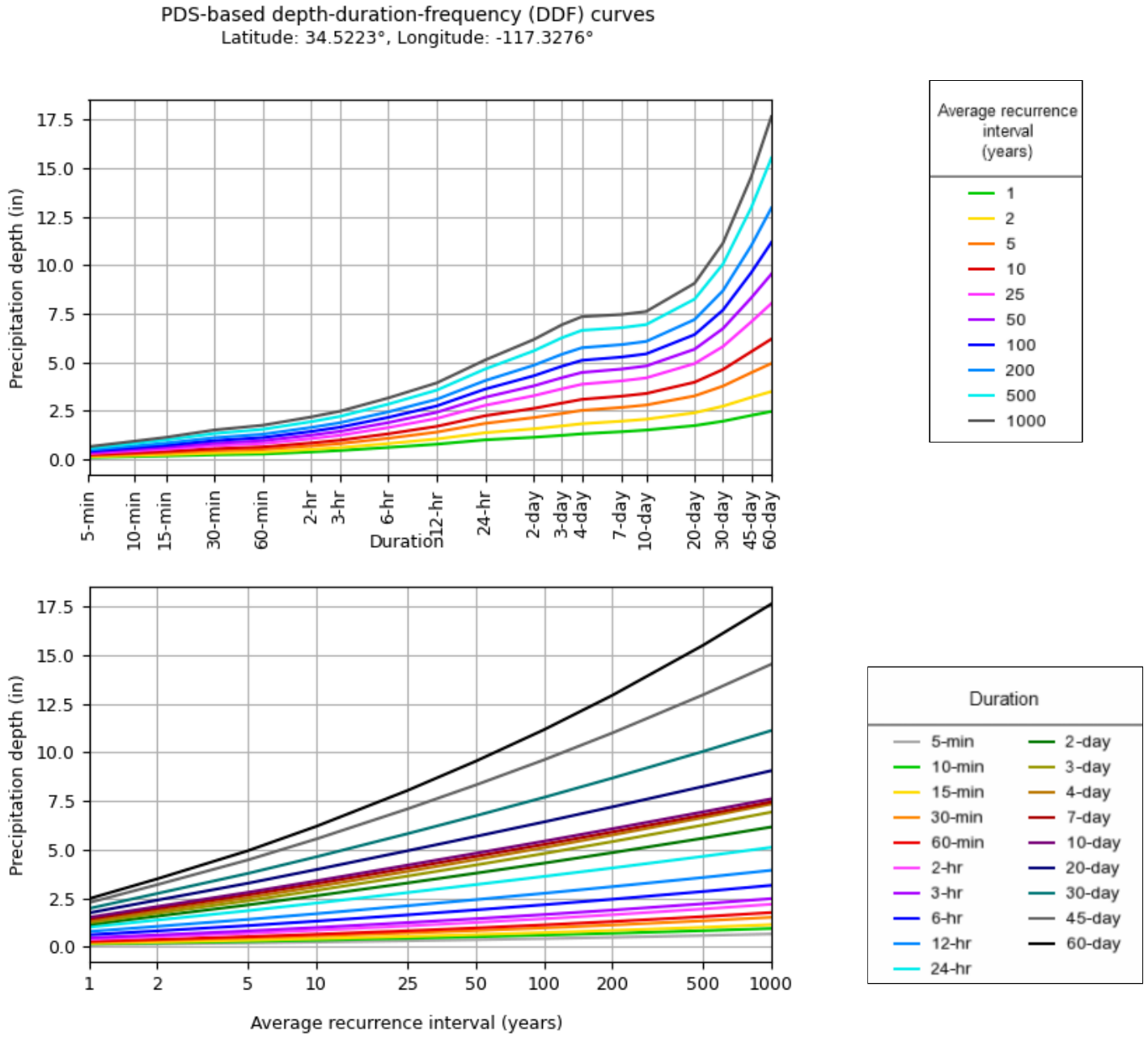
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

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PF graphical



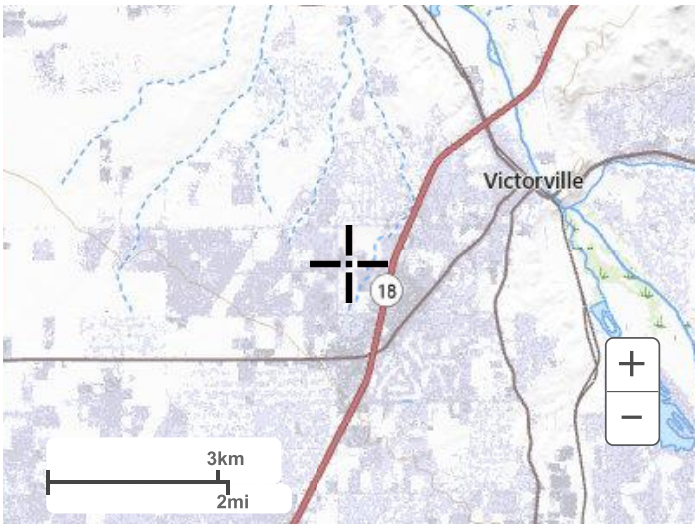
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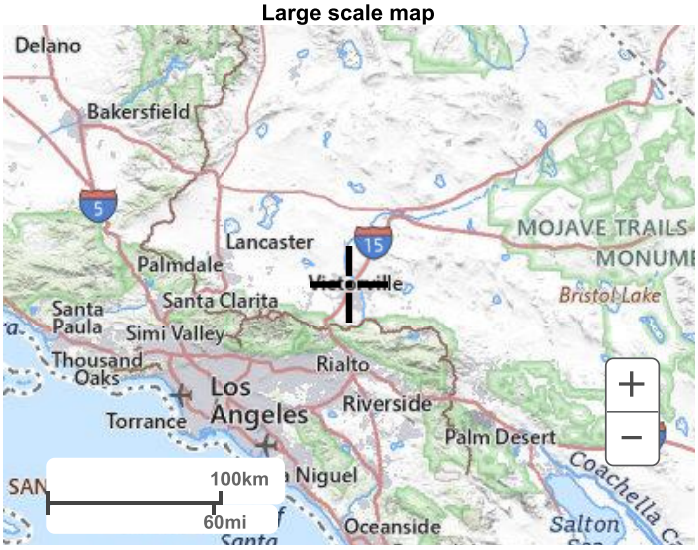
Small scale terrain



Large scale terrain



Large scale map



Large scale aerial



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Appendix D

Figure ADD-1
Antecedent Moisture Condition (AMC)

5-day Rainfall - NOAA Atlas 14
(50% of Total Rainfall Prior to Peak)*

*1/2 (11-day - 1-day) =
1/2 (([10-day] + (1/10 ([20-day] - [10-day]))) - [1-day])

5 0 5 10 15
Miles

N
W E
S

Growing Season
- AMC I
- AMC II
- AMC III

APPROXIMATE LOCATION OF SITE. AMC III

STATE HWY 127
I-15
US HWY 395
I-40
STATE HWY 247
STATE HWY 62

Death Valley
Ridgecrest
Boron
Barstow
Adelanto
George AFB
George AFB
Victorville
Mountain View Acres
Hesperia
Wrightwood
Crestline
Lake Arrowhead
Running Springs
Big Bear City
Big Bear Lake
Claremont
Yucca Valley
Joshua Tree
Twentynine Palms
Morongo Valley
Needles
Parker Dam
Blythe

Developed weighted CN = 0.933

POOR: Heavily grazed or regularly burned areas. Less than 50 percent of the ground surface is protected by plant cover or brush and tree canopy.

FAIR: Moderate cover with 50 percent to 75 percent of the ground surface protected by vegetation.

GOOD: Heavy or dense cover with more than 75 percent of the ground surface protected by vegetation.

In most cases, watershed existing conditions cover type and quality can be readily determined by a field review of a watershed. In ultimate planned open spaces, the soil cover condition shall be considered as "good." Figure C-3 provides the CN values for various types and quality of ground cover. Impervious areas shall be assigned a CN of 98. It is noted that for ultimately developed conditions, the CN for urban landscaping (turf) is provided in Figure C-3.

C.4. WATERSHED DEVELOPMENT CONDITIONS

Ultimate development of the watershed should normally be assumed since watershed urbanization is reasonably likely within the expected life of most hydraulic facilities. Long range master plans for the County and incorporated cities should be reviewed to insure that reasonable land use assumptions are made for the ultimate development of the watershed. A field review shall also be made to confirm existing use and drainage patterns. Particular attention shall be paid to existing and proposed landscape practices, as it is common in some areas to use ornamental gravels underlain by impervious plastic materials in place of lawns and shrubs. Appropriate actual impervious percentages can then be selected from Figure C-4. It should be noted that the recommended values from these figures are for average conditions and, therefore, some adjustment for particular applications may be required.

Curve (1) Numbers of Hydrologic Soil-Cover Complexes For Pervious Areas-AMC II

Cover Type (3)	Quality of Cover (2)	Soil Group A	B	C	D
NATURAL COVERS -					
Barren (Rockland, eroded and graded land)		78	86	91	93
Chaparral, Broadleaf (Manzonita, ceanothus and scrub oak)	Poor	53	70	80	85
	Fair	40	63	75	81
	Good	31	57	71	78
Chaparral, Narrowleaf (Chamise and redshank)	Poor	71	82	88	91
	Fair	55	72	81	86
Grass, Annual or Perennial	Poor	67	78	86	89
	Fair	50	69	79	84
	Good	38	61	74	80
Meadows or Cienegas (Areas with seasonally high water table, principal vegetation is sod forming grass)	Poor	63	77	85	88
	Fair	51	70	80	84
	Good	30	58	71	78
Open Brush (Soft wood shrubs - buckwheat, sage, etc.)	Poor	62	76	84	88
	Fair	46	66	77	83
	Good	41	63	75	81
Woodland (Coniferous or broadleaf trees predominate. Canopy density is at least 50 percent.)	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	25	55	70	77
Woodland, Grass (Coniferous or broadleaf trees with canopy density from 20 to 50 percent)	Poor	57	73	82	86
	Fair	44	65	77	82
	Good	33	58	72	79
URBAN COVERS -					
Residential or Commercial Landscaping (Lawn, shrubs, etc.)	Good	32	56	69	75
Turf (Irrigated and mowed grass)	Poor	58	74	83	87
	Fair	44	65	77	82
	Good	33	58	72	79
AGRICULTURAL COVERS -					
Fallow (Land plowed but not tilled or seeded)		77	86	91	94

SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

CURVE NUMBERS FOR PERVIOUS AREAS

Figure C-3 (1 of 2)

Curve (1) Numbers of Hydrologic Soil-Cover Complexes For Pervious Areas-AMC II

Cover Type (3)	Quality of Cover (2)	Soil Group A	B	C	D
AGRICULTURAL COVERS (Continued)					
Legumes, Close Seeded (Alfalfa, sweetclover, timothy, etc.)	Poor	66	77	85	89
	Good	58	72	81	85
Orchards, Evergreen (Citrus, avocados, etc.)	Poor	57	73	82	86
	Fair	44	65	77	82
	Good	33	58	72	79
Pasture, Dryland (Annual grasses)	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Pasture, Irrigated (Legumes and perennial grass)	Poor	58	74	83	87
	Fair	44	65	77	82
	Good	33	58	72	79
Row Crops (Field crops - tomatoes, sugar beets, etc.)	Poor	72	81	88	91
	Good	67	78	85	89
Small grain (Wheat, oats, barley, etc.)	Poor	65	76	84	88
	Good	63	75	83	87

Notes:

1. All curve numbers are for Antecedent Moisture Condition (AMC) II.
2. Quality of cover definitions:

   Poor-Heavily grazed, regularly burned areas, or areas of high burn potential. Less than 50 percent of the ground surface is protected by plant cover or brush and tree canopy.

   Fair-Moderate cover with 50 percent to 75 percent of the ground surface protected.

   Good-Heavy or dense cover with more than 75 percent of the ground surface protected.
3. See Figure C-2 for definition of cover types.

SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

CURVE NUMBERS FOR PERVIOUS AREAS

Figure C-3 (2 of 2)

ACTUAL IMPERVIOUS COVER

Land Use (1)	Range-Percent	Recommended Value For Average Conditions-Percent (2)
Natural or Agriculture	0 - 0	0
Public Park	10 - 25	15
School	30 - 50	40
Single Family Residential: (3)		
2.5 acre lots	5 - 15	10
1 acre lots	10 - 25	20
2 dwellings/acre	20 - 40	30
3-4 dwellings/acre	30 - 50	40
5-7 dwellings/acre	35 - 55	50
8-10 dwellings/acre	50 - 70	60
More than 10 dwellings/acre	65 - 90	80
Multiple Family Residential:		
Condominiums	45 - 70	65
Apartments	65 - 90	80
Mobile Home Park	60 - 85	75
Commercial, Downtown Business or Industrial	80 - 100	90

Notes:

1. Land use should be based on ultimate development of the watershed. Long range master plans for the County and incorporated cities should be reviewed to insure reasonable land use assumptions.

2. Recommended values are based on average conditions which may not apply to a particular study area. The percentage impervious may vary greatly even on comparable sized lots due to differences in dwelling size, improvements, etc. Landscape practices should also be considered as it is common in some areas to use ornamental gravels underlain by impervious plastic materials in place of lawns and shrubs. A field investigation of a study area shall always be made, and a review of aerial photos, where available, may assist in estimating the percentage of impervious cover in developed areas.

3. For typical equestrian subdivisions increase impervious area 5 percent over the values recommended in the table above.

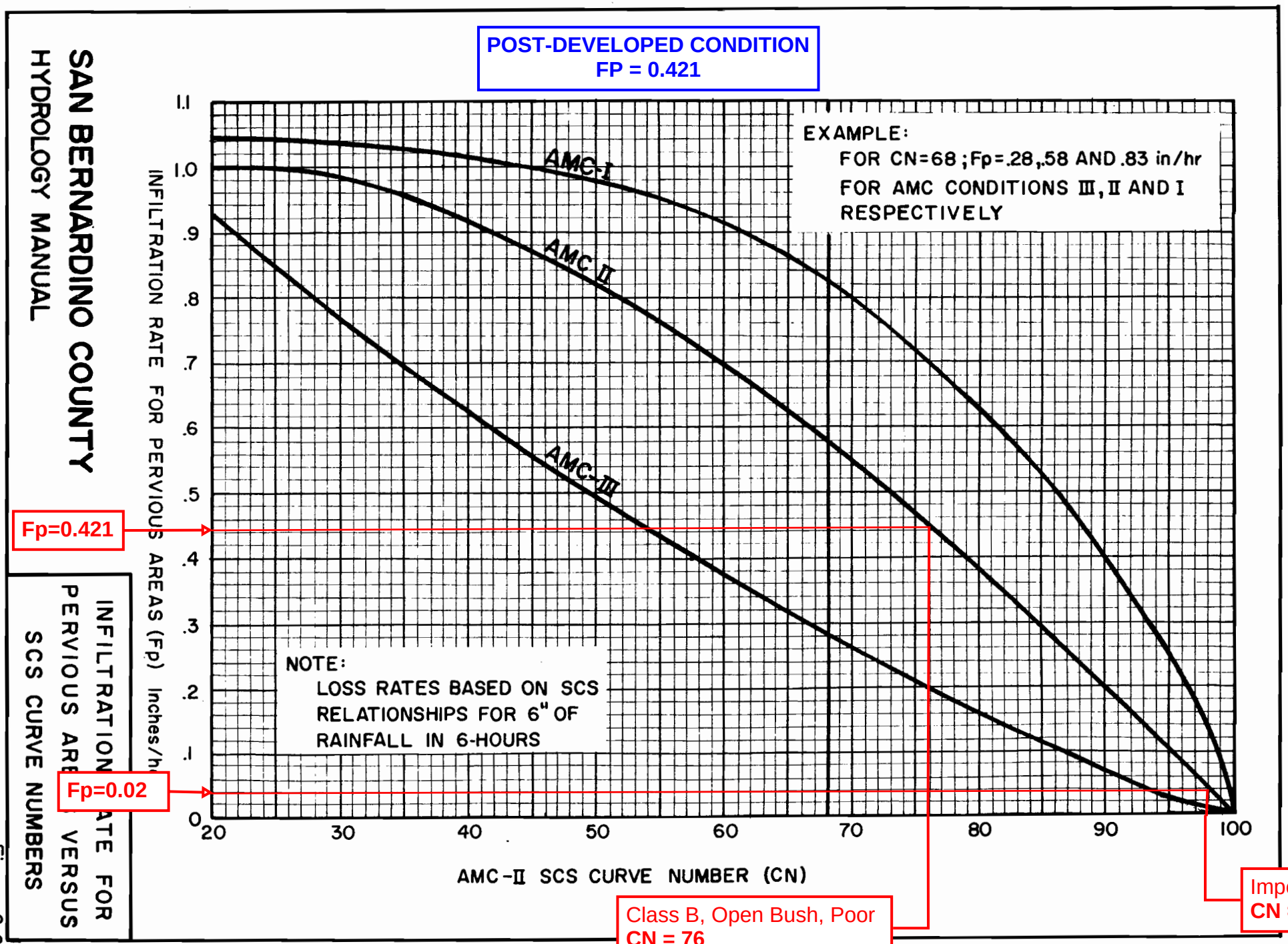
SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

ACTUAL IMPERVIOUS COVER FOR DEVELOPED AREAS

Figure C-4

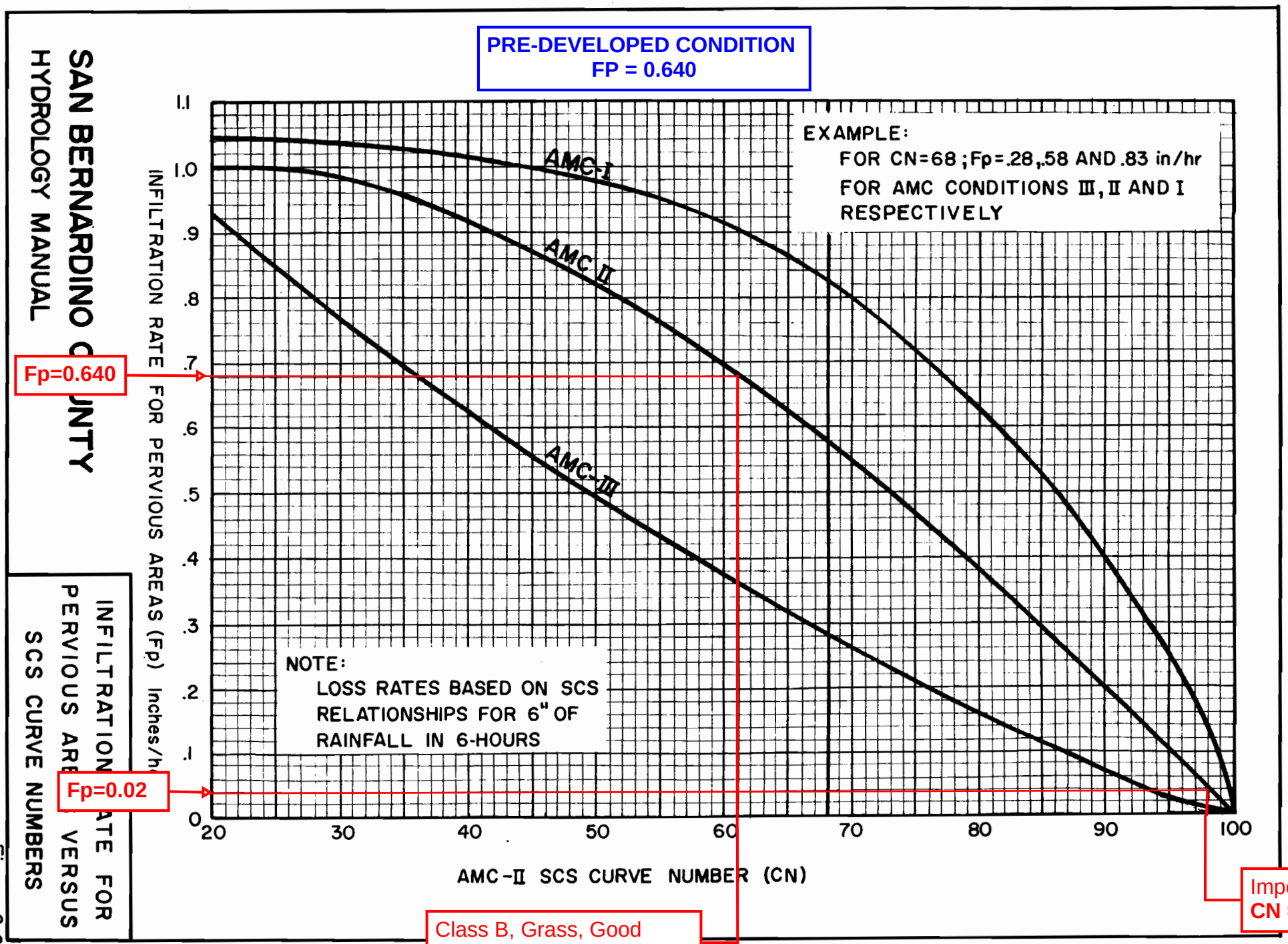
POST-DEVELOPED CONDITION
FP = 0.421



INFILTRATION RATE FOR PERVIOUS AREAS VERSUS SCS CURVE NUMBERS

Figure C-6

PRE-DEVELOPED CONDITION
FP = 0.640



Fp=0.640

Fp=0.02

Class B, Grass, Good
CN = 61

Impervious
CN = 98

INFILTRATION RATE FOR PERVIOUS AREAS VERSUS SCS CURVE NUMBERS

Figure C-6

Curve (1) Numbers of Hydrologic Soil-Cover Complexes For Pervious Areas-AMC II

Cover Type (3)	Quality of Cover (2)	Soil Group A	B	C	D
NATURAL COVERS -					
Barren (Rockland, eroded and graded land)		78	86	91	93
Chaparral, Broadleaf (Manzonita, ceanothus and scrub oak)	Poor	53	70	80	85
	Fair	40	63	75	81
	Good	31	57	71	78
Chaparral, Narrowleaf (Chamise and redshank)	Poor	71	82	88	91
	Fair	55	72	81	86
Grass, Annual or Perennial	Poor	67	78	86	89
	Fair	50	69	79	84
	Good	38	61	74	80
Meadows or Cienegas (Areas with seasonally high water table, principal vegetation is sod forming grass)	Poor	63	77	85	88
	Fair	51	70	80	84
	Good	30	58	71	78
Open Brush (Soft wood shrubs - buckwheat, sage, etc.)	Poor	62	76	84	88
	Fair	46	66	77	83
	Good	41	63	75	81
Woodland (Coniferous or broadleaf trees predominate. Canopy density is at least 50 percent.)	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	25	55	70	77
Woodland, Grass (Coniferous or broadleaf trees with canopy density from 20 to 50 percent)	Poor	57	73	82	86
	Fair	44	65	77	82
	Good	33	58	72	79
URBAN COVERS -					
Residential or Commercial Landscaping (Lawn, shrubs, etc.)	Good	32	56	69	75
Turf (Irrigated and mowed grass)	Poor	58	74	83	87
	Fair	44	65	77	82
	Good	33	58	72	79
AGRICULTURAL COVERS -					
Fallow (Land plowed but not tilled or seeded)		77	86	91	94

SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

CURVE NUMBERS FOR PERVIOUS AREAS

Figure C-3 (1 of 2)

Appendix E

Figure ADD-1
Antecedent Moisture Condition (AMC)

5-day Rainfall - NOAA Atlas 14
(50% of Total Rainfall Prior to Peak)*

*1/2 (11-day - 1-day) =
1/2 (([10-day] + (1/10 ([20-day] - [10-day]))) - [1-day])

5 0 5 10 15
Miles

N
W E
S

Growing Season
- AMC I
- AMC II
- AMC III

APPROXIMATE LOCATION OF SITE. AMC III

STATE HWY 127
I-15
US HWY 395
I-40
STATE HWY 247
STATE HWY 62

Death Valley
Ridgecrest
Boron
Barstow
Adelanto
George AFB
George AFB
Victorville
Mountain View Acres
Hesperia
Wrightwood
Crestline
Lake Arrowhead
Running Springs
Big Bear City
Big Bear Lake
Claremont
Yucca Valley
Joshua Tree
Twentynine Palms
Morongo Valley
Needles
Parker Dam
Blythe

Developed weighted CN = 0.933

POOR: Heavily grazed or regularly burned areas. Less than 50 percent of the ground surface is protected by plant cover or brush and tree canopy.

FAIR: Moderate cover with 50 percent to 75 percent of the ground surface protected by vegetation.

GOOD: Heavy or dense cover with more than 75 percent of the ground surface protected by vegetation.

In most cases, watershed existing conditions cover type and quality can be readily determined by a field review of a watershed. In ultimate planned open spaces, the soil cover condition shall be considered as "good." Figure C-3 provides the CN values for various types and quality of ground cover. Impervious areas shall be assigned a CN of 98. It is noted that for ultimately developed conditions, the CN for urban landscaping (turf) is provided in Figure C-3.

C.4. WATERSHED DEVELOPMENT CONDITIONS

Ultimate development of the watershed should normally be assumed since watershed urbanization is reasonably likely within the expected life of most hydraulic facilities. Long range master plans for the County and incorporated cities should be reviewed to insure that reasonable land use assumptions are made for the ultimate development of the watershed. A field review shall also be made to confirm existing use and drainage patterns. Particular attention shall be paid to existing and proposed landscape practices, as it is common in some areas to use ornamental gravels underlain by impervious plastic materials in place of lawns and shrubs. Appropriate actual impervious percentages can then be selected from Figure C-4. It should be noted that the recommended values from these figures are for average conditions and, therefore, some adjustment for particular applications may be required.

Curve (1) Numbers of Hydrologic Soil-Cover Complexes For Pervious Areas-AMC II

Cover Type (3)	Quality of Cover (2)	Soil Group A	B	C	D
NATURAL COVERS -					
Barren (Rockland, eroded and graded land)		78	86	91	93
Chaparral, Broadleaf (Manzonita, ceanothus and scrub oak)	Poor	53	70	80	85
	Fair	40	63	75	81
	Good	31	57	71	78
Chaparral, Narrowleaf (Chamise and redshank)	Poor	71	82	88	91
	Fair	55	72	81	86
Grass, Annual or Perennial	Poor	67	78	86	89
	Fair	50	69	79	84
	Good	38	61	74	80
Meadows or Cienegas (Areas with seasonally high water table, principal vegetation is sod forming grass)	Poor	63	77	85	88
	Fair	51	70	80	84
	Good	30	58	71	78
Open Brush (Soft wood shrubs - buckwheat, sage, etc.)	Poor	62	76	84	88
	Fair	46	66	77	83
	Good	41	63	75	81
Woodland (Coniferous or broadleaf trees predominate. Canopy density is at least 50 percent.)	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	25	55	70	77
Woodland, Grass (Coniferous or broadleaf trees with canopy density from 20 to 50 percent)	Poor	57	73	82	86
	Fair	44	65	77	82
	Good	33	58	72	79
URBAN COVERS -					
Residential or Commercial Landscaping (Lawn, shrubs, etc.)	Good	32	56	69	75
Turf (Irrigated and mowed grass)	Poor	58	74	83	87
	Fair	44	65	77	82
	Good	33	58	72	79
AGRICULTURAL COVERS -					
Fallow (Land plowed but not tilled or seeded)		77	86	91	94

SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

CURVE NUMBERS FOR PERVIOUS AREAS

Figure C-3 (1 of 2)

Curve (1) Numbers of Hydrologic Soil-Cover Complexes For Pervious Areas-AMC II

Cover Type (3)	Quality of Cover (2)	Soil Group A	B	C	D
AGRICULTURAL COVERS (Continued)					
Legumes, Close Seeded (Alfalfa, sweetclover, timothy, etc.)	Poor	66	77	85	89
	Good	58	72	81	85
Orchards, Evergreen (Citrus, avocados, etc.)	Poor	57	73	82	86
	Fair	44	65	77	82
	Good	33	58	72	79
Pasture, Dryland (Annual grasses)	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Pasture, Irrigated (Legumes and perennial grass)	Poor	58	74	83	87
	Fair	44	65	77	82
	Good	33	58	72	79
Row Crops (Field crops - tomatoes, sugar beets, etc.)	Poor	72	81	88	91
	Good	67	78	85	89
Small grain (Wheat, oats, barley, etc.)	Poor	65	76	84	88
	Good	63	75	83	87

Notes:

1. All curve numbers are for Antecedent Moisture Condition (AMC) II.
2. Quality of cover definitions:

   Poor-Heavily grazed, regularly burned areas, or areas of high burn potential. Less than 50 percent of the ground surface is protected by plant cover or brush and tree canopy.

   Fair-Moderate cover with 50 percent to 75 percent of the ground surface protected.

   Good-Heavy or dense cover with more than 75 percent of the ground surface protected.
3. See Figure C-2 for definition of cover types.

SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

CURVE NUMBERS FOR PERVIOUS AREAS

Figure C-3 (2 of 2)

ACTUAL IMPERVIOUS COVER

Land Use (1)	Range-Percent	Recommended Value For Average Conditions-Percent (2)
Natural or Agriculture	0 - 0	0
Public Park	10 - 25	15
School	30 - 50	40
Single Family Residential: (3)		
2.5 acre lots	5 - 15	10
1 acre lots	10 - 25	20
2 dwellings/acre	20 - 40	30
3-4 dwellings/acre	30 - 50	40
5-7 dwellings/acre	35 - 55	50
8-10 dwellings/acre	50 - 70	60
More than 10 dwellings/acre	65 - 90	80
Multiple Family Residential:		
Condominiums	45 - 70	65
Apartments	65 - 90	80
Mobile Home Park	60 - 85	75
Commercial, Downtown Business or Industrial	80 - 100	90

Notes:

1. Land use should be based on ultimate development of the watershed. Long range master plans for the County and incorporated cities should be reviewed to insure reasonable land use assumptions.

2. Recommended values are based on average conditions which may not apply to a particular study area. The percentage impervious may vary greatly even on comparable sized lots due to differences in dwelling size, improvements, etc. Landscape practices should also be considered as it is common in some areas to use ornamental gravels underlain by impervious plastic materials in place of lawns and shrubs. A field investigation of a study area shall always be made, and a review of aerial photos, where available, may assist in estimating the percentage of impervious cover in developed areas.

3. For typical equestrian subdivisions increase impervious area 5 percent over the values recommended in the table above.

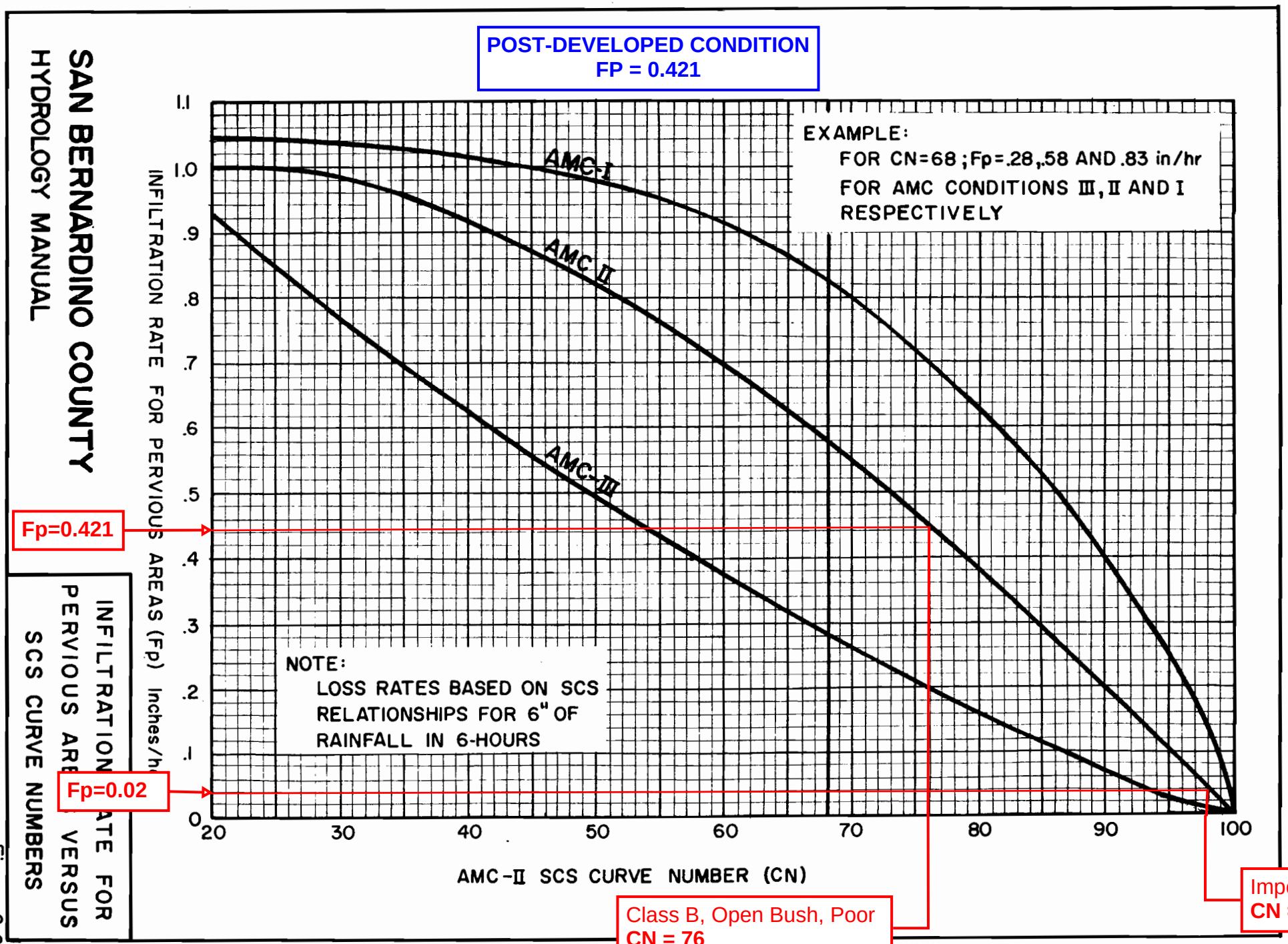
SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

ACTUAL IMPERVIOUS COVER FOR DEVELOPED AREAS

Figure C-4

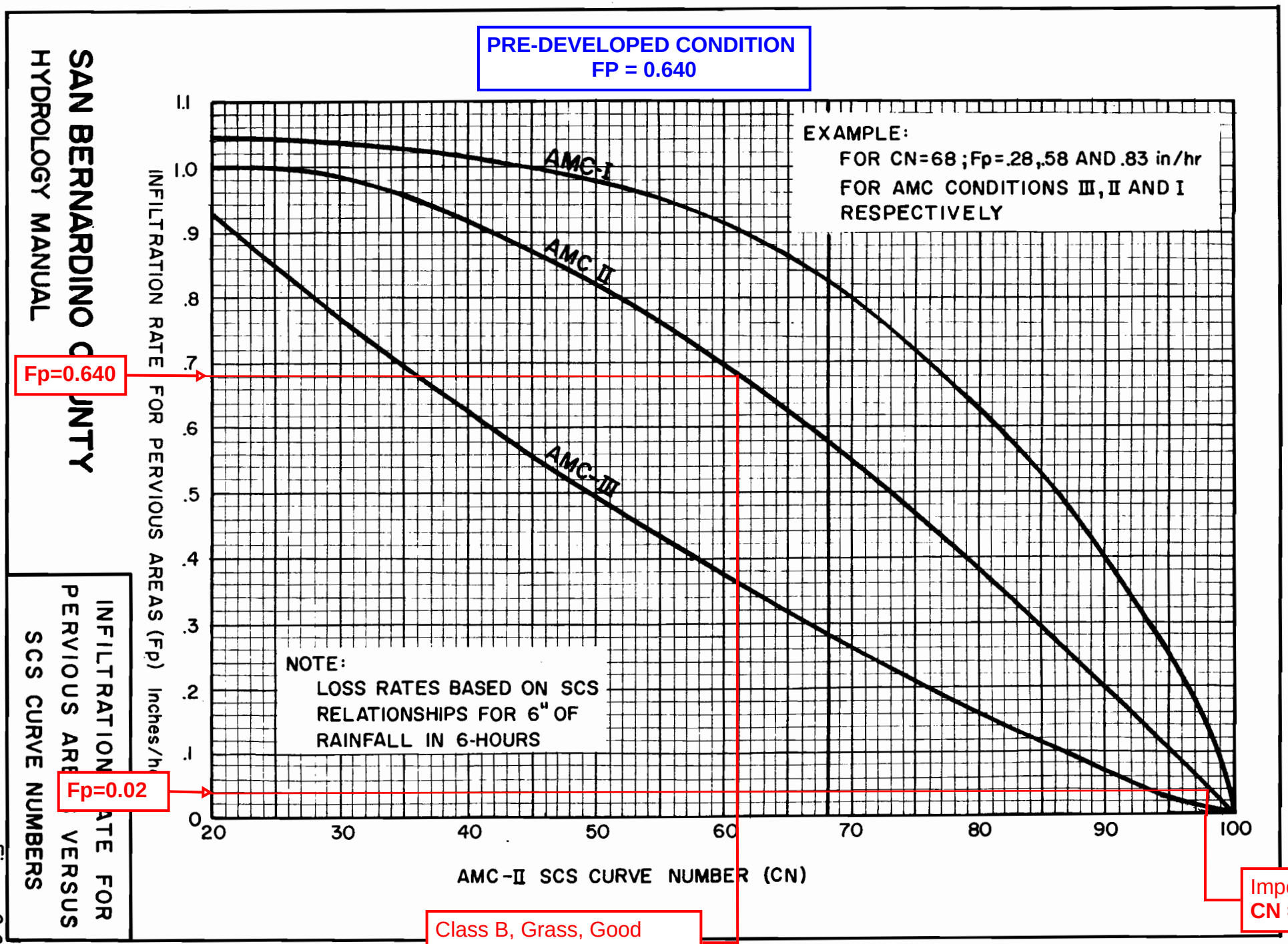
POST-DEVELOPED CONDITION
FP = 0.421



INFILTRATION RATE FOR PERVIOUS AREAS VERSUS SCS CURVE NUMBERS

Figure C-6

PRE-DEVELOPED CONDITION
FP = 0.640



Fp=0.640

Fp=0.02

Class B, Grass, Good
CN = 61

Impervious
CN = 98

INFILTRATION RATE FOR PERVIOUS AREAS VERSUS SCS CURVE NUMBERS

Figure C-6

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	Fair	55	72	81	86
Grass, Annual or Perennial	Poor	67	78	86	89
	Fair	50	69	79	84
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Meadows or Cienegas (Areas with seasonally high water table, principal vegetation is sod forming grass)	Poor	63	77	85	88
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URBAN COVERS -					
Residential or Commercial Landscaping (Lawn, shrubs, etc.)	Good	32	56	69	75
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	Fair	44	65	77	82
	Good	33	58	72	79
AGRICULTURAL COVERS -					
Fallow (Land plowed but not tilled or seeded)		77	86	91	94

SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

CURVE NUMBERS FOR PERVIOUS AREAS

Figure C-3 (1 of 2)

Appendix F

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 San Bernardino County, California, Mojave River Area



July 9, 2025

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 (https://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.

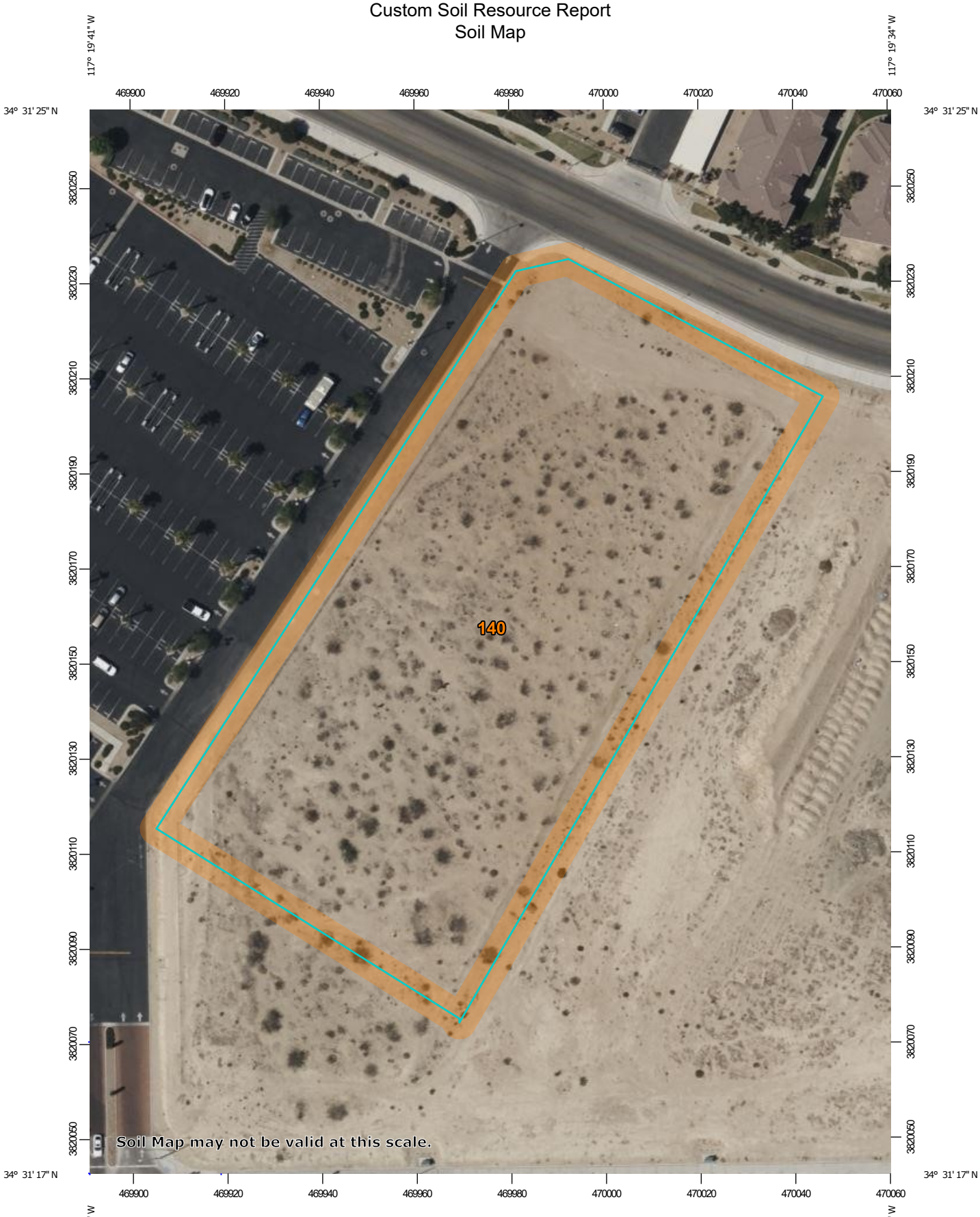
After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

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 Scale: 1:1,090 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 15 30 60 90

Feet: 0 50 100 200 300

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 11N WGS84

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.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
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: San Bernardino County, California, Mojave River Area
Survey Area Data: Version 16, Aug 30, 2024

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 17, 2022—Jun 12, 2022

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background

MAP LEGEND

MAP INFORMATION

imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
140	LAVIC LOAMY FINE SAND	2.7	100.0%
Totals for Area of Interest		**2.7**	**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.

San Bernardino County, California, Mojave River Area

140—LAVIC LOAMY FINE SAND

Map Unit Setting

National map unit symbol: hksf
Elevation: 2,800 to 3,100 feet
Mean annual precipitation: 3 to 6 inches
Mean annual air temperature: 59 to 63 degrees F
Frost-free period: 180 to 280 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Lavic and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Lavic

Setting

Landform: Fan skirts, fan aprons
Landform position (two-dimensional): Toeslope, footslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from granite sources

Typical profile

H1 - 0 to 10 inches: loamy fine sand
H2 - 10 to 20 inches: loamy sand
H3 - 20 to 49 inches: loam
H4 - 49 to 60 inches: stratified sand to loamy sand

Properties and qualities

Slope: 0 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 26 percent
Maximum salinity: Slightly saline to moderately saline (4.0 to 8.0 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 5.5 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B
Ecological site: R030XF012CA - Sandy
Hydric soil rating: No

Minor Components

Unnamed soils

Percent of map unit: 14 percent
Hydric soil rating: No

Unnamed

Percent of map unit: 1 percent
Landform: Playas
Hydric soil rating: Yes

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Durban Development
106 Foster Avenue
Charlotte, NC 28203

Geotechnical Engineering Report
Proposed Tractor Supply Company
Roy Rogers Drive East of Amargosa Road
Victorville, San Bernardino County, California

July 26, 2024

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File No.: 306687-002
Doc. No.: 24-07-703

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July 26, 2024

File No.: 306687-002
Doc. No.: 24-07-703

Durban Development
106 Foster Avenue
Charlotte, NC 28203

Attention: Mr. Stephen Knudsen

Subject: Geotechnical Engineering Report

Projects: **Proposed Tractor Supply Company**
Roy Rogers Drive East of Amargosa Road
Victorville, San Bernardino County, California

Earth Systems Pacific (Earth Systems) is pleased to present this Geotechnical Engineering Report for the proposed new Tractor Supply Company retail store located east of the existing WinCo Foods store east of Amargosa Road and north of Roy Rogers Drive in the city of Victorville, San Bernardino County, California. This report presents our findings and recommendations for site grading and foundation design, incorporating the information provided to our office. The site is suitable for the proposed development, provided the recommendations in this report are followed in design and construction. This report should stand as a whole, and no part of the report should be excerpted or used to the exclusion of any other part.

This report completes our scope of services in accordance with our proposal (BER-24-4-002) with an authorization date of May 17, 2024. Other geotechnical related services that may be required, such as plan reviews, responses to agency inquiries, and grading observation and testing are additional services and will be billed according to the Fee Schedule in effect at the time services are provided as per our authorized proposal. Unless requested in writing, the Client is responsible to distribute the report to the appropriate governing agency and other members of the design team. Please review the Limitations (Section 6) of this report as it is vital to the understanding of this report.

We appreciate the opportunity to provide our professional services. Please contact our office if there are any questions or comments concerning this report or its recommendations.

Respectfully submitted,
EARTH SYSTEMS PACIFIC

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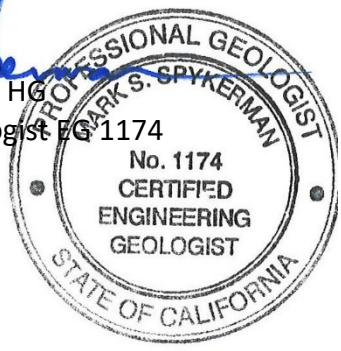


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Geotechnical Engineering Report
Proposed Tractor Supply Company
Roy Rogers Drive East of Amargosa Road
Victorville, San Bernardino County, California

Section 1.0
INTRODUCTION

1.1 Project Description

This Geotechnical Engineering Report has been prepared for the proposed new Tractor Supply Company retail store located east of the existing WinCo store along Amargosa Road and Roy Rogers Drive in the city of Victorville, San Bernardino County, California, see Plate 1. Based on a client provided site plan, project improvements include approximately 44,000 square feet of indoor building area, receiving dock, vehicular parking, east-west access road, and a pylon sign along Roy Rogers Drive. Appurtenant site work is anticipated to include underground utilities, shallow retention basins, hardscape, driveway improvements, block walls, and landscaping. Preliminary grading and foundation plans, and appurtenant site work plans were not available at the time that this report was prepared. We have assumed site grades will be similar in elevation to the surrounding street grades (+-5 feet). The proposed site layout along with our exploration locations is presented on Plates 2a & 2b in Appendix A.

We have assumed the new buildings will be one to two-stories in extended wall height made of wood, metal, or light steel frame construction, founded on shallow permanent foundations. No below grade basement levels are anticipated. Column loads are anticipated not to exceed approximately 100 kips for spread footings and 3 kip/lf for continuous footing loads. Preliminary design loading was not provided by the structural engineer. If actual structural loading exceeds these assumed values, we will need to re-evaluate the given recommendations.

1.2 Site Description

The proposed new Tractor Supply Company retail store is located in the northeast quadrant of the intersection of Roy Rogers Drive and Amargosa Road. The project is located east of the existing WinCo store about 860 feet east of Amargosa Road in the city of Victorville, San Bernardino County, California. Based on the site plan provided and a San Bernardino GIS online service, the legal description of the land is identified as Accessor Pacel Number (APN) 3106-201-20-0000 and 3106-201-21-000 encompassing approximately 3.45 acres. Coordinates near the center of the proposed site are 34.5223°N/117.3274°W. Site elevations range from approximately 2,938 feet to 2,948 feet (msl) based on Google Earth. Access to the site is via Roy Rogers Drive; a paved improved street located adjacent to the southern boundary of the site.

Topographically, the site is generally flat to gently sloping ground with a descending cut slope in alluvium along the southeast margin of the site. The cut slope is about 6 to 8 feet high and graded at about a 2:1 (H:V) slope. The site is comprised of vacant unimproved land and is vegetated with a sparse covering of typical desert vegetation consisting of weeds, grasses, and bushes. Fill piles and disturbed soils are present in the eastern portion of the site. Localized areas of trash and debris exist. There was a soil stockpile offsite on the vacant lot located to the east. Drainage is by

sheet flow to the northeast. No evidence was noted of significant erosion at the time of our site visit.

1.3 Purpose and Scope of Services

The purpose for our services was to evaluate the site soil and geologic conditions at our exploration locations and to provide professional opinions and recommendations, from a geologic and geotechnical point of view, regarding the proposed development of the site. We understand that the proposed site improvements will be developed under the regulation of the current California Building Code (2022). The scope of services included:

Task 1 – Literature and Photograph Reviews

We began our services by reviewing select geologic and geotechnical literature pertaining to the project. This included a review of various hazard, fault, and geologic maps prepared by the California Geological Survey, the U.S. Geological Survey, the County of San Bernardino and other governmental agencies as they relate to the project area. Select historical aerial photographs were reviewed using the Google Earth Pro website and Historical Aerials website. The aerial photographs reviewed are listed in the References section of this report.

Task 2 – Utility Clearance, USA Dig Alert

Each of our proposed field exploration locations was located and marked in the field and cleared with known utility lines as identified by Underground Service Alert (USA), “Dig Alert”. Our exploration locations were located in the field by pacing with sighting from landmarks identified on the project site plan. Private utility locating was also performed for greater assurance of not encountering a buried utility at our boring locations.

Task 3 – Field Exploration

We evaluated the general subsurface conditions at the site by drilling nine small-diameter hollow-stem auger borings, to depths from approximately 6½ feet to 48½ feet below the existing ground surface (bgs). The field exploration also included a visual site reconnaissance of the project area and immediate surroundings. Plate 2a shows the approximate locations of the borings and planned improvements. A local geologic map is depicted as Plate 2b.

Task 4 – Laboratory Testing

Laboratory tests were performed on selected samples to evaluate the physical characteristics of the materials encountered during our field exploration. Laboratory testing included moisture content, dry unit weight, maximum dry density/optimum moisture content, sieve analysis, consolidation/collapse potential, Expansion Index, and R-value. The testing was performed in general accordance with American Society for Testing and Materials (ASTM) or appropriate test procedures. Selected samples were also tested for a preliminary screening level of corrosion potential (pH, electrical resistivity, water-soluble sulfates and water-soluble chlorides).

Task 5 – Analysis and Report

Earth Systems analyzed the recent and past field data, performed engineering analyses, and provided recommended design parameters for earthwork and foundations for the structure as described within. Our report includes:

- A description of the proposed project including a site plan showing the approximate boring locations;
- A description of the surface and of subsurface site conditions including groundwater conditions, as encountered in our recent field explorations.
- A description of the site geologic setting and possible associated geology-related hazards, including liquefaction, subsidence, and seismic settlement analysis.
- A discussion of regional geology and site seismicity.
- A description of local and regional active faults.
- A discussion of other geologic hazards such as ground shaking, landslides, flooding, and tsunamis.
- A discussion of site conditions, including the geotechnical suitability of the site for the general type of construction proposed.
- A "General Procedure" seismic analysis including geotechnical seismic design coefficients in accordance with the 2022 CBC and ASCE 7-16.
- Recommendations for foundation design including parameters for shallow foundations, pole foundations, and building pad and subgrade preparation if needed.
- Anticipated total and differential settlements for the recommended foundation system if needed.
- Recommendations for the mitigation of seismic induced settlement.
- Recommendations for lateral earth pressures (active, at-rest, and passive) for retaining walls, including drainage requirements, coefficients of friction and seismic earth pressures.,
- Recommendations for slabs-on-grade (slabs and walkways), including recommendations for reducing the potential for moisture transmission through interior slabs.
- Roadway and parking asphalt concrete and Portland cement concrete recommendations for site access, parking areas, and truck aisles will be provided.
- Recommendations for collapsible or expansive soils (if applicable).
- A discussion of the corrosion potential of the near-surface soils encountered during our field exploration.
- An appendix, which will include a summary of the field exploration and laboratory testing program.

Not Contained in This Report: Although available through Earth Systems, the current geotechnical scope of our services does not include:

- A study for the presence or absence of wetlands, hazardous or toxic materials in the soil, surface water, groundwater, or air on, below, or adjacent to the subject property, nor exploration or delineation of past development or remaining structures/debris.
- The client did not direct Earth Systems to provide any service to investigate or detect the presence of moisture, mold, or other biological contaminates in or around any structure, or any service that was designed or intended to prevent or lower the risk or the occurrence of the amplification of the same. Client is hereby informed that mold is ubiquitous to the environment, with mold amplification occurring when building materials are impacted by moisture. Site conditions are outside of Earth Systems' control, and mold amplification will likely occur or continue to occur in the presence of moisture. As such, Earth Systems cannot and shall not be held responsible for the occurrence or recurrence of mold.

Section 2.0
METHODS OF EXPLORATION AND TESTING

2.1 Field Exploration

The subsurface exploration program consisted of advancing nine exploratory borings. The borings were drilled to depths ranging from approximately 6½ to 48½ feet bgs using a Mobile B-61 truck-mounted drill rig equipped with 6-inch hollow-stem augers provided by GP Drilling of Apple Valley, California. The borings were advanced to observe soil profiles and obtain samples for laboratory testing. The approximate boring locations are shown on Plate 2, in Appendix A.

Staff from Earth Systems maintained a log of the subsurface conditions encountered and obtained samples for logging, classification and laboratory testing. Subsurface conditions encountered in the borings were categorized and logged in general accordance with the Unified Soil Classification System (USCS) and ASTM D 2487 and 2488 (current edition). Our typical sampling interval within the borings was approximately every 2½ or 5 feet to the full depth explored; however, sampling intervals were adjusted depending on the materials encountered onsite. Samples were obtained within the test borings using a California type ring sampler (ASTM D 3550 with those similar to ASTM D 1586). The California type sampler has an approximate 3-inch outside diameter and 2.4-inch inside diameter. The sampler was mounted on a drill rod and driven using a rig-mounted 140-pound automatic hammer falling for a height of 30 inches. The number of blows necessary to drive the sampler within the borings was recorded.

Design parameters provided by Earth Systems in this report have considered an estimated 75% hammer efficiency based on data provided by the drilling subcontractor and limits per SP117A. The N-values (blow count) using the California sampler can be roughly correlated to SPT N-values using a conversion factor that may vary from about 0.5 to 0.7. In general, a conversion factor of approximately 0.63 from a study at the Port of Los Angeles (Zueger and McNeilan, 1998 per SP 117A) is considered satisfactory. A value of 0.63 was applied in our calculations for this project.

Bulk samples of the soil materials were obtained from the drill auger cuttings, representing a mixture of soils encountered at the depths noted. The depth to groundwater, if any, was measured in the boreholes. Following drilling, sampling, and logging, the borings were backfilled with the cuttings and tamped upon completion. Our field exploration was provided under the direction of a State of California Registered Geotechnical Engineer from our firm.

The logs of the borings represent our interpretation of the contents of the field data and the results of laboratory testing performed on the samples obtained during the subsurface exploration. The final logs are included in Appendix A of this report. The stratification lines represent the approximate boundaries between soil types, although the transitions may be gradual. In reviewing the logs and legend, the reader should recognize the legend is intended as a guideline only, and there are a number of conditions that may influence the soil characteristics observed during drilling. These include, but are not limited to cementation, variations in soil moisture, presence of groundwater, and other factors.

The boring logs present field blow counts per 6 inches of driven embedment (or portion thereof) for a total driven depth attempted of 18 inches. The blow counts on the logs are uncorrected (i.e. not corrected for overburden, sampling, etc.). Consequently, the user must correct the blow

counts per standard methodology if they are to be used for design and exercise judgment in interpreting soil characteristics, possibly resulting in soil descriptions that vary somewhat from the legend.

2.2 Laboratory Testing

Samples were reviewed along with field logs to select those that would be analyzed further. Those selected for laboratory testing include, but were not limited to, soils that would be exposed and those deemed to be within the influence of the proposed structures. Test results are presented in graphic and tabular form in Appendix B of this report. Testing was performed in general accordance with American Society for Testing and Materials (ASTM) or other appropriate test procedure. Selected samples were also tested for a screening level of corrosion potential (pH, electrical resistivity, water-soluble sulfates, and water-soluble chlorides). Earth Systems does not practice corrosion engineering; however, these test results may be used by a qualified corrosion engineer in designing an appropriate corrosion control plan for the project.

Our testing program consisted of the following:

- Density and Moisture Content of select samples of the site soils (ASTM D 2937 & 2216).
- Maximum Dry Density/Optimum Moisture Content tests to evaluate the moisture-density relationship of typical soils encountered (ASTM D 1557).
- Particle Size Analysis to classify and evaluate soil composition. The gradation characteristics of selected samples were made by sieve analysis procedures (ASTM D 6913).
- Consolidation and Collapse Potential to evaluate the compressibility and hydroconsolidation (collapse) potential of the soil upon wetting (ASTM D 5333).
- Expansion Index tests to evaluate the expansive nature of the soil. The samples were surcharged under 144 pounds per square foot at moisture contents of near 50% saturation. Samples were then submerged in water for 24 hours and the amount of expansion was recorded with a dial indicator (ASTM D 4829).
- Screening Level Chemical Analyses (Soluble Sulfates and Chlorides (ASTM D 4327), pH (APHA 2320-B), and Electrical Resistivity/Conductivity (ASTM G 187) to evaluate the potential for adverse effects of the soil on concrete and steel.
- R-Value for pavement section analysis (CTM 301).

Section 3.0
DISCUSSION

3.1 Soil Conditions

The field exploration and literature review indicate that the site soils consist generally sporadic shallow fill or fill piles overlying native alluvial soils of sand with varying amounts of silt and silt with varying amounts of sand (Unified Soils Classification System symbols of SM, SP, and ML) to the maximum depth of exploration of 48½ feet below the ground surface. The underlying coarse-grained soils encountered were found to be loose to very dense. Groundwater was not encountered. Soils were generally "very low" in Expansion Index with isolated layers which could be defined as "low". The boring logs provided in Appendix A include more detailed descriptions of the soils encountered.

3.2 Groundwater

Groundwater or perched water was not encountered during our field exploration to the maximum depth of exploration of 48½ feet. Nearby State monitoring wells were researched for their recent and historic well readings. The following is a summary of our findings from three documented wells near the site.

- Well No. 05N04W08N001S is located approximately 0.5 miles to the north of the site. The surface elevation of the well is approximately 2,930 feet and groundwater elevation readings as measured from 2004 to 2014 varied from 2,699 to 2,730 feet.
- Well No. 05N04W16M002S is located approximately 0.6 miles east of the site. The surface elevation of this well is approximately 2,943 feet and the groundwater elevation readings as measured from 1957 were 2,787 feet.
- Well No. 05N05W13H002S is located approximately 1.2 miles to the west of the site. The surface elevation of this well is approximately 2,979 feet and the groundwater elevation readings as measured from 2006 were 2,759 feet.

Based on the above data, groundwater is not anticipated to be encountered during construction and is historically expected to be deeper than 150 feet at the site. Fluctuations of the groundwater level and localized zones of increased soil moisture content should be anticipated during and following the rainy season or from irrigation. Fluctuations in groundwater levels may occur due to variations in rainfall, regional climate, and other factors.

3.3 Collapse Potential

Collapsible soil deposits generally exist in regions of moisture deficiency. Collapsible soils are generally defined as soils that have potential to suddenly decrease in volume upon increase in moisture content even without an increase in external loads. Soils susceptible to collapse include loess, weakly cemented sands and silts where the cementing agent is soluble (e.g. soluble gypsum, halite), valley alluvial deposits within semi-arid to arid climate, and certain granite residual soils above the groundwater table. In arid climatic regions, granular soils may have a potential to collapse upon wetting. Collapse (hydro-consolidation) may occur when the soils are lubricated or the soluble cements (carbonates) in the soil matrix dissolve, causing the soil to densify from its loose configuration from deposition.

The degree of collapse of a soil can be defined by the Collapse Potential (CP) value, which is expressed as a percent of collapse of the sample using the Collapse Potential Test (ASTM Standard Test Method D 5333). Based on the Naval Facilities Engineering Command (NAVFAC) Design Manual 7.1, the severity of collapse potential is commonly evaluated by the following Table 1, Collapse Potential Values.

Table 1
Collapse Potential Values

Collapse Potential Value	Severity of Problem
0-1%	No Problem
1-5%	Moderate Problem
5-10%	Trouble
10-20%	Severe Trouble
> 20%	Very Severe Trouble

Table 1 can be combined with other factors such as the probability of ground wetting to occur on-site and the extent or depth of potential collapsible soil zone to evaluate the potential hazard by collapsible soil at a specific site. A hazard ranking system associated with collapsible soil as developed by Hunt (1984) is presented in Table 2, Collapsible Soil Hazard Ranking System.

Table 2
Collapsible Soil Hazard Ranking System

Degree of Hazard	Definition of Hazard
No Hazard	No hazard exists where the potential collapse magnitudes are non-existent under any condition of ground wetting.
Low Hazard	Low hazards exist where the potential collapse magnitudes are small and tolerable, or the probability of significant ground wetting is low.
Moderate Hazard	Moderate hazards exist where the potential collapse magnitudes are undesirable, or the probability of substantial ground wetting is low, or the occurrence of the collapsible unit is limited.
High Hazard	High hazard exists where potential collapse magnitudes are undesirably high and the probability of occurrence is high.

Based on recent collapse testing studies, we estimate there is a “moderate” collapse potential from soil layers between 2 to 15 ft bgs. The results of collapse potential tests performed on ten selected single ring samples from depths ranging from 2½ to 12½ feet below the ground surface indicated a collapse potential on the order of 1.5 to 2.9 percent. Collapse appears to be related to carbonate cementation as in-place densities were elevated and similar. Assuming the recommended grading is accomplished according to Section 5.1 of this report, we estimate the collapse potential is on the order of approximately 1.0 inch.

3.4 Expansive Soils

Expansive soils are characterized by their ability to undergo significant volume change (shrink or swell) due to variations in moisture content. Changes in soil moisture content can result from

rainfall, landscape irrigation, utility leakage, roof drainage, perched groundwater, drought, or other factors, and may cause unacceptable settlement or heave of structures, concrete slabs supported-on-grade, or pavements supported over these materials. Depending on the extent and location below finished subgrade, expansive soils can have a detrimental effect on structures. Based on our laboratory testing and experience with the project, the expansion potential of the on-site soils is generally “very low” for coarse grained shallow soils and “low” for shallow silts, as defined by ASTM D 4829 and the 2022 California Building Code.

Testing and/or observation of the subgrade soils during grading within the pad and at footing grade should be performed to further evaluate the expansion potential and confirm or modify the recommendations presented herein.

3.5 Corrosion Potential

One sample of the near-surface soils within the site was tested for potential corrosion of concrete and ferrous metals. Soils were tested as blended (composite) samples. The tests were conducted in general accordance with the ASTM Standard Test Methods to evaluate pH, resistivity, and water-soluble sulfate and chloride content. The test results are presented in Appendix B. These tests should be considered as only an indicator of corrosivity for the samples tested. Other earth materials found on site may be more, less, or of a similar corrosive nature.

Water-soluble sulfates in soil can react adversely with concrete. ACI 318 provides the relationship between corrosivity to concrete and sulfate concentration, presented in the table below:

Table 3

Water-Soluble Sulfate in Soil (ppm)	Corrosivity to Concrete
0-1,000	Negligible
1,000 – 2,000	Moderate
2,000 – 20,000	Severe
Over 20,000	Very Severe

In general, the lower the pH (the more acidic the environment), the higher the soil corrosivity will be with respect to ferrous structures and utilities. As soil pH increases above 7 (the neutral value), the soil is increasingly more alkaline and less corrosive to buried steel structures, due to protective surface films, which form on steel in high pH environments. A pH between 5 and 8.5 is generally considered relatively passive from a corrosion standpoint. High chloride levels tend to reduce soil resistivity and break down otherwise protective surface deposits, which can result in corrosion of buried steel or reinforced concrete structures. Soil resistivity is a measure of how easily electrical current flows through soils and is the most influential factor. Based on the findings of studies presented in ASTM STP 1013 titled “Effects of Soil Characteristics on Corrosion” (ASTM, 1989), the approximate relationship between soil resistivity and soil corrosivity was developed as shown in Table 4.

Table 4

Soil Resistivity (Ohm-cm)	Corrosivity to Ferrous Metals
0 to 900	Very Severely Corrosive
900 to 2,300	Severely Corrosive
2,300 to 5,000	Moderately Corrosive
5,000 to 10,000	Mildly Corrosive
10,000 to >100,000	Very Mildly Corrosive

Test results show a pH value of 8.4, chloride content of 5 ppm, sulfate content of 96 ppm and minimum resistivity of 3,680 Ohm-cm. Although Earth Systems does not practice corrosion engineering, the corrosion values from the soils tested are normally considered as being moderately corrosive to buried metals and as possessing a "negligible" exposure to sulfate attack for concrete as defined in American Concrete Institute (ACI, 2011) 318, Section 4.3. The results of chemical testing have been provided in Appendix B. The above values can potentially change based on several factors, such as importing soil from another job site and the quality of construction water used during grading and subsequent landscape irrigation.

3.6 Geologic Setting

Regional Geology: The project site is located at the southwestern edge of the Mojave Desert Geomorphic Province a broad interior region of isolated mountain ranges separated by desert plains and basins (see Plate 3). The Western Mojave Desert is a wedge-shaped structural block bounded on the north by the Garlock fault and along the southwest by the San Andreas rift zone. North of the Garlock fault are the Sierra Nevada and Tehachapi Mountains. Southwest of the San Andreas fault are the Transverse Ranges and coastal basins. Regional features of the western Mojave Desert include the alluvial-filled Antelope Valley, Victor Valley, San Gabriel and San Bernardino Mountains, the and the Mojave River. Victorville is within the high desert Victor Valley portion of the Western Mojave Desert, east of Palmdale and north of Cajon Pass. Lithologic units exposed in this area consist predominantly of Quaternary sediments, including both fluvial and alluvial fan deposits.

Local active faults are typically located along the margins of Victor Valley including the Frontal Fault system and San Andreas fault zone. Other faults within the Mojave Desert include the many faults within the Eastern California shear zone located north and east of the Victorville. The North Frontal Fault zone is located along the northern margin of the San Bernardino Mountains about 11 miles south of Victorville. The transform San Andreas rift zone, which forms the boundary between the North American and Pacific crustal plates, dominates the geology of the southwestern Mojave Desert and Victor Valley area, with the primary fault zone embedded within the adjacent San Gabriel and San Bernardino Mountains. The rift zone is an extensive zone of Holocene-active faults that extends from the Gulf of California to Cape Mendocino in northern California. The San Andreas fault, at its nearest point, is approximately 19 miles southwest of the site.

Faults associated with the Eastern California shear zone are located predominately within the eastern Mojave Desert and include the Helendale-Lockhart, Cleghorn, Lenwood, and Johnson Valley faults. Refer to Table A-1 in Appendix A for a listing of select local and regional Holocene-

active faults within approximately 50 miles of Victorville. No known Holocene-active faults exist within the project site boundaries.

Locally, the site is underlain by native older alluvial fan/river terrace deposits. These include interbedded gravel and sand associated with the deposition by the ancestral Mojave River

Local Geology: Victorville is located upon the generally flat or gently sloping alluvial and terrace deposits associated with alluvial fan deposition off the San Gabriel and San Bernardino Mountains and the Mojave River. Older alluvial terrace deposits associated with Pleistocene deposition by the Mojave River form elevated geomorphic surfaces generally above modern drainage grades. Locally, thick sequences of interbedded alluvium deposits underlie the site.

No active faults have been mapped across the site, with the nearest active faults being the North Frontal fault zone, Helendale, and San Andreas faults, located about 11, 13, and 19 miles respectively from the project. Native sediments underlying the site consist of fine- to coarse-grained sands with interbedded gravels and calcium carbonate (caliche), of fluvial and alluvial origin. Undocumented fills associated with adjacent site improvements are present, and generally undifferentiated from the native soils, except in stockpile areas where the fill is readily evident.

Regional Faulting: No active faults have been mapped within the project limits based upon local and regional select published geologic maps by the California Geological Survey (2010) or United States Geological Survey fault database (2006). The site is not located within a currently designated Alquist-Priolo Earthquake fault zone or City designated fault zone.

3.7 Geologic Hazards

Geologic hazards that may affect the region include seismic hazards (ground shaking, surface fault rupture, soil liquefaction, and other secondary earthquake-related hazards), flooding, ground subsidence, and erosion. A discussion follows on the specific hazards to this site.

Seismic Sources: Approximately 37 active faults or seismic zones lie within 50 miles of the project site (see Table A-1). The primary seismic hazard to the site is strong ground shaking from earthquakes along regional faults including the San Andreas fault, Garlock fault, Eastern California shear zone, and the many faults within the Los Angeles basin and Inland Empire. The Mojave and San Bernardino segments of the San Andreas fault are located approximately 19 miles southwest of the site.

Surface Fault Rupture: The project site does not lie within a currently delineated State of California, Alquist-Priolo Earthquake Fault Zone (CGS, 2018). Well-delineated fault lines cross through the Western Mojave Desert as shown on California Geological Survey (CGS) maps (Jennings, 2010), but none are mapped within the Victorville city limits. Therefore, active fault rupture is unlikely to occur at the project site. While fault rupture would most likely occur along previously established fault traces, future fault rupture could occur at other locations.

Historic Seismicity: The site is located within an active seismic area in southern California where large numbers of earthquakes are recorded each year. Magnitudes that are above 6 and prior to accurate instrumental measurements (after 1933) are based on moment magnitudes (M_W). Magnitudes that are below 6 or earthquakes prior to 1933 are based on local magnitudes (M_L).

Approximately 37 earthquakes of magnitude 5.5 or greater have occurred within 60 miles of the site. Significant regional earthquakes include the 1812 Wrightwood, 1857 Fort Tejon, 1872 Owens Valley, 1952 Arvin-Tehachapi, 1971 San Fernando, 1992 Landers, and 1999 Hector Mine earthquakes. Strong ground motions were experienced with magnitudes ranging from approximately 5.9 to 7.8. Major historic earthquakes felt in the vicinity of Victorville have usually originated from faults located outside the area. With the exception of the 1812 Wrightwood and 1857 Fort Tejon earthquakes, these include the 1872 Owens Valley, 1952 Kern County, 1971 San Fernando, 1987 Whittier Narrows, 1992 Landers, 1994 Northridge, and 1999 Hector Mine earthquakes. Of recent note, the July 6, 2019 7.1 Ridgecrest earthquake was about 88 miles north-northwest of Victorville.

Historically, the San Andreas fault is responsible for two of the three great earthquakes experienced in California. These are the 1857 Fort Tejon and 1906 San Francisco earthquakes. Each event is credited with approximately 200 miles of surface rupture and horizontal displacements as great as 30 feet. Ground shaking was very intense and damage to man-made structures widespread. The 1857 rupture extended along the San Andreas fault from Parkfield to Cajon Pass and was felt throughout most of California. No significant earthquakes or fault movements have been attributed to this segment of the San Andreas fault since 1857. Prior to 1857, a strong earthquake that occurred in 1812 near Wrightwood, a small community in the eastern San Gabriel Mountains, originated on the San Andreas fault.

On March 26, 1872, the greatest recorded earthquake in the western United States, excluding Alaska, occurred along the Owens Valley fault near Lone Pine. The earthquake is estimated to have had a Richter magnitude of about 8.3, and significantly shook most of California.

In 1952, the White Wolf fault, located approximately 100 miles northwest of Victorville, was responsible for the Kern County earthquake. The earthquake registered 7.5 on the Richter Scale and did significant damage to the Bakersfield and Tehachapi areas. Considerable damage occurred to unreinforced masonry structures and to railroad tunnels located nearby.

The 1971 San Fernando earthquake resulted in extensive damage to structures in parts of San Fernando and the Santa Clarita Valley. The epicenter of the earthquake was located near Soledad Junction approximately 60 miles southwest of Victorville. Strong motion accelerographs recorded ground accelerations as high as 1.25 g at Pacoima Dam near the epicenter of the earthquake. Some structures designed in accordance with the Building Code in effect at the time were extensively damaged. Freeways, hospitals, schools, electrical facilities, water projects, and some residential structures sustained light to major damage as a result of severe ground shaking.

The major 1992 Landers/Big Bear earthquakes also shook the Victorville area. Damage in the Victor Valley was moderate. This earthquake was generated by a system of strike-slip faults in the mountain and desert areas about 55 miles east of Victorville. Structural damage and loss of life was limited primarily because of the remote area of occurrence.

The 1994 Northridge earthquake and related aftershocks significantly shook the Victorville area for 10 to 20 seconds. Like the Whittier Narrows earthquake, this event was produced by a buried thrust fault that underlies portions of the San Fernando Valley and the Santa Susana Mountains. The epicenter of the Northridge earthquake was approximately 70 miles southwest of Victorville.

Another major earthquake to affect the Victorville area was the 1999 Hector Mine earthquake. The epicenter of this magnitude 7.1 earthquake was approximately 60 miles east of northeast of Victorville. Approximately 26 miles of surface rupture occurred along the Lavic Lake fault and the central section of the Bullion fault.

The last major earthquake to affect the Victorville area was the July 2019 Ridgecrest earthquake. The epicenter of this magnitude 7.1 earthquake was approximately 88 miles north-northwest of the site. Surface rupture occurred near segments of the Little Lake fault zone near Ridgecrest.

Seismic intensity, a measure of earthquake effects, is typically described using the Modified Mercalli Scale. A description of damage based on the Modified Mercalli Scale is included in Table 1. For the above-mentioned earthquakes, Modified Mercalli Scale intensities ranged from IV to IX, with the 1857 Fort Tejon and 1992 Landers events generating the highest intensities.

From this analysis, it appears that the past maximum intensity in the Victorville area from major historical earthquakes due to regional faults is on the order of VIII-IX on the Modified Mercalli Scale. Anticipated intensities from a local 7+ magnitude earthquake along the nearby San Andreas fault is VIII-IX. Refer to Table A-1 in Appendix A for a list of active faults and their approximate distances from the site.

Table 5
Modified Mercalli Intensity Scale of 1931[1], (1956 version)[2]

Masonry A, B, C, D. To avoid ambiguity of language, the quality of masonry, brick or otherwise, is specified by the following lettering.

Masonry A Good workmanship, mortar, and design; reinforced, especially laterally and bound together by using steel, concrete, etc.; designed to resist lateral forces.

Masonry B Good workmanship and mortar; reinforced, but no designed in detail to resist lateral forces.

Masonry C Ordinary workmanship and mortar; no extreme weaknesses like failing to tie in at corners, but neither reinforced nor designed against horizontal forces.

Masonry D Weak materials, such as adobe; poor mortar; low standards of workmanship; weak horizontally.

I.	**Not felt. Marginal and long-period effects of large earthquakes.**
II.	**Felt by persons at rest, on upper floors, or favorably placed.**
III.	**Felt indoors. Hanging objects swing. Vibration like passing of light trucks. Duration estimated. May not be recognized as an earthquake.**
IV.	**Hanging objects swing. Vibrations like passing of heavy trucks; or sensation of a jolt like a heavy ball striking the walls. Standing motor cars rock. Windows, dishes, doors rattle. Glasses clink. Crockery clashes. In the upper range of IV wooden walls and frame creak.**
V	**Felt outdoors; direction estimated. Sleepers wakened. Liquids disturbed, some spilled. Small unstable objects displaced or upset. Doors swing, close, open. Shutters, pictures move. Pendulum clocks stop, start, change rate.**
VI.	**Felt by all. Many frightened and run outdoors. Persons walk unsteadily. Windows, dishes, glassware broken. Knickknacks, books, etc., off shelves. Pictures off walls. Furniture moved or overturned. Weak plaster and masonry D cracked. Small bells ring (church, school). Trees, bushes shaken visibly, or heard to rustle.**
VII.	**Difficult to stand. Noticed by drivers of motor cars. Hanging objects quiver. Furniture broken. Damage to masonry D, including cracks. Weak chimneys broken at roof line. Fall of plaster, loose bricks, stones, tiles, cornices also unbraced parapets and architectural ornaments. Some cracks in masonry C. Waves on ponds; water turbid with mud. Small slides and caving in along sand or gravel banks. Large bells ring. Concrete irrigation ditches damaged.**
VII.	**Steering of motor cars affected. Damage to masonry C; partial collapse. Some damage to masonry B; none to masonry A. Fall of stucco and some masonry walls. Twisting, fall of chimneys, factory stacks, monuments, towers, elevated tanks. Frame houses moved on foundations if not bolted down; loose panel walls thrown out. Decayed piling broken off. Branches broken from trees. Changes in flow or temperature of springs and wells. Cracks in wet ground and on steep slopes.**
IX.	**General panic. Masonry D destroyed; masonry C heavily damaged, sometimes with complete collapse; masonry B seriously damaged. General damage to foundations. Frame structures, if not bolted, shifted off foundations Frames racked. Serious damage to reservoirs. Underground pipes broken. Conspicuous cracks in ground. In alluviated areas sand and mud ejected, earthquake fountains, sand craters.**
X.	**Most masonry and frame structures destroyed with their foundations. Some well-built wooden structures and bridges destroyed. Serious damage to dams, dikes, embankments. Large landslides. Water thrown on banks of canals, rivers, lakes, etc. Sand and mud shifted horizontally on beaches and flat land. Rails bent slightly.**
XI.	**Rails bent greatly. Underground pipelines completely out of service.**
XII.	**Damage nearly total. Large rock masses displaced. Lines of sight and level distorted. Objects thrown into the air.**

[1]Original 1931 version in Wood, H.O., and Neumann, F., 1931, Modified Mercalli intensity scale of 1931: Seismological Society of America Bulletin, v. 53, no. 5, p. 979-987.

[2]1956 version prepared by Charles F. Richter, in Elementary Seismology, 1958, p. 137-138, W. H. Freeman & Co.

Seismic Risk: While accurate earthquake predictions are not possible, various agencies have conducted statistical risk analyses. In 2013, the California Geological Survey (CGS) and the United States Geological Survey (USGS) presented new earthquake forecasts for California (USGS

UCERF3). We have used these maps in our evaluation of the seismic risk at the site. The recent Working Group of California Earthquake Probabilities (WGCEP, 2014) estimated a 43 percent conditional probability that a magnitude 6.7 or greater earthquake may occur in 30 years (2014 as base year) along the nearby Mojave segment of the San Andreas fault. The revised estimate for a 7.5+ magnitude earthquake along the local San Andreas fault is about 35%. For the nearby Frontal Fault zone, the probability of a 6.7 event in the same time period is estimated at about 2%.

The primary seismic risk at the site is a potential earthquake along the San Andreas fault that is about 19 miles southwest of the site and is considered as fault Type A per the CGS. Geologists believe that the San Andreas fault has characteristic earthquakes that result from rupture of each fault segment. The estimated mean characteristic earthquake is magnitude 7.9 for the Mojave segment of the fault, which is being used for analysis. Historically, the San Andreas fault is responsible for two of the three great earthquakes experienced in the Southern California area. These are the 1812 Wrightwood and the 1857 Fort Tejon earthquakes. The 1857 rupture extended along the San Andreas fault from Parkfield to Cajon Pass and was felt throughout most of California. While the epicenter of this earthquake is assumed to be located near Parkfield, California, the fault rupture extended southeastward to the vicinity of Cajon Pass. No significant earthquakes or fault movements have been attributed to this segment of the San Andreas fault since 1857. A great earthquake that occurred in 1812 near Wrightwood in the eastern San Gabriel Mountains also originated on the San Andreas fault.

In general, Victorville is in a very high seismic risk area. Besides the San Andreas fault, other Holocene-active faults in southern California capable of generating significant seismic shaking include the San Jacinto fault near San Bernardino, the Garlock fault north of Mojave, and the many faults associated with the Eastern California shear zone. Approximately 5,400 earthquakes have been felt in Victorville since 1931 with a conditional probability of approximately 97% that a 5.0 magnitude earthquake will be felt in the next 50 years (Homefacts, 2024)

Soil Liquefaction and Lateral Spreading: Liquefaction is the loss of soil strength from sudden shock (usually earthquake shaking), causing the soil to become a fluid mass. Liquefaction describes a phenomenon in which saturated soil loses shear strength and deforms as a result of increased pore water pressure induced by strong ground shaking during an earthquake. Dissipation of the excess pore pressures will produce volume changes within the liquefied soil layer, which can cause settlement. Shear strength reduction combined with inertial forces from the ground motion may also result in lateral migration (lateral spreading). Factors known to influence liquefaction include soil type, structure, grain size, relative density, confining pressure, depth to groundwater, and the intensity and duration of ground shaking. Soils most susceptible to liquefaction are saturated, loose sandy soils and low plasticity clay and silt.

In general, for the effects of liquefaction to be manifested, groundwater levels must be within 50 feet of the ground surface and the soils within the saturated zone must also be susceptible to liquefaction. Our exploration did not reveal a shallow groundwater table or a perched water table. Our research of nearby water well data and historic groundwater levels indicate both current and historic groundwater tables are greater than 50 feet below the ground surface. Since groundwater tables are greater than 50 feet bgs, and no perched layers were encountered, Earth Systems estimated the potential for liquefaction at the site is low.

Dry Seismic Settlement: The amount of dry seismic settlement is dependent on relative density of the soil, ground motion, and earthquake duration. In accordance with current CGS policy (Earth Systems discussion with Jennifer Thornburg, CGS May 2014), we used a site peak ground acceleration of ⅔ $PGA_{M.}$ The reasoning for using ⅔ PGA_M has stemmed from the limitations of the Pradel (modified Tokimatsu and Seed) method of calculating dry seismic settlement. This issue manifested during the code change from ASCE 7-05 to ASCE 7-10 (2013) and has been continued into the ASCE 7-16 document, where it was no longer codified to evaluate liquefaction and seismic settlement as a design value (S_{DS}/2.5) but to evaluate it at full PGA. PGA_M equated to a maximum considered value and the design spectral response, $S_{DS,}$ is equal to ⅔ S_{MS}, where S_{MS} is the Site Class adjusted maximum considered earthquake value. When using the full PGA_M in Pradel's method, (Pradel's method is the Standard of Care methodology of calculating dry sand settlement), the potential settlements increased dramatically resulting in unreasonable amounts of assumed settlement (stress/strain curves defaulted to 10 percent vertical strain as high acceleration) which did not correlate with field observations of earthquake events. Given these unreasonably high potential settlements and after much discussion with agencies and CGS, the PGA used for dry seismic analysis was returned to a "design" value in practice. This is on the basis that since dry seismic shaking will typically not cause bearing failure (like liquefaction will) but is only settlement related deformation. Earth Systems is in concurrence with this methodology and thus the method utilized for our analysis and that ⅔ PGA_M may be used as an appropriate acceleration in the analysis of seismic settlement of unsaturated soils.

In accordance with the above discussion, we used a site peak ground acceleration of ⅔ PGA_M (where PGA_M = 0.548) and an earthquake magnitude of 7.9 to evaluate dry seismic settlement potential. The design peak ground acceleration values were obtained from the SEAOC/OSHPD online application (https://seismicmaps.org/). Based upon methods presented by Tokimatsu and Seed (1987), the potential for seismically induced dry settlement of soils above the groundwater table for the full soil column height (48½ feet) was calculated in our deeper boring at the site and estimated to be 0.1 inches in boring B-1. Seismic settlement is based on post grading recommendations stated in Section 5.1.

Fissuring and Ground Subsidence: Subsidence is the gradual settling or sudden sinking of the Earth's surface due to subsurface movement of earth materials. It can result in the loss of aquifer storage, increased flooding, cracks and fissures at the land surface, damage to man-made structures, and associated economic costs. The site is not in an area of documented significant subsidence (SMAG 2024).

In areas of fairly uniform thickness of alluvium, fissures are thought to be the result of tensional stress near the ground surface and generally occur near the margins of the areas of maximum subsidence. Surface runoff and erosion of the incipient fissures augment the appearance and size of the fissures.

Changes in pumping regimes can affect localized groundwater depths, related cones of depression, and associated subsidence such that the prediction of where fissures might occur in the future is difficult. In the project area, groundwater depths remain fairly deep and we consider the current subsidence potential low. However, in the event of future nearby aggressive groundwater pumping and utilization, the occurrence of deep subsidence cannot be ruled out. Changes in regional groundwater pumping could result in areal subsidence. The risk of areal

subsidence in the future is more a function of whether groundwater recharge continues and/or over-drafting stops, than geologic processes, and therefore the future risk cannot be predicted or quantified from a geotechnical perspective.

Seismic Hazard Zones: This portion of San Bernardino County has been mapped for the California Seismic Hazard Mapping Act (Ca. PRC 2690 to 2699) for earthquake faults, liquefaction, and slope instability (CGS, 2005). These maps indicate the site is not currently within a designated hazard zone for these maps.

Site Acceleration and Seismic Coefficients: In developing site seismic design criteria, the characteristics of the earth units underlying the site are an important input to evaluate the site response at a given site. Based on the results of our evaluation at the site, the project site is underlain by some artificial fill overlying Quaternary older alluvial deposits. Based on the average field blowcount of 45 for the upper 50 feet of site soils (see Appendix A for output), the site classification for site response is Site Class D according to Table 20.3-1 of ASCE7-16. The D characterization is defined as a soil profile consisting of stiff soil with blowcounts between 15 to 50 blows per foot.

General Procedure: The Code seismic parameter S_1 is 0.447 g (< 0.75 g). The site is not within a designated Alquist-Priolo Earthquake Fault Zone or subject to bearing failure. Estimated shear wave velocities indicate a Site Class D. Seismic Design Category is D. Please see Section 5.8 for further discussion on the method to use for structural evaluation.

Earthquake horizontal peak ground motions of approximately 0.54 g is estimated based upon a 2% probability of exceedance in 50 years SEA US Seismic Design Maps website. Acceleration values provided are estimates only. Actual spectral acceleration values may be more or less than those provided and could exceed 1 g assuming a maximum considered earthquake event occurs on the nearby San Andreas fault. Vertical accelerations are typically 1/3 to 2/3 of the horizontal accelerations, but can equal or exceed the horizontal accelerations depending upon the local site effects and amplification.

2022 CBC Seismic Coefficients: The General Procedure seismic parameters given in Chapter 16 of the 2022 California Building Code are provided in Section 5.8 of this report.

3.7.1 Other Geologic Hazards

Other seismic hazards related to ground shaking include ground lurching, landslides, tsunamis, seiches, and flooding. Ground lurching is generally associated with fault rupture and liquefaction. As these two hazards are considered unlikely, it is Earth Systems opinion that the potential for ground lurching is also low. Due to the inland location of the site, hazards from tsunamis are considered nonexistent.

Landslides and Slope Instability: The site is relatively flat and proposed new slopes are anticipated to be less than 8 feet high and at shallow inclination as recommended. The site is not within a current Earthquake Induced Landslide Hazard Zones designated by the California Geological Survey. Therefore, potential hazards from slope instability, landslides, or debris flows are considered very low.

Flooding: The project site lies in an area designated as Zone X: “Areas determined to be outside the 0.2% annual chance floodplain.” This project area and Zone X are identified on FEMA Map No.: 06071C5815H, Panel 5815 of 9400, Map Revised August 28, 2008. Appropriate project civil design, construction, and maintenance can minimize the site sheet flooding potential.

Seiches: Seiching is defined as a periodic oscillation of liquid within a container or reservoir. Its period is determined by the resonant characteristics of the container, as controlled by its physical dimensions. Fluid storage tanks are not located near the project site, and no significant water storage facilities are currently located up gradient of the property. The site is not within a dam inundation zone. Therefore, it is Earth Systems opinion that significant hazards due to local reservoir failure (seiches) are currently considered very low.

Section 4.0
CONCLUSIONS

The following is a summary of our conclusions and professional opinions based on the data obtained from a review of selected technical literature and our field exploration.

General: Based on our recent and past field exploration, laboratory testing, and geotechnical analyses conducted for this study, it is our professional opinion that the site is suitable, from a geotechnical and geologic standpoint, for construction as proposed, provided the recommendations presented in this report are incorporated into project design and construction.

The recommendations presented in this report may change pending a review of final grading plans and foundation plans. Recommendations presented in this report should not be extrapolated to other areas or be used for other projects (beyond those expressly identified within) without our prior review and comment.

Geotechnical Constraints and Mitigation:

- The primary geologic hazard is moderate to severe ground shaking from earthquakes originating on regional faults. A major earthquake originating on the nearby segments of the San Andreas fault zone, and other regional faults would be the critical seismic event that may affect the site within the design life. Engineered design and earthquake-resistant construction increase safety and allow development within seismic areas.
- The underlying geologic condition for seismic design is Site Class D. The site is about 19 miles from a Type A seismic source as defined by the California Geological Survey. A qualified professional should design any permanent structure constructed on the site. The ***minimum*** seismic design should comply with the 2022 edition of the California Building Code.
- The site is not within a currently designated Alquist-Priolo Earthquake Fault Zone. No known faults cross the site. Therefore, the potential for surface fault rupture at the site is considered very low.
- The potential for liquefaction induced settlement is considered low for current groundwater conditions and for historic groundwater conditions for this project. The site is not within an area of significant documented areal subsidence distress.
- The potential for ground subsidence is considered low for this project under current conditions.
- The soils are susceptible to wind and water erosion.
- Other geologic hazards, including flooding, and landslides, are considered very low to low potential on this site.
- Based on current conditions, groundwater is not anticipated to be encountered during construction.
- Based on our laboratory testing, the Expansion Index of the onsite soil is “very low” as defined by ASTM D 4829, however silt zones do exist and if encountered could increase the expansion potential of the soil or fill. Soils should be graded to remove or blend silt soils to achieve a “very low” to “low” Expansion Index. Samples of soils should be tested or observed during grading to confirm or modify these findings.

- Laboratory testing of one sample showed potentially “moderate” corrosivity to buried metallic elements and “negligible” for sulfate exposure to concrete. See Section 3.5 for further information. Site soils should be reviewed by an engineer competent in corrosion evaluation and protection for all elements embedded or founded upon site soils.
- In our professional opinion, structure foundations can be supported on shallow foundations bearing on a zone of properly prepared and compacted soils placed as recommended in Section 5.1, or deep cast in drilled hole foundations for sign structures. The recommendations that follow are based on “very low” to “low” expansion category soils.

Section 5.0
RECOMMENDATIONS

5.1 Site Development and Grading

A representative of Earth Systems should observe site clearing, grading, and the bottoms of excavations before placing fill. Local variations in soil conditions may warrant increasing or decreasing the depth of recompaction and over-excavation. Proper geotechnical observation and testing during construction is imperative to allow the geotechnical engineer the opportunity to verify assumptions made during the design process, to verify that our geotechnical recommendations have been properly interpreted and implemented during construction and is required by the 2022 California Building Code. Preventative measures to reduce seasonal flooding and erosion should be incorporated into site grading plans. Dust control should also be implemented during construction. Site grading should be in strict compliance with the requirements of the local Air Quality Management District.

Observation of fill placement by the Geotechnical Engineer of Record should be in conformance with the 2022 California Building Code. The California Building Code requires full time observation by the geotechnical consultant during site grading (fill placement). Therefore, we recommend that Earth Systems be retained during the construction of the proposed improvements to provide testing and observe compliance with the design concepts and geotechnical recommendations, and to allow design changes in the event that subsurface conditions or methods of construction differ from those assumed while completing this study. Additionally, the California Building Code requires the testing agency to be employed by the project owner or representative (i.e., architect) to avoid a conflict of interest if employed by the contractor. Unless noted otherwise, grading should be performed in general accordance with the 2022 CBC.

Clearing and Grubbing: At the start of site grading (if any), existing vegetation, trees (including the entire rootball), large roots, overly wet and/or soft soil, undocumented fill, pavements, foundations, construction debris, septic tanks, leach fields, deleterious material, trash, and abandoned underground utilities should be removed from the proposed improvement areas. Organic growth should be stripped off the surface and removed from the construction area. Areas disturbed during demolition and clearing should be properly backfilled and compacted as described below.

Buried utilities may be located in the vicinity of the planned structures and within other areas of the project site. All buried structures which are removed should have the resultant excavation backfilled with soil compacted as engineered fill described herein or with a minimum 2-sack cement-sand slurry approved by the project geotechnical engineer. Abandoned utilities should be removed entirely, or pressure-filled with concrete or grout, and be capped. Abandoned buried utilities structures, or foundations should not extend under building limits.

After stripping and grubbing operations, areas to receive fill should be stripped of loose or soft earth materials until a firm subgrade is exposed, as evaluated by the geotechnical engineer or geologist (or their representative). Before the placement of fill or after cut, the existing surface soils within the building pads and improvement areas should be over-excavated as follows:

Building Pad Preparation and Slope Grading: Due to the potentially collapsible soils in the upper soil profile, existing soils within the building pads, slab-on-grade, and foundation areas should be over-excavated a minimum of 6 feet below existing grade, below proposed grade, or 2 feet below the bottom of the footings or foundations, whichever is lower. The over-excavation should extend laterally a distance of 6 feet from the outside edge of the slab or footings, or the depth of overexcavation, whichever is deeper, where possible, as approved by the project geotechnical engineer. The exposed undisturbed subgrade bottom should be observed and tested by the geotechnical engineer or his representative to verify an in-place density of the subgrade is at or greater than 85% relative compaction per ASTM D 1557 or soils are firm (as determined by the geotechnical engineer or his representative). Deeper over-excavation may be recommended if the required in-place density is not achieved, soils are not firm, or undocumented fill exists.

The approved bottom of the over-excavation should then be scarified 12 inches; moisture conditioned to near optimum moisture content, and recompacted to at least 90% relative compaction (ASTM D 1557) prior to fill placement. Moisture conditioned and compacted engineered fill should then be placed to finish subgrade elevation in suitable compacted lifts. Compaction should be to at least 90% relative compaction prior to the placement of subsequent lifts with the final upper 12 inches of pad subgrade compacted to at least 95% relative compaction. Compaction should be verified by testing.

The adjacent property cut slope should be excavated and reconstructed as a buttress fill slope. The slope should be excavated a minimum of 5 feet below the slope face (normal to the face) and be reconstructed in a series of benches (2 horizontal feet for every 1 foot vertical) as compacted engineered fill. A key way should also be constructed at the slope toe. See Section J of the 2022 CBC and Section 5.5 within for slope grading requirements.

Auxiliary Structures Subgrade Preparation: Auxiliary structures such as retaining walls, site walls, lightly loaded equipment pads (less than 2 kips), or other site structures with foundations, etc., unless otherwise noted, should have the foundation subgrade prepared similar to the building pad recommendations given above. The over-excavation should extend horizontally for 2 feet beyond the outer edge. The exposed soils should then be moisture conditioned to near optimum moisture content, and recompacted to at least 90 percent relative compaction (ASTM D 1557). Moisture conditioned, engineered fill may then be placed to finished subgrade in suitable, compacted lifts. Compaction should be verified by testing.

Subgrade Preparation: In areas to receive fill not supporting structure, pavements, or hardscape the subgrade should be scarified; moisture conditioned and compacted to at least 90% relative compaction (ASTM D 1557) for a depth of 2 feet below existing grade or finished subgrade, whichever is deeper. Compaction should be verified by testing.

New Pavement, Hardscape, Area Preparation: In street, drive, permanent parking, and exterior hardscape areas, the subgrade should be over-excavated a minimum depth of 2 feet below existing grade or finish grade, or 2 feet below the slab bottom (whichever is deeper) for the applicable item described above. The excavation bottom should be scarified 8 inches, moisture conditioned to near or over optimum moisture content and be recompacted to at least 90% relative compaction. Engineered fill should then be moisture conditioned, placed in suitable lifts, and compacted to a minimum of 90% relative compaction prior to the placement of subsequent

lifts, with the upper 1 foot compacted to at least 95% relative compaction in parking and drive areas. Compacted fill should be placed to finish subgrade elevation.

All over-excavations should extend to a depth where the project geologist, engineer or his representative has deemed the exposed soils as being suitable for receiving compacted fill. The materials exposed at the bottom of excavations should be observed by a geotechnical engineer or geologist from our office prior to the placement of any compacted fill soils to verify that all old fill is removed. Additional removals may be required as a result of observation and/or testing of the exposed subgrade subsequent to the required over-excavation.

Engineered Fill Soils: The existing native soils when processed appropriately are considered to be suitable for use as engineered fill. Much of the existing on-site soils are very low in Expansion Index and suitable for location under structures or hardscape after remedial grading.

Engineered fill should be generally free from expansive soil (Expansive in this case defined as Expansive Index (EI) greater than 50), vegetation, trash, large roots, overly wet and/or soft soil, clods larger than 3 inches, construction debris, oversized rock (greater than 6 inches) and other deleterious material as determined by the geotechnical engineer or his representative. Deleterious materials should be hauled offsite. Engineered fill soils should have a “very low” to “low” Expansion Index (Expansion Index less than 50).

Engineered fill (and any import) should be placed in maximum 8-inch lifts (loose) and compacted to at least 90 percent relative compaction (ASTM D 1557) near its optimum moisture content prior to placement of a subsequent loose lift. Within pavement and slab areas, the upper 12 inches of subgrade should be compacted to at least 95 percent relative compaction (ASTM D 1557). Compaction should be verified by testing. Rocks larger than 6 inches in greatest dimension should be removed from fill or backfill material.

All soils should be moisture conditioned (if needed) prior to application of compactive effort and prior to foundation, slab-on-grade and pavement placement. Moisture conditioning of soils refers to adjusting the soil moisture to or just above optimum moisture content. If the soils are overly moist so that instability occurs, or if the minimum recommended compaction cannot be readily achieved or pumping or instability exists, it may be necessary to aerate to dry the soil to optimum moisture content or use other means to address soft soils (as approved by the geotechnical engineer prior to use).

Imported fill soils should be “very low” expansion potential granular soils meeting the USCS classifications of ML (as pre-approved by the geotechnical engineer), SM, SP-SM, or SW-SM with a maximum rock size of 3 inches and 5 to 35-percent passing the No. 200 sieve (unless otherwise approved by the geotechnical engineer). The geotechnical engineer should evaluate the import fill soils before hauling to the site. However, because of the potential variations within the borrow source, import soil will not be prequalified by Earth Systems. See also Section 5.3 for coarse grained backfill/fill recommendations and the use of filter fabric.

A program of compaction testing, including frequency and method of test, should be developed by the project geotechnical engineer at the time of grading. Acceptable methods of testing may include Nuclear methods such as those outlined in ASTM D 6938 (Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods). Alternative

methods may include methods outlined in ASTM D 1556 (Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method) or correlation probing with a hand probe.

Sand-Cement Slurry Backfill (Controlled Low Strength Material, CLSM): Where approved by the geotechnical engineer for use, sand-cement "slurry" (controlled low strength material (CLSM)), shall comply with the provisions of this report for the following:

1. Specifications for the preparation of the site prior to placement of the CLSM.
    - Remove any spoils, uncertified fill, loose material, debris and standing water from the existing excavations to a firm subgrade as approved by the geotechnical engineer or his representative.
    - A representative of Earth Systems should observe bottoms of excavations before placing CLSM.
    - CLSM shall not be placed on a sloping surface with a gradient steeper than 5:1 (H:V).
2. Specifications for the CLSM.
    - CLSM shall be ready-mixed by an ACI approved batch plant.
    - Use 2 to 3-sack sand-cement CLSM complying with Caltrans Standard Specification (2015) Section 19-3.02G Controlled Low-Strength Material or similar as approved by the geotechnical engineer. CLSM should have a low or non-shrinkage potential.
    - CLSM must have a 28-day compressive strength of at least 120 psi; however, it is cautioned that increased strength may not be excavatable.
3. Placement of CLSM After Item 1 above is Completed
    i. Place CLSM to the bottom of the foundation area or, in maximum 3-foot lifts (the minimum placement of CLSM should be 12 inches thickness), and allow the CLSM to cure at least for 24 hours or initial set, whichever is longer before placing a subsequent lift. Vibration and rodding of the entire lift should be accomplished during placement. Repeat as needed until the CLSM is within the bottom of the footing.
4. Laboratory or field test method(s) to be used to determine the compressive strength or bearing capacity of the CLSM.
    - Sample CLSM and fabricate test cylinder in accordance with ASTM D4832. Test for density in accordance with ASTM D6023 where there is concern. Test for compressive strength at 28 days in accordance with ASTM D4832.
5. Test methods for determining the acceptance of the CLSM in the field.
    - ASTM D4832-16, Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.
    - ASTM D6023-07, Density (Unit Weight), Yield, Cement Content, and Air Content (Gravimetric) of Controlled Low-Strength Material (CLSM). At placement, wet density should be within 10% of the design wet unit weight.
6. Number and frequency of field tests required to determine compliance with items 4 and 5.

- Fabricate one set of 5 cylinders or cubes for compressive strength testing (average of three), and test for density for each 50 cubic yards or fraction thereof or as directed by the geotechnical engineer (GE) of record or the GE's representative.

Dust Control: The proposed site lies within an area of high potential for wind erosion. The site soils have a fine-grained component of their composition. As such, exposed soil surfaces may be subject to disturbed fine particulate matter (PM_{10}) which can create airborne dust if the soil surface or roadways are not maintained. During construction, watering the soil surface can reduce airborne dust. Alternatively, a dust control palliative may be spray applied to the soil surface to act as a tackifier which contains loose soil particles. Palliatives must be reapplied periodically as they weather and degrade. Further guidance for dust palliatives can be found in reviewing the United States Department of Agriculture publication *Dust Palliative Selection and Application Guide*, Document No. 9977-1207-SDTDC.

5.2 Excavations and Shoring

Excavations should be made in accordance with Cal/OSHA requirements. Using the Cal/OSHA standards and general soil information obtained from the field exploration, classification of the near surface on-site soils will likely be characterized as Type C. Actual classification of site-specific soil type per Cal/OSHA specifications as they pertain to trench safety should be based on real-time observations and determinations of exposed soils by the contractors *Competent Person* (as defined by OSHA) during grading and trenching operations.

Our site exploration and knowledge of the general area indicates there is a high potential for caving and sloughing of site excavations (over excavation areas, utilities, footings, etc.) due to potential dry to damp sandy soil conditions. Lateral bracing or appropriate cut slopes of 1.5:1 (horizontal/vertical) should be provided. No surcharge loads from stockpiled soils or construction materials should be allowed within a horizontal distance measured from the top of the excavation slope and equal to the depth of the excavation. Existing structures adjacent to excavation should be monitored and protected against caving, undermining, and settlement.

The borings were advanced with moderate effort within the existing on-site soils within the anticipated depths of excavation. Conventional equipment should be capable of performing shallow on-site excavations.

Excavations which parallel structures, pavements, or other flatwork, should be planned so that they do not extend into a plane having a downward slope of 1:1 (horizontal: vertical) from the bottom edge of the footings, pavements, or flatwork. Shoring or other excavation techniques may be required where these recommendations cannot be satisfied due to space limitations or foundation layout.

Shoring: Shoring may be required where soil conditions, space, or other restrictions do not allow a sloped excavation. A braced or cantilevered shoring system may be used. Trench boxes should not be placed below or within the pipe zone elevation as their removal may loosen compacted backfill. Positive trench shoring will likely be required (jacks and plates).

A temporary cantilevered shoring system should be designed to resist an active earth pressure equivalent to a fluid weighing as shown in the table below. Braced or restrained excavations

above the groundwater table should be designed to resist a uniform horizontal equivalent soil pressure as presented in the table below.

Table 6
Temporary Cantilevered and Braced Shoring System Parameters

Equivalent Fluid Pressure pounds per cubic foot (pcf)	
Cantilevered	**Braced**
31	50

The values provided above assume a level ground surface adjacent to the top of the shoring and do not include a factor of safety. Fifty percent of an areal surcharge (including construction equipment) placed adjacent to the shoring may be assumed to act as an additional uniform horizontal pressure against the shoring. Special cases such as combinations of slopes and shoring or other surcharge loads may require an increase in the design values recommended above. These conditions should be evaluated by the project geotechnical or shoring engineer on a case-by-case basis. Walls subjected to traffic loads should include a uniform surcharge load equivalent to at least 250 psf for auto or delivery truck (2 axle) traffic kept at least 3 feet from the back of the wall. Retaining walls with closer traffic or heavier non-construction HS20 type traffic loads should be designed for a 450 psf surcharge load. Construction equipment and aircraft loads should be considered on a case-by-case basis by the shoring designer.

The wall pressures above the groundwater do not include hydrostatic pressures; it is assumed that drainage will be provided. If drainage is not provided, shoring extending below the groundwater level should be evaluated on a case-by-case basis.

Cantilevered shoring must extend to a sufficient depth below the excavation bottom to provide the required lateral resistance. We recommend required embedment depths be determined using methods for evaluating sheet pile walls and based on the principles of force and moment equilibrium. For this method, the allowable passive pressure against shoring, which extends below the level of excavation, may be assumed to be equivalent to a fluid weighing 275 pcf. Additionally, we recommend a factor of safety of at least 1.2 be applied to the calculated embedment depth and that passive pressure be limited to 1,500 psf.

The contractor should be responsible for the structural design and safety of all temporary shoring systems. The contractor should carefully review the boring logs in this report, and perform their own assessment of potential construction difficulties, and methods should be selected accordingly. Shoring should be sealed to prevent the piping of soil material and potential soil loss conditions which can cause settlement. The method of excavation and support is ultimately left to the contractor with guidance and restrictions provided by the designer and owner. We recommend that existing structures be monitored for both vertical and horizontal movement.

The contractor should carefully review the boring logs in this report, and perform their own assessment of potential construction difficulties, and methods should be selected accordingly. The method of excavation and support is ultimately left to the contractor. A representative from

our firm should be present during grading operations to monitor site conditions; substantiate proper use of materials; evaluate compaction operations; and verify that the recommendations contained herein are met.

5.3 Utility Trenches

Backfill of utilities within roads or public right-of-way should be placed in conformance with the requirements of the governing agency (water district, public works department, etc.). Utility trench backfill within private property should be placed in conformance with the provisions of this report. Backfill operations should be observed and tested to monitor compliance with these recommendations.

Trench Width and Vertical Loads on Pipelines: Vertical loads to the utilities are highly dependent upon the geometry of the trench. In general, the narrower the trench is at the top of the pipe/conduit with respect to the diameter of the conduit, the less vertical load is applied to the conduit. This is because as the trench backfill and bedding compress or consolidate over time, the weight of the soil mass is partially offset by the frictional resistance along the trench sidewalls. In addition, the type of bedding supporting the pipeline affects the bearing strength of the conduit. This is accounted by a load factor that is multiplied to the design strength of the conduit. The pipe manufacturer recommendations for trench installation and maximum width should be followed to reduce the potential for overloading the pipe due to excess backfill load.

Pipe Bedding: Pipeline subgrade should be compacted to a minimum of 90% relative compaction (ASTM D 1557) or be in a firm condition as evaluated by the geotechnical engineer or his representative for a depth of 6 inches below any bedding. Bedding, where specified by the manufacturer, material shall consist of sand 100 percent passing a No. 4 sieve and less than 5 percent fines (passing a No. 200 sieve) with a sand equivalent of 30 or more if jetted, and a fines content no greater than 15 percent with a sand equivalent of 30 or more if mechanically compacted, or as approved by the project inspector and geotechnical engineer. Bedding should be compacted to at least 90% relative compaction or firm (less than 2” insertion of a ½“-probe under typical 200 pound user weight).

Pipe-Zone, Trench–Zone, Trench Backfill and Compaction: Backfill of utilities should be placed in conformance with the requirements of the specifications. Backfill of utilities within roads or public right-of-ways should be placed in conformance with the requirements of the governing agency (water district, public works department, etc.).

Pipe zone backfill material (the pipe area from the bedding to 12 inches above the top of pipe, see figure below) may consist of material as described above for bedding or as dictated by the pipe designer or manufacturer. The pipe zone backfill material should be placed in maximum 8-inch lifts (loose) and compacted near its optimum moisture content. Pipe zone backfill should be compacted to a minimum of 90% relative compaction (ASTM D 1557) or to a firm condition as evaluated by the geotechnical engineer or his representative. Compaction should be assured in the pipe haunches.

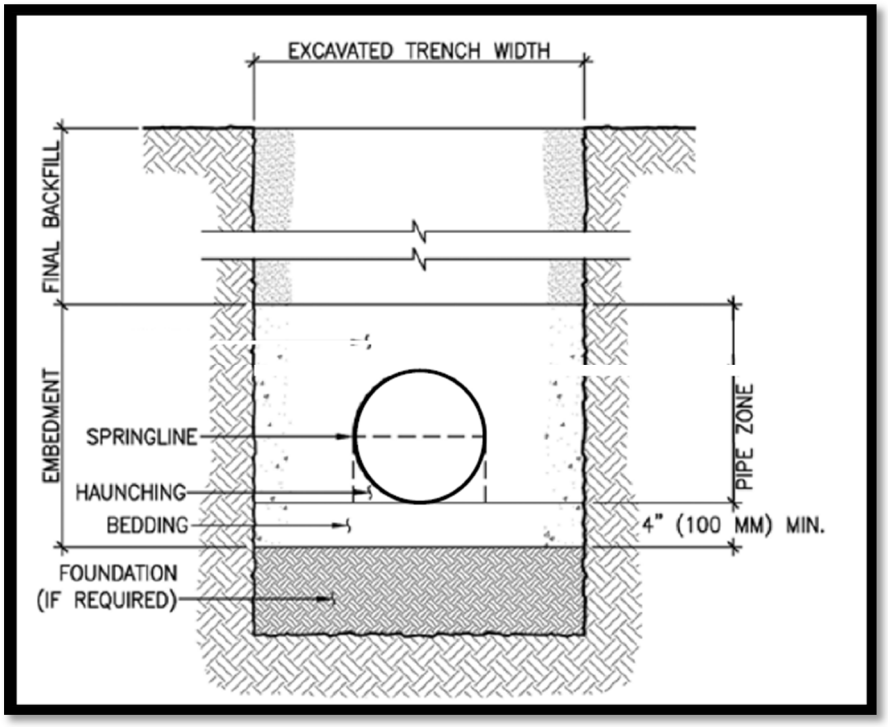


Figure 1 Trench Cross Section

The native soil is suitable for use as trench zone (final backfill) and street zone (and manholes) backfill (from the top of pipe zone up to finished grade), provided it is free of significant organic or deleterious matter, have an Expansion Index of "very low" as evaluated by ASTM D 4829, and oversize materials (greater than 3" in maximum dimension) are removed. The final backfill material should be placed in maximum 8-inch lifts (loose) and be compacted to at least 90% relative compaction (ASTM D 1557) near its optimum moisture content for the trench zone and 95% for the street zone (upper 12 inches) below pavement or Portland cement concrete. Compaction should be verified by testing.

Backfill materials should be brought up at substantially the same rate on both sides of the pipe or conduit. Reduction of the lift thickness may be necessary to achieve the above recommended compaction. Care should be taken to not overstress the piping during compaction operations. Mechanical compaction is recommended; ponding or jetting is not recommended.

Alternatively, if the utility cannot accommodate the increased stress, or if compaction is difficult, we recommend the pipe or conduit be encased on all sides by at least 1 foot of 1-sack cement-sand slurry (at least 1 foot as measured from the top of pipe); Note: 2 sack slurry required if under structural improvements. Grouped conduit should be spaced adequately to allow soil compaction as required within or spaced a minimum of 2 inches edge to edge to allow adequate slurry inflow to encase the conduit(s). Slurry should be tamped, rodded, or vibrated to assure adequate flow. Backfill operations should be observed and tested to monitor compliance with these recommendations.

In general, coarse-grained sand and/or gap graded gravel (i.e. ¾-inch rock or pea-gravel, etc.) should not be used for pipe or trench zone backfill due to the potential for soil migration into the relatively large void spaces present in this type of material and water seepage along trenches

backfilled with coarse-grained sand and/or gravel. Water seepage or soil migration will cause settlement of the overlying soils. Rock backfill, where permitted by the geotechnical consultant, should be wrapped in filter fabric such as Mirafi 140N where there is contact with native or other fill soils.

Compaction should be verified by testing. Backfill operations should be observed and tested to monitor compliance with these recommendations. Trench backfill compacted per these requirements can be expected to settle 0.1 to 0.3 percent of the trench depth. This can cause an elevation difference between backfilled trenches and the surrounding soil or pavement. Increased relative compaction can reduce settlement if the potentials presented are not acceptable. The geotechnical engineer should be consulted on a case-by-case basis to provide further recommendations to reduce the settlement potential if needed.

STRUCTURES

In our professional opinion, site structure foundations, as described in Section 5.4.1 and 5.4.2 can be supported on shallow foundations bearing on a zone of properly prepared and compacted soils as described in Section 5.1.

5.4 Foundations

Footing design of widths, depths, and reinforcing are the responsibility of the Structural Engineer, considering the structural loading and the geotechnical parameters given in this report. A minimum footing depth of 18 inches (below lowest adjacent grade) should be maintained for continuous footings and 24 inches for isolated spread footings and considers a “very low” to “low” Expansion Index soil as per Section 5.1. Lowest adjacent grade is the lowest grade within 3 feet laterally of the footing edge. A representative of Earth Systems should observe foundation excavations to verify compaction (minimum 90% per ASTM D 1557) before placement of reinforcing steel or concrete. Loose soil or construction debris should be removed from footing excavations before placement of concrete. *All footing excavations should be probed for uniformity. Soft or loose zones should be excavated and recompacted to finish foundation bottom subgrade. The bottom of all foundations should be tested to confirm compaction effort and moisture contents as stated in Section 5.1 of this report are met.* The moisture contents should be at least the indicated moisture content 24 hours prior to and immediately prior to placing concrete for a depth of at least 12 inches below the foundation subgrade. If the moisture condition is less than indicated, it shall be brought up to or above the indicated moisture content.

5.4.1 Conventional Shallow Foundations: Allowable soil bearing pressures are given below for foundations bearing on recompacted soils as described in Section 5.1. Allowable bearing pressures are net (weight of footing and soil overburden may be neglected).

- Continuous wall foundations, 12-inch minimum and 24 inches maximum width and 18 inches minimum embedment (or per CBC, whichever is deeper), maximum 36 inches embedment (to bottom of footing):

  2,000 psf for dead plus design live loads

  Allowable increases of 300 psf for each additional 0.5-foot of footing depth may be used up to a maximum value of 3,200 psf.

- Isolated pad foundations, 2 x 2-foot minimum in plan dimension, maximum 7 x 7 feet in plan dimension and 24-inch minimum depth, maximum 4 feet embedment:

  2,400 psf for dead plus design live loads

  Allowable increases of 300 psf for each additional 0.5-foot of footing depth may be used up to a maximum value of 3,600 psf.

Maximum foundation sizes and allowable bearing pressures given above are based on a factor of safety of 3.0 due to Dead + sustained Live loads. In addition, settlements were evaluated to determine maximum allowable bearing stress and limitation of foundation sizing. Transient loads such as earthquake or wind loads are not subject to the stated size limitations; however, the allowable bearing pressure (including ⅓ increase) should be followed considering the relevant foundation sizes given above. As the provided allowable bearing pressures are soil failure governed, a one-third (⅓) increase in the allowable bearing pressure can be used when calculating resistance to short term wind or seismic loads increase allowed if a lessor factor of safety is permitted (see Table 4).

The table below is based upon the above presented allowable, short term, and ultimate bearing pressures. Values may be increased by the provisions given above. Short Term allowable bearing may use the values presented below (based on Allowable Stress Design) or be based on Code mandated structural reductions, whichever is less. Ultimate bearing capacities consider a factor of safety of 1 (ASD design) and a safety factor of 2.25 on transient loads (1/3 increase). Ultimate bearing to soil failure depends on foundation size and type and could be much greater than 5,400 pounds per square foot (psf) for continuous footings and 6,600 psf for column footings (see Table 4).

Table 7
Bearing Capacity Governed by Allowable Settlement - Continuous and Isolated Foundations

	Allowable Bearing Capacity (psf) (FS = 3)	Short Term (Wind/Seismic) (psf) (FS = 2.25)	Ultimate Bearing Capacity (psf) (FS = 1)
Continuous Foundations	2,000	2,667	6,000
Isolated Pad Foundations	2,400	3,200	7,200

FS = Factor of Safety
Allowable Bearing increase may be used as described above

Minimum Foundation Reinforcement: Minimum reinforcement should be provided by the structural engineer to accommodate the settlement potentials presented within.

A 1:1 (h:v) influence zone may be considered for footing design which extends downward and outward from the footing outside edges. Other structures or footings within this 1:1 projection should include surcharge loading and vice versa if other footings or structures project onto new footings.

The spacing between any large spread footings should be evaluated by the geotechnical engineer during the plan review stage to confirm or modify the settlement estimates and bearing capacity due to large footings and the influences from adjacent footings. A preliminary analysis suggests spacing the footings (adjacent edge to adjacent edge) a lateral distance from one another of the width of the largest footing from any adjacent footing, such that influence effects are minor.

Stepped foundations should be designed in accordance with the 2022 CBC. CBC 2022 and ACI Section 4.3, Table 4.3.1 should be followed for recommended cement type, water cement ratio, and compressive strength. Seismic Design Category for compressive strength determination is 'D'. Due to the potentially corrosive soils, a corrosion engineer should evaluate corrosion protection. Hot weather proportions should be used during high ambient heat days during placement and curing.

Expected Foundation and Fill Settlement: Estimated total static settlement (including collapse) should be less than 1½ inches, based on footings founded remediated or firm soils as recommended within. Differential static settlement between similarly loaded bearing members should be less than ¾ inch and may be designed using a distortion angle of 1:480, which meets typical geotechnical guidelines.

Seismic differential settlement could be on the order of 0.1 inches. Considering static and seismic differential settlements, we estimate a total differential settlement on the order of less than 1 inch. Expressed as an angular distortion, this is approximately 1:480.

Settlement calculations are presented in Appendix A. The actual settlement of large spread footings should be evaluated by the geotechnical engineer during the plan review stage based on the actual column loads to confirm or modify the settlement estimates presented. Settlement of compacted fill is calculated to be on the order of 0.20% of the total fill height.

Earthquake Performance Statement: Depending upon the extent of structural and geotechnical design of exterior flatwork, walls, utilities, roadways, and other similar site improvements, some damage due to seismic events will occur. Note that all of southern California in general is in earthquake country. Site developments in southern California are typically not designed to mitigate anticipated seismic events without some damage. In fact, the Building Code is intended to provide Life-Safety performance, not complete damage-free design. In other words, some damage from earthquakes in the form of structural damage, settlement, cracking, and disruption of utilities is expected and that repair after an earthquake event will likely be required. It is not the standard of practice for site developers to fully mitigate all anticipated earthquake induced hazards. This report is based on that understanding and Standard of Care.

According to literature form Robert W. Day, doors and windows may stick at distortion angles between 1:240 and 1:175. In this situation, a human being could be put in a life-threatening situation. Therefore, Earth Systems recommends the maximum distortion angle using all the settlement conditions including seismic settlements be 1:240 or better. For all settlement

conditions excluding seismic settlement, the structure's maximum distortion angle should be 1:480 unless greater structural design is provided to accommodate the anticipated distortion.

Minimum Slope Setback for Shallow Foundations: Earth Systems recommends a minimum setback distance of +1 feet, where H is the height of the slope. The 2022 California Building Code provides setback distances for foundations along slopes. Setback distances are measured differently for foundations located above the slope and those located below the slope. For foundations located at the top of the slope, the measurement is taken horizontally from the outside face of the foundation footing to the face of the slope. For foundations located below the slope, the horizontal distance is measured from the face of the structure foundation to the toe of the slope. For pools and slopes steeper than 1(H):1(V), please contact Earth System for these setbacks with submittal of detailed information using plan form.

Pier Foundations: Where required, such as for lighting or light standards, or pylon signs, structures can be supported on cast-in-place piers, and the design be based on parameters presented within. Pier design, diameters, depths, and reinforcing are the responsibility of the project Structural Engineer, considering the structural loading and the geotechnical parameters given in this report. A representative of Earth Systems should observe foundation boreholes during excavation, and prior to placement of reinforcing steel or concrete (if any). Loose\soil, water, or construction debris should be removed from foundation excavations prior to placement of concrete.

Due to the small, estimated degree of settlement (less than 1 inch), it is estimated that the majority of load will be carried by side friction that will be mobilized on a pier. Therefore, the drilled pier should be designed as side friction pier without considering end bearing. Frictional and lateral resistance for uncased cast piles may be determined per CBC Section 1810.3.3.1.4 and .5 for silt (ML) soils as per Table 1806.2 and Section 1806.3. The lateral bearing pressure values (psf/ft) given in Table 1806.2 may be used for design. Additionally, where piers are constructed adjacent to the tops of slopes, there should be a minimum distance between the top of the slope and the closest edge of the pier of H/3, where 'H' is the height of the slope, otherwise a lateral resistance reduction must be applied. For piers for structures as described above, founded closer than a distance H/3 to the crest or within the slope area itself, the lateral resistance of the soil should be reduced by 30 percent. The above recommendations have considered slopes no steeper than 2:1 (horizontal:vertical). Steeper slopes will require additional analysis and may change the recommendations presented.

Since the piers are anticipated to be founded within compacted fill or native soil, potential axial load capacity reduction from negative skin friction/downdrag developed from seismic settlement of surrounding soils is anticipated to be nil. The allowable skin friction may be increased by ⅓ for short-term loading due to wind or seismic forces.

Where conditions have a pile located adjacent, but not connected, to a below grade wall, where piles are located at least 2.5 pile diameters from the nearest edge of pile to nearest wall edge considering axial pile loading and 5.5 pile diameters from the nearest edge of pile to nearest wall edge under lateral conditions for lateral loads towards the wall, there is no additional load that needs to be applied to the wall.

Where piers are proposed to be founded within areas protected from erosion by asphalt concrete pavement, the pile depth of embedment may be considered from the underlying soil surface. For piers founded in areas with native soil at the surface, an additional 1.5 feet should be added to the calculated pile embedment due to the potential effects of long-term surficial disturbance and erosion.

The piers are assumed to be a single isolated pile; however, additional piers may be incorporated to accommodate the design loads. If the piers are to be grouped, then the center-to-center spacing between piers should be at least 3 times the pier diameter. With such spacing, no group capacity reduction is considered necessary for the axial or lateral loading conditions. If grouped piers with spacing less than 3 times the pier diameter under axial conditions and 6 times the pier diameter under lateral conditions are required, or Lpile or other design will be utilized, our office can evaluate these conditions on a case-by-case basis.

We recommend a minimum Factor of Safety of 3 be applied to the axial downward load capacities calculated from the data presented. The allowable uplift capacity Factor of Safety should be at least 2 and may include the dead weight of the foundation concrete or driven pile.

Pier Installation: The onsite soils are expected to be excavatable with conventional power drilling. Drilled piers should have a minimum 3 inches of clearance between the embedded post and the soil side wall to allow for adequate placement and flow of concrete and be a maximum of 8 feet in depth, otherwise pre-approval will be required from the geotechnical engineer. To avoid a reduction in lateral and uplift resistance caused by variable subsurface conditions, we recommend that drawings instruct the contractor to notify the engineer if subsurface conditions are significantly different than encountered in our borings. Under these circumstances, it may be necessary to adjust the overall length of the pier.

Drill holes may end up oversize. Casing or other means may be required in a drilled hole. Any "slough" or loose soils at the bottom of the shaft must be removed or tamped prior to setting rebar cages and placing concrete. Extreme care must be exercised to carefully position reinforcing steel cages and place concrete without disturbing the sidewalls of the drilled shafts. We recommend centralizers be used to positively locate rebar cages within the pier shaft. It is recommended that pier excavations that have not received concrete, not be left open overnight and concrete should be placed the same day.

Normally, drilled pier excavations should be made without the use of water. If necessary, water may be used to facilitate removal of cuttings unless it aggravates caving problems. Added water that may accumulate at the bottom of the hole should be removed from the drilled hole prior to placing the concrete. Sidewalls which have softened from the addition of water should be cleaned of the soft/loose material. Each excavation should be completed in a continuous operation and the concrete should be placed without undue delay. The contractor should use appropriate means to clean the bottom of the excavation so that no loose material is present at the base of the pier. We do not recommend overdrilling beyond specified pier tip elevations to eliminate the need for bottom cleaning in order to account for slough or loose materials at the excavation bottom. The excavation should be protected with a platform to prevent the collar of the excavation from caving during placing of the concrete. To reduce the potential for caving and sidewall sloughing which may contaminate concrete during placement, and segregation, concrete should be placed by tremie methods and not directly chute-dumped into the hole.

Where casing is used with drilled holes and cannot be withdrawn, the skin friction capacity is theoretically reduced, as are passive resistance and stiffness. The amount of reduction is subject to assessment by the geotechnical consultant. The use of casing with drilled holes should be approved prior to use by the geotechnical engineer.

Concrete Quality and Placement for Drilled Piers: Concrete placement should begin within four hours after completion of drilling. Concrete placement should be continuous without interruption and at such a rate that fresh concrete will not be deposited on concrete that has hardened sufficiently to form cold joints or planes of weakness.

If casing is required, it should be withdrawn as the concrete is being placed, maintaining a 3-foot minimum head of concrete within the casing. This is to prevent reduction in the diameter of the drilled shaft due to earth pressure on the fresh concrete and to prevent extraneous material from falling in from the sides and mixing with the concrete. Concrete placement should continue in this manner until suitable concrete extends to the top of the excavation or forms. The upper ten feet of the pier should be consolidated by vibratory means.

Pier Inspections: Pier capacity is greatly dependent on the soil conditions at the location of the pier and upon contractor means and methods of placement. It is recommended that pier driving or drilled pier drilling operations and concrete placement be performed in the continuous presence of the geotechnical consultant or his representative to confirm that suitable materials for pier support are penetrated, that the dimensions of the installed piers meet the design dimensions, and that the installation has been performed as specified by the 2022 California Building Code. Observation during drilling or driving is required by the 2022 California Building Code on a full-time basis by the geotechnical engineer or his representative. If subsurface conditions noted during drilled pier installation are significantly different than those encountered in our borings, it may be necessary to adjust the overall length of the pier.

Prior to the placement of steel, and again prior to and during the placement of concrete, the excavation must be examined by the geotechnical consultant before proceeding with construction. The contractor should provide all aid and assistance required by the geotechnical and geologic consultants for field monitoring of the drilled pier operations.

Piers are accepted or rejected based on visual observation and testing during construction. The contractor should not allow nor cause any of this work to be permanently enclosed or covered up until it has been observed, tested, and accepted by the geotechnical engineer and all legally constituted authorities having jurisdiction.

The contractor should review the logs of this report and perform their own assessment of potential construction difficulties. However, the logs are only an indicator of potential site conditions, and the contractor is ultimately left to their own experience in regard to potential site conditions.

Expected Pier Settlement: Based on the recommendation for compacted fill, the estimated total settlement should be less than one inch, based on piers founded on firm soils as recommended and the loads presented in Section 1.1. Differential total settlement between similarly loaded bearing members should be less than 1 inch over a distance of approximately 40 feet, expressed in a post-construction angular distortion ratio of 1:480 or better. At a minimum, foundations

should be designed by the structural engineer for the specific static and seismic settlement conditions presented.

5.5 Slope Construction

Slopes are not generally proposed for this project; however, minor slopes (less than 8 feet in height) may be constructed as per Section 5.1. Compacted fill slopes protected against erosion (per approved methods such as significant planting, facing, or erosion blankets, etc.) may be constructed at 2:1 (horizontal: vertical) or flatter inclinations. Unprotected slopes with exposed native soils or compacted fill at the surface should be expected to require repair after heavy nuisance or storm runoff due to significant erosion. Slope recommendations may change pending a more in-depth geotechnical evaluation once design plans are developed. Slopes used as nuisance or storm drainage channel slopes should be no steeper than 3:1 and protected with heavy 12" minimum Rip-Rap.

Compacted fill should be placed at near optimum moisture content and compacted to a minimum 90 percent of the maximum dry unit weight, as measured in relation to ASTM D 1557 test procedures. The exposed face of any slope (upper 12 inches) should have a minimum relative compaction of 90 percent, as measured in relation to ASTM D 1557 test procedures and be compacted at near optimum moisture content. Due to the erodible site soils, slope faces should be protected with facing or densely spaced vegetation to reduce the erosion potential.

Surficial Slope Failures: All slopes will be exposed to weathering, resulting in decomposition of surficial earth materials, thus potentially reducing shear strength properties of the surficial soils. In addition, these slopes become increasingly susceptible to rodent burrowing. As these slopes deteriorate, they can be expected to become susceptible to surficial instability such as soil slumps, erosion, soil creep, and debris flows. Development areas immediately adjacent to ascending or descending slopes should address future surficial sloughing of soil material and erosion. Such measures may include debris fences, slope facing, catchment areas or walls, diversion ditches or berms, soil planting, velocity reducers or other techniques to contain soil material away from developed areas and reduce erosion. Additionally, foundations should be set back at least 5 feet from the edge of slope or as per the 2022 CBC, whichever is greater.

Operation and maintenance inspections should be done after a significant rainfall event and on a time-based criterion (annually or less) to evaluate distress such as erosion, slope condition, rodent infestation burrows, etc. Inspections should be recorded, and photographs taken to document current conditions. The repair procedure should outline a plan for fixing and maintaining surficial slope failures, erosional areas, gullies, animal burrows, etc. Repair methods could consist of excavating and infilling with compacted soil erosional features, track walking the slope faces with heavy equipment, as determined by the type and size of repair. These repairs should be performed in a prompt manner after their occurrence. Slope inclinations should be maintained, and a maintenance program should include identifying areas where slopes begin to steepen. Where future maintenance is not possible, slopes should be faced to reduce the erosion and degradation potential.

Slope faces are highly erodible even if compacted and will gradually erode and move down slope presenting maintenance issues and debris deposited in drainage devices and flatwork areas. The

minimum material necessary to support landscaping should be specified by the landscape consultant (typically less than 6 inches).

5.6 Slabs-on-Grade

Subgrade: Concrete slabs-on-grade and flatwork should be supported by compacted and moisture conditioned soil placed in accordance with Section 5.1 of this report. The moisture content below slabs should be at least optimum moisture content 24 hours prior to and immediately prior to placing concrete for a depth 12 inches. If the moisture condition is less than indicated, it shall be brought up to or above the indicated moisture content.

Vapor Retarder: In areas of moisture-sensitive floor coverings, coatings, adhesives, underlayment, goods or equipment stored in direct contact with the top of the slab, bare slabs, humidity controlled environments, or climate-controlled cooled environments, an appropriate vapor retarder that maintains a permeance of 0.01 perms or less after ASTM E1745's mandatory conditioning tests should be installed to reduce moisture transmission from the subgrade soil to the slab. For these areas, a vapor retarder (Stego wrap 15-mil thickness or equal) should underlie the floor slabs. If a Class A vapor retarder (ASTM E 1745) is specified, the retarder can be placed directly on non-expansive soil and can be covered with a minimum 2 inches of clean sand. At the architect's discretion, the 2-inches of sand can be omitted and the slab concrete placed directly on the vapor retarder; however additional curing and concrete placement techniques are required to reduce the potential for slab cracking and curling.

Clean sand is defined as well or poorly graded sand (ASTM D 2488) of which less than 5 percent passes the No. 200 sieve and all the material passes a No. 4 sieve. The site soils do not fulfill the criteria to be considered clean sand. Alternatively, the slab designer may consider the use of other vapor retarder systems that are recommended by the American Concrete Institute.

Low-slump concrete should be used to help reduce the potential for concrete shrinkage. The effectiveness of the membrane is dependent upon its quality, the method of overlapping, its protection during construction, the successful sealing of the membrane around utility lines, and sealing the membrane at perimeter terminations and of all penetrations. Capillary breaks, if any, beneath slabs should consist of a minimum of at least four inches of permeable base (Caltrans gradation below) material with the following specified gradation.

Table 8
Percent Passing Sieve Size

Sieve Size	Percent Passing
1 inch	100
¾ Inch	90-100
3/8 Inch	40-100
#4	25-40
#8	18-33
#30	5-15
#50	0-7
#200	0-3

Where vapor retarders are placed directly on a gravel capillary break, they should be a minimum of 15 mil thickness.

Where concrete is placed directly on the vapor retarder "plastic", proper curing techniques are essential to minimizing the potential of slab edge curl and shrinkage cracking. The edges of slabs can curl upward because of differential shrinkage when the top of the slab dries to lower moisture content than the bottom of the slab. Curling and cracking are caused by the difference in drying shrinkage between the top and bottom of the slab. Curling and cracking can be exacerbated by hot weather, or dry condition concrete placement, even with proper curing techniques.

The following minimum slab recommendations are intended to address geotechnical concerns such as potential variations of the subgrade and are not to be construed as superseding any structural design. A design engineer should be retained to provide building specific systems to handle subgrade moisture to ensure compliance with SB800 with regards to moisture and moisture vapor.

Slab Thickness and Reinforcement: Structure slabs should be a minimum of 5 inches in actual thickness and be reinforced with # 3 bars at 18 inches on center both ways. Flatwork slabs should be a minimum of 4 inches thick and be jointed to reduce cracking potential. Drive slabs should per Earth Systems trench and pavement report under separate cover. Slabs for forklift traffic should be designed by the structural engineer for these specific loading conditions. Slabs in contact with earth should use closer joints to control cracking or be thickened to allow adequate earth to rebar clearance. Reinforcing bars should extend at least 40 bar diameters into the footings and slabs. Concrete slabs-on-grade and flatwork should be supported by compacted and moisture conditioned soil placed in accordance with this report. If slabs are structural, they should be designed for the specific settlement conditions presented within.

Slab thickness and reinforcement of slabs-on-grade are contingent on the recommendations of the structural engineer or architect and the Expansion Index of the supporting soil. Based upon our findings, a modulus of subgrade reaction of approximately 100 pounds per cubic inch can be used in concrete lightly loaded (not mat) slab design for the expected compacted subgrade. Mat

slab design will require differing modulus values. ACI Section 4.3, Table 4.3.1 should be followed for recommended cement type, water cement ratio, and compressive strength.

If heavily loaded flatwork is proposed (forklift drive areas, heavy racking, etc.), the actual thickness should be designed by the structural engineer utilizing techniques of the American Concrete Institute (ACI) and may be greater than 5 inches in thickness. Concrete floor slabs may either be monolithically placed with the foundations or doweled (No. 4 bar embedded at least 40 bar diameters) after footing placement. The thickness and reinforcing given are not intended to supersede any structural requirements provided by the structural engineer. The project architect or concrete inspector should continually observe all reinforcing steel in slabs during placement of concrete to check for proper location within the slab. The minimum concrete rebar cover should be as per the project architect or structural engineer.

Slab-On-Grade Control Joints: Control joints should be provided in all regular concrete slabs-on-grade at a maximum spacing of 26 to 36 times the slab thickness (12 feet maximum on-center each way, 4 to 6 feet for sidewalks) as recommended by American Concrete Institute [ACI] guidelines. All joints should form approximately square patterns to reduce the potential for randomly oriented shrinkage cracks. Control joints in the slabs should be tooled at the time of the concrete placement or saw cut (¼ of slab depth) as soon as practical but not more than 8 hours from concrete placement. We recommend a concrete joint location plan be included with the project plans by the architect.

Construction (cold) joints, especially at door threshold exterior to interior slab transitions, should be reinforced with thickened butt joints with ¾-inch dowels at 12 inches on center embedded per ACI or a thickened keyed-joint to resist vertical deflection at the joint. All control joints in exterior flatwork should be sealed to reduce the potential of moisture or foreign material intrusion. These procedures will reduce the potential for randomly oriented cracks, but may not prevent them from occurring.

Curing and Quality Control: The contractor should take precautions to reduce the potential of curling and cracking of slabs in this arid desert region using proper batching, placement, and curing methods. Curing is highly affected by temperature, wind, and humidity.

Quality control procedures should be used, including trial batch mix designs, batch plant inspection, and on-site special inspection and testing. Curing should be in accordance with ACI recommendations contained in ACI 211, 304, 305, 308, 309, and 318. Additionally, the concrete should be vibrated during placement. Concrete should be continuously wet cured for at least 7 days with sealed or clipped burlap or plastic and not allowed to dry out to minimize surface cracking.

5.7 Retaining Walls and Lateral Earth Pressures

Retaining Walls: Walls which are restrained at the top such as retaining wall returns, below-grade walls and top of walls tied to floor slabs should be designed with “at rest” earth pressures. Retaining walls, free to tilt at the top 0.2 percent of the wall height, should be designed for “active” earth pressures.

The following list presents lateral earth pressures for use in wall design. The values are given as equivalent fluid pressures ***without*** surcharge loads or hydrostatic pressure. Clay or silt, non-free

draining soils are not suitable for wall backfill. Silty sand material may be used for backfill or free draining material should be imported as wall backfill within the zone of 45 degrees projected up from the wall bottom. For native or import free draining material, active and restrained walls equivalent fluid pressures are as follows:

- Retaining walls should be designed for an active soil pressure equivalent to a fluid density of 31 pcf. The active lateral earth pressures are for slope conditions similar to those on-site and backfills using the on-site soils on walls that are free to rotate at least 0.1 percent of the wall height. Walls, which are restrained against movement or rotation at the top, should be designed for an at-rest equivalent fluid pressure of 50 pcf. Walls retaining sloped backfill of 3:1 or 2:1 should increase the presented fluid pressures by 5 pcf and 8 pcf, respectively. Earth Pressures for walls retaining other sloping backfill above the wall can be provided on a case-by-case basis by the geotechnical engineer. The lateral earth pressure values for level backfill are provided for walls backfilled with drainage materials and “very low” expansive soils.
- In addition to the active or at rest soil pressure, the proposed wall structures should be designed (where not excepted) to include forces from dynamic (seismic) earth pressure. Dynamic pressures are <u>additive</u> to active and at-rest earth pressures (and utilize their respective standard load distribution) and should be considered as an additional 13 pcf for flexible walls, and 25 pcf for rigid walls (Al Atik and Sitar, 2010, Mikola and Sitar, 2013). Seismic pressures are based on PGA_M of 0.548 g (ASCE7-16), Friction Soil Angle of 36^o, and a maximum total moist fill density of 120 pcf.
- The above recommended values do not include compaction or truck-induced wall pressures. Care must be taken during the compaction operation not to overstress the wall. Heavy construction equipment should be maintained a distance of at least 3 feet away from the walls while the backfill soils are placed. Upward sloping backfill or rock, or surcharge loads from nearby footings can create larger lateral pressures. Should any walls be considered for retaining sloped backfill (or rock) or placed next to foundations, our office should be contacted for recommended design parameters. Surcharge loads should be considered if they exist within a zone between the face of the wall and a plane projected 45 degrees upward from the base of the wall. The increase in lateral earth pressure should be taken as 50% of the surcharge load within this zone. Retaining walls subjected to traffic loads should include a uniform surcharge load as described in Section 5.2. Retaining walls should be designed with a minimum factor of safety of 1.5.
- A backdrain or an equivalent system of backfill drainage should be incorporated into the retaining wall design, whereby the collected water is conveyed to an approved point of discharge. Design should be in accordance with the 2022 California Building Code. Drain rock should be wrapped in filter fabric such as Mirafi 140N as a minimum. Backfill immediately behind the retaining structure should be a free-draining granular material or commercial drainage panels behind the wall which lead to an approved outlet system. Waterproofing should be according to the designer’s specifications. Water should not be allowed to pond or infiltrate near the top of the wall. To accomplish this, the final backfill grade should be such that water is diverted away from the retaining wall.
- Compaction on the retained side of the wall within a horizontal distance equal to one wall height (to a maximum of 6 feet) should be performed by hand-operated or other

lightweight compaction equipment (90% compaction relative to ASTM D 1557 at near optimum moisture content). This is intended to reduce potential locked-in lateral pressures caused by compaction with heavy grading equipment. Foundation subgrade preparation should be as specified in Section 5.1.

Frictional and Lateral Coefficients:

- Resistance to lateral loads (including those due to wind or seismic forces) may be provided by frictional resistance between the bottom of concrete foundations and the underlying soil/slurry, and by ½ of the calculated passive soil pressure against the foundations (when combined). An allowable coefficient of friction of 0.35 may be used between cast-in-place concrete foundations and slabs and the underlying soil. An allowable coefficient of friction of 0.30 may be used between pre-cast or formed concrete foundations and slabs and the underlying soil
- Allowable passive pressure may be taken as equivalent to the pressure exerted by a fluid weighing 300 pounds per cubic foot (pcf). The upper 1 foot of soil should not be considered when calculating passive pressure unless confined by overlying asphalt concrete pavement or Portland cement concrete slab. The soils pressures presented have considered onsite fill soils. Testing or observation should be performed during grading by the soils engineer or his representative to confirm or revise the presented values.
- Passive resistance for thrust blocks bearing against firm natural soil or properly compacted backfill can be calculated using an equivalent fluid pressure of 300 pcf. The maximum passive resistance should not exceed 2,000 psf.
- Friction and soil pressure values (resistance) presented above are considered to have a factor of safety of 1.5 in relation to ultimate values (factor of safety = 1) and may be combined. The above values are not permitted to be increased by 1/3 due to short term loads such as wind or seismic forces.
- Construction employing poles or posts (i.e. lamp posts) may utilize design methods presented in Section 1807 of the CBC for Silt (ML) material class. The lateral bearing pressure values (psf/ft) given in Table 1806.2 may be increased by a factor of 1.5 for design if constructed in areas graded per Section 5:1; otherwise no increase is permitted.
- The passive resistance of the subsurface soils will diminish or be non-existent if trench sidewalls slough, cave, or are over-widened during or following excavations. If this condition is encountered, our firm should be notified to review the condition and provide remedial recommendations, if warranted.

5.8 Seismic Design Criteria

This site is subject to strong ground shaking due to potential fault movements along regional faults including the San Andreas fault. Engineered design and earthquake-resistant construction increase safety and allow development of seismic areas. The minimum seismic design should comply with the 2022 edition of the California Building Code and ASCE 7-16 (Supplement 3) using the seismic coefficients given in the table below, which assume Exception 11.4.8 in ASCE 7-16 applies. The site is not within an Alquist-Priolo or other hazard zone, is Site Class D, and the spectral acceleration S_1 is less than 0.75.

Note to the Structural Engineer: the seismic coefficients in Table 9, below, apply to the general procedure for determining seismic coefficients. In other words, the seismic coefficients were not determined by a Site-Specific Ground Motion Analysis, which is allowed if ASCE 7-16's Section 11.4.8 Supplement 3 Exceptions are accepted by the structural engineer.

Additionally, according to the current procedure as outlined in ASCE 7-16, Supplement 3, a ground motion hazard analysis shall be performed in accordance with Section 21.2 for structures:

1) On Site Class D sites with S_1 greater than or equal to 0.2.

> EXCEPTION Item 1: A ground motion hazard analysis is not required where the value of the parameter S_{M1} determined by Eq. (11.4-2) is increased by 50% for all applications of S_{M1} in this Standard. The resulting value of the parameter S_{D1} determined by Eq. (11.4-4) shall be used for all applications of S_{D1} in this Standard.

During plan review of the foundation, **Earth Systems will request a letter from the structural engineer** stating ASCE 7-16's Section 11.4.8 Exception 1 applies to the structures applicable to this report's Table 5 below, which contains the modified S_{M1} and resultant modified S_{D1} values. The structural engineer and client should contact Earth Systems if ASCE 7-16's Exceptions do not apply to the structure/s and request Earth Systems to perform a Site-Specific Ground Motion Hazard Analysis.

General Procedure for seismic parameters is presented below considering a Site Class D shear wave velocity (results in Appendix A). Values were obtained from a web site (https://seismicmaps.org/) using a coordinate location of Latitude 34.5223°N and Longitude 117.3274°W. The structural design engineer should use the most conservative results based of the specific building design and spectral response.

Table 9
2022 CBC (ASCE 7-16) Seismic Parameters

Site Class:	D
Risk Category:	II
Seismic Design Category	D
Maximum Considered Earthquake [MCE] Ground Motion	
Short Period Spectral Response S_s:	1.155 g
1 second Spectral Response, S_1:	0.447 g
Code Design Earthquake Ground Motion	
F_a	1.04
F_v	1.85
F_{PGA}	1.103
S_{MS}	1.199 g
$S_{M1\ (unmodified)}$	0.828 g
$S_{M1\ (ASCE\ 7\text{-}16\ Supplement\ 3\ Modified)}$	1.242 g
Short Period Spectral Response, S_{DS}	0.799 g
1 second Spectral Response, $S_{D1\ (unmodified)}$	0.552 g
1 second Spectral Response, $S_{D1\ (ASCE\ 7\text{-}16\ Supplement\ 3\ Modified)}$	0.828 g
Peak Ground Acceleration (PGA_M) Eq 11.8-1	0.548 g

The intent of the CBC lateral force requirements is to provide a structural design that will resist collapse to provide reasonable life safety from a major earthquake but may experience some structural and nonstructural damage. A fundamental tenet of seismic design is that inelastic yielding is allowed to adapt to the seismic demand on the structure. In other words, *damage is allowed*. The CBC lateral force requirements should be considered a *minimum* design. The owner and the designer may evaluate the level of risk and performance that is acceptable. Performance-based criteria could be set in the design. The design engineer should exercise special care so that all components of the design are fully met with attention to providing a continuous load path. An adequate quality assurance and control program is urged during project construction to verify that the design plans and good construction practices are followed. This is especially important for sites lying close to the major seismic sources.

Spectral accelerations will exceed one g. Actual acceleration may be more or less than estimated. Vertical accelerations are typically ⅓ to ⅔ of the horizontal accelerations, but can equal or exceed the horizontal accelerations, depending upon the local site effects and amplification.

Earthquake Performance Statement: Depending upon the extent of structural and geotechnical design of exterior flatwork, walls, utilities, roadways, and other similar site improvements, some damage due to seismic events will occur. Note that all of southern California in general is

earthquake country. Site developments in southern California are typically not designed to mitigate anticipated seismic events without some damage. In fact, the Building Code is intended to provide Life-Safety performance, not complete damage-free design. In other words, some damage from earthquakes in the form of structural damage, settlement, cracking, and disruption of utilities is expected and that repair after an earthquake event will likely be required. It is not the standard of practice for site developers to fully mitigate all anticipated earthquake induced hazards. It is incumbent on the developer to advise the end-users of the project of the anticipated hazards in the form of disclosure statements during development. This report is based on that understanding and current Standard of Care.

5.9 Driveways and Parking Areas

Pavement structural sections for associated drive areas including recommendations for standard asphalt concrete, and Portland cement concrete are provided below and are based upon on-site soils as described in Section 5.1. Soils differing from those described will require differing pavement sections. The appropriate pavement section depends primarily on the shear strength of the subgrade soil exposed after grading in the near finished subgrade elevation and the anticipated traffic over the useful life of the pavement. R-value testing or observation of subgrade soils should be performed of near finished subgrade elevation soils to verify and/or modify the preliminary pavement sections presented within this report.

Pavement Area Preparation: In street, drive, and parking areas, the exposed subgrade should be overexcavated as recommended in Section 5.1, moisture conditioned, and compacted. Compaction should be verified by testing. Aggregate base should be compacted to a minimum 95% relative compaction (ASTM D 1557).

Traffic and Parking Areas: Pavement sections presented in the following table for automobile type traffic areas and are based on an assumed R-value and current Caltrans design procedures. Truck and Main Drive drives are also included. Traffic Indices (TI) of 5, 7, and 9 were used to facilitate the design of asphalt concrete pavements for parking and main drives, including fire lanes. The fire lane calculation assumed a conservative traffic flow of one fire truck per day entering and exiting the site on the same path (20 year life cycle), and a maximum loading of an 88,000 lb Tandem Axle apparatus (approximate 12,000 lb front axle load and two 34,000 lb rear axles loads) which is based upon the *Emergency Vehicle Size and Weight Regulation Guideline*, dated November 22, 2011, prepared by the Fire Apparatus Manufacturers' Association.

Based on the above stated traffic pattern and apparatus loads, a Traffic Index of 4.6 is calculated for fire lanes. For comparison, a 40 year fire lane life cycle analysis results in a Traffic Index of 5. The TI's assumed below should be reviewed by the project Civil Engineer to evaluate the suitability for this project. All design should be based upon an appropriately selected traffic index. Changes in the traffic indices will affect the corresponding pavement section.

Table 10
Preliminary Flexible Pavement Section Recommendations
On-site/Interior Automobile Drive Areas

R-Value of Subgrade Soils - 39 (Tested) Design Method – CALTRANS

Traffic Index (Assumed)*	Pavement Use	Flexible Pavements** #	
		Asphaltic Concrete Thickness (inches)	Aggregate Base Thickness (inches)
5	Parking Areas & Fire Lanes***	3.0	4.0
7	Parking Lot Main Drive Areas	4.0	7.0
9	Tractor Trailer Access and Main Drive Road/Entrance-Exit Roads	5.5	9.5

*The presented Traffic Indices should be confirmed by the project civil engineer. Changes to the Traffic Index will result in a differing pavement section required.

**Pavement Sections were calculated using Caltrans methodology.

***Where fire lanes will be a part of a main drive use with other traffic, buses, or trucks, the Main Drive Area pavement section should be used.

City of Victorville Street Standards should be referred to where required.

Conventional, rigid pavements, i.e. Portland cement concrete (PCC) pavements, are recommended in areas that will be subject to relatively high static wheel loads and/or heavy vehicle loading and unloading and turning areas (i.e. truck/bus lanes and Trash Truck approach pads). This is due to rutting and shoving, as well as cracking, that can occur due to the heavy vehicle loads and the repetitious set path which is followed at the bus/delivery trucks areas where the same wheel track and stopping occurs generally in the same spot each time. The vehicle load combined with hot summer asphalt (AC) concrete causes the upper surface of the AC to creep forming ruts in conjunction with the braking and accelerating forces which shove the AC. Turning forces also do the same.

The pavement section below is based upon the American Concrete Institute (ACI) Guide for Construction of Concrete Parking Lots, ACI 330R, and the assumptions outlined below.

Table 11
Preliminary Portland Cement Concrete Pavement Sections

Area	Minimum Pavement PCC Thickness (inches)	Minimum 28 Day Flexural Strength (psi)	Concrete Compressive Strength (psi)
Tractor Trailer Drives and Trash Truck Access/Loading Pads (Traffic Category D, ADTT =700)	8.0	550	3,250

Should the actual traffic category vary from those assumed and listed above, these sections should be modified. All above recommended preliminary pavement sections are contingent on the following recommendations being implemented during construction:

- Subsequent to utility installation, the entire pavement (including PCC) final subgrade should be scarified 12 inches, moisture conditioned to near optimum moisture content, and compacted to a minimum 95% relative compaction immediately prior (within a few days) to the placement and compaction of aggregate base to re-establish proper moisture content and compaction in site soils.
- Subgrade soils and aggregate base should be in a stable, non-pumping condition at the time of placement and compaction. Exposed subgrades should be proof-rolled to verify the absence of soft or unstable zones.
- Aggregate base materials should be compacted at near optimum moisture content to at least 95 percent relative compaction (ASTM D 1557) and should conform to Caltrans Class II criteria. Standard Specifications for Public Works Construction “Greenbook: standards (Crushed Aggregate Base Class) may be used in lieu of Caltrans. Compaction efforts should include rubber tire proof-rolling of the aggregate base with heavy compaction-specific equipment (i.e. fully loaded water trucks).
- All concrete curbs separating pavement from landscaped areas should extend at least 6 inches into the subgrade soils to reduce the potential for movement of moisture into the aggregate base layer (this reduces the risk of pavement failures due to subsurface water originating from landscaped areas).
- Portland cement concrete pavements should be constructed with transverse joints at maximum spacing of 12 feet. A thickened edge should be used where possible and, as a minimum, where concrete pavements abut asphalt pavements. The thickened edge should be 1.2 times the thickness of the pavement (8½ inches for a 7-inch pavement), and should taper back to the PCC thickness over a horizontal distance on the order of 3 feet.
- All longitudinal or transverse control joints should be constructed by hand forming or placing pre-molded filler such as "zip strips." Expansion joints should be used to isolate fixed objects abutting or within the pavement area.

  The expansion joint should extend the full depth of the PCC pavement. Joints should run continuously and extend through integral curbs and thickened edges. We recommend that joint

layout be adjusted to coincide with the corners of objects and structures. In addition, the following is recommended for concrete pavements:

1. Slope pavement at least ½ percent to provide drainage;
2. Provide rough surface texture for traction;
3. Cure PCC concrete with curing compound or keep continuously moist for a minimum of seven days;
4. Keep all traffic off concrete until PCC compressive strength exceeds 2,000 pounds per square inch (truck traffic should be limited until the concrete meets the design strength (3,250 psi); and
5. Consideration should be given to having PCC construction joints keyed or using slip dowels on 24-inch centers to strengthen control and construction joints. Dowels placed within dowel baskets should be incorporated into the concrete at each saw-cut control joint (i.e. dowel baskets and dowels are set in place prior to placement of concrete).

- Portland cement concrete placement and curing should, at a minimum, be in accordance with the American Concrete Institute [ACI] recommendations contained in ACI 211, 304, 305, 308, 309, and 318.
- Asphaltic concrete should be ½-in. or ¾-in. grading and compacted to a minimum of 95% of the 75-below Marshall density (ASTM D 1559) or equivalent.
- Within the structural pavement section areas, positive drainage (both surface and subsurface) should be provided. In no instance should water be allowed to pond on the pavement. Roadway performance depends greatly on how well runoff water drains from the site. This drainage should be maintained both during construction and over the entire life of the project.
- Proper methods, such as hot-sealing or caulking, should be employed to limit water infiltration into the pavement base course and/or subgrade at construction/expansion joints and/or between existing and reconstructed asphalt concrete sections (if any). Water infiltration could lead to premature pavement failure.
- To reduce the potential for detrimental settlement, excess soil material, and/or fill material removed during any footing or utility trench excavation, should not be spread or placed over compacted finished grade soils unless subsequently compacted to at least 90% of the maximum dry unit weight, as evaluated by ASTM D 1557 test procedure, at near optimum moisture content, or 95% if placed under areas designated for pavement.
- Where new roadways will be installed against existing roadways, the repaired asphalt concrete pavement section should be designed and constructed to have at least the pavement and aggregate base section as the original pavement section thickness (for both AC and base) or upon the newly calculated pavement sections presented within, whichever is greater.
- **Pavement designs assume that heavy construction traffic will not be allowed on base cap or finished pavement sections**. **Failure to heed these recommendations will subject the pavement to increased potential for random cracking, distress, premature aging and failure.**

5.10 Surface and Subsurface Site Drainage and Maintenance

Positive drainage should be maintained away from the structures (5 percent for 10 feet minimum) to prevent ponding and subsequent saturation of the foundation soils. Gutters and downspouts in conjunction with a 1 to 2% hardscape grade can be considered as a means to convey water away from foundations if increased fall is not provided. Drainage should be maintained for paved areas. Water should not pond on or near paved areas or foundations. Ponded water can saturate subgrade soils and lead to pavement failure. The following recommendations are provided in regard to site drainage and structure performance:

- Water control and conveyance is a critical aspect of project design. It is highly recommended that landscape irrigation or other sources of water be collected and conducted to an approved drainage device. Landscaping grades should be lowered and sloped such that water drains to appropriate collection and disposal areas. All runoff water should be controlled, collected, and drained into proper drain outlets. Control methods may include curbing, ribbon gutters, landscape vertical barriers in planters, 'V' ditches, or other suitable containment and redirection devices.
- It is highly recommended that landscape irrigation or other sources of water be collected and conducted to an approved drainage device. Site drainage should be devised such that runoff should be directed away from the tops of all graded slopes. Water should not freely flow over slopes or retaining wall faces. Diversion and conveyance structures which can accommodate water and eroded soil should be constructed at the tops and toes of all slopes. Lined swales at the top and bottom of slopes, and at the top of retaining walls are recommended.
- In no instance should water be allowed to flow or pond against structures, slabs or foundations or flow over unprotected slope faces. Adequate provisions should be employed to control and limit moisture changes in the subgrade beneath foundations or structures to reduce the potential for soil saturation. Landscape borders should not act as traps for water within landscape areas. Potential sources of water such as piping, drains, over-spray broken sprinklers, etc., should be frequently examined. Any such leakage, over-spray, or plugging should be immediately repaired.
- Applied irrigation to maintain landscaping should be controlled to the minimum volume and frequency necessary to sustain plant material. Excess and frequent watering could lead to saturation and standing water which increase the potential for soil expansion and failure. The irrigation system designer should consider these conditions in their design and control irrigation accordingly.
- Maintenance of drainage systems and infiltration structures can be the most critical element in determining the success of a design. They must be protected and maintained from sediment-laden water both during and after construction to prevent clogging of the surficial soils any filter medium. The potential for clogging can be reduced by pre-treating structure inflow through the installation of maintainable forebays, biofilters, or sedimentation chambers. In addition, sediment, leaves, and debris must be removed from inlets and traps on a regular basis. Since these and other factors (such as varying soil conditions) may affect the rate of water infiltration, it is imperative to apply a conservative factor of safety [FOS] to unfactored Basic Percolation/Infiltration Rates to provide a reliable basis for design. In order to account not only for the unknown factors above but also for changes of conditions during

the use of the structures such as potential clogging effects due to washing in of soil fines, a FOS between 3 and 12 should be applied to lower infiltration rates as per LA County guidelines.

- The factor of safety should be selected by the project drainage engineer and may be dependent on agency guidelines and the presence of testing, filters, and sedimentation structures. If these measures are provided, the factor of safety can be reduced.
- The drainage pattern should be established at the time of final grading and maintained throughout the life of the project. Additionally, drainage structures should be maintained (including the de-clogging of piping, basin bottom scarification, soil crust removal, etc.) throughout their design life. Maintenance of these structures should be incorporated into the facility operation and maintenance manual. Structural performance is dependent on many drainage-related factors such as landscaping, irrigation, lateral drainage patterns and other improvements.
- Drywells and any gravel fill should be separated from the native soils with filter fabric such as Mirafi 140N or directly similar (similarly approved by the geotechnical engineer).
- Drywells and infiltration underground chambers/structures or basins/trenches should be located at least 50 feet from any structure or be setback outside a projection of 1:1 (h:v) from the projection upward from the bottom of any foundation, whichever is greater.

Section 6.0
LIMITATIONS AND ADDITIONAL SERVICES

6.1 Uniformity of Conditions and Limitations

Our findings and recommendations in this report are based on selected points of current field exploration, laboratory testing, and our understanding of the proposed project. Furthermore, our findings and recommendations are based on the assumption that soil conditions do not vary significantly from those found at specific exploratory locations. Variations in soil or groundwater conditions could exist between and beyond the exploration points. The nature and extent of these variations may not become evident until construction. Variations in soil or groundwater may require additional studies, consultation, and possible revisions to our recommendations.

The planning and construction process is an integral design component with respect to the geotechnical aspects of this project. Because geotechnical engineering is an inexact science due to the variability of natural processes and because we sample only a small portion of the soil and material affecting the performance of the proposed structure, unanticipated or changed conditions can be disclosed during demolition and construction. Proper geotechnical observation and testing during construction is imperative to allow the geotechnical engineer the opportunity to verify assumptions made during the design process and to verify that our geotechnical recommendations have been properly interpreted and implemented during construction. Therefore, we recommend that Earth Systems be retained during the construction of the proposed improvements to observe compliance with the design concepts and geotechnical recommendations, and to allow design changes in the event that subsurface conditions or methods of construction differ from those assumed while completing this investigation. If we are not accorded the privilege of performing this review, we can assume no responsibility for misinterpretation or the applicability of our recommendations. The above services can be provided in accordance with our current Fee Schedule.

Our evaluation of subsurface conditions at the site has considered subgrade soil and groundwater conditions present at the time of our study. The influence(s) of post-construction changes to these conditions such as introduction or removal of water into or from the subsurface will likely influence future performance of the proposed project. It should be recognized that definition and evaluation of subsurface conditions are difficult. Judgments leading to conclusions and recommendations are generally made with incomplete knowledge of the subsurface conditions due to the limitation of data from field studies. The availability and broadening of knowledge and professional standards applicable to engineering services are continually evolving. As such, our services are intended to provide the Client with a source of professional advice, opinions and recommendations based on the information available as applicable to the project location and scope. If the scope of the proposed construction changes from that described in this report, the conclusions and recommendations contained in this report are not considered valid unless the changes are reviewed, and the conclusions of this report are modified or approved in writing by Earth Systems.

Findings of this report are valid as of the issued date of the report. However, changes in conditions of a property can occur with passage of time, whether they are from natural processes or works of man, on this or adjoining properties. In addition, changes in applicable standards occur, whether they result from legislation or broadening of knowledge. Accordingly, findings of

this report may be invalidated wholly or partially by changes outside our control. Therefore, this report is subject to review and should not be relied upon after a period of one year.

This report is issued with the understanding that the owner or the owner's representative has the responsibility to bring the information and recommendations contained herein to the attention of the architect and engineers for the project so that they are incorporated into the plans and specifications for the project. The owner or the owner's representative also has the responsibility to verify that the general contractor and all subcontractors follow such recommendations. It is further understood that the owner or the owner's representative is responsible for submittal of this report to the appropriate governing agencies.

Earth Systems has striven to provide our services in accordance with generally accepted geotechnical engineering practices in this locality at this time. No warranty or guarantee, express or implied, is made. This report was prepared for the exclusive use of the Client and the Client's authorized agents.

Earth Systems should be provided the opportunity for a general review of final design and specifications in order that earthwork and foundation recommendations may be properly interpreted and implemented in the design and specifications. If Earth Systems is not accorded the privilege of making this recommended review, we can assume no responsibility for misinterpretation of our recommendations. The owner or the owner's representative has the responsibility to provide the final plans requiring review to Earth Systems' attention so that we may perform our review.

Any party other than the client who wishes to use this report shall notify Earth Systems of such intended use. Based on the intended use of the report, Earth Systems may require that additional work be performed and that an updated report be issued. Non-compliance with any of these requirements by the client or anyone else will release Earth Systems from any liability resulting from the use of this report by any unauthorized party.

In addition, if there are any changes in the field to the plans and specifications, the Client must obtain written approval from Earth Systems' engineer that such changes do not affect our recommendations. Failure to do so will vitiate Earth Systems' recommendations.

Although available through Earth Systems, the current scope of our services does not include an environmental assessment or an investigation for the presence or absence of wetlands, hazardous or toxic materials in the soil, surface water, groundwater, or air on, below, or adjacent to the subject property.

6.2 Additional Services

This report is based on the assumption that an adequate program of client consultation, construction monitoring, and testing will be performed during the final design and construction phases to check compliance with these recommendations. Maintaining Earth Systems as the geotechnical consultant from beginning to end of the project will provide continuity of services. ***The geotechnical engineering firm providing tests and observations shall assume the responsibility of Geotechnical Engineer of Record.***

Construction monitoring and testing would be additional services provided by our firm. The costs of these services are not included in our present fee arrangements, but can be obtained from our office. The recommended review, tests, and observations include, but are not necessarily limited to, the following:

- Consultation during the final design stages of the project;
- A review of the building and grading plans to observe that recommendations of our report have been properly implemented into the design;
- Observation and testing as well as Special Inspection as required by CBC Sections 17 and Appendix J or local grading ordinances;
- Consultation as needed during construction.

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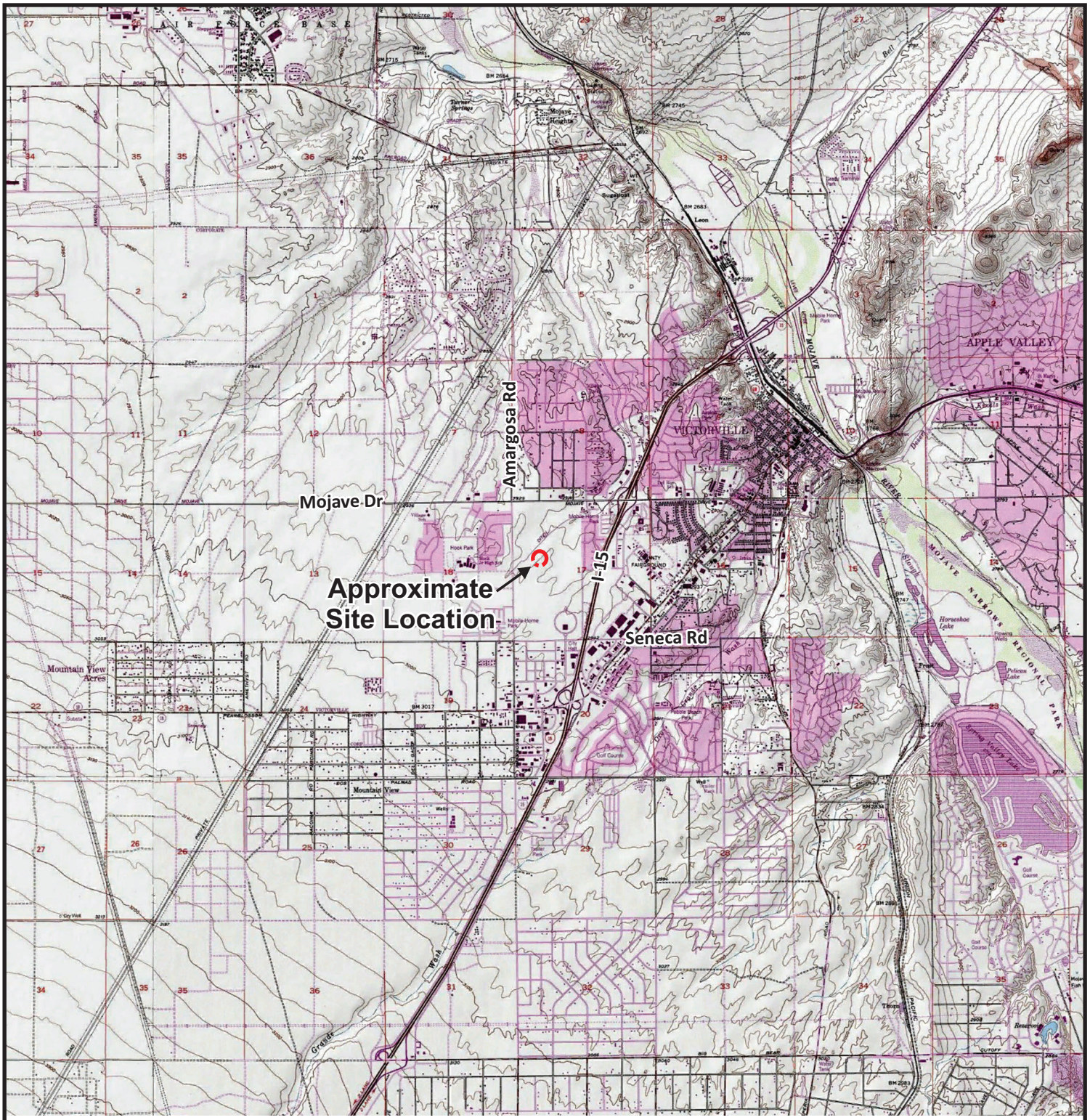
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APPENDIX A

Plate 1 – Site Location Map
Plate 2a – Exploration Location Map
Plate 2b – Local Geologic Map
Plate 3 – Regional Geologic Map
Table A-1 Fault Parameters
Table A-2 Historic Earthquakes
Table A-3 2022 California Building Code Seismic - General Procedure
Terms and Symbols Used on Boring Logs
Soil Classification System
Logs of Geotechnical Borings (9 pages)
Site Class Estimate (1 page)
Dry Seismic Settlement (1 page)
Continuous Footing Settlement (1 page)
Spread Footing Settlement (1 page)



Source: Google Earth satellite image with USGS topographic map overlay.

LEGEND

Approximate Site Location

Approximate Scale: 1" = 1 Mile

0 1 Mile 2 Miles

N

Plate 1
Site Location Map

Proposed Tractor Supply Company
Roy Rogers Drive
Victorville, San Bernardino County, California

Earth Systems

7/26/2024

File No.: 306687-002



LEGEND

B-9 Approximate Exploration Locations

N

Approximate Scale: 1" = 100'

0 100' 200'

Source: Google Earth satellite image dated 8/23/2022, with Durban Development Site Plan Overlay dated 12/14/23

Plate 2a
Exploration Location Map

Proposed Tractor Supply Company
Roy Rogers Drive
Victorville, San Bernardino County, California

Earth Systems

7/26/2024 | File No.: 306687-002



LEGEND

B-9	Approximate Exploration Locations
af	Undocumented Fill
Qoa	Quaternary Older Alluvium

N

Approximate Scale: 1" = 100'

0 100' 200'

Source: Google Earth satellite image dated 8/23/2022

Plate 2b
Local Geologic Map

Proposed Tractor Supply Company
Roy Rogers Drive
Victorville, San Bernardino County, California

Earth Systems

7/26/2024 | File No.: 306687-002



LEGEND

Qs	Dune sand	Qc	Oligocene nonmarine
Qal	Alluvium	Ec	Eocene nonmarine
Ql	Lake deposits	E	Eocene marine
Qg	Glacial deposits	Ep	Paleocene marine
Qr	River terrace deposits	Tc	Tertiary nonmarine
Qm	Pleistocene marine and marine terrace deposits	Tm	Tertiary marine
Qpv	Pleistocene volcanic rocks Qpv^r-rhyolite Qpv^a-andesite Qpv^b-basalt Qpv^p-pyroclastic rocks	Ti	Tertiary intrusive (hypabyssal) rocks Ti^r-rhyolite Ti^a-andesite Ti^b-basalt
Qc	Pleistocene nonmarine	Tl	Tertiary lake deposits
QP	Plio-Pleistocene nonmarine	Tv	Tertiary volcanic rocks Tv^r-rhyolite Tv^a-andesite Tv^b-basalt Tv^p-pyroclastic rocks
	Quaternary and/or Pliocene cinder cones	Ku	Upper Cretaceous marine
Pc	Undivided Pliocene nonmarine	Ju	Upper Jurasssic marine
Pu	Upper Pliocene marine	gr	Mesozoic granitic rocks
Pmlc	Middle and/or lower Pliocene nonmarine	bi	Mesozoic basic intrusive rocks
Pml	Middle and/or lower Pliocene marine	ub	Mesozoic ultrabasic intrusive rocks
Pv	Pliocene volcanic rocks Pv^r-rhyolite Pv^a-andesite Pv^b-basalt Pv^p-pyroclastic rocks	JTrv	Jurassic-Triassic metavolcanic rocks
Mc	Undivided Miocene nonmarine	ls	Pre-Cretaceous metamorphic rocks (ls=limestone)
Muc	Upper Miocene nonmarine	ms	Pre-Cretaceous metasedimentary rocks
Mu	Upper Miocene marine	mv	Pre-Cretaceous metavolcanic rocks
Mm	Middle Miocene marine	gr-m	Pre-Cenozoic granitic and metamorphic rocks
Ml	Lower Miocene marine	pCc	Precambrian igneous and metamorphic rock complex
Mv	Miocene volcanic rocks Mv^r-rhyolite Mv^a-andesite Mv^b-basalt Mv^p-pyroclastic rocks	pC	Undivided Precambrian metamorphic rocks pCg=gneiss pCs=schist pCls=limestone and/or dolomite
		pCgr	Undivided Precambrian granitic rocks

– Fault: Dashed where approximate, dotted where concealed

Source: USGS Geologic Map of California, Santa Ana sheet, dated 1965 & USGS Geologic Map of California, Long Beach sheet, dated 1962

Plate 3
Regional Geologic Map

Proposed Tractor Supply Company
Roy Rogers Drive
Victorville, San Bernardino County, California

Earth Systems

7/26/2024	File No.: 306687-002

Table A-1
Fault Parameters

Fault Section Name	Distance (miles)	Distance (km)	Upper Seis. Depth (km)	Lower Seis. Depth (km)	Avg Dip Angle (deg.)	Avg Dip Direction (deg.)	Avg Rake (deg.)	Trace Length (km)	Fault Type	**Mean Mag**	Mean Return Interval (years)	Slip Rate (mm/yr)
North Frontal (West) FM3.1, 3.2	10.8	17.4	0.0	15.7	49	171	90	50	B	**7.2**		1
Helendale-So Lockhart FM3.1, 3.2	13.1	21.1	0.0	12.8	90	51	180	114	B	**7.4**		0.6
Cleghorn FM3.1, 3.2	15.8	25.4	0.0	15.5	90	187	0	25	B	**6.7**		3
San Andreas (San Bernardino N) FM3.1, 3.2	18.7	30.1	0.0	12.8	90	212	180	35	A	**7.5**	103	27
San Andreas (Mojave S) FM3.1, 3.2	19.0	30.6	0.0	13.1	90	206	180	98	A	**7.7**	102	34
San Jacinto (San Bernardino) FM3.1, 3.2	20.5	33.0	0.0	16.1	90	225	180	37	A	**7.6**	219	17
San Jacinto (Lytle Creek connector) FM3.1, 3.2	21.5	34.5	0.0	16.1	90	na	na	23	B'	**6.7**		
San Andreas, (North Branch, Mill Creek) FM3.1,	24.4	39.3	0.0	18.2	76	204	180	106	A	**7.6**	219	34
Cucamonga FM3.1, 3.2	24.5	39.4	0.0	7.8	45	347	90	28	B	**6.6**		5
San Gabriel (Extension) FM3.1, 3.2	24.9	40.1	0.0	14.7	61	6	180	62	B'	**7.2**		
San Andreas (San Bernardino S) FM3.1, 3.2	26.4	42.5	0.0	12.8	90	210	180	43	A	**7.6**	150	29
Fontana (Seismicity) FM3.1, 3.2	26.5	42.6	0.0	16.3	80	313	na	24	B'	**6.7**		
Lenwood-Lockhart-Old Woman Springs FM3.1, :	27.5	44.3	0.0	13.2	90	43	180	145	B	**7.5**		0.9
North Frontal (East) FM3.1, 3.2	31.7	51.0	0.0	16.6	41	187	90	28	B	**6.9**		0.5
Camp Rock FM3.1, 3.2	32.2	51.9	0.0	15.1	90	na	na	45	B'	**6.9**		
Gravel Hills-Harper Lk FM3.1, 3.2	32.7	52.7	0.0	11.4	90	41	180	65	B	**7.0**		0.7
San Jose FM3.1, 3.2	35.0	56.3	0.0	15.8	74	334	30	20	B	**6.6**		0.5
San Jacinto (San Jacinto Valley) rev FM3.1, 3.2	35.3	56.8	0.0	16.1	90	223	180	18	A	**7.6**	219	18
Clamshell-Sawpit FM3.1, 3.2	35.4	56.9	0.0	14.0	50	334	90	16	B	**6.6**		0.5
Johnson Valley (No) 2011 rev FM3.1, 3.2	35.9	57.7	0.0	15.9	90	51	180	52	B	**6.8**		0.6
Sierra Madre FM3.1, 3.2	36.2	58.3	0.0	14.2	53	19	90	57	B	**7.2**		2
Blackwater FM 3.1, 3.2	37.8	60.8	0.0	12.1	90	55	180	60	B	**7.0**		0.5
Calico-Hidalgo FM3.1, 3.2	39.6	63.7	0.0	13.9	90	52	180	117	B	**7.4**		1.8
San Gorgonio Pass FM3.1, 3.2	40.0	64.3	0.0	18.5	60	11	na	29	B'	**6.9**		
Chino, alt 2, FM3.2	41.3	66.5	0.0	13.4	65	234	150	29	B	**6.7**		1
Chino, alt 1, FM3.1	41.4	66.7	0.0	9.0	50	236	150	24	B	**6.6**		1
Paradise FM3.1, 3.2	41.7	67.1	0.0	13.4	90	255	na	55	B'	**7.0**		
Mission Creek FM3.1, 3.2	42.1	67.8	0.0	17.7	65	5	180	31	B'	**6.9**		
Coyote Lake FM3.1, 3.2	42.5	68.3	0.0	13.4	90	165	na	52	B'	**7.0**		
Manix-Afton Hills FM3.1, 3.2	42.7	68.8	0.0	13.2	90	161	na	59	B'	**7.0**		
San Jacinto (San Jacinto Valley, stepover)	44.8	72.0	0.0	16.1	90	224	180	24	A	**7.6**	219	9
San Jacinto (Stepovers Combined) FM3.1, 3.2	44.8	72.0	0.0	16.5	90	229	180	25	A	**7.5**	110	4
Emerson-Copper Mtn FM3.1, 3.2	44.8	72.1	0.0	14.1	90	51	180	54	B	**7.0**		0.6
Homestead Valley FM3.1, 3.2	45.0	72.3	0.0	15.9	90	na	na	46	B'	**7.0**		
Raymond FM3.1, 3.2	45.2	72.7	0.0	15.6	79	348	60	22	B	**6.7**		1.5
Yorba Linda FM3.1, 3.2	46.6	74.9	0.0	13.3	90	153	na	18	B'	**6.5**		
Pinto Mtn FM3.1, 3.2	47.3	76.2	0.0	15.5	90	175	0	74	B	**7.2**		2.5
San Andreas (San Gorgonio Pass-Garnet HIll) FM	49.5	79.6	0.0	12.8	58	20	180	56	A	**7.6**	219	24
Whittier, alt 1, FM3.1	49.6	79.8	0.0	12.4	70	24	150	46	A	**7.1**	530	4
Whittier, alt 2 FM3.2	49.6	79.8	0.0	14.1	75	24	150	46	A	**6.9**	165	4

Reference: USGS OFR 2013-1165 (CGS SP 228) Based on Site Coordinates of 34.52231 Latitude, -117.32743 Longitude

Mean Magnitude for Type A Faults based on 0.1 weight for unsegmented section, 0.9 weight for segmented model (weighted by probability of each scenario with section listed as given on Table 3 of Appendix G in OFR 2008-1437). Mean magntude is average of Ellworths-B and Hanks & Bakun moment area relationship.

Site Coordinates: 34.522 N 117.327 W

Table A-2
Historical Earthquakes in Vicinity of Project Site, M >= 5.0

		Epicenter		*Distance*	
		Latittude	*Longitude*	*from*	*Magnitude*
Day	*Year*	*(Degrees)*		*Site (mi)*	M_W
7/22	1899	34.30	117.50	18.2	**6.4**
9/12	1970	34.27	117.53	20.9	**5.2**
12/8	1812	34.37	117.65	21.2	**7.5**
7/30	1894	34.30	117.60	21.8	**6.2**
12/16	1858	34.20	117.40	22.6	**6.0**
7/22	1899	34.20	117.40	22.6	**5.9**
6/14	1892	34.20	117.50	24.3	**5.5**
10/16	1999	34.24	117.04	25.5	**5.6**
9/20	*1907	34.20	117.10	25.8	**5.8**
12/4	1992	34.37	116.90	26.5	**5.2**
2/10	2001	34.29	116.95	26.8	**5.1**
8/29	1943	34.31	116.93	27.0	**5.3**
11/27	1992	34.34	116.90	27.4	**5.3**
6/28	1992	34.26	116.91	29.9	**5.3**
2/22	2003	34.31	116.85	30.9	**5.2**
1/16	1930	34.20	116.90	33.0	**5.5**
1/16	1930	34.18	116.92	33.1	**5.1**
2/28	1990	34.14	117.70	33.9	**5.7**
7/9	1992	34.24	116.84	33.9	**5.3**
8/17	1992	34.20	116.86	34.7	**5.2**
6/28	1992	34.20	116.83	36.0	**6.5**
7/23	*1923	34.00	117.25	36.3	**6.2**
6/28	1992	34.16	116.85	37.0	**5.5**
9/5	1928	35.00	117.00	37.9	**5.5**
8/28	1889	34.20	117.90	39.5	**5.6**
1/16	1857	34.52	118.04	40.5	**6.3**
11/22	1880	34.00	117.00	40.6	**5.5**
12/19	1880	34.00	117.00	40.6	**5.9**
6/28	1991	34.27	117.99	41.6	**5.6**
3/18	1997	34.97	116.82	42.2	**5.3**
2/7	1889	34.10	116.70	46.2	**5.6**
7/29	2008	33.96	117.77	46.5	**5.4**
6/1	1975	34.51	116.49	47.7	**5.3**
6/28	1992	34.34	116.51	48.2	**5.4**
4/99	1803	34.20	118.10	49.3	**5.5**
6/12	1944	34.00	116.72	50.0	**5.1**
9/26	1929	34.83	116.52	50.5	**5.1**
6/12	1944	34.01	116.69	50.7	**5.2**
7/1	1992	34.33	116.46	51.2	**5.3**
3/15	1979	34.33	116.44	52.3	**5.5**

From full earthquake catalog in USGS OFR 2008-1437h as updated with current events through 2021. For events with an asterisk, alternate solutions are given in the OFR. Ordered By Closest Event. Maximum 40 Closest Events Shown.

Table A-3 - General Procedure Seismic Design Values

2022 California Building Code (CBC) (ASCE 7-16, Supplement 3) Seismic Design Parameters

(Values presented should only be used by a Structural Engineer to determine if the exception in 11.4.8 (ASCE 7-16) can be used)

				CBC Reference	ASCE 7-16 Reference
Seismic Design Category		**D**			
Site Class		**D**		Table 1613.5.6	Table 11.6-1
Latitude:		34.522		Table 1613.5.2	Table 20.3-1
Longitude:		-117.327			
Maximum Considered Earthquake (MCE) Ground Motion					
Short Period Spectral Reponse	S_S	**1.155**	**g**	Figure 1613.5	Figure 22-1
1 second Spectral Response	S_1	**0.447**	**g**	Figure 1613.5	Figure 22-2
Site Coefficient	F_a	1.04		Table 1613.5.3(1)	Table 11.4-1
Site Coefficient	F_v	1.85		Table 1613.5.3(2)	Table 11-4.2
	S_{MS}	1.199	g	$= F_a x S_S$	
	S_{M1}	0.828	g	$= F_v x S_1$	
ASCE7-16 Supplement 3, Exception 1*	S_{M1*}	1.242	g	$=S_{M1} x 1.5$	Exception 1, 11.4.8, Supplement 3
Design Earthquake Ground Motion					
Short Period Spectral Reponse	S_{DS}	**0.799**	**g**	$= 2/3 x S_{MS}$	
Unadjusted 1 second Spectral Response	S_{D1}	**0.552**	**g**	$= 2/3 x S_{M1}$	
Modified 1 second Spectral Response*	S_{D1*}	**0.828**	**g**	$= 2/3 x S_{M1}$*	*Exception 1, 11.4.8, Supplement 3

Site Specific Evaluation May Be Required for Site Class=D or E & S1>=0.2. The Above SDS and SD1 are NOT Valid Unless the Exception of ASCE7-16 Supplement 3, Section 11.4.8 Applies & the SM1* & SD1* Values are used for Site Class D.

To		0.14	sec	$= 0.2 * S_{D1}/S_{DS}$
Ts (11.4.8 ASCE 7-16 Exception Assumed)		0.69	sec	$= S_{D1}/S_{DS}$
Risk Category		II		Table 1604.5
Seismic Importance Factor		1.00		
	F_{PGA}	1.10		
	PGA_M	**0.55**		
Vertical Coefficient (C_V)		1.33		Table 11.9-1

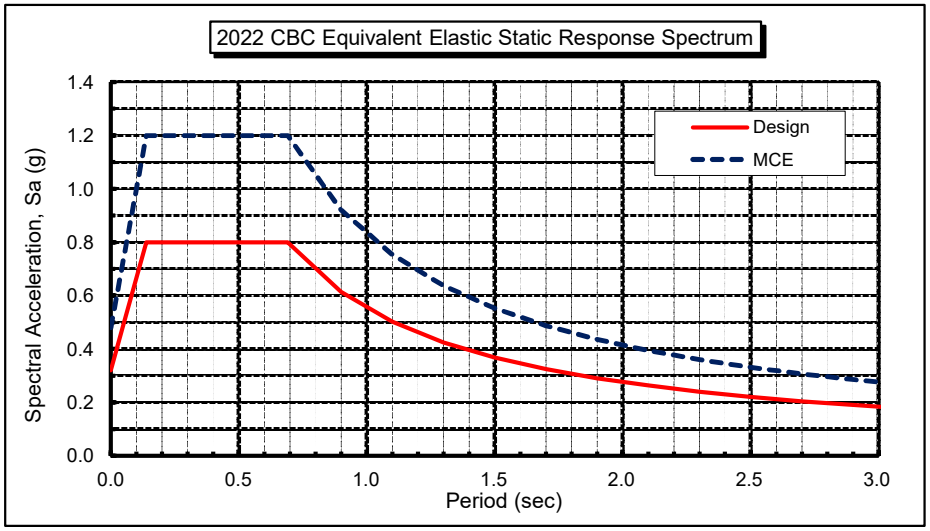
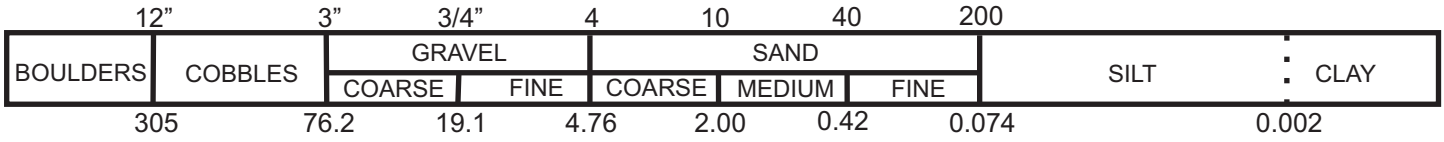


Table 11.5-1 Period T (sec)	Design Sa (g)
0.00	0.320
0.05	0.493
0.14	0.799
0.69	0.799
0.90	0.614
1.10	0.502
1.30	0.425
1.50	0.368
1.70	0.325
1.90	0.291
2.10	0.263
2.30	0.240
2.50	0.221
2.70	0.205
2.90	0.190
3.10	0.178

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification is based on ASTM Designations D 2487 and D 2488 (Unified Soil Classification System). Information on each boring log is a compilation of subsurface conditions obtained from the field as well as from laboratory testing of selected samples. The indicated boundaries between strata on the boring logs are approximate only and may be transitional.

SOIL GRAIN SIZE



SOIL GRAIN SIZE IN MILLIMETERS

RELATIVE DENSITY OF GRANULAR SOILS (GRAVELS, SANDS, AND NON-PLASTIC SILTS)

Very Loose	*N=0-4	RD=0-30	Easily push a 1/2-inch reinforcing rod by hand
Loose	N=5-10	RD=30-50	Push a 1/2-inch reinforcing rod by hand
Medium Dense	N=11-30	RD=50-70	Easily drive a 1/2-inch reinforcing rod with hammer
Dense	N=31-50	RD=70-90	Drive a 1/2-inch reinforcing rod 1 foot with difficulty by a hammer
Very Dense	N>50	RD=90-100	Drive a 1/2-inch reinforcing rod a few inches with hammer

*N=Blows per foot in the Standard Penetration Test at 60% theoretical energy. For the 3-inch diameter Modified California sampler,140-pound weight, multiply the blow count by 0.63 (about 2/3) to estimate N. If automatic hammer is used, multiply a factor of 1.3 to 1.5 to estimate N. RD=Relative Density (%). C=Undrained shear strength (cohesion).

CONSISTENCY OF COHESIVE SOILS (CLAY OR CLAYEY SOILS)

Very Soft	*N=0-1	*C=0-250 psf	Squeezes between fingers
Soft	N=2-4	C=250-500 psf	Easily molded by finger pressure
Firm	N=5-8	C=500-1000 psf	Molded by strong finger pressure
Stiff	N=9-15	C=1000-2000 psf	Dented by strong finger pressure
Very Stiff	N=16-30	C=2000-4000 psf	Dented slightly by finger pressure
Hard	N>30	C>4000	Dented slightly by a pencil point or thumbnail

MOISTURE DENSITY

Moisture Condition: An observational term; dry, damp, moist, wet, saturated.
Moisture Content: The weight of water in a sample divided by the weight of dry soil in the soil sample expressed as a percentage.
Dry Density: The pounds of dry soil in a cubic foot.

MOISTURE CONDITION

Dry.....Absence of moisture, dusty, dry to the touch
Damp.....Slight indication of moisture
Slightly Moist.....Very quick (less than 1 minute) color change when exposed to air (granular soil), Below optimum (granular)
Moist.....Color change with period of air exposure (granular soil) Below optimum moisture content (cohesive soil)
Very Moist.....High degree of saturation by visual and touch (granular soil) Above optimum moisture content (cohesive soil), No free water
Wet.....Free surface water

PLASTICITY

DESCRIPTION	FIELD TEST
Nonplastic	A 1/8 in. (3-mm) thread cannot be rolled at any moisture content.
Low	The thread can barely be rolled.
Medium	The thread is easy to roll and not much time is required to reach the plastic limit.
High	The thread can be rerolled several times after reaching the plastic limit.

GROUNDWATER LEVEL

Water Level (measured or after drilling)

Water Level (during drilling)

RELATIVE PROPORTIONS

Trace.....minor amount (<5%)
some.....significant amount
with.....(Typically greater than 15%)
modifier/and...sufficient amount to influence material behavior (Typically >30%)

LOG KEY SYMBOLS

Bulk, Bag or Grab Sample

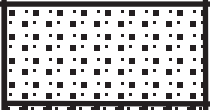
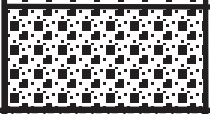
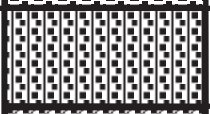
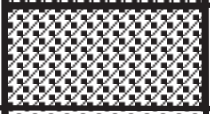
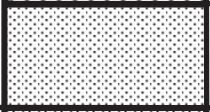
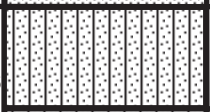
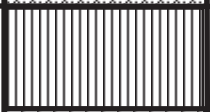
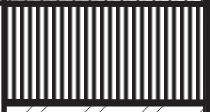
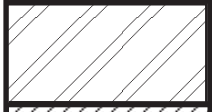
Standard Penetration Split Spoon Sampler (2” outside diameter)

Modified California Sampler (3” outside diameter)

No Recovery

Terms and Symbols Used on Boring Logs

Earth Systems

MAJOR DIVISIONS			GRAPHIC SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS More than 50% of material is larger than No. 200 sieve size	GRAVEL AND GRAVELLY SOILS More than 50% of coarse fraction retained on No. 4 sieve	CLEAN GRAVELS		GW	Well-graded gravels, gravel-sand mixtures, little or no fines
				GP	Poorly-graded gravels, gravel-sand mixtures. Little or no fines
		GRAVELS WITH FINES		GM	Silty gravels, gravel-sand-silt mixtures
				GC	Clayey gravels, gravel-sand-clay mixtures
	SAND AND SANDY SOILS More than 50% of coarse fraction passing No. 4 sieve	CLEAN SAND (Little or no fines)		SW	Well-graded sands, gravelly sands, little or no fines
				SP	Poorly-graded sands, gravelly sands, little or no fines
		SAND WITH FINES (appreciable amount of fines)		SM	Silty sands, sand-silt mixtures
				SC	Clayey sands, sand-clay mixtures
FINE-GRAINED SOILS More than 50% of material is smaller than No. 200 sieve size	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	Inorganic silts and very fine sands, rock flour, silty low clayey fine sands or clayey silts with slight plasticity
				CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
				OL	Organic silts and organic silty clays of low plasticity
		LIQUID LIMIT GREATER THAN 50		MH	Inorganic silty, micaceous, or diatomaceous fine sand or silty soils
				CH	Inorganic clays of high plasticity, fat clays
				OH	Organic clays of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS				PT	Peat, humus, swamp soils with high organic contents
VARIOUS SOILS AND MAN MADE MATERIALS					Fill Materials
MAN MADE MATERIALS					Asphalt and concrete

Soil Classification System

Earth Systems

Earth Systems

1680 Illinois Ave., Perris, CA 92571
Phone (951) 928-9799, Fax (951) 928-9948

Boring No. B-1

Project Name: Proposed Tractor Supply Company
Project Number 306687-002
Boring Location: See Plate 2

Drilling Date: June 17, 2024
Drilling Method: Mobile B-61 CME w/auto hammer
Drill Type: 8" HSA
Logged By: JG

Description of Units

Note: The stratification lines shown represent the approximate boundary between soil and/or rock types and the transition may be gradational.

Depth (Ft.)	Sample Type (Bulk / SPT / MOD Calif.)	Penetration Resistance (Blows/6")	Symbol	USCS	Dry Density (pcf)	Moisture Content (%)	Description
0	Bulk			SM			SILTY SAND: light brown, loose, damp, fine to medium grained sand, some coarse grained sand, and traces of roots, heavy calcium carbonate (CaCO3), white, cemented
	MOD Calif.	29,50/6"			116	3	
5	MOD Calif.	7,9,15		SP	113	3	SAND: light brown, medium dense, damp, fine to coarse grained sand, with traces of gravel to 3/8"
	MOD Calif.	31,50		ML	112	6	SANDY SILT: light tan brown, very stiff, damp, fine to medium grained sand, with traces of CaCO3
10	MOD Calif.	26,50			114	5	
	MOD Calif.	27,50		SM	114	6	SILTY SAND: mottled tan/red brown, dense, damp, fine grained sand, slightly cemented
15	SPT	18,23,25		SM			SILTY SAND: light tan brown, very dense, dry, fine to medium grained sand, no cementation
20	MOD Calif.	25,25,29			115	3	becomes slightly cemented, with lenses of fine to coarse grained sand, damp
25	SPT	16,17,21		SP			SAND: light brown, medium dense, dry, fine to medium grained sand, with some coarse grained sand
30	MOD Calif.	19,25,37		ML	111	6	SANDY SILT: light brown, hard, damp, fine grained sand, slightly cemented
35	SPT	17,28,39					
40	MOD Calif.	19,29,35		SP	111	2	SAND: light brown, medium dense, dry, fine to coarse grained sand, traces of silt
45	SPT	17,30,31		SM		8	SILTY SAND: light brown, dense, damp, fine grained sand, traces of cemented nodules to 1/2"
	MOD Calif.	28,50		ML	110	5	SILT: grey brown, hard, dry, fine grained sand, few iron oxide stains very hard drilling - Refusal
50							
55							Boring refusal at 48-1/2 feet No groundwater encountered Backfilled with cuttings
60							

Graphic Trend
Blow Count Dry Density

Earth Systems

1680 Illinois Ave., Perris, CA 92571
Phone (951) 928-9799, Fax (951) 928-9948

Boring No. B-2

Project Name: Proposed Tractor Supply Company
Project Number 306687-002
Boring Location: See Plate 2

Drilling Date: June 17, 2024
Drilling Method: Mobile B-61 CME w/auto hammer
Drill Type: 8" HSA
Logged By: JG

Description of Units

Note: The stratification lines shown represent the approximate boundary between soil and/or rock types and the transition may be gradational.

Depth (Ft.)	Sample Type (Bulk / SPT / MOD Calif.)	Penetration Resistance (Blows/6")	Symbol	USCS	Dry Density (pcf)	Moisture Content (%)	Description
0	MOD Calif.	50/6"		SM	96	4	SILTY SAND: light brown, dense, dry, fine to medium grained sand, some coarse grained sand, traces of gravel to 1/2" and root hairs, moderately cemented with varying amounts of CaCO3
5	MOD Calif.	21,50		SM	105	6	damp SILTY SAND: very light gray brown, very dense, damp, fine grained sand, severely cemented with CaCO3
	MOD Calif.	15,27,40			119	2	dry
10	MOD Calif.	14,26,28		ML	99	5	SANDY SILT: very light grey brown, hard, damp, moderately cemented with CaCO3
15	Bulk / MOD Calif.	11,17,19		ML			SANDY SILT: brown, hard, dry, fine grained sand
20	MOD Calif.	17,30,39		SM			SILTY SAND: light brown, very dense, dry, fine grained sand
25							
30							
35							
40							
45							
50							
55							End of Boring at 21-1/2 feet No groundwater encountered Backfilled with cuttings
60							

Graphic Trend
Blow Count Dry Density



Earth Systems

1680 Illinois Ave., Perris, CA 92571
Phone (951) 928-9799, Fax (951) 928-9948

Boring No. B-3

Project Name: Proposed Tractor Supply Company
Project Number 306687-002
Boring Location: See Plate 2

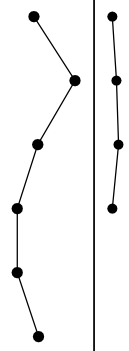
Drilling Date: June 17, 2024
Drilling Method: Mobile B-61 CME w/auto hammer
Drill Type: 8" HSA
Logged By: JG

Depth (Ft.)	Sample Type (Bulk / SPT / MOD Calif.)	Penetration Resistance (Blows/6")	Symbol	USCS	Dry Density (pcf)	Moisture Content (%)	Description of Units
0				SM			SILTY SAND: light brown, very loose, dry, fine to medium grained sand, some coarse grained sand, and traces of gravel 3/8", roots to 1/4"
	MOD Calif.	20,28,43			118	4	very dense, damp
5	MOD Calif.	24,37,48			122	3	
	MOD Calif.	17,26,50			124	2	dry
10	MOD Calif.	19,27,42			118	4	damp
	SPT	14,22,27					becomes fine grained sand
15	SPT	12,16,17					becomes fine to medium grained sand
20							End of Boring at 16-1/2 feet No groundwater encountered Backfilled with cuttings
25							
30							
35							
40							
45							
50							
55							
60							

Description of Units

Note: The stratification lines shown represent the approximate boundary between soil and/or rock types and the transition may be gradational.

Graphic Trend
Blow Count Dry Density



Earth Systems

1680 Illinois Ave., Perris, CA 92571
Phone (951) 928-9799, Fax (951) 928-9948

Boring No. B-4

Project Name: Proposed Tractor Supply Company
Project Number 306687-002
Boring Location: See Plate 2

Drilling Date: June 17, 2024
Drilling Method: Mobile B-61 CME w/auto hammer
Drill Type: 8" HSA
Logged By: JG

Depth (Ft.)	Sample Type (Bulk / SPT / MOD Calif.)	Penetration Resistance (Blows/6")	Symbol	USCS	Dry Density (pcf)	Moisture Content (%)	Description of Units
0				SM			SILTY SAND: light brown, medium dense, dry, fine to medium grained sand, some coarse grained sand
	MOD Calif.	9,18,30		ML	112	5	SANDY SILT: grey brown, very stiff, damp, fine grained sand, slightly cemented, traces of CaCO3
5	MOD Calif.	16,25,30			116	4	
10							
15							
20							
25							
30							
35							
40							
45							
50							
55							End of Boring at 6-1/2 feet No groundwater encountered Backfilled with cuttings
60							

Note: The stratification lines shown represent the approximate boundary between soil and/or rock types and the transition may be gradational.

Graphic Trend
Blow Count Dry Density

Earth Systems

1680 Illinois Ave., Perris, CA 92571
Phone (951) 928-9799, Fax (951) 928-9948

Boring No. B-5

Project Name: Proposed Tractor Supply Comapny
Project Number 306687-002
Boring Location: See Plate 2

Drilling Date: June 17, 2024
Drilling Method: Mobile B-61 CME w/auto hammer
Drill Type: 8" HSA
Logged By: JG

Depth (Ft.)	Sample Type (Bulk / SPT / MOD Calif.)	Penetration Resistance (Blows/6")	Symbol	USCS	Dry Density (pcf)	Moisture Content (%)	Description of Units
0				SM			SILTY SAND: light brown, very dense, dry, fine to medium grained sand, some coarse grained sand, and traces of gravel to 1", with carbonate stringers
	MOD Calif.	15,18,21			112	2	
5				SP			SAND: light brown, very dense, dry, fine to coarse grained sand, with gravel to 1/2" and silt
	MOD Calif.	13,22,31		SM	116	3	
10							SILTY SAND: white, very dense, damp, fine grained sand, cemented heavily with CaCO3
15							
20							
25							
30							
35							
40							
45							
50							
55							End of Boring at 6-1/2 feet No groundwater encountered Backfilled with cuttings
60							

Note: The stratification lines shown represent the approximate boundary between soil and/or rock types and the transition may be gradational.

Graphic Trend
Blow Count Dry Density

Earth Systems

1680 Illinois Ave., Perris, CA 92571
Phone (951) 928-9799, Fax (951) 928-9948

Boring No. B-6

Project Name: Proposed Tractor Supply Company
Project Number 306687-002
Boring Location: See Plate 2

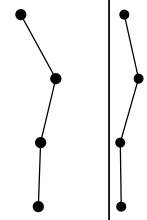
Drilling Date: June 17, 2024
Drilling Method: Bobile B-61 CME w/auto hammer
Drill Type: 8" HSA
Logged By: JG

Description of Units

Note: The stratification lines shown represent the approximate boundary between soil and/or rock types and the transition may be gradational.

Depth (Ft.)	Sample Type (Bulk / SPT / MOD Calif.)	Penetration Resistance (Blows/6")	Symbol	USCS	Dry Density (pcf)	Moisture Content (%)	Description
0	Bulk			SM			SILTY SAND: light brown, loose, damp, fine to medium grained sand, some coarse grained sand, gravel to 1/2"
	MOD Calif.	8,12,22			115	3	becomes more fine, heavily cemented with CaCO3
5	MOD Calif.	30,50/5"		ML	109	7	SANDY SILT: very light brown and white, hard, damp, fine grained sand, heavy CaCO3 cementation
	MOD Calif.	17,24,36			111	6	slight caliche stringers
10	MOD Calif.	19,26,31			112	6	light olive brown, less CaCO3
15							
20							
25							
30							
35							
40							
45							
50							
55							End of Boring at 11-1/2 feet No groundwater encountered Backfilled with cuttings
60							

Graphic Trend
Blow Count Dry Density



Earth Systems

1680 Illinois Ave., Perris, CA 92571
Phone (951) 928-9799, Fax (951) 928-9948

Boring No. B-7

Project Name: Proposed Tractor Supply Comapny
Project Number 306687-002
Boring Location: See Plate 2

Drilling Date: June 17, 2024
Drilling Method: Mobile B-61 CME w/auto hammer
Drill Type: 8" HSA
Logged By: JG

Depth (Ft.)	Sample Type (Bulk / SPT / MOD Calif.)	Penetration Resistance (Blows/6")	Symbol	USCS	Dry Density (pcf)	Moisture Content (%)	Description of Units
0				SM			SILTY SAND: light brown, very loose, dry, fine to medium grained sand, with coarse grained sand
	MOD Calif.	28,50/4"		ML	100	6	SANDY SILT: very light grey brown, hard, damp, fine grained sand, cemented with CaCO3
5	MOD Calif.	21,50		ML	100	4	SANDY SILT: light brown, hard, damp, fine grained sand, with CaCO3 nodules and stringers
10							
15							
20							
25							
30							
35							
40							
45							
50							
55							End of Boring at 6-1/2 feet No groundwater encountered Backfilled with cuttings
60							

Note: The stratification lines shown represent the approximate boundary between soil and/or rock types and the transition may be gradational.

Graphic Trend
Blow Count Dry Density

Earth Systems

1680 Illinois Ave., Perris, CA 92571
Phone (951) 928-9799, Fax (951) 928-9948

Boring No. B-8

Project Name: Proposed Tractor Supply Company
Project Number 306687-002
Boring Location: See Plate 2

Drilling Date: June 17, 2024
Drilling Method: Mobile B-61CME w/auto hammer
Drill Type: 8" HSA
Logged By: JG

Depth (Ft.)	Sample Type (Bulk / SPT / MOD Calif.)	Penetration Resistance (Blows/6")	Symbol	USCS	Dry Density (pcf)	Moisture Content (%)	Description of Units
0	Bulk			SM			SILTY SAND: light brown, loose, dry, fine to medium grained sand, some coarse grained sand, possible Fill
	MOD Calif.	16,22,32		SM	105	3	SILTY SAND: light brown, loose, damp, fine to medium grained sand, some coarse grained sand
5	MOD Calif.	23,50			113	3	slightly cemented with CaCO3 stringers
	MOD Calif.	26,50		SP	111	2	SAND: light brown, medium dense, dry, fine to coarse grained sand, traces of gravel to 3/8"
10	MOD Calif.	7,12,15		ML	105	7	SANDY SILT: light brown and white, hard, damp, fine grained sand, cemented with CaCO3, slight porosity, root hair
	MOD Calif.	15,19,30					
15	MOD Calif.	15,50/4"					less cemented, no CaCO3
	SPT	30,31,35		SM			SILTY SAND: mottled olive/red brown, dense, dry, fine to medium grained sand, traces of coarse grained sand
20	MOD Calif.	24,32,50		SM			SILTY SAND: olive brown, very dense, dry, fine grained sand, strongly cemented
25	SPT	19,24,29		SP-SM			SAND WITH SILT: brown, very dense, dry, fine grained sand with silt Refusal due to hard drilling
30							
35							
40							
45							
50							
55							Boring refusal at 26-1/2 feet No groundwater encountered Backfilled with cuttings
60							

Note: The stratification lines shown represent the approximate boundary between soil and/or rock types and the transition may be gradational.

Graphic Trend
Blow Count Dry Density

Earth Systems

1680 Illinois Ave., Perris, CA 92571
Phone (951) 928-9799, Fax (951) 928-9948

Boring No. B-9

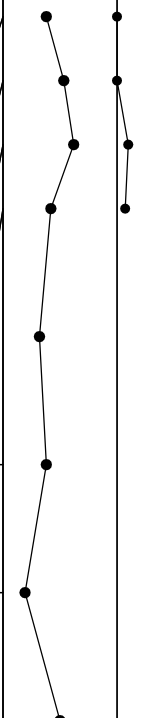
Project Name: Proposed Tractor Supply Company
Project Number 306687-002
Boring Location: See Plate 2

Drilling Date: June 17, 2024
Drilling Method: Mobile B-61 CME w/auto hammer
Drill Type: 8" HSA
Logged By: JG

Depth (Ft.)	Sample Type (Bulk / SPT / MOD Calif.)	Penetration Resistance (Blows/6")	Symbol	USCS	Dry Density (pcf)	Moisture Content (%)	Description of Units
0	Bulk			SM			SILTY SAND: light brown, very loose, dry, fine to medium grained sand, some coarse grained sand and gravel to 1/2", roots to 1/2"
	MOD Calif.	7,18,39		SM	100	5	
5	MOD Calif.	30,50/3"		ML	83	6	SILTY SAND: light brown, loose, damp, fine grained sand, white layers of CaCO3 streaking
	MOD Calif.	9,18,25		SP	111	2	SANDY SILT: very light grey brown, very stiff, damp, fine grained sand, moderately cemented
10	MOD Calif.	15,29,34		ML	108	2	SAND: light brown, dense, dry, fine to coarse grained sand
15	SPT	15,29,24					SANDY SILT: light brown, hard, dry, fine to medium grained sand, some coarse grained sand
20	MOD Calif.	20,25,32		SP			SAND: light brown, dense, dry, fine to coarse grained sand, with traces of silt
25	SPT	10.13.16		ML			CLAYEY SILT: olive brown, very stiff, damp, fine grained sand
30	MOD Calif.	20,31,44		SP			SAND: light brown, dense, dry, fine to coarse grained sand, gravel to 1/2"
35							
40							
45							
50							
55							End of Boring at 31-1/2 feet No groundwater encountered Backfilled with cuttings
60							

Note: The stratification lines shown represent the approximate boundary between soil and/or rock types and the transition may be gradational.

Graphic Trend
Blow Count Dry Density



Boring No.	B-1	Project and Number	Proposed Tractor Sup	306687-002
		ESSW Field Staff		
		Drilling Company	GP Drilling	
		Drilling Method	6-8" H S A	HSA Inner Diameter 3"
		Site Latitude (North)	Decimal Degrees	34.5223°N
		Site Longitude (West)	Decimal Degrees	117.3274°W

Date Drilled
6/17/2024

Hammer Weight (lbs)
140

Hammer Drop (inches)
30

Hammer Efficiency (E_M)
72

Borehole Correction (Cb)*
1

*inside diameter of Hollow Stem Auger

Sampler Correction Mod Cal to SPT
0.63

Sampler Liner Correction (Cs)
1.2 Applied if SPT Sampler Used
1.0 Applied if Cal Sampler Used

Rod Length Above Ground (ft)
3

Depth to Estimate Vs Over (ft)*
100

*Caltrans Estimation Method

*N_{sub} Value Desired For Column 6
70

*Only Used for Calculating Nsub otherwise not used by program (i.e.N50, N70, N80, etc)

Calculation Results
Ave. SPT N_{60HE}-value (blows/ft)
46
(Based on Upper 47.5 feet)
Ave. Shear Wave Velocity (ft/sec)
1017
(Based on Upper 47.5 feet)
Soil Profile Type (Site Class)
D
(Based on Upper 47.5 feet)
Ave. Friction Angle (degrees)
37
(Based on Upper 47.5 feet)
Estimated Shear Wave Velocity **
Based on Depth Less than 100' ft
1024 (ft/sec Upper 100 feet)
Soil Profile Type (Site Class)**
D
Based on
Ave. Shear Wave Velocity (ft/sec)
312 (m/sec Upper 100 feet)
Ave. Field SPT N-value (blows/ft)
38.1
(Based on Upper 47.5 feet)
Ave. Field SPT N-value (blows/ft)
44.7
(Based on Upper 100 feet)

Soil Profile Type (Site Class)**
D
Based on
Ave. Field Blow Count
45 (Upper 100 feet)

	Equipment variable	Typical Correction (%/100)
Energy ratio (Skempton, 1986)	Donut Hammer	0.50 to 1.00
	Safety Hammer	0.70 to 1.20
	Automatic-Trip Donut-type Hammer	0.80 to 1.30

→ Hammer energy as related to the standard 60% delivered energy, i.e. a 72% hammer has and energy ratio of 1.2, i.e. (72/60=1.2)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Bottom of Layer Depth (ft)	Blow Count***	Type of Sampler	d_i (feet)	N_{60} (blows/ft)	N70 (blows/ft)	N_{60HE} (blows/ft)	V_{si}** (m/sec)	V_{si} (ft/sec)	Φ_i (degrees)	d_i/N_{60HEi}	d_i/V_{si}	d_i/Φ_i	Consistency if Coarse Grained (Based on ASTM and Corrected for N60)	Consistency if Fine Grained (Based on ASTM and Corrected for N60)
2.5	79	c	2.5	44.79	38.39	59.72	329.04	1079.25	38.41	0.04186	0.00232	0.065095	Dense	Hard
5.0	24	c	2.5	13.61	11.66	18.14	232.92	763.96	31.80	0.13779	0.00327	0.078622	Medium Dense	Stiff
7.5	81	c	2.5	45.93	39.37	61.24	331.43	1087.11	38.57	0.04083	0.00230	0.064818	Dense	Hard
10.0	76	c	2.5	43.09	36.94	57.46	325.37	1067.20	38.15	0.04351	0.00234	0.065525	Dense	Hard
12.5	77	c	2.5	49.48	42.41	58.21	326.60	1071.26	38.24	0.04295	0.00233	0.06538	Dense	Hard
15.0	48	c	2.5	30.84	26.44	36.29	284.77	934.05	35.37	0.06889	0.00268	0.070684	Dense	Hard
20.0	54	c	5.0	38.78	33.24	40.82	294.67	966.51	36.05	0.12248	0.00517	0.138704	Dense	Hard
25.0	38	c	5.0	27.29	23.39	28.73	266.12	872.87	34.09	0.17405	0.00573	0.146688	Medium Dense	Very Stiff
30.0	62	s	5.0	89.28	76.53	74.40	350.69	1150.26	39.89	0.06720	0.00435	0.125352	Very Dense	Hard
35.0	67	c	5.0	50.65	43.42	50.65	313.69	1028.90	37.35	0.09871	0.00486	0.133858	Very Dense	Hard
40.0	64	s	5.0	92.16	78.99	76.80	353.93	1160.90	40.11	0.06510	0.00431	0.124658	Very Dense	Hard
45.0	61	c	5.0	46.12	39.53	46.12	305.27	1001.28	36.78	0.10842	0.00499	0.135959	Dense	Hard
47.5	78	s	2.5	112.32	96.27	93.60	374.83	1229.45	41.54	0.02671	0.00203	0.060183	Very Dense	Hard
		Total:	47.5	"d" Feet				Total:		1.03850	0.04668	1.275526		

**Used When Boring Depths are less than 100 feet to estimate Shear Wave Velocity over 100 feet. Caltrans Geotechnical Services Design Manual, Version 1.0, August 2009 using N60HE corrected only for Hammer Energy (Empirical Calculation)

*** Uncorrected blowcount not to exceed 100 blows as entry per CBC

Consistency classification based upon ASCE 1996

BOREHOLE, SAMPLER, AND ROD CORRECTION FACTORS

Factor	Equipment Variables	Value
Borehole diameter factor, C_B	2.5 - 4.5 in (65 - 115 mm)	1.00
	6 in (150 mm)	1.05
	8 in (200 mm)	1.15
Sampling method factor, C_S	Standard sampler	1.00
	Sampler without liner	1.20
Rod length factor, C_R	10 - 13 ft (3 - 4 m)	0.75
	13 - 20 ft (4 - 6 m)	0.85
	20 - 30 ft (6 - 10 m)	0.95
	> 30 ft (> 10 m)	1.00

Adapted from Skempton (1986).

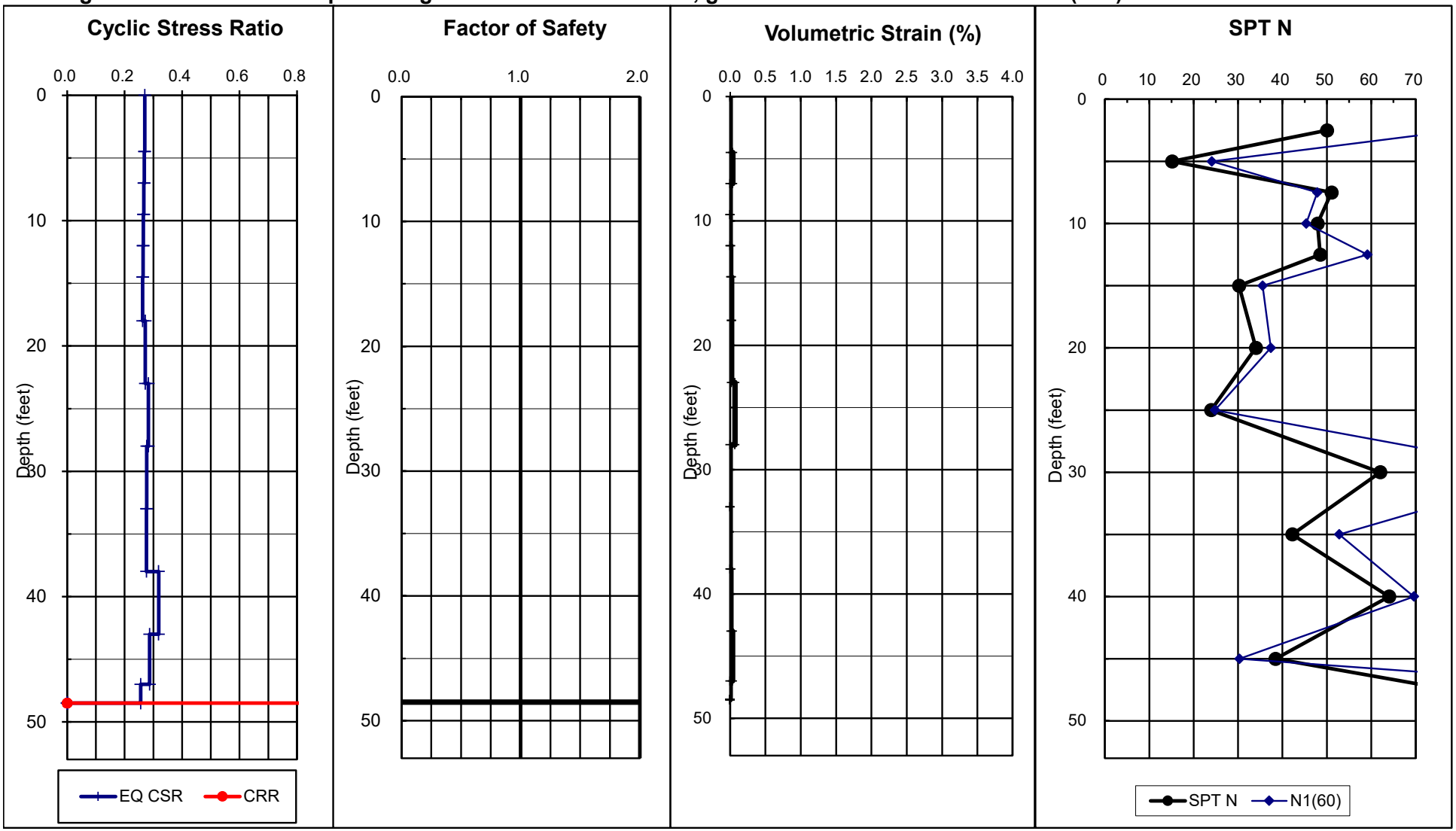
Spreadsheet Version 2.6, 2019: Prepared by Kevin L. Paul, PE, GE

EARTH SYSTEMS - EVALUATION OF LIQUEFACTION POTENTIAL AND INDUCED SUBSIDENCE

Proposed Tractor Supply Company **Project No: 306687-002** 1996/1998 NCEER Method

Ground Compaction Remediated to 5 foot depth

Boring: B-1 **Earthquake Magnitude: 7.9** **PGA, g: 0.37** **Calc GWT (feet): 50**



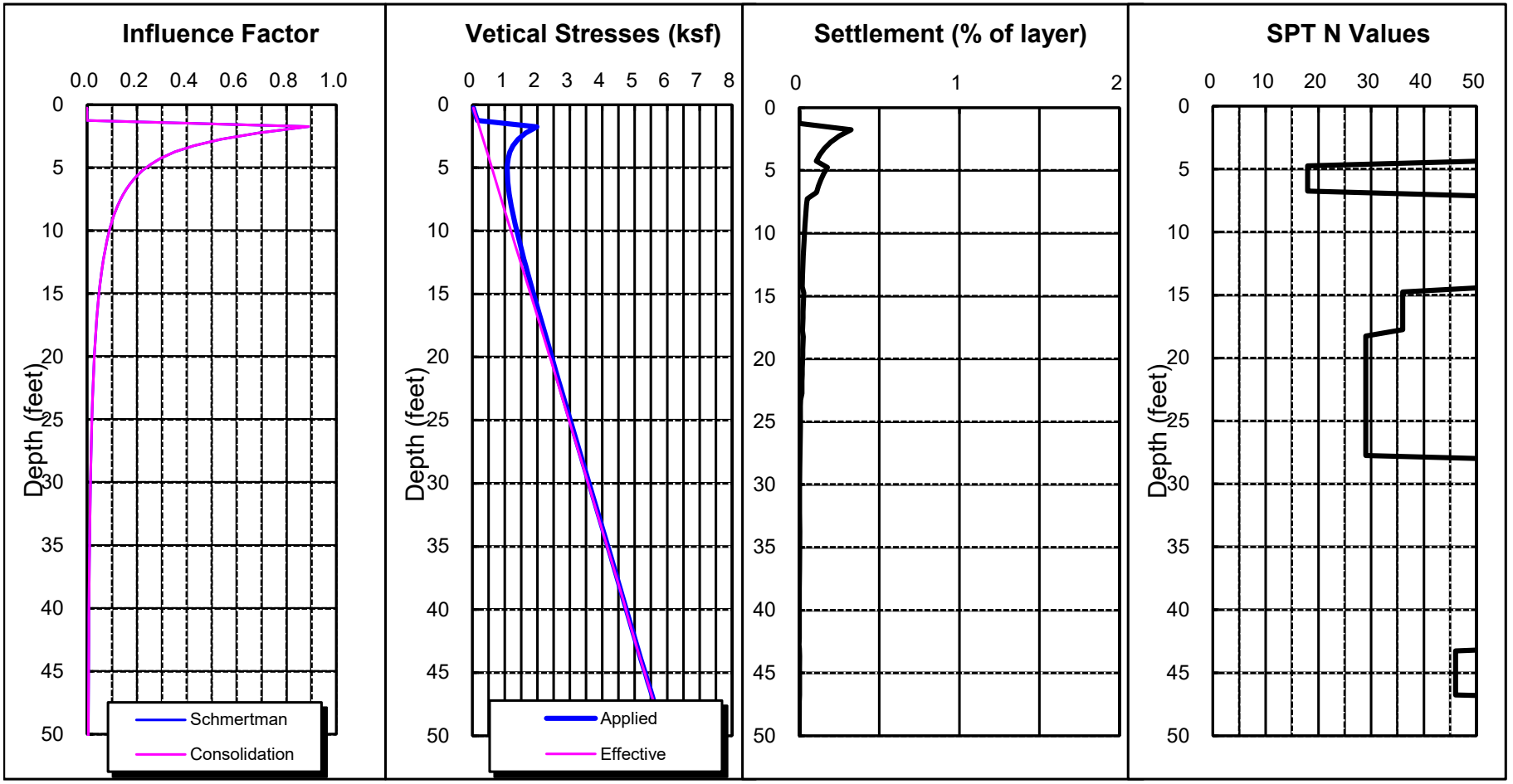
Total Thickness of Liquefiable Layers: 0.0 feet

Estimated Total Ground Subsidence: 0.1 inches

EARTH SYSTEMS - SETTLEMENT ANALYSES

Proposed Tractor Supply Company 306687-002

Width, ft: 2.0 Length, ft: 20.0 Net pressure, ksf: 2.00 **Settlement, inches: 0.2**

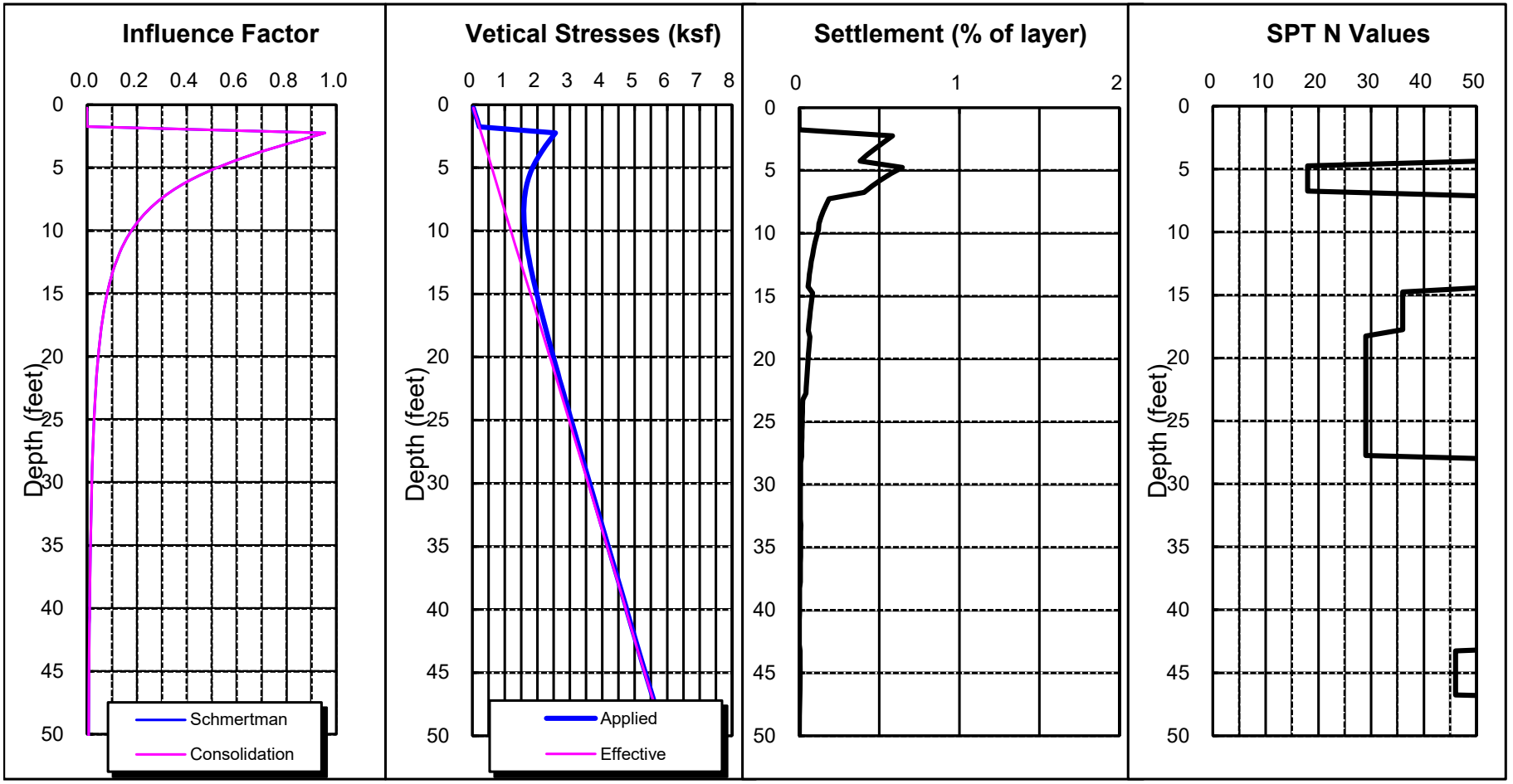


Load, Q: 4 kpf Embedment, feet: 1.5 **Boring: B-1**

EARTH SYSTEMS - SETTLEMENT ANALYSES

Proposed Tractor Supply Company 306687-002

Width, ft: 7.0 Length, ft: 7.0 Net pressure, ksf: 2.40 **Settlement, inches: 0.5**



Load, Q: 118 kips Embedment, feet: 2.0 **Boring: B-1**

APPENDIX B

Laboratory Test Results

File No.: 306687-002 July 26, 2024

Lab No.: 24-283

UNIT DENSITIES AND MOISTURE CONTENT ASTM D2937 & D2216

Job Name: Proposed Tractor Supply Company

Sample Location	Depth (feet)	Unit Dry Density (pcf)	Moisture Content (%)	USCS Group Symbol
B-1	2.5	116	3	SM
B-1	5	113	3	SP
B-1	7.5	112	6	ML
B-1	10	114	5	ML
B-1	12.5	114	6	SM
B-1	20	115	3	SM
B-1	30	111	6	ML
B-1	40	111	2	SP
B-1	45	---	8	SM
B-1	47.5	110	5	ML
B-2	2.5	96	4	SM
B-2	5	105	6	SM
B-2	7.5	119	2	SM
B-2	10	99	5	ML
B-3	2.5	118	4	SM
B-3	5	122	3	SM
B-3	7.5	124	2	SM
B-3	10	118	4	SM
B-4	2.5	112	5	ML
B-4	5	116	4	ML
B-5	2.5	112	2	SP
B-5	5	116	3	SM

File No.: 306687-002 July 26, 2024

Lab No.: 24-283

UNIT DENSITIES AND MOISTURE CONTENT ASTM D2937 & D2216

Job Name: Proposed Tractor Supply Company

Sample Location	Depth (feet)	Unit Dry Density (pcf)	Moisture Content (%)	USCS Group Symbol
B-6	2.5	115	3	SM
B-6	5	109	7	ML
B-6	7.5	111	6	ML
B-6	10	112	6	ML
B-7	2.5	100	6	ML
B-7	5	100	4	ML
B-8	2.5	105	3	SM
B-8	5	113	3	SM
B-8	7.5	111	2	SP
B-8	10	105	7	ML
B-9	2.5	100	5	SM
B-9	5	83	6	ML
B-9	7.5	111	2	SP
B-9	10	108	2	ML

File No.: 306687-002 7/26/2024

Lab No.: 24-283

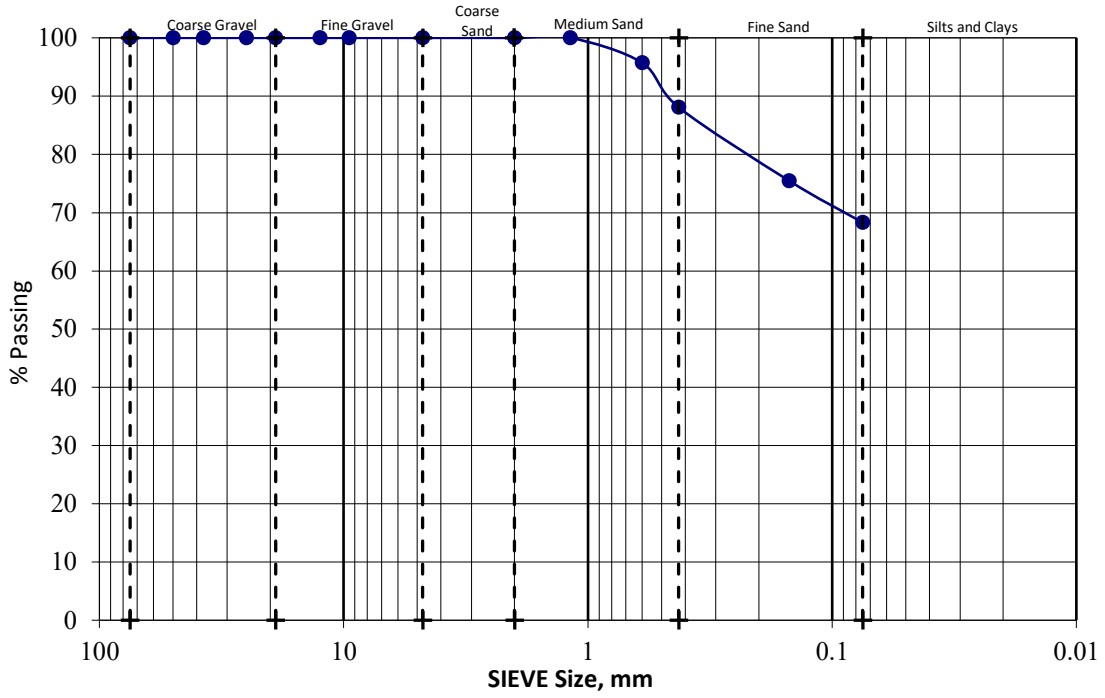
SIEVE ANALYSIS ASTM D6913

Job Name: Proposed Tractor Supply Company

Sample ID: B-7 @ 0-5'

Description: Sandy Silt (ML)

Sieve Size	% Passing
3"	100
2"	100
1-1/2"	100
1"	100
3/4"	100
1/2"	100
3/8"	100
#4	100
#10	100
#16	100
#30	96
#40	88
#100	75
#200	68.3



FM= 0.47

% Coarse Gravel:	0	% Coarse Sand:	0			
% Fine Gravel:	0	% Medium Sand:	12	Cu:	NA	
		% Fine Sand:	20	Cc:	NA	Gradation
% Total Gravel	0	% Total Sand	32	% Fines:	68.3	NA

File No.: 306687-002 July 26, 2024

Job Name: Proposed Tractor Supply Company

Lab Number: 24-283

ASTM D-1140 or Earth Systems Method (circle one)

AMOUNT PASSING NO. 200 SIEVE (Earth Systems Method Transfers Sample until water runs clear)

Sample Location	Depth (feet)	Fines Content (%)	USCS Group Symbol	Soaking Time
B-4	5	61.5	ML	10

File No.: 306687-002
Lab No.: 24-283

July 26, 2024

CONSOLIDATION TEST **ASTM D 2435 & D 5333**

Proposed Tractor Supply Company
B-1 @ 5'

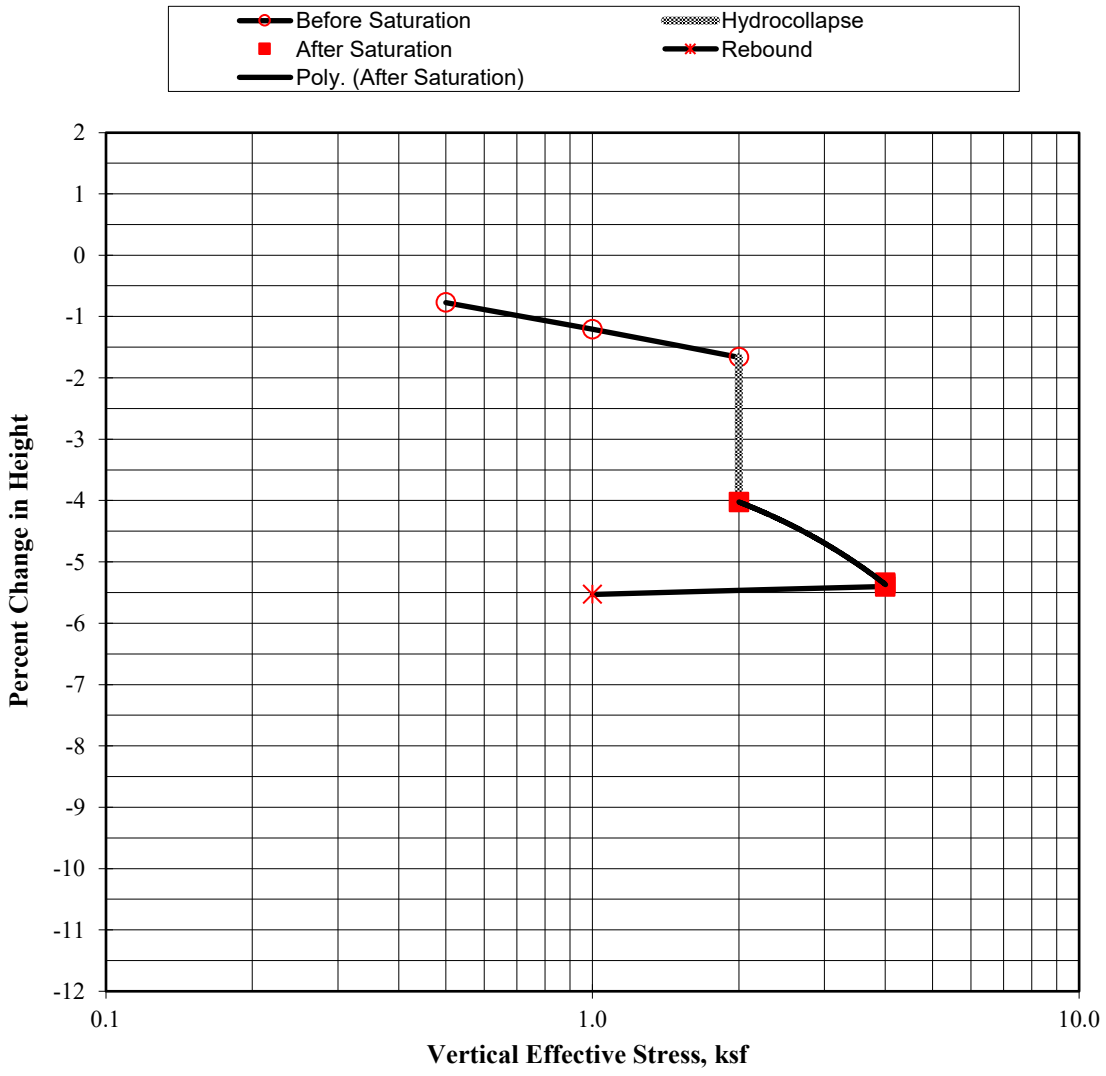
Sand (SP)

Ring Sample

Initial Dry Density: 112.0 pcf
Initial Moisture: 3.4%
Specific Gravity: 2.67
Initial Void Ratio: 0.489

Hydrocollapse: 2.4% @ 2.0 ksf

% Change in Height vs Normal Pressure Diagram



File No.: 306687-002
Lab No.: 24-283

July 26, 2024

CONSOLIDATION TEST **ASTM D 2435 & D 5333**

Proposed Tractor Supply Company
B-1 @ 7.5'

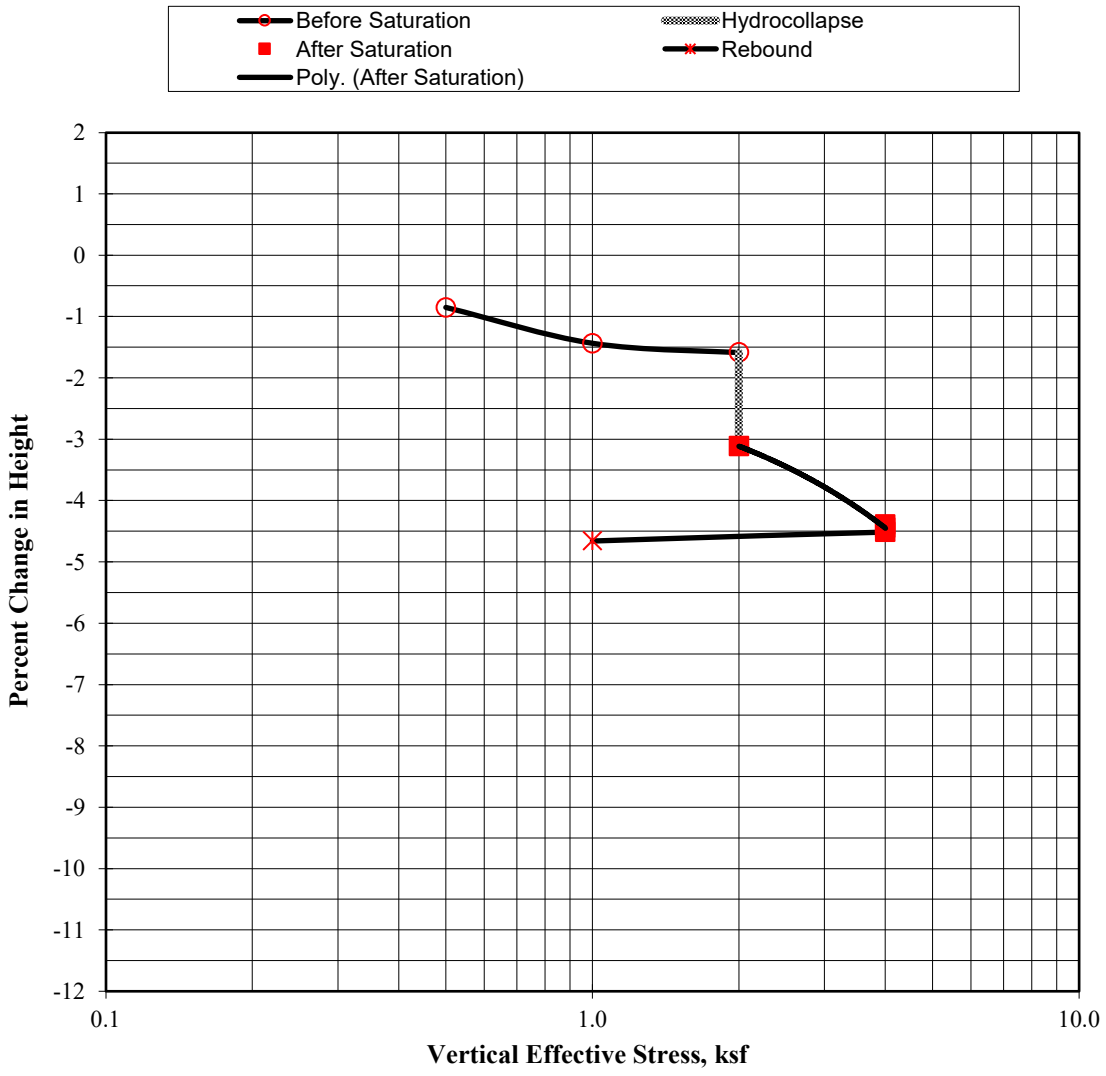
Sandy Silt (ML)

Ring Sample

Initial Dry Density: 115.2 pcf
Initial Moisture: 3.1%
Specific Gravity: 2.67
Initial Void Ratio: 0.447

Hydrocollapse: 1.5% @ 2.0 ksf

% Change in Height vs Normal Pressure Diagram



File No.: 306687-002
Lab No.: 24-283

July 26, 2024

CONSOLIDATION TEST **ASTM D 2435 & D 5333**

Proposed Tractor Supply Company
B-1 @ 10'

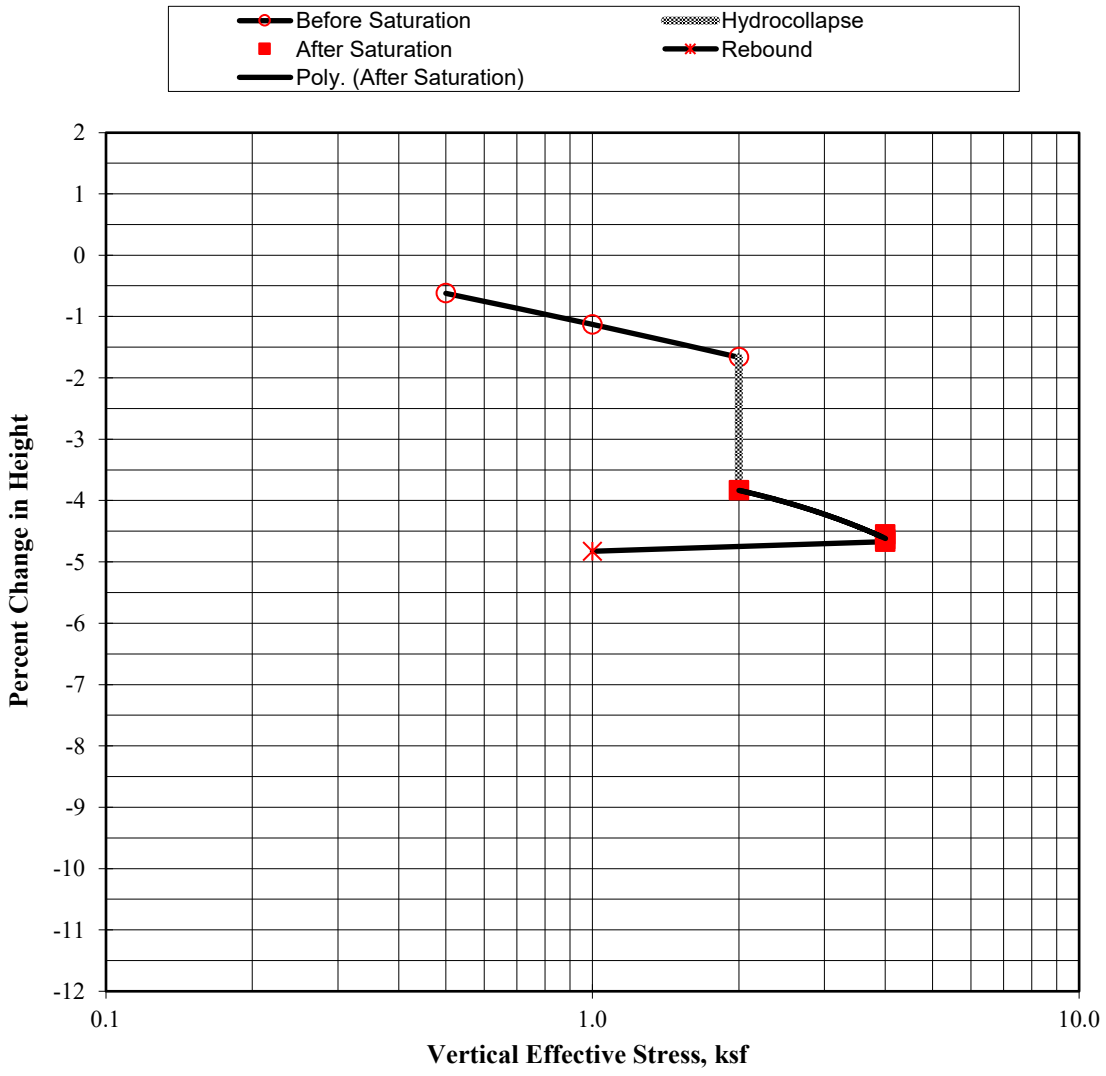
Sandy Silt (ML)

Ring Sample

Initial Dry Density: 113.6 pcf
Initial Moisture: 6.2%
Specific Gravity: 2.67
Initial Void Ratio: 0.468

Hydrocollapse: 2.2% @ 2.0 ksf

% Change in Height vs Normal Pressure Diagram



File No.: 306687-002
Lab No.: 24-283

July 26, 2024

CONSOLIDATION TEST **ASTM D 2435 & D 5333**

Proposed Tractor Supply Company
B-1 @ 12.5'

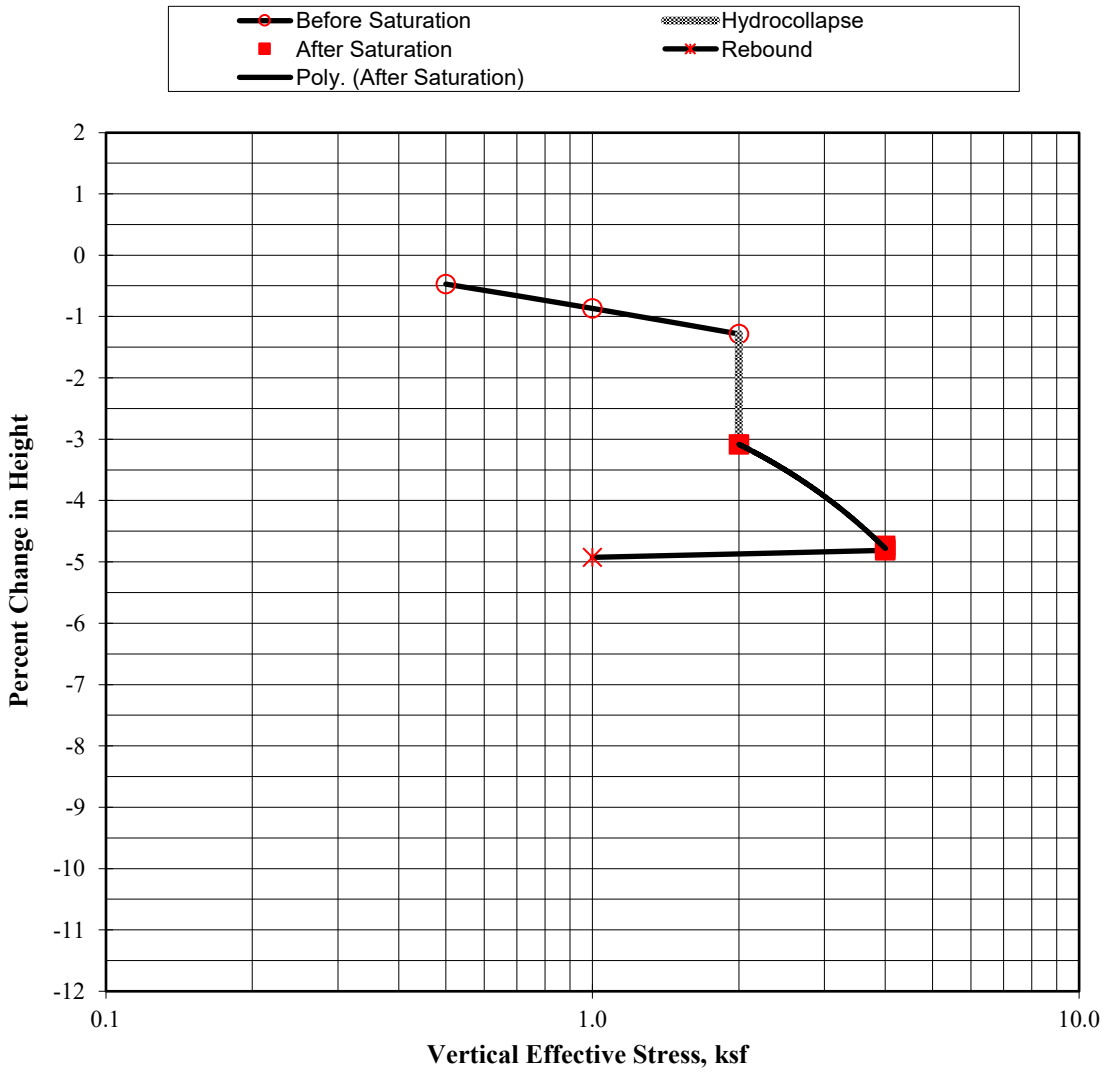
Silty Sand (SM)

Ring Sample

Initial Dry Density: 115.8 pcf
Initial Moisture: 4.8%
Specific Gravity: 2.67
Initial Void Ratio: 0.440

Hydrocollapse: 1.8% @ 2.0 ksf

% Change in Height vs Normal Pressure Diagram



File No.: 306687-002
Lab No.: 24-283

July 26, 2024

CONSOLIDATION TEST **ASTM D 2435 & D 5333**

Proposed Tractor Supply Company
B-2 @ 5'

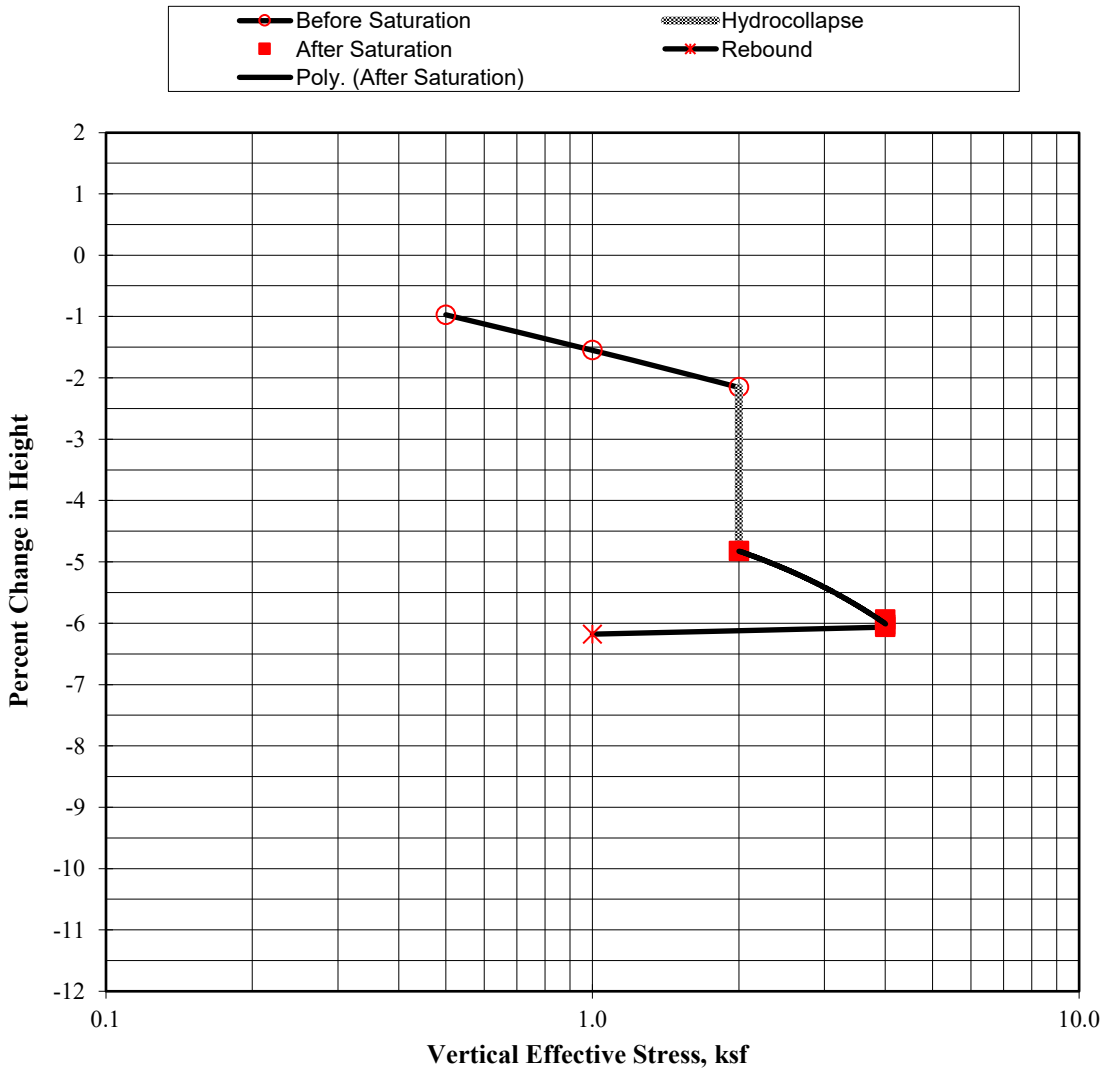
Silty Sand (SM)

Ring Sample

Initial Dry Density: 108.3 pcf
Initial Moisture: 2.9%
Specific Gravity: 2.67
Initial Void Ratio: 0.539

Hydrocollapse: 2.7% @ 2.0 ksf

% Change in Height vs Normal Pressure Diagram



File No.: 306687-002
Lab No.: 24-283

July 26, 2024

CONSOLIDATION TEST **ASTM D 2435 & D 5333**

Proposed Tractor Supply Company
B-4 @ 2.5'

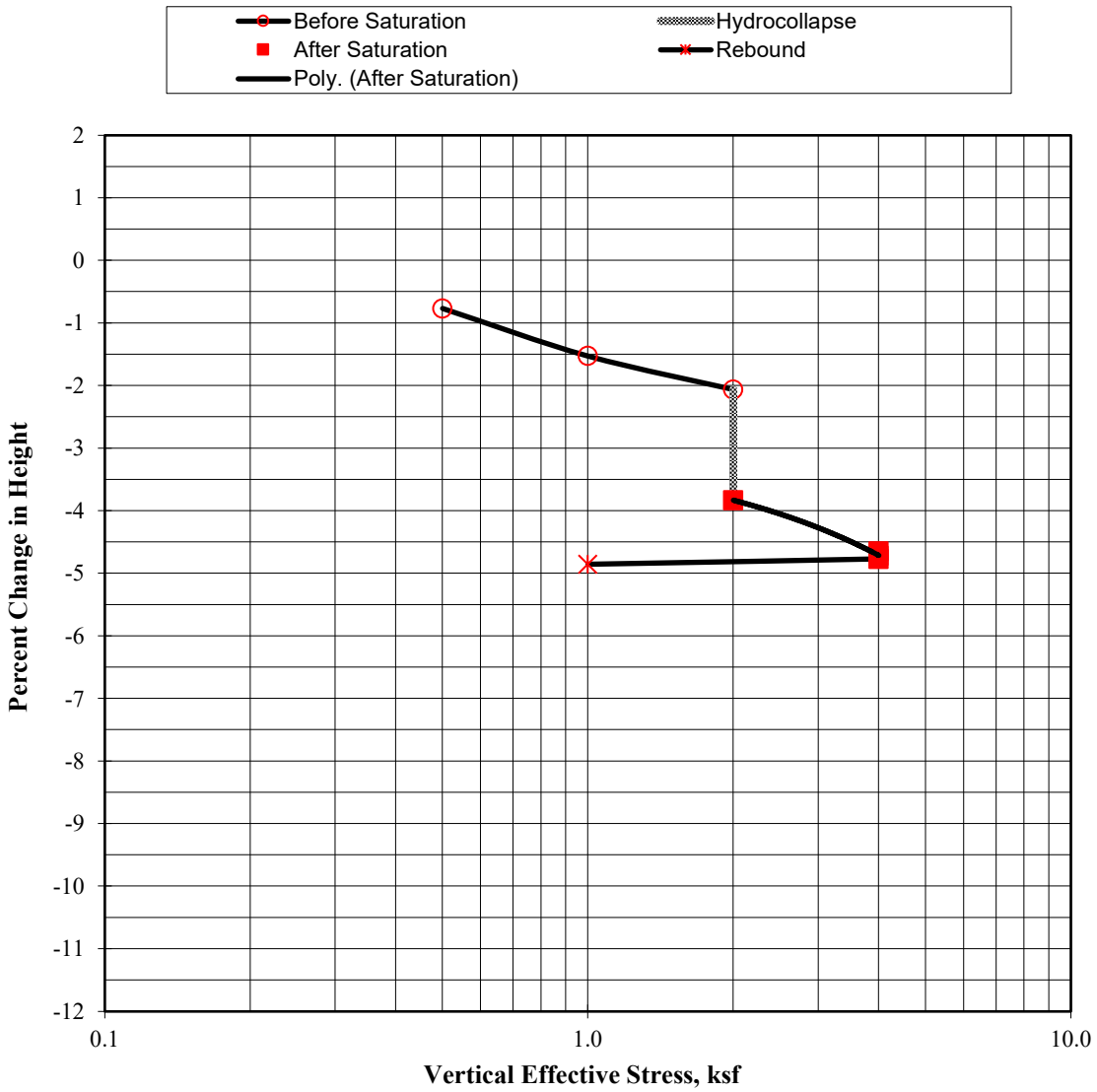
Sandy Silt (ML)

Ring Sample

Initial Dry Density: 113.7 pcf
Initial Moisture: 4.4%
Specific Gravity: 2.67
Initial Void Ratio: 0.466

Hydrocollapse: 1.8% @ 2.0 ksf

% Change in Height vs Normal Pressure Diagram



File No.: 306687-002
Lab No.: 24-283

July 26, 2024

CONSOLIDATION TEST **ASTM D 2435 & D 5333**

Proposed Tractor Supply Company
B-5 @ 5'

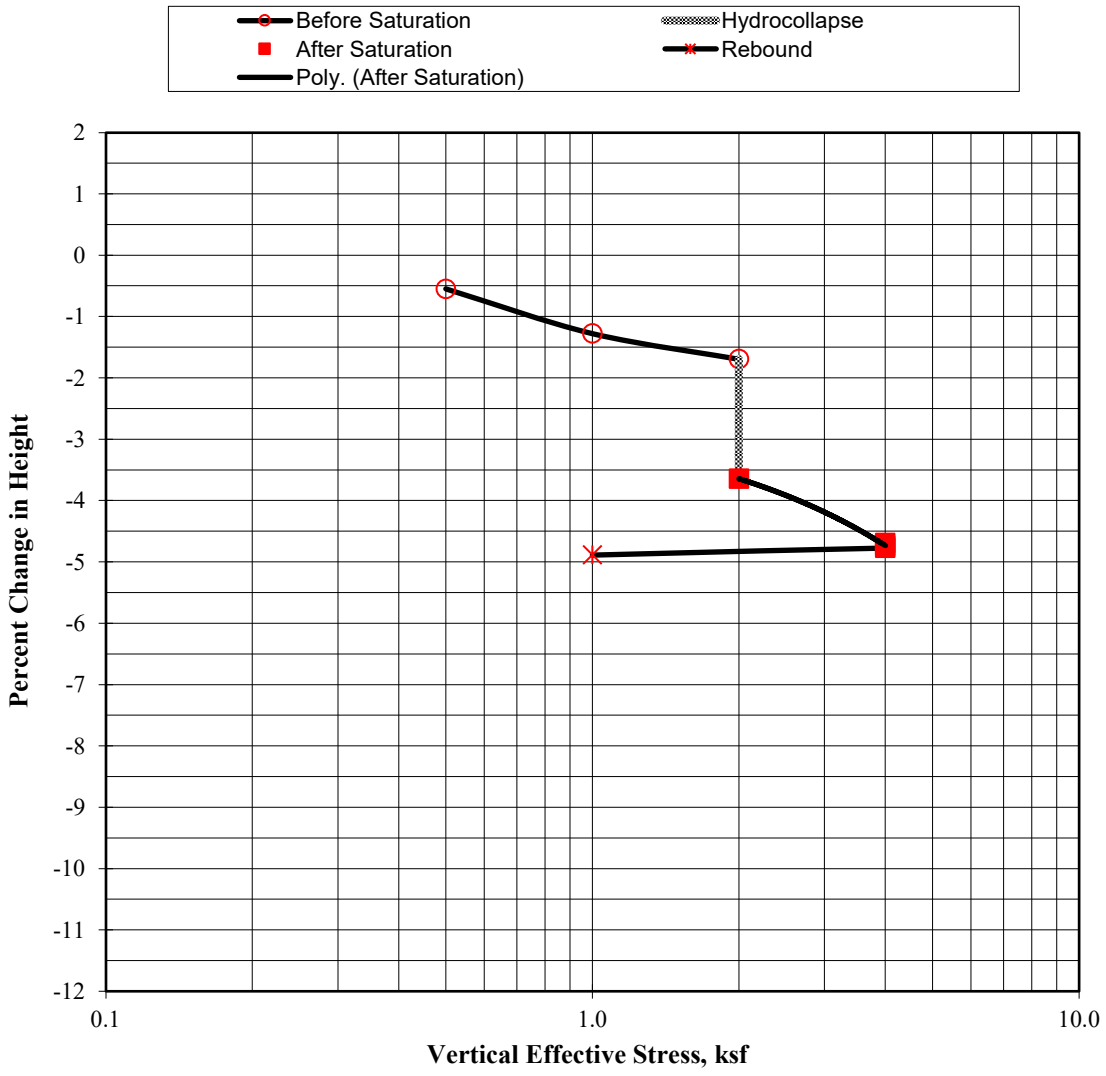
Silty Sand (SM)

Ring Sample

Initial Dry Density: 115.9 pcf
Initial Moisture: 4.4%
Specific Gravity: 2.67
Initial Void Ratio: 0.439

Hydrocollapse: 2.0% @ 2.0 ksf

% Change in Height vs Normal Pressure Diagram



File No.: 306687-002
Lab No.: 24-283

July 26, 2024

CONSOLIDATION TEST **ASTM D 2435 & D 5333**

Proposed Tractor Supply Company
B-6 @ 2.5'

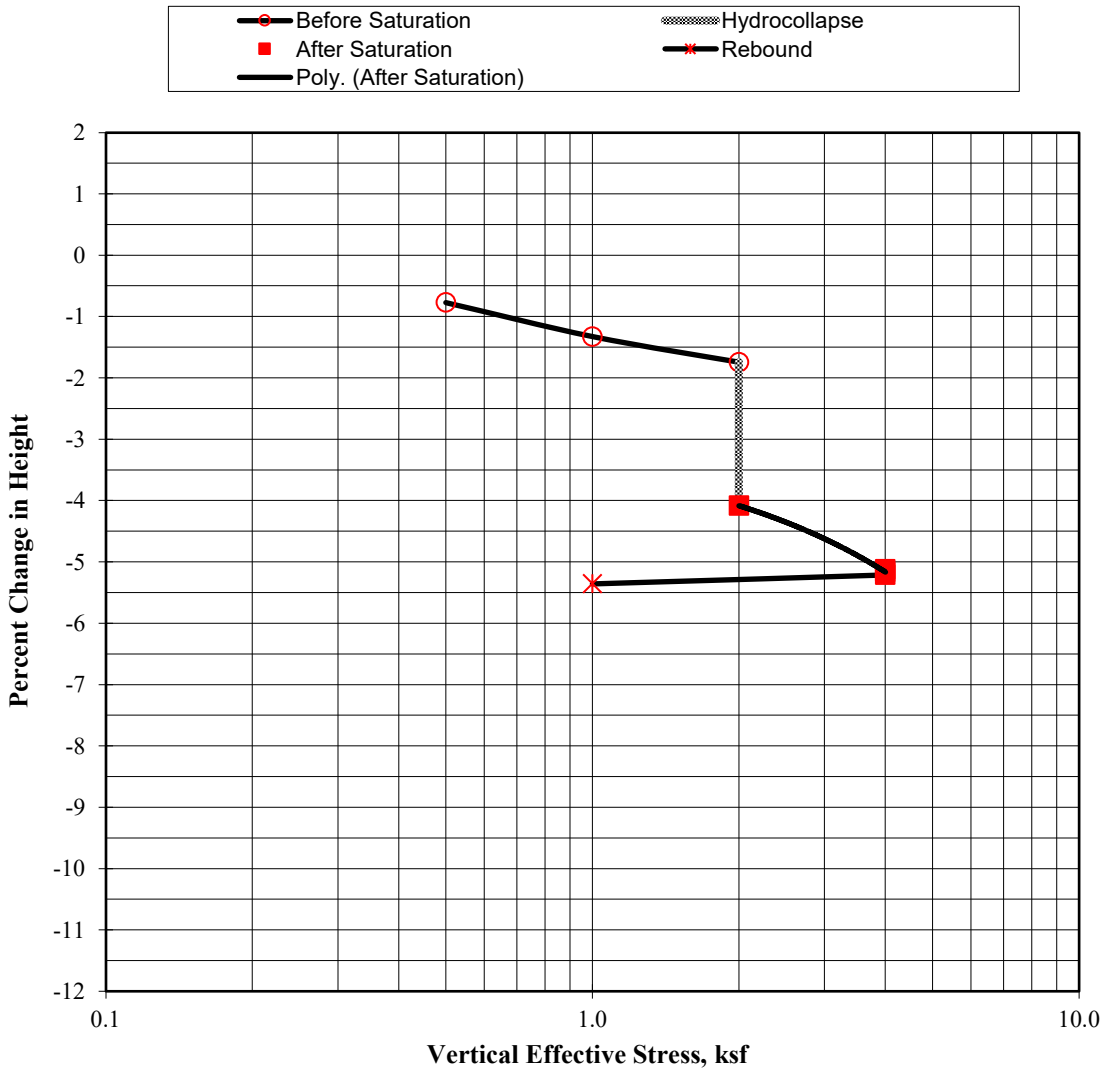
Silty Sand (SM)

Ring Sample

Initial Dry Density: 114.7 pcf
Initial Moisture: 3.6%
Specific Gravity: 2.67
Initial Void Ratio: 0.453

Hydrocollapse: 2.3% @ 2.0 ksf

% Change in Height vs Normal Pressure Diagram



File No.: 306687-002
Lab No.: 24-283

July 26, 2024

CONSOLIDATION TEST **ASTM D 2435 & D 5333**

Proposed Tractor Supply Company
B-6 @ 10'

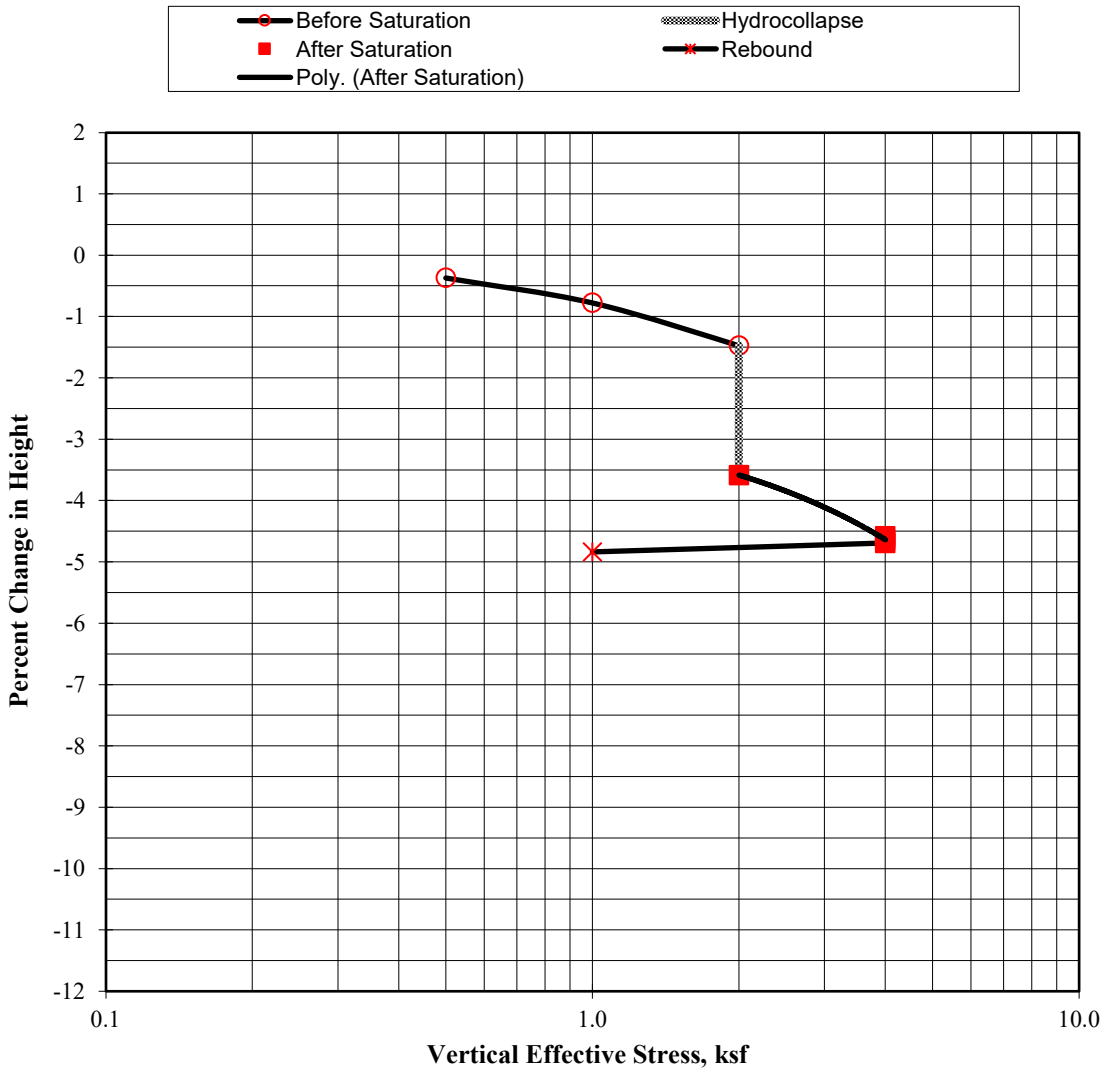
Sandy Silt (ML)

Ring Sample

Initial Dry Density: 116.9 pcf
Initial Moisture: 3.8%
Specific Gravity: 2.67
Initial Void Ratio: 0.425

Hydrocollapse: 2.1% @ 2.0 ksf

% Change in Height vs Normal Pressure Diagram



File No.: 306687-002
Lab No.: 24-283

July 26, 2024

CONSOLIDATION TEST **ASTM D 2435 & D 5333**

Proposed Tractor Supply Company
B-9 @ 7.5'

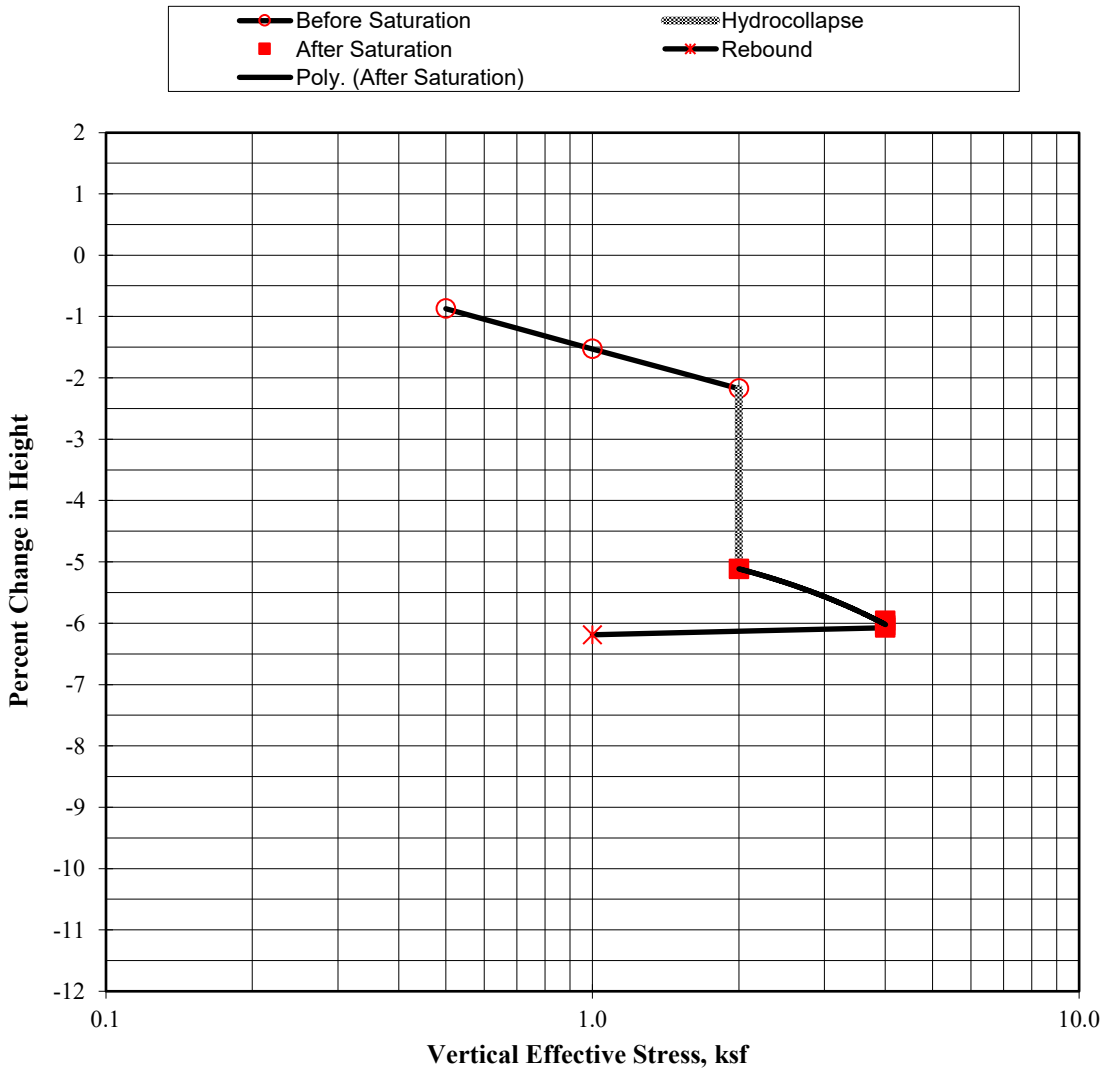
Sand (SP)

Ring Sample

Initial Dry Density: 109.7 pcf
Initial Moisture: 3.2%
Specific Gravity: 2.67
Initial Void Ratio: 0.520

Hydrocollapse: 2.9% @ 2.0 ksf

% Change in Height vs Normal Pressure Diagram



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Lab No.: 24-283

EXPANSION INDEX **ASTM D-4829**

Job Name: Proposed Tractor Supply Company
Sample ID: B-1 @ 0-4'
Soil Description: Silty Sand (SM)

Initial Moisture, %:	11.1	
Initial Compacted Dry Density, pcf:	103.4	
Initial Saturation, %:	48	
Final Moisture, %:	24.8	
Volumetric Swell, %:	0.4	
Expansion Index, EI:	**3**	**Very Low**

EI	ASTM Classification
0-20	Very Low
21-50	Low
51-90	Medium
91-130	High
>130	Very High

File No.: 306687-002 July 26, 2024
Lab No.: 24-283

MAXIMUM DRY DENSITY / OPTIMUM MOISTURE ASTM D 1557 (Modified)

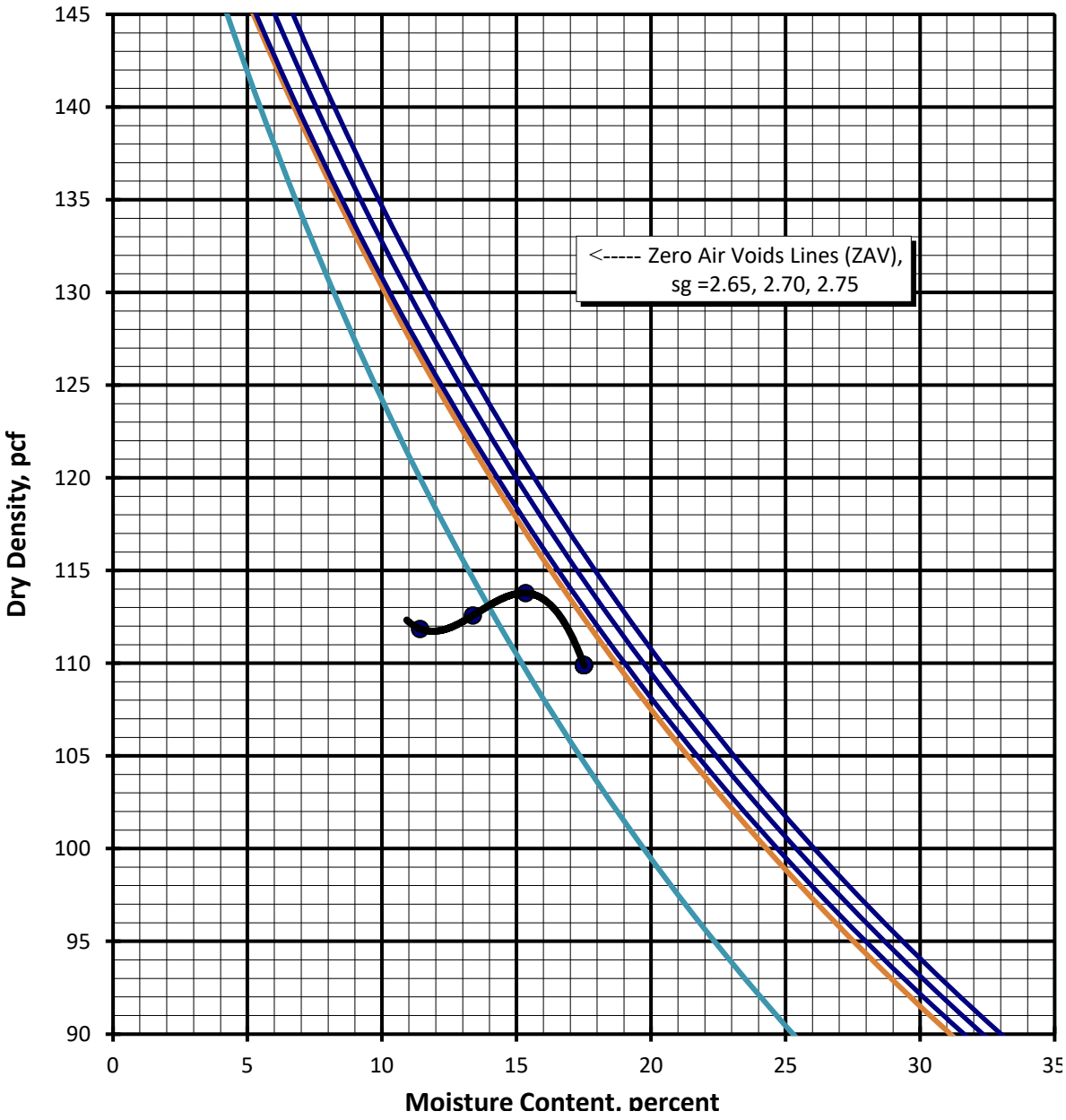
Job Name: Proposed Tractor Supply Company
Sample ID: 0
Location: B-1 @ 0-4'

Description: Silty Sand (SM)

Procedure Used: A
Preparation Method: Moist
Rammer Type: Manuel

Maximum Dry Density: **113.8 pcf**
Optimum Moisture: **15.3%**

Sieve Size	% Retained (Cumulative)
3/4"	0.0
3/8"	0.3
#4	0.7



File No.: 306687-002
Lab No.: 24-283

July 26, 2024

MAXIMUM DRY DENSITY / OPTIMUM MOISTURE

ASTM D 1557 (Modified)

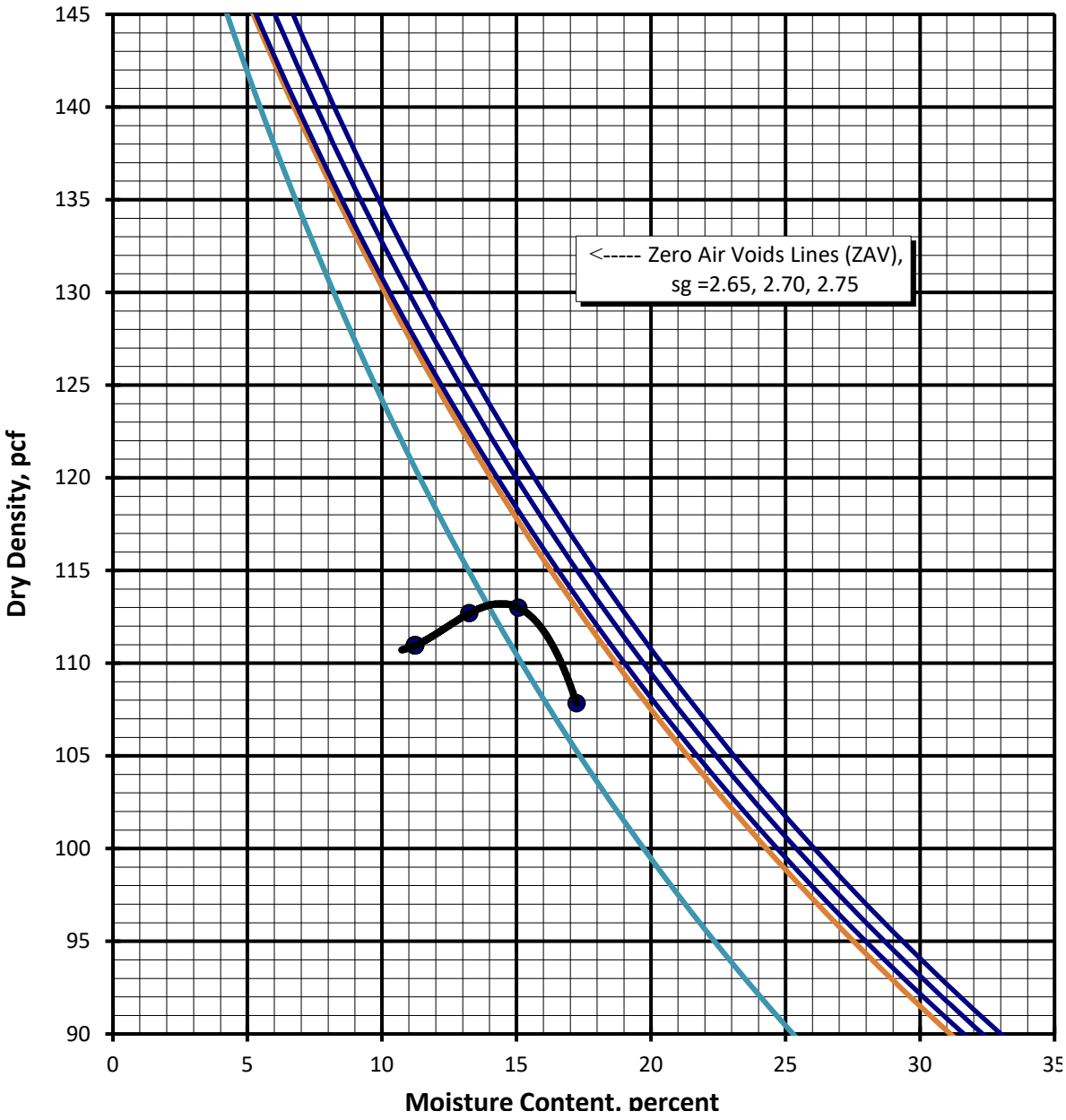
Job Name: Proposed Tractor Supply Company
Sample ID: 0
Location: B-7 @ 0-5'

Procedure Used: A
Preparation Method: Moist
Rammer Type: Manuel

Description: Sandy Silt (ML)

Maximum Dry Density: **113.2 pcf**
Optimum Moisture: **14.4%**

Sieve Size	% Retained (Cumulative)
3/4"	0.0
3/8"	0.2
#4	2.4



File No.: 306687-002 7/26/2024

Lab No.: 24-283

SOIL CHEMICAL ANALYSES

Job Name:	Proposed Tractor Supply Company
Job No.:	306687-002
Sample ID:	
Sample Location:	B-1 @ 0-4'
Resistivity (Units)	
as-received (ohm-cm)	>4,400,000
saturated (ohm-cm)	3,680
pH	8.4
Electrical Conductivity (mS/cm)	0.14
Chemical Analyses	
Cations	
calcium Ca^{2+} (mg/kg)	122
magnesium Mg^{2+} (mg/kg)	5
sodium Na^{1+} (mg/kg)	46
potassium K^{1+} (mg/kg)	4
ammonium NH41+ (mg/kg)	ND
Anions	
carbonate CO_3^{2-} (mg/kg)	14
bicarbonate HCO_3^{1-}(mg/kg)	226
fluoride F^{1-} (mg/kg)	13
chloride Cl^{1-} (mg/kg)	5
sulfate SO_4^{2-} (mg/kg)	96
nitrate NO31- (mg/kg)	3
phosphate PO_4^{3-} (mg/kg)	ND
Other Tests	
% moisture H_2O (%)	na
total acidity H^{1+} (mml/kg)	na
sulfide S^{2-} (qual)	na
Redox (mV)	na

Note: Tests performed by Subcontract Laboratory:
HDR Engineering, Inc.
431 West Baseline Road
Claremont, California 91711 Tel: (909) 962-5485

mg/kg = milligrams per kilogram (parts per million) of dry soil.
Redox = oxidation-reduction potential in millivolts
ND = not detected
na = not analyzed
T.O.P. = top of pipe

Resistivity per ASTM G187, Cations per ASTM D6919, Anions per ASTM D4327, and Alkalinity per APHA 2320-B. Electrical conductivity in millisiemens/cm and chemical analyses were made on a 1:5 soil-to-water extract.

General Guidelines for Soil Corrosivity

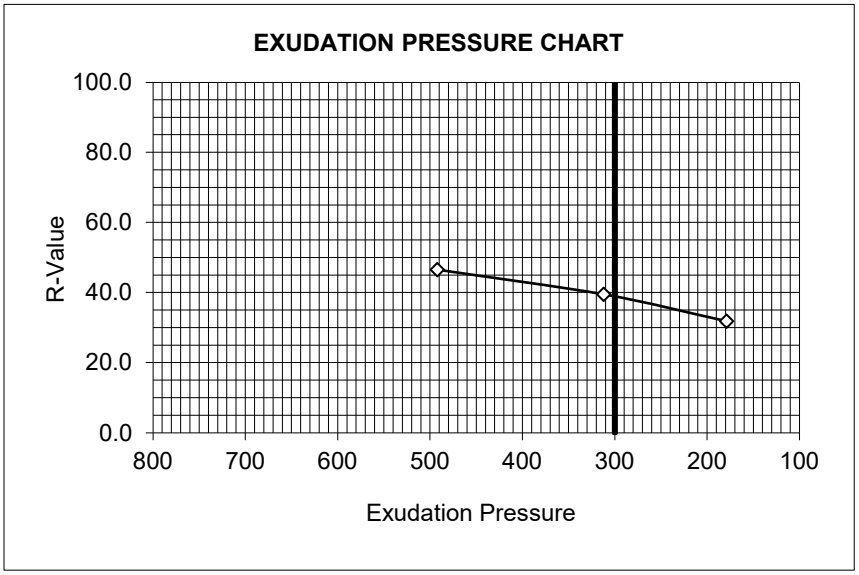
Chemical Agent	Amount in Soil	Degree of Corrosivity
Soluble Sulfates[1]	0 -1,000 mg/Kg (ppm) [0-.1%]	Low
	1,000 - 2,000 mg/Kg (ppm) [0.1-0.2%]	Moderate
	2,000 - 20,000 mg/Kg (ppm) [0.2-2.0%]	Severe
	> 20,000 mg/Kg (ppm) [>2.0%]	Very Severe
Resistivity[2] (Saturated)	0- 900 ohm-cm	Very Severely Corrosive
	900 to 2,300 ohm-cm	Severely Corrosive
	2,300 to 5,000 ohm-cm	Moderately Corrosive
	5,000-10,000 ohm-cm	Mildly Corrosive
	10,000+ ohm-cm	Progressively Less Corrosive

1 - General corrosivity to concrete elements. American Concrete Institute (ACI) Water Soluble Sulfate in Soil by Weight, ACI 318, Tables 4.2.2 - Exposure Conditions and Table 4.3.1 - Requirements for Concrete Exposed to Sulfate-Containing Solutions. It is recommended that concrete be proportioned in accordance with the requirements of the two ACI tables listed above (4.2.2 and 4.3.1). The current ACI should be referred to for further information.

2 - General corrosivity to metallic elements (iron, steel, etc.). Although no standard has been developed and accepted by corrosion engineering organizations, it is generally agreed that the classification shown above, or other similar classifications, reflect soil corrosivity. Source: Corrosionsource.com. The classification presented is excerpted from ASTM STP 1013 titled "Effects of Soil Characteristics on Corrosion" (February, 1989)

3 - Earth Systems does not practice corrosion engineering. Results should be reviewed by an engineer competent in corrosion evaluation, especially in regard to nitrites and ammonium.

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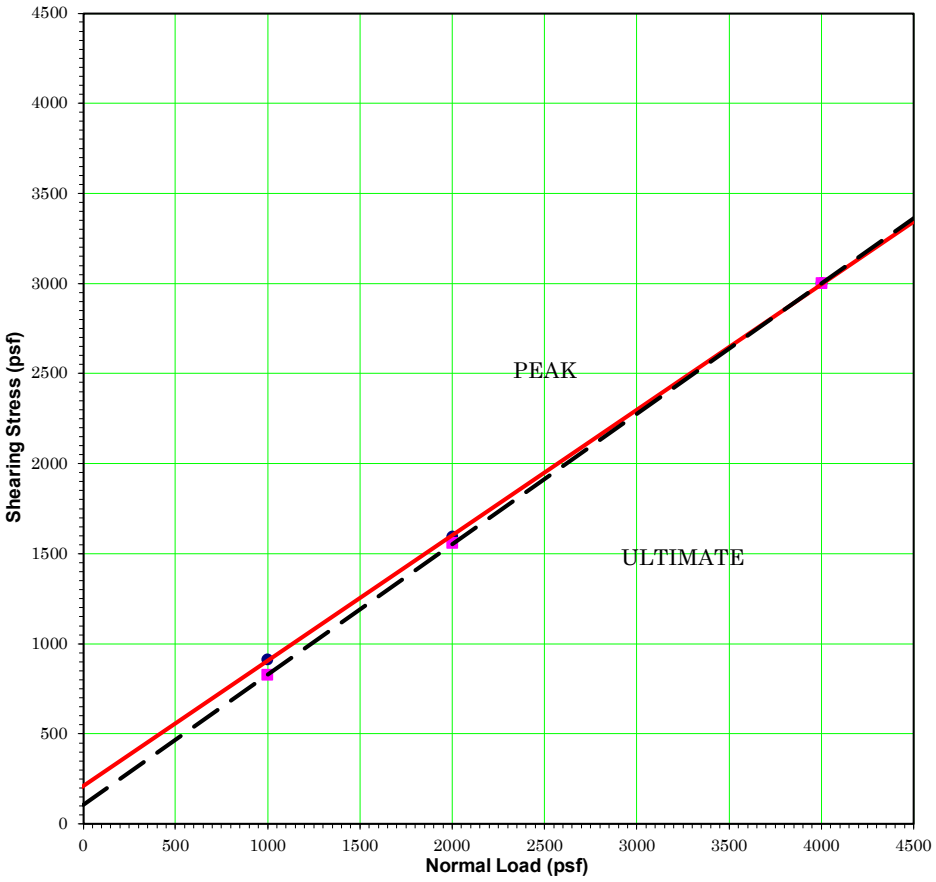


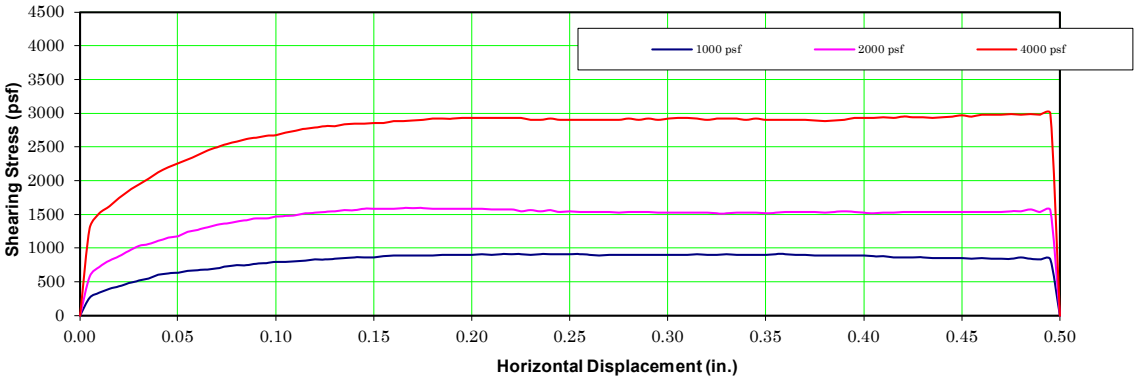
JOB NAME: Proposed Tractor Supply Company
SAMPLE I. D.: B-7 @ 0-5'
SOIL DESCRIPTION: Sandy Silt (ML)

SPECIMEN NUMBER	D	E	F
EXUDATION PRESSURE	492	312	179
RESISTANCE VALUE	46.5	39.5	31.8
EXPANSION DIAL(0.0001")	0	0	0
EXPANSION PRESSURE (PSF)	0.0	0.0	0.0
% MOISTURE AT TEST	12.3	13.0	13.7
DRY DENSITY AT TEST	119.0	118.5	117.4

R-VALUE @ 300 PSI EXUDATION **39**

**Based on Traffic Index = 8.00 & Gravel Factor = 1.34*





DIRECT SHEAR DATA*

Sample Location: B-1 @ 0-4'
Material: Silty Sand (SM)
Dry Density (pcf): 113.8

	Initial	Final
Moisture Content (%):	15.3	19.6
Saturation (%):	88	100
	Peak	Ultimate
ϕ Angle of Friction (degrees):	35	36
c Cohesive Strength (psf):	210	100

Test Type: Peak and Ulitimate
Shear Rate (in/min): 0.005

* Test Method: ASTM D-3080

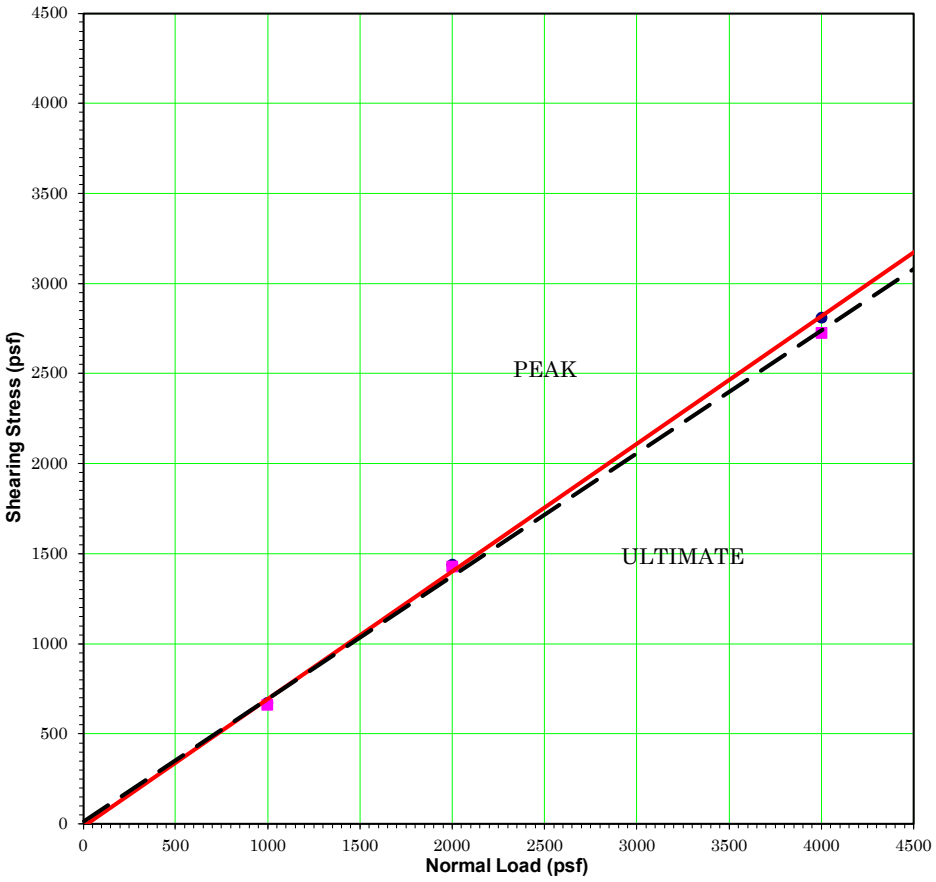
DIRECT SHEAR TEST

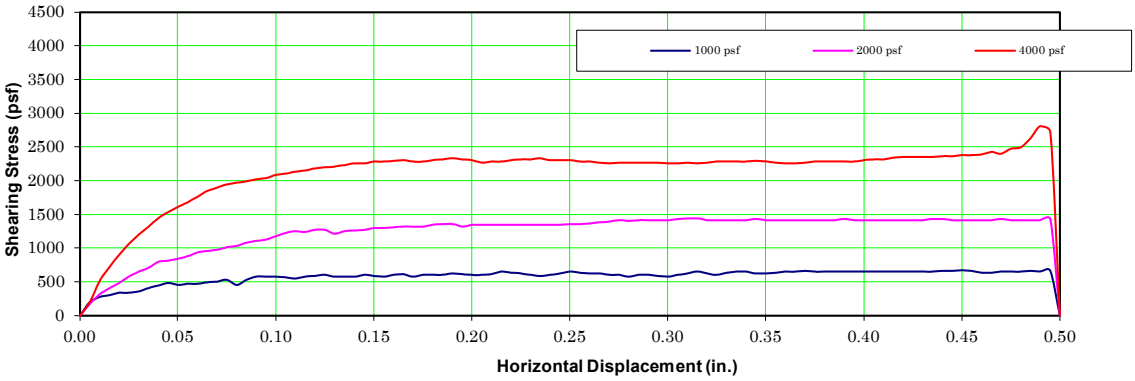
Proposed Tractor Supply Company

Victorville, CA

Earth Systems Pacific

7/26/2024 | 306687-002





DIRECT SHEAR DATA*

Sample Location: B-8 @ 10'
Material: Sandy Silt (ML)
Dry Density (pcf): 105.0

	Initial	Final
Moisture Content (%):	7	18.3
Saturation (%):	32	100
	Peak	Ultimate
ϕ Angle of Friction (degrees):	35	34
c Cohesive Strength (psf):	0	10

Test Type: Peak and Ulitimate
Shear Rate (in/min): 0.005

* Test Method: ASTM D-3080

DIRECT SHEAR TEST

Proposed Tractor Supply Company

Victorville, CA

Earth Systems Pacific

7/26/2024 | 306687-002

Appendix G

SECTION ( )
MODULAR SUBSURFACE FLOW WETLAND SYSTEM

1.0 GENERAL

1.1. The purpose of this specification is to establish generally acceptable criteria for Modular Subsurface Flow Wetland Systems used for biofiltration of stormwater runoff including dry weather flows and other contaminated water sources. It is intended to serve as a guide to producers, distributors, architects, engineers, contractors, plumbers, installers, inspectors, agencies, and users; to promote understanding regarding materials, manufacture and installation; and to provide for identification of devices complying with this specification.

1.2. Modular Subsurface Flow Wetland Systems (MSFWS) are used for filtration of stormwater runoff including dry weather flows. The MSFWS is a pre-engineered biofiltration system composed of a pretreatment chamber containing filtration cartridges, a horizontal flow biofiltration chamber with a peripheral void area and a centralized and vertically extending underdrain, the biofiltration chamber containing a sorptive media mix which does not contain any organic material and a layer of plant establishment media, and a discharge chamber containing an orifice control structure. Treated water flows horizontally in series through the pretreatment chamber cartridges, biofiltration chamber and orifice control structure.

1.3. The manufacturer of the MSFWS shall be one that is regularly engaged in the engineering design and production of systems developed for the treatment of storm water runoff for at least (10) years, and which have a history of successful production, acceptable to the engineer of work. In accordance with the drawings, the MSFWS(s) shall be a device manufactured by:

Contech Engineered Solutions LLC
9100 Centre Pointe Drive, Suite 400
West Chester, OH, 45069
Tel: 1 800 338 1122
https://www.conteches.com

1.4. Submittals

1.4.1. Shop drawings are to be provided with each order to the contractor and consulting engineer.

1.4.2. Shop drawings are to detail the MSFWS and all components required and the sequence for installation, including:
- System configuration with primary dimensions
- Interior components
- Any accessory equipment called out on shop drawings

1.4.3. Inspection and maintenance documentation submitted upon request.

1.5. Work Included

1.4.1. Specification requirements for installation of MSFWS.

1.5.2. Manufacturer to supply components of the MSFWS(s) Modules:
- Pretreatment chamber components (pre-assembled)

- Concrete Structure(s)
- Biofiltration chamber components (pre-assembled)
- Flow control discharge structure (pre-assembled)

1.6. Reference Standards

ASTM C 29	Standard Test Method for Unit Weight and Voids in Aggregate
ASTM C 88	C 88 Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C131	C 131 Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregates by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	C 136 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C 330	C 330 Standard Specification for Lightweight Aggregate for Structural Concrete
ASTM D 698	Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft.-lbf/ft3 (600 kN-m/m3)
ASTM D 1621	10 Standard Test Method for Compressive Properties Of Rigid Cellular Plastics
ASTM D 1777	ASTM D1777 - 96(2007) Standard Test Method for Thickness of Textile Materials
ASTM D 4716	Standard Test Method for Determining the (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
ASTM A 615	Standard Specifications for Deformed and Plan Carbon-Steel Bars for Concrete Reinforcement
ASTM A 706	Standard Specifications for Deformed and Plan Low-Alloy Steel Bars for Concrete Reinforcement
AASHTO T 99-01	Standard Method of Test for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in) Drop
AASHTO T 104	Standard Method of Test for Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate
AASHTO T 260	Standard Method of Test for Sampling and Testing for Chloride Ion in Concrete and Concrete Raw Materials.
AASHTO T 288	Standard Method of Test for Determining Minimum Laboratory Soil Resistivity
AASHTO T 289	Standard Method of Test for Determining ph of Soil for Use in Corrosion Testing
AASHTO T 291	Standard Method of Test for Determining Water Soluble Chloride Ion Content in Soil
AASHTO T 290	T 290 Standard Method of Test for Determining Water Soluble Sulfate Ion Content in Soil

2.0 MATERIALS

2.1. The Modular Subsurface Flow Wetland Systems (MSFWS) and all of its components shall be self-contained within a concrete structure constructed of concrete with a minimum 28-day compressive strength of 5,000 psi, with reinforcing per ASTM A 615 or ASTM A 706, Grade 60, and supports and H20 loading as indicated by AASHTO. Each Chamber shall have appropriate access hatches for easy maintenance and sized to allow removal of all internal components without disassembly. All water transfer system components shall conform with the following:

- Filter netting shall be 100% Polyester with a number 16 sieve size, and strength tested per ASTM D 3787.
- Drainage cells shall be manufactured of lightweight injection-molded plastic and have a minimum compressive strength test of 6,000 psi and a void area along the surface making contact with the filter media of 75% or greater. The cells shall be at least 2" in thickness and allow water to freely flow in all four directions.

2.2. PRETREATMENT CHAMBER COMPONENTS

2.2.1 Filter Cartridges shall operate at a loading rate not to exceed 3 gallons per minute per square foot surface area.

2.2.2 Drain Down System shall include a pervious floor that allows water to drain into the underdrain pipe that is connected to the discharge chamber.

2.3. BIOFILTRATION CHAMBER COMPONENTS

2.3.1. Engineered biofiltration media shall consist of inorganic components. Media shall not contain any organic material. Flow through media shall be horizontal from the outer perimeter of the chamber toward the centralized and vertically extending underdrain. The retention time in the media shall be at least 3 minutes. Downward flow filters are not acceptable alternatives. The thickness of the media shall be at least 19" from influent end to effluent end. The loading rate on the media shall not exceed 1.1 gallons per minute per square foot surface area. Media must be contained within structure that spaces the surface of the media at least 2" from all vertically extending walls of the concrete structure.

2.4. DISCHARGE CHAMBER

2.4.1. The discharge chamber shall house a flow control orifice plate that restricts flows greater than designed treatment flow rate. All piping components shall be made of a high-density polyethylene. The discharge chamber shall also contain a drain down filter if specified on the drawing.

3.0 PERFORMANCE

3.1. Function - The MSFWS has no moving internal components and functions based on gravity flow, unless otherwise specified. The MSFWS is composed of a pretreatment chamber, a biofiltration chamber and a discharge chamber. The pretreatment device houses cartridge media filters, which consist of filter media housed in a perforated enclosure. The untreated

runoff flows into the system via subsurface piping and or surface inlet. Water entering the system is forced through the filter cartridge enclosures by gravity flow. Then the flow contacts the filter media. The flow through the media is horizontal toward the center of each individual media filter. In the center of the media shall be a round slotted PVC pipe of no greater than 1.5" in diameter. The slotted PVC pipe shall extend downward into the water transfer cavity of the cartridge. The slotted PVC pipe shall be threaded on the bottom to connect to the water transfer cavity. After pollutants have been removed by the filter media the water discharges the pretreatment chamber and flows into the water transfer system and is conveyed to the biofiltration chamber. Once runoff has been filtered by the biofiltration chamber it is collected by the vertical underdrain and conveyed to a discharge chamber equipped with a flow control orifice plate. Finally, the treated flow exits the system.

3.2. Pollutants - The MSFWS will remove and retain debris, sediments, TSS, dissolved and particulate metals and nutrients including nitrogen and phosphorus species, bacteria, BOD, oxygen demanding substances, organic compounds and hydrocarbons entering the filter during frequent storm events and continuous dry weather flows.

3.3. Treatment Flow Rate and Bypass - The MSFWS operates in-line. The MSFWS will treat 100% of the required water quality treatment flow based on a minimum filtration capacities listed in section 3.4. The size of the system must match those provided on the drawing to ensure proper performance and hydraulic residence time.

3.4. System must be capable of treating flows to the specified treatment flow rate on the drawings. The flow rate shall be controlled by an orifice.

3.5. Quality Assurance and Quality Control procedures shall be followed for all batches of engineered biofiltration media produced. Engineered biofiltration media shall be certified by the Manufacturer for performance and composition.

3.5.1. Media particle size distribution and composition shall be verified as per relevant ASTM Standards.

3.5.2. Media pollutant removal performance shall be verified as per relevant ASTM Standards as well as a minimum of one scientific method approved by the USEPA.

3.5.3. Media hydraulic performance shall be verified as per relevant ASTM Standards.

3.5.4. Media fertility shall be verified as per a minimum of one published scientific method.

4.0 EXECUTION

4.1. The installation of the MSFWS shall conform to all applicable national, state, state highway, municipal and local specifications.

4.2. Installation

The Contractor shall furnish all labor, equipment, materials and incidentals required to install the MSFWS modules and appurtenances in accordance with the drawings and these specifications.

4.2.1. Grading and Excavation site shall be properly surveyed by a registered professional surveyor, and clearly marked with excavation limits and elevations. After site is marked it is the responsibility of the contractor to contact local utility companies and/or DigAlert to check for underground utilities. All grading permits shall be approved by governing agencies before commencement of grading and excavation. Soil conditions shall be tested in accordance with the governing agencies requirements. All earth removed shall be transported, disposed, stored, and handled per governing agencies standards. It is the responsibility of the contractor to install and maintain proper erosion control measures during grading and excavation operations.

4.2.2. Compaction – All soil shall be compacted per registered professional soils engineer's recommendations prior to installation of MSFWS components. Compaction shall be to 95% of Standard Proctor or 90% of Modified Proctor.

4.2.3. Backfill shall be placed according to a registered professional soils engineer's recommendations, and with a minimum of 6" of gravel under all concrete structures.

4.2.4. Concrete Structures – After backfill has been inspected by the governing agency and approved the concrete structures shall be lifted and placed in proper position per plans.

4.2.5. Subsurface Flow Wetland Media shall be carefully loaded into area so as not to damage the wetland liner or water transfer systems. The entire wetland area shall be filled to the level indicated on the drawings.

4.3. Shipping, Storage and Handling

4.3.1. Shipping – MSFWS shall be shipped to the contractor's address or job site, and is the responsibility of the contractor to offload the unit(s) and place in the exact site of installation.

4.3.2. Storage and Handling– The contractor shall exercise care in the storage and handling of the MSFWS and all components prior to and during installation. Any repair or replacement costs associated with events occurring after delivery is accepted and unloading has commenced shall be born by the contractor. The MSFWS(s) and all components shall always be stored indoors and transported inside the original shipping container until the unit(s) are ready to be installed. The MSFWS shall always be handled with care and lifted according to OSHA and NIOSA lifting recommendations and/or contractor's workplace safety professional recommendations.

5.0 INSPECTION AND MAINTENANCE

5.1. Inspection – After installation, the contractor shall demonstrate that the MSFWS has been properly installed at the correct location(s), elevations, and with appropriate components. All components associated with the MSFWS and its installation shall be subject to inspection by the engineer at the place of installation. In addition, the contractor shall demonstrate that the MSFWS has been installed per the manufacturer's specifications and recommendations. All components shall be inspected by a qualified person once a year and results of inspection shall be kept in an inspection log.

5.2. Maintenance – The manufacturer recommends cleaning and debris removal maintenance of once a year and replacement of the Cartridge Filters as needed. The maintenance shall be performed by someone qualified. A Maintenance Manual is available upon request from the manufacturer. The manual has detailed information regarding the maintenance of the MSFWS. A Maintenance/Inspection record shall be kept by the maintenance operator. The record shall include any maintenance activities preformed, amount and description of debris collected, and the condition of the filter.

5.3. Material Disposal - All debris, trash, organics, and sediments captured by the MSFWS shall be transported and disposed of at an approved facility for disposal in accordance with local and state requirements. Please refer to state and local regulations for the proper disposal of toxic and non-toxic material.

END OF SECTION

Appendix H

User Inputs

Project Name:	TSC_ 23964
State:	California
City:	Victorville
Engineer::	Jai Barrientos
Measurement Type:	Imperial
Product:	HDPE N-12
Nominal diameter:	60
Required volume:	12125 cubic ft.
Available length:	130 ft.
Available width:	40 ft.
Pipe fill above:	6 in.
Pipe bedding below:	6 in.

Results

Installed Storage Volume:	12150.44 cubic ft.
System length:	124.90 ft.
System width:	38.54 ft.
Number Of Rows:	5
Approx. Bed Size Required:	4814.27 square ft.

System Components

Amount of fill required:	619.38 cubic yards
Volume of excavation (Bottom of system to top of system):	1164.34 cubic yards

PROJECT INFORMATION	
ENGINEERED PRODUCT MANAGER	
ADS SALES REP	
PROJECT NO.	

Advanced Drainage Systems, Inc.

TSC_ 23964
VICTORVILLE, CA

ADS RETENTION/DETENTION PIPE SYSTEM SPECIFICATION

SCOPE
THIS SPECIFICATION DESCRIBES ADS RETENTION/DETENTION PIPE SYSTEMS FOR USE IN NON-PRESSURE GRAVITY-FLOW STORM WATER COLLECTION SYSTEMS UTILIZING A CONTINUOUS OUTFALL STRUCTURE.

PIPE REQUIREMENTS
ADS RETENTION/DETENTION SYSTEMS MAY UTILIZE ANY OF THE VARIOUS PIPE PRODUCTS BELOW:
- N-12® STIB PIPE (PER AASHTO) SHALL MEET AASHTO M 294, TYPE S OR ASTM F2306
- N-12® STIB PIPE (PER ASTM F2648) SHALL MEET ASTM F2648
- N-12® MEGA GREEN™ STIB SHALL MEET ASTM F2648

ALL PRODUCTS SHALL HAVE A SMOOTH INTERIOR AND ANNULAR EXTERIOR CORRUGATIONS. ALL STIB PIPE PRODUCTS ARE AVAILABLE AS PERFORATED OR NON-PERFORATED. WTIB PIPE PRODUCTS ARE ONLY AVAILABLE AS NON-PERFORATED. PRODUCT-SPECIFIC PIPE SPECIFICATIONS ARE AVAILABLE IN THE DRAINAGE HANDBOOK SECTION 1 "SPECIFICATIONS".

JOINT PERFORMANCE
PLAIN END / SOIL-TIGHT (STIB):
STIB PIPE SHALL BE JOINED USING A BELL AND SPIGOT JOINT. THE BELL AND SPIGOT JOINT SHALL MEET THE SOIL-TIGHT REQUIREMENTS OF ASTM F2306 AND GASKETS SHALL MEET THE REQUIREMENTS OF ASTM F477.

PLAIN END PIPE AND FITTINGS CONNECTIONS SHALL BE JOINED WITH COUPLING BANDS COVERING AT LEAST TWO FULL CORRUGATIONS ON EACH END OF THE PIPE. GASKETED SOIL-TIGHT COUPLING BAND CONNECTIONS SHALL INCORPORATE A CLOSED-CELL SYNTHETIC EXPANDED RUBBER GASKET MEETING THE REQUIREMENTS OF ASTM D1056 GRADE 2A2. GASKETS, WHEN APPLICABLE, SHALL BE INSTALLED BY THE PIPE MANUFACTURER.

FITTINGS
FITTINGS SHALL CONFORM TO ASTM F2306 AND MEET JOINT PERFORMANCE INDICATED ABOVE FOR FITTINGS CONNECTIONS. CUSTOM FITTINGS ARE AVAILABLE AND MAY REQUIRE SPECIAL INSTALLATION CRITERION.

INSTALLATION
INSTALLATION SHALL BE IN ACCORDANCE WITH ASTM D2321 AND ADS RECOMMENDED INSTALLATION GUIDELINES, WITH THE EXCEPTION THAT MINIMUM COVER IN NON-TRAFFIC AREAS FOR 12-60 INCH (300-1500 mm) DIAMETERS SHALL BE 1 FT (0.3 m). MINIMUM COVER IN TRAFFICKED AREAS FOR 12-36 INCH (300-900 mm) DIAMETERS SHALL BE 1 FT (0.3 m) AND FOR 42-60 INCH (1050-1500 mm) DIAMETERS, THE MINIMUM COVER SHALL BE 2 FT (0.6 m). BACKFILL SHALL CONSIST OF CLASS I (COMPACTED) OR CLASS II (MINIMUM 95% SPD) MATERIAL, WITH THE EXCEPTION THAT 60 INCH (1500 mm) SYSTEMS SHALL USE CLASS I MATERIAL ONLY. MINIMUM COVER HEIGHTS DO NOT ACCOUNT FOR PIPE BUOYANCY. REFER TO ADS TECHNICAL NOTE 5.05 "PIPE FLOTATION" FOR BUOYANCY DESIGN CONSIDERATIONS. MAXIMUM COVER OVER SYSTEM USING STANDARD BACKFILL IS 8 FT (2.4 m); CONTACT A REPRESENTATIVE WHEN MAXIMUM FILL HEIGHT MAY BE EXCEEDED. ADDITIONAL INSTALLATION REQUIREMENTS ARE PROVIDED IN THE DRAINAGE HANDBOOK SECTION 6 "RETENTION/DETENTION".

ADS RECOMMENDS THE USE OF "FLEXSTORM CATCH IT" INSERTS DURING CONSTRUCTION FOR ALL INLETS TO PROTECT THE SUBSURFACE STORMWATER MANAGEMENT SYSTEM FROM CONSTRUCTION SITE RUNOFF.

NOTES:

1) ALL ELEVATIONS, DIMENSIONS AND LOCATIONS OF RISERS, INLETS AND OUTLETS, SHALL BE VERIFIED BY THE ENGINEER PRIOR TO RELEASING FOR FABRICATION.

2) IN SITUATIONS WHERE A FINE-GRAINED BACKFILL MATERIAL IS USED ADJACENT TO THE PIPE SYSTEM, AND ESPECIALLY INVOLVING GROUND WATER CONDITIONS, CONSIDERATION SHOULD BE GIVEN TO THE USE OF GASKETED PIPE JOINTS. AT THE VERY LEAST THE PIPE JOINTS SHOULD BE WRAPPED IN A SUITABLE, NON-WOVEN GEOTEXTILE FABRIC TO PREVENT INFILTRATION OF FINES INTO THE PIPE SYSTEM.

3) CONSIDERATION FOR CONSTRUCTION EQUIPMENT LOADS MUST BE TAKEN INTO ACCOUNT.

4) ALL PIPE DIMENSIONS ARE SUBJECT TO MANUFACTURERS TOLERANCES.

5) ALL RISERS TO BE FIELD EXTENDED OR TRIMMED TO FINAL GRADE.

THE UNDERSIGNED HERBY APPROVES THE ATTACHED PAGES.

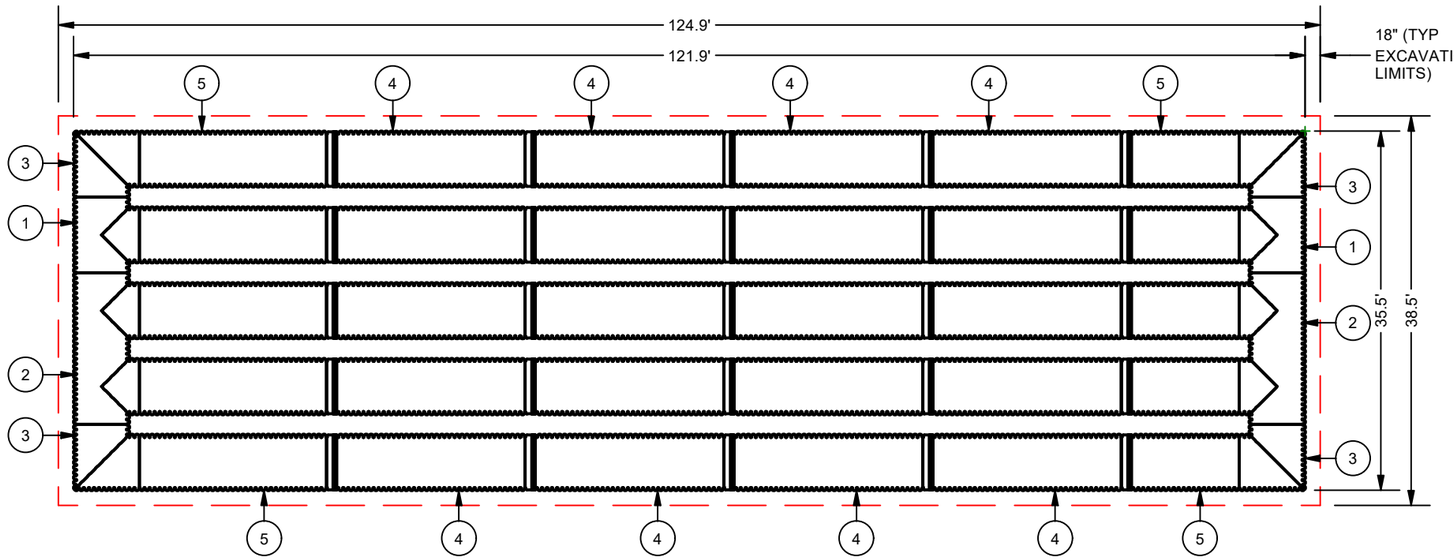
CUSTOMER DATE

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ITEM	QTY	ALT. QTY	PART #	DESCRIPTION	STAN.	VENDOR	NOTE
1	2		6051AN	60".SINGLE MANIFOLD TEE	STAN	ADS	SEE DETAIL
2	2		6052AN	60".DOUBLE MANIFOLD TEE	STAN	ADS	SEE DETAIL
3	4		6098AN	60".MANIFOLD 90 DEG BEND	STAN	ADS	SEE DETAIL
4	20 STICKS	394 LF	60850020IB	60".N12 HWY.STIB.SOLID.20'	STAN	ADS	AS SHOWN
5	8 STICKS	151 LF	60850020IB	60".N12 HWY.STIB.SOLID.20'	STAN	ADS	FIELD CUT
6	16		6065AA	60".SPLIT COUPLER.(25/PALLET)	STAN	ADS	NOT SHOWN
7	4 ROLLS	2000 SY	0601TG	601.15' X 300'.(500 SY).(NTPEP SCAN) (20% OVERAGE)	STAN	ADS	SEE DETAIL
8	31438 CF	1165 CY	NA	EXCAVATION	NA	NA	NOT SHOWN

NOTES

- THE SITE DESIGN ENGINEER MUST REVIEW ELEVATIONS AND IF NECESSARY ADJUST GRADING TO ENSURE THE PIPE COVER REQUIREMENTS ARE MET.
- STUB SIZES AND INVERTS TO BE VERIFIED BY THE SITE DESIGN ENGINEER PRIOR TO FABRICATION.
- ADS RISERS ARE FABRICATED 36" (900 mm) FROM TOP OF PIPE TO TOP OF RISER DUE TO SHIPPING LIMITATIONS. ADDITIONAL PIPE AND COUPLERS CAN BE USED TO EXTEND THE RISERS TO GRADE.
- LAYOUT SHOWN DOES NOT INCLUDE ADDITIONAL PIPE & MANIFOLD NEEDED FOR PROPER PIPE INSERTION INTO STRUCTURES.
- **NOT FOR CONSTRUCTION:** THIS LAYOUT IS FOR DIMENSIONAL PURPOSES ONLY TO PROVE CONCEPT & THE REQUIRED STORAGE VOLUME CAN BE ACHIEVED ON SITE.



ADS GEOTEXTILE FABRIC

TSC_ 23964
VICTORVILLE, CA
DATE: 07/14/2025
DRAWN: JB
PROJECT #:
CHECKED: N/A

DATE	DWN	CHK

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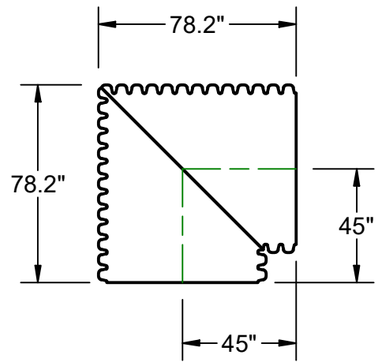
60" STIB SOLID
DETENTION SYSTEM
LandMax
Stormwater Management System

4640 TRUEMAN BLVD
HILLIARD, OH 43026
1-800-733-7473

0 15 30

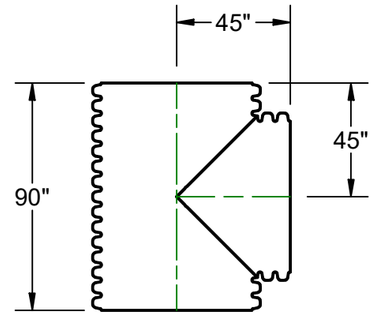
SHEET
2 OF 5

60" X 90° MANIFOLD BEND [6098AN]



ITEM #: 3
QTY: 4
6098AN

60" SINGLE MANIFOLD TEE [6051AN]



ITEM #: 1
QTY: 2
6051AN

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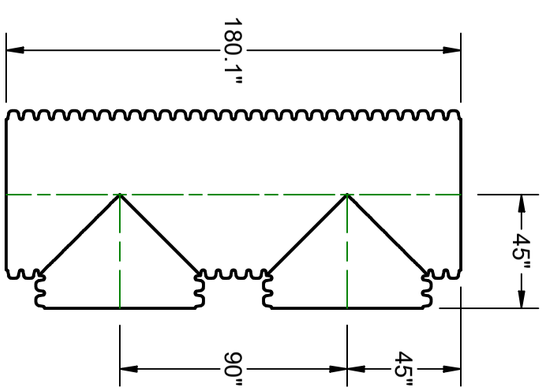
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60" STIB SOLID
DETENTION SYSTEM

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Stormwater Management System

60" DOUBLE MANIFOLD TEE [6052AN]



ITEM #: 2
QTY: 2
6052AN

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60" STIB SOLID
DETENTION SYSTEM

LandMax

Stormwater Management System

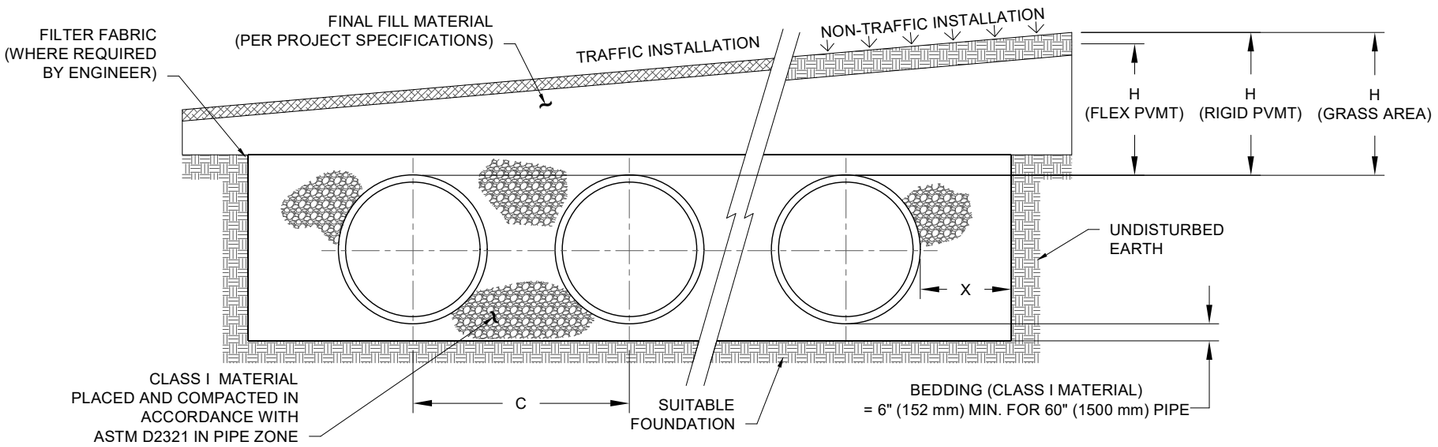
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DWN	
CHK	

TSC_ 23964

VICTORVILLE, CA

DATE: 07/14/2025	DRAWN: JB
PROJECT #:	CHECKED: N/A

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NOMINAL DIAMETER	NOMINAL O.D.	TYPICAL SPACING "C"	TYPICAL SIDE WALL "X"	MIN. H (NON-TRAFFIC)	MIN. H (TRAFFIC)	MAX. H*
60" (1500 mm)	67" (1702 mm)	90" (2286 mm)	18" (457 mm)	12" (305 mm)	24" (610 mm)	8' (2.4 m)

* MAXIMUM FILL HEIGHTS OVER MANIFOLD FITTINGS. CONTACT MANUFACTURER'S REPRESENTATIVE FOR INSTALLATION CONSIDERATIONS WHEN COVER EXCEEDS 8 FT (2.4 m).
**60" (1500 mm) SYSTEMS REQUIRE CLASS I BACKFILL AROUND ALL LATERALS AND FITTINGS.

NOTES:

1. ALL REFERENCES TO CLASS I MATERIAL ARE PER ASTM D2321 "STANDARD PRACTICE FOR UNDERGROUND INSTALLATION OF THERMOPLASTIC PIPE FOR SEWERS AND OTHER GRAVITY FLOW APPLICATIONS", LATEST EDITION.
2. ALL RETENTION AND DETENTION SYSTEMS SHALL BE INSTALLED IN ACCORDANCE WITH ASTM D2321, LATEST EDITION AND THE MANUFACTURER'S PUBLISHED INSTALLATION GUIDELINES.
3. MEASURES SHOULD BE TAKEN TO PREVENT THE MIGRATION OF NATIVE FINES INTO THE BACKFILL MATERIAL, WHEN REQUIRED. SEE ASTM D2321.
4. FILTER FABRIC: A GEOTEXTILE FABRIC MAY BE USED AS SPECIFIED BY THE ENGINEER TO PREVENT THE MIGRATION OF FINES FROM THE NATIVE SOIL INTO THE SELECT BACKFILL MATERIAL.
5. FOUNDATION: WHERE THE TRENCH BOTTOM IS UNSTABLE. THE CONTRACTOR SHALL EXCAVATE TO A DEPTH REQUIRED BY THE ENGINEER AND REPLACE WITH SUITABLE MATERIAL AS SPECIFIED BY THE ENGINEER. AS AN ALTERNATIVE AND AT THE DISCRETION OF THE DESIGN ENGINEER, THE TRENCH BOTTOM MAY BE STABILIZED USING A GEOTEXTILE MATERIAL.
6. BEDDING: SUITABLE MATERIAL SHALL BE CLASS I. THE CONTRACTOR SHALL PROVIDE DOCUMENTATION FOR MATERIAL SPECIFICATION TO ENGINEER. UNLESS OTHERWISE NOTED BY THE ENGINEER, MINIMUM BEDDING THICKNESS SHALL BE 4" (102 mm) FOR 4"-24" (100-600 mm); 6" (152 mm) FOR 30-60" (750-900 mm).
7. INITIAL BACKFILL: SUITABLE MATERIAL SHALL BE CLASS I IN THE PIPE ZONE EXTENDING NOT LESS THAN 6" (152 mm) ABOVE CROWN OF PIPE. THE CONTRACTOR SHALL PROVIDE DOCUMENTATION FOR MATERIAL SPECIFICATION TO ENGINEER. MATERIAL SHALL BE INSTALLED AS REQUIRED IN ASTM D2321, LATEST EDITION.
8. COVER: MINIMUM COVER OVER ALL RETENTION/DETENTION SYSTEMS IN NON-TRAFFIC APPLICATIONS (GRASS OR LANDSCAPE AREAS) IS 12" (305 mm) FROM TOP OF PIPE TO GROUND SURFACE. ADDITIONAL COVER MAY BE REQUIRED TO PREVENT FLOATATION. FOR TRAFFIC APPLICATIONS, MINIMUM COVER IS 12" (305 mm) UP TO 36" (900 mm) DIAMETER PIPE AND 24" (610 mm) OF COVER FOR 42-60" (1050-1500 mm) DIAMETER PIPE, MEASURED FROM TOP OF PIPE TO BOTTOM OF FLEXIBLE PAVEMENT OR TO TOP OF RIGID PAVEMENT. MAXIMUM FILL HEIGHT LIMITED TO 8 FT (2.4 m) OVER FITTINGS FOR STANDARD INSTALLATIONS. CONTACT A SALES REPRESENTATIVE WHEN MAXIMUM FILL HEIGHTS EXCEED 8 FT (2.4 m) FOR INSTALLATION CONSIDERATIONS.

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60" STIB SOLID
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LandMax
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