MOJAVE RIVER WATERSHED

Water Quality Management Plan

For:

Covington - Phelan 20

APN: 3064-531-06

PROJECT NO. R316042.01

Prepared for:

Covington Development Partners, LLC

Cambria 60 Partners, LLC

3 Corporate Plaza, Suite 230

Newport Beach, CA 92660

949-274-0044

Prepared by:

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Submittal Date: 06/02/2023

Revision No. and Date: No. 1 - 09/12/23

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

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 Cambria 60 Partners, LLC and Covington Development Partners, LLC by Huitt-Zollars. 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):		Grading Permit Number(s):	
Tract/Parcel Map Number(s):	N/A	Building Permit Number(s):	
CUP, SUP, and/or APN (Specify Lot Numbers if Portions of Tract):			APN: 3064-531-06

Owner's Signature			
Owner Name: Ron Rakunas for Dana Whitmer			
Title	Authorized Signator		
Company	Cambria 60 Partners, LLC		
Address	3 Corporate Plaza, Suite 230		
Email	rrakunas@covingtongroupinc.com		
Telephone #	949-274-0044		
Signature	FINAL TO BE SIGNED	Date	

Preparer's Certification

Project Data			
Permit/Application Number(s):		Grading Permit Number(s):	
Tract/Parcel Map Number(s):	N/A	Building Permit Number(s):	
CUP, SUP, and/or APN (Specify Lot Numbers if Portions of Tract):			APN: 3064-531-06

"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: Manny Gonzales, PE		PE Stamp Below
Title	Project Manager	
Company	Huitt-Zollars, Inc	
Address	3990 Concours, Suite 330 Ontario, CA 91764	
Email	mgonzales@huitt-zollars.com	
Telephone #	909-941-7799	
Signature	FINAL TO BE SIGNED	
Date		

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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	Covington - Phelan 20				
Project Owner Contact Name:	Ronald J. Rakunas for Dana Whitmer				
Mailing Address:	3 Corporate Plaza, Suite 230	E-mail Address:	rrakunas@covingtongroupinc.com	Telephone:	949-274-0044
Permit/Application Number(s):		Tract/Parcel Map Number(s):	APN: 3064-531-06		
Additional Information/ Comments:	N/A				
Description of Project:	The project is a new development of an industrial warehouse facility located on the southeast of Los Banos Ave and Phelan Rd and bound by New Caliente Rd to the east in the city of Hesperia, California in the county of San Bernardino. The proposed building is approximately 420,000 square feet in size on approximately 18.2 acres of vacant land and requires a WQMP.				
Provide summary of Conceptual WQMP conditions (if previously submitted and approved). Attach complete copy.	All off-site runon will be captured by one of two u-channels that border the western and southern property line of the site. On-site and off-site runoff will not commingle. All on-site runoff will be collected by catch basins and conveyed to the underground infiltration/detention chmaber on the east side of the project site for treatment. The design captured volume will infiltrate through the bottom of the underground basin. Higher volumes will discharge through a proposed 24" outlet pipe which will diverge into three 4' parkway drains. Said structures will drain at the northeasterly corner onto Phelan Rd at a maximum routed controlled discharge rate of 20.73 cfs which will be lower than the existing hydrology historic discharge. Refer to the Hydrology Study and Drainage maps for more calculations and details. In accordance with the MS4 Permit, the implemented site design measures will include, 1) an underground infiltration system, full-trash capture filter inserts in the catch basins and a water quality CDS unit at each inflow location to the underground system. The CDS units will serve as pre-treatment devices and the catch basin filters will add redundancy to the pre-treatment to improve the water quality and maximize the efficient and life span of the underground system.				

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):	791,325	**3** Number of Dwelling Units:	N/A	**4** SIC Code:	1541

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:

The property is being developed by Cambria 60 Partners. Cambria 60 Partners, LLC will be the entity responsible for long term maintenance of WQMP Storm Water Facilities throughout the site.

Name: Cambria 60 Partners, LLC & Covington Development Partners, LLC

Address: 3 Corporate Plaza, Suite 230

Contact Person: Ronald J. Rakunas/ Project Manager

Phone: 949-274-0044

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 ☐	Pathogens are typically caused by the transport of animal or human fecal wastes from the watershed.
Nutrients - Phosphorous	E ☒	N ☐	Primary sources of nutrients in urban runoff are fertilizers and eroded soils.
Nutrients - Nitrogen	E ☒	N ☐	Primary sources of nutrients in urban runoff are fertilizers and eroded soils.
Noxious Aquatic Plants	E ☒	N ☐	Noxious aquatic plants are typically from animals or vehicle transport that grow aggressively, multiply quickly without natural controls (native herbivores, soil chemistry, etc.), and adversely affect native habitats.
Sediment	E ☒	N ☐	Sediments are solid materials that are eroded from the land surface.
Metals	E ☒	N ☐	The primary source of metal pollution in stormwater is typically commercially available metals and metal products, as well as emissions from brake pad and tire tread wear associated with driving.
Oil and Grease	E ☒	N ☐	Primary sources of oil and grease are petroleum hydrocarbon products, motor products from leaking vehicles, esters, oils, fats, waxes, and high molecular-weight fatty acids.
Trash/Debris	E ☒	N ☐	Trash (such as paper, plastic, polystyrene packing foam, and aluminum materials) and biodegradable organic matter (such as leaves, grass cuttings, and food waste) are general waste from human or animals.
Pesticides / Herbicides	E ☒	N ☐	Pesticides and herbicides can be washed off urban landscapes during storm events.
Organic Compounds	E ☒	N ☐	Sources of organic compounds may include waste handling areas and vehicle or landscape maintenance areas.
Other:	E ☐	N ☐	
Other:	E ☐	N ☐	
Other:	E ☐	N ☐	

Section 3 Site and Watershed Description

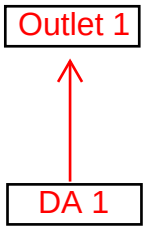
Describe the project site conditions that will facilitate the selection of BMPs through an analysis of the physical conditions and limitations of the site and its receiving waters. Identify distinct drainage areas (DA) that collect flow from a portion of the site and describe how runoff from each DA (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 34.4253=34°25'31.08"	Longitude -117.4057=-117°24'20.52"	Thomas Bros Map page 4475

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 A to Outlet 1	Runoff from the project site will be directed to the proposed infiltration/ detention basin on the east side of the project site. Higher volumes will discharge through a proposed 24" outlet pipe outlet which will divulge into three 4' parkway drains. Said structure will outlet onto Phelan Rd at the northeasterly portion of the site.
	N/A
	N/A

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)	791,325	N/A	N/A	N/A
2 Existing site impervious area (ft^2)	791,325	N/A	N/A	N/A
3 Antecedent moisture condition *For desert areas, use http://www.sbcounty.gov/dpw/floodcontrol/pdf/20100412_map.pdf*	AMC III	N/A	N/A	N/A
4 Hydrologic soil group *Refer to County Hydrology Manual Addendum for Arid Regions – http://www.sbcounty.gov/dpw/floodcontrol/pdf/20100412_addendum.pdf*	A	N/A	N/A	N/A
5 Longest flowpath length (ft)	1361	N/A	N/A	N/A
6 Longest flowpath slope (ft/ft)	2.02%	N/A	N/A	N/A
7 Current land cover type(s) *Select from Fig C-3 of Hydrology Manual*	Barren	N/A	N/A	N/A
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	N/A	N/A	N/A

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)	N/A	N/A	N/A	N/A
2 Existing site impervious area (ft^2)	N/A	N/A	N/A	N/A
3 Antecedent moisture condition *For desert areas, use http://www.sbcounty.gov/dpw/floodcontrol/pdf/20100412_map.pdf*	N/A	N/A	N/A	N/A
4 Hydrologic soil group *County Hydrology Manual Addendum for Arid Regions – http://www.sbcounty.gov/dpw/floodcontrol/pdf/20100412_addendum.pdf*	N/A	N/A	N/A	N/A
5 Longest flowpath length (ft)	N/A	N/A	N/A	N/A
6 Longest flowpath slope (ft/ft)	N/A	N/A	N/A	N/A
7 Current land cover type(s) *Select from Fig C-3 of Hydrology Manual*	N/A	N/A	N/A	N/A
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*	N/A	N/A	N/A	N/A

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, Soda Lake and Silver Lake
Applicable TMDLs *http://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2010.shtml*	Per 2010 303(d) list, Mojave River: TMDLs still required. Soda Lake: TMDLs still required.
303(d) listed impairments *http://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2010.shtml*	The project expects to generate Pathogens, Nutrients (Soda Lake), metals and Other Inorganics (fluoride & sulfate) (Mojave River) which are listed for downstream receiving waters on the latest CWA 303(d) list.
Environmentally Sensitive Areas (ESA) *Refer to Watershed Mapping Tool –* *http://sbcounty.permitrack.com/WAP*	NO
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 Provided computer calculations in lieu.* ☐ 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	☒	☐	Property owners shall review and become familiar with the site specific WQMP. Additional educational materials for day to day operations are contained in Attachment C. Additional materials can be obtained from the local water pollution prevention program. Education of property owners begin with the review/preparation of the site specific WQMP and continues through the review of additional educational material as it applies to their project.
N2	Activity Restrictions	☒	☐	Activity restriction shall be stated in the owners lease terms prior to occupancy; • Fuelling areas, air/water supply areas, maintenance bays, vehicle washing areas, outdoor material storage areas, outdoor work areas, outdoor processing areas, wash water from food preparation areas within the project site will not be allowed on the project site. • Storage of hazardous materials will not be allowed on the project site. • All pesticide applications shall be performed by a licensed contractor certified by the California Department of Pesticide Regulation. • All dumpster lids shall be kept closed at all times. • Blowing, Sweeping or hosing of debris (leaf, litter, grass clippings, trash or debris) into the streets, underground stormdrain facilities or other storm water conveyance areas shall be strictly prohibited
N3	Landscape Management BMPs	☒	☐	A landscape architect will provide design plans for the on-site landscaping and irrigation system. The design shall incorporate the use of native and drought tolerant trees and shrubs throughout the project site.
N4	BMP Maintenance	☒	☐	Property owners shall maintain the designated on-site BMP areas, see Section 5 for self inspection and maintenance form

Form 4.1-1 Non-Structural Source Control BMPs				
N5	Title 22 CCR Compliance (How development will comply)	☐	☒	Industrial purposed warehouse does not apply to Title 22 CCR (California Code of Regulations). CCR licensing in child care, residential and family child care.
N6	Local Water Quality Ordinances	☒	☐	Local Water Quality Ordinances will be addressed by implementation of this WQMP
N7	Spill Contingency Plan	☒	☐	Industrial Warehouse buildings and truck dock areas have potential for spills and therefore each tenant shall be required to prepare a spill contingency plan and it shall be implemented in accordance with section 6.95 of the California Health and Safety Code. The spill contingency plan shall identify responsible persons in the event of a spill, an action item list identifying how the spill should be contained, cleaned up and who should be contacted in the event of a spill. Documentation of any spill event and cleanup process shall be kept on site in perpetuity.
N8	Underground Storage Tank Compliance	☐	☒	No underground storage tanks are proposed for this site
N9	Hazardous Materials Disclosure Compliance	☐	☒	No hazardous materials are planned to be stored on this site.

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	☒	☐	Underground fire protection service and fire sprinklers will be provided per the uniform fire code and the requirements of the County of San Bernardino Fire Department.
N11	Litter/Debris Control Program	☒	☐	Trash storage areas will be designed to have adjacent areas drain away from the trash storage areas as well as have a permanent roof over them. The trash storage areas shall be inspected and maintained on a monthly basis. Collection of trash from the trash storage areas shall occur on a regular basis to ensure that the trash receptacles are not overflowing. Documentation of such inspection/maintenance and trash collection shall be kept by the owner in perpetuity. See the WQMP site map in Attachment A for anticipated location of trash storage areas.
N12	Employee Training	☒	☐	The following shall be provided to the tentant by the owner; an Employee Training/Education program shall be provided annually to help educate employees about storm water quality management and practices that help prevent storm water pollution. Documentation of such training/education program implementation shall be kept by the owner for a minimum of ten years. Sample education materials have been provided in Attachment C. Additional educational materials can be obtained from the County of San Bernardino storm water program.
N13	Housekeeping of Loading Docks	☒	☐	The project site will have truck docks. The truck docks shall be inspected on a weekly basis to help ensure that any trash and debris are collected prior to being washed into the underground storm drain system. All storm water runoff from the loading dock areas will be discharged into infiltration basins and/or underground infiltration chambers prior to conveyance to the public storm drain system. Documentation of such inspection/maintenance shall be kept by the owner in perpetuity.
N14	Catch Basin Inspection Program	☒	☐	The on-site catch basins shall be inspected on a quarterly basis. Inspection of the on-site catch basins shall consist of visual inspection of any sediment, trash or debris collected in the bottom of each catch basin. Any sediment, trash or debris found shall be removed from the catch basins and disposed of in a legal manner. Documentation of

				such inspection/maintenance shall be kept by the owner in perpetuity.
N15	Vacuum Sweeping of Private Streets and Parking Lots	☒	☐	The on-site parking lots, drive aisles, and loading dock areas shall be hand swept on a monthly basis. Documentation of such sweeping shall be kept by the owner in perpetuity. Frequency of sweeping shall be adjusted as needed to maintain a clean site.
N16	Other Non-structural Measures for Public Agency Projects	☐	☒	None, proposed BMP's satisfy requirements
N17	Comply with all other applicable NPDES permits	☒	☐	General construction permit "SWRCB Orders No. 2009-009-DWQ as amended by Order 2010-0014-DWQ"

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)	☒	☐	The on-site storm drain catch basins shall be stenciled with the phrase "Drains to River" or other approved language. The signage shall be inspected on an annual basis. Missing or faded signage shall be replaced. Documentation of such inspection/maintenance shall be kept by the owner in perpetuity.
S2	Design and construct outdoor material storage areas to reduce pollution introduction (CASQA New Development BMP Handbook SD-34)	☐	☒	No outdoor material storage area are proposed for this site.
S3	Design and construct trash and waste storage areas to reduce pollution introduction (CASQA New Development BMP Handbook SD-32)	☒	☐	Trash storage areas will be designed to have adjacent areas drain away from the trash storage areas as well as have a permanent roof over them. The trash storage areas shall be inspected and maintained on a monthly basis. Collection of trash from the trash storage areas shall occur on a regular basis to ensure that the trash receptacles are not overflowing. Documentation of such inspection/maintenance and trash collection shall be kept by the owner in perpetuity. See the WQMP site map in Attachment A for anticipated location of trash storage areas.
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)	☒	☐	The landscape architect will follow CASQA SD-12 for design and provide design plans for the on-site irrigation system. The irrigation system shall be inspected on a monthly basis to ensure proper operation. Any broken sprinkler heads shall be repaired immediately to ensure that the system continues to operate efficiently. Documentation of such inspection/maintenance shall be kept by the owner in perpetuity.
S5	Finish grade of landscaped areas at a minimum of 1-2 inches below top of curb, sidewalk, or pavement	☒	☐	The landscape architect will provide design plans for the on-site landscaping and irrigation system. The design shall incorporate that finish grade of landsapced areas at a minimum of 1-2 inches below top of curb, sidewalk, or pavement throughout the project site.
S6	Protect slopes and channels and provide energy dissipation (CASQA New Development BMP Handbook SD-10)	☒	☐	Basin slopes shall be designed with a minimum slope of 3 horizontal to 1 vertical to help ensure that erosion of the side slopes does not occur. Perimeter slopes and slopes to catch grade will have a minimum slope of 2:1. The slopes will be landscaped appropriately to also help ensure that erosion of the slopes does not occur. Slopes will be inspected and maintained bi-annually. Documentation of

				such inspection/maintenance shall be kept by the owner in perpetuity.
S7	Covered dock areas (CASQA New Development BMP Handbook SD-31)	☐	☒	Docks are not covered
S8	Covered maintenance bays with spill containment plans (CASQA New Development BMP Handbook SD-31)	☐	☒	No maintenance bays are planned for this site.
S9	Vehicle wash areas with spill containment plans (CASQA New Development BMP Handbook SD-33)	☐	☒	No vehicle wash area are planned for this site.
S10	Covered outdoor processing areas (CASQA New Development BMP Handbook SD-36)	☐	☒	No outdoor processing areas are planned for this site.

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)	☐	☒	No equipment wash areas are planned for this site.
S12	Fueling areas (CASQA New Development BMP Handbook SD-30)	☐	☒	No fueling areas are planned for this site.
S13	Hillside landscaping (CASQA New Development BMP Handbook SD-10)	☐	☒	No hillside landscaping are planned in this area.
S14	Wash water control for food preparation areas	☐	☒	Food preparation areas are not planned for this site.
S15	Community car wash racks (CASQA New Development BMP Handbook SD-33)	☐	☒	No community car wash rack are planned for this site.

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 infiltration chamber system was oversized to accommodate more pervious areas.
Maximize natural infiltration capacity; Including improvement and maintenance of soil: Yes ☒ No ☐ Explanation: The entire site drains to the underground infiltration/detention chamber thereby maximizing the natural infiltration capacity.
Preserve existing drainage patterns and time of concentration: Yes ☒ No ☐ Explanation: The existing drainage pattern, south to north, will be preserved. The flood routing and controlled outlet in the infiltration/ detention chamber will lengthen the time of concentration thus mimicking the existing conditions.
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: The site layout does not allow for roof drains to discharge to previous areas.
Use of Porous Pavement.: Yes ☐ No ☒ Explanation: Porous pavement will not be used and is not practical for developments with heavy trucks.
Protect existing vegetation and sensitive areas: Yes ☐ No ☒ Explanation: Joshua Trees will be removed and replanted or replce in kind by an arborist to be hired by owner. Planting of new vegetation will occur throughout the site.
Re-vegetate disturbed areas. Including planting and preservation of drought tolerant vegetation. : Yes ☒ No ☐ Explanation: All landscape areas will be vegetated for stablization using drought tolerant plants and trees.

Minimize unnecessary compaction in stormwater retention/infiltration basin/trench areas: Yes ☒ No ☐ Explanation: The soils in the proposed infiltration system area will be uncompacted in-place native material and as directed by the Geotech.
Utilize naturalized/rock-lined drainage swales in place of underground piping or imperviously lined swales: Yes ☐ No ☒ Explanation: No rock-lined drainage swales are proposed.
Stake off areas that will be used for landscaping to minimize compaction during construction : Yes ☒ No ☐ Explanation: All landscaped areas will be staked by designation of curb throughout the project site.
Use of Rain Barrels and Cisterns, Including the use of on-site water collection systems.: Yes ☐ No ☒ Explanation: No rain barrels or cisterns are planned for this site.
Stream Setbacks. Includes a specified distance from an adjacent steam: : Yes ☒ No ☐ Explanation: There is a dry stream at the southeasterly corner that drains to the north. The property corner which overlaps that area will be kept native and undisturbed.

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): 791,325	[2] Imperviousness after applying preventative site design practices (Imp%): 88.87	[3] Runoff Coefficient (Rc): _0.69 *$R_c = 0.858(Imp\%)^{\wedge 3} - 0.78(Imp\%)^{\wedge 2} + 0.774(Imp\%) + 0.04$*
[4] Determine 1-hour rainfall depth for a 2-year return period $P_{2yr\text{-}1hr}$ (in): 0.458 *http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html*		
[5] Compute P_6, Mean 6-hr Precipitation (inches): 0.567 *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): 1/12*[791,325*0.69*0.567*1.963]=50,844 *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] 78,299 (1.7975 ac-ft) *Form 4.2-3 Item 12*	[2] 16.19 *Form 4.2-4 Item 13*	[3] 23.45 Rational 24.4UH *Form 4.2-5 Item 10*
Post-developed	[4] 207,372 (4.76 ac-ft) *Form 4.2-3 Item 13*	[5] 11.72 *Form 4.2-4 Item 14*	[6] 37.81 Rational 32.2UH *Form 4.2-5 Item 14*
Difference	[7] *129,073 ; -50,844 ret. 78,229 after routing* *Item 4 – Item 1*	[8] *4.47, 0 diff after routing* *Item 2 – Item 5*	[9] *13.36, less than ex. after routing* *Item 6 – Item 3*
Difference (as % of pre-developed)	[10] *0% once routing and infiltration%* *Item 7 / Item 1*	[11] *0% after routing%* *Item 8 / Item 2*	[12] *0% after routing%* *Item 9 / Item 3*

NOTE: COMPUTER CALCULATIONS USED TO COMPLETE THIS TABLE.

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	SEE CALCS							
2a Hydrologic Soil Group (HSG)								
3a DMA Area, ft^2 *sum of areas of DMA should equal area of DA*								
4a Curve Number (CN) *use Items 1 and 2 to select the appropriate CN from Appendix C-2 of the TGD for WQMP*								
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								
2b Hydrologic Soil Group (HSG)								
3b DMA Area, ft^2 *sum of areas of DMA should equal area of DA*								
4b Curve Number (CN) *use Items 5 and 6 to select the appropriate CN from Appendix C-2 of the TGD for WQMP*								

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

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

12 Pre-developed Volume (ft^3):
*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):
*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): SEE SEPARATE HYD CALCULATIONS IN APPENDIX B
*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*	SEE CALCS							
2 Change in elevation (ft)								
3 Slope (ft/ft), S_o = *Item 2 / Item 1*								
4 Land cover								
5 Initial DMA Time of Concentration (min) *Appendix C-1 of the TGD for WQMP*								
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*								

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

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

15 Additional time of concentration needed to meet hydromodification requirement (min): $T_{C\text{-}Hydro}$ = *(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)*		SEE CALCS					
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 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)*							
4 Pervious area infiltration rate (in/hr) *Use pervious area CN and antecedent moisture condition with Appendix C-3 of the TGD for WQMP*							
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)*							
6 Peak Flow from DMA (cfs) *Q_p =Item 2 * 0.9 * (Item 1 - Item 5)*							
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: *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):		*Maximum of Item 8, 9, and 10 (including additional forms as needed)*
11 Post-developed Q_p at T_c for DMA A: *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):		*Maximum of Item 11, 12, and 13 (including additional forms as needed)*
15 Peak runoff reduction needed to meet Hydromodification Requirement (cfs):		*$Q_{p\text{-}hydro}$ = (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) N/A

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): 0 *$V_{retention}$ =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): 0 *$V_{retention}$ =Sum of Item 12 for all BMPs*			

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

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): 0 $V_{retention}$ *= Sum of Item 17 for all BMPs*			
19 Total Retention Volume from Site Design BMPs: 0 *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): 50,844 *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 1 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*	11.2		
3 Infiltration safety factor *See TGD Section 5.4.2 and Appendix D*	2.7		
4 Design percolation rate (in/hr) *P_{design} = Item 2 / Item 3*	4.14		
5 Ponded water drawdown time (hr) *Copy Item 6 in Form 4.2-1*	48		
6 Maximum ponding depth (ft) *BMP specific, see Table 5-4 of the TGD for WQMP for BMP design details*	9		
7 Ponding Depth (ft) *d_{BMP} = Minimum of (1/12*Item 4*Item 5) or Item 6*	9		
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*	230'x90'		
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*	N/A		
10 Amended soil porosity	N/A		
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*	0.5'		
12 Gravel porosity	0.4		
13 Duration of storm as basin is filling (hrs) *Typical ~ 3hrs*	3		
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))]*	0		
15 Underground Retention Volume (ft^3) *Volume determined using manufacturer's specifications and calculations*	55,955 Infil. 128,853 Tot. See sizing in Attch. B		

16 Total Retention Volume from LID Infiltration BMPs: 128,853 *(Sum of Items 14 and 15 for all infiltration BMP included in plan)*

17 Fraction of DCV achieved with infiltration BMP: 253% *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): 0 *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.*	
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): *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) – N/A
Bioretention and Planter Boxes with Underdrains

Biotreatment BMP Type *(Bioretention w/underdrain, planter box w/underdrain, other comparable BMP)*	DA 0 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: 0 *Sum of Item 14 for all volume-based BMPs included in this form*			

Form 4.3-6 Volume Based Biotreatment (DA 1) – N/A
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 0 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 : 0 *(Sum of Item 12 for all BMP included in plan)*				

Form 4.3-7 Flow Based Biotreatment (DA 1) N/A

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*			
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)*			
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*			
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): 50,844 *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): 55,955; 128,853 tot. with detention *Copy Item 16 in Form 4.3-3*

4 On-site biotreatment with volume based biotreatment BMP (ft^3): 0 *Copy Item 3 in Form 4.3-4*

5 Flow capacity provided by flow based biotreatment BMP (cfs): 0 *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): 0 *(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): 128,853 *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): 0 *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).

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
UG. Infiltration System (N_4)	Owner	-Inspect/Maintain UG-Infiltration Basin Systems -Isolator Row or clarifier (TBD) for collected trash, sediments, and/or debris. Remove trash, sediments and debris by jet-vac and pump and dispose of trash, sediments and debris in a legal manner. -Inspect system for standing water. If system has standing water, peform re-inspection within 48 hours. If system still gas standing water then the system shall be jet-vacuumed and pumped and removed debris shall be diposed of in a legal manner.	Bi-monthly and prior to storm event and 48 hours after storm has passed.
Loading Docks & Parking Areas	Owner	Sweep loading dock and parking lot and truck courts.	Monthly / As needed.
Catch Basin Filter	Owner	- Inspect and maintain catch basin filters as required. - Inspect catch basin bottom for debris / remove debris and dispose as required.	Quarterly

Truck Dock	Owner	Inspect loading dock for trash debris and sediments. Inspect loading dock for evidence of spills and broken containers. Clean up spills and dispose of collected material in a legal manner.	Weekly
Planting	Owner	Inspect helth of planting and erosion of landscape area. Trimming trees and bushes when needed.	Monthly
Efficient Irrigation	Owner	- Inspect irrigation system general operation and durations. - Repair damaged sprinkler and drip irrigation lines as needed. - Reduce durations during the winter season to prevent over irrigation.	Monthly
Storm drain system signage	Owner	Inspect Catch basin signage for faded or lost signs / repair or replace as needed.	Annually
Trash Storage Areas and Litter Control (SD-32)	Owner	Inspect trash container, lids, screens and clean trash storage areas..	Weekly

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.

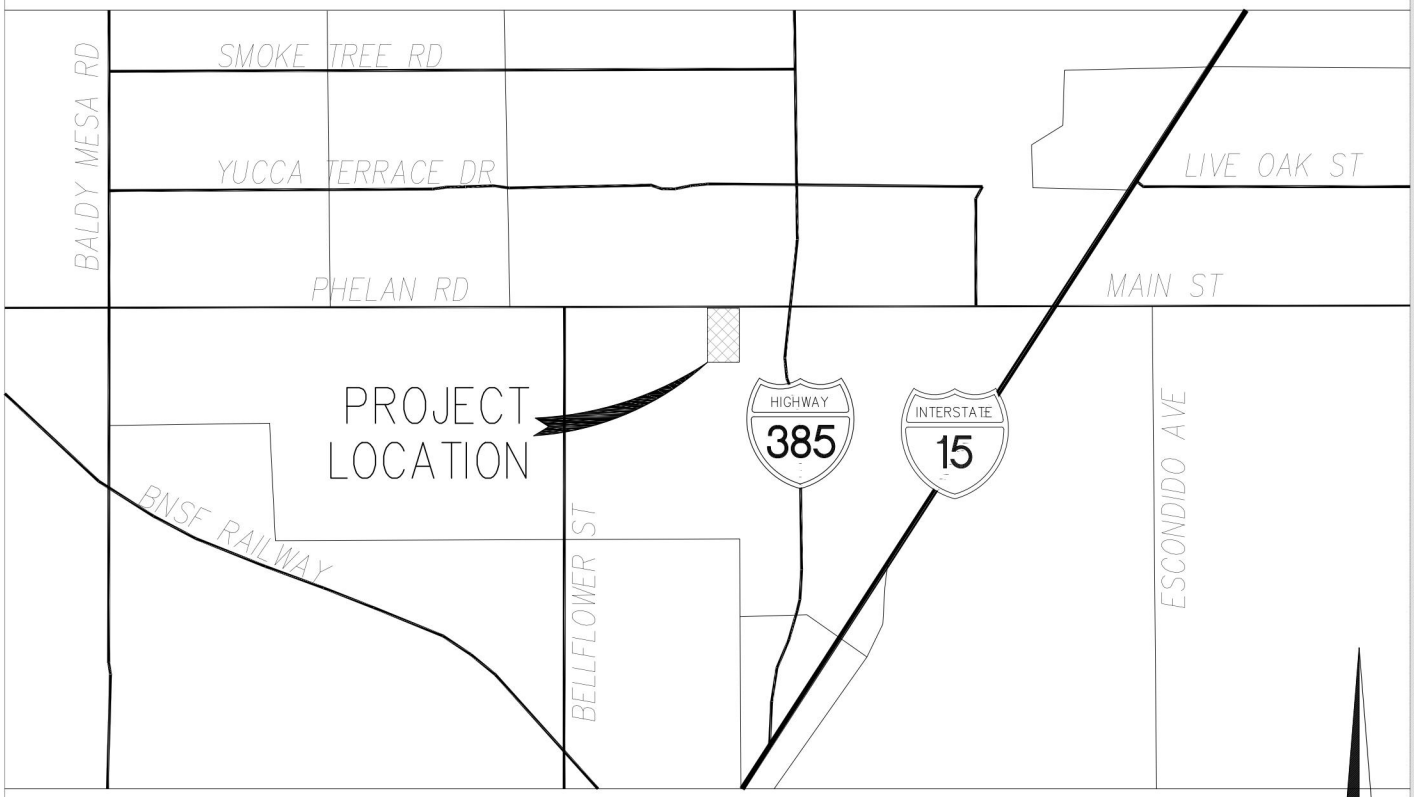
6.3 Post Construction

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

Attachment A
WQMP Site Plan

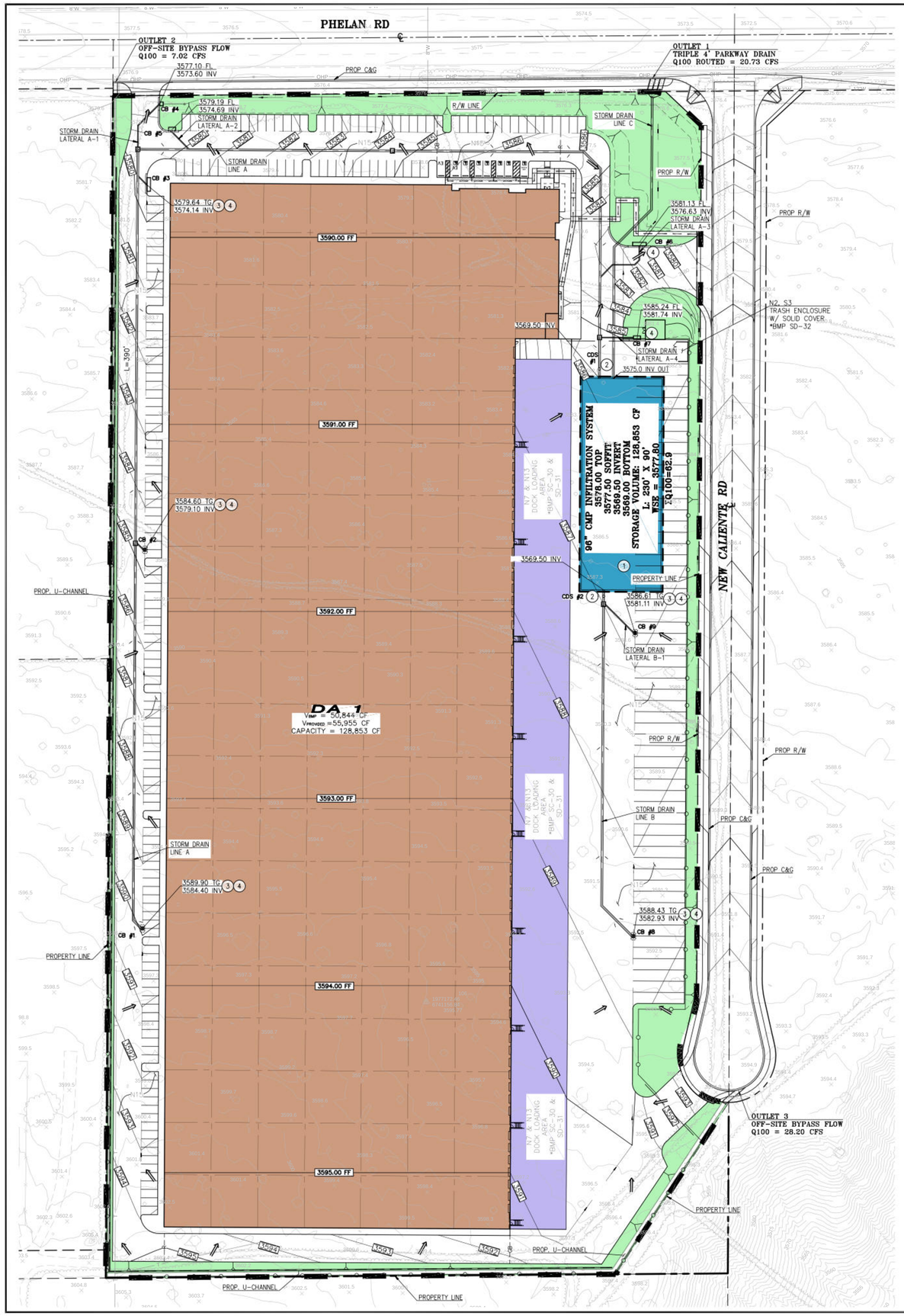


LEGEND

PROJECT LIMITS

VICINITY MAP

NOT TO SCALE



0 25 50 100 150

SCALE 1" = 50'

WQMP BMP NOTES

** (1) INSTALL INFILTRATION/DETENTION SYSTEM PER DETAIL HEREON

(2) INSTALL CONTECH CDS UNIT PER DETAIL HEREON

(3) INSTALL STORM DRAIN STENCIL, SEE SAMPLE HEREON

(4) INSTALL CATCH BASIN FILTRATION INSERT

**THE UNDERGROUND SYSTEM IS ALSO SIZED TO DETAIN 100-YEAR STORM FULLY FOR MITIGATION TO EXISTING CONDITION.

SOURCE CONTROL BMPs INCLUDED ONSITE		
IDENTIFIER	DESCRIPTION OF BMP	RESPONSIBLE PARTY
N2	INSPECT/MAINTAIN TRASH CONTAINER	OWNER
N3	LANDSCAPE MAINTENANCE BMP'S	OWNER
N7	PROVIDE SPILL PLAN	OWNER
N11	LITTER/DEBRIS CONTROL PROGRAM	OWNER
N13	HOUSEKEEPING OF LOADING DOCKS	OWNER
N14	CATCH BASIN INSPECTION PROGRAM	OWNER
N15	VACUUM SWEEPING OF PARKING LOTS	OWNER
N17	NPDES COMPLIANCE	OWNER
S1	STORM DRAIN STENCILING	OWNER
S3	REDUCED WASTE STORAGE POLLUTION	OWNER
S4	EFFICIENT IRRIGATION SYSTEM	OWNER
S5	LANDSCAPING MIN. 1-2" BELOW PAVEMENT	OWNER

*SEE WQMP REPORT ATTACHMENT C FOR BMP FACT SHEET

LEGEND

- PROPOSED STORM DRAIN
- PROPOSED CURB OPENING INLET
- DRAINAGE BOUNDARY
- FLOWLINE
- FLOW DIRECTION
- PROPOSED LANDSCAPING AREA
- PROPOSED LOADING DOCK AREA
- PROPOSED UNDERGROUND BASIN AREA
- PROPOSED ROOF AREA





③ STORM DRAIN STENCIL
NOT TO SCALE

ARCHITECTURE

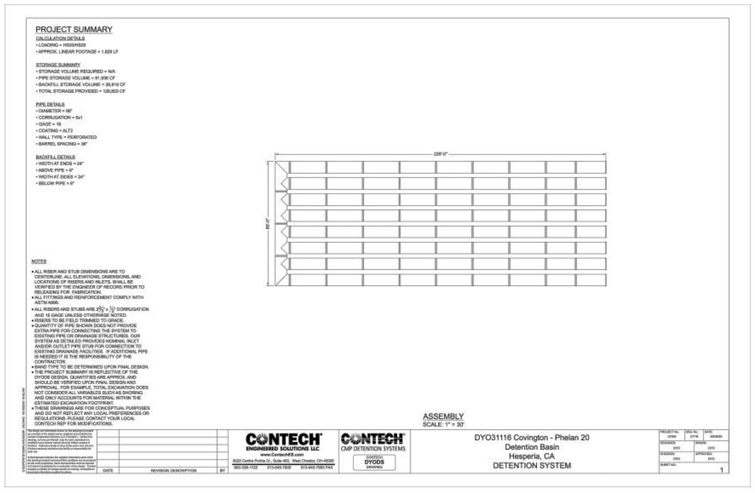
RGA
15231 ALTON PARKWAY, SUITE 100
IRVINE, CA 92618
PHONE: (949) 341-0920X101
CONTACT: CHRIS SAVAGE
CHRIS@RGA-ARCH.COM

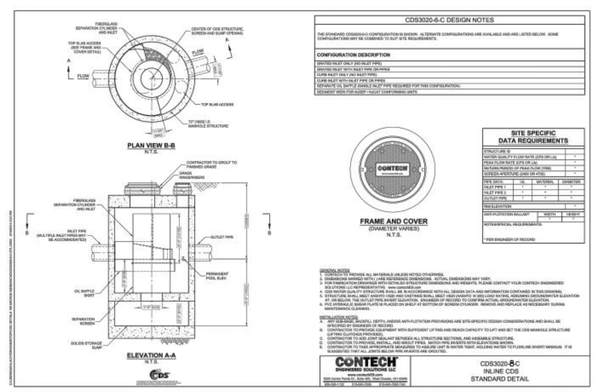
ENGINEER

HUITT-ZOLLARS
3990 CONCOURS, SUITE 330
ONTARIO, CA 91764
PHONE: (909) 941-7799
CONTACT: MANUEL GONZALES

OWNER

COVINGTON DEVELOPMENT PARTNERS, LLC
3 CORPORATE PLAZA, SUITE 230
NEWPORT BEACH, CA 92660
PHONE: (760) 668-5597
CONTACT: DANIELLE GRAHAM





ON-SITE RETENTION

DA NAME	AREA (SF)	i	C	DCV_{BMP} (CF)	$V_{PROVIDED}$ (CF)	UNDERGROUND CAPACITY FOR PEAK STORM MITIGATION (CF)
DA 1	791,325	88.9	0.69	50,844	55,955 FOR RETENTION	128,853 CF STORM DETENTION

HUITT ZOLLARS
3990 CONCOURS, SUITE 330, ONTARIO, CALIFORNIA 91764
Phone (909) 941-7799, www.huitt-zollars.com

CITY OF HESPERIA

CONCEPTUAL WATER QUALITY MANAGEMENT PLAN FOR COVINGTON - PHELAN 20

SHEET 1 NO. 1

Worksheet 2

Design Procedure Form for Design Flow

Uniform Intensity Design Flow

Designer: Tobi Adabale
Company: Huitt-Zollars, Inc
Date: 05/26/2023
Project: Covington - Phelan 20
Location: CDS#1

1. Determine Impervious Percentage		
a. Determine total tributary area	A_{total} = 12.20 acres	***(1)***
b. Determine Impervious %	i = 90 %	***(2)***
2. Determine Runoff Coefficient Values Use **Table 4** and impervious % found in step 1		
a. A Soil Runoff Coefficient	C_a = 0.88	***(3)***
b. B Soil Runoff Coefficient	C_b =	***(4)***
c. C Soil Runoff Coefficient	C_c =	***(5)***
d. D Soil Runoff Coefficient	C_d =	***(6)***
3. Determine the Area decimal fraction of each soil type in tributary area		
a. Area of A Soil / ***(1)*** =	A_a = 1	***(7)***
b. Area of B Soil / ***(1)*** =	A_b =	***(8)***
c. Area of C Soil / ***(1)*** =	A_c =	***(9)***
d. Area of D Soil / ***(1)*** =	A_d =	***(10)***
4. Determine Runoff Coefficient		
a. C = ***(3)***x***(7)*** + ***(4)***x***(8)*** + ***(5)***x***(9)*** + ***(6)***x***(10)*** =	C = 0.88	***(11)***
5. Determine BMP Design flow		
a. Q_{BMP} = C x I x A = ***(11)*** x 0.2 x ***(1)***	Q_{BMP} = 2.15 $\frac{ft^3}{s}$	***(12)***

Worksheet 2

Design Procedure Form for Design Flow

Uniform Intensity Design Flow

Designer: Tobi Adabale
Company: Huitt-Zollars, Inc
Date: 05/26/2023
Project: Covington - Phelan 20
Location: CDS#2

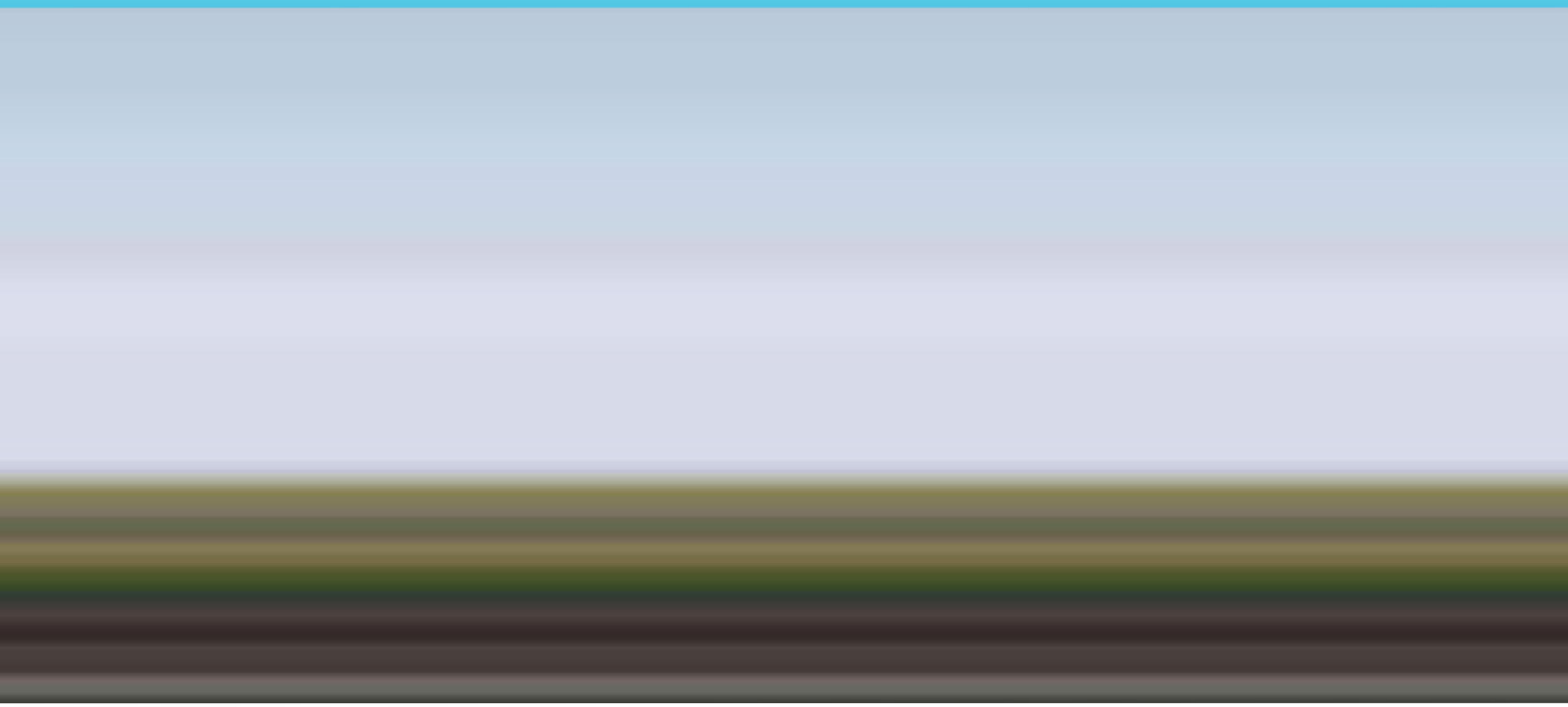
1. Determine Impervious Percentage		
a. Determine total tributary area	A_{total} = 6 acres	***(1)***
b. Determine Impervious %	i = 90 %	***(2)***
2. Determine Runoff Coefficient Values Use **Table 4** and impervious % found in step 1		
a. A Soil Runoff Coefficient	C_a = 0.88	***(3)***
b. B Soil Runoff Coefficient	C_b =	***(4)***
c. C Soil Runoff Coefficient	C_c =	***(5)***
d. D Soil Runoff Coefficient	C_d =	***(6)***
3. Determine the Area decimal fraction of each soil type in tributary area		
a. Area of A Soil / ***(1)*** =	A_a = 1	***(7)***
b. Area of B Soil / ***(1)*** =	A_b =	***(8)***
c. Area of C Soil / ***(1)*** =	A_c =	***(9)***
d. Area of D Soil / ***(1)*** =	A_d =	***(10)***
4. Determine Runoff Coefficient		
a. C = ***(3)***x***(7)*** + ***(4)***x***(8)*** + ***(5)***x***(9)*** + ***(6)***x***(10)*** =	C = 0.88	***(11)***
5. Determine BMP Design flow		
a. Q_{BMP} = C x I x A = ***(11)*** x 0.2 x ***(1)***	Q_{BMP} = 1.06 $\frac{ft^3}{s}$	***(12)***

CONTECH®
ENGINEERED SOLUTIONS

CDS®
Hydrodynamic Separator



The experts you need to solve your stormwater management challenges



Contech is the leader in stormwater management solutions, helping engineers, contractors and owners with infrastructure and land development projects throughout North America.

With our responsive team of stormwater experts, local regulatory expertise and flexible solutions, Contech is the trusted partner you can count on for stormwater management solutions.

Your Contech Team



STORMWATER CONSULTANT

It's my job to recommend the best solution to meet permitting requirements.



STORMWATER DESIGN ENGINEER

I work with consultants to design the best approved solution to meet your project's needs.



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I understand the local stormwater regulations and what solutions will be approved.



SALES ENGINEER

I make sure our solutions meet the needs of the contractor during construction.

Contech is your partner in stormwater management solutions



Unique screening technology for stormwater runoff – CDS®

The CDS hydrodynamic separator uses swirl concentration and continuous deflective separation to screen, separate and trap trash, debris, sediment, and hydrocarbons from stormwater runoff.

At the heart of the CDS system is a unique screening technology used to capture and retain trash and debris. The screen face is louvered so that it is smooth in the downstream direction. The effect created is called “Continuous Deflective Separation.” The power of the incoming flow is harnessed to continually shear debris off the screen and to direct trash and sediment toward the center of the separation cylinder. This results in a screen that is self-cleaning and provides 100% removal of floatables and neutrally buoyant material debris 4.7 mm or larger, without blinding.

CDS is used to meet trash Total Maximum Daily Load (TMDL) requirements, for stormwater quality control, inlet and outlet pollution control, and as pretreatment for filtration, detention/infiltration, bioretention, rainwater harvesting systems, and a variety of green infrastructure practices.

CDS® Features and Benefits

FEATURE	BENEFIT
Captures and retains 100% of floatables and neutrally buoyant debris 4.7mm or larger	Superior pollutant removal
Self-cleaning screen	Ease of maintenance
Isolated storage sump eliminates scour potential	Excellent pollutant retention
Internal bypass	Eliminates the need for additional structures
Multiple pipe inlets and 90-180º angles	Design flexibility
Clear access to sump and stored pollutants	Fast, easy maintenance



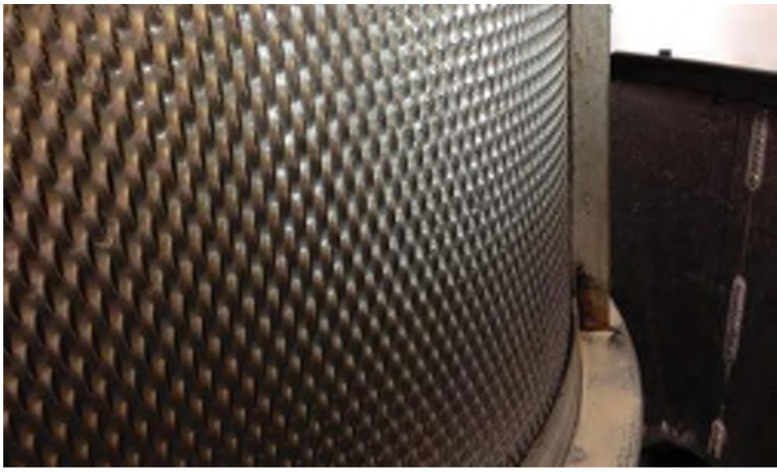
APPLICATION TIPS

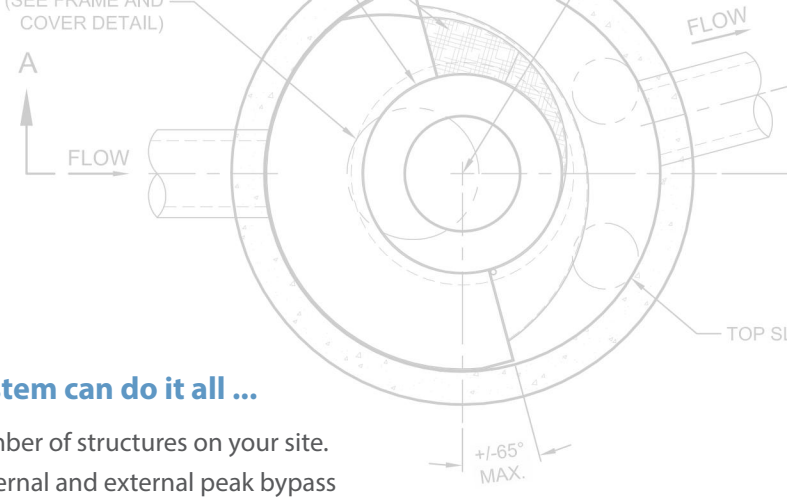
- Because of its internal peak bypass weirs, CDS systems can provide cost savings by eliminating the need for additional structures.
- Pretreating detention, infiltration, and green infrastructure practices with CDS can protect downstream structures and provide for easy maintenance.
- The CDS an ideal solution for retrofit applications due to its compact footprint and configuration flexibility.

The CDS® Screen

A fundamentally different approach to trash control ...

Traditional approaches to trash control typically involve "direct screening" that can easily become clogged, as trash is pinned to the screen as water passes through. Clogged screens can lead to flooding as water backs up. The design of the CDS screen is fundamentally different. Flow is introduced to the screen face which is louvered so that it is smooth in the downstream direction. The effect created is called "Continuous Deflective Separation." The power of the incoming flow is harnessed to continually shear debris off the screen and to direct trash and sediment toward the center of the separation cylinder.

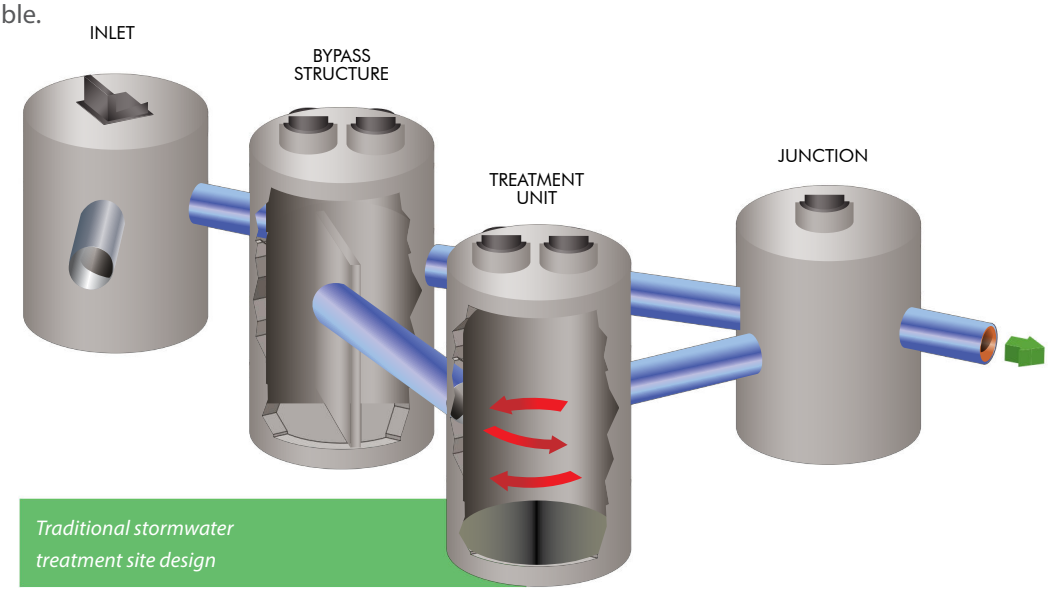




CDS® Design Configuration

Why use traditional stormwater design when ONE system can do it all ...

The CDS effectively treats stormwater runoff while reducing the number of structures on your site. Inline, offline, grate inlet, and drop inlet configurations available. Internal and external peak bypass options also available.

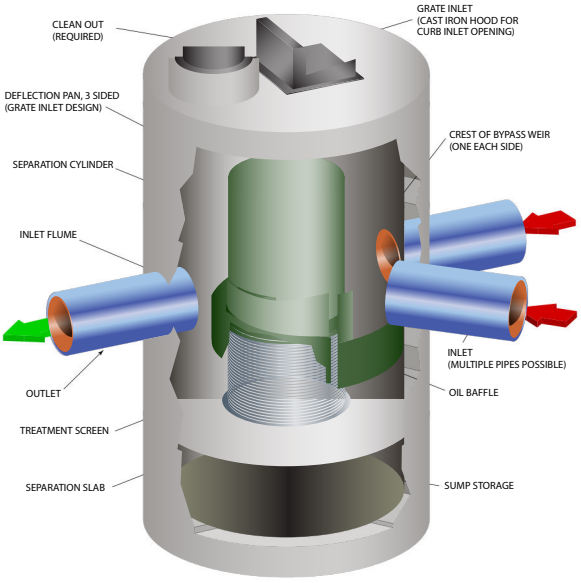


Traditional stormwater treatment site design

A Traditional Stormwater Treatment Site Design would require several structures on your site. With CDS, one system can do it all!

CDS® Advantages

- Grate inlet option available
- Internal bypass weir
- Accepts multiple inlets at a variety of angles
- Advanced hydrodynamic separator
- Captures and retains 100% of floatables and neutrally buoyant debris 4.7 mm or larger
- Indirect screening capability keeps screen from clogging
- Retention of all captured pollutants, even at high flows
- Performance verified by NJCAT, WA Ecology, and ETV Canada



Learn More:
www.ContechES.com/cds

CDS® Applications

CDS is commonly used in the following stormwater applications:

- Stormwater quality control – trash, debris, sediment, and hydrocarbon removal
- Urban retrofit and redevelopment
- Inlet and outlet protection
- Pretreatment for filtration, detention/infiltration, bioretention, rainwater harvesting systems, and Low Impact Development designs



CDS® provides trash control



CDS® pretreats a bioswale

Select CDS® Certifications and Verifications

CDS has been verified by some of the most stringent stormwater technology evaluation organizations in North America, including:

- Washington State Department of Ecology (GULD) - Pretreatment
- New Jersey Department of Environmental Protection (NJ DEP)
- Canadian Environmental Technology Verification (ETV)
- California Statewide Trash Amendments Full Capture System Certified*

**The CDS System has been certified by the California State Water Resources Control Board as a Full Capture System provided that it is sized to treat the peak flow rate from the region specific 1-year, 1-hour design storm, or the peak flow capacity of the corresponding storm drain, whichever is less.*

Save time, space and money with CDS

CDS® Maintenance

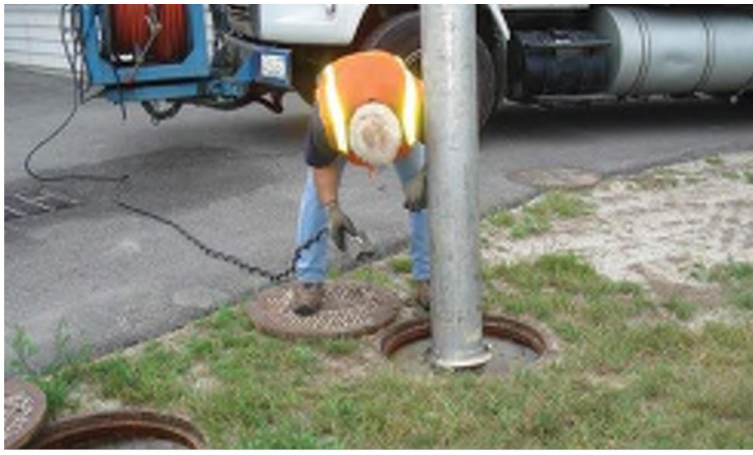
Select a cost-effective and easy-to-access treatment system ...

Systems vary in their maintenance needs, and the selection of a cost-effective and easy-to-access treatment system can mean a huge difference in maintenance expenses for years to come.

A CDS unit is designed to minimize maintenance and make it as easy and inexpensive as possible to keep our systems working properly.

INSPECTION

Inspection is the key to effective maintenance. Pollutant deposition and transport may vary from year to year and site to site. Semi-annual inspections will help ensure that the system is cleaned out at the appropriate time. Inspections should be performed more frequently where site conditions may cause rapid accumulation of pollutants.



Most CDS® units can easily be cleaned within thirty minutes.

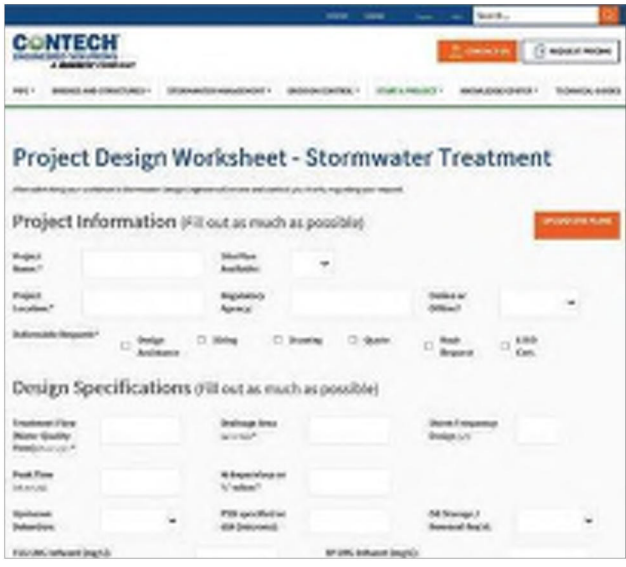
RECOMMENDATIONS FOR CDS MAINTENANCE

The recommended cleanout of solids within the CDS unit's sump should occur at 75% of the sump capacity. Access to the CDS unit is typically achieved through two manhole access covers – one allows inspection and cleanout of the separation chamber and sump, and another allows inspection and cleanout of sediment captured and retained behind the screen. A vacuum truck is recommended for cleanout of the CDS unit and can be easily accomplished in less than 30 minutes for most installations.

HDS Product Design Worksheets

Our in-house team of engineers can support you through the entire permitting process - and the first step is sending us your project information by filling out one of the Project Design Worksheets. We will forward your information to an in-house engineer who will contact you with specific recommendations for your project.

The free tool is available at www.ContechES.com/pdw-treatment



Learn More:
www.ContechES.com/pdw-treatment

A partner you can rely on

CDS® Models and Capacities

	CDS MODEL	Treatment Flow Rates[1] 75 microns (cfs)/(L/s)	125 microns[2] (cfs)/(L/s)	Trash & Debris (cfs)/(L/s)	Estimated Maximum Peak Conveyance Flow[3] (cfs)/(L/s)	Minimum Sump Storage Capacity[4] (yd^3)/(m^3)	Minimum Oil Storage Capacity[4] (gal)/(L)
PRECAST	CDS2015-4	0.5 (14.2)	0.7 (19.8)	1.0 (28.3)	10 (283)	0.9 (0.7)	61 (232)
	CDS2015-5	0.5 (14.2)	0.7(19.8)	1.0 (28.3)	10 (283)	1.5 (1.1)	83 (313)
	CDS2020-5	0.7 (19.8)	1.1 (31.2)	1.5 (42.5)	14 (396)	1.5 (1.1)	99 (376)
	CDS2025-5	1.1 (31.2)	1.6 (45.3)	2.2 (62.3)	14 (396)	1.5 (1.1)	116 (439)
	CDS3020-6	1.4 (39.6)	2.0 (56.6)	2.8 (79.3)	20 (566)	2.1 (1.6)	184 (696)
	CDS3025-6	1.7 (48.1)	2.5 (70.8)	3.5 (99.2)	20 (566)	2.1 (1.6)	210 (795)
	CDS3030-6	2.0 (56.6)	3.0 (85.0)	4.2 (118.9)	20 (566)	2.1 (1.6)	236 (895)
	CDS3035-6	2.6 (73.6)	3.8 (106.2)	5.3 (150.0)	20 (566)	2.1 (1.6)	263 (994)
	CDS4030-8	3.1 (87.7)	4.5 (127.4)	6.3 (178.3)	30 (850)	5.6 (4.3)	426 (1612)
	CDS4040-8	4.1 (116.1)	6.0 (169.9)	8.4 (237.8)	30 (850)	5.6 (4.3)	520 (1970)
	CDS4045-8	5.1 (144.4)	7.5 (212.4)	10.5 (297.2)	30 (850)	5.6 (4.3)	568 (2149)
	CDS5640-10	6.1 (172.7)	9.0 (254.9)	12.6 (356.7)	50 (1416)	8.7 (6.7)	758 (2869)
	CDS5653-10	9.5 (268.9)	14.0 (396.5)	19.6 (554.8)	50 (1416)	8.7 (6.7)	965 (3652)
	CDS5668-10	12.9 (365.1)	19.0 (538.1)	26.6 (752.9)	50 (1416)	8.7 (6.7)	1172 (4435)
	CDS5678-10	17.0 (481.2)	25.0 (708.0)	35.0 (990.7)	50 (1416)	8.7 (6.7)	1309 (4956)
	CDS9280-12	27.2 (770.2)	40.0 (1132.7)	56.0 (1585.7)		16.8 (12.8)	
	CDS9290-12	35.4 (1002.4)	52.0 (1472.5)	72 (2038.8)		16.8 (12.8)	
	CDS92100-12	42.8 (1212.0)	63.0 (1783.9)	88 (2491.9)	Offline	16.8 (12.8)	N/A
CAST-IN-PLACE	CDS150134-22	100.7 (2851.5)	148.0 (4190.9)	270 (7645.6)		56.3 (43.0)	
	CDS200164-26	183.6 (5199.0)	270.0 (7645.6)	378.0 (10703.8)		78.7 (60.2)	
	CDS240160-32	204 (5776.6)	300.0 (8495.1)	420.0 (11893.0)		119.1 (91.1)	
	Additional Cast-in-Place models available upon request.						

1. Alternative PSD/D_{50} sizing is available upon request.
2. 125 micron flows are based on the CDS Washington State Department of Ecology approval for 80% removal of a particle size distribution (PSD) having a mean particle size (D_{50}) of 125 microns.
3. Estimated maximum peak conveyance flow is calculated using conservative values and may be exceeded on sites with lower inflow velocities and sufficient head over the weir.
4. Sump and oil capacities can be customized to meet site needs.

CDS#1 &2

STORMWATER SOLUTIONS

PIPE SOLUTIONS

STRUCTURES SOLUTIONS

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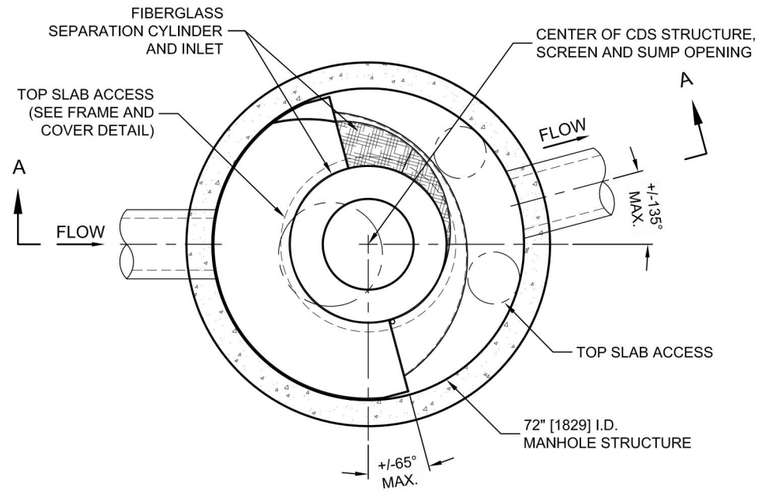
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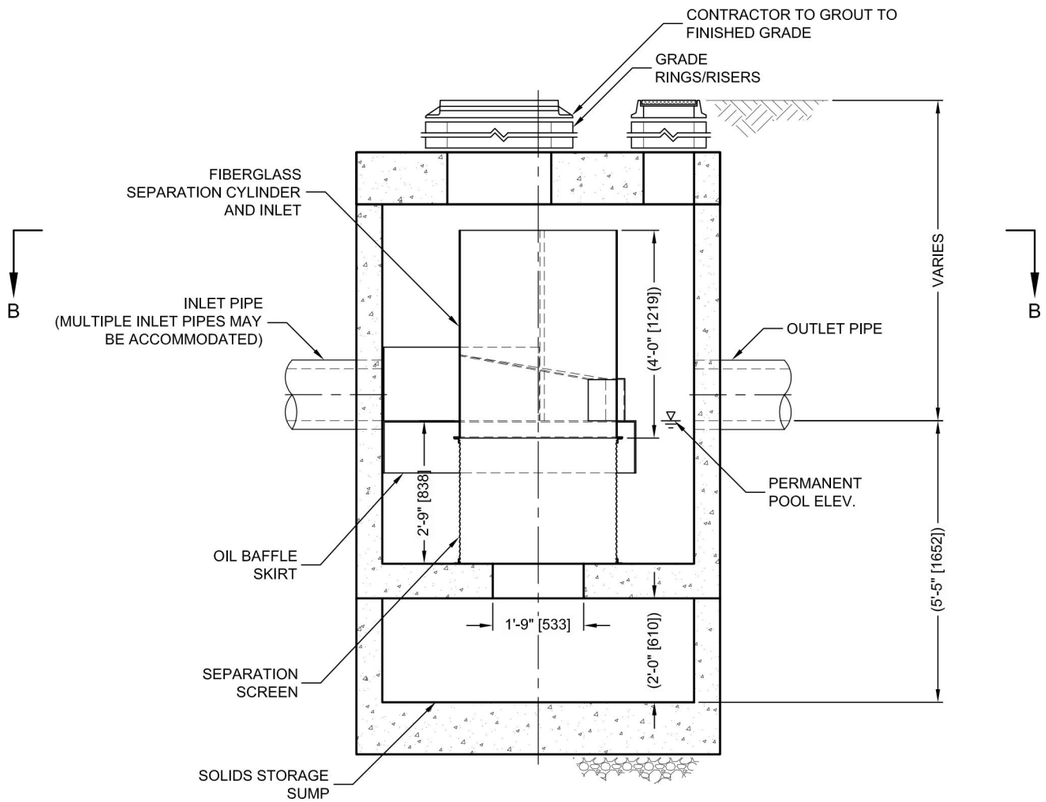
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PLAN VIEW B-B
N.T.S.



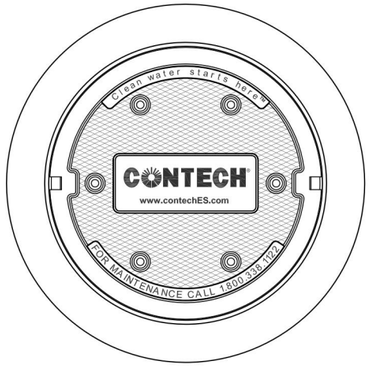
ELEVATION A-A
N.T.S.

THIS PRODUCT MAY BE PROTECTED BY ONE OR MORE OF THE FOLLOWING U.S. PATENTS: 5,788,848; 6,641,720; 6,511,595; 6,581,783; RELATED FOREIGN PATENTS, OR OTHER PATENTS PENDING.

CDS3020-6-C DESIGN NOTES

THE STANDARD CDS3020-6-C CONFIGURATION IS SHOWN. ALTERNATE CONFIGURATIONS ARE AVAILABLE AND ARE LISTED BELOW. SOME CONFIGURATIONS MAY BE COMBINED TO SUIT SITE REQUIREMENTS.

CONFIGURATION DESCRIPTION
GRATED INLET ONLY (NO INLET PIPE)
GRATED INLET WITH INLET PIPE OR PIPES
CURB INLET ONLY (NO INLET PIPE)
CURB INLET WITH INLET PIPE OR PIPES
SEPARATE OIL BAFFLE (SINGLE INLET PIPE REQUIRED FOR THIS CONFIGURATION)
SEDIMENT WEIR FOR NJDEP / NJCAT CONFORMING UNITS



FRAME AND COVER
(DIAMETER VARIES)
N.T.S.

SITE SPECIFIC DATA REQUIREMENTS

STRUCTURE ID	
WATER QUALITY FLOW RATE (CFS OR L/s)	*
PEAK FLOW RATE (CFS OR L/s)	*
RETURN PERIOD OF PEAK FLOW (YRS)	*
SCREEN APERTURE (2400 OR 4700)	*

PIPE DATA:	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	*	*	*
INLET PIPE 2	*	*	*
OUTLET PIPE	*	*	*

RIM ELEVATION	*

ANTI-FLOTATION BALLAST	WIDTH	HEIGHT
	*	*

NOTES/SPECIAL REQUIREMENTS:

* PER ENGINEER OF RECORD

GENERAL NOTES
1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. DIMENSIONS MARKED WITH ( ) ARE REFERENCE DIMENSIONS. ACTUAL DIMENSIONS MAY VARY.
3. FOR FABRICATION DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHTS, PLEASE CONTACT YOUR CONTECH ENGINEERED SOLUTIONS LLC REPRESENTATIVE. www.contechES.com
4. CDS WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING.
5. STRUCTURE SHALL MEET AASHTO HS20 AND CASTINGS SHALL MEET HS20 (AASHTO M 306) LOAD RATING, ASSUMING GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION.
6. PVC HYDRAULIC SHEAR PLATE IS PLACED ON SHELF AT BOTTOM OF SCREEN CYLINDER. REMOVE AND REPLACE AS NECESSARY DURING MAINTENANCE CLEANING.

INSTALLATION NOTES
A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE CDS MANHOLE STRUCTURE (LIFTING CLUTCHES PROVIDED).
C. CONTRACTOR TO ADD JOINT SEALANT BETWEEN ALL STRUCTURE SECTIONS, AND ASSEMBLE STRUCTURE.
D. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT PIPES. MATCH PIPE INVERTS WITH ELEVATIONS SHOWN.
E. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO ASSURE UNIT IS WATER TIGHT, HOLDING WATER TO FLOWLINE INVERT MINIMUM. IT IS SUGGESTED THAT ALL JOINTS BELOW PIPE INVERTS ARE GROUTED.

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CDS3020-8·C
INLINE CDS
STANDARD DETAIL

C:\USERS\SCHLACHTERH\DESKTOP\CDS DETAILS 180 MICRON SIZING\ACAD\CDS3020-6-C-DTL.DWG 5/19/2014 5:21 PM

VII.4.1. Site Suitability Considerations

Suitability assessment related considerations include (**Table VII.3**):

- Soil assessment methods – the site assessment extent (e.g., number of borings, test pits, etc.) and the measurement method used to estimate the short-term infiltration rate.
- Predominant soil texture/percent fines – soil texture and the percent of fines can greatly influence the potential for clogging.
- Site soil variability – site with spatially heterogeneous soils (vertically or horizontally) as determined from site investigations are more difficult to estimate average properties for resulting in a higher level of uncertainty associated with initial estimates.
- Depth to seasonal high groundwater/impervious layer – groundwater mounding may become an issue during excessively wet conditions where shallow aquifers or shallow clay lenses are present.

Table VII.3: Suitability Assessment Related Considerations for Infiltration Facility Safety Factors

Consideration	High Concern	Medium Concern	Low Concern	
Assessment methods (see explanation below)	Use of soil survey maps or simple texture analysis to estimate short-term infiltration rates	Direct measurement of ≥ 20 percent of infiltration area with localized infiltration measurement methods (e.g., infiltrometer)	Direct measurement of ≥ 50 percent of infiltration area with localized infiltration measurement methods or Use of extensive test pit infiltration measurement methods	Per infiltration report in Attachment D
Texture Class	Silty and clayey soils with significant fines	Loamy soils	Granular to slightly loamy soils	Per infiltration report in Attachment D
Site soil variability	Highly variable soils indicated from site assessment or limited soil borings collected during site assessment	Soil borings/test pits indicate moderately homogeneous soils	Multiple soil borings/test pits indicate relatively homogeneous soils	Per infiltration report in Attachment D
Depth to groundwater/ impervious layer	<5 ft below facility bottom	5-10 ft below facility bottom	>10 below facility bottom	Per infiltration report in Attachment D

Localized infiltration testing refers to methods such as the double ring infiltrometer test (ASTM D3385-88) which measure infiltration rates over an area less than 10 sq-ft, may include lateral

flow, and do not attempt to account for heterogeneity of soil. The amount of area each test represents should be estimated depending on the observed heterogeneity of the soil.

Extensive infiltration testing refers to methods that include excavating a significant portion of the proposed infiltration area, filling the excavation with water, and monitoring drawdown. The excavation should be to the depth of the proposed infiltration surface and ideally be at least 50 to 100 square feet.

In all cases, testing should be conducted in the area of the proposed BMP where, based on review of available geotechnical data, soils appear least likely to support infiltration.

VII.4.2. Design Related Considerations

Design related considerations include (**Table VII.4**):

- Size of area tributary to facility – all things being equal, risk factors related to infiltration facilities increase with an increase in the tributary area served. Therefore facilities serving larger tributary areas should use more restrictive adjustment factors.
- Level of pretreatment/expected influent sediment loads – credit should be given for good pretreatment by allowing less restrictive factors to account for the reduced probability of clogging from high sediment loading. Also, facilities designed to capture runoff from relatively clean surfaces such as rooftops are likely to see low sediment loads and therefore should be allowed to apply less restrictive safety factors.
- Redundancy – facilities that consist of multiple subsystems operating in parallel such that parts of the system remains functional when other parts fail and/or bypass should be rewarded for the built-in redundancy with less restrictive correction and safety factors. For example, if bypass flows would be at least partially treated in another BMP, the risk of discharging untreated runoff in the event of clogging the primary facility is reduced. A bioretention facility that overflows to a landscaped area is another example.
- Compaction during construction – proper construction oversight is needed during construction to ensure that the bottoms of infiltration facility are not overly compacted. Facilities that do not commit to proper construction practices and oversight should have to use more restrictive correction and safety factors.

Table VII.4: Design Related Considerations for Infiltration Facility Safety Factors

Consideration	High Concern	Medium Concern	Low Concern
Tributary area size	Greater than 10 acres.	Greater than 2 acres but less than 10 acres.	2 acres or less.
Level of pretreatment/ expected influent sediment loads	Pretreatment from gross solids removal devices only, such as hydrodynamic separators, racks and screens AND tributary area includes landscaped areas, steep slopes, high traffic areas, or any other areas expected to produce high sediment, trash, or debris loads.	Good pretreatment with BMPs that mitigate coarse sediments such as vegetated swales AND influent sediment loads from the tributary area are expected to be relatively low (e.g., low traffic, mild slopes, disconnected impervious areas, etc.).	Excellent pretreatment with BMPs that mitigate fine sediments such as bioretention or media filtration OR sedimentation or facility only treats runoff from relatively clean surfaces, such as rooftops.
Redundancy of treatment	No redundancy in BMP treatment train.	Medium redundancy, other BMPs available in treatment train to maintain at least 50% of function of facility in event of failure.	High redundancy, multiple components capable of operating independently and in parallel, maintaining at least 90% of facility functionality in event of failure.
Compaction during construction	Construction of facility on a compacted site or elevated probability of unintended/ indirect compaction.	Medium probability of unintended/ indirect compaction.	Heavy equipment actively prohibited from infiltration areas during construction and low probability of unintended/ indirect compaction.

3 acres

CDS Units will be provided in all on-site storm drain as a pre-treatment control BMP prior to allowing runoff to be conveyed to the primary treatment BMP. The CDS Units will remove large debris, trash, sediment and oil/grease from the runoff before outleting into the on-site infiltration systems. See Attachment B for CDS Unit and catch basin filter specifications & calculations.

The soil in the proposed infiltration system footprints will be uncompacted in-place native material.

VII.4.3. Determining Factor of Safety

A factor of safety shall be used. To assist in selecting the appropriate design infiltration rate, the measured short term infiltration rate should be adjusted using a weighted average of several safety factors using the worksheet shown in **Worksheet H** below. The design infiltration rate would be determined as follows:

1. For each consideration shown in **Table VII.3** and **Table VII.4** above, determine whether the consideration is a high, medium, or low concern.
2. For all high concerns, assign a factor value of 3, for medium concerns, assign a factor value of 2, and for low concerns assign a factor value of 1.
3. Multiply each of the factors by the corresponding weight to get a product.
4. Sum the products within each factor category to obtain a safety factor for each.
5. Multiply the two safety factors together to get the final combined safety factor. If the combined safety factor is less than 2, then 2 shall be used as the safety factor.
6. Divide the measured short term infiltration rate by the combined safety factor to obtain the adjusted design infiltration rate for use in sizing the infiltration facility.

The design infiltration rate shall be used to size BMPs and to evaluate their expected long term performance. This rate shall not be less than 2, but may be higher at the discretion of the design engineer.

Worksheet H: Factor of Safety and Design Infiltration Rate and Worksheet

Factor Category		Factor Description	Assigned Weight (w)	Factor Value (v)	Product (p) p = w x v
A	Suitability Assessment	Soil assessment methods	0.25	2	0.50
		Predominant soil texture	0.25	1	0.25
		Site soil variability	0.25	1	0.25
		Depth to groundwater / impervious layer	0.25	1	0.25
		Suitability Assessment Safety Factor, $S_A = \Sigma p$			1.25
B	Design	Tributary area size	0.25	3	0.75
		Level of pretreatment/ expected sediment loads	0.25	1	0.25
		Redundancy	0.25	1	0.25
		Compaction during construction	0.25	1	0.25
		Design Safety Factor, $S_B = \Sigma p$			1.50
Combined Safety Factor, $S_{TOT} = S_A \times S_B$					2.75
Measured Infiltration Rate, inch/hr, K_M (corrected for test-specific bias)					*11.2
Design Infiltration Rate, in/hr, $K_{DESIGN} = ~~S_{TOT} \times K_M~~ \quad K_M \div S_{TOT}$					4.07 in/hr

Supporting Data

Briefly describe infiltration test and provide reference to test forms:

*See Attachment D for Infiltration Report for infiltration rate.

Note: The minimum combined adjustment factor shall not be less than 2.0 and the maximum combined adjustment factor shall not exceed 9.0.

VII.5. References

ASTM D 3385-94, 2003. "Standard Test Method for Infiltration Rate of Soils Field Using Double-Ring Infiltrometer." American Society for Testing Materials, Conshohocken, PA. 10 Jun, 2003.

Caltrans, 2003. "Infiltration Basin Site Selection". Study Volume I. California Department of Transportation. Report No. CTSW-RT-03-025.

City of Portland, 2010. *Appendix F.2: Infiltration Testing.* Portland Stormwater Management Manual, Revised February 1, 2010.

United States Department of the Interior, Bureau of Reclamation (USBR), 1990a, "Procedure for Performing Field Permeability Testing by the Well Permeameter Method (USBR 7300-89)," in Earth Manual, Part 2, A Water Resources Technical Publication, 3rd ed., Bureau of Reclamation, Denver, Colo.

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NOAA ATLAS 14 POINT PRECIPITATION FREQUENCY ESTIMATES: CA

Data description

Data type: Precipitation depth **Units:** English **Time series type:** Partial duration

Select location

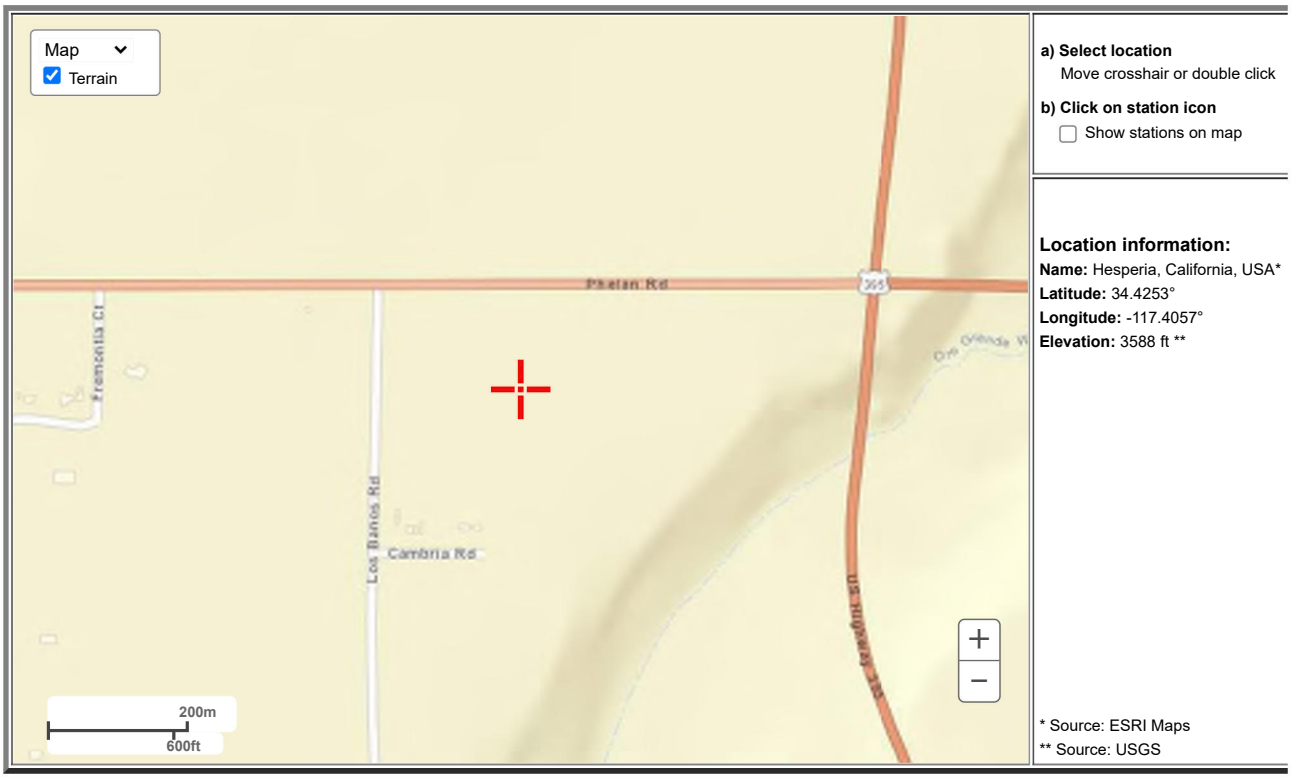
1) Manually:

a) By location (decimal degrees, use "-" for S and W): Latitude: Longitude: Submit

b) By station (list of CA stations): Select station

c) By address PHELAN RD AND LOS BANOS AVE

2) Use map:



POINT PRECIPITATION FREQUENCY (PF) ESTIMATES

WITH 90% CONFIDENCE INTERVALS AND SUPPLEMENTARY INFORMATION
NOAA Atlas 14, Volume 6, Version 2

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PDS-based 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	**0.086** (0.072-0.106)	**0.123** (0.102-0.150)	**0.172** (0.141-0.210)	**0.211** (0.173-0.261)	**0.266** (0.211-0.340)	**0.309** (0.239-0.403)	**0.353** (0.267-0.472)	**0.399** (0.293-0.549)	**0.462** (0.326-0.663)	**0.512** (0.348-0.760)
10-min	**0.124** (0.103-0.151)	**0.176** (0.146-0.216)	**0.246** (0.203-0.301)	**0.303** (0.248-0.374)	**0.382** (0.302-0.488)	**0.443** (0.343-0.578)	**0.506** (0.382-0.677)	**0.572** (0.420-0.786)	**0.662** (0.467-0.950)	**0.734** (0.499-1.09)
15-min	**0.150** (0.124-0.183)	**0.213** (0.176-0.261)	**0.297** (0.245-0.364)	**0.367** (0.300-0.453)	**0.462** (0.365-0.590)	**0.536** (0.415-0.699)	**0.612** (0.462-0.818)	**0.692** (0.508-0.951)	**0.801** (0.564-1.15)	**0.888** (0.604-1.32)
30-min	**0.227** (0.188-0.277)	**0.323** (0.267-0.395)	**0.450** (0.371-0.552)	**0.555** (0.454-0.685)	**0.699** (0.553-0.893)	**0.811** (0.628-1.06)	**0.926** (0.700-1.24)	**1.05** (0.769-1.44)	**1.21** (0.854-1.74)	**1.34** (0.914-1.99)
60-min	**0.321** (0.266-0.392)	**0.458** (0.378-0.559)	**0.638** (0.526-0.782)	**0.786** (0.643-0.971)	**0.990** (0.783-1.26)	**1.15** (0.890-1.50)	**1.31** (0.992-1.76)	**1.48** (1.09-2.04)	**1.72** (1.21-2.46)	**1.90** (1.30-2.83)
2-hr	**0.471** (0.390-0.574)	**0.639** (0.529-0.781)	**0.867** (0.715-1.06)	**1.06** (0.865-1.31)	**1.33** (1.05-1.69)	**1.54** (1.19-2.01)	**1.76** (1.33-2.36)	**2.00** (1.47-2.75)	**2.33** (1.64-3.34)	**2.60** (1.77-3.86)
3-hr	**0.595** (0.492-0.726)	**0.795** (0.657-0.972)	**1.07** (0.881-1.31)	**1.30** (1.06-1.61)	**1.63** (1.29-2.08)	**1.89** (1.46-2.47)	**2.17** (1.64-2.90)	**2.47** (1.81-3.39)	**2.89** (2.04-4.14)	**3.23** (2.20-4.80)

6-hr	**0.846** (0.700-1.03)	**1.12** (0.927-1.37)	**1.50** (1.24-1.84)	**1.82** (1.49-2.25)	**2.29** (1.81-2.92)	**2.67** (2.06-3.48)	**3.07** (2.32-4.10)	**3.51** (2.58-4.82)	**4.14** (2.91-5.93)	**4.66** (3.17-6.91)
12-hr	**1.10** (0.914-1.35)	**1.50** (1.24-1.84)	**2.05** (1.69-2.51)	**2.52** (2.06-3.11)	**3.19** (2.52-4.08)	**3.74** (2.90-4.88)	**4.32** (3.27-5.78)	**4.96** (3.64-6.82)	**5.87** (4.13-8.41)	**6.62** (4.51-9.83)
24-hr	**1.50** (1.33-1.72)	**2.11** (1.86-2.43)	**2.94** (2.60-3.40)	**3.66** (3.20-4.26)	**4.68** (3.97-5.64)	**5.51** (4.58-6.78)	**6.40** (5.18-8.06)	**7.36** (5.80-9.53)	**8.73** (6.60-11.8)	**9.86** (7.20-13.8)
2-day	**1.73** (1.53-1.99)	**2.43** (2.15-2.80)	**3.40** (3.00-3.93)	**4.24** (3.71-4.94)	**5.46** (4.62-6.57)	**6.46** (5.36-7.94)	**7.53** (6.10-9.49)	**8.71** (6.86-11.3)	**10.4** (7.87-14.1)	**11.8** (8.65-16.5)
3-day	**1.85** (1.64-2.13)	**2.60** (2.30-3.00)	**3.64** (3.22-4.21)	**4.55** (3.98-5.30)	**5.87** (4.98-7.07)	**6.97** (5.78-8.57)	**8.15** (6.60-10.3)	**9.45** (7.45-12.2)	**11.4** (8.58-15.3)	**12.9** (9.45-18.1)
4-day	**2.00** (1.77-2.30)	**2.80** (2.48-3.23)	**3.93** (3.47-4.54)	**4.90** (4.30-5.71)	**6.34** (5.37-7.63)	**7.52** (6.24-9.25)	**8.80** (7.13-11.1)	**10.2** (8.05-13.2)	**12.3** (9.28-16.6)	**14.0** (10.2-19.6)
7-day	**2.24** (1.99-2.58)	**3.12** (2.76-3.60)	**4.34** (3.84-5.02)	**5.41** (4.74-6.30)	**6.96** (5.90-8.38)	**8.24** (6.84-10.1)	**9.63** (7.80-12.1)	**11.2** (8.79-14.4)	**13.4** (10.1-18.1)	**15.2** (11.1-21.3)
10-day	**2.40** (2.13-2.76)	**3.33** (2.95-3.84)	**4.61** (4.07-5.33)	**5.73** (5.02-6.67)	**7.34** (6.22-8.84)	**8.68** (7.21-10.7)	**10.1** (8.20-12.8)	**11.7** (9.23-15.2)	**14.0** (10.6-18.9)	**16.0** (11.7-22.3)
20-day	**2.89** (2.56-3.33)	**3.98** (3.52-4.59)	**5.49** (4.85-6.35)	**6.80** (5.95-7.92)	**8.68** (7.36-10.5)	**10.2** (8.50-12.6)	**11.9** (9.65-15.0)	**13.8** (10.8-17.8)	**16.5** (12.4-22.2)	**18.7** (13.7-26.1)
30-day	**3.41** (3.03-3.93)	**4.67** (4.14-5.39)	**6.41** (5.66-7.41)	**7.90** (6.92-9.21)	**10.1** (8.53-12.1)	**11.8** (9.83-14.6)	**13.8** (11.2-17.4)	**15.9** (12.5-20.6)	**19.0** (14.4-25.7)	**21.6** (15.8-30.2)
45-day	**4.07** (3.61-4.69)	**5.50** (4.87-6.34)	**7.46** (6.59-8.63)	**9.16** (8.02-10.7)	**11.6** (9.82-14.0)	**13.6** (11.3-16.7)	**15.8** (12.8-19.9)	**18.2** (14.3-23.6)	**21.8** (16.4-29.4)	**24.8** (18.1-34.6)
60-day	**4.65** (4.12-5.35)	**6.18** (5.47-7.12)	**8.28** (7.31-9.57)	**10.1** (8.83-11.8)	**12.7** (10.8-15.3)	**14.9** (12.3-18.3)	**17.2** (13.9-21.7)	**19.8** (15.6-25.7)	**23.7** (17.9-31.9)	**26.9** (19.7-37.6)

[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.

Please refer to NOAA Atlas 14 document for more information.

Estimates from the table in CSV format: Precipitation frequency estimates Submit

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National Weather Service
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Silver Spring, MD 20910
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San Bernardino County Rational Hydrology Program

(Hydrology Manual Date - August 1986)

CIVILCADD/CIVILDESIGN Engineering Software, (c) 1989-2005 Version 7.1
Rational Hydrology Study Date: 05/24/23

COVINGTON - PHELAN 20
10 YEAR STORM EVENT - EXISTING CONDITION
6042Q10E
T.A.

Program License Serial Number 6145

********* Hydrology Study Control Information **********

Rational hydrology study storm event year is 10.0
Computed rainfall intensity:
Storm year = 10.00 1 hour rainfall = 0.786 (In.)
Slope used for rainfall intensity curve b = 0.7000
Soil antecedent moisture condition (AMC) = 2

++
Process from Point/Station 1.000 to Point/Station 2.000
**** INITIAL AREA EVALUATION ****

UNDEVELOPED (poor cover) subarea
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2) = 67.00
Pervious ratio(Ap) = 1.0000 Max loss rate(Fm)= 0.578(In/Hr)
Initial subarea data:
Initial area flow distance = 746.000(Ft.)
Top (of initial area) elevation = 3603.700(Ft.)
Bottom (of initial area) elevation = 3588.830(Ft.)
Difference in elevation = 14.870(Ft.)
Slope = 0.01993 s(%)= 1.99
TC = k(0.525)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration = 16.193 min.
Rainfall intensity = 1.966(In/Hr) for a 10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.635
Subarea runoff = 12.364(CFS)
Total initial stream area = 9.900(Ac.)
Pervious area fraction = 1.000
Initial area Fm value = 0.578(In/Hr)

++
Process from Point/Station 2.000 to Point/Station 3.000
**** SUBAREA FLOW ADDITION ****

UNDEVELOPED (poor cover) subarea
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2) = 67.00
Pervious ratio(Ap) = 1.0000 Max loss rate(Fm)= 0.578(In/Hr)
Time of concentration = 16.19 min.
Rainfall intensity = 1.966(In/Hr) for a 10.0 year storm
Effective runoff coefficient used for area,(total area with modified rational method)(Q=KCIA) is C = 0.635

Subarea runoff = 10.991(CFS) for 8.800(Ac.)
Total runoff = 23.355(CFS)
Effective area this stream = 18.70(Ac.)
Total Study Area (Main Stream No. 1) = 18.70(Ac.)
Area averaged Fm value = 0.578(In/Hr)
End of computations, Total Study Area = 18.70 (Ac.)
The following figures may
be used for a unit hydrograph study of the same area.
Note: These figures do not consider reduced effective area
effects caused by confluences in the rational equation.

Area averaged pervious area fraction(Ap) = 1.000
Area averaged SCS curve number = 67.0

U n i t H y d r o g r a p h A n a l y s i s

Copyright (c) CIVILCADD/CIVILDESIGN, 1989 - 2004, Version 7.0

Study date 05/24/23

++

San Bernardino County Synthetic Unit Hydrology Method
Manual date - August 1986

Program License Serial Number 6145

COVINGTON - PHELAN 20
UNIT HYDROGRAPH 10 YEAR - EXISTING CONDITION
6042UHQ10E
T.A.

Storm Event Year = 10

Antecedent Moisture Condition = 2

English (in-lb) Input Units Used

English Rainfall Data (Inches) Input Values Used

English Units used in output format

Area averaged rainfall intensity isohyetal data:

Sub-Area (Ac.)	Duration (hours)	Isohyetal (In)
Rainfall data for year 10		
18.20	1	0.79
Rainfall data for year 10		
18.20	6	1.82
Rainfall data for year 10		
18.20	24	3.66

++

******** Area-averaged max loss rate, Fm ********

SCS curve No.(AMCII)	SCS curve NO.(AMC 2)	Area (Ac.)	Area Fraction	Fp(Fig C6) (In/Hr)	Ap (dec.)	Fm (In/Hr)
67.0	67.0	18.20	1.000	0.578	1.000	0.578

Area-averaged adjusted loss rate Fm (In/Hr) = 0.578

********* Area-Averaged low loss rate fraction, Yb **********

Area (Ac.)	Area Fract	SCS CN (AMC2)	SCS CN (AMC2)	S	Pervious Yield Fr
18.20	1.000	67.0	67.0	4.93	0.257

Area-averaged catchment yield fraction, Y = 0.257
Area-averaged low loss fraction, Yb = 0.743
Direct entry of lag time by user
++

Watershed area = 18.20(Ac.)
Catchment Lag time = 0.205 hours
Unit interval = 5.000 minutes
Unit interval percentage of lag time = 40.6504
Hydrograph baseflow = 0.00(CFS)
Average maximum watershed loss rate(Fm) = 0.578(In/Hr)
Average low loss rate fraction (Yb) = 0.743 (decimal)
DESERT S-Graph Selected
Computed peak 5-minute rainfall = 0.373(In)
Computed peak 30-minute rainfall = 0.638(In)
Specified peak 1-hour rainfall = 0.786(In)
Computed peak 3-hour rainfall = 1.315(In)
Specified peak 6-hour rainfall = 1.820(In)
Specified peak 24-hour rainfall = 3.660(In)

Rainfall depth area reduction factors:
Using a total area of 18.20(Ac.) (Ref: fig. E-4)

5-minute factor = 0.999 Adjusted rainfall = 0.373(In)
30-minute factor = 0.999 Adjusted rainfall = 0.638(In)
1-hour factor = 0.999 Adjusted rainfall = 0.785(In)
3-hour factor = 1.000 Adjusted rainfall = 1.315(In)
6-hour factor = 1.000 Adjusted rainfall = 1.820(In)
24-hour factor = 1.000 Adjusted rainfall = 3.660(In)

U n i t H y d r o g r a p h

Interval Number	'S' Graph Mean values	Unit Hydrograph ((CFS))
(K = 220.11 (CFS))		
1	2.820	6.207
2	19.439	36.579
3	50.078	67.439
4	66.263	35.625
5	75.321	19.936
6	81.307	13.176
7	85.642	9.543
8	88.934	7.245
9	91.325	5.262
10	93.283	4.309
11	94.812	3.367
12	96.054	2.733
13	97.032	2.153
14	97.742	1.564
15	98.197	1.000
16	98.661	1.022
17	99.149	1.074
18	99.565	0.917
19	99.825	0.572
20	100.000	0.385

Peak Unit Number	Adjusted mass rainfall (In)	Unit rainfall (In)
1	0.3726	0.3726
2	0.4588	0.0861
3	0.5181	0.0593
4	0.5648	0.0467
5	0.6039	0.0391
6	0.6379	0.0340
7	0.6681	0.0302
8	0.6954	0.0273
9	0.7204	0.0250
10	0.7435	0.0231
11	0.7651	0.0216
12	0.7853	0.0202
13	0.8154	0.0301

14	0.8442	0.0289
15	0.8720	0.0278
16	0.8988	0.0268
17	0.9248	0.0259
18	0.9499	0.0251
19	0.9743	0.0244
20	0.9981	0.0237
21	1.0212	0.0231
22	1.0437	0.0225
23	1.0657	0.0220
24	1.0872	0.0215
25	1.1083	0.0210
26	1.1288	0.0206
27	1.1490	0.0202
28	1.1688	0.0198
29	1.1882	0.0194
30	1.2073	0.0191
31	1.2260	0.0187
32	1.2444	0.0184
33	1.2625	0.0181
34	1.2803	0.0178
35	1.2978	0.0175
36	1.3151	0.0173
37	1.3321	0.0170
38	1.3489	0.0168
39	1.3654	0.0165
40	1.3817	0.0163
41	1.3978	0.0161
42	1.4136	0.0159
43	1.4293	0.0157
44	1.4448	0.0155
45	1.4601	0.0153
46	1.4752	0.0151
47	1.4902	0.0149
48	1.5049	0.0148
49	1.5195	0.0146
50	1.5340	0.0145
51	1.5483	0.0143
52	1.5625	0.0142
53	1.5765	0.0140
54	1.5903	0.0139
55	1.6041	0.0137
56	1.6177	0.0136
57	1.6312	0.0135
58	1.6445	0.0134
59	1.6577	0.0132
60	1.6708	0.0131
61	1.6838	0.0130
62	1.6967	0.0129
63	1.7095	0.0128
64	1.7222	0.0127
65	1.7347	0.0126
66	1.7472	0.0125
67	1.7595	0.0124
68	1.7718	0.0123
69	1.7840	0.0122
70	1.7960	0.0121
71	1.8080	0.0120
72	1.8199	0.0119
73	1.8326	0.0127
74	1.8452	0.0126
75	1.8577	0.0125
76	1.8702	0.0124
77	1.8825	0.0124
78	1.8948	0.0123
79	1.9070	0.0122
80	1.9191	0.0121
81	1.9312	0.0121
82	1.9432	0.0120
83	1.9551	0.0119

84	1.9669	0.0118
85	1.9787	0.0118
86	1.9904	0.0117
87	2.0020	0.0116
88	2.0136	0.0116
89	2.0251	0.0115
90	2.0365	0.0114
91	2.0479	0.0114
92	2.0592	0.0113
93	2.0704	0.0113
94	2.0816	0.0112
95	2.0928	0.0111
96	2.1038	0.0111
97	2.1149	0.0110
98	2.1258	0.0110
99	2.1367	0.0109
100	2.1476	0.0109
101	2.1584	0.0108
102	2.1691	0.0107
103	2.1798	0.0107
104	2.1904	0.0106
105	2.2010	0.0106
106	2.2116	0.0105
107	2.2221	0.0105
108	2.2325	0.0104
109	2.2429	0.0104
110	2.2532	0.0103
111	2.2635	0.0103
112	2.2738	0.0103
113	2.2840	0.0102
114	2.2942	0.0102
115	2.3043	0.0101
116	2.3144	0.0101
117	2.3244	0.0100
118	2.3344	0.0100
119	2.3443	0.0099
120	2.3543	0.0099
121	2.3641	0.0099
122	2.3739	0.0098
123	2.3837	0.0098
124	2.3935	0.0097
125	2.4032	0.0097
126	2.4129	0.0097
127	2.4225	0.0096
128	2.4321	0.0096
129	2.4416	0.0096
130	2.4512	0.0095
131	2.4607	0.0095
132	2.4701	0.0094
133	2.4795	0.0094
134	2.4889	0.0094
135	2.4982	0.0093
136	2.5075	0.0093
137	2.5168	0.0093
138	2.5261	0.0092
139	2.5353	0.0092
140	2.5444	0.0092
141	2.5536	0.0091
142	2.5627	0.0091
143	2.5718	0.0091
144	2.5808	0.0090
145	2.5898	0.0090
146	2.5988	0.0090
147	2.6078	0.0090
148	2.6167	0.0089
149	2.6256	0.0089
150	2.6345	0.0089
151	2.6433	0.0088
152	2.6521	0.0088
153	2.6609	0.0088

154	2.6696	0.0088
155	2.6784	0.0087
156	2.6871	0.0087
157	2.6957	0.0087
158	2.7044	0.0086
159	2.7130	0.0086
160	2.7216	0.0086
161	2.7301	0.0086
162	2.7387	0.0085
163	2.7472	0.0085
164	2.7557	0.0085
165	2.7641	0.0085
166	2.7725	0.0084
167	2.7809	0.0084
168	2.7893	0.0084
169	2.7977	0.0084
170	2.8060	0.0083
171	2.8143	0.0083
172	2.8226	0.0083
173	2.8309	0.0083
174	2.8391	0.0082
175	2.8473	0.0082
176	2.8555	0.0082
177	2.8637	0.0082
178	2.8718	0.0081
179	2.8799	0.0081
180	2.8880	0.0081
181	2.8961	0.0081
182	2.9041	0.0081
183	2.9122	0.0080
184	2.9202	0.0080
185	2.9282	0.0080
186	2.9361	0.0080
187	2.9441	0.0079
188	2.9520	0.0079
189	2.9599	0.0079
190	2.9678	0.0079
191	2.9757	0.0079
192	2.9835	0.0078
193	2.9913	0.0078
194	2.9991	0.0078
195	3.0069	0.0078
196	3.0147	0.0078
197	3.0224	0.0077
198	3.0301	0.0077
199	3.0378	0.0077
200	3.0455	0.0077
201	3.0532	0.0077
202	3.0608	0.0076
203	3.0684	0.0076
204	3.0761	0.0076
205	3.0836	0.0076
206	3.0912	0.0076
207	3.0988	0.0076
208	3.1063	0.0075
209	3.1138	0.0075
210	3.1213	0.0075
211	3.1288	0.0075
212	3.1363	0.0075
213	3.1437	0.0074
214	3.1511	0.0074
215	3.1586	0.0074
216	3.1660	0.0074
217	3.1733	0.0074
218	3.1807	0.0074
219	3.1880	0.0073
220	3.1954	0.0073
221	3.2027	0.0073
222	3.2100	0.0073
223	3.2173	0.0073

224	3.2245	0.0073	
225	3.2318	0.0072	
226	3.2390	0.0072	
227	3.2462	0.0072	
228	3.2534	0.0072	
229	3.2606	0.0072	
230	3.2678	0.0072	
231	3.2749	0.0072	
232	3.2821	0.0071	
233	3.2892	0.0071	
234	3.2963	0.0071	
235	3.3034	0.0071	
236	3.3104	0.0071	
237	3.3175	0.0071	
238	3.3246	0.0070	
239	3.3316	0.0070	
240	3.3386	0.0070	
241	3.3456	0.0070	
242	3.3526	0.0070	
243	3.3596	0.0070	
244	3.3665	0.0070	
245	3.3735	0.0069	
246	3.3804	0.0069	
247	3.3873	0.0069	
248	3.3942	0.0069	
249	3.4011	0.0069	
250	3.4080	0.0069	
251	3.4149	0.0069	
252	3.4217	0.0068	
253	3.4286	0.0068	
254	3.4354	0.0068	
255	3.4422	0.0068	
256	3.4490	0.0068	
257	3.4558	0.0068	
258	3.4625	0.0068	
259	3.4693	0.0068	
260	3.4760	0.0067	
261	3.4828	0.0067	
262	3.4895	0.0067	
263	3.4962	0.0067	
264	3.5029	0.0067	
265	3.5096	0.0067	
266	3.5162	0.0067	
267	3.5229	0.0067	
268	3.5295	0.0066	
269	3.5362	0.0066	
270	3.5428	0.0066	
271	3.5494	0.0066	
272	3.5560	0.0066	
273	3.5626	0.0066	
274	3.5691	0.0066	
275	3.5757	0.0066	
276	3.5823	0.0065	
277	3.5888	0.0065	
278	3.5953	0.0065	
279	3.6018	0.0065	
280	3.6083	0.0065	
281	3.6148	0.0065	
282	3.6213	0.0065	
283	3.6278	0.0065	
284	3.6342	0.0065	
285	3.6407	0.0064	
286	3.6471	0.0064	
287	3.6535	0.0064	
288	3.6599	0.0064	

Unit Period (number)	Unit Rainfall (In)	Unit Soil-Loss (In)	Effective Rainfall (In)

1	0.0064	0.0048	0.0016
2	0.0064	0.0048	0.0017
3	0.0064	0.0048	0.0017
4	0.0065	0.0048	0.0017
5	0.0065	0.0048	0.0017
6	0.0065	0.0048	0.0017
7	0.0065	0.0048	0.0017
8	0.0065	0.0048	0.0017
9	0.0065	0.0049	0.0017
10	0.0066	0.0049	0.0017
11	0.0066	0.0049	0.0017
12	0.0066	0.0049	0.0017
13	0.0066	0.0049	0.0017
14	0.0066	0.0049	0.0017
15	0.0067	0.0049	0.0017
16	0.0067	0.0050	0.0017
17	0.0067	0.0050	0.0017
18	0.0067	0.0050	0.0017
19	0.0067	0.0050	0.0017
20	0.0067	0.0050	0.0017
21	0.0068	0.0050	0.0017
22	0.0068	0.0050	0.0017
23	0.0068	0.0051	0.0018
24	0.0068	0.0051	0.0018
25	0.0068	0.0051	0.0018
26	0.0069	0.0051	0.0018
27	0.0069	0.0051	0.0018
28	0.0069	0.0051	0.0018
29	0.0069	0.0051	0.0018
30	0.0069	0.0052	0.0018
31	0.0070	0.0052	0.0018
32	0.0070	0.0052	0.0018
33	0.0070	0.0052	0.0018
34	0.0070	0.0052	0.0018
35	0.0071	0.0052	0.0018
36	0.0071	0.0053	0.0018
37	0.0071	0.0053	0.0018
38	0.0071	0.0053	0.0018
39	0.0072	0.0053	0.0018
40	0.0072	0.0053	0.0018
41	0.0072	0.0053	0.0019
42	0.0072	0.0054	0.0019
43	0.0072	0.0054	0.0019
44	0.0073	0.0054	0.0019
45	0.0073	0.0054	0.0019
46	0.0073	0.0054	0.0019
47	0.0073	0.0055	0.0019
48	0.0074	0.0055	0.0019
49	0.0074	0.0055	0.0019
50	0.0074	0.0055	0.0019
51	0.0074	0.0055	0.0019
52	0.0075	0.0055	0.0019
53	0.0075	0.0056	0.0019
54	0.0075	0.0056	0.0019
55	0.0076	0.0056	0.0019
56	0.0076	0.0056	0.0019
57	0.0076	0.0057	0.0020
58	0.0076	0.0057	0.0020
59	0.0077	0.0057	0.0020
60	0.0077	0.0057	0.0020
61	0.0077	0.0057	0.0020
62	0.0077	0.0058	0.0020
63	0.0078	0.0058	0.0020
64	0.0078	0.0058	0.0020
65	0.0078	0.0058	0.0020
66	0.0079	0.0058	0.0020
67	0.0079	0.0059	0.0020
68	0.0079	0.0059	0.0020
69	0.0080	0.0059	0.0020
70	0.0080	0.0059	0.0021

71	0.0080	0.0060	0.0021
72	0.0081	0.0060	0.0021
73	0.0081	0.0060	0.0021
74	0.0081	0.0060	0.0021
75	0.0082	0.0061	0.0021
76	0.0082	0.0061	0.0021
77	0.0082	0.0061	0.0021
78	0.0083	0.0061	0.0021
79	0.0083	0.0062	0.0021
80	0.0083	0.0062	0.0021
81	0.0084	0.0062	0.0022
82	0.0084	0.0062	0.0022
83	0.0085	0.0063	0.0022
84	0.0085	0.0063	0.0022
85	0.0085	0.0063	0.0022
86	0.0086	0.0064	0.0022
87	0.0086	0.0064	0.0022
88	0.0086	0.0064	0.0022
89	0.0087	0.0065	0.0022
90	0.0087	0.0065	0.0022
91	0.0088	0.0065	0.0023
92	0.0088	0.0065	0.0023
93	0.0089	0.0066	0.0023
94	0.0089	0.0066	0.0023
95	0.0090	0.0067	0.0023
96	0.0090	0.0067	0.0023
97	0.0090	0.0067	0.0023
98	0.0091	0.0067	0.0023
99	0.0091	0.0068	0.0024
100	0.0092	0.0068	0.0024
101	0.0092	0.0069	0.0024
102	0.0093	0.0069	0.0024
103	0.0093	0.0069	0.0024
104	0.0094	0.0070	0.0024
105	0.0094	0.0070	0.0024
106	0.0095	0.0070	0.0024
107	0.0096	0.0071	0.0025
108	0.0096	0.0071	0.0025
109	0.0097	0.0072	0.0025
110	0.0097	0.0072	0.0025
111	0.0098	0.0073	0.0025
112	0.0098	0.0073	0.0025
113	0.0099	0.0074	0.0025
114	0.0099	0.0074	0.0026
115	0.0100	0.0075	0.0026
116	0.0101	0.0075	0.0026
117	0.0102	0.0075	0.0026
118	0.0102	0.0076	0.0026
119	0.0103	0.0077	0.0026
120	0.0103	0.0077	0.0027
121	0.0104	0.0078	0.0027
122	0.0105	0.0078	0.0027
123	0.0106	0.0079	0.0027
124	0.0106	0.0079	0.0027
125	0.0107	0.0080	0.0028
126	0.0108	0.0080	0.0028
127	0.0109	0.0081	0.0028
128	0.0110	0.0081	0.0028
129	0.0111	0.0082	0.0028
130	0.0111	0.0083	0.0029
131	0.0113	0.0084	0.0029
132	0.0113	0.0084	0.0029
133	0.0114	0.0085	0.0029
134	0.0115	0.0085	0.0030
135	0.0116	0.0086	0.0030
136	0.0117	0.0087	0.0030
137	0.0118	0.0088	0.0030
138	0.0119	0.0088	0.0031
139	0.0121	0.0090	0.0031
140	0.0121	0.0090	0.0031

141	0.0123	0.0091	0.0032
142	0.0124	0.0092	0.0032
143	0.0125	0.0093	0.0032
144	0.0126	0.0094	0.0032
145	0.0119	0.0088	0.0031
146	0.0120	0.0089	0.0031
147	0.0122	0.0090	0.0031
148	0.0123	0.0091	0.0032
149	0.0125	0.0093	0.0032
150	0.0126	0.0093	0.0032
151	0.0128	0.0095	0.0033
152	0.0129	0.0096	0.0033
153	0.0131	0.0097	0.0034
154	0.0132	0.0098	0.0034
155	0.0135	0.0100	0.0035
156	0.0136	0.0101	0.0035
157	0.0139	0.0103	0.0036
158	0.0140	0.0104	0.0036
159	0.0143	0.0106	0.0037
160	0.0145	0.0107	0.0037
161	0.0148	0.0110	0.0038
162	0.0149	0.0111	0.0038
163	0.0153	0.0114	0.0039
164	0.0155	0.0115	0.0040
165	0.0159	0.0118	0.0041
166	0.0161	0.0119	0.0041
167	0.0165	0.0123	0.0042
168	0.0168	0.0124	0.0043
169	0.0173	0.0128	0.0044
170	0.0175	0.0130	0.0045
171	0.0181	0.0134	0.0047
172	0.0184	0.0137	0.0047
173	0.0191	0.0142	0.0049
174	0.0194	0.0144	0.0050
175	0.0202	0.0150	0.0052
176	0.0206	0.0153	0.0053
177	0.0215	0.0160	0.0055
178	0.0220	0.0163	0.0057
179	0.0231	0.0172	0.0059
180	0.0237	0.0176	0.0061
181	0.0251	0.0187	0.0065
182	0.0259	0.0193	0.0067
183	0.0278	0.0206	0.0071
184	0.0289	0.0214	0.0074
185	0.0202	0.0150	0.0052
186	0.0216	0.0160	0.0055
187	0.0250	0.0186	0.0064
188	0.0273	0.0203	0.0070
189	0.0340	0.0252	0.0087
190	0.0391	0.0290	0.0101
191	0.0593	0.0441	0.0153
192	0.0861	0.0482	0.0379
193	0.3726	0.0482	0.3245
194	0.0467	0.0347	0.0120
195	0.0302	0.0224	0.0078
196	0.0231	0.0172	0.0060
197	0.0301	0.0223	0.0077
198	0.0268	0.0199	0.0069
199	0.0244	0.0181	0.0063
200	0.0225	0.0167	0.0058
201	0.0210	0.0156	0.0054
202	0.0198	0.0147	0.0051
203	0.0187	0.0139	0.0048
204	0.0178	0.0132	0.0046
205	0.0170	0.0126	0.0044
206	0.0163	0.0121	0.0042
207	0.0157	0.0116	0.0040
208	0.0151	0.0112	0.0039
209	0.0146	0.0109	0.0038
210	0.0142	0.0105	0.0036

211	0.0137	0.0102	0.0035
212	0.0134	0.0099	0.0034
213	0.0130	0.0097	0.0033
214	0.0127	0.0094	0.0033
215	0.0124	0.0092	0.0032
216	0.0121	0.0090	0.0031
217	0.0127	0.0094	0.0033
218	0.0124	0.0092	0.0032
219	0.0122	0.0091	0.0031
220	0.0120	0.0089	0.0031
221	0.0118	0.0087	0.0030
222	0.0116	0.0086	0.0030
223	0.0114	0.0084	0.0029
224	0.0112	0.0083	0.0029
225	0.0110	0.0082	0.0028
226	0.0109	0.0081	0.0028
227	0.0107	0.0079	0.0028
228	0.0105	0.0078	0.0027
229	0.0104	0.0077	0.0027
230	0.0103	0.0076	0.0026
231	0.0101	0.0075	0.0026
232	0.0100	0.0074	0.0026
233	0.0099	0.0073	0.0025
234	0.0097	0.0072	0.0025
235	0.0096	0.0072	0.0025
236	0.0095	0.0071	0.0024
237	0.0094	0.0070	0.0024
238	0.0093	0.0069	0.0024
239	0.0092	0.0068	0.0024
240	0.0091	0.0068	0.0023
241	0.0090	0.0067	0.0023
242	0.0089	0.0066	0.0023
243	0.0088	0.0066	0.0023
244	0.0088	0.0065	0.0023
245	0.0087	0.0064	0.0022
246	0.0086	0.0064	0.0022
247	0.0085	0.0063	0.0022
248	0.0084	0.0063	0.0022
249	0.0084	0.0062	0.0021
250	0.0083	0.0062	0.0021
251	0.0082	0.0061	0.0021
252	0.0081	0.0060	0.0021
253	0.0081	0.0060	0.0021
254	0.0080	0.0059	0.0021
255	0.0079	0.0059	0.0020
256	0.0079	0.0059	0.0020
257	0.0078	0.0058	0.0020
258	0.0078	0.0058	0.0020
259	0.0077	0.0057	0.0020
260	0.0076	0.0057	0.0020
261	0.0076	0.0056	0.0020
262	0.0075	0.0056	0.0019
263	0.0075	0.0056	0.0019
264	0.0074	0.0055	0.0019
265	0.0074	0.0055	0.0019
266	0.0073	0.0054	0.0019
267	0.0073	0.0054	0.0019
268	0.0072	0.0054	0.0019
269	0.0072	0.0053	0.0018
270	0.0071	0.0053	0.0018
271	0.0071	0.0053	0.0018
272	0.0070	0.0052	0.0018
273	0.0070	0.0052	0.0018
274	0.0070	0.0052	0.0018
275	0.0069	0.0051	0.0018
276	0.0069	0.0051	0.0018
277	0.0068	0.0051	0.0018
278	0.0068	0.0050	0.0017
279	0.0068	0.0050	0.0017
280	0.0067	0.0050	0.0017

281	0.0067	0.0050	0.0017
282	0.0066	0.0049	0.0017
283	0.0066	0.0049	0.0017
284	0.0066	0.0049	0.0017
285	0.0065	0.0049	0.0017
286	0.0065	0.0048	0.0017
287	0.0065	0.0048	0.0017
288	0.0064	0.0048	0.0017

Total soil rain loss = 2.47(In)

Total effective rainfall = 1.19(In)

Peak flow rate in flood hydrograph = 24.44(CFS)

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24 - H O U R S T O R M

R u n o f f H y d r o g r a p h

Hydrograph in 5 Minute intervals ((CFS))

Time(h+m)	Volume Ac.Ft	Q(CFS)	0	7.5	15.0	22.5	30.0
0+ 5	0.0001	0.01	Q				
0+10	0.0006	0.07	Q				
0+15	0.0018	0.18	Q				
0+20	0.0035	0.24	Q				
0+25	0.0054	0.27	Q				
0+30	0.0074	0.30	Q				
0+35	0.0096	0.31	Q				
0+40	0.0118	0.33	Q				
0+45	0.0141	0.34	Q				
0+50	0.0165	0.34	Q				
0+55	0.0189	0.35	Q				
1+ 0	0.0214	0.36	Q				
1+ 5	0.0238	0.36	Q				
1+10	0.0263	0.36	Q				
1+15	0.0289	0.37	Q				
1+20	0.0314	0.37	Q				
1+25	0.0340	0.37	Q				
1+30	0.0365	0.37	Q				
1+35	0.0391	0.38	Q				
1+40	0.0417	0.38	Q				
1+45	0.0444	0.38	Q				
1+50	0.0470	0.38	QV				
1+55	0.0496	0.38	QV				
2+ 0	0.0522	0.38	QV				
2+ 5	0.0549	0.38	QV				
2+10	0.0575	0.38	QV				
2+15	0.0602	0.39	QV				
2+20	0.0628	0.39	QV				
2+25	0.0655	0.39	QV				
2+30	0.0682	0.39	QV				
2+35	0.0709	0.39	QV				
2+40	0.0736	0.39	QV				
2+45	0.0763	0.39	QV				
2+50	0.0790	0.39	QV				
2+55	0.0817	0.40	QV				
3+ 0	0.0845	0.40	QV				
3+ 5	0.0872	0.40	QV				
3+10	0.0899	0.40	Q V				
3+15	0.0927	0.40	Q V				
3+20	0.0955	0.40	Q V				
3+25	0.0982	0.40	Q V				
3+30	0.1010	0.40	Q V				
3+35	0.1038	0.41	Q V				
3+40	0.1066	0.41	Q V				
3+45	0.1094	0.41	Q V				
3+50	0.1122	0.41	Q V				
3+55	0.1151	0.41	Q V				

4+ 0	0.1179	0.41	Q V	|	|	|	|
4+ 5	0.1207	0.41	Q V	|	|	|	|
4+10	0.1236	0.41	Q V	|	|	|	|
4+15	0.1265	0.42	Q V	|	|	|	|
4+20	0.1293	0.42	Q V	|	|	|	|
4+25	0.1322	0.42	Q V	|	|	|	|
4+30	0.1351	0.42	Q V	|	|	|	|
4+35	0.1380	0.42	Q V	|	|	|	|
4+40	0.1410	0.42	Q V	|	|	|	|
4+45	0.1439	0.42	Q V	|	|	|	|
4+50	0.1468	0.43	Q V	|	|	|	|
4+55	0.1498	0.43	Q V	|	|	|	|
5+ 0	0.1527	0.43	Q V	|	|	|	|
5+ 5	0.1557	0.43	Q V	|	|	|	|
5+10	0.1587	0.43	Q V	|	|	|	|
5+15	0.1617	0.43	Q V	|	|	|	|
5+20	0.1647	0.44	Q V	|	|	|	|
5+25	0.1677	0.44	Q V	|	|	|	|
5+30	0.1707	0.44	Q V	|	|	|	|
5+35	0.1737	0.44	Q V	|	|	|	|
5+40	0.1768	0.44	Q V	|	|	|	|
5+45	0.1799	0.44	Q V	|	|	|	|
5+50	0.1829	0.45	Q V	|	|	|	|
5+55	0.1860	0.45	Q V	|	|	|	|
6+ 0	0.1891	0.45	Q V	|	|	|	|
6+ 5	0.1922	0.45	Q V	|	|	|	|
6+10	0.1953	0.45	Q V	|	|	|	|
6+15	0.1985	0.46	Q V	|	|	|	|
6+20	0.2016	0.46	Q V	|	|	|	|
6+25	0.2048	0.46	Q V	|	|	|	|
6+30	0.2080	0.46	Q V	|	|	|	|
6+35	0.2111	0.46	Q V	|	|	|	|
6+40	0.2143	0.46	Q V	|	|	|	|
6+45	0.2176	0.47	Q V	|	|	|	|
6+50	0.2208	0.47	Q V	|	|	|	|
6+55	0.2240	0.47	Q V	|	|	|	|
7+ 0	0.2273	0.47	Q V	|	|	|	|
7+ 5	0.2306	0.48	Q V	|	|	|	|
7+10	0.2338	0.48	Q V	|	|	|	|
7+15	0.2371	0.48	Q V	|	|	|	|
7+20	0.2405	0.48	Q V	|	|	|	|
7+25	0.2438	0.48	Q V	|	|	|	|
7+30	0.2471	0.49	Q V	|	|	|	|
7+35	0.2505	0.49	Q V	|	|	|	|
7+40	0.2539	0.49	Q V	|	|	|	|
7+45	0.2573	0.49	Q V	|	|	|	|
7+50	0.2607	0.50	Q V	|	|	|	|
7+55	0.2641	0.50	Q V	|	|	|	|
8+ 0	0.2676	0.50	Q V	|	|	|	|
8+ 5	0.2710	0.50	Q V	|	|	|	|
8+10	0.2745	0.51	Q V	|	|	|	|
8+15	0.2780	0.51	Q V	|	|	|	|
8+20	0.2815	0.51	Q V	|	|	|	|
8+25	0.2850	0.51	Q V	|	|	|	|
8+30	0.2886	0.52	Q V	|	|	|	|
8+35	0.2922	0.52	Q V	|	|	|	|
8+40	0.2957	0.52	Q V	|	|	|	|
8+45	0.2994	0.52	Q V	|	|	|	|
8+50	0.3030	0.53	Q V	|	|	|	|
8+55	0.3066	0.53	Q V	|	|	|	|
9+ 0	0.3103	0.53	Q V	|	|	|	|
9+ 5	0.3140	0.54	Q V	|	|	|	|
9+10	0.3177	0.54	Q V	|	|	|	|
9+15	0.3214	0.54	Q V	|	|	|	|
9+20	0.3252	0.55	Q V	|	|	|	|
9+25	0.3290	0.55	Q V	|	|	|	|
9+30	0.3328	0.55	Q V	|	|	|	|
9+35	0.3366	0.56	Q V	|	|	|	|
9+40	0.3404	0.56	Q V	|	|	|	|
9+45	0.3443	0.56	Q V	|	|	|	|

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 9+50       0.3482      0.57  Q      V  |          |          |          |
 9+55       0.3521      0.57  Q      V  |          |          |          |
10+ 0       0.3561      0.57  Q      V  |          |          |          |
10+ 5       0.3600      0.58  Q       V |          |          |          |
10+10       0.3640      0.58  Q       V |          |          |          |
10+15       0.3681      0.58  Q       V |          |          |          |
10+20       0.3721      0.59  Q       V |          |          |          |
10+25       0.3762      0.59  Q       V |          |          |          |
10+30       0.3803      0.60  Q       V |          |          |          |
10+35       0.3844      0.60  Q       V |          |          |          |
10+40       0.3886      0.61  Q       V |          |          |          |
10+45       0.3928      0.61  Q       V |          |          |          |
10+50       0.3970      0.61  Q       V |          |          |          |
10+55       0.4013      0.62  Q       V |          |          |          |
11+ 0       0.4056      0.62  Q        V|          |          |          |
11+ 5       0.4099      0.63  Q        V|          |          |          |
11+10       0.4143      0.63  Q        V|          |          |          |
11+15       0.4187      0.64  Q        V|          |          |          |
11+20       0.4231      0.64  Q        V|          |          |          |
11+25       0.4276      0.65  Q        V|          |          |          |
11+30       0.4321      0.65  Q        V|          |          |          |
11+35       0.4366      0.66  Q        V|          |          |          |
11+40       0.4412      0.67  Q        V|          |          |          |
11+45       0.4458      0.67  Q        V|          |          |          |
11+50       0.4505      0.68  Q         V          |          |          |
11+55       0.4552      0.68  Q         V          |          |          |
12+ 0       0.4600      0.69  Q         V          |          |          |
12+ 5       0.4648      0.70  Q         V          |          |          |
12+10       0.4696      0.69  Q         V          |          |          |
12+15       0.4743      0.69  Q         V          |          |          |
12+20       0.4790      0.69  Q         V          |          |          |
12+25       0.4838      0.69  Q         V          |          |          |
12+30       0.4885      0.69  Q         V          |          |          |
12+35       0.4933      0.70  Q         V          |          |          |
12+40       0.4982      0.71  Q          |V         |          |          |
12+45       0.5031      0.71  Q          |V         |          |          |
12+50       0.5081      0.72  Q          |V         |          |          |
12+55       0.5131      0.73  Q          |V         |          |          |
13+ 0       0.5182      0.74  Q          |V         |          |          |
13+ 5       0.5233      0.75  Q          |V         |          |          |
13+10       0.5285      0.76  |Q         |V         |          |          |
13+15       0.5338      0.77  |Q         |V         |          |          |
13+20       0.5392      0.78  |Q         |V         |          |          |
13+25       0.5446      0.79  |Q         | V        |          |          |
13+30       0.5502      0.80  |Q         | V        |          |          |
13+35       0.5558      0.82  |Q         | V        |          |          |
13+40       0.5615      0.83  |Q         | V        |          |          |
13+45       0.5673      0.84  |Q         | V        |          |          |
13+50       0.5732      0.86  |Q         | V        |          |          |
13+55       0.5792      0.87  |Q         | V        |          |          |
14+ 0       0.5853      0.89  |Q         |  V       |          |          |
14+ 5       0.5916      0.91  |Q         |  V       |          |          |
14+10       0.5979      0.92  |Q         |  V       |          |          |
14+15       0.6044      0.95  |Q         |  V       |          |          |
14+20       0.6111      0.97  |Q         |  V       |          |          |
14+25       0.6179      0.99  |Q         |  V       |          |          |
14+30       0.6249      1.01  |Q         |  V       |          |          |
14+35       0.6320      1.04  |Q         |   V      |          |          |
14+40       0.6393      1.06  |Q         |   V      |          |          |
14+45       0.6469      1.09  |Q         |   V      |          |          |
14+50       0.6546      1.13  |Q         |   V      |          |          |
14+55       0.6626      1.16  |Q         |   V      |          |          |
15+ 0       0.6709      1.20  |Q         |   V      |          |          |
15+ 5       0.6794      1.24  |Q         |    V     |          |          |
15+10       0.6883      1.29  |Q         |    V     |          |          |
15+15       0.6976      1.34  |Q         |    V     |          |          |
15+20       0.7072      1.40  |Q         |    V     |          |          |
15+25       0.7172      1.45  |Q         |    V     |          |          |
15+30       0.7270      1.43  |Q         |     V    |          |          |
15+35       0.7362      1.33  |Q         |     V    |          |          |
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15+40	0.7453	1.33	Q	V			
15+45	0.7550	1.40	Q	V			
15+50	0.7655	1.53	Q	V			
15+55	0.7776	1.76	Q	V			
16+ 0	0.7932	2.26	Q	V			
16+ 5	0.8297	5.31	Q	V			
16+10	0.9373	15.62		Q			
16+15	1.1057	24.44			V	Q	
16+20	1.2018	13.96		Q	V		
16+25	1.2609	8.57	Q		V		
16+30	1.3034	6.18	Q		V		
16+35	1.3374	4.94	Q		V		
16+40	1.3654	4.07	Q		V		
16+45	1.3883	3.32	Q		V		
16+50	1.4082	2.89	Q		V		
16+55	1.4254	2.49	Q		V		
17+ 0	1.4405	2.20	Q		V		
17+ 5	1.4538	1.93	Q		V		
17+10	1.4652	1.66	Q		V		
17+15	1.4751	1.43	Q		V		
17+20	1.4846	1.39	Q		V		
17+25	1.4939	1.35	Q		V		
17+30	1.5026	1.25	Q		V		
17+35	1.5101	1.10	Q		V		
17+40	1.5169	0.99	Q		V		
17+45	1.5227	0.84	Q		V		
17+50	1.5283	0.81	Q		V		
17+55	1.5337	0.79	Q		V		
18+ 0	1.5390	0.76	Q		V		
18+ 5	1.5441	0.74	Q		V		
18+10	1.5491	0.73	Q		V		
18+15	1.5541	0.73	Q		V		
18+20	1.5591	0.72	Q		V		
18+25	1.5639	0.71	Q		V		
18+30	1.5687	0.70	Q		V		
18+35	1.5734	0.68	Q		V		
18+40	1.5781	0.67	Q		V		
18+45	1.5826	0.66	Q		V		
18+50	1.5871	0.65	Q		V		
18+55	1.5915	0.64	Q		V		
19+ 0	1.5959	0.63	Q		V		
19+ 5	1.6001	0.62	Q		V		
19+10	1.6044	0.61	Q		V		
19+15	1.6085	0.60	Q		V		
19+20	1.6126	0.60	Q		V		
19+25	1.6167	0.59	Q		V		
19+30	1.6207	0.58	Q		V		
19+35	1.6246	0.57	Q		V		
19+40	1.6285	0.56	Q		V		
19+45	1.6323	0.56	Q		V		
19+50	1.6361	0.55	Q		V		
19+55	1.6399	0.54	Q		V		
20+ 0	1.6436	0.54	Q		V		
20+ 5	1.6472	0.53	Q		V		
20+10	1.6509	0.53	Q		V		
20+15	1.6544	0.52	Q		V		
20+20	1.6580	0.51	Q		V		
20+25	1.6615	0.51	Q		V		
20+30	1.6650	0.50	Q		V		
20+35	1.6684	0.50	Q		V		
20+40	1.6718	0.49	Q		V		
20+45	1.6752	0.49	Q		V		
20+50	1.6785	0.49	Q		V		
20+55	1.6818	0.48	Q		V		
21+ 0	1.6851	0.48	Q		V		
21+ 5	1.6884	0.47	Q		V		
21+10	1.6916	0.47	Q		V		
21+15	1.6948	0.46	Q		V		
21+20	1.6980	0.46	Q		V		
21+25	1.7011	0.46	Q		V		

21+30	1.7042	0.45	Q	|	|	|	V |
21+35	1.7073	0.45	Q	|	|	|	V |
21+40	1.7104	0.45	Q	|	|	|	V |
21+45	1.7134	0.44	Q	|	|	|	V |
21+50	1.7165	0.44	Q	|	|	|	V |
21+55	1.7195	0.44	Q	|	|	|	V |
22+ 0	1.7224	0.43	Q	|	|	|	V |
22+ 5	1.7254	0.43	Q	|	|	|	V |
22+10	1.7283	0.43	Q	|	|	|	V |
22+15	1.7312	0.42	Q	|	|	|	V |
22+20	1.7341	0.42	Q	|	|	|	V |
22+25	1.7370	0.42	Q	|	|	|	V |
22+30	1.7399	0.41	Q	|	|	|	V |
22+35	1.7427	0.41	Q	|	|	|	V |
22+40	1.7455	0.41	Q	|	|	|	V |
22+45	1.7483	0.41	Q	|	|	|	V |
22+50	1.7511	0.40	Q	|	|	|	V |
22+55	1.7538	0.40	Q	|	|	|	V|
23+ 0	1.7566	0.40	Q	|	|	|	V|
23+ 5	1.7593	0.40	Q	|	|	|	V|
23+10	1.7620	0.39	Q	|	|	|	V|
23+15	1.7647	0.39	Q	|	|	|	V|
23+20	1.7674	0.39	Q	|	|	|	V|
23+25	1.7700	0.39	Q	|	|	|	V|
23+30	1.7727	0.38	Q	|	|	|	V|
23+35	1.7753	0.38	Q	|	|	|	V|
23+40	1.7779	0.38	Q	|	|	|	V|
23+45	1.7805	0.38	Q	|	|	|	V|
23+50	1.7831	0.38	Q	|	|	|	V|
23+55	1.7857	0.37	Q	|	|	|	V|
24+ 0	1.7883	0.37	Q	|	|	|	V|
24+ 5	1.7907	0.36	Q	|	|	|	V|
24+10	1.7928	0.30	Q	|	|	|	V|
24+15	1.7941	0.18	Q	|	|	|	V|
24+20	1.7949	0.12	Q	|	|	|	V|
24+25	1.7955	0.09	Q	|	|	|	V|
24+30	1.7960	0.07	Q	|	|	|	V|
24+35	1.7964	0.05	Q	|	|	|	V|
24+40	1.7967	0.04	Q	|	|	|	V|
24+45	1.7969	0.03	Q	|	|	|	V|
24+50	1.7971	0.02	Q	|	|	|	V|
24+55	1.7972	0.02	Q	|	|	|	V|
25+ 0	1.7973	0.01	Q	|	|	|	V|
25+ 5	1.7974	0.01	Q	|	|	|	V|
25+10	1.7974	0.01	Q	|	|	|	V|
25+15	1.7975	0.01	Q	|	|	|	V|
25+20	1.7975	0.00	Q	|	|	|	V|
25+25	1.7975	0.00	Q	|	|	|	V|
25+30	1.7975	0.00	Q	|	|	|	V|
25+35	1.7975	0.00	Q	|	|	|	V

San Bernardino County Rational Hydrology Program

(Hydrology Manual Date - August 1986)

CIVILCADD/CIVILDESIGN Engineering Software, (c) 1989-2005 Version 7.1
Rational Hydrology Study Date: 05/24/23

COVINGOTN - PHELAN 20
HYDROLOGY Q10 STUDY - PROPOSED CONDITION
6042Q10P
T.A.

Program License Serial Number 6145

********* Hydrology Study Control Information **********

Rational hydrology study storm event year is 10.0
Computed rainfall intensity:
Storm year = 10.00 1 hour rainfall = 0.786 (In.)
Slope used for rainfall intensity curve b = 0.7000
Soil antecedent moisture condition (AMC) = 2

++
Process from Point/Station 1.000 to Point/Station 2.000
**** INITIAL AREA EVALUATION ****

COMMERCIAL subarea type
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2) = 32.00
Pervious ratio(Ap) = 0.1000 Max loss rate(Fm)= 0.098(In/Hr)
Initial subarea data:
Initial area flow distance = 544.000(Ft.)
Top (of initial area) elevation = 3595.260(Ft.)
Bottom (of initial area) elevation = 3589.900(Ft.)
Difference in elevation = 5.360(Ft.)
Slope = 0.00985 s(%)= 0.99
TC = k(0.304)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration = 9.515 min.
Rainfall intensity = 2.853(In/Hr) for a 10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.869
Subarea runoff = 5.455(CFS)
Total initial stream area = 2.200(Ac.)
Pervious area fraction = 0.100
Initial area Fm value = 0.098(In/Hr)

++
Process from Point/Station 2.000 to Point/Station 3.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****

Upstream point/station elevation = 3584.400(Ft.)
Downstream point/station elevation = 3578.630(Ft.)
Pipe length = 421.00(Ft.) Manning's N = 0.013
No. of pipes = 1 Required pipe flow = 5.455(CFS)
Nearest computed pipe diameter = 15.00(In.)
Calculated individual pipe flow = 5.455(CFS)
Normal flow depth in pipe = 9.43(In.)
Flow top width inside pipe = 14.49(In.)
Critical Depth = 11.36(In.)
Pipe flow velocity = 6.71(Ft/s)
Travel time through pipe = 1.05 min.

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Time of concentration (TC) =    10.56 min.

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Process from Point/Station        3.000 to Point/Station        3.000
**** SUBAREA FLOW ADDITION ****
________________________________________________________________________
COMMERCIAL subarea type
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 32.00
Pervious ratio(Ap) = 0.1000     Max loss rate(Fm)=     0.098(In/Hr)
Time of concentration =    10.56 min.
Rainfall intensity =      2.652(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.867
Subarea runoff =      5.349(CFS) for    2.500(Ac.)
Total runoff =     10.804(CFS)
Effective area this stream =        4.70(Ac.)
Total Study Area (Main Stream No. 1) =        4.70(Ac.)
Area averaged Fm value =    0.098(In/Hr)


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Process from Point/Station        3.000 to Point/Station        4.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =  3578.630(Ft.)
Downstream point/station elevation =  3573.260(Ft.)
Pipe length  =   394.00(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    10.804(CFS)
Nearest computed pipe diameter  =     18.00(In.)
Calculated individual pipe flow  =    10.804(CFS)
Normal flow depth in pipe =   13.13(In.)
Flow top width inside pipe =   16.00(In.)
Critical Depth =   15.12(In.)
Pipe flow velocity =      7.83(Ft/s)
Travel time through pipe =    0.84 min.
Time of concentration (TC) =    11.40 min.


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Process from Point/Station        4.000 to Point/Station        4.000
**** SUBAREA FLOW ADDITION ****
________________________________________________________________________
COMMERCIAL subarea type
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 32.00
Pervious ratio(Ap) = 0.1000     Max loss rate(Fm)=     0.098(In/Hr)
Time of concentration =    11.40 min.
Rainfall intensity =      2.514(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.865
Subarea runoff =      4.634(CFS) for    2.400(Ac.)
Total runoff =     15.438(CFS)
Effective area this stream =        7.10(Ac.)
Total Study Area (Main Stream No. 1) =        7.10(Ac.)
Area averaged Fm value =    0.098(In/Hr)


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Process from Point/Station        4.000 to Point/Station        5.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =  3573.260(Ft.)
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Downstream point/station elevation =  3572.830(Ft.)
Pipe length  =    31.00(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    15.438(CFS)
Nearest computed pipe diameter  =     21.00(In.)
Calculated individual pipe flow  =    15.438(CFS)
Normal flow depth in pipe =   14.57(In.)
Flow top width inside pipe =   19.36(In.)
Critical Depth =   17.44(In.)
Pipe flow velocity =      8.67(Ft/s)
Travel time through pipe =    0.06 min.
Time of concentration (TC) =    11.46 min.


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Process from Point/Station        5.000 to Point/Station        5.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________________
COMMERCIAL subarea type
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 32.00
Pervious ratio(Ap) = 0.1000     Max loss rate(Fm)=     0.098(In/Hr)
Time of concentration =    11.46 min.
Rainfall intensity =      2.505(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.865
Subarea runoff =      0.158(CFS) for    0.100(Ac.)
Total runoff =     15.596(CFS)
Effective area this stream =        7.20(Ac.)
Total Study Area (Main Stream No. 1) =        7.20(Ac.)
Area averaged Fm value =    0.098(In/Hr)


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Process from Point/Station        5.000 to Point/Station        6.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
______________________________________________________________________________
Upstream point/station elevation =  3572.830(Ft.)
Downstream point/station elevation =  3572.570(Ft.)
Pipe length  =    52.00(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    15.596(CFS)
Nearest computed pipe diameter  =     24.00(In.)
Calculated individual pipe flow  =    15.596(CFS)
Normal flow depth in pipe =   19.15(In.)
Flow top width inside pipe =   19.28(In.)
Critical Depth =   17.08(In.)
Pipe flow velocity =      5.80(Ft/s)
Travel time through pipe =    0.15 min.
Time of concentration (TC) =    11.61 min.


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Process from Point/Station        6.000 to Point/Station        6.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________________
COMMERCIAL subarea type
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 32.00
Pervious ratio(Ap) = 0.1000     Max loss rate(Fm)=     0.098(In/Hr)
Time of concentration =    11.61 min.
Rainfall intensity =      2.482(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.865
Subarea runoff =      0.283(CFS) for    0.200(Ac.)
Total runoff =     15.879(CFS)
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Effective area this stream =        7.40(Ac.)
Total Study Area (Main Stream No. 1) =        7.40(Ac.)
Area averaged Fm value =    0.098(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        6.000 to Point/Station        6.000
**** SUBAREA FLOW ADDITION ****
________________________________________________________________________
COMMERCIAL subarea type
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 32.00
Pervious ratio(Ap) = 0.1000     Max loss rate(Fm)=     0.098(In/Hr)
Time of concentration =    11.61 min.
Rainfall intensity =      2.482(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.865
Subarea runoff =      1.717(CFS) for    0.800(Ac.)
Total runoff =     17.595(CFS)
Effective area this stream =        8.20(Ac.)
Total Study Area (Main Stream No. 1) =        8.20(Ac.)
Area averaged Fm value =    0.098(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        6.000 to Point/Station        7.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =  3572.570(Ft.)
Downstream point/station elevation =  3567.500(Ft.)
Pipe length  =   462.00(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    17.595(CFS)
Nearest computed pipe diameter  =     24.00(In.)
Calculated individual pipe flow  =    17.595(CFS)
Normal flow depth in pipe =   15.40(In.)
Flow top width inside pipe =   23.02(In.)
Critical Depth =   18.13(In.)
Pipe flow velocity =      8.26(Ft/s)
Travel time through pipe =    0.93 min.
Time of concentration (TC) =    12.54 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        7.000 to Point/Station        7.000
**** SUBAREA FLOW ADDITION ****
________________________________________________________________________
COMMERCIAL subarea type
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 32.00
Pervious ratio(Ap) = 0.1000     Max loss rate(Fm)=     0.098(In/Hr)
The area added to the existing stream causes a
a lower flow rate of Q =     17.443(CFS)
therefore the upstream flow rate of Q =     17.595(CFS) is being used
Time of concentration =    12.54 min.
Rainfall intensity =      2.351(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.863
Subarea runoff =      0.000(CFS) for    0.400(Ac.)
Total runoff =     17.595(CFS)
Effective area this stream =        8.60(Ac.)
Total Study Area (Main Stream No. 1) =        8.60(Ac.)
Area averaged Fm value =    0.098(In/Hr)
```

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++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        7.000 to Point/Station        7.000
**** CONFLUENCE OF MINOR STREAMS ****
_____________________________________________________________________________
Along Main Stream number: 1 in normal stream number 1
Stream flow area =      8.600(Ac.)
Runoff from this stream =     17.595(CFS)
Time of concentration =   12.54 min.
Rainfall intensity =     2.351(In/Hr)
Area averaged loss rate (Fm) =    0.0978(In/Hr)
Area averaged Pervious ratio (Ap) = 0.1000


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       11.000 to Point/Station       12.000
**** INITIAL AREA EVALUATION ****
_____________________________________________________________________________
COMMERCIAL subarea type
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 32.00
Pervious ratio(Ap) = 0.1000     Max loss rate(Fm)=     0.098(In/Hr)
Initial subarea data:
Initial area flow distance =   784.000(Ft.)
Top (of initial area) elevation =  3602.940(Ft.)
Bottom (of initial area) elevation =  3588.430(Ft.)
Difference in elevation =    14.510(Ft.)
Slope =    0.01851  s(%)=       1.85
TC = k(0.304)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =    9.708 min.
Rainfall intensity =      2.813(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.869
Subarea runoff =      7.819(CFS)
Total initial stream area =        3.200(Ac.)
Pervious area fraction = 0.100
Initial area Fm value =    0.098(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       12.000 to Point/Station       13.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
_____________________________________________________________________________
Upstream point/station elevation =  3582.930(Ft.)
Downstream point/station elevation =  3580.280(Ft.)
Pipe length  =   474.00(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     7.819(CFS)
Nearest computed pipe diameter  =     18.00(In.)
Calculated individual pipe flow  =     7.819(CFS)
Normal flow depth in pipe =   14.67(In.)
Flow top width inside pipe =   13.98(In.)
Critical Depth =   13.01(In.)
Pipe flow velocity =      5.07(Ft/s)
Travel time through pipe =    1.56 min.
Time of concentration (TC) =    11.27 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       13.000 to Point/Station       13.000
**** SUBAREA FLOW ADDITION ****
_____________________________________________________________________________
COMMERCIAL subarea type
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 32.00
Pervious ratio(Ap) = 0.1000     Max loss rate(Fm)=     0.098(In/Hr)
Time of concentration =    11.27 min.
```

```
Rainfall intensity =      2.534(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.865
Subarea runoff =      6.434(CFS) for    3.300(Ac.)
Total runoff =     14.254(CFS)
Effective area this stream =        6.50(Ac.)
Total Study Area (Main Stream No. 1) =       15.10(Ac.)
Area averaged Fm value =    0.098(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       13.000 to Point/Station       14.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =  3580.280(Ft.)
Downstream point/station elevation =  3574.740(Ft.)
Pipe length  =   197.00(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    14.254(CFS)
Nearest computed pipe diameter  =     18.00(In.)
Calculated individual pipe flow  =    14.254(CFS)
Normal flow depth in pipe =   12.28(In.)
Flow top width inside pipe =   16.76(In.)
Critical Depth =   16.66(In.)
Pipe flow velocity =     11.10(Ft/s)
Travel time through pipe =    0.30 min.
Time of concentration (TC) =    11.56 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       14.000 to Point/Station       14.000
**** SUBAREA FLOW ADDITION ****
________________________________________________________________________
COMMERCIAL subarea type
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 32.00
Pervious ratio(Ap) = 0.1000     Max loss rate(Fm)=     0.098(In/Hr)
Time of concentration =    11.56 min.
Rainfall intensity =      2.489(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.865
Subarea runoff =      3.607(CFS) for    1.800(Ac.)
Total runoff =     17.860(CFS)
Effective area this stream =        8.30(Ac.)
Total Study Area (Main Stream No. 1) =       16.90(Ac.)
Area averaged Fm value =    0.098(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       14.000 to Point/Station       15.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
________________________________________________________________________
Upstream point/station elevation =  3574.740(Ft.)
Downstream point/station elevation =  3573.230(Ft.)
Pipe length  =    64.00(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    17.860(CFS)
Nearest computed pipe diameter  =     21.00(In.)
Calculated individual pipe flow  =    17.860(CFS)
Normal flow depth in pipe =   13.36(In.)
Flow top width inside pipe =   20.21(In.)
Critical Depth =   18.49(In.)
Pipe flow velocity =     11.05(Ft/s)
Travel time through pipe =    0.10 min.
Time of concentration (TC) =    11.66 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       15.000 to Point/Station       15.000
```

**** SUBAREA FLOW ADDITION ****

COMMERCIAL subarea type
Decimal fraction soil group A = 1.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2) = 32.00
Pervious ratio(Ap) = 0.1000 Max loss rate(Fm)= 0.098(In/Hr)
Time of concentration = 11.66 min.
Rainfall intensity = 2.474(In/Hr) for a 10.0 year storm
Effective runoff coefficient used for area,(total area with modified rational method)(Q=KCIA) is C = 0.864
Subarea runoff = 2.673(CFS) for 1.300(Ac.)
Total runoff = 20.533(CFS)
Effective area this stream = 9.60(Ac.)
Total Study Area (Main Stream No. 1) = 18.20(Ac.)
Area averaged Fm value = 0.098(In/Hr)

++
Process from Point/Station 15.000 to Point/Station 7.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****

Upstream point/station elevation = 3573.230(Ft.)
Downstream point/station elevation = 3567.500(Ft.)
Pipe length = 66.00(Ft.) Manning's N = 0.013
No. of pipes = 1 Required pipe flow = 20.533(CFS)
Nearest computed pipe diameter = 18.00(In.)
Calculated individual pipe flow = 20.533(CFS)
Normal flow depth in pipe = 10.71(In.)
Flow top width inside pipe = 17.67(In.)
Critical depth could not be calculated.
Pipe flow velocity = 18.73(Ft/s)
Travel time through pipe = 0.06 min.
Time of concentration (TC) = 11.72 min.

++
Process from Point/Station 7.000 to Point/Station 7.000
**** CONFLUENCE OF MINOR STREAMS ****

Along Main Stream number: 1 in normal stream number 2
Stream flow area = 9.600(Ac.)
Runoff from this stream = 20.533(CFS)
Time of concentration = 11.72 min.
Rainfall intensity = 2.466(In/Hr)
Area averaged loss rate (Fm) = 0.0978(In/Hr)
Area averaged Pervious ratio (Ap) = 0.1000
Summary of stream data:

Stream No.	Flow rate (CFS)	Area (Ac.)	TC (min)	Fm (In/Hr)	Rainfall Intensity (In/Hr)
1	17.60	8.600	12.54	0.098	2.351
2	20.53	9.600	11.72	0.098	2.466

```
Qmax(1) =
          1.000 *    1.000 *    17.595) +
          0.952 *    1.000 *    20.533) + =      37.138
Qmax(2) =
          1.051 *    0.934 *    17.595) +
          1.000 *    1.000 *    20.533) + =      37.809
```

Total of 2 streams to confluence:
Flow rates before confluence point:
17.595 20.533
Maximum flow rates at confluence using above data:
37.138 37.809
Area of streams before confluence:

```
        8.600        9.600
Effective area values after confluence:
       18.200       17.636
Results of confluence:
Total flow rate =      37.809(CFS)
Time of concentration =    11.718 min.
Effective stream area after confluence =     17.636(Ac.)
Study area average Pervious fraction(Ap) =  0.100
Study area average soil loss rate(Fm) =    0.098(In/Hr)
Study area total (this main stream) =      18.20(Ac.)
End of computations, Total Study Area =           18.20 (Ac.)
The following figures may
be used for a unit hydrograph study of the same area.
Note: These figures do not consider reduced effective area
effects caused by confluences in the rational equation.

Area averaged pervious area fraction(Ap) = 0.100
Area averaged SCS curve number =  32.0
```

U n i t H y d r o g r a p h A n a l y s i s

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Study date 05/24/23

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San Bernardino County Synthetic Unit Hydrology Method
Manual date - August 1986

Program License Serial Number 6145

COVINGTON - PHELAN 20
UNIT HYDROGRAPH - 10 YEAR STORM EVENT - PROPOSED CONDITION
6042UHQ10P
TA

Storm Event Year = 10

Antecedent Moisture Condition = 2

English (in-lb) Input Units Used

English Rainfall Data (Inches) Input Values Used

English Units used in output format

Area averaged rainfall intensity isohyetal data:

Sub-Area (Ac.)	Duration (hours)	Isohyetal (In)
Rainfall data for year 10		
18.20	1	0.79
Rainfall data for year 10		
18.20	6	1.82
Rainfall data for year 10		
18.20	24	3.66

++

******** Area-averaged max loss rate, Fm ********

SCS curve No.(AMCII)	SCS curve NO.(AMC 2)	Area (Ac.)	Area Fraction	Fp(Fig C6) (In/Hr)	Ap (dec.)	Fm (In/Hr)
32.0	32.0	18.20	1.000	0.978	0.100	0.098

Area-averaged adjusted loss rate Fm (In/Hr) = 0.098

********* Area-Averaged low loss rate fraction, Yb **********

Area (Ac.)	Area Fract	SCS CN (AMC2)	SCS CN (AMC2)	S	Pervious Yield Fr
1.82	0.100	32.0	32.0	18.30	0.000
16.38	0.900	98.0	98.0	0.20	0.936

Area-averaged catchment yield fraction, Y = 0.842
Area-averaged low loss fraction, Yb = 0.158
Direct entry of lag time by user

++
Watershed area = 18.20(Ac.)
Catchment Lag time = 0.156 hours
Unit interval = 5.000 minutes
Unit interval percentage of lag time = 53.4188
Hydrograph baseflow = 0.00(CFS)
Average maximum watershed loss rate(Fm) = 0.098(In/Hr)
Average low loss rate fraction (Yb) = 0.158 (decimal)
DESERT S-Graph Selected
Computed peak 5-minute rainfall = 0.373(In)
Computed peak 30-minute rainfall = 0.638(In)
Specified peak 1-hour rainfall = 0.786(In)
Computed peak 3-hour rainfall = 1.315(In)
Specified peak 6-hour rainfall = 1.820(In)
Specified peak 24-hour rainfall = 3.660(In)

Rainfall depth area reduction factors:
Using a total area of 18.20(Ac.) (Ref: fig. E-4)

5-minute factor = 0.999 Adjusted rainfall = 0.373(In)
30-minute factor = 0.999 Adjusted rainfall = 0.638(In)
1-hour factor = 0.999 Adjusted rainfall = 0.785(In)
3-hour factor = 1.000 Adjusted rainfall = 1.315(In)
6-hour factor = 1.000 Adjusted rainfall = 1.820(In)
24-hour factor = 1.000 Adjusted rainfall = 3.660(In)

U n i t H y d r o g r a p h
++

Interval Number	'S' Graph Mean values	Unit Hydrograph ((CFS))
	(K = 220.11 (CFS))	
1	4.451	9.797
2	34.445	66.019
3	63.447	63.835
4	75.941	27.499
5	83.200	15.977
6	88.116	10.821
7	91.401	7.230
8	93.858	5.409
9	95.667	3.982
10	97.007	2.949
11	97.890	1.944
12	98.475	1.286
13	99.113	1.405
14	99.631	1.140
15	100.000	0.813

Total soil rain loss = 0.52(In)
Total effective rainfall = 3.14(In)
Peak flow rate in flood hydrograph = 32.22(CFS)

++
24 - H O U R S T O R M
R u n o f f H y d r o g r a p h

Hydrograph in 5 Minute intervals ((CFS))

Time(h+m)	Volume Ac.Ft	Q(CFS)	0	10.0	20.0	30.0	40.0
0+ 5	0.0004	0.05	Q	|	|	|	|
0+10	0.0032	0.41	Q	|	|	|	|
0+15	0.0084	0.76	Q	|	|	|	|
0+20	0.0146	0.91	Q	|	|	|	|

0+25	0.0215	0.99	Q				
0+30	0.0287	1.06	VQ				
0+35	0.0363	1.10	VQ				
0+40	0.0441	1.13	VQ				
0+45	0.0520	1.15	VQ				
0+50	0.0601	1.17	VQ				
0+55	0.0683	1.19	VQ				
1+ 0	0.0765	1.20	VQ				
1+ 5	0.0848	1.21	VQ				
1+10	0.0932	1.22	VQ				
1+15	0.1016	1.22	VQ				
1+20	0.1101	1.23	VQ				
1+25	0.1185	1.23	VQ				
1+30	0.1270	1.23	|Q				
1+35	0.1356	1.24	|Q				
1+40	0.1441	1.24	|Q				
1+45	0.1527	1.24	|Q				
1+50	0.1613	1.25	|Q				
1+55	0.1699	1.25	|Q				
2+ 0	0.1786	1.26	|Q				
2+ 5	0.1872	1.26	|Q				
2+10	0.1959	1.26	|Q				
2+15	0.2047	1.27	|Q				
2+20	0.2134	1.27	|Q				
2+25	0.2222	1.27	|Q				
2+30	0.2310	1.28	|Q				
2+35	0.2398	1.28	|QV				
2+40	0.2487	1.29	|QV				
2+45	0.2576	1.29	|QV				
2+50	0.2665	1.29	|QV				
2+55	0.2754	1.30	|QV				
3+ 0	0.2844	1.30	|QV				
3+ 5	0.2934	1.31	|QV				
3+10	0.3024	1.31	|QV				
3+15	0.3114	1.31	|QV				
3+20	0.3205	1.32	|QV				
3+25	0.3296	1.32	|QV				
3+30	0.3388	1.33	|QV				
3+35	0.3479	1.33	|QV				
3+40	0.3571	1.34	|Q V				
3+45	0.3663	1.34	|Q V				
3+50	0.3756	1.34	|Q V				
3+55	0.3849	1.35	|Q V				
4+ 0	0.3942	1.35	|Q V				
4+ 5	0.4036	1.36	|Q V				
4+10	0.4129	1.36	|Q V				
4+15	0.4224	1.37	|Q V				
4+20	0.4318	1.37	|Q V				
4+25	0.4413	1.38	|Q V				
4+30	0.4508	1.38	|Q V				
4+35	0.4603	1.39	|Q V				
4+40	0.4699	1.39	|Q V				
4+45	0.4795	1.40	|Q V				
4+50	0.4892	1.40	|Q V				
4+55	0.4989	1.41	|Q V				
5+ 0	0.5086	1.41	|Q V				
5+ 5	0.5184	1.42	|Q V				
5+10	0.5281	1.42	|Q V				
5+15	0.5380	1.43	|Q V				
5+20	0.5478	1.43	|Q V				
5+25	0.5577	1.44	|Q V				
5+30	0.5677	1.44	|Q V				
5+35	0.5777	1.45	|Q V				
5+40	0.5877	1.45	|Q V				
5+45	0.5977	1.46	|Q V				
5+50	0.6078	1.47	|Q V				
5+55	0.6180	1.47	|Q V				
6+ 0	0.6281	1.48	|Q V				
6+ 5	0.6384	1.48	|Q V				
6+10	0.6486	1.49	|Q V				

6+15	0.6589	1.50	|Q V |				
6+20	0.6693	1.50	|Q V |				
6+25	0.6797	1.51	|Q V |				
6+30	0.6901	1.51	|Q V |				
6+35	0.7006	1.52	|Q V |				
6+40	0.7111	1.53	|Q V |				
6+45	0.7217	1.53	|Q V |				
6+50	0.7323	1.54	|Q V |				
6+55	0.7429	1.55	|Q V |				
7+ 0	0.7536	1.55	|Q V |				
7+ 5	0.7644	1.56	|Q V |				
7+10	0.7752	1.57	|Q V |				
7+15	0.7860	1.58	|Q V |				
7+20	0.7969	1.58	|Q V |				
7+25	0.8079	1.59	|Q V |				
7+30	0.8189	1.60	|Q V |				
7+35	0.8300	1.61	|Q V |				
7+40	0.8411	1.61	|Q V |				
7+45	0.8522	1.62	|Q V |				
7+50	0.8635	1.63	|Q V |				
7+55	0.8747	1.64	|Q V |				
8+ 0	0.8861	1.64	|Q V |				
8+ 5	0.8974	1.65	|Q V |				
8+10	0.9089	1.66	|Q V |				
8+15	0.9204	1.67	|Q V |				
8+20	0.9319	1.68	|Q V |				
8+25	0.9436	1.69	|Q V |				
8+30	0.9552	1.70	|Q V |				
8+35	0.9670	1.71	|Q V |				
8+40	0.9788	1.71	|Q V |				
8+45	0.9907	1.72	|Q V |				
8+50	1.0026	1.73	|Q V |				
8+55	1.0146	1.74	|Q V |				
9+ 0	1.0267	1.75	|Q V |				
9+ 5	1.0388	1.76	|Q V |				
9+10	1.0511	1.77	|Q V |				
9+15	1.0633	1.78	|Q V |				
9+20	1.0757	1.79	|Q V|				
9+25	1.0881	1.80	|Q V|				
9+30	1.1006	1.82	|Q V|				
9+35	1.1132	1.83	|Q V|				
9+40	1.1259	1.84	|Q V|				
9+45	1.1386	1.85	|Q V|				
9+50	1.1514	1.86	|Q V|				
9+55	1.1644	1.87	|Q V|				
10+ 0	1.1773	1.89	|Q V|				
10+ 5	1.1904	1.90	|Q V |				
10+10	1.2036	1.91	|Q V |				
10+15	1.2168	1.92	|Q V |				
10+20	1.2302	1.94	|Q V |				
10+25	1.2436	1.95	|Q V |				
10+30	1.2572	1.97	|Q V |				
10+35	1.2708	1.98	|Q V |				
10+40	1.2845	1.99	|Q V |				
10+45	1.2984	2.01	| Q V |				
10+50	1.3123	2.02	| Q |V |				
10+55	1.3263	2.04	| Q |V |				
11+ 0	1.3405	2.06	| Q |V |				
11+ 5	1.3548	2.07	| Q |V |				
11+10	1.3692	2.09	| Q |V |				
11+15	1.3836	2.11	| Q |V |				
11+20	1.3983	2.12	| Q |V |				
11+25	1.4130	2.14	| Q |V |				
11+30	1.4279	2.16	| Q |V |				
11+35	1.4429	2.18	| Q | V |				
11+40	1.4580	2.20	| Q | V |				
11+45	1.4733	2.22	| Q | V |				
11+50	1.4887	2.24	| Q | V |				
11+55	1.5043	2.26	| Q | V |				
12+ 0	1.5200	2.28	| Q | V |				

12+ 5	1.5358	2.30	Q	V			
12+10	1.5514	2.27	Q	V			
12+15	1.5669	2.24	Q	V			
12+20	1.5823	2.25	Q	V			
12+25	1.5979	2.26	Q	V			
12+30	1.6136	2.28	Q	V			
12+35	1.6295	2.30	Q	V			
12+40	1.6455	2.32	Q	V			
12+45	1.6617	2.35	Q	V			
12+50	1.6780	2.38	Q	V			
12+55	1.6946	2.41	Q	V			
13+ 0	1.7114	2.44	Q	V			
13+ 5	1.7284	2.47	Q	V			
13+10	1.7457	2.51	Q	V			
13+15	1.7632	2.54	Q	V			
13+20	1.7810	2.58	Q	V			
13+25	1.7990	2.62	Q	V			
13+30	1.8173	2.66	Q	V			
13+35	1.8359	2.70	Q	V			
13+40	1.8549	2.75	Q	V			
13+45	1.8741	2.80	Q	V			
13+50	1.8937	2.85	Q	V			
13+55	1.9137	2.90	Q	V			
14+ 0	1.9341	2.96	Q	V			
14+ 5	1.9548	3.01	Q	V			
14+10	1.9760	3.08	Q	V			
14+15	1.9977	3.15	Q	V			
14+20	2.0199	3.22	Q	V			
14+25	2.0425	3.29	Q	V			
14+30	2.0658	3.38	Q	V			
14+35	2.0896	3.46	Q	V			
14+40	2.1142	3.56	Q	V			
14+45	2.1394	3.66	Q	V			
14+50	2.1653	3.77	Q	V			
14+55	2.1922	3.89	Q	V			
15+ 0	2.2199	4.03	Q	V			
15+ 5	2.2487	4.18	Q	V			
15+10	2.2786	4.35	Q	V			
15+15	2.3098	4.53	Q	V			
15+20	2.3425	4.75	Q	V			
15+25	2.3762	4.89	Q	V			
15+30	2.4076	4.56	Q	V			
15+35	2.4371	4.28	Q	V			
15+40	2.4674	4.41	Q	V			
15+45	2.5000	4.73	Q	V			
15+50	2.5366	5.31	Q	V			
15+55	2.5794	6.21	Q	V			
16+ 0	2.6355	8.15	Q	V			
16+ 5	2.7329	14.13	Q	V			
16+10	2.9548	32.22	Q	V			
16+15	3.1617	30.04	Q	V			
16+20	3.2780	16.89	Q	V			
16+25	3.3591	11.77	Q	V			
16+30	3.4252	9.60	Q	V			
16+35	3.4816	8.18	Q	V			
16+40	3.5309	7.16	Q	V			
16+45	3.5741	6.28	Q	V			
16+50	3.6125	5.57	Q	V			
16+55	3.6464	4.93	Q	V			
17+ 0	3.6771	4.46	Q	V			
17+ 5	3.7064	4.26	Q	V			
17+10	3.7336	3.95	Q	V			
17+15	3.7586	3.63	Q	V			
17+20	3.7806	3.19	Q	V			
17+25	3.8016	3.05	Q	V			
17+30	3.8218	2.93	Q	V			
17+35	3.8413	2.83	Q	V			
17+40	3.8601	2.73	Q	V			
17+45	3.8782	2.64	Q	V			
17+50	3.8958	2.56	Q	V			

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17+55       3.9129      2.48  | Q       |         |         | V       |
18+ 0       3.9295      2.41  | Q       |         |         |  V      |
18+ 5       3.9458      2.36  | Q       |         |         |  V      |
18+10       3.9620      2.35  | Q       |         |         |  V      |
18+15       3.9781      2.34  | Q       |         |         |  V      |
18+20       3.9941      2.31  | Q       |         |         |  V      |
18+25       4.0098      2.28  | Q       |         |         |  V      |
18+30       4.0252      2.24  | Q       |         |         |  V      |
18+35       4.0404      2.21  | Q       |         |         |  V      |
18+40       4.0553      2.17  | Q       |         |         |   V     |
18+45       4.0700      2.14  | Q       |         |         |   V     |
18+50       4.0845      2.10  | Q       |         |         |   V     |
18+55       4.0988      2.07  | Q       |         |         |   V     |
19+ 0       4.1128      2.04  | Q       |         |         |   V     |
19+ 5       4.1266      2.01  | Q       |         |         |   V     |
19+10       4.1403      1.98  |Q        |         |         |   V     |
19+15       4.1537      1.95  |Q        |         |         |   V     |
19+20       4.1670      1.93  |Q        |         |         |    V    |
19+25       4.1801      1.90  |Q        |         |         |    V    |
19+30       4.1930      1.87  |Q        |         |         |    V    |
19+35       4.2057      1.85  |Q        |         |         |    V    |
19+40       4.2183      1.83  |Q        |         |         |    V    |
19+45       4.2307      1.81  |Q        |         |         |    V    |
19+50       4.2430      1.78  |Q        |         |         |    V    |
19+55       4.2552      1.76  |Q        |         |         |    V    |
20+ 0       4.2672      1.74  |Q        |         |         |    V    |
20+ 5       4.2790      1.72  |Q        |         |         |    V    |
20+10       4.2908      1.71  |Q        |         |         |     V   |
20+15       4.3024      1.69  |Q        |         |         |     V   |
20+20       4.3139      1.67  |Q        |         |         |     V   |
20+25       4.3253      1.65  |Q        |         |         |     V   |
20+30       4.3366      1.64  |Q        |         |         |     V   |
20+35       4.3477      1.62  |Q        |         |         |     V   |
20+40       4.3588      1.61  |Q        |         |         |     V   |
20+45       4.3697      1.59  |Q        |         |         |     V   |
20+50       4.3806      1.58  |Q        |         |         |     V   |
20+55       4.3913      1.56  |Q        |         |         |     V   |
21+ 0       4.4020      1.55  |Q        |         |         |     V   |
21+ 5       4.4125      1.53  |Q        |         |         |      V  |
21+10       4.4230      1.52  |Q        |         |         |      V  |
21+15       4.4334      1.51  |Q        |         |         |      V  |
21+20       4.4437      1.50  |Q        |         |         |      V  |
21+25       4.4539      1.48  |Q        |         |         |      V  |
21+30       4.4641      1.47  |Q        |         |         |      V  |
21+35       4.4741      1.46  |Q        |         |         |      V  |
21+40       4.4841      1.45  |Q        |         |         |      V  |
21+45       4.4940      1.44  |Q        |         |         |      V  |
21+50       4.5038      1.43  |Q        |         |         |      V  |
21+55       4.5136      1.42  |Q        |         |         |      V  |
22+ 0       4.5233      1.41  |Q        |         |         |       V |
22+ 5       4.5329      1.40  |Q        |         |         |       V |
22+10       4.5424      1.39  |Q        |         |         |       V |
22+15       4.5519      1.38  |Q        |         |         |       V |
22+20       4.5613      1.37  |Q        |         |         |       V |
22+25       4.5706      1.36  |Q        |         |         |       V |
22+30       4.5799      1.35  |Q        |         |         |       V |
22+35       4.5892      1.34  |Q        |         |         |       V |
22+40       4.5983      1.33  |Q        |         |         |       V |
22+45       4.6074      1.32  |Q        |         |         |       V |
22+50       4.6165      1.31  |Q        |         |         |       V |
22+55       4.6255      1.31  |Q        |         |         |       V |
23+ 0       4.6344      1.30  |Q        |         |         |       V |
23+ 5       4.6433      1.29  |Q        |         |         |        V|
23+10       4.6521      1.28  |Q        |         |         |        V|
23+15       4.6609      1.27  |Q        |         |         |        V|
23+20       4.6696      1.27  |Q        |         |         |        V|
23+25       4.6783      1.26  |Q        |         |         |        V|
23+30       4.6869      1.25  |Q        |         |         |        V|
23+35       4.6955      1.24  |Q        |         |         |        V|
23+40       4.7040      1.24  |Q        |         |         |        V|
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   23+45       4.7125      1.23  |Q        |         |         |        V|
   23+50       4.7209      1.22  |Q        |         |         |        V|
   23+55       4.7293      1.22  |Q        |         |         |        V|
   24+ 0       4.7376      1.21  |Q        |         |         |        V|
   24+ 5       4.7455      1.15  |Q        |         |         |        V|
   24+10       4.7510      0.79  Q         |         |         |        V|
   24+15       4.7540      0.44  Q         |         |         |        V|
   24+20       4.7560      0.29  Q         |         |         |        V|
   24+25       4.7574      0.20  Q         |         |         |        V|
   24+30       4.7584      0.14  Q         |         |         |        V|
   24+35       4.7591      0.10  Q         |         |         |        V|
   24+40       4.7596      0.07  Q         |         |         |        V|
   24+45       4.7600      0.05  Q         |         |         |        V|
   24+50       4.7602      0.04  Q         |         |         |        V|
   24+55       4.7604      0.03  Q         |         |         |        V|
   25+ 0       4.7605      0.02  Q         |         |         |        V|
   25+ 5       4.7606      0.01  Q         |         |         |        V|
   25+10       4.7606      0.00  Q         |         |         |         V
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FLOOD HYDROGRAPH ROUTING PROGRAM
Copyright (c) CIVILCADD/CIVILDESIGN, 1989 - 2005
Study date: 05/30/23

COVINGTON - PHELAN 20
10 YEAR BASIN ROUTING
6042ROUTING
TA

Program License Serial Number 6145

********** HYDROGRAPH INFORMATION **********

From study/file name: 6042uhq10p.rte
**********HYDROGRAPH DATA**********
Number of intervals = 302
Time interval = 5.0 (Min.)
Maximum/Peak flow rate = 32.223 (CFS)
Total volume = 4.761 (Ac.Ft)
Status of hydrographs being held in storage

	Stream 1	Stream 2	Stream 3	Stream 4	Stream 5
Peak (CFS)	0.000	0.000	0.000	0.000	0.000
Vol (Ac.Ft)	0.000	0.000	0.000	0.000	0.000

****

++
Process from Point/Station 1.000 to Point/Station 2.000
**** RETARDING BASIN ROUTING ****

User entry of depth-outflow-storage data

Total number of inflow hydrograph intervals = 302
Hydrograph time unit = 5.000 (Min.)
Initial depth in storage basin = 0.00(Ft.)

Initial basin depth = 0.00 (Ft.)
Initial basin storage = 0.00 (Ac.Ft)
Initial basin outflow = 0.00 (CFS)

Depth vs. Storage and Depth vs. Discharge data:

Basin Depth (Ft.)	Storage (Ac.Ft)	Outflow (CFS)	(S-O*dt/2) (Ac.Ft)	(S+O*dt/2) (Ac.Ft)
0.000	0.000	0.000	0.000	0.000
0.500	0.094	1.970	0.087	0.101
1.000	0.221	1.970	0.214	0.228
2.000	0.540	1.970	0.533	0.547
3.000	0.902	1.970	0.895	0.909
4.000	1.285	1.970	1.278	1.292
5.000	1.674	1.970	1.667	1.681
6.000	2.056	1.970	2.049	2.063
7.000	2.418	13.930	2.370	2.466
8.000	2.737	18.890	2.672	2.802
8.500	2.864	20.890	2.792	2.936
9.000	2.958	22.690	2.880	3.036

Hydrograph Detention Basin Routing

Graph values: 'I'= unit inflow; 'O'=outflow at time shown

Time (Hours)	Inflow (CFS)	Outflow (CFS)	Storage (Ac.Ft)	.0 8.1 16.11 24.17 32.22	Depth (Ft.)
0.083	0.05	0.00	0.000	O	0.00
0.167	0.41	0.03	0.002	O	0.01
0.250	0.76	0.11	0.005	O	0.03
0.333	0.91	0.21	0.010	O	0.05
0.417	0.99	0.31	0.015	O	0.08
0.500	1.06	0.40	0.019	OI	0.10
0.583	1.10	0.49	0.024	OI	0.13
0.667	1.13	0.58	0.028	OI	0.15
0.750	1.15	0.65	0.031	OI	0.17
0.833	1.17	0.72	0.034	OI	0.18
0.917	1.19	0.78	0.037	OI	0.20
1.000	1.20	0.84	0.040	OI	0.21
1.083	1.21	0.89	0.042	OI	0.23
1.167	1.22	0.93	0.044	OI	0.24
1.250	1.22	0.97	0.046	OI	0.25
1.333	1.23	1.00	0.048	OI	0.25
1.417	1.23	1.03	0.049	|O	0.26
1.500	1.23	1.06	0.051	|O	0.27
1.583	1.24	1.08	0.052	|O	0.28
1.667	1.24	1.11	0.053	|O	0.28
1.750	1.24	1.12	0.054	|O	0.29
1.833	1.25	1.14	0.054	|O	0.29
1.917	1.25	1.16	0.055	|O	0.29
2.000	1.26	1.17	0.056	|O	0.30
2.083	1.26	1.18	0.056	|O	0.30
2.167	1.26	1.19	0.057	|O	0.30
2.250	1.27	1.20	0.057	|O	0.30
2.333	1.27	1.21	0.058	|O	0.31
2.417	1.27	1.22	0.058	|O	0.31
2.500	1.28	1.23	0.059	|O	0.31
2.583	1.28	1.23	0.059	|O	0.31
2.667	1.29	1.24	0.059	|O	0.31
2.750	1.29	1.25	0.059	|O	0.32
2.833	1.29	1.25	0.060	|O	0.32
2.917	1.30	1.26	0.060	|O	0.32
3.000	1.30	1.26	0.060	|O	0.32
3.083	1.31	1.27	0.061	|O	0.32
3.167	1.31	1.27	0.061	|O	0.32
3.250	1.31	1.28	0.061	|O	0.32
3.333	1.32	1.28	0.061	|O	0.33
3.417	1.32	1.29	0.062	|O	0.33
3.500	1.33	1.29	0.062	|O	0.33
3.583	1.33	1.30	0.062	|O	0.33
3.667	1.34	1.30	0.062	|O	0.33
3.750	1.34	1.31	0.062	|O	0.33
3.833	1.34	1.31	0.063	|O	0.33
3.917	1.35	1.32	0.063	|O	0.33
4.000	1.35	1.32	0.063	|O	0.34
4.083	1.36	1.33	0.063	|O	0.34
4.167	1.36	1.33	0.063	|O	0.34
4.250	1.37	1.34	0.064	|O	0.34
4.333	1.37	1.34	0.064	|O	0.34
4.417	1.38	1.34	0.064	|O	0.34
4.500	1.38	1.35	0.064	|O	0.34
4.583	1.39	1.35	0.065	|O	0.34
4.667	1.39	1.36	0.065	|O	0.34
4.750	1.40	1.36	0.065	|O	0.35
4.833	1.40	1.37	0.065	|O	0.35
4.917	1.41	1.37	0.066	|O	0.35
5.000	1.41	1.38	0.066	|O	0.35
5.083	1.42	1.38	0.066	|O	0.35
5.167	1.42	1.39	0.066	|O	0.35
5.250	1.43	1.39	0.066	|O	0.35
5.333	1.43	1.40	0.067	|O	0.35

5.417	1.44	1.40	0.067	|O	|	|	|	0.36
5.500	1.44	1.41	0.067	|O	|	|	|	0.36
5.583	1.45	1.41	0.067	|O	|	|	|	0.36
5.667	1.45	1.42	0.068	|O	|	|	|	0.36
5.750	1.46	1.42	0.068	|O	|	|	|	0.36
5.833	1.47	1.43	0.068	|O	|	|	|	0.36
5.917	1.47	1.43	0.068	|O	|	|	|	0.36
6.000	1.48	1.44	0.069	|O	|	|	|	0.37
6.083	1.48	1.45	0.069	|O	|	|	|	0.37
6.167	1.49	1.45	0.069	|O	|	|	|	0.37
6.250	1.50	1.46	0.069	|O	|	|	|	0.37
6.333	1.50	1.46	0.070	|O	|	|	|	0.37
6.417	1.51	1.47	0.070	|O	|	|	|	0.37
6.500	1.51	1.47	0.070	|O	|	|	|	0.37
6.583	1.52	1.48	0.071	|O	|	|	|	0.38
6.667	1.53	1.49	0.071	|O	|	|	|	0.38
6.750	1.53	1.49	0.071	|O	|	|	|	0.38
6.833	1.54	1.50	0.071	|O	|	|	|	0.38
6.917	1.55	1.50	0.072	|O	|	|	|	0.38
7.000	1.55	1.51	0.072	|O	|	|	|	0.38
7.083	1.56	1.52	0.072	|O	|	|	|	0.39
7.167	1.57	1.52	0.073	|O	|	|	|	0.39
7.250	1.58	1.53	0.073	|O	|	|	|	0.39
7.333	1.58	1.54	0.073	|O	|	|	|	0.39
7.417	1.59	1.54	0.074	|O	|	|	|	0.39
7.500	1.60	1.55	0.074	|O	|	|	|	0.39
7.583	1.61	1.56	0.074	|O	|	|	|	0.40
7.667	1.61	1.56	0.075	|O	|	|	|	0.40
7.750	1.62	1.57	0.075	|O	|	|	|	0.40
7.833	1.63	1.58	0.075	|O	|	|	|	0.40
7.917	1.64	1.59	0.076	|O	|	|	|	0.40
8.000	1.64	1.59	0.076	|O	|	|	|	0.40
8.083	1.65	1.60	0.076	|O	|	|	|	0.41
8.167	1.66	1.61	0.077	|O	|	|	|	0.41
8.250	1.67	1.62	0.077	|O	|	|	|	0.41
8.333	1.68	1.62	0.077	|O	|	|	|	0.41
8.417	1.69	1.63	0.078	|O	|	|	|	0.41
8.500	1.70	1.64	0.078	|O	|	|	|	0.42
8.583	1.71	1.65	0.079	|O	|	|	|	0.42
8.667	1.71	1.66	0.079	|O	|	|	|	0.42
8.750	1.72	1.66	0.079	|O	|	|	|	0.42
8.833	1.73	1.67	0.080	|O	|	|	|	0.42
8.917	1.74	1.68	0.080	|O	|	|	|	0.43
9.000	1.75	1.69	0.081	|O	|	|	|	0.43
9.083	1.76	1.70	0.081	|O	|	|	|	0.43
9.167	1.77	1.71	0.082	|O	|	|	|	0.43
9.250	1.78	1.72	0.082	|O	|	|	|	0.44
9.333	1.79	1.73	0.082	|O	|	|	|	0.44
9.417	1.80	1.74	0.083	|O	|	|	|	0.44
9.500	1.82	1.75	0.083	|O	|	|	|	0.44
9.583	1.83	1.76	0.084	|O	|	|	|	0.45
9.667	1.84	1.77	0.084	|O	|	|	|	0.45
9.750	1.85	1.78	0.085	|O	|	|	|	0.45
9.833	1.86	1.79	0.085	|O	|	|	|	0.45
9.917	1.87	1.80	0.086	|O	|	|	|	0.46
10.000	1.89	1.81	0.086	|O	|	|	|	0.46
10.083	1.90	1.82	0.087	|O	|	|	|	0.46
10.167	1.91	1.83	0.087	|O	|	|	|	0.47
10.250	1.92	1.84	0.088	|O	|	|	|	0.47
10.333	1.94	1.86	0.089	|O	|	|	|	0.47
10.417	1.95	1.87	0.089	|O	|	|	|	0.47
10.500	1.97	1.88	0.090	|O	|	|	|	0.48
10.583	1.98	1.89	0.090	|O	|	|	|	0.48
10.667	1.99	1.91	0.091	|O	|	|	|	0.48
10.750	2.01	1.92	0.092	|O	|	|	|	0.49
10.833	2.02	1.93	0.092	|OI	|	|	|	0.49
10.917	2.04	1.94	0.093	|OI	|	|	|	0.49
11.000	2.06	1.96	0.093	|OI	|	|	|	0.50
11.083	2.07	1.97	0.094	|OI	|	|	|	0.50
11.167	2.09	1.97	0.095	|OI	|	|	|	0.50

11.250	2.11	1.97	0.096	|OI	|	|	|	|	0.51
11.333	2.12	1.97	0.097	|OI	|	|	|	|	0.51
11.417	2.14	1.97	0.098	|OI	|	|	|	|	0.52
11.500	2.16	1.97	0.099	|OI	|	|	|	|	0.52
11.583	2.18	1.97	0.100	|OI	|	|	|	|	0.53
11.667	2.20	1.97	0.102	|OI	|	|	|	|	0.53
11.750	2.22	1.97	0.104	|OI	|	|	|	|	0.54
11.833	2.24	1.97	0.105	|OI	|	|	|	|	0.54
11.917	2.26	1.97	0.107	|OI	|	|	|	|	0.55
12.000	2.28	1.97	0.109	|OI	|	|	|	|	0.56
12.083	2.30	1.97	0.112	|OI	|	|	|	|	0.57
12.167	2.27	1.97	0.114	|OI	|	|	|	|	0.58
12.250	2.24	1.97	0.116	|OI	|	|	|	|	0.59
12.333	2.25	1.97	0.118	|OI	|	|	|	|	0.59
12.417	2.26	1.97	0.120	|OI	|	|	|	|	0.60
12.500	2.28	1.97	0.122	|OI	|	|	|	|	0.61
12.583	2.30	1.97	0.124	|OI	|	|	|	|	0.62
12.667	2.32	1.97	0.126	|OI	|	|	|	|	0.63
12.750	2.35	1.97	0.129	|OI	|	|	|	|	0.64
12.833	2.38	1.97	0.131	|OI	|	|	|	|	0.65
12.917	2.41	1.97	0.134	|OI	|	|	|	|	0.66
13.000	2.44	1.97	0.137	|OI	|	|	|	|	0.67
13.083	2.47	1.97	0.141	|OI	|	|	|	|	0.68
13.167	2.51	1.97	0.144	|OI	|	|	|	|	0.70
13.250	2.54	1.97	0.148	|OI	|	|	|	|	0.71
13.333	2.58	1.97	0.152	|OI	|	|	|	|	0.73
13.417	2.62	1.97	0.157	|OI	|	|	|	|	0.75
13.500	2.66	1.97	0.161	|OI	|	|	|	|	0.76
13.583	2.70	1.97	0.166	|OI	|	|	|	|	0.78
13.667	2.75	1.97	0.171	|OI	|	|	|	|	0.80
13.750	2.80	1.97	0.177	|OI	|	|	|	|	0.83
13.833	2.85	1.97	0.183	|OI	|	|	|	|	0.85
13.917	2.90	1.97	0.189	|OI	|	|	|	|	0.87
14.000	2.96	1.97	0.196	|OI	|	|	|	|	0.90
14.083	3.01	1.97	0.203	|OI	|	|	|	|	0.93
14.167	3.08	1.97	0.210	|O I	|	|	|	|	0.96
14.250	3.15	1.97	0.218	|O I	|	|	|	|	0.99
14.333	3.22	1.97	0.226	|O I	|	|	|	|	1.02
14.417	3.29	1.97	0.235	|O I	|	|	|	|	1.04
14.500	3.38	1.97	0.244	|O I	|	|	|	|	1.07
14.583	3.46	1.97	0.254	|O I	|	|	|	|	1.10
14.667	3.56	1.97	0.265	|O I	|	|	|	|	1.14
14.750	3.66	1.97	0.276	|O I	|	|	|	|	1.17
14.833	3.77	1.97	0.288	|O I	|	|	|	|	1.21
14.917	3.89	1.97	0.301	|O I	|	|	|	|	1.25
15.000	4.03	1.97	0.315	|O I	|	|	|	|	1.29
15.083	4.18	1.97	0.330	|O I	|	|	|	|	1.34
15.167	4.35	1.97	0.345	|O I	|	|	|	|	1.39
15.250	4.53	1.97	0.362	|O I	|	|	|	|	1.44
15.333	4.75	1.97	0.381	|O I	|	|	|	|	1.50
15.417	4.89	1.97	0.400	|O I	|	|	|	|	1.56
15.500	4.56	1.97	0.419	|O I	|	|	|	|	1.62
15.583	4.28	1.97	0.436	|O I	|	|	|	|	1.67
15.667	4.41	1.97	0.453	|O I	|	|	|	|	1.73
15.750	4.73	1.97	0.470	|O I	|	|	|	|	1.78
15.833	5.31	1.97	0.491	|O I	|	|	|	|	1.85
15.917	6.21	1.97	0.518	|O I |	|	|	|	1.93
16.000	8.15	1.97	0.553	|O I	|	|	|	2.04
16.083	14.13	1.97	0.617	|O	| I |	|	|	2.21
16.167	32.22	1.97	0.763	|O	|	|	| I	2.62
16.250	30.04	1.97	0.964	|O	|	|	| I |	3.16
16.333	16.89	1.97	1.112	|O	| I	|	|	3.55
16.417	11.77	1.97	1.197	|O	| I	|	|	3.77
16.500	9.60	1.97	1.257	|O	|I	|	|	3.93
16.583	8.18	1.97	1.304	|O	| I	|	|	4.05
16.667	7.16	1.97	1.344	|O	| I|	|	|	4.15
16.750	6.28	1.97	1.376	|O	| I |	|	|	4.23
16.833	5.57	1.97	1.404	|O	| I |	|	|	4.31
16.917	4.93	1.97	1.426	|O	| I |	|	|	4.36
17.000	4.46	1.97	1.445	|O	| I |	|	|	4.41

17.083	4.26	1.97	1.461	|O I	|	|	|	4.45
17.167	3.95	1.97	1.476	|O I	|	|	|	4.49
17.250	3.63	1.97	1.489	|O I	|	|	|	4.52
17.333	3.19	1.97	1.499	|O I	|	|	|	4.55
17.417	3.05	1.97	1.506	|O I	|	|	|	4.57
17.500	2.93	1.97	1.514	|OI	|	|	|	4.59
17.583	2.83	1.97	1.520	|OI	|	|	|	4.60
17.667	2.73	1.97	1.525	|OI	|	|	|	4.62
17.750	2.64	1.97	1.530	|OI	|	|	|	4.63
17.833	2.56	1.97	1.535	|OI	|	|	|	4.64
17.917	2.48	1.97	1.538	|OI	|	|	|	4.65
18.000	2.41	1.97	1.542	|OI	|	|	|	4.66
18.083	2.36	1.97	1.544	|OI	|	|	|	4.67
18.167	2.35	1.97	1.547	|OI	|	|	|	4.67
18.250	2.34	1.97	1.550	|OI	|	|	|	4.68
18.333	2.31	1.97	1.552	|OI	|	|	|	4.69
18.417	2.28	1.97	1.554	|OI	|	|	|	4.69
18.500	2.24	1.97	1.556	|OI	|	|	|	4.70
18.583	2.21	1.97	1.558	|OI	|	|	|	4.70
18.667	2.17	1.97	1.560	|OI	|	|	|	4.71
18.750	2.14	1.97	1.561	|OI	|	|	|	4.71
18.833	2.10	1.97	1.562	|OI	|	|	|	4.71
18.917	2.07	1.97	1.563	|OI	|	|	|	4.71
19.000	2.04	1.97	1.563	|OI	|	|	|	4.72
19.083	2.01	1.97	1.564	|O	|	|	|	4.72
19.167	1.98	1.97	1.564	|O	|	|	|	4.72
19.250	1.95	1.97	1.564	|O	|	|	|	4.72
19.333	1.93	1.97	1.564	|O	|	|	|	4.72
19.417	1.90	1.97	1.563	|O	|	|	|	4.72
19.500	1.87	1.97	1.563	|O	|	|	|	4.71
19.583	1.85	1.97	1.562	|O	|	|	|	4.71
19.667	1.83	1.97	1.561	|O	|	|	|	4.71
19.750	1.81	1.97	1.560	|O	|	|	|	4.71
19.833	1.78	1.97	1.559	|O	|	|	|	4.70
19.917	1.76	1.97	1.557	|O	|	|	|	4.70
20.000	1.74	1.97	1.556	|O	|	|	|	4.70
20.083	1.72	1.97	1.554	|O	|	|	|	4.69
20.167	1.71	1.97	1.553	|O	|	|	|	4.69
20.250	1.69	1.97	1.551	|O	|	|	|	4.68
20.333	1.67	1.97	1.549	|O	|	|	|	4.68
20.417	1.65	1.97	1.547	|O	|	|	|	4.67
20.500	1.64	1.97	1.544	|O	|	|	|	4.67
20.583	1.62	1.97	1.542	|O	|	|	|	4.66
20.667	1.61	1.97	1.539	|O	|	|	|	4.65
20.750	1.59	1.97	1.537	|O	|	|	|	4.65
20.833	1.58	1.97	1.534	|O	|	|	|	4.64
20.917	1.56	1.97	1.531	|O	|	|	|	4.63
21.000	1.55	1.97	1.529	|O	|	|	|	4.63
21.083	1.53	1.97	1.526	|O	|	|	|	4.62
21.167	1.52	1.97	1.523	|O	|	|	|	4.61
21.250	1.51	1.97	1.519	|O	|	|	|	4.60
21.333	1.50	1.97	1.516	|O	|	|	|	4.59
21.417	1.48	1.97	1.513	|O	|	|	|	4.59
21.500	1.47	1.97	1.510	|O	|	|	|	4.58
21.583	1.46	1.97	1.506	|O	|	|	|	4.57
21.667	1.45	1.97	1.503	|O	|	|	|	4.56
21.750	1.44	1.97	1.499	|O	|	|	|	4.55
21.833	1.43	1.97	1.495	|O	|	|	|	4.54
21.917	1.42	1.97	1.491	|O	|	|	|	4.53
22.000	1.41	1.97	1.488	|O	|	|	|	4.52
22.083	1.40	1.97	1.484	|O	|	|	|	4.51
22.167	1.39	1.97	1.480	|O	|	|	|	4.50
22.250	1.38	1.97	1.476	|O	|	|	|	4.49
22.333	1.37	1.97	1.471	|O	|	|	|	4.48
22.417	1.36	1.97	1.467	|O	|	|	|	4.47
22.500	1.35	1.97	1.463	|O	|	|	|	4.46
22.583	1.34	1.97	1.459	|O	|	|	|	4.45
22.667	1.33	1.97	1.454	|O	|	|	|	4.44
22.750	1.32	1.97	1.450	|O	|	|	|	4.42
22.833	1.31	1.97	1.445	|O	|	|	|	4.41

22.917	1.31	1.97	1.441	|O	|	|	|	4.40
23.000	1.30	1.97	1.436	|O	|	|	|	4.39
23.083	1.29	1.97	1.432	|O	|	|	|	4.38
23.167	1.28	1.97	1.427	|O	|	|	|	4.36
23.250	1.27	1.97	1.422	|O	|	|	|	4.35
23.333	1.27	1.97	1.417	|O	|	|	|	4.34
23.417	1.26	1.97	1.412	|O	|	|	|	4.33
23.500	1.25	1.97	1.408	|O	|	|	|	4.31
23.583	1.24	1.97	1.403	|O	|	|	|	4.30
23.667	1.24	1.97	1.398	|O	|	|	|	4.29
23.750	1.23	1.97	1.392	|O	|	|	|	4.28
23.833	1.22	1.97	1.387	|O	|	|	|	4.26
23.917	1.22	1.97	1.382	|O	|	|	|	4.25
24.000	1.21	1.97	1.377	|O	|	|	|	4.24
24.083	1.15	1.97	1.372	|O	|	|	|	4.22
24.167	0.79	1.97	1.365	IO	|	|	|	4.20
24.250	0.44	1.97	1.355	IO	|	|	|	4.18
24.333	0.29	1.97	1.344	IO	|	|	|	4.15
24.417	0.20	1.97	1.332	IO	|	|	|	4.12
24.500	0.14	1.97	1.320	IO	|	|	|	4.09
24.583	0.10	1.97	1.307	IO	|	|	|	4.06
24.667	0.07	1.97	1.294	IO	|	|	|	4.02
24.750	0.05	1.97	1.281	IO	|	|	|	3.99
24.833	0.04	1.97	1.268	IO	|	|	|	3.96
24.917	0.03	1.97	1.255	IO	|	|	|	3.92
25.000	0.02	1.97	1.241	IO	|	|	|	3.89
25.083	0.01	1.97	1.228	IO	|	|	|	3.85
25.167	0.00	1.97	1.214	IO	|	|	|	3.82
25.250	0.00	1.97	1.201	IO	|	|	|	3.78
25.333	0.00	1.97	1.187	IO	|	|	|	3.74
25.417	0.00	1.97	1.174	IO	|	|	|	3.71
25.500	0.00	1.97	1.160	IO	|	|	|	3.67
25.583	0.00	1.97	1.146	IO	|	|	|	3.64
25.667	0.00	1.97	1.133	IO	|	|	|	3.60
25.750	0.00	1.97	1.119	IO	|	|	|	3.57
25.833	0.00	1.97	1.106	IO	|	|	|	3.53
25.917	0.00	1.97	1.092	IO	|	|	|	3.50
26.000	0.00	1.97	1.079	IO	|	|	|	3.46
26.083	0.00	1.97	1.065	IO	|	|	|	3.43
26.167	0.00	1.97	1.051	IO	|	|	|	3.39
26.250	0.00	1.97	1.038	IO	|	|	|	3.35
26.333	0.00	1.97	1.024	IO	|	|	|	3.32
26.417	0.00	1.97	1.011	IO	|	|	|	3.28
26.500	0.00	1.97	0.997	IO	|	|	|	3.25
26.583	0.00	1.97	0.984	IO	|	|	|	3.21
26.667	0.00	1.97	0.970	IO	|	|	|	3.18
26.750	0.00	1.97	0.956	IO	|	|	|	3.14
26.833	0.00	1.97	0.943	IO	|	|	|	3.11
26.917	0.00	1.97	0.929	IO	|	|	|	3.07
27.000	0.00	1.97	0.916	IO	|	|	|	3.04
27.083	0.00	1.97	0.902	IO	|	|	|	3.00
27.167	0.00	1.97	0.889	IO	|	|	|	2.96
27.250	0.00	1.97	0.875	IO	|	|	|	2.93
27.333	0.00	1.97	0.861	IO	|	|	|	2.89
27.417	0.00	1.97	0.848	IO	|	|	|	2.85
27.500	0.00	1.97	0.834	IO	|	|	|	2.81
27.583	0.00	1.97	0.821	IO	|	|	|	2.78
27.667	0.00	1.97	0.807	IO	|	|	|	2.74
27.750	0.00	1.97	0.794	IO	|	|	|	2.70
27.833	0.00	1.97	0.780	IO	|	|	|	2.66
27.917	0.00	1.97	0.767	IO	|	|	|	2.63
28.000	0.00	1.97	0.753	IO	|	|	|	2.59
28.083	0.00	1.97	0.739	IO	|	|	|	2.55
28.167	0.00	1.97	0.726	IO	|	|	|	2.51
28.250	0.00	1.97	0.712	IO	|	|	|	2.48
28.333	0.00	1.97	0.699	IO	|	|	|	2.44
28.417	0.00	1.97	0.685	IO	|	|	|	2.40
28.500	0.00	1.97	0.672	IO	|	|	|	2.36
28.583	0.00	1.97	0.658	IO	|	|	|	2.33
28.667	0.00	1.97	0.644	IO	|	|	|	2.29

28.750	0.00	1.97	0.631	IO				2.25
28.833	0.00	1.97	0.617	IO				2.21
28.917	0.00	1.97	0.604	IO				2.18
29.000	0.00	1.97	0.590	IO				2.14
29.083	0.00	1.97	0.577	IO				2.10
29.167	0.00	1.97	0.563	IO				2.06
29.250	0.00	1.97	0.549	IO				2.03
29.333	0.00	1.97	0.536	IO				1.99
29.417	0.00	1.97	0.522	IO				1.94
29.500	0.00	1.97	0.509	IO				1.90
29.583	0.00	1.97	0.495	IO				1.86
29.667	0.00	1.97	0.482	IO				1.82
29.750	0.00	1.97	0.468	IO				1.77
29.833	0.00	1.97	0.454	IO				1.73
29.917	0.00	1.97	0.441	IO				1.69
30.000	0.00	1.97	0.427	IO				1.65
30.083	0.00	1.97	0.414	IO				1.60
30.167	0.00	1.97	0.400	IO				1.56
30.250	0.00	1.97	0.387	IO				1.52
30.333	0.00	1.97	0.373	IO				1.48
30.417	0.00	1.97	0.359	IO				1.43
30.500	0.00	1.97	0.346	IO				1.39
30.583	0.00	1.97	0.332	IO				1.35
30.667	0.00	1.97	0.319	IO				1.31
30.750	0.00	1.97	0.305	IO				1.26
30.833	0.00	1.97	0.292	IO				1.22
30.917	0.00	1.97	0.278	IO				1.18
31.000	0.00	1.97	0.265	IO				1.14
31.083	0.00	1.97	0.251	IO				1.09
31.167	0.00	1.97	0.237	IO				1.05
31.250	0.00	1.97	0.224	IO				1.01
31.333	0.00	1.97	0.210	IO				0.96
31.417	0.00	1.97	0.197	IO				0.90
31.500	0.00	1.97	0.183	IO				0.85
31.583	0.00	1.97	0.170	IO				0.80
31.667	0.00	1.97	0.156	IO				0.74
31.750	0.00	1.97	0.142	IO				0.69
31.833	0.00	1.97	0.129	IO				0.64
31.917	0.00	1.97	0.115	IO				0.58
32.000	0.00	1.97	0.102	IO				0.53
32.083	0.00	1.86	0.089	IO				0.47
32.167	0.00	1.61	0.077	IO				0.41
32.250	0.00	1.39	0.066	IO				0.35
32.333	0.00	1.20	0.057	IO				0.31
32.417	0.00	1.04	0.050	IO				0.26
32.500	0.00	0.90	0.043	O				0.23
32.583	0.00	0.78	0.037	O				0.20
32.667	0.00	0.67	0.032	O				0.17
32.750	0.00	0.58	0.028	O				0.15
32.833	0.00	0.51	0.024	O				0.13
32.917	0.00	0.44	0.021	O				0.11
33.000	0.00	0.38	0.018	O				0.10
33.083	0.00	0.33	0.016	O				0.08
33.167	0.00	0.28	0.014	O				0.07
33.250	0.00	0.25	0.012	O				0.06
33.333	0.00	0.21	0.010	O				0.05
33.417	0.00	0.18	0.009	O				0.05
33.500	0.00	0.16	0.008	O				0.04
33.583	0.00	0.14	0.007	O				0.03
33.667	0.00	0.12	0.006	O				0.03
33.750	0.00	0.10	0.005	O				0.03
33.833	0.00	0.09	0.004	O				0.02
33.917	0.00	0.08	0.004	O				0.02
34.000	0.00	0.07	0.003	O				0.02
34.083	0.00	0.06	0.003	O				0.01
34.167	0.00	0.05	0.002	O				0.01
34.250	0.00	0.04	0.002	O				0.01
34.333	0.00	0.04	0.002	O				0.01
34.417	0.00	0.03	0.002	O				0.01
34.500	0.00	0.03	0.001	O				0.01

34.583	0.00	0.02	0.001	O	|	|	|	0.01
34.667	0.00	0.02	0.001	O	|	|	|	0.01
34.750	0.00	0.02	0.001	O	|	|	|	0.00
34.833	0.00	0.02	0.001	O	|	|	|	0.00
34.917	0.00	0.01	0.001	O	|	|	|	0.00
35.000	0.00	0.01	0.001	O	|	|	|	0.00
35.083	0.00	0.01	0.000	O	|	|	|	0.00
35.167	0.00	0.01	0.000	O	|	|	|	0.00
35.250	0.00	0.01	0.000	O	|	|	|	0.00
35.333	0.00	0.01	0.000	O	|	|	|	0.00
35.417	0.00	0.01	0.000	O	|	|	|	0.00
35.500	0.00	0.00	0.000	O	|	|	|	0.00
35.583	0.00	0.00	0.000	O	|	|	|	0.00
35.667	0.00	0.00	0.000	O	|	|	|	0.00

**********HYDROGRAPH DATA**********

Number of intervals = 428
Time interval = 5.0 (Min.)
Maximum/Peak flow rate = 1.970 (CFS)
Total volume = 4.760 (Ac.Ft)

Status of hydrographs being held in storage

	Stream 1	Stream 2	Stream 3	Stream 4	Stream 5
Peak (CFS)	0.000	0.000	0.000	0.000	0.000
Vol (Ac.Ft)	0.000	0.000	0.000	0.000	0.000

****

Project: Covington - Phelan 20

Detention/ Infiltration System Routing Study Summary

Stage Storage Number	Storage Depth (ft)	Elevation (ft)	Area (ft^2)	Incremental volume (ft^3)	Total Volume (ft^3)	Total Volume (acre-ft)	Total CFS	Notes
1	0.0	3,569.00	20,700	0	0	0		**Bottom of Infiltration System Rock**
2	0.5	3,569.50	20,700	4,094	4,094	0.094	1.97	**96" CMP Invert**
3	1.0	3,570.00	20,700	5,530	9,624	0.221	1.97	
4	2.0	3,571.00	20,700	13,912	23,536	0.540	1.97	
5	3.0	3,572.00	20,700	15,756	39,291	0.902	1.97	
6	4.0	3,573.00	20,700	16,663	55,955	1.285	1.97	***Meets WQMP DCV**
7	5.0	3,574.00	20,700	16,944	72,899	1.674	1.97	
8	6.0	3,575.00	20,700	16,663	89,562	2.056	1.97	*invert of outlet pipe
9	7.0	3,576.00	20,700	15,756	105,318	2.418	13.94	
10	8.0	3,577.00	20,700	13,912	119,230	2.737	18.89	
11	8.5	3,577.50	20,700	5,529	124,759	2.864	20.89	**96" CMP Soffitt**
12	9.0	3,578.00	20,700	4,094	128,853	2.958	22.70	**Top of Infiltration System Rock**

96" CMP system with 6" rock top & bottom

Infiltration System Bottom Area Discharge ($Q_{out,bottom}$)		
Infiltration Rate per Geo Tech Report (in/hr)	=	11.2
Factor of Safety		2.75
Unit Conversion (ft/sec) $\frac{11\frac{in}{hr}}{2.75} \times \frac{1\ ft}{12\ in} \times \frac{1\ hr}{60\ min} \times \frac{1\ min}{60\ sec} =$		0.0000943
Infiltration System Footprint (ft^2) (From CONTECH)	=	20,700
$Q_{out,bottom}$ (cfs)	=	**1.97**

*WQMP Design Capture Volume (DCV) is 50,844 CF

Storm Drain System Net Drainage (Q_{net})	
FOR 21" OUTLET PIPE	
$Q = C \times A \times (2 \times g \times h)$^0.5	
$Q = 0.62 \times A \times (2 \times 32.2 \times (h - 3575))$^0.5	
A: Area of Outlet Pipe	
h: Water Surface Elevation	
$Q_{net} = C \times A \times (2 \times g \times h)$^.5	
C	0.62
A (ft^2)**	2.41
WSE (ft)	3,578.00
Invert of Pipe (ft)	3575
h (ft)	3.00
Q (cfs)	20.73
Q_{net} =	**20.73**

Basin Routing Summary Table	100-yr	10-yr
Existing Q (cfs) (18.20 AC)	41.5	23.4
Proposed Q (cfs) (18.20 AC)	66.3 *	37.8 *
Q (cfs) after Routing	22.7	1.97
Height (ft)	8.8	4.7
WSE (ft)	3577.8	3573.7

* Results from unit hydrographs

** A 24" SD line will be used with an orifice plate to accommodate a 21" outlet from the detention basin. A 21" diameter oulet has been used to calculate the Qnet and thus the resulting Qout in elevations 3576.00 and higher.

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Attachment C
Educational Materials

Outdoor Loading / Unloading SC-30



Objectives

- Cover
- Contain
- Educate
- Reduce/Minimize
- Product Substitution

Description

The loading/unloading of materials usually takes place outside on docks or terminals; therefore, materials spilled, leaked, or lost during loading/unloading may collect in the soil or on other surfaces and have the potential to be carried away by stormwater runoff or when the area is cleaned. Additionally, rainfall may wash pollutants from machinery used to unload or move materials. Implementation of the following protocols will prevent or reduce the discharge of pollutants to stormwater from outdoor loading/unloading of materials.

Targeted Constituents

Sediment	✓
Nutrients	✓
Trash	
Metals	✓
Bacteria	
Oil and Grease	✓
Organics	✓

Approach

Reduce potential for pollutant discharge through source control pollution prevention and BMP implementation. Successful implementation depends on effective training of employees on applicable BMPs and general pollution prevention strategies and objectives.

Pollution Prevention

- Keep accurate maintenance logs to evaluate materials removed and improvements made.
- Park tank trucks or delivery vehicles in designated areas so that spills or leaks can be contained.
- Limit exposure of material to rainfall whenever possible.
- Prevent stormwater run-on.
- Check equipment regularly for leaks.

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Suggested Protocols

Loading and Unloading – General Guidelines

- Develop an operations plan that describes procedures for loading and/or unloading.
- Conduct loading and unloading in dry weather if possible.
- Cover designated loading/unloading areas to reduce exposure of materials to rain.
- Consider placing a seal or door skirt between delivery vehicles and building to prevent exposure to rain.
- Design loading/unloading area to prevent stormwater run-on, which would include grading or berming the area, and position roof downspouts so they direct stormwater away from the loading/unloading areas.
- Have employees load and unload all materials and equipment in covered areas such as building overhangs at loading docks if feasible.
- Load/unload only at designated loading areas.
- Use drip pans underneath hose and pipe connections and other leak-prone spots during liquid transfer operations, and when making and breaking connections. Several drip pans should be stored in a covered location near the liquid transfer area so that they are always available, yet protected from precipitation when not in use. Drip pans can be made specifically for railroad tracks. Drip pans must be cleaned periodically, and drip collected materials must be disposed of properly.
- Pave loading areas with concrete instead of asphalt.
- Avoid placing storm drains in the area.
- Grade and/or berm the loading/unloading area to a drain that is connected to a deadend.

Inspection

- Check loading and unloading equipment regularly for leaks, including valves, pumps, flanges and connections.
- Look for dust or fumes during loading or unloading operations.

Training

- Train employees (e.g., fork lift operators) and contractors on proper spill containment and cleanup.
- Have employees trained in spill containment and cleanup present during loading/unloading.
- Train employees in proper handling techniques during liquid transfers to avoid spills.
- Make sure forklift operators are properly trained on loading and unloading procedures.

Spill Response and Prevention

- Keep your Spill Prevention Control and Countermeasure (SPCC) Plan up-to-date.
- Contain leaks during transfer.
- Store and maintain appropriate spill cleanup materials in a location that is readily accessible and known to all and ensure that employees are familiar with the site's spill control plan and proper spill cleanup procedures.
- Have an emergency spill cleanup plan readily available.
- Use drip pans or comparable devices when transferring oils, solvents, and paints.

Other Considerations (Limitations and Regulations)

- Space and time limitations may preclude all transfers from being performed indoors or under cover.
- It may not be possible to conduct transfers only during dry weather.

Requirements

Costs

Costs should be low except when covering a large loading/unloading area.

Maintenance

- Conduct regular inspections and make repairs as necessary. The frequency of repairs will depend on the age of the facility.
- Check loading and unloading equipment regularly for leaks.
- Conduct regular broom dry-sweeping of area.

Supplemental Information

Further Detail of the BMP

Special Circumstances for Indoor Loading/Unloading of Materials

Loading or unloading of liquids should occur in the manufacturing building so that any spills that are not completely retained can be discharged to the sanitary sewer, treatment plant, or treated in a manner consistent with local sewer authorities and permit requirements.

- For loading and unloading tank trucks to above and below ground storage tanks, the following procedures should be used:
  - The area where the transfer takes place should be paved. If the liquid is reactive with the asphalt, Portland cement should be used to pave the area.
  - The transfer area should be designed to prevent run-on of stormwater from adjacent areas. Sloping the pad and using a curb, like a speed bump, around the uphill side of the transfer area should reduce run-on.

- The transfer area should be designed to prevent runoff of spilled liquids from the area. Sloping the area to a drain should prevent runoff. The drain should be connected to a dead-end sump or to the sanitary sewer. A positive control valve should be installed on the drain.

- For transfer from rail cars to storage tanks that must occur outside, use the following procedures:

  - Drip pans should be placed at locations where spillage may occur, such as hose connections, hose reels, and filler nozzles. Use drip pans when making and breaking connections.

  - Drip pan systems should be installed between the rails to collect spillage from tank cars.

References and Resources

California's Nonpoint Source Program Plan http://www.swrcb.ca.gov/nps/index.html

Clark County Storm Water Pollution Control Manual
http://www.co.clark.wa.us/pubworks/bmpman.pdf

King County Storm Water Pollution Control Manual http://dnr.metrokc.gov/wlr/dss/spcm.htm

Santa Clara Valley Urban Runoff Pollution Prevention Program http://www.scvurppp.org

The Storm Water Managers Resource Center http://www.stormwatercenter.net/

Building & Grounds Maintenance SC-41



Objectives

- Cover
- Contain
- Educate
- Reduce/Minimize
- Product Substitution

Targeted Constituents

Sediment	✓
Nutrients	✓
Trash	
Metals	✓
Bacteria	✓
Oil and Grease	
Organics	

Description

Stormwater runoff from building and grounds maintenance activities can be contaminated with toxic hydrocarbons in solvents, fertilizers and pesticides, suspended solids, heavy metals, abnormal pH, and oils and greases. Utilizing the protocols in this fact sheet will prevent or reduce the discharge of pollutants to stormwater from building and grounds maintenance activities by washing and cleaning up with as little water as possible, following good landscape management practices, preventing and cleaning up spills immediately, keeping debris from entering the storm drains, and maintaining the stormwater collection system.

Approach

Reduce potential for pollutant discharge through source control pollution prevention and BMP implementation. Successful implementation depends on effective training of employees on applicable BMPs and general pollution prevention strategies and objectives.

Pollution Prevention

- Switch to non-toxic chemicals for maintenance when possible.
- Choose cleaning agents that can be recycled.
- Encourage proper lawn management and landscaping, including use of native vegetation.

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- Encourage use of Integrated Pest Management techniques for pest control.
- Encourage proper onsite recycling of yard trimmings.
- Recycle residual paints, solvents, lumber, and other material as much as possible.

Suggested Protocols

Pressure Washing of Buildings, Rooftops, and Other Large Objects

- In situations where soaps or detergents are used and the surrounding area is paved, pressure washers must use a water collection device that enables collection of wash water and associated solids. A sump pump, wet vacuum or similarly effective device must be used to collect the runoff and loose materials. The collected runoff and solids must be disposed of properly.
- If soaps or detergents are not used, and the surrounding area is paved, wash runoff does not have to be collected but must be screened. Pressure washers must use filter fabric or some other type of screen on the ground and/or in the catch basin to trap the particles in wash water runoff.
- If you are pressure washing on a grassed area (with or without soap), runoff must be dispersed as sheet flow as much as possible, rather than as a concentrated stream. The wash runoff must remain on the grass and not drain to pavement.

Landscaping Activities

- Dispose of grass clippings, leaves, sticks, or other collected vegetation as garbage, or by composting. Do not dispose of collected vegetation into waterways or storm drainage systems.
- Use mulch or other erosion control measures on exposed soils.

Building Repair, Remodeling, and Construction

- Do not dump any toxic substance or liquid waste on the pavement, the ground, or toward a storm drain.
- Use ground or drop cloths underneath outdoor painting, scraping, and sandblasting work, and properly dispose of collected material daily.
- Use a ground cloth or oversized tub for activities such as paint mixing and tool cleaning.
- Clean paintbrushes and tools covered with water-based paints in sinks connected to sanitary sewers or in portable containers that can be dumped into a sanitary sewer drain. Brushes and tools covered with non-water-based paints, finishes, or other materials must be cleaned in a manner that enables collection of used solvents (e.g., paint thinner, turpentine, etc.) for recycling or proper disposal.
- Use a storm drain cover, filter fabric, or similarly effective runoff control mechanism if dust, grit, wash water, or other pollutants may escape the work area and enter a catch basin. This is particularly necessary on rainy days. The containment device(s) must be in place at the beginning of the work day, and accumulated dirty runoff and solids must be collected and disposed of before removing the containment device(s) at the end of the work day.

- If you need to de-water an excavation site, you may need to filter the water before discharging to a catch basin or off-site. If directed off-site, you should direct the water through hay bales and filter fabric or use other sediment filters or traps.
- Store toxic material under cover during precipitation events and when not in use. A cover would include tarps or other temporary cover material.

Mowing, Trimming, and Planting

- Dispose of leaves, sticks, or other collected vegetation as garbage, by composting or at a permitted landfill. Do not dispose of collected vegetation into waterways or storm drainage systems.
- Use mulch or other erosion control measures when soils are exposed.
- Place temporarily stockpiled material away from watercourses and drain inlets, and berm or cover stockpiles to prevent material releases to the storm drain system.
- Consider an alternative approach when bailing out muddy water: do not put it in the storm drain; pour over landscaped areas.
- Use hand weeding where practical.

Fertilizer and Pesticide Management

- Follow all federal, state, and local laws and regulations governing the use, storage, and disposal of fertilizers and pesticides and training of applicators and pest control advisors.
- Use less toxic pesticides that will do the job when applicable. Avoid use of copper-based pesticides if possible.
- Do not use pesticides if rain is expected.
- Do not mix or prepare pesticides for application near storm drains.
- Use the minimum amount needed for the job.
- Calibrate fertilizer distributors to avoid excessive application.
- Employ techniques to minimize off-target application (e.g., spray drift) of pesticides, including consideration of alternative application techniques.
- Apply pesticides only when wind speeds are low.
- Fertilizers should be worked into the soil rather than dumped or broadcast onto the surface.
- Irrigate slowly to prevent runoff and then only as much as is needed.
- Clean pavement and sidewalk if fertilizer is spilled on these surfaces before applying irrigation water.
- Dispose of empty pesticide containers according to the instructions on the container label.

- Use up the pesticides. Rinse containers, and use rinse water as product. Dispose of unused pesticide as hazardous waste.
- Implement storage requirements for pesticide products with guidance from the local fire department and County Agricultural Commissioner. Provide secondary containment for pesticides.

Inspection

- Inspect irrigation system periodically to ensure that the right amount of water is being applied and that excessive runoff is not occurring. Minimize excess watering and repair leaks in the irrigation system as soon as they are observed.

Training

- Educate and train employees on pesticide use and in pesticide application techniques to prevent pollution.
- Train employees and contractors in proper techniques for spill containment and cleanup.
- Be sure the frequency of training takes into account the complexity of the operations and the nature of the staff.

Spill Response and Prevention

- Keep your Spill Prevention Control and Countermeasure (SPCC) Plan up-to-date.
- Place a stockpile of spill cleanup materials, such as brooms, dustpans, and vacuum sweepers (if desired) near the storage area where it will be readily accessible.
- Have employees trained in spill containment and cleanup present during the loading/unloading of dangerous wastes, liquid chemicals, or other materials.
- Familiarize employees with the Spill Prevention Control and Countermeasure Plan.
- Clean up spills immediately.

Other Considerations

Alternative pest/weed controls may not be available, suitable, or effective in many cases.

Requirements

Costs

- Cost will vary depending on the type and size of facility.
- Overall costs should be low in comparison to other BMPs.

Maintenance

Sweep paved areas regularly to collect loose particles. Wipe up spills with rags and other absorbent material immediately, do not hose down the area to a storm drain.

Supplemental Information

Further Detail of the BMP

Fire Sprinkler Line Flushing

Building fire sprinkler line flushing may be a source of non-stormwater runoff pollution. The water entering the system is usually potable water, though in some areas it may be non-potable reclaimed wastewater. There are subsequent factors that may drastically reduce the quality of the water in such systems. Black iron pipe is usually used since it is cheaper than potable piping, but it is subject to rusting and results in lower quality water. Initially, the black iron pipe has an oil coating to protect it from rusting between manufacture and installation; this will contaminate the water from the first flush but not from subsequent flushes. Nitrates, poly-phosphates and other corrosion inhibitors, as well as fire suppressants and antifreeze may be added to the sprinkler water system. Water generally remains in the sprinkler system a long time (typically a year) and between flushes may accumulate iron, manganese, lead, copper, nickel, and zinc. The water generally becomes anoxic and contains living and dead bacteria and breakdown products from chlorination. This may result in a significant BOD problem and the water often smells. Consequently dispose fire sprinkler line flush water into the sanitary sewer. Do not allow discharge to storm drain or infiltration due to potential high levels of pollutants in fire sprinkler line water.

References and Resources

California's Nonpoint Source Program Plan http://www.swrcb.ca.gov/nps/index.html

Clark County Storm Water Pollution Control Manual
http://www.co.clark.wa.us/pubworks/bmpman.pdf

King County Storm Water Pollution Control Manual http://dnr.metrokc.gov/wlr/dss/spcm.htm

Mobile Cleaners Pilot Program: Final Report. 1997. Bay Area Stormwater Management Agencies Association (BASMAA). http://www.basmaa.org/

Pollution from Surface Cleaning Folder. 1996. Bay Area Stormwater Management Agencies Association (BASMAA). http://www.basmaa.org/

Santa Clara Valley Urban Runoff Pollution Prevention Program http://www.scvurppp.org

The Storm Water Managers Resource Center http://www.stormwatercenter.net/

Site Design & Landscape Planning SD-10



Design Objectives

- ☑ Maximize Infiltration
- ☑ Provide Retention
- ☑ Slow Runoff
- ☑ Minimize Impervious Land Coverage
- Prohibit Dumping of Improper Materials
- Contain Pollutants
- Collect and Convey

Description

Each project site possesses unique topographic, hydrologic, and vegetative features, some of which are more suitable for development than others. Integrating and incorporating appropriate landscape planning methodologies into the project design is the most effective action that can be done to minimize surface and groundwater contamination from stormwater.

Approach

Landscape planning should couple consideration of land suitability for urban uses with consideration of community goals and projected growth. Project plan designs should conserve natural areas to the extent possible, maximize natural water storage and infiltration opportunities, and protect slopes and channels.

Suitable Applications

Appropriate applications include residential, commercial and industrial areas planned for development or redevelopment.

Design Considerations

Design requirements for site design and landscapes planning should conform to applicable standards and specifications of agencies with jurisdiction and be consistent with applicable General Plan and Local Area Plan policies.

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Designing New Installations

Begin the development of a plan for the landscape unit with attention to the following general principles:

- Formulate the plan on the basis of clearly articulated community goals. Carefully identify conflicts and choices between retaining and protecting desired resources and community growth.
- Map and assess land suitability for urban uses. Include the following landscape features in the assessment: wooded land, open unwooded land, steep slopes, erosion-prone soils, foundation suitability, soil suitability for waste disposal, aquifers, aquifer recharge areas, wetlands, floodplains, surface waters, agricultural lands, and various categories of urban land use. When appropriate, the assessment can highlight outstanding local or regional resources that the community determines should be protected (e.g., a scenic area, recreational area, threatened species habitat, farmland, fish run). Mapping and assessment should recognize not only these resources but also additional areas needed for their sustenance.

Project plan designs should conserve natural areas to the extent possible, maximize natural water storage and infiltration opportunities, and protect slopes and channels.

Conserve Natural Areas during Landscape Planning

If applicable, the following items are required and must be implemented in the site layout during the subdivision design and approval process, consistent with applicable General Plan and Local Area Plan policies:

- Cluster development on least-sensitive portions of a site while leaving the remaining land in a natural undisturbed condition.
- Limit clearing and grading of native vegetation at a site to the minimum amount needed to build lots, allow access, and provide fire protection.
- Maximize trees and other vegetation at each site by planting additional vegetation, clustering tree areas, and promoting the use of native and/or drought tolerant plants.
- Promote natural vegetation by using parking lot islands and other landscaped areas.
- Preserve riparian areas and wetlands.

Maximize Natural Water Storage and Infiltration Opportunities Within the Landscape Unit

- Promote the conservation of forest cover. Building on land that is already deforested affects basin hydrology to a lesser extent than converting forested land. Loss of forest cover reduces interception storage, detention in the organic forest floor layer, and water losses by evapotranspiration, resulting in large peak runoff increases and either their negative effects or the expense of countering them with structural solutions.
- Maintain natural storage reservoirs and drainage corridors, including depressions, areas of permeable soils, swales, and intermittent streams. Develop and implement policies and

regulations to discourage the clearing, filling, and channelization of these features. Utilize them in drainage networks in preference to pipes, culverts, and engineered ditches.

- Evaluating infiltration opportunities by referring to the stormwater management manual for the jurisdiction and pay particular attention to the selection criteria for avoiding groundwater contamination, poor soils, and hydrogeological conditions that cause these facilities to fail. If necessary, locate developments with large amounts of impervious surfaces or a potential to produce relatively contaminated runoff away from groundwater recharge areas.

Protection of Slopes and Channels during Landscape Design

- Convey runoff safely from the tops of slopes.
- Avoid disturbing steep or unstable slopes.
- Avoid disturbing natural channels.
- Stabilize disturbed slopes as quickly as possible.
- Vegetate slopes with native or drought tolerant vegetation.
- Control and treat flows in landscaping and/or other controls prior to reaching existing natural drainage systems.
- Stabilize temporary and permanent channel crossings as quickly as possible, and ensure that increases in run-off velocity and frequency caused by the project do not erode the channel.
- Install energy dissipaters, such as riprap, at the outlets of new storm drains, culverts, conduits, or channels that enter unlined channels in accordance with applicable specifications to minimize erosion. Energy dissipaters shall be installed in such a way as to minimize impacts to receiving waters.
- Line on-site conveyance channels where appropriate, to reduce erosion caused by increased flow velocity due to increases in tributary impervious area. The first choice for linings should be grass or some other vegetative surface, since these materials not only reduce runoff velocities, but also provide water quality benefits from filtration and infiltration. If velocities in the channel are high enough to erode grass or other vegetative linings, riprap, concrete, soil cement, or geo-grid stabilization are other alternatives.
- Consider other design principles that are comparable and equally effective.

Redeveloping Existing Installations

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. The definition of " redevelopment" must be consulted to determine whether or not the requirements for new development apply to areas intended for redevelopment. If the definition applies, the steps outlined under "designing new installations" above should be followed.

Redevelopment may present significant opportunity to add features which had not previously been implemented. Examples include incorporation of depressions, areas of permeable soils, and swales in newly redeveloped areas. While some site constraints may exist due to the status of already existing infrastructure, opportunities should not be missed to maximize infiltration, slow runoff, reduce impervious areas, disconnect directly connected impervious areas.

Other Resources

A Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP), Los Angeles County Department of Public Works, May 2002.

Stormwater Management Manual for Western Washington, Washington State Department of Ecology, August 2001.

Model Standard Urban Storm Water Mitigation Plan (SUSMP) for San Diego County, Port of San Diego, and Cities in San Diego County, February 14, 2002.

Model Water Quality Management Plan (WQMP) for County of Orange, Orange County Flood Control District, and the Incorporated Cities of Orange County, Draft February 2003.

Ventura Countywide Technical Guidance Manual for Stormwater Quality Control Measures, July 2002.

Roof Runoff Controls SD-11



Rain Garden

Design Objectives

- ☑ Maximize Infiltration
- ☑ Provide Retention
- ☑ Slow Runoff
- Minimize Impervious Land Coverage
- Prohibit Dumping of Improper Materials
- ☑ Contain Pollutants
- Collect and Convey

Description

Various roof runoff controls are available to address stormwater that drains off rooftops. The objective is to reduce the total volume and rate of runoff from individual lots, and retain the pollutants on site that may be picked up from roofing materials and atmospheric deposition. Roof runoff controls consist of directing the roof runoff away from paved areas and mitigating flow to the storm drain system through one of several general approaches: cisterns or rain barrels; dry wells or infiltration trenches; pop-up emitters, and foundation planting. The first three approaches require the roof runoff to be contained in a gutter and downspout system. Foundation planting provides a vegetated strip under the drip line of the roof.

Approach

Design of individual lots for single-family homes as well as lots for higher density residential and commercial structures should consider site design provisions for containing and infiltrating roof runoff or directing roof runoff to vegetative swales or buffer areas. Retained water can be reused for watering gardens, lawns, and trees. Benefits to the environment include reduced demand for potable water used for irrigation, improved stormwater quality, increased groundwater recharge, decreased runoff volume and peak flows, and decreased flooding potential.

Suitable Applications

Appropriate applications include residential, commercial and industrial areas planned for development or redevelopment.

Design Considerations

Designing New Installations

Cisterns or Rain Barrels

One method of addressing roof runoff is to direct roof downspouts to cisterns or rain barrels. A cistern is an above ground storage vessel with either a manually operated valve or a permanently open outlet. Roof runoff is temporarily stored and then released for irrigation or infiltration between storms. The number of rain

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barrels needed is a function of the rooftop area. Some low impact developers recommend that every house have at least 2 rain barrels, with a minimum storage capacity of 1000 liters. Roof barrels serve several purposes including mitigating the first flush from the roof which has a high volume, amount of contaminants, and thermal load. Several types of rain barrels are commercially available. Consideration must be given to selecting rain barrels that are vector proof and childproof. In addition, some barrels are designed with a bypass valve that filters out grit and other contaminants and routes overflow to a soak-away pit or rain garden.

If the cistern has an operable valve, the valve can be closed to store stormwater for irrigation or infiltration between storms. This system requires continual monitoring by the resident or grounds crews, but provides greater flexibility in water storage and metering. If a cistern is provided with an operable valve and water is stored inside for long periods, the cistern must be covered to prevent mosquitoes from breeding.

A cistern system with a permanently open outlet can also provide for metering stormwater runoff. If the cistern outlet is significantly smaller than the size of the downspout inlet (say ¼ to ½ inch diameter), runoff will build up inside the cistern during storms, and will empty out slowly after peak intensities subside. This is a feasible way to mitigate the peak flow increases caused by rooftop impervious land coverage, especially for the frequent, small storms.

Dry wells and Infiltration Trenches

Roof downspouts can be directed to dry wells or infiltration trenches. A dry well is constructed by excavating a hole in the ground and filling it with an open graded aggregate, and allowing the water to fill the dry well and infiltrate after the storm event. An underground connection from the downspout conveys water into the dry well, allowing it to be stored in the voids. To minimize sedimentation from lateral soil movement, the sides and top of the stone storage matrix can be wrapped in a permeable filter fabric, though the bottom may remain open. A perforated observation pipe can be inserted vertically into the dry well to allow for inspection and maintenance.

In practice, dry wells receiving runoff from single roof downspouts have been successful over long periods because they contain very little sediment. They must be sized according to the amount of rooftop runoff received, but are typically 4 to 5 feet square, and 2 to 3 feet deep, with a minimum of 1-foot soil cover over the top (maximum depth of 10 feet).

To protect the foundation, dry wells must be set away from the building at least 10 feet. They must be installed in solids that accommodate infiltration. In poorly drained soils, dry wells have very limited feasibility.

Infiltration trenches function in a similar manner and would be particularly effective for larger roof areas. An infiltration trench is a long, narrow, rock-filled trench with no outlet that receives stormwater runoff. These are described under Treatment Controls.

Pop-up Drainage Emitter

Roof downspouts can be directed to an underground pipe that daylights some distance from the building foundation, releasing the roof runoff through a pop-up emitter. Similar to a pop-up irrigation head, the emitter only opens when there is flow from the roof. The emitter remains flush to the ground during dry periods, for ease of lawn or landscape maintenance.

Foundation Planting

Landscape planting can be provided around the base to allow increased opportunities for stormwater infiltration and protect the soil from erosion caused by concentrated sheet flow coming off the roof. Foundation plantings can reduce the physical impact of water on the soil and provide a subsurface matrix of roots that encourage infiltration. These plantings must be sturdy enough to tolerate the heavy runoff sheet flows, and periodic soil saturation.

Redeveloping Existing Installations

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. The definition of " redevelopment" must be consulted to determine whether or not the requirements for new development apply to areas intended for redevelopment. If the definition applies, the steps outlined under "designing new installations" above should be followed.

Supplemental Information

Examples

- City of Ottawa's Water Links Surface –Water Quality Protection Program
- City of Toronto Downspout Disconnection Program
- City of Boston, MA, Rain Barrel Demonstration Program

Other Resources

Hager, Marty Catherine, Stormwater, "Low-Impact Development", January/February 2003. www.stormh2o.com

Low Impact Urban Design Tools, Low Impact Development Design Center, Beltsville, MD. www.lid-stormwater.net

Start at the Source, Bay Area Stormwater Management Agencies Association, 1999 Edition

Efficient Irrigation SD-12



Design Objectives

- ☑ Maximize Infiltration
- ☑ Provide Retention
- ☑ Slow Runoff
- Minimize Impervious Land Coverage
- Prohibit Dumping of Improper Materials
- Contain Pollutants
- Collect and Convey

Description

Irrigation water provided to landscaped areas may result in excess irrigation water being conveyed into stormwater drainage systems.

Approach

Project plan designs for development and redevelopment should include application methods of irrigation water that minimize runoff of excess irrigation water into the stormwater conveyance system.

Suitable Applications

Appropriate applications include residential, commercial and industrial areas planned for development or redevelopment. (Detached residential single-family homes are typically excluded from this requirement.)

Design Considerations

Designing New Installations

The following methods to reduce excessive irrigation runoff should be considered, and incorporated and implemented where determined applicable and feasible by the Permittee:

- Employ rain-triggered shutoff devices to prevent irrigation after precipitation.
- Design irrigation systems to each landscape area's specific water requirements.
- Include design featuring flow reducers or shutoff valves triggered by a pressure drop to control water loss in the event of broken sprinkler heads or lines.
- Implement landscape plans consistent with County or City water conservation resolutions, which may include provision of water sensors, programmable irrigation times (for short cycles), etc.

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- Design timing and application methods of irrigation water to minimize the runoff of excess irrigation water into the storm water drainage system.
- Group plants with similar water requirements in order to reduce excess irrigation runoff and promote surface filtration. Choose plants with low irrigation requirements (for example, native or drought tolerant species). Consider design features such as:
  - Using mulches (such as wood chips or bar) in planter areas without ground cover to minimize sediment in runoff
  - Installing appropriate plant materials for the location, in accordance with amount of sunlight and climate, and use native plant materials where possible and/or as recommended by the landscape architect
  - Leaving a vegetative barrier along the property boundary and interior watercourses, to act as a pollutant filter, where appropriate and feasible
  - Choosing plants that minimize or eliminate the use of fertilizer or pesticides to sustain growth
- Employ other comparable, equally effective methods to reduce irrigation water runoff.

Redeveloping Existing Installations

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. The definition of " redevelopment" must be consulted to determine whether or not the requirements for new development apply to areas intended for redevelopment. If the definition applies, the steps outlined under "designing new installations" above should be followed.

Other Resources

A Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP), Los Angeles County Department of Public Works, May 2002.

Model Standard Urban Storm Water Mitigation Plan (SUSMP) for San Diego County, Port of San Diego, and Cities in San Diego County, February 14, 2002.

Model Water Quality Management Plan (WQMP) for County of Orange, Orange County Flood Control District, and the Incorporated Cities of Orange County, Draft February 2003.

Ventura Countywide Technical Guidance Manual for Stormwater Quality Control Measures, July 2002.

Storm Drain Signage SD-13



Design Objectives

- Maximize Infiltration
- Provide Retention
- Slow Runoff
- Minimize Impervious Land Coverage
- ☑ Prohibit Dumping of Improper Materials
- Contain Pollutants
- Collect and Convey

Description

Waste materials dumped into storm drain inlets can have severe impacts on receiving and ground waters. Posting notices regarding discharge prohibitions at storm drain inlets can prevent waste dumping. Storm drain signs and stencils are highly visible source controls that are typically placed directly adjacent to storm drain inlets.

Approach

The stencil or affixed sign contains a brief statement that prohibits dumping of improper materials into the urban runoff conveyance system. Storm drain messages have become a popular method of alerting the public about the effects of and the prohibitions against waste disposal.

Suitable Applications

Stencils and signs alert the public to the destination of pollutants discharged to the storm drain. Signs are appropriate in residential, commercial, and industrial areas, as well as any other area where contributions or dumping to storm drains is likely.

Design Considerations

Storm drain message markers or placards are recommended at all storm drain inlets within the boundary of a development project. The marker should be placed in clear sight facing toward anyone approaching the inlet from either side. All storm drain inlet locations should be identified on the development site map.

Designing New Installations

The following methods should be considered for inclusion in the project design and show on project plans:

- Provide stenciling or labeling of all storm drain inlets and catch basins, constructed or modified, within the project area with prohibitive language. Examples include "NO DUMPING

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– DRAINS TO OCEAN" and/or other graphical icons to discourage illegal dumping.

- Post signs with prohibitive language and/or graphical icons, which prohibit illegal dumping at public access points along channels and creeks within the project area.

Note - Some local agencies have approved specific signage and/or storm drain message placards for use. Consult local agency stormwater staff to determine specific requirements for placard types and methods of application.

Redeveloping Existing Installations

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. If the project meets the definition of "redevelopment", then the requirements stated under " designing new installations" above should be included in all project design plans.

Additional Information

Maintenance Considerations

- Legibility of markers and signs should be maintained. If required by the agency with jurisdiction over the project, the owner/operator or homeowner's association should enter into a maintenance agreement with the agency or record a deed restriction upon the property title to maintain the legibility of placards or signs.

Placement

- Signage on top of curbs tends to weather and fade.
- Signage on face of curbs tends to be worn by contact with vehicle tires and sweeper brooms.

Supplemental Information

Examples

- Most MS4 programs have storm drain signage programs. Some MS4 programs will provide stencils, or arrange for volunteers to stencil storm drains as part of their outreach program.

Other Resources

A Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP), Los Angeles County Department of Public Works, May 2002.

Model Standard Urban Storm Water Mitigation Plan (SUSMP) for San Diego County, Port of San Diego, and Cities in San Diego County, February 14, 2002.

Model Water Quality Management Plan (WQMP) for County of Orange, Orange County Flood Control District, and the Incorporated Cities of Orange County, Draft February 2003.

Ventura Countywide Technical Guidance Manual for Stormwater Quality Control Measures, July 2002.

Maintenance Bays & Docks SD-31



Design Objectives

- Maximize Infiltration
- Provide Retention
- Slow Runoff
- Minimize Impervious Land Coverage
- ☑ Prohibit Dumping of Improper Materials
- ☑ Contain Pollutants
- Collect and Convey

Description

Several measures can be taken to prevent operations at maintenance bays and loading docks from contributing a variety of toxic compounds, oil and grease, heavy metals, nutrients, suspended solids, and other pollutants to the stormwater conveyance system.

Approach

In designs for maintenance bays and loading docks, containment is encouraged. Preventative measures include overflow containment structures and dead-end sumps. However, in the case of loading docks from grocery stores and warehouse/distribution centers, engineered infiltration systems may be considered.

Suitable Applications

Appropriate applications include commercial and industrial areas planned for development or redevelopment.

Design Considerations

Design requirements for vehicle maintenance and repair are governed by Building and Fire Codes, and by current local agency ordinances, and zoning requirements. The design criteria described in this fact sheet are meant to enhance and be consistent with these code requirements.

Designing New Installations

Designs of maintenance bays should consider the following:

- Repair/maintenance bays and vehicle parts with fluids should be indoors; or designed to preclude urban run-on and runoff.
- Repair/maintenance floor areas should be paved with Portland cement concrete (or equivalent smooth impervious surface).

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- Repair/maintenance bays should be designed to capture all wash water leaks and spills. Provide impermeable berms, drop inlets, trench catch basins, or overflow containment structures around repair bays to prevent spilled materials and wash-down waters form entering the storm drain system. Connect drains to a sump for collection and disposal. Direct connection of the repair/maintenance bays to the storm drain system is prohibited. If required by local jurisdiction, obtain an Industrial Waste Discharge Permit.
- Other features may be comparable and equally effective.

The following designs of loading/unloading dock areas should be considered:

- Loading dock areas should be covered, or drainage should be designed to preclude urban run-on and runoff.
- Direct connections into storm drains from depressed loading docks (truck wells) are prohibited.
- Below-grade loading docks from grocery stores and warehouse/distribution centers of fresh food items should drain through water quality inlets, or to an engineered infiltration system, or an equally effective alternative. Pre-treatment may also be required.
- Other features may be comparable and equally effective.

Redeveloping Existing Installations

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. The definition of " redevelopment" must be consulted to determine whether or not the requirements for new development apply to areas intended for redevelopment. If the definition applies, the steps outlined under "designing new installations" above should be followed.

Additional Information

Stormwater and non-stormwater will accumulate in containment areas and sumps with impervious surfaces. Contaminated accumulated water must be disposed of in accordance with applicable laws and cannot be discharged directly to the storm drain or sanitary sewer system without the appropriate permit.

Other Resources

A Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP), Los Angeles County Department of Public Works, May 2002.

Model Standard Urban Storm Water Mitigation Plan (SUSMP) for San Diego County, Port of San Diego, and Cities in San Diego County, February 14, 2002.

Model Water Quality Management Plan (WQMP) for County of Orange, Orange County Flood Control District, and the Incorporated Cities of Orange County, Draft February 2003.

Ventura Countywide Technical Guidance Manual for Stormwater Quality Control Measures, July 2002.

Trash Storage Areas SD-32

Description

Trash storage areas are areas where a trash receptacle (s) are located for use as a repository for solid wastes. Stormwater runoff from areas where trash is stored or disposed of can be polluted. In addition, loose trash and debris can be easily transported by water or wind into nearby storm drain inlets, channels, and/or creeks. Waste handling operations that may be sources of stormwater pollution include dumpsters, litter control, and waste piles.

Approach

This fact sheet contains details on the specific measures required to prevent or reduce pollutants in stormwater runoff associated with trash storage and handling. Preventative measures including enclosures, containment structures, and impervious pavements to mitigate spills, should be used to reduce the likelihood of contamination.

Design Objectives

- Maximize Infiltration
- Provide Retention
- Slow Runoff
- Minimize Impervious Land Coverage
- Prohibit Dumping of Improper Materials
- ☑ Contain Pollutants
- Collect and Convey

Suitable Applications

Appropriate applications include residential, commercial and industrial areas planned for development or redevelopment. (Detached residential single-family homes are typically excluded from this requirement.)

Design Considerations

Design requirements for waste handling areas are governed by Building and Fire Codes, and by current local agency ordinances and zoning requirements. The design criteria described in this fact sheet are meant to enhance and be consistent with these code and ordinance requirements. Hazardous waste should be handled in accordance with legal requirements established in Title 22, California Code of Regulation.

Wastes from commercial and industrial sites are typically hauled by either public or commercial carriers that may have design or access requirements for waste storage areas. The design criteria in this fact sheet are recommendations and are not intended to be in conflict with requirements established by the waste hauler. The waste hauler should be contacted prior to the design of your site trash collection areas. Conflicts or issues should be discussed with the local agency.

Designing New Installations

Trash storage areas should be designed to consider the following structural or treatment control BMPs:

- Design trash container areas so that drainage from adjoining roofs and pavement is diverted around the area(s) to avoid run-on. This might include berming or grading the waste handling area to prevent run-on of stormwater.
- Make sure trash container areas are screened or walled to prevent off-site transport of trash.

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- Use lined bins or dumpsters to reduce leaking of liquid waste.
- Provide roofs, awnings, or attached lids on all trash containers to minimize direct precipitation and prevent rainfall from entering containers.
- Pave trash storage areas with an impervious surface to mitigate spills.
- Do not locate storm drains in immediate vicinity of the trash storage area.
- Post signs on all dumpsters informing users that hazardous materials are not to be disposed of therein.

Redeveloping Existing Installations

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. The definition of " redevelopment" must be consulted to determine whether or not the requirements for new development apply to areas intended for redevelopment. If the definition applies, the steps outlined under "designing new installations" above should be followed.

Additional Information

Maintenance Considerations

The integrity of structural elements that are subject to damage (i.e., screens, covers, and signs) must be maintained by the owner/operator. Maintenance agreements between the local agency and the owner/operator may be required. Some agencies will require maintenance deed restrictions to be recorded of the property title. If required by the local agency, maintenance agreements or deed restrictions must be executed by the owner/operator before improvement plans are approved.

Other Resources

A Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP), Los Angeles County Department of Public Works, May 2002.

Model Standard Urban Storm Water Mitigation Plan (SUSMP) for San Diego County, Port of San Diego, and Cities in San Diego County, February 14, 2002.

Model Water Quality Management Plan (WQMP) for County of Orange, Orange County Flood Control District, and the Incorporated Cities of Orange County, Draft February 2003.

Ventura Countywide Technical Guidance Manual for Stormwater Quality Control Measures, July 2002.

Street Sweeping and Vacuuming SE-7



Categories		
EC	Erosion Control	
SE	Sediment Control	☒
TC	Tracking Control	☑
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:
☑ **Primary Objective**
☒ **Secondary Objective**

Targeted Constituents	
Sediment	☑
Nutrients	
Trash	☑
Metals	
Bacteria	
Oil and Grease	☑
Organics	

Potential Alternatives

None

Description and Purpose

Street sweeping and vacuuming includes use of self-propelled and walk-behind equipment to remove sediment from streets and roadways, and to clean paved surfaces in preparation for final paving. Sweeping and vacuuming prevents sediment from the project site from entering storm drains or receiving waters.

Suitable Applications

Sweeping and vacuuming are suitable anywhere sediment is tracked from the project site onto public or private paved streets and roads, typically at points of egress. Sweeping and vacuuming are also applicable during preparation of paved surfaces for final paving.

Limitations

Sweeping and vacuuming may not be effective when sediment is wet or when tracked soil is caked (caked soil may need to be scraped loose).

Implementation

- Controlling the number of points where vehicles can leave the site will allow sweeping and vacuuming efforts to be focused, and perhaps save money.
- Inspect potential sediment tracking locations daily.
- Visible sediment tracking should be swept or vacuumed on a daily basis.
- Do not use kick brooms or sweeper attachments. These tend to spread the dirt rather than remove it.

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- If not mixed with debris or trash, consider incorporating the removed sediment back into the project

Costs

Rental rates for self-propelled sweepers vary depending on hopper size and duration of rental. Expect rental rates from $58/hour (3 yd^3 hopper) to $88/hour (9 yd^3 hopper), plus operator costs. Hourly production rates vary with the amount of area to be swept and amount of sediment. Match the hopper size to the area and expect sediment load to minimize time spent dumping.

Inspection and Maintenance

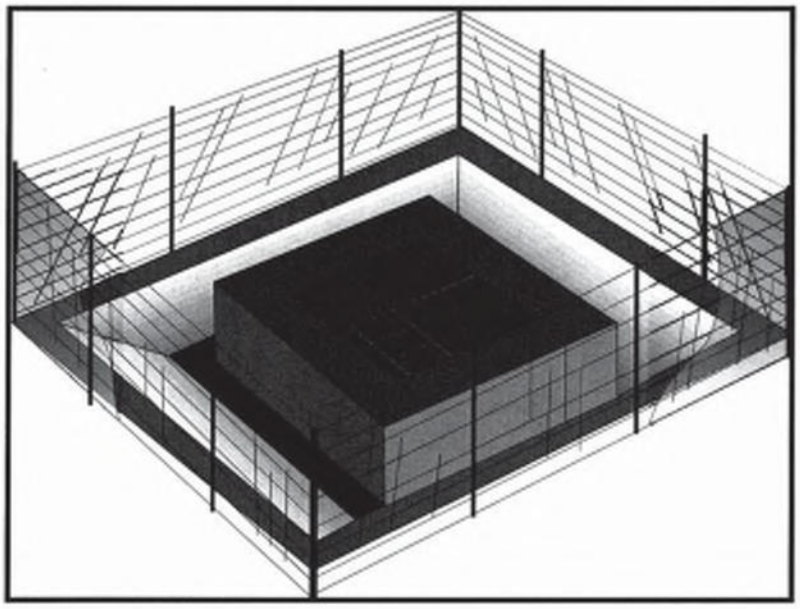
- Inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- When actively in use, points of ingress and egress must be inspected daily.
- When tracked or spilled sediment is observed outside the construction limits, it must be removed at least daily. More frequent removal, even continuous removal, may be required in some jurisdictions.
- Be careful not to sweep up any unknown substance or any object that may be potentially hazardous.
- Adjust brooms frequently; maximize efficiency of sweeping operations.
- After sweeping is finished, properly dispose of sweeper wastes at an approved dumpsite.

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Labor Surcharge and Equipment Rental Rates, State of California Department of Transportation (Caltrans), April 1, 2002 – March 31, 2003.

Storm Drain Inlet Protection SE-10



Categories

EC	Erosion Control	
SE	Sediment Control	☑
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	☒
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-1 Silt Fence

SE-5 Fiber Rolls

SE-6 Gravel Bag Berm

SE-8 Sandbag Barrier

SE-14 Biofilter Bags

Description and Purpose

Storm drain inlet protection consists of a sediment filter or an impounding area in, around or upstream of a storm drain, drop inlet, or curb inlet. Storm drain inlet protection measures temporarily pond runoff before it enters the storm drain, allowing sediment to settle. Some filter configurations also remove sediment by filtering, but usually the ponding action results in the greatest sediment reduction. Temporary geotextile storm drain inserts attach underneath storm drain grates to capture and filter storm water.

Suitable Applications

Every storm drain inlet receiving runoff from unstabilized or otherwise active work areas should be protected. Inlet protection should be used in conjunction with other erosion and sediment controls to prevent sediment-laden stormwater and non-stormwater discharges from entering the storm drain system.

Limitations

- Drainage area should not exceed 1 acre.
- In general straw bales should not be used as inlet protection.
- Requires an adequate area for water to pond without encroaching into portions of the roadway subject to traffic.

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- Sediment removal may be inadequate to prevent sediment discharges in high flow conditions or if runoff is heavily sediment laden. If high flow conditions are expected, use other onsite sediment trapping techniques in conjunction with inlet protection.
- Frequent maintenance is required.
- Limit drainage area to 1 acre maximum. For drainage areas larger than 1 acre, runoff should be routed to a sediment-trapping device designed for larger flows. See BMPs SE-2, Sediment Basin, and SE-3, Sediment Traps.
- Excavated drop inlet sediment traps are appropriate where relatively heavy flows are expected, and overflow capability is needed.

Implementation

General

Inlet control measures presented in this handbook should not be used for inlets draining more than one acre. Runoff from larger disturbed areas should be first routed through SE-2, Sediment Basin or SE-3, Sediment Trap and/or used in conjunction with other drainage control, erosion control, and sediment control BMPs to protect the site. Different types of inlet protection are appropriate for different applications depending on site conditions and the type of inlet. Alternative methods are available in addition to the methods described/shown herein such as prefabricated inlet insert devices, or gutter protection devices.

Design and Layout

Identify existing and planned storm drain inlets that have the potential to receive sediment-laden surface runoff. Determine if storm drain inlet protection is needed and which method to use.

- The key to successful and safe use of storm drain inlet protection devices is to know where runoff that is directed toward the inlet to be protected will pond or be diverted as a result of installing the protection device.
  - Determine the acceptable location and extent of ponding in the vicinity of the drain inlet. The acceptable location and extent of ponding will influence the type and design of the storm drain inlet protection device.
  - Determine the extent of potential runoff diversion caused by the storm drain inlet protection device. Runoff ponded by inlet protection devices may flow around the device and towards the next downstream inlet. In some cases, this is acceptable; in other cases, serious erosion or downstream property damage can be caused by these diversions. The possibility of runoff diversions will influence whether or not storm drain inlet protection is suitable; and, if suitable, the type and design of the device.
- The location and extent of ponding, and the extent of diversion, can usually be controlled through appropriate placement of the inlet protection device. In some cases, moving the inlet protection device a short distance upstream of the actual inlet can provide more efficient sediment control, limit ponding to desired areas, and prevent or control diversions.

- Six types of inlet protection are presented below. However, it is recognized that other effective methods and proprietary devices exist and may be selected.
  - Silt Fence: Appropriate for drainage basins with less than a 5% slope, sheet flows, and flows under 0.5 cfs.
  - Excavated Drop Inlet Sediment Trap: An excavated area around the inlet to trap sediment (SE-3).
  - Gravel bag barrier: Used to create a small sediment trap upstream of inlets on sloped, paved streets. Appropriate for sheet flow or when concentrated flow may exceed 0.5 cfs, and where overtopping is required to prevent flooding.
  - Block and Gravel Filter: Appropriate for flows greater than 0.5 cfs.
  - Temporary Geotextile Storm drain Inserts: Different products provide different features. Refer to manufacturer details for targeted pollutants and additional features.
  - Biofilter Bag Barrier: Used to create a small retention area upstream of inlets and can be located on pavement or soil. Biofilter bags slowly filter runoff allowing sediment to settle out. Appropriate for flows under 0.5 cfs.
- Select the appropriate type of inlet protection and design as referred to or as described in this fact sheet.
- Provide area around the inlet for water to pond without flooding structures and property.
- Grates and spaces around all inlets should be sealed to prevent seepage of sediment-laden water.
- Excavate sediment sumps (where needed) 1 to 2 ft with 2:1 side slopes around the inlet.

Installation

- ***DI Protection Type 1 - Silt Fence*** - Similar to constructing a silt fence; see BMP SE-1, Silt Fence. Do not place fabric underneath the inlet grate since the collected sediment may fall into the drain inlet when the fabric is removed or replaced and water flow through the grate will be blocked resulting in flooding. See typical Type 1 installation details at the end of this fact sheet.

  1. Excavate a trench approximately 6 in. wide and 6 in. deep along the line of the silt fence inlet protection device.
  2. Place 2 in. by 2 in. wooden stakes around the perimeter of the inlet a maximum of 3 ft apart and drive them at least 18 in. into the ground or 12 in. below the bottom of the trench. The stakes should be at least 48 in.
  3. Lay fabric along bottom of trench, up side of trench, and then up stakes. See SE-1, Silt Fence, for details. The maximum silt fence height around the inlet is 24 in.
  4. Staple the filter fabric (for materials and specifications, see SE-1, Silt Fence) to wooden stakes. Use heavy-duty wire staples at least 1 in. in length.

5. Backfill the trench with gravel or compacted earth all the way around.

- ***DI Protection Type 2 - Excavated Drop Inlet Sediment Trap*** - Install filter fabric fence in accordance with DI Protection Type 1. Size excavated trap to provide a minimum storage capacity calculated at the rate 67 yd^3/acre of drainage area. See typical Type 2 installation details at the end of this fact sheet.

- ***DI Protection Type 3 - Gravel bag*** - Flow from a severe storm should not overtop the curb. In areas of high clay and silts, use filter fabric and gravel as additional filter media. Construct gravel bags in accordance with SE-6, Gravel Bag Berm. Gravel bags should be used due to their high permeability. See typical Type 3 installation details at the end of this fact sheet.

  1. Construct on gently sloping street.
  2. Leave room upstream of barrier for water to pond and sediment to settle.
  3. Place several layers of gravel bags – overlapping the bags and packing them tightly together.
  4. Leave gap of one bag on the top row to serve as a spillway. Flow from a severe storm (e.g., 10 year storm) should not overtop the curb.

- ***DI Protection Type 4 – Block and Gravel Filter*** - Block and gravel filters are suitable for curb inlets commonly used in residential, commercial, and industrial construction. See typical Type 4 installation details at the end of this fact sheet.

  1. Place hardware cloth or comparable wire mesh with 0.5 in. openings over the drop inlet so that the wire extends a minimum of 1 ft beyond each side of the inlet structure. If more than one strip is necessary, overlap the strips. Place woven geotextile over the wire mesh.
  2. Place concrete blocks lengthwise on their sides in a single row around the perimeter of the inlet, so that the open ends face outward, not upward. The ends of adjacent blocks should abut. The height of the barrier can be varied, depending on design needs, by stacking combinations of blocks that are 4 in., 8 in., and 12 in. wide. The row of blocks should be at least 12 in. but no greater than 24 in. high.
  3. Place wire mesh over the outside vertical face (open end) of the concrete blocks to prevent stone from being washed through the blocks. Use hardware cloth or comparable wire mesh with 0.5 in. opening.
  4. Pile washed stone against the wire mesh to the top of the blocks. Use 0.75 to 3 in.

- ***DI Protection Type 5 – Temporary Geotextile Insert (proprietary)*** – Many types of temporary inserts are available. Most inserts fit underneath the grate of a drop inlet or inside of a curb inlet and are fastened to the outside of the grate or curb. These inserts are removable and many can be cleaned and reused. Installation of these inserts differs between manufacturers. Please refer to manufacturer instruction for installation of proprietary devices.

- ***DI Protection Type 6 - Biofilter bags*** – Biofilter bags may be used as a substitute for gravel bags in low-flow situations. Biofilter bags should conform to specifications detailed in SE-14, Biofilter bags.

    1. Construct in a gently sloping area.
    2. Biofilter bags should be placed around inlets to intercept runoff flows.
    3. All bag joints should overlap by 6 in.
    4. Leave room upstream for water to pond and for sediment to settle out.
    5. Stake bags to the ground as described in the following detail. Stakes may be omitted if bags are placed on a paved surface.

Costs

- Average annual cost for installation and maintenance of DI Type 1-4 and 6 (one year useful life) is $200 per inlet.
- Temporary geotextile inserts are proprietary and cost varies by region. These inserts can often be reused and may have greater than 1 year of use if maintained and kept undamaged. Average cost per insert ranges from $50-75 plus installation, but costs can exceed $100. This cost does not include maintenance.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Silt Fences. If the fabric becomes clogged, torn, or degrades, it should be replaced. Make sure the stakes are securely driven in the ground and are in good shape (i.e., not bent, cracked, or splintered, and are reasonably perpendicular to the ground). Replace damaged stakes. At a minimum, remove the sediment behind the fabric fence when accumulation reaches one-third the height of the fence or barrier height.
- Gravel Filters. If the gravel becomes clogged with sediment, it should be carefully removed from the inlet and either cleaned or replaced. Since cleaning gravel at a construction site may be difficult, consider using the sediment-laden stone as fill material and put fresh stone around the inlet. Inspect bags for holes, gashes, and snags, and replace bags as needed. Check gravel bags for proper arrangement and displacement.
- Sediment that accumulates in the BMP should be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height.
- Inspect and maintain temporary geotextile insert devices according to manufacturer's specifications.
- Remove storm drain inlet protection once the drainage area is stabilized.

- Clean and regrade area around the inlet and clean the inside of the storm drain inlet, as it should be free of sediment and debris at the time of final inspection.

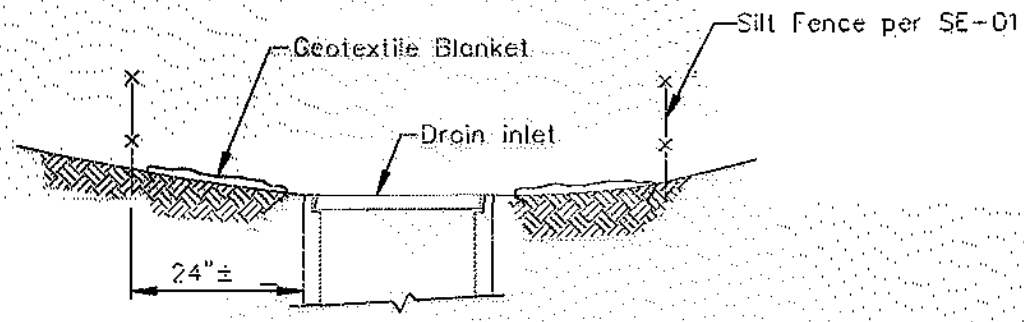
References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

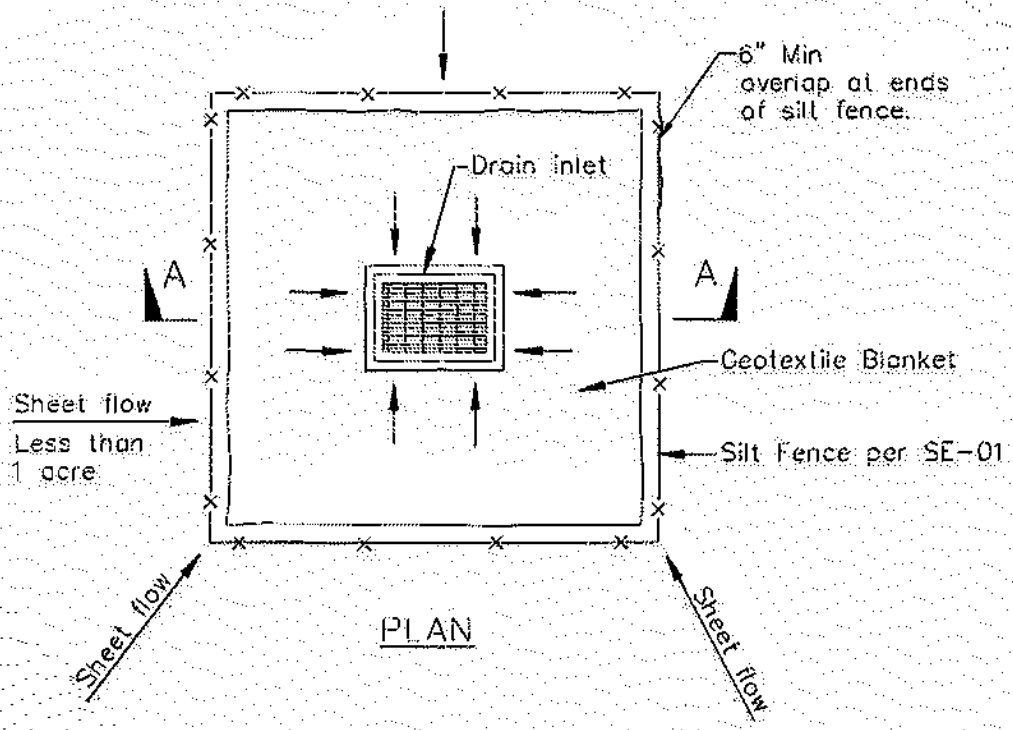
Stormwater Management Manual for The Puget Sound Basin, Washington State Department of Ecology, Public Review Draft, 1991.

Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, February 2005.

Storm Drain Inlet Protection SE-10



SECTION A-A



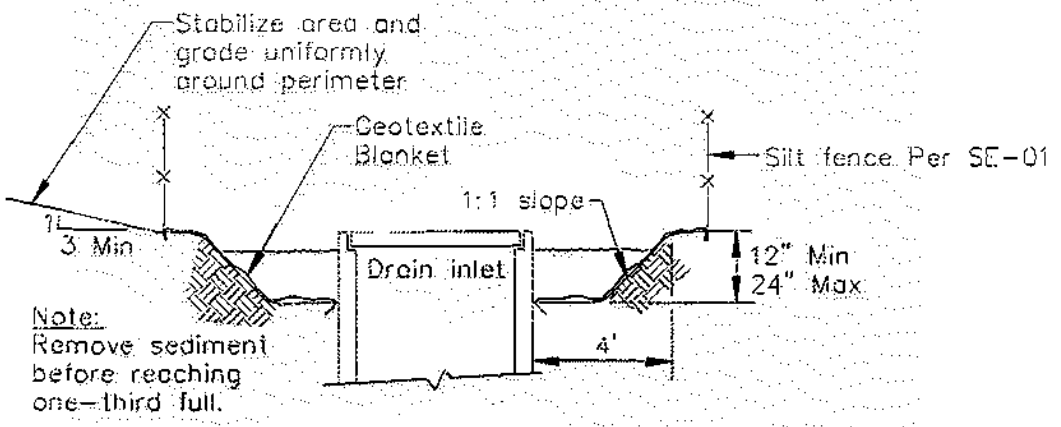
PLAN

DI PROTECTION TYPE 1
NOT TO SCALE

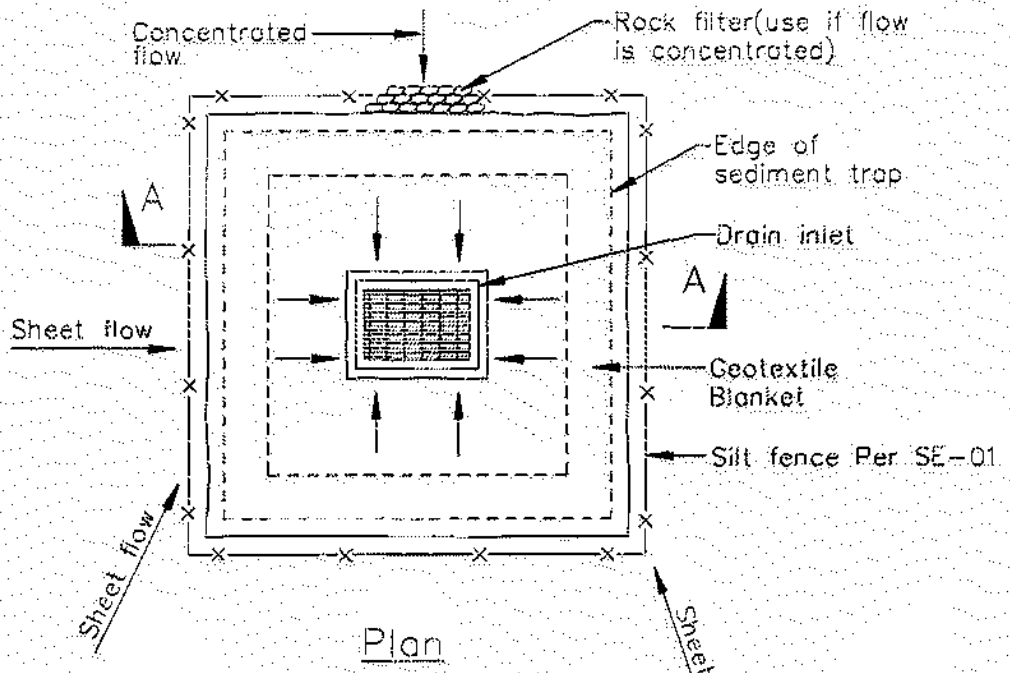
NOTES:

1. For use in areas where grading has been completed and final soil stabilization and seeding are pending.
2. Not applicable in paved areas.
3. Not applicable with concentrated flows.

Storm Drain Inlet Protection SE-10



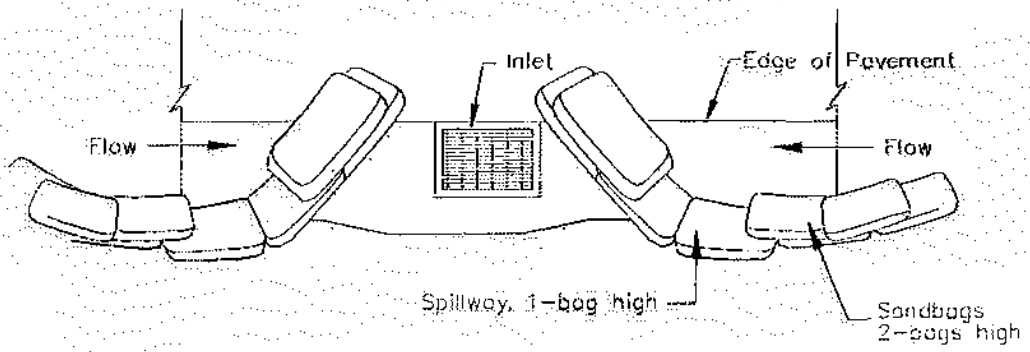
Section A-A



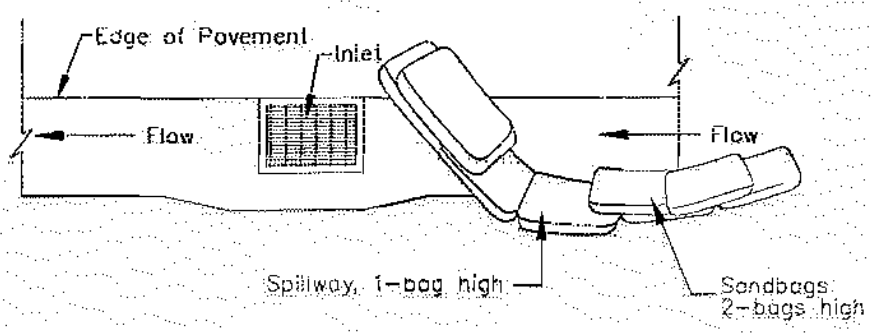
Plan

DI PROTECTION TYPE 2
NOT TO SCALE

Notes
1. For use in cleared and grubbed and in graded areas.
2. Shape basin so that longest inflow area faces longest length of trap.
3. For concentrated flows, shape basin in 2:1 ratio with length oriented towards direction of flow.



TYPICAL PROTECTION FOR INLET ON SUMP

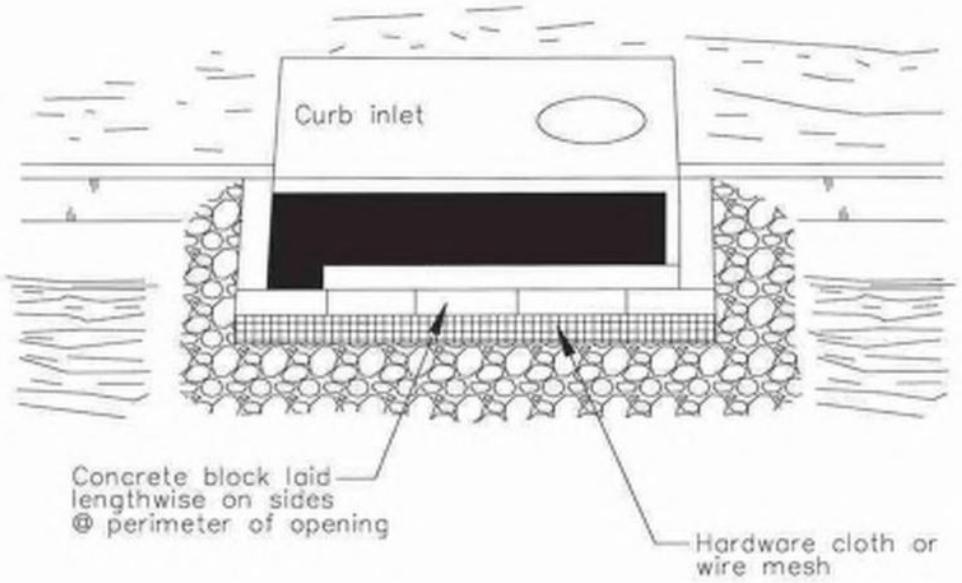


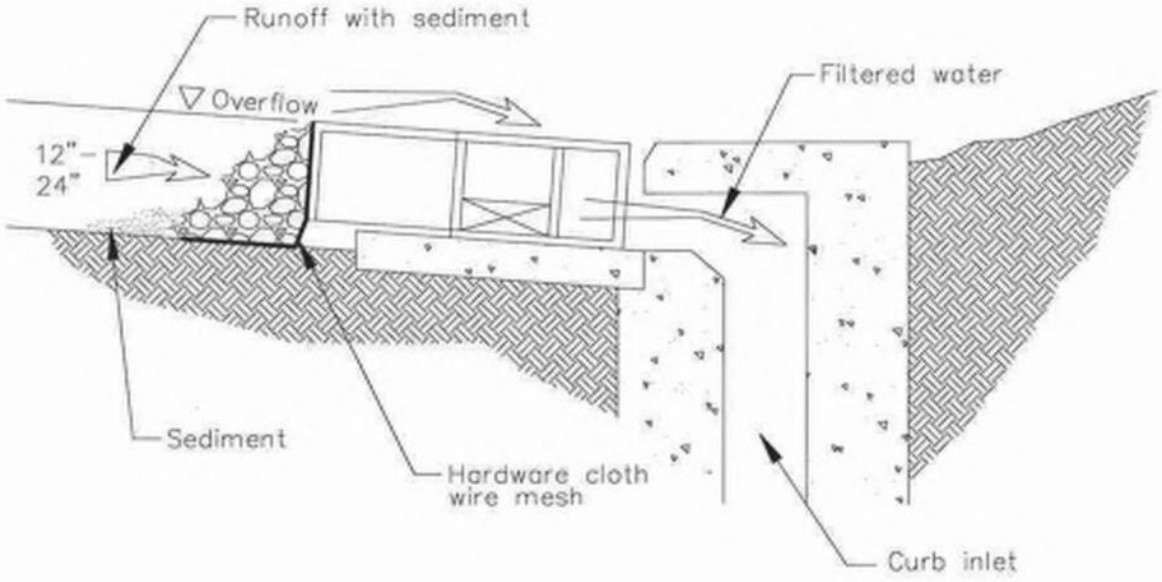
TYPICAL PROTECTION FOR INLET ON GRADE

NOTES:

1. Intended for short-term use.
2. Use to inhibit non-storm water flow.
3. Allow for proper maintenance and cleanup.
4. Bags must be removed after adjacent operation is completed
5. Not applicable in areas with high silts and clays without filter fabric.

DI PROTECTION TYPE 3
NOT TO SCALE





DI PROTECTION – TYPE 4
NOT TO SCALE

Drain Inserts MP-52

Description

Drain inserts are manufactured filters or fabric placed in a drop inlet to remove sediment and debris. There are a multitude of inserts of various shapes and configurations, typically falling into one of three different groups: socks, boxes, and trays. The sock consists of a fabric, usually constructed of polypropylene. The fabric may be attached to a frame or the grate of the inlet holds the sock. Socks are meant for vertical (drop) inlets. Boxes are constructed of plastic or wire mesh. Typically a polypropylene "bag" is placed in the wire mesh box. The bag takes the form of the box. Most box products are one box; that is, the setting area and filtration through media occur in the same box. Some products consist of one or more trays or mesh grates. The trays may hold different types of media. Filtration media vary by manufacturer. Types include polypropylene, porous polymer, treated cellulose, and activated carbon.

California Experience

The number of installations is unknown but likely exceeds a thousand. Some users have reported that these systems require considerable maintenance to prevent plugging and bypass.

Advantages

- Does not require additional space as inserts as the drain inlets are already a component of the standard drainage systems.
- Easy access for inspection and maintenance.
- As there is no standing water, there is little concern for mosquito breeding.
- A relatively inexpensive retrofit option.

Limitations

Performance is likely significantly less than treatment systems that are located at the end of the drainage system such as ponds and vaults. Usually not suitable for large areas or areas with trash or leaves than can plug the insert.

Design and Sizing Guidelines

Refer to manufacturer's guidelines. Drain inserts come any many configurations but can be placed into three general groups: socks, boxes, and trays. The sock consists of a fabric, usually constructed of polypropylene. The fabric may be attached to a frame or the grate of the inlet holds the sock. Socks are meant for vertical (drop) inlets. Boxes are constructed of plastic or wire mesh. Typically a polypropylene "bag" is placed in the wire mesh box. The bag takes the form of the box. Most box products are

Design Considerations

- Use with other BMPs
- Fit and Seal Capacity within Inlet

Targeted Constituents

- ✓ Sediment
- ✓ Nutrients
- ✓ Trash
- ✓ Metals
- Bacteria
- ✓ Oil and Grease
- ✓ Organics

Removal Effectiveness

See New Development and Redevelopment Handbook-Section 5.

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one box; that is, the setting area and filtration through media occurs in the same box. One manufacturer has a double-box. Stormwater enters the first box where setting occurs. The stormwater flows into the second box where the filter media is located. Some products consist of one or more trays or mesh grates. The trays can hold different types of media. Filtration media vary with the manufacturer: types include polypropylene, porous polymer, treated cellulose, and activated carbon.

Construction/Inspection Considerations

Be certain that installation is done in a manner that makes certain that the stormwater enters the unit and does not leak around the perimeter. Leakage between the frame of the insert and the frame of the drain inlet can easily occur with vertical (drop) inlets.

Performance

Few products have performance data collected under field conditions.

Siting Criteria

It is recommended that inserts be used only for retrofit situations or as pretreatment where other treatment BMPs presented in this section area used.

Additional Design Guidelines

Follow guidelines provided by individual manufacturers.

Maintenance

Likely require frequent maintenance, on the order of several times per year.

Cost

- The initial cost of individual inserts ranges from less than $100 to about $2,000. The cost of using multiple units in curb inlet drains varies with the size of the inlet.
- The low cost of inserts may tend to favor the use of these systems over other, more effective treatment BMPs. However, the low cost of each unit may be offset by the number of units that are required, more frequent maintenance, and the shorter structural life (and therefore replacement).

References and Sources of Additional Information

Hrachovec, R., and G. Minton, 2001, Field testing of a sock-type catch basin insert, Planet CPR, Seattle, Washington

Interagency Catch Basin Insert Committee, Evaluation of Commercially-Available Catch Basin Inserts for the Treatment of Stormwater Runoff from Developed Sites, 1995

Larry Walker Associates, June 1998, NDMP Inlet/In-Line Control Measure Study Report

Manufacturers literature

Santa Monica (City), Santa Monica Bay Municipal Stormwater/Urban Runoff Project - Evaluation of Potential Catch basin Retrofits, Woodward Clyde, September 24, 1998

Woodward Clyde, June 11, 1996, Parking Lot Monitoring Report, Santa Clara Valley Nonpoint Source Pollution Control Program.

Infiltration Basin TC-11



Design Considerations

- Soil for Infiltration
- Slope
- Aesthetics

Targeted Constituents

☑	Sediment	■
☑	Nutrients	■
☑	Trash	■
☑	Metals	■
☑	Bacteria	■
☑	Oil and Grease	■
☑	Organics	■

Legend *(Removal Effectiveness)*

● Low ■ High

▲ Medium

Description

An infiltration basin is a shallow impoundment that is designed to infiltrate stormwater. Infiltration basins use the natural filtering ability of the soil to remove pollutants in stormwater runoff. Infiltration facilities store runoff until it gradually exfiltrates through the soil and eventually into the water table. This practice has high pollutant removal efficiency and can also help recharge groundwater, thus helping to maintain low flows in stream systems. Infiltration basins can be challenging to apply on many sites, however, because of soils requirements. In addition, some studies have shown relatively high failure rates compared with other management practices.

California Experience

Infiltration basins have a long history of use in California, especially in the Central Valley. Basins located in Fresno were among those initially evaluated in the National Urban Runoff Program and were found to be effective at reducing the volume of runoff, while posing little long-term threat to groundwater quality (EPA, 1983; Schroeder, 1995). Proper siting of these devices is crucial as underscored by the experience of Caltrans in siting two basins in Southern California. The basin with marginal separation from groundwater and soil permeability failed immediately and could never be rehabilitated.

Advantages

- Provides 100% reduction in the load discharged to surface waters.
- The principal benefit of infiltration basins is the approximation of pre-development hydrology during which a

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significant portion of the average annual rainfall runoff is infiltrated and evaporated rather than flushed directly to creeks.

- If the water quality volume is adequately sized, infiltration basins can be useful for providing control of channel forming (erosion) and high frequency (generally less than the 2-year) flood events.

Limitations

- May not be appropriate for industrial sites or locations where spills may occur.
- Infiltration basins require a minimum soil infiltration rate of 0.5 inches/hour, not appropriate at sites with Hydrologic Soil Types C and D.
- If infiltration rates exceed 2.4 inches/hour, then the runoff should be fully treated prior to infiltration to protect groundwater quality.
- Not suitable on fill sites or steep slopes.
- Risk of groundwater contamination in very coarse soils.
- Upstream drainage area must be completely stabilized before construction.
- Difficult to restore functioning of infiltration basins once clogged.

Design and Sizing Guidelines

- Water quality volume determined by local requirements or sized so that 85% of the annual runoff volume is captured.
- Basin sized so that the entire water quality volume is infiltrated within 48 hours.
- Vegetation establishment on the basin floor may help reduce the clogging rate.

Construction/Inspection Considerations

- Before construction begins, stabilize the entire area draining to the facility. If impossible, place a diversion berm around the perimeter of the infiltration site to prevent sediment entrance during construction or remove the top 2 inches of soil after the site is stabililized. Stabilize the entire contributing drainage area, including the side slopes, before allowing any runoff to enter once construction is complete.
- Place excavated material such that it can not be washed back into the basin if a storm occurs during construction of the facility.
- Build the basin without driving heavy equipment over the infiltration surface. Any equipment driven on the surface should have extra-wide ("low pressure") tires. Prior to any construction, rope off the infiltration area to stop entrance by unwanted equipment.
- After final grading, till the infiltration surface deeply.
- Use appropriate erosion control seed mix for the specific project and location.

Performance

As water migrates through porous soil and rock, pollutant attenuation mechanisms include precipitation, sorption, physical filtration, and bacterial degradation. If functioning properly, this approach is presumed to have high removal efficiencies for particulate pollutants and moderate removal of soluble pollutants. Actual pollutant removal in the subsurface would be expected to vary depending upon site-specific soil types. This technology eliminates discharge to surface waters except for the very largest storms; consequently, complete removal of all stormwater constituents can be assumed.

There remain some concerns about the potential for groundwater contamination despite the findings of the NURP and Nightingale (1975; 1987a,b,c; 1989). For instance, a report by Pitt et al. (1994) highlighted the potential for groundwater contamination from intentional and unintentional stormwater infiltration. That report recommends that infiltration facilities not be sited in areas where high concentrations are present or where there is a potential for spills of toxic material. Conversely, Schroeder (1995) reported that there was no evidence of groundwater impacts from an infiltration basin serving a large industrial catchment in Fresno, CA.

Siting Criteria

The key element in siting infiltration basins is identifying sites with appropriate soil and hydrogeologic properties, which is critical for long term performance. In one study conducted in Prince George's County, Maryland (Galli, 1992), all of the infiltration basins investigated clogged within 2 years. It is believed that these failures were for the most part due to allowing infiltration at sites with rates of less than 0.5 in/hr, basing siting on soil type rather than field infiltration tests, and poor construction practices that resulted in soil compaction of the basin invert.

A study of 23 infiltration basins in the Pacific Northwest showed better long-term performance in an area with highly permeable soils (Hilding, 1996). In this study, few of the infiltration basins had failed after 10 years. Consequently, the following guidelines for identifying appropriate soil and subsurface conditions should be rigorously adhered to.

- Determine soil type (consider RCS soil type 'A, B or C' only) from mapping and consult USDA soil survey tables to review other parameters such as the amount of silt and clay, presence of a restrictive layer or seasonal high water table, and estimated permeability. The soil should not have more than 30% clay or more than 40% of clay and silt combined. Eliminate sites that are clearly unsuitable for infiltration.

- Groundwater separation should be at least 3 m from the basin invert to the measured ground water elevation. There is concern at the state and regional levels of the impact on groundwater quality from infiltrated runoff, especially when the separation between groundwater and the surface is small.

- Location away from buildings, slopes and highway pavement (greater than 6 m) and wells and bridge structures (greater than 30 m). Sites constructed of fill, having a base flow or with a slope greater than 15% should not be considered.

- Ensure that adequate head is available to operate flow splitter structures (to allow the basin to be offline) without ponding in the splitter structure or creating backwater upstream of the splitter.

- Base flow should not be present in the tributary watershed.

Secondary Screening Based on Site Geotechnical Investigation

- At least three in-hole conductivity tests shall be performed using USBR 7300-89 or Bouwer-Rice procedures (the latter if groundwater is encountered within the boring), two tests at different locations within the proposed basin and the third down gradient by no more than approximately 10 m. The tests shall measure permeability in the side slopes and the bed within a depth of 3 m of the invert.

- The minimum acceptable hydraulic conductivity as measured in any of the three required test holes is 13 mm/hr. If any test hole shows less than the minimum value, the site should be disqualified from further consideration.

- Exclude from consideration sites constructed in fill or partially in fill unless no silts or clays are present in the soil boring. Fill tends to be compacted, with clays in a dispersed rather than flocculated state, greatly reducing permeability.

- The geotechnical investigation should be such that a good understanding is gained as to how the stormwater runoff will move in the soil (horizontally or vertically) and if there are any geological conditions that could inhibit the movement of water.

Additional Design Guidelines

(1) Basin Sizing - The required water quality volume is determined by local regulations or sufficient to capture 85% of the annual runoff.

(2) Provide pretreatment if sediment loading is a maintenance concern for the basin.

(3) Include energy dissipation in the inlet design for the basins. Avoid designs that include a permanent pool to reduce opportunity for standing water and associated vector problems.

(4) Basin invert area should be determined by the equation:

$$A = \frac{WQV}{kt}$$

where A = Basin invert area (m^2)

WQV = water quality volume (m^3)

k = 0.5 times the lowest field-measured hydraulic conductivity (m/hr)

t = drawdown time (48 hr)

(5) The use of vertical piping, either for distribution or infiltration enhancement shall not be allowed to avoid device classification as a Class V injection well per 40 CFR146.5(e)(4).

Maintenance

Regular maintenance is critical to the successful operation of infiltration basins. Recommended operation and maintenance guidelines include:

- Inspections and maintenance to ensure that water infiltrates into the subsurface completely (recommended infiltration rate of 72 hours or less) and that vegetation is carefully managed to prevent creating mosquito and other vector habitats.
- Observe drain time for the design storm after completion or modification of the facility to confirm that the desired drain time has been obtained.
- Schedule semiannual inspections for beginning and end of the wet season to identify potential problems such as erosion of the basin side slopes and invert, standing water, trash and debris, and sediment accumulation.
- Remove accumulated trash and debris in the basin at the start and end of the wet season.
- Inspect for standing water at the end of the wet season.
- Trim vegetation at the beginning and end of the wet season to prevent establishment of woody vegetation and for aesthetic and vector reasons.
- Remove accumulated sediment and regrade when the accumulated sediment volume exceeds 10% of the basin.
- If erosion is occurring within the basin, revegetate immediately and stabilize with an erosion control mulch or mat until vegetation cover is established.
- To avoid reversing soil development, scarification or other disturbance should only be performed when there are actual signs of clogging, rather than on a routine basis. Always remove deposited sediments before scarification, and use a hand-guided rotary tiller, if possible, or a disc harrow pulled by a very light tractor.

Cost

Infiltration basins are relatively cost-effective practices because little infrastructure is needed when constructing them. One study estimated the total construction cost at about $2 per ft (adjusted for inflation) of storage for a 0.25-acre basin (SWRPC, 1991). As with other BMPs, these published cost estimates may deviate greatly from what might be incurred at a specific site. For instance, Caltrans spent about $18/ft^3 for the two infiltration basins constructed in southern California, each of which had a water quality volume of about 0.34 ac.-ft. Much of the higher cost can be attributed to changes in the storm drain system necessary to route the runoff to the basin locations.

Infiltration basins typically consume about 2 to 3% of the site draining to them, which is relatively small. Additional space may be required for buffer, landscaping, access road, and fencing. Maintenance costs are estimated at 5 to 10% of construction costs.

One cost concern associated with infiltration practices is the maintenance burden and longevity. If improperly maintained, infiltration basins have a high failure rate. Thus, it may be necessary to replace the basin with a different technology after a relatively short period of time.

References and Sources of Additional Information

Caltrans, 2002, BMP Retrofit Pilot Program Proposed Final Report, Rpt. CTSW-RT-01-050, California Dept. of Transportation, Sacramento, CA.

Galli, J. 1992. *Analysis of Urban BMP Performance and Longevity in Prince George's County, Maryland*. Metropolitan Washington Council of Governments, Washington, DC.

Hilding, K. 1996. Longevity of infiltration basins assessed in Puget Sound. *Watershed Protection Techniques* 1(3):124–125.

Maryland Department of the Environment (MDE). 2000. *Maryland Stormwater Design Manual*. http://www.mde.state.md.us/environment/wma/stormwatermanual. Accessed May 22, 2002.

Metzger, M. E., D. F. Messer, C. L. Beitia, C. M. Myers, and V. L. Kramer. 2002. The Dark Side Of Stormwater Runoff Management: Disease Vectors Associated With Structural BMPs. Stormwater 3(2): 24-39.

Nightingale, H.I., 1975, "Lead, Zinc, and Copper in Soils of Urban Storm-Runoff Retention Basins," American Water Works Assoc. Journal. Vol. 67, p. 443-446.

Nightingale, H.I., 1987a, "Water Quality beneath Urban Runoff Water Management Basins," Water Resources Bulletin, Vol. 23, p. 197-205.

Nightingale, H.I., 1987b, "Accumulation of As, Ni, Cu, and Pb in Retention and Recharge Basin Soils from Urban Runoff," Water Resources Bulletin, Vol. 23, p. 663-672.

Nightingale, H.I., 1987c, "Organic Pollutants in Soils of Retention/Recharge Basins Receiving Urban Runoff Water," Soil Science Vol. 148, pp. 39-45.

Nightingale, H.I., Harrison, D., and Salo, J.E., 1985, "An Evaluation Technique for Ground-water Quality Beneath Urban Runoff Retention and Percolation Basins," Ground Water Monitoring Review, Vol. 5, No. 1, pp. 43-50.

Oberts, G. 1994. Performance of Stormwater Ponds and Wetlands in Winter. *Watershed Protection Techniques* 1(2): 64–68.

Pitt, R., et al. 1994, *Potential Groundwater Contamination from Intentional and Nonintentional Stormwater Infiltration*, EPA/600/R-94/051, Risk Reduction Engineering Laboratory, U.S. EPA, Cincinnati, OH.

Schueler, T. 1987. *Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs*. Metropolitan Washington Council of Governments, Washington, DC.

Schroeder, R.A., 1995, *Potential For Chemical Transport Beneath a Storm-Runoff Recharge (Retention) Basin for an Industrial Catchment in Fresno, CA*, USGS Water-Resource Investigations Report 93-4140.

Southeastern Wisconsin Regional Planning Commission (SWRPC). 1991. *Costs of Urban Nonpoint Source Water Pollution Control Measures*. Southeastern Wisconsin Regional Planning Commission, Waukesha, WI.

U.S. EPA, 1983, *Results of the Nationwide Urban Runoff Program: Volume 1 – Final Report*, WH-554, Water Planning Division, Washington, DC.

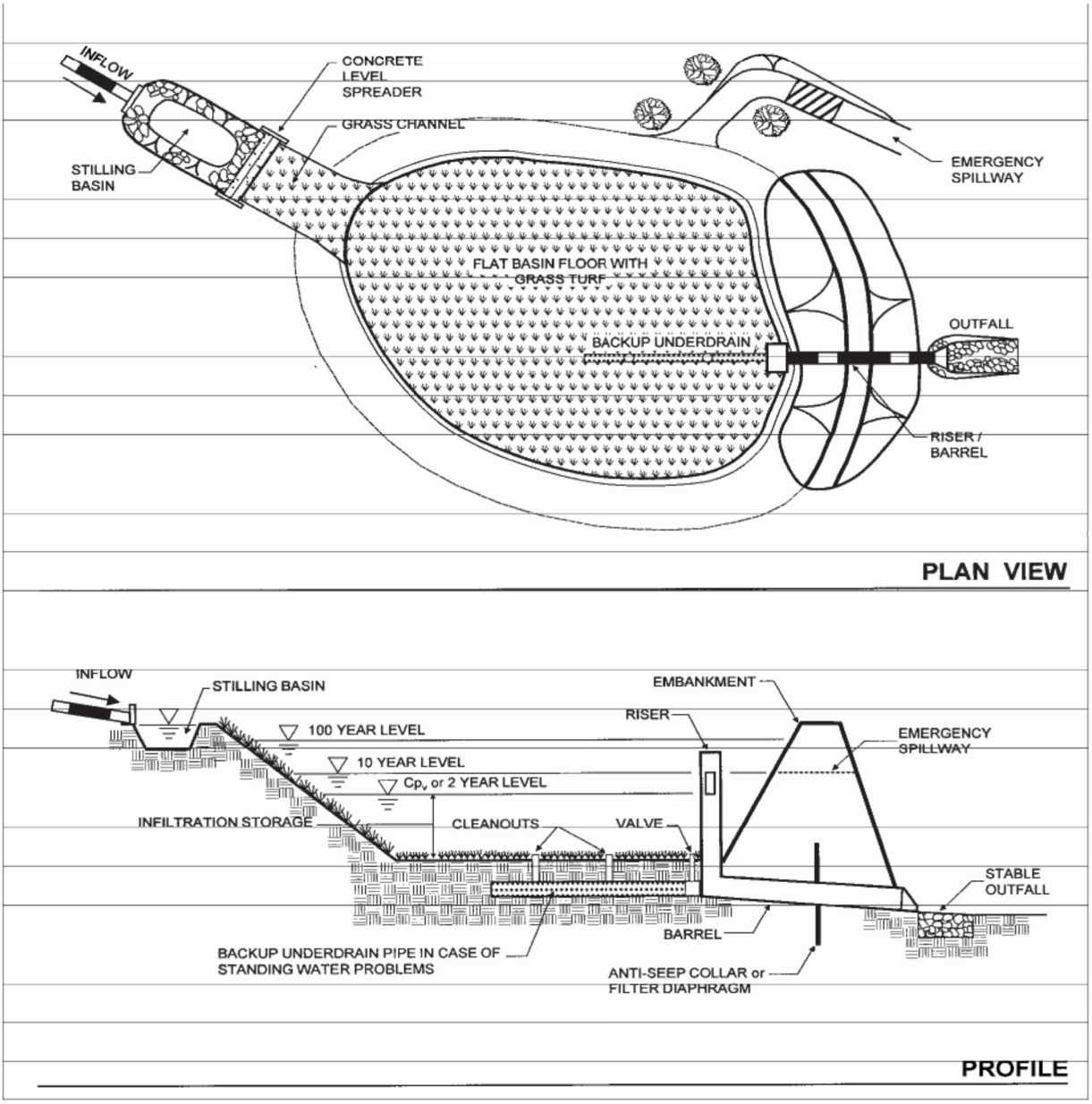
Watershed Management Institute (WMI). 1997. *Operation, Maintenance, and Management of Stormwater Management Systems*. Prepared for U.S. Environmental Protection Agency Office of Water, Washington, DC.

Information Resources

Center for Watershed Protection (CWP). 1997. *Stormwater BMP Design Supplement for Cold Climates*. Prepared for U.S. Environmental Protection Agency Office of Wetlands, Oceans and Watersheds. Washington, DC.

Ferguson, B.K., 1994. *Stormwater Infiltration*. CRC Press, Ann Arbor, MI.

USEPA. 1993. *Guidance to Specify Management Measures for Sources of Nonpoint Pollution in Coastal Waters*. EPA-840-B-92-002. U.S. Environmental Protection Agency, Office of Water, Washington, DC.


INFLOW
CONCRETE LEVEL SPREADER
GRASS CHANNEL
STILLING BASIN
EMERGENCY SPILLWAY
FLAT BASIN FLOOR WITH GRASS TURF
OUTFALL
BACKUP UNDERDRAIN
RISER / BARREL
PLAN VIEW
INFLOW
STILLING BASIN
EMBANKMENT
RISER
100 YEAR LEVEL
EMERGENCY SPILLWAY
10 YEAR LEVEL
Cpv or 2 YEAR LEVEL
INFILTRATION STORAGE
CLEANOUTS
VALVE
STABLE OUTFALL
BARREL
BACKUP UNDERDRAIN PIPE IN CASE OF STANDING WATER PROBLEMS
ANTI-SEEP COLLAR or FILTER DIAPHRAGM
PROFILE

Bioretention TC-32



Maintenance Concerns, Objectives, and Goals

- Clogged Soil or Outlet Structures
- Invasive Species
- Vegetation/Landscape Maintenance
- Erosion
- Channelization of Flow
- Aesthetics

General Description

The bioretention best management practice (BMP) functions as a soil and plant-based filtration device that removes pollutants through a variety of physical, biological, and chemical treatment processes. These facilities normally consist of a grass buffer strip, sand bed, ponding area, organic layer or mulch layer, planting soil, and plants. The runoff's velocity is reduced by passing over or through a sand bed and is subsequently distributed evenly along a ponding area. Exfiltration of the stored water in the bioretention area planting soil into the underlying soils occurs over a period of days.

Inspection/Maintenance Considerations

Bioretention requires frequent landscaping maintenance, including measures to ensure that the area is functioning properly, as well as maintenance of the landscaping on the practice. In many cases, bioretention areas initially require intense maintenance, but less maintenance is needed over time. In many cases, maintenance tasks can be completed by a landscaping contractor, who may already be hired at the site. In cold climates the soil may freeze, preventing runoff from infiltrating into the planting soil.

Targeted Constituents

✓	Sediment	■
✓	Nutrients	▲
✓	Trash	■
✓	Metals	■
✓	Bacteria	■
✓	Oil and Grease	■
✓	Organics	■
✓	Oxygen Demanding	■

Legend ***(Removal Effectiveness)***

● Low ■ High

▲ Medium

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Inspection Activities	Suggested Frequency
■ Inspect soil and repair eroded areas.	Monthly
■ Inspect for erosion or damage to vegetation, preferably at the end of the wet season to schedule summer maintenance and before major fall runoff to be sure the strips are ready for winter. However, additional inspection after periods of heavy runoff is desirable.	Semi-annual inspection
■ Inspect to ensure grass is well established. If not, either prepare soil and reseed or replace with alternative species. Install erosion control blanket.	
■ Check for debris and litter, and areas of sediment accumulation.	
■ Inspect health of trees and shrubs.	
Maintenance Activities	**Suggested Frequency**
■ Water plants daily for 2 weeks.	At project completion
■ Remove litter and debris.	Monthly
■ Remove sediment.	As needed
■ Remulch void areas.	
■ Treat diseased trees and shrubs.	
■ Mow turf areas.	
■ Repair erosion at inflow points.	
■ Repair outflow structures.	
■ Unclog underdrain.	
■ Regulate soil pH regulation.	
■ Remove and replace dead and diseased vegetation.	Semi-annual
■ Add mulch.	Annual
■ Replace tree stakes and wires.	
■ Mulch should be replaced every 2 to 3 years or when bare spots appear. Remulch prior to the wet season.	Every 2-3 years, or as needed

Additional Information

Landscaping is critical to the function and aesthetic value of bioretention areas. It is preferable to plant the area with native vegetation, or plants that provide habitat value, where possible. Another important design feature is to select species that can withstand the hydrologic regime they will experience. At the bottom of the bioretention facility, plants that tolerate both wet and dry conditions are preferable. At the edges, which will remain primarily dry, upland species will be the most resilient. It is best to select a combination of trees, shrubs, and herbaceous materials.

References

Metropolitan Council, Urban Small Sites Best Management Practices Manual. Available at: http://www.metrocouncil.org/environment/Watershed/BMP/manual.htm

Model Urban Runoff Program: A How-To Guide for Developing Urban Runoff Programs for Small Municipalities. Prepared by City of Monterey, City of Santa Cruz, California Coastal Commission, Monterey Bay National Marine Sanctuary, Association of Monterey Bay Area Governments, Woodward-Clyde, Central Coast Regional Water Quality Control Board. July, 1998, revised February, 2002.

U.S. Environmental Protection Agency, Post-Construction Stormwater Management in New Development & Redevelopment BMP Factsheets. Available at: cfpub.epa.gov/npdes/stormwater/menuofbmps/bmp_files.cfm

Ventura Countywide Stormwater Quality Management Program, Technical Guidance Manual for Stormwater Quality Control Measures. July, 2002.

XIV.1. Hydrologic Source Control Fact Sheets (HSC)

HSC-1: Localized On-Lot Infiltration

'Localized on-lot infiltration' refers to the practice of collecting on-site runoff from small distributed areas within a catchment and diverting it to a dedicated on-site infiltration area. This technique can include disconnecting downspouts and draining sidewalks and patios into french drains, trenches, small rain gardens, or other surface depressions. For downspout disconnections and other impervious area disconnection involving dispersion over pervious surfaces, but without intentional ponding, see HSC-2: Impervious Area Dispersion.

Also known as:

- *Downspout infiltration*
- *Retention grading*
- *French drains*
- *On-lot rain gardens*



On-lot rain garden
Source: lowimpactdevelopment.org

Feasibility Screening Considerations

- 'Localized on-lot infiltration' shall meet infiltration infeasibility screening criteria to be considered for use.

Opportunity Criteria

- Runoff can be directed to and temporarily pond in pervious area depressions, rock trenches, or similar.
- Soils are adequate for infiltration or can be amended to provide an adequate infiltration rate.
- Shallow utilities are not present below infiltration areas.

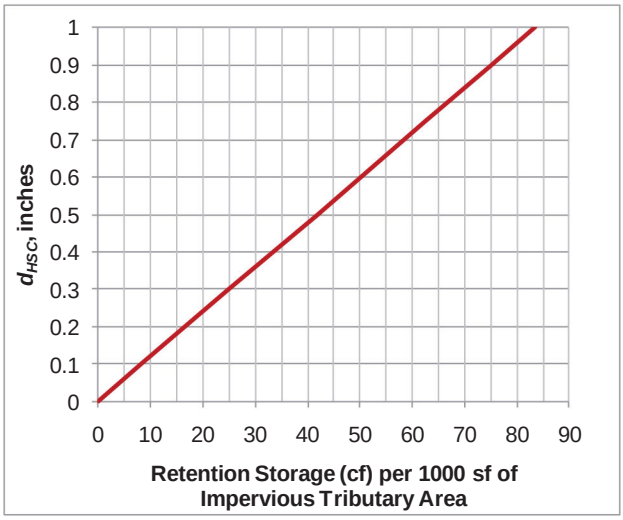
OC-Specific Design Criteria and Considerations

- ☐ A single on-lot infiltration area should not be sized to retain runoff from impervious areas greater than 4,000 sq. ft.; if the drainage area exceeds this criteria, sizing should be based on calculations for bioretention areas or infiltration trenches.
- ☐ Soils should be sufficiently permeable to eliminate ponded water within 24 hours following a 85th percentile, 24-hour storm event.
- ☐ Maximum ponding depth should be should be less than 3 inches and trench depth should be less than 1.5 feet.
- ☐ Infiltration should not be used when the depth to the mounded seasonally high table is within 5 feet of the bottom of infiltrating surface.
- ☐ Infiltration via depression storage, french drains, or rain gardens should be located greater than 8 feet from building foundations.
- ☐ Site slope should be less than 10%.
- ☐ Infiltration unit should not be located within 50 feet of slopes greater than 15 percent.
- ☐ Side slopes of rain garden or depression storage should not exceed 3H:1V.
- ☐ Effective energy dissipation and uniform flow spreading methods should be employed to prevent erosion resulting fromwater entering infiltration areas.

☐ Overflow should be located such that it does not cause erosion orand is conveyed away from structures toward the downstream conveyance and treatment system. .

Calculating HSC Retention Volume

- The retention volume provided by localized on-lot infiltration can be computed as the storage volume provided by surface ponding and the pore space within an amended soil layer or gravel trench.
- Estimate the average retention volume per 1000 square feet impervious tributary area provided by on-lot infiltration.
- Look up the storm retention depth, d_{HSC} from the chart to the right.
- The max d_{HSC} is equal to the design capture storm depth for the project site.



Configuration for Use in a Treatment Train

- Localized on-lot infiltration would typically serve as the first in a treatment train and should only be used where tributary areas do not generate significant sediment that would require pretreatment to mitigate clogging.
- The use of impervious area disconnection reduces the sizing requirement for downstream LID and/or conventional treatment control BMPs.

Additional References for Design Guidance

- LID Center – Rain Garden Design Template. http://www.lowimpactdevelopment.org/raingarden_design/
- University of Wisconsin Extension. Rain Gardens: A How-To Manual for Homeowners. http://learningstore.uwex.edu/assets/pdfs/GWQ037.pdf

HSC-2: Impervious Area Dispersion

Impervious area dispersion refers to the practice of routing runoff from impervious areas, such as rooftops, walkways, and patios onto the surface of adjacent pervious areas. Runoff is dispersed uniformly via splash block or dispersion trench and soaks into the ground as it move slowly across the surface of pervious areas. Minor ponding may occur, but it is not the intent of this practice to actively promote localized on-lot storage (See HSC-1: Localized On-Lot Infiltration).

Also known as:

- *Downspout disconnection*
- *Impervious area disconnection*
- *Sheet flow dispersion*



Simple Downspout Dispersion
Source: toronto.ca/environment/water.htm

Feasibility Screening Considerations

- Impervious area dispersion can be used where infiltration would otherwise be infeasible, however dispersion depth over landscaped areas should be limited by site-specific conditions to prevent standing water or geotechnical issues.

Opportunity Criteria

- Rooftops and other low traffic impervious surface present in drainage area.
- Soils are adequate for infiltration. If not, soils can be amended to improve capacity to absorb dispersed water (see MISC-2: Amended Soils).
- Significant pervious area present in drainage area with shallow slope
- Overflow from pervious area can be safely managed.

OC-Specific Design Criteria and Considerations

- ☐ Soils should be preserved from their natural condition or restored via soil amendments to meet minimum criteria described in Section .
- ☐ A minimum of 1 part pervious area capable of receiving flow should be provided for every 2 parts of impervious area disconnected.
- ☐ The pervious area receiving flow should have a slope ≤ 2 percent and path lengths of ≥ 20 feet per 1000 sf of impervious area.
- ☐ Dispersion areas should be maintained to remove trash and debris, loose vegetation, and protect any areas of bare soil from erosion.
- ☐ Velocity of dispersed flow should not be greater than 0.5 ft per second to avoid scour.

Calculating HSC Retention Volume

- The retention volume provided by downspout dispersion is a function of the ratio of impervious to pervious area and the condition of soils in the pervious area.
- Determine flow patterns in pervious area and estimate footprint of pervious area receiving dispersed flow. Calculate the ratio of pervious to impervious area.
- Check soil conditions using the soil condition design criteria below; amend if necessary.
- Look up the storm retention depth, d_{HSC} from the chart below.

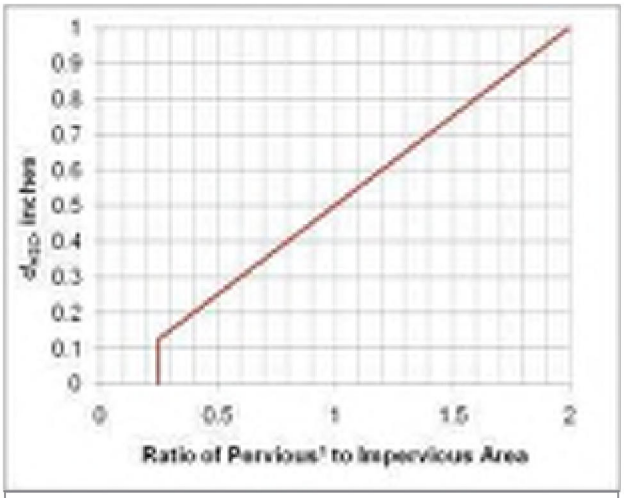
- The max d_{HSC} is equal to the design storm depth for the project site.

Soil Condition Design Criteria

- ☐ Maximum slope of 2 percent
- ☐ Well-established lawn or landscaping
- ☐ Minimum soil amendments per criteria in MISC-2: Amended Soils.

Configuration for Use in a Treatment Train

- Impervious area disconnection is an HSC that may be used as the first element in any treatment train
- The use of impervious area disconnection reduces the sizing requirement for downstream LID and/or treatment control BMPs



[1] Pervious area used in calculation should only include the pervious area receiving flow, not pervious area receiving only direct rainfall or upslope pervious drainage.

Additional References for Design Guidance

- SMC LID Manual (pp 131) http://www.lowimpactdevelopment.org/guest75/pub/All_Projects/SoCal_LID_Manual/SoCalLID_Manual_FINAL_040910.pdf
- City of Portland Bureau of Environmental Services. 2010. How to manage stormwater – Disconnect Downspouts. http://www.portlandonline.com/bes/index.cfm?c=43081&a=177702
- Seattle Public Utility: http://www.cityofseattle.org/util/stellent/groups/public/@spu/@usm/documents/webcontent/spu01_006395.pdf
- Thurston County, Washington State (pp 10): http://www.co.thurston.wa.us/stormwater/manual/docs-faqs/DG-5-Roof-Runoff-Control_Rev11Jan24.pdf

HSC-3: Street Trees

By intercepting rainfall, trees can provide several aesthetic and stormwater benefits including peak flow control, increased infiltration and ET, and runoff temperature reduction. The volume of precipitation intercepted by the canopy reduces the treatment volume required for downstream treatment BMPs. Shading reduces the heat island effect as well as the temperature of adjacent impervious surfaces, over which stormwater flows, and thus reduces the heat transferred to downstream receiving waters. Tree roots also strengthen the soil structure and provide infiltrative pathways, simultaneously reducing erosion potential and enhancing infiltration.

Also known as:

- *Canopy interception*



Street trees
Source: Geosyntec Consultants

Feasibility Screening Considerations

- Not applicable

Opportunity Criteria

- Street trees can be incorporated in green streets designs along sidewalks, streets, parking lots, or driveways.
- Street trees can be used in combination with bioretention systems along medians or in traffic calming bays.
- There must be sufficient space available to accommodate both the tree canopy and root system.

OC-Specific Design Criteria and Considerations

☐ Mature tree canopy, height, and root system should not interfere with subsurface utilities, suspended powerlines, buildings and foundations, or other existing or planned structures. Required setbacks should be adhered to.

☐ Depending on space constarints, a 20 to 30 foot diameter canopy (at maturity) is recommended for stormwater mitigation.

☐ Native, drought-tolerant species should be selected in order to minimize irrigation requirements and improve the long-term viability of trees.

☐ Trees should not impede pedstrian or vehicle sight lines.

☐ Planting locations should receive adequate sunlight and wind protection; other environmental factors should be considered prior to planting.

☐ Frequency and degree of vegetation management and maintenance should be considered with respect to owner capabilities (e.g., staffing, funding, etc.).

☐ Soils should be preserved in their natural condition (if appropriate for planting) or restored via soil amendments to meet minimum criteria described in MISC-2: Amended Soils. If necessary, a landscape architect or plant biologist should be consulted.

☐ A street tree selection guide, such as that specific to the City of Los Angeles, may need to be consulted to select species appropriate for the site design constraints (e.g., parkway size, tree height, canopy spread, etc.)

☐ Infiltration should not cause geotechnical hazards related to adjacent structures (buildings,

roadways, sidewalks, utilities, etc.)

Calculating HSC Retention Volume

- The retention volume provided by streets trees via canopy interception is dependent on the tree species, time of the year, and maturity.
- To compute the retention depth, the expected impervious area covered by the full tree canopy after 4 years of growth must be computed (IA_{HSC}). The maximum retention depth credit for canopy interception (d_{HSC}) is 0.05 inches over the area covered by the canopy at 4 years of growth.

Configuration for Use in a Treatment Train

- As a HSC, street trees would serve as the first step in a treatment train by reducing the treatment volume and flow rate of a downstream treatment BMP.

Additional References for Design Guidance

- California Stormwater BMP Handbook.
  http://www.cabmphandbooks.com/Documents/Development/Section_3.pdf
- City of Los Angeles, Street Tree Division - Street Tree Selection Guide.
  http://bss.lacity.org/UrbanForestryDivision/StreetTreeSelectionGuide.htm
- Portland Stormwater Management Manual.
  http://www.portlandonline.com/bes/index.cfm?c=35122&a=55791
- San Diego County – Low Impact Development Fact Sheets.
  http://www.sdcounty.ca.gov/dplu/docs/LID-Appendices.pdf

STORMWATER Pollution Prevention

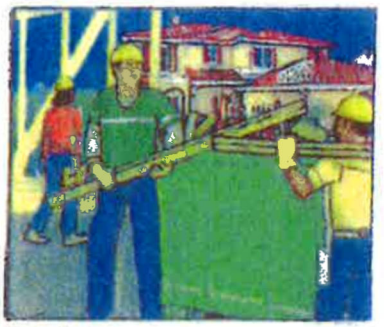
CONSTRUCTION

Cement wash, sediment, vehicle fluids, dust and hazardous debris from construction sites often make their way into the San Bernardino County storm drain system and do not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates waterways, making them unsafe for people and wildlife. Follow these best management practices to prevent pollution and protect public health.



Store Materials Safely

Keep construction materials and debris away from the street, gutter and storm drains. Cover exposed stockpiles of soil, sand or gravel and excavated material with plastic sheeting, protected from rain, wind and runoff.



Ordering Materials & Recycling Waste

Reduce waste by ordering only the amounts of materials needed for the job. Use recycled or recyclable materials whenever possible. You can recycle broken asphalt, concrete, wood, and cleared vegetation. Non-recyclable materials should be taken to a landfill or disposed of as hazardous waste. For recycling and disposal information, call (909) 386-8401.



Cleaning & Preventing Spills

Use a drip pan and funnel when draining or pouring fluids. Sweep up dry spills, instead of hosing. Be ready for spills by preparing and using spill containment and cleanup kits that include safety equipment and dry cleanup materials such as kitty litter or sawdust. To report serious spills, call 911.



Preventing Erosion

Avoid excavation or grading during wet weather. Plant temporary vegetation or add hydromulch on slopes where construction is not immediately planned, and permanent vegetation once excavation and grading are complete. Construct diversion dikes to channel runoff to a detention basin and around the construction site. Channels can be lined with grass or roughened pavement to reduce runoff velocity.



Maintaining Vehicles & Equipment

Maintain and refuel vehicles and equipment at a single location on-site, away from the street, gutter and storm drains. Perform major equipment repairs and washings off-site. Inspect vehicles and equipment frequently for leaks, and prevent leaks from stored vehicles by draining gas, hydraulic oil, transmission, brake and radiator fluids.

To report illegal dumping or for more information on stormwater pollution prevention, call:

1 (800) CLEANUP

www.1800cleanup.org

STORMWATER Pollution Prevention

EXCAVATION AND GRADING

Sediment, cement wash, asphalt and vehicle fluids from soil excavation and grading often make their way into the San Bernardino County storm drain system and do not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates waterways, making them unsafe for people and wildlife. Follow these best management practices to prevent pollution and protect public health.



Recycling Waste
Recycle broken asphalt, concrete, wood, and cleared vegetation whenever possible. Non-recyclable materials should be taken to a landfill or disposed of as hazardous waste. For recycling and disposal information, call (909) 386-8401.



Maintaining Vehicles & Equipment
Maintain and refuel vehicles and equipment at a single location on-site, away from the street, gutters and storm drains. Perform major equipment repairs and washings off-site. Inspect vehicles and equipment frequently for leaks. Use gravel approaches where truck traffic is heavy to reduce soil compaction and limit the tracking of sediment into the street.



Cleaning & Preventing Spills
Use a drip pan and funnel when draining or pouring fluids. Sweep up dry spills, instead of hosing. Be ready for spills by preparing and using spill containment and cleanup kits that include safety equipment and dry cleanup materials such as kitty litter or sawdust. Prevent leaks from stored vehicles by draining gas, hydraulic oil, transmission, brake and radiator fluids. To report serious spills, call 911.



Storing Materials
Keep construction materials and debris away from the street, gutter and storm drains. Cover exposed stockpiles of soil, sand or gravel and excavated material with plastic sheeting, protected from rain, wind and runoff.



Preventing Erosion
Avoid excavation or grading during wet weather. Plant temporary vegetation on slopes where construction is not immediately planned, and permanent vegetation once excavation and grading are complete. Construct diversion dikes to channel runoff. Channels can be lined with grass or roughened pavement to reduce runoff velocity.



To report illegal dumping or for more information on stormwater pollution prevention, call

1 (800) CLEANUP

www.1800cleanup.org

STORMWATER Pollution Prevention

FRESH CONCRETE & MORTAR APPLICATION

Cement wash, sediment, vehicle fluids, dust and hazardous debris from construction sites often make their way into the San Bernardino County storm drain system and do not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates waterways, making them unsafe for people and wildlife. Follow these best management practices to prevent pollution and protect public health.



Storing Materials

Keep construction materials and debris away from the street, gutter and storm drains. Secure open bags of cement and cover exposed stockpiles of soil, sand or gravel and excavated material with plastic sheeting, protected from rain, wind and runoff.



Ordering Materials & Recycling Waste

Reduce waste by ordering only the amounts of materials needed for the job. Use recycled or recyclable materials whenever possible. When breaking up paving, recycle the pieces at a crushing company. You can also recycle broken asphalt, concrete, wood, and cleared vegetation. Non-recyclable materials should be taken to a landfill or disposed of as hazardous waste. Call (909) 386-8401 for recycling and disposal information.



During Construction

Schedule excavation and grading during dry weather. Prevent mortar and cement from entering the street and storm drains by placing erosion controls. Setup small mixers on tarps or drop cloths, for easy cleanup of debris. Never bury waste material. Recycle or dispose of it as hazardous waste.



Cleaning Up

Wash concrete dust onto designated dirt areas, not down driveways or into the street or storm drains. Wash out concrete mixers and equipment in specified washout areas, where water can flow into a containment pond. Cement washwater can be recycled by pumping it back into cement mixers for reuse. Never dispose of cement washout into driveways, streets, gutters, storm drains or drainage ditches.



To report illegal dumping or for storm information on stormwater pollution prevention, call:

1 (800) CLEANUP

www.1800cleanup.org

STORMWATER Pollution Prevention

ROADWORK AND PAVING

Asphalt, saw-cut slurry and excavated materials from road paving, surfacing and pavement removal often make their way into the San Bernardino County storm drain system and do not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates waterways, making them unsafe for people and wildlife. Follow these best management practices to prevent pollution and protect public health.



Preventing Erosion
Schedule excavation and grading work during dry weather. Develop and implement erosion and sediment control plans for excavated embankments. Cover exposed stockpiles of soil, sand or gravel and excavated material with plastic sheeting, protected from rain, wind and runoff.



During Construction
Cover catch basins and maintenance holes when applying seal coat, slurry seal or fog seal. Use check dams, ditches or berms around excavations, and avoid over applying water for dust control. Never wash excess materials from exposed aggregate or concrete into the street, gutter or a storm drain.



Maintaining Vehicles & Equipment
Maintain and refuel vehicles and equipment at a single location on-site, away from the street, gutter and storm drains. Perform major equipment repairs and washings off-site. Inspect vehicles and equipment frequently for leaks, and prevent leaks from stored vehicles by draining gas, hydraulic oil, transmission, brake and radiator fluids.

Asphalt & Concrete Removal
Barricade storm drain openings during saw-cutting, and recycle broken up pavement at a crushing company. For recycling information, call (909) 386-8401.





Cleaning & Preventing Spills
Be ready for spills by preparing and using spill containment and cleanup kits that include safety equipment and dry cleanup materials such as kitty litter or sawdust. Sweep up dry spills, instead of hosing. Prevent spills from paver machines by using drip pans, or by placing absorbent materials like cloths or rags under the machines when not in use. To report serious spills, call 911.

To report illegal dumping or for more information on stormwater pollution prevention, call:

1 (800) CLEANUP

www.1800cleanup.org

STORMWATER Pollution Prevention

PAINTING

Paints, solvents, adhesives and other toxic chemicals used in painting often make their way into the San Bernardino County storm drain system and do not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates waterways, making them unsafe for people and wildlife. Follow these simple tips to prevent pollution and protect our health.



Water-Based Paints
Use water-based paints whenever possible. They are less toxic than oil-based paints and easier to clean up. Look for products labeled "latex" or "cleans with water."



Paint Removal
Sweep up paint stripping residue, chips and dust instead of hosing into the street and dispose of them safely at a household hazardous waste collection facility. Call (800) CLEANUP for the facility in your area.



Painting Cleanup
Never clean brushes or rinse paint containers in the street, gutter or near a storm drain. Clean water-based paints in the sink. Clean oil-based paints with thinner, which can be reused by putting it in a jar to settle out the paint particles and then pouring off the clear liquid for future use. Wrap dried paint residue in newspaper and dispose of it in the trash.



Exterior Paint Removal
When stripping or cleaning building exteriors with high-pressure water, block nearby storm drains and divert washwater onto a designated dirt area. Ask your local wastewater treatment authority if you can collect building cleaning water and discharge it to the sewer.



Recycling Paint
Recycle leftover paint at a household hazardous waste collection facility, save it for touch ups or give it to someone who can use it, like a theatre group, school, city or community organization.

To report illegal dumping or for more information on stormwater pollution prevention, call:

1 (800) CLEANUP

www.1800cleanup.org

STORMWATER Pollution Prevention

HOME & GARDEN

Yard waste and household toxics like paints and pesticides often make their way into the San Bernardino County storm drain system and do not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates waterways, making them unsafe for people and wildlife. Follow these simple tips to prevent pollution and protect your health.



Recycle Household Hazardous Waste
Household products like paint, pesticides, solvents and cleaners are too dangerous to dump and too toxic to trash. Take them to be recycled at a convenient household hazardous waste collection facility. Call (800) CLEANUP for the facility in your area.



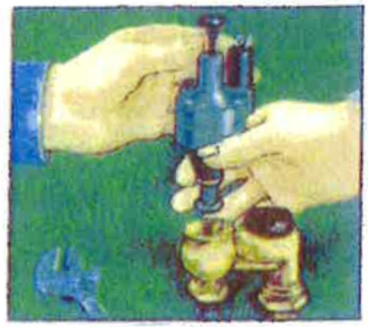
Disposing of Yard Waste
Recycle leaves, grass clippings and other yard waste, instead of blowing, sweeping or hosing into the street. Try grasscycling, leaving grass clippings on your lawn instead of using a grass catcher. The clippings act as a natural fertilizer, and because grass is mostly water, it also irrigates your lawn, conserving water.



Use Fertilizers & Pesticides Safely
Fertilizers and pesticides are often carried into the storm drain system by sprinkler runoff. Try using organic or non-toxic alternatives. If you use chemical fertilizers or pesticides, avoid applying near curbs and driveways and never apply before a rain.



Planting in the Yard
Produce less yard waste and save water by planting low maintenance, drought-tolerant trees and shrubs. Using drip irrigation, soaker hoses or micro-spray systems for flower beds and vegetation can also help reduce your water bill and prevent runoff.



Use Water Wisely
Cut your water costs and prevent runoff by controlling the amount of water and direction of sprinklers. The average lawn needs about an inch of water a week, including rainfall, or 10 to 20 minutes of watering. A half-inch per week is enough for fall and spring. Sprinklers should be on long enough to allow water to soak into the ground but not so long as to cause runoff.

To report illegal dumping or for more information on stormwater pollution prevention, call:

1 (800) CLEANUP

www.1800cleanup.org

STORMWATER Pollution Prevention

FOOD AND RESTAURANT

Food waste, grease, cleaning fluids, mop water and trash from restaurant operations often make their way into the San Bernardino County storm drain system, and do not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates waterways, making them unsafe for people and wildlife. Follow these best management practices to prevent pollution and protect public health.



Recycle Oil & Grease

Oil and grease wastes can be recycled. Look in the yellow pages for rendering companies, or call (909) 386-8401 for disposal information. Don't pour oil or grease into sinks, floor drains or onto a parking lot or street. Keep grease bins covered and contained. Keep your grease interceptor maintained to prevent sewer overflows or backups and keep records of grease waste hauling.



Dumpster Areas

Keep dumpster lids closed and the areas around them clean. Do not fill with liquid waste or hose them out. Call your trash hauler to replace any dumpsters that are damaged or leak.



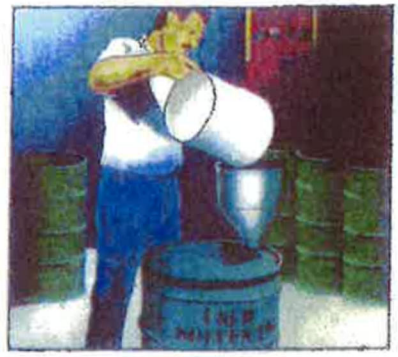
Cleaning & Maintenance

Clean equipment, floor mats, filters and garbage cans in a mop sink, wash rack or floor drain connected to the sewer through a grease trap. Don't wash them or pour wash water in a parking lot, alley, sidewalk or street. Sweep outside areas and put the debris in the garbage, instead of sweeping or hosing it into the parking lot or street.



Managing Spills

Clean food spills in loading and trash areas by using absorbent materials and sweeping then mopping, and discharge mop water into the sewer through a grease interceptor. Have spill containment and cleanup kits available. To report serious toxic spills, call 911.



Handling Toxic Chemicals

Dispose of all unwanted toxics materials like cleaners, solvents and detergents through a hazardous waste hauler. These items are not trash. For information on hazardous waste pickup, call (909) 386-8401. Use non-toxic cleaning products whenever possible.



To report illegal dumping or for more information on stormwater pollution prevention, call

1 (800) CLEANUP

www.1800cleanup.org

Prevención de Contaminación del Desagüe

RESTAURANTES

Desechos de comida, grasa, líquidos de limpieza, agua del trapiador y basura de un restaurant acaban por llegar a los drenajes del Condado de San Bernardino y terminando en el río de Santa Ana. Para prevenir esta contaminación y protejer la salud publica, siga estas practicas.



Reciclando Aceite & Grasa

El aceite y la grasa se pueden reciclar. Busca en las paginas amarillas compañías de reciclaje o llama al (909) 386-8401 para información. No los tires en los lavaderos, las coladeras, el estacionamiento o en la calle. Manten los recipientes de grasa cubiertos y guardados.



Areas de Basura

Manten el bote de basura cerrada y el área del basurero limpia. No lo llenes con desechos líquidos ni utilices la manguera para lavarlo. Llama al transportador de basura para reemplasar los botes de basura que esten dañados.



Limpiando & Mantenimiento

Limpia los tapetes de piso, los filtros y los botes de basura en el conteneder para trapeadores, lavavo, o en la coladera aprupiado que llegue al drenaje. No los laves en el estacionamiento, los callejones, en la banqueta o en la calle. Barre el area de afuera y pon todo en la basura, en ves de dejarlo en la banqueta o en la calle.



Controlando Derrames

Usa métodos secos para limpiar los derrames, barriendo y usando tierra para desechos de gato, no uses la manguera para limpiar los derrames. Manten un kit de limpieza de derramamientos en tu negocio. Para reportar derrames llama al 911.



Manejando Quimicos Toxicos

Deposita los desechos toxicos como limpiadores, solventes, detergentes a un bote para toxicos. Estos no son basura. Para mas información sobre desechos peligrosos, llama al (909) 386-8401. Usa productos de limpieza que no sean toxicos.



Para reportar actividadas ilegales u obtener más información de la prevención de contaminación llamar al

1 (800) CLEANUP

www.1800cleanup.org

Prevención de Contaminación del Desagüe

TRABAJO DE CARRETERAS & PAVIMENTO

Asfalto, mezcle y materiales de excavaciones del pavimento acaban por llegar a los drenajes del Condado de San Bernardino y terminando en el Rio de Santa Ana. Esto contamina el agua que tomamos, haciendola peligorsa para la gente y la vida salvaje. Sigue estas practicas para prevenir la contaminación y protejer la salud publica.



Previniendo Erosiones

Planea las excavaciones trabajo de jardineria durante el clima seco. Desarrolla e implementa planes de embancamientos de control de sedimento y excavaciones. Cubre montones de tierra, grava y otros materiales con un plastico para protejerlos de la lluvia, aire y desagüe.



Durante Construcción

Cubre los lavados y de mantenimiento a los hoyos al aplicar selladura o mezcle. Revisa las areas de excavaciones, y evita pasarte de agua para proveenir polvadura. Nunca laves los materiales llenos de concreto en la calle, drenajes o en el desagüe.



Mantenimiento de Vehiculos & Herramientas

Has el mantenimiento y carga de vehiculos en el mismo lugar, lejos de la calle, las alcantarillas y los drenajes. Inspecciona los vehiculos y el equipo de cualquier goteadura y evita goteaduras de autos que no se usan vaciandoles la gasolina, aceite de transmision, frenos y liquidos del radiador.

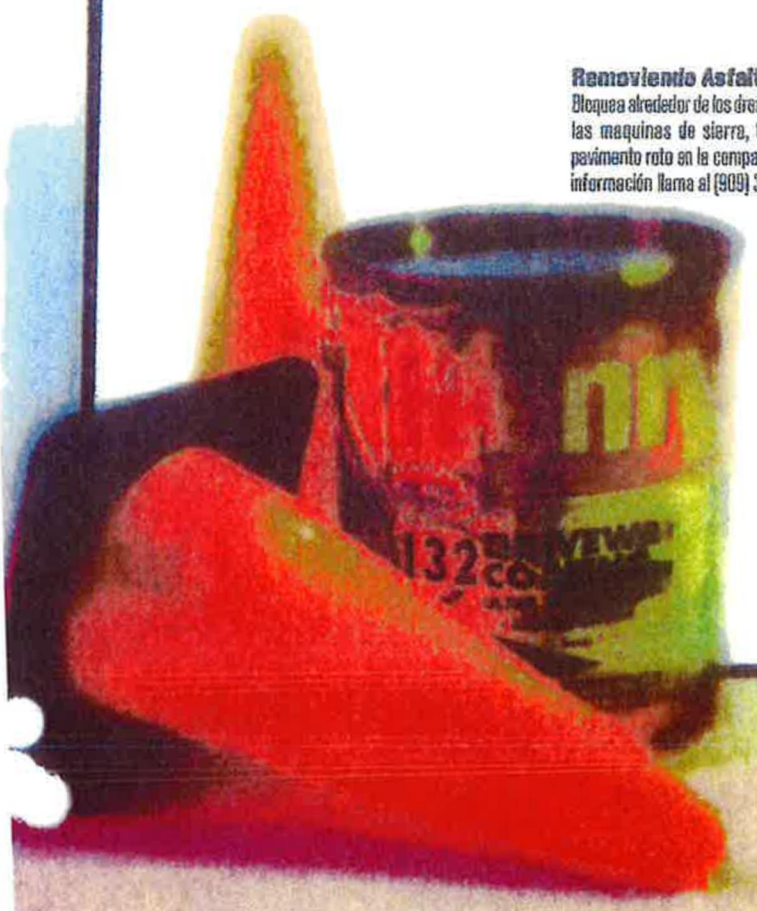
Removiendo Asfalto & Concreto

Bloquea alrededor de los drenajes cuando estes usande las maquinas de sierra, tambien recicla todo el pavimento roto en la compañia demolidora. Para más información llama al (909) 386-8491.



Limpiando & Previniendo Derrames

Mantente siempre preparado para cualquier derrame, usa siempre las herramientas de seguridad al igual que materiales como, tierra para desechos de gato o aserrin Barre los derrames en ves de lavarlos con la manguera. Previene los derrames de las maquinas usando anbudos o colocanto garras para absorver cualquier liquido. Para reportar derrames llama al 911.



Para reportar actividades ilegales u obtener más información de la prevención de contaminación llamar al:

1 (800) CLEANUP

www.1800cleanup.org

Prevención de Contaminación del Desagüe

PINTURA Pintura, solventes y otros quimicos peligrosos que se usan al pintar acaban por llegar a los drenajes del Condado de San Bernardino y terminando en el Rio de Santa Ana. Esto contamina el agua que tomamos, haciendola peligorsa para la gente y la vida salvaje. Sigue estas practicas para prevenir la contaminación y protejer la salud publica.



Pinturas de Agua
Usa pinturas de agua cuando sea posible. Son menos toxicos que las pinturas de aceite y mas faciles para limpiar. Busca los productos "latex" or "cleans with water".



Removiendo Pintura
Residuos de pintura, polvo de pintura y pinturas que contienen plomo son peligrosas. Barrelos en vez de lavarlos con la manguera y desechalos en vez de colección de desechos peligrosos. Llama al (800) CLEANUP para un lugar en tu area.



Limpiando Pintura
Nunca laves las brochas ni los contenedores de pintura en la calle, coladeras o desagües. Las de pintura de agua limpielas en el labavo y las de pintura de aceite con thiner, y vuelvelas a guardar en un frasco, para un uso futuro. Envuelve los residuos de pintura en un periodico y tiralos a la basura.



Removiendo Pintura en Exteriores
Al despintar o lavar exteriores de los edificios con agua de alta presión bloquea los drenajes cercanos y desvia el desagüe. Pregunta las autoridades si puedes desecharla en las alcantarillas.



Reciclando Pintura
Recicla la pintura que sobra en un lugar de colección de materiales peligrosos, guardala para re-toques or regalela a alguien que la use, como a un teatro, a la escuela, una oraganizacion de la ciudad o de la comunidad.

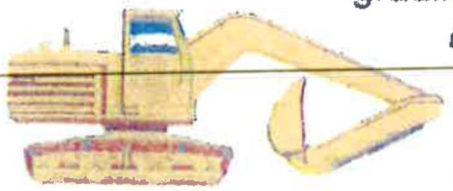
Para reportar actividades ilegales u obtener mas información de la prevención de contaminación llamar al:

1 (800) CLEANUP

www.1800cleanup.org

EXCAVATION & GRADING OPERATIONS

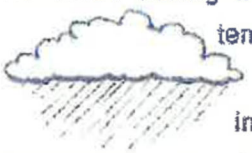
Sediment, cement wash, asphalt, and motor oil from soil excavation and grading operations often make their way into the San Bernardino County storm drain system and DO NOT GET TREATED before reaching the Santa Ana River. These wastes pollute our drinking water, and make our waters unhealthy and unsafe for people and wildlife.



Follow these practices to help prevent stormwater pollution...

Erosion Prevention...

Reduce erosion by avoiding excavation or grading activities during wet weather, and by planting



temporary vegetation on slopes where construction is not immediately planned. Plant permanent vegetation as soon as possible, once excavation and grading activities are complete. Diversion dikes can be constructed to channel runoff around the site; channels can be lined with grass or roughened pavement to reduce runoff velocity. For information on erosion control, call 799-7407.

General Business Practices...

Cover exposed piles of soil and other construction materials with plastic sheeting to prevent contact with rain water.

Recycling...



Recycle broken asphalt, concrete, wood, and cleared vegetation whenever possible. Unrecyclable materials must be taken to an appropriate landfill or disposed of as hazardous waste. For recycling or disposal information, call 386-8401.

Equipment Maintenance...



Maintain all vehicles and equipment by inspecting them frequently for leaks. Also, conduct maintenance and refueling at one location -- away from storm drains, and perform major equipment repairs and washings off site. Finally, use gravel approaches where truck traffic is frequent to reduce soil compaction and limit the tracking of sediment into the streets.

Spills...

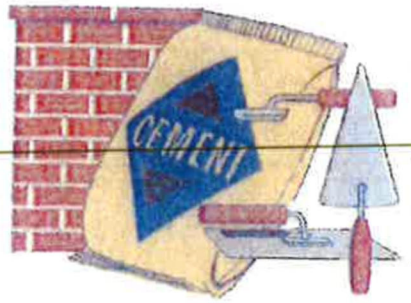
Avoid accidental spills by using a drip pan and funnel when draining or pouring fluids. Be ready for unexpected spills by preparing and using easy to find



spill containment and cleanup kits. Kits should include safety equipment and cleanup materials such as kitty litter, sawdust or commeal. Furthermore, prevent leaks from stored vehicles by draining gas, hydraulic oil, and transmission, brake & radiator fluid. REMEMBER: Never hose down dirty surfaces. To report serious spills, call 1-800-33-TOXIC.

For more information, call your city's stormwater representative

FRESH CONCRETE & MORTAR APPLICATION



Cement, cement wash, gravel, asphalt, solvents, and motor oil from fresh concrete and mortar activities often make their way into the San Bernardino County storm drain system and DO NOT GET TREATED before reaching the Santa Ana River. These wastes pollute our drinking water, and make our waters unhealthy and unsafe for people and wildlife.

Follow these practices to help prevent stormwater pollution...

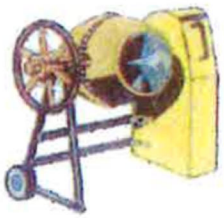
General Business Practices...

Schedule excavation and grading work during dry weather, and in case it rains, prevent materials from contacting stormwater by storing them under cover. Also, secure open bags of cement to keep wind-blown cement powder away from streets, gutters and storm drains.



During Construction...

Prevent mortar and cement from entering the storm drains by placing erosion controls (i.e., berms or temporary vegetation) down-slope to capture runoff. When breaking up paving, be sure to pick up all pieces and recycle them at a crushing company; small amounts of excess dry concrete, grout and mortar can be disposed of in the trash. Setup small mixers on tarps or heavy drop cloths to allow for easy cleanup of debris. REMEMBER: Never bury waste material -- recycle or dispose of it as hazardous waste. Call 386-8401 for recycling and disposal information.



Handling Materials & Wastes...

Minimize wastes when ordering materials by ordering only the amounts needed to complete the job. Whenever possible, use recycled or recyclable materials. Recycle broken asphalt, concrete, wood, and cleared vegetation. Unrecyclable materials must be taken to an appropriate landfill or disposed of as hazardous waste. For recycling and disposal information, call 386-8401.



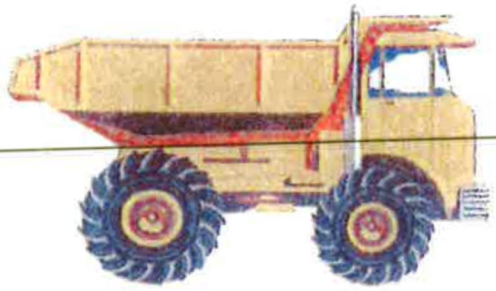
Cleaning up...

When cleaning up after driveway or sidewalk construction, wash concrete dust onto designated dirt areas, not down the driveway or into the street or storm drain. Also, wash out concrete mixers and equipment only in specified wash-out areas, where the water flows into containment ponds. Cement washwater can be recycled by pumping it back into cement mixers for reuse. REMEMBER: Never dispose of cement washout into driveways, streets, gutters, storm drains or drainage ditches.



For more information, call your city's stormwater representative

GENERAL CONSTRUCTION



Soil, cement wash, asphalt and motor oil from construction sites often make their way into the San Bernardino County storm drain system and DO NOT GET TREATED before reaching the Santa Ana River. These wastes pollute our drinking water, and make our waters unhealthy and unsafe for people and wildlife.

Follow these practices to help prevent stormwater pollution...

General Business Practices...

Cover exposed piles of soil and other construction materials with plastic sheeting to prevent contact with rain water.

Erosion Prevention...

Reduce erosion by avoiding excavation or grading activities during wet weather, and by planting temporary vegetation on slopes where construction is not immediately planned.



Plant permanent vegetation as soon as possible, once excavation and grading activities are complete. Diversion dikes can be constructed to channel runoff around the site; channels can be lined with grass or roughened pavement to reduce runoff velocity. For information on erosion control, call 799-7407.

Equipment Maintenance...

Maintain all vehicles and equipment by inspecting them frequently for leaks. Also, conduct maintenance and refueling at one location -- away from storm drains, and perform major equipment repairs and washings off site.

Handling Materials & Waste...

Minimize wastes when ordering materials by ordering only the amounts needed to complete the job. Whenever possible, use recycled or recyclable materials. Recycle broken asphalt, concrete, wood, and cleared vegetation. Unrecyclable materials must be taken to an appropriate landfill or disposed of as hazardous waste. For recycling and disposal information, call 386-8401.

Spills...

Avoid accidental spills by using a drip pan and funnel when draining or pouring fluids. Be ready for unexpected spills by preparing and using easy to find spill containment and cleanup kits. Kits should include safety equipment and cleanup materials such as kitty litter, sawdust or commeal. Furthermore, prevent leaks from stored vehicles by draining gas, hydraulic oil, and transmission, brake & radiator fluid. REMEMBER: Never hose down dirty surfaces; instead, sweep regularly. To report serious spills, call 1-800-33-TOXIC.



For more information, call your city's stormwater representative

HOME & GARDEN



Yard waste and household toxics such as paints, solvents, and pesticides often make their way into the San Bernardino County storm drain system and DO NOT GET TREATED before reaching the Santa Ana River. These wastes pollute our drinking water and make our waters unhealthy and unsafe for people and wildlife.

Follow these practices to help prevent stormwater pollution...

In Your Home...

Household products such as paints, paint thinners, drain openers, motor oil, wood polishes, insecticides & herbicides, oven cleaners, and many other general cleaners frequently get dumped on the ground, or into a gutter, street or storm drain. Instead of polluting our stormwaters, take these items to a household hazardous waste collection facility. Call 1-800-OILY-CAT for a facility in your area.



Fertilizers and Pesticides...

Fertilizers and pesticides are often carried into our storm drains by sprinkler runoff. To minimize stormwater pollution, use organic or non-toxic pesticides and fertilizers as directed, and keep them away from ditches, gutters and storm drains. Store them in a covered area, off the ground, to prevent contact with water. For additional gardening questions, call the San Bernardino Master Gardeners at 387-2182.



Trimmin' the Garden...

Decaying organic materials that enter our storm drains, such as grass, leaves, yard clippings, and pet waste, will use up oxygen in nearby streams, stressing aquatic life. Prevent stormwater pollution by not blowing, sweeping, raking or hosing yard waste into the street, gutter, or storm drain. Alternatively, leave grass clippings on your lawn after mowing, or compost your clippings and yard waste. Pet waste should not be composted, but rather disposed of in the trash to prevent the potential spread of diseases.



Planting In The Yard

Produce less yard waste and save water by planting low maintenance trees and shrubs. Also, conserve water and minimize unwanted runoff by using drip irrigation, soaker hoses, or micro-spray systems to water vegetation.



For more information, call your city's stormwater representative

HOME REPAIR & REMODELING

Paints, solvents, adhesives, dusts, sediments, pesticides and household toxics commonly associated with home repair and remodeling activities often make their way into the San Bernardino County storm drain system and DO NOT GET TREATED before reaching the Santa Ana River. These wastes pollute our drinking water, and make our waters unhealthy and unsafe for people and wildlife.



Follow these practices to help prevent stormwater pollution...

Household Hazardous Wastes...

Common household cleaners, paint products, and wallpaper & tile adhesives contain toxic substances. Dispose of these products properly. REMEMBER: Toxic wastes should never enter the storm drain system. For disposal information, call 1-800-OILY-CAT.



Construction...

Keep all construction debris away from the street, gutter and storm drain, and if possible, schedule grading and excavation projects for dry weather. Cover excavated material and stockpiles of asphalt, sand, etc. with plastic tarps, and prevent erosion by planting fast-growing annual and perennial grasses, which will shield and bind the soil.

Landscape & Gardening...

Use fertilizers and pesticides as directed. Keep them away from ditches, gutters and storm drains, and store them in a covered area to prevent contact with rain water. Also, minimize runoff and conserve water by using drip irrigation, soaker hoses, or micro-spray systems. REMEMBER: Do not deposit leaves into the street, gutter, or storm drain.



Painting...

CLEANUP... Avoid cleaning brushes or rinsing paint containers into a street, gutter, or storm drain. For water-based paints, "brush out" as much paint as possible, and rinse in the sink. For oil-based paints, "brush out" as much paint as possible, clean with thinner, and then filter and reuse thinner or solvent.



REMOVAL... Paint stripping residue, chips & dust from marine paints, and paints containing lead or tributyl tin are hazardous wastes. Sweep them up and call 1-800-OILY-CAT for disposal information.

RECYCLING... Recycle or reuse leftover paint by using it for touch-ups, or by giving it to someone who can us it, such as a theatre group, school, city or other community organization. If you're unable to give it away, contact 1-800-OILY-CAT for disposal information.

Concrete & Masonry...

Store bags of cement and plaster away from gutters and storm drains, and under cover, protected from rainfall, runoff and wind. REMEMBER: Never dispose of cement washout or concrete dust onto driveways, streets, gutters or storm drains.

For more information, call your city's stormwater representative



PAINTING

Paints, solvents, adhesives, and toxic chemicals from painting operations often make their way into the San Bernardino County storm drain system and DO NOT GET TREATED before reaching the Santa Ana River. These wastes pollute our drinking water, and make our waters unhealthy and unsafe for people and wildlife.

Follow these practices to help prevent stormwater pollution...

General Business Practices...

Keep all paint products and wastes away from the street, gutter, and storm drains. Reuse paint thinner by setting used thinner aside in a closed, labeled jar to settle out paint particles, and then pouring off the clear liquid for future use. Wrap dried paint residue in newspaper and dispose of it in the trash.

Water-Based Paints...

Purchase water-based paints whenever possible. Look for products labeled "latex" or "clean up with water."

Recycle or Reuse Paints...

Recycle/reuse leftover paint by using it for touch-ups, or by giving it to someone who can use it, such as a theatre group, school, city or other community organization. If you're unable to give it away, contact 386-8401 for information on hazardous waste pick-up.

Paint Cleanup...



Avoid cleaning brushes and rinsing paint containers in a street, gutter, or storm drain. For water-based paints, "brush out" as much paint as possible and and rinse in the sink. For oil-based paints, "brush out" as much paint as possible, clean with thinner, and then filter and reuse thinner or solvent.

Paint Removal...

Chemical paint stripping residue, chips & dust from marine paints, and paints containing lead or tributyl tin are hazardous wastes. For disposal information, call 386-8401. Also, when stripping or cleaning building exteriors with high-pressure water, block storm drains and divert the washwater onto a designated dirt area. Check with your local wastewater treatment authority to find out if you can collect building cleaning water and discharge it to the sewer.



For more information, call your city's stormwater representative

ROADWORK & PAVING

Asphalt, saw-cut slurry, and excavated materials from Road paving, surfacing and pavement removal operations often make their way into the San Bernardino County storm drain system and DO NOT GET TREATED before reaching the Santa Ana River. These wastes pollute our drinking water, and make our waters unhealthy and unsafe for people and wildlife.



Follow these practices to help prevent stormwater pollution...

During Construction...

Cover catch basins and maintenance holes when applying seal coat, slurry seal, fog seal, etc. Use check dams, ditches or berms around excavations, and avoid over-application of water for dust control. REMEMBER: Never wash excess materials from exposed aggregate or concrete into a street, gutter, or storm drain; collect and recycle them.

Asphalt & Concrete Removal...



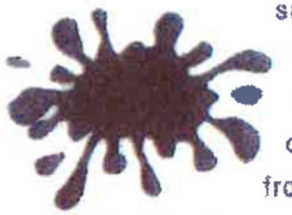
Barricade storm drain openings during saw-cutting, and after breaking up paving, be sure to remove all chunks and pieces and recycle them at a crushing company. For recycling information, call 386-8401.

Equipment Maintenance...

Maintain all vehicles and equipment by inspecting them frequently for leaks. Also, conduct maintenance and refueling at one location -- away from storm drains, and perform major equipment repairs and washings off site.

Spills...

Be ready for unexpected spills by preparing and using spill containment and cleanup kits. Kits should include safety equipment and cleanup materials such as kitty litter, sawdust or cornmeal. Prevent drips from paver machines by catching fluids with drip pans or by placing absorbent material (cloth, rags, etc....) underneath the machines when they're not in use. To report serious spills, call 1-800-33-TOXIC.



General Business Practices...

Schedule excavation and grading work during dry weather, and develop and implement erosion and sediment control plans for excavated embankments. In case it rains, cover exposed piles of soil and other construction materials with plastic sheeting to prevent contact with rain water.



For more information, call your city's stormwater representative

Attachment D
Infiltration Report

GEOTECHNICAL INVESTIGATION
PHELAN 20 INDUSTRIAL BUILDING

Phelan Road, 650± feet East of Los Banos Avenue
Hesperia, California
for
Cambria 60 Partners LLC

SoCalGeo
SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

May 23, 2023

Cambria 60 Partners LLC
14180 Dallas Parkway, Suite 730
Dallas, Texas 75254

Attention: Mr. Ron Rakunas

Project No.: **23G131-1**

Subject: **Geotechnical Investigation**
Phelan 20 Industrial Building
Phelan Road, 650± feet east of Los Banos Avenue
Hesperia, California

Mr. Rakunas:

In accordance with your request, we have conducted a geotechnical investigation at the subject site. We are pleased to present this report summarizing the conclusions and recommendations developed from our investigation.

We sincerely appreciate the opportunity to be of service on this project. We look forward to providing additional consulting services during the course of the project. If we may be of further assistance in any manner, please contact our office.

Respectfully Submitted,

SOUTHERN CALIFORNIA GEOTECHNICAL, INC.

Pablo Montes Jr.
Project Engineer

Robert G. Trazo, M.Sc., GE 2655
Principal Engineer

REGISTERED PROFESSIONAL ENGINEER
ROBERT TRAZO
No. 2655
GEOTECHNICAL
STATE OF CALIFORNIA

Distribution: (1) Addressee

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APPENDICES

A Plate 1: Site Location Map
Plate 2: Boring Location Plan
B Boring Logs
C Laboratory Test Results
D Grading Guide Specifications
E Seismic Design Parameters

1.0 EXECUTIVE SUMMARY

Presented below is a brief summary of the conclusions and recommendations of this investigation. Since this summary is not all inclusive, it should be read in complete context with the entire report.

Site Preparation Recommendations

- Site stripping will be necessary to remove the dense native grass and shrub growth which is present throughout the majority of the site. Trees and their associated root masses should be removed in their entirety. All vegetation and any organic topsoil should be removed during site stripping.
- The soils encountered at the boring locations consist of younger native alluvium, underlain by older alluvium. The near-surface younger alluvium generally possesses varying densities and low strengths. The results of laboratory testing indicate that some of the near-surface alluvium possesses unfavorable consolidation/collapse characteristics. Based on these considerations, remedial grading is recommended to be performed within the proposed building area in order to remove a portion of the near-surface native alluvium and replace these materials as compacted structural fill.
- The existing soils within the proposed building area should be overexcavated to a depth of 5 feet below existing grades and to a depth of 3 feet below proposed pad grades. The proposed foundation influence zones should be overexcavated to a depth of at least 3 feet below proposed foundation bearing grade. The overexcavation should also extend to a sufficient depth to remove any variability in the soils.
- After overexcavation has been completed, the resulting subgrade soils should be evaluated by the geotechnical engineer to identify any additional soils that should be overexcavated. The resulting soils should be scarified and moisture conditioned to achieve a moisture content of 0 to 4 percent above optimum moisture, to a depth of at least 12 inches. The overexcavation subgrade soils should then be recompacted under the observation of the geotechnical engineer. The previously excavated soils may then be replaced as compacted structural fill.
- The new pavement and flatwork subgrade soils are recommended to be scarified to a depth of 12± inches, thoroughly moisture conditioned and recompacted to at least 90 percent of the ASTM D-1557 maximum dry density.

Building Foundation Recommendations

- Spread footing foundations, supported in newly placed structural fill soils.
- Maximum, net allowable soil bearing pressure: 3,000 lbs/ft^2.
- Reinforcement consisting of at least two (2) No. 5 rebars (1 top and 1 bottom) in strip footings. Additional reinforcement may be necessary for structural considerations.

Building Floor Slab Recommendations

- Conventional Slab on Grade, at least 6 inches thick
- Modulus of Subgrade Reaction: k = 150 psi/in
- Reinforcement is not considered to be necessary for geotechnical considerations.
- The actual thickness and reinforcement of the floor slab should be determined by the structural engineer, based on the imposed slab loading.

Pavements

ASPHALT PAVEMENTS (R=40)					
Materials	**Thickness (inches)**				
	Auto Parking and Auto Drive Lanes (TI = 4.0 to 5.0)	Truck Traffic			
		TI = 6.0	TI = 7.0	TI = 8.0	TI = 9.0
Asphalt Concrete	3	3½	4	5	5½
Aggregate Base	4	6	7	8	10
Compacted Subgrade	12	12	12	12	12

PORTLAND CEMENT CONCRETE PAVEMENTS (R=40)				
Materials	**Thickness (inches)**			
	Autos and Light Truck Traffic (TI = 6.0)	Truck Traffic		
		TI = 7.0	TI = 8.0	TI = 9.0
PCC	5	5½	6½	8
Compacted Subgrade (95% minimum compaction)	12	12	12	12

2.0 SCOPE OF SERVICES

The scope of services performed for this project was in accordance with our Proposal No. 23P122R2, dated March 30, 2023. The scope of services included a visual site reconnaissance, subsurface exploration, field and laboratory testing, and geotechnical engineering analysis to provide criteria for preparing the design of the building foundations, building floor slab, and parking lot pavements along with site preparation recommendations and construction considerations for the proposed development. The evaluation of the environmental aspects of this site was beyond the scope of services for this geotechnical investigation.

3.0 SITE AND PROJECT DESCRIPTION

3.1 Site Conditions

The subject site is located on the south side of Phelan Road, 650± feet east of Los Banos Avenue in Hesperia, California. The site is bounded to the north by Phelan Road, to the west by a vacant lot and a single-family residence, and to the south and east by vacant parcels. The Oro Grande Wash is located to the southeast of the property. The general location of the site is illustrated on the Site Location Map, included as Plate 1 of this report.

The site consists of a rectangular-shaped parcel, 19.3± acres in size. The site is vacant and undeveloped. Ground surface cover throughout the site consists of exposed soils with moderate to heavy native grass, weed and shrub growth. Small trees are also present throughout the site in sparse concentration.

Detailed topographic information was obtained from a schematic site plan, prepared by RGA. Based on the elevation data provided on that plan, the overall site topography generally slopes downward to the northeast at a gradient of 2± percent. The Oro Grande Wash is located to the southeast of the property. The bottom of the Oro Grande Wash extends approximately 50 to 60± feet below the adjacent site grades. A descending slope extends from the site downward to the wash at an inclination of approximately 4h:1v (horizontal to vertical).

3.2 Proposed Development

Based on the site plan that was provided to our office, the site will be developed with one (1) industrial building, 420,000± ft² in size. The building will be located in the west-central area of the site, with dock-high doors along a portion of the east building wall. The building will be surrounded by asphaltic concrete pavements in the automobile parking and drive areas, Portland cement concrete pavements in the truck court, and areas of concrete flatwork and landscape planters.

Detailed structural information has not been provided. It is assumed that the new building will be a single-story structure of tilt-up concrete construction, typically supported on a conventional shallow foundation with a concrete slab-on-grade floor. Based on the assumed construction, maximum column and wall loads are expected to be on the order of 100 kips and 4 to 7 kips per linear foot, respectively.

No significant amounts of below-grade construction, such as basements or crawl spaces, are expected to be included in the proposed development. Based on the existing site topography, cuts and fills of 7 to 15± feet will be necessary to achieve the proposed site grades. It is expected that cut slopes and fill slopes along with new retaining walls will be required in order to achieve the new site grades.

4.0 SUBSURFACE EXPLORATION

4.1 Scope of Exploration/Sampling Methods

The subsurface exploration performed for this project consisted of seven (7) borings (identified as Boring Nos. B-1 through B-7) advanced to depths of 15 to 25± feet below the existing site grades. All of the borings were logged during drilling by a member of our staff.

The borings were advanced with hollow-stem augers, by a conventional truck-mounted drilling rig. Representative bulk and relatively undisturbed soil samples were taken during drilling. Relatively undisturbed samples were taken with a split barrel "California Sampler" containing a series of one-inch-long, 2.416± inch diameter brass rings. This sampling method is described in ASTM Test Method D-3550. Samples were also taken using a 1.4±-inch inside diameter split spoon sampler, in general accordance with ASTM D-1586. Both of these samplers are driven into the ground with successive blows of a 140-pound weight falling 30 inches. The blow counts obtained during driving are recorded for further analysis. Bulk samples were collected in plastic bags to retain their original moisture content. The relatively undisturbed ring samples were placed in molded plastic sleeves that were then sealed and transported to our laboratory.

The approximate locations of the borings are indicated on the Boring Location Plan, included as Plate 2 in Appendix A of this report. The Boring Logs, which illustrate the conditions encountered at the boring locations, as well as the results of some of the laboratory testing, are included in Appendix B.

4.2 Geotechnical Conditions

Younger Alluvium

All of the borings encountered native younger alluvial soils at the ground surface, extending to depths ranging from 5½ to 12± feet below existing site grades. These soils generally consist of very loose to medium dense silty fine sands, varying medium to coarse sand, clay and gravel content.

Older Alluvium

Native older alluvium was encountered beneath the younger alluvium at all of the boring locations, extending to at least the maximum explored depth of 25± feet below existing site grades. The older alluvial soils consist of medium dense to very dense silty fine to coarse sands with occasional clayey fine to coarse sands, with varying gravel content. Some of the samples of the older alluvial soils were weakly cemented.

Groundwater

Free water was not encountered during the drilling of any of the borings. Based on the lack of any water within the borings and the moisture contents of the recovered soil samples, the static groundwater table is considered to have existed at a depth in excess of 30± feet at the time of the subsurface exploration.

As part of our research, we also reviewed recent groundwater data available for wells within the vicinity of the site. Recent water level data was obtained from the California Department of Water Resources website, http://www.water.ca.gov/waterdatalibrary/. The nearest monitoring well with available records in this database is located 800 feet to the southeast, adjacent to the Oro Grande Wash. Water level readings within this monitoring well indicates a groundwater level of 658± feet below the ground surface in September 2022.

5.0 LABORATORY TESTING

The soil samples recovered from the subsurface exploration were returned to our laboratory for further testing to determine selected physical and engineering properties of the soils. The tests are briefly discussed below. It should be noted that the test results are specific to the actual samples tested, and variations could be expected at other locations and depths.

Classification

All recovered soil samples were classified using the Unified Soil Classification System (USCS), in accordance with ASTM D-2488. Field identifications were then supplemented with additional visual classifications and/or by laboratory testing. The USCS classifications are shown on the Boring Logs and are periodically referenced throughout this report.

Density and Moisture Content

The density has been determined for selected relatively undisturbed ring samples. These densities were determined in general accordance with the method presented in ASTM D-2937. The results are recorded as dry unit weight in pounds per cubic foot. The moisture contents are determined in accordance with ASTM D-2216, and are expressed as a percentage of the dry weight. These test results are presented on the Boring Logs.

Consolidation

Selected soil samples have been tested to determine their consolidation potential, in accordance with ASTM D-2435. The testing apparatus is designed to accept either natural or remolded samples in a one-inch-high ring, approximately 2.416 inches in diameter. Each sample is then loaded incrementally in a geometric progression and the resulting deflection is recorded at selected time intervals. Porous stones are in contact with the top and bottom of the sample to permit the addition or release of pore water. The samples are typically inundated with water at an intermediate load to determine their potential for collapse or heave. The results of the consolidation testing are plotted on Plates C-1 through C-8 in Appendix C of this report.

Maximum Dry Density and Optimum Moisture Content

One representative bulk sample of the near-surface soils has been tested to determine its maximum dry density and optimum moisture content. The results have been obtained using the Modified Proctor procedure, per ASTM D-1557 and are presented on Plate C-9 in Appendix C of this report. This test is generally used to compare the in-situ densities of undisturbed field samples, and for later compaction testing. Additional testing of other soil types or soil mixes may be necessary at a later date.

Expansion Index

The expansion potential of the on-site soils was determined in general accordance with ASTM D-4829. The testing apparatus is designed to accept a 4-inch diameter, 1-in high, remolded sample. The sample is initially remolded to 50± 1 percent saturation and then loaded with a surcharge

equivalent to 144 pounds per square foot. The sample is then inundated with water and allowed to swell against the surcharge. The resultant swell or consolidation is recorded after a 24-hour period. The results of the EI testing are as follows:

Sample Identification	Expansion Index	Expansive Potential
B-7 @ 1 to 5 feet	0	Non-Expansive

Soluble Sulfates

A representative sample of the near-surface soils has been submitted to a subcontracted analytical laboratory for evaluation of soluble sulfate content. Soluble sulfates are naturally present in soils, and if the concentration is high enough, can result in degradation of concrete which comes into contact with these soils. The result of the soluble sulfate testing is presented below, and are discussed further in a subsequent section of this report.

Sample Identification	Soluble Sulfates (%)	Severity
B-1 @ 1 to 5 feet	<0.001	Not Applicable (S0)

Corrosivity Testing

A representative bulk sample of the near-surface soils was submitted to a subcontracted corrosion engineering laboratory to determine if the near-surface soils possess corrosive characteristics with respect to common construction materials. The corrosivity testing included a determination of the electrical resistivity, pH, and chloride and nitrate concentrations of the soils, as well as other tests. The results of some of these tests are presented below.

Sample Identification	Minimum Resistivity (ohm-cm)	pH	Chlorides (mg/kg)	Nitrates (mg/kg)	Sulfides (mg/kg)	Redox Potential (mV)
B-1 @ 1 to 5 feet	13,400	8.2	14.5	9.0	1.3	140

6.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the results of our review, field exploration, laboratory testing and geotechnical analysis, the proposed development is considered feasible from a geotechnical standpoint. The recommendations contained in this report should be taken into the design, construction, and grading considerations.

The recommendations are contingent upon all grading and foundation construction activities being monitored by the geotechnical engineer of record. The recommendations are provided with the assumption that an adequate program of client consultation, construction monitoring, and testing will be performed during the final design and construction phases to verify compliance with these recommendations. Maintaining Southern California Geotechnical, Inc., (SCG) as the geotechnical consultant from the beginning to the end of the project will provide continuity of services. The geotechnical engineering firm providing testing and observation services shall assume the responsibility of Geotechnical Engineer of Record.

The Grading Guide Specifications, included as Appendix D, should be considered part of this report, and should be incorporated into the project specifications. The contractor and/or owner of the development should bring to the attention of the geotechnical engineer any conditions that differ from those stated in this report, or which may be detrimental for the development.

6.1 Seismic Design Considerations

The subject site is located in an area which is subject to strong ground motions due to earthquakes. The performance of a site-specific seismic hazards analysis was beyond the scope of this investigation. However, numerous faults capable of producing significant ground motions are located near the subject site. Due to economic considerations, it is not generally considered reasonable to design a structure that is not susceptible to earthquake damage. Therefore, significant damage to the structure may be unavoidable during large earthquakes. The proposed structure should, however, be designed to resist structural collapse and thereby provide reasonable protection from serious injury, catastrophic property damage and loss of life.

Faulting and Seismicity

Research of available maps indicates that the subject site is not located within an Alquist-Priolo Earthquake Fault Zone. Furthermore, SCG did not identify any evidence of faulting during the geotechnical investigation. Therefore, the possibility of significant fault rupture on the site is considered to be low.

The potential for other geologic hazards such as seismically induced settlement, lateral spreading, tsunamis, inundation, seiches, flooding, and subsidence affecting the site is considered low.

Seismic Design Parameters

The 2022 California Building Code (CBC) provides procedures for earthquake resistant structural design that include considerations for on-site soil conditions, occupancy, and the configuration of the structure including the structural system and height. The seismic design parameters presented below are based on the soil profile and the proximity of known faults with respect to the subject site. Based on the anticipated adoption of the 2022 California Building Code (CBC) on January 1, 2023, we expect that the proposed development will be designed in accordance with the 2022 CBC.

The 2022 CBC Seismic Design Parameters have been generated using the SEAOC/OSHPD Seismic Design Maps Tool, a web-based software application available at the website www.seismicmaps.org. This software application calculates seismic design parameters in accordance with several building code reference documents, including ASCE 7-16, upon which the 2022 CBC is based. The application utilizes a database of risk-targeted maximum considered earthquake (MCE_R) site accelerations at 0.01-degree intervals for each of the code documents. The table below was created using data obtained from the application. The output generated from this program is attached to this letter.

The 2022 CBC states that for Site Class D sites with a mapped S1 value greater than 0.2, a site-specific ground motion analysis may be required in accordance with Section 11.4.8 of ASCE 7-16. Supplement 3 to ASCE 7-16 modifies Section 11.4.8 of ASCE 7-16 and states that "a ground motion hazard analysis is not required where the value of the parameter SM1 determined by Eq. (11.4-2) is increased by 50% for all applications of SM1 in this Standard. The resulting value of the parameter SD1 determined by Eq. (11.4-4) shall be used for all applications of SD1 in this Standard."

The seismic design parameters presented in the table below were calculated using the site coefficients (Fa and Fv) from Tables 1613.2.3(1) and 1613.2.3(2) presented in Section 16.4.4 of the 2022 CBC. It should be noted that the site coefficient Fv and the parameters SM1 and SD1 were not included in the SEAOC/OSHPD Seismic Design Maps Tool output for the ASCE 7-16 standard. We calculated these parameters-based on Table 1613.2.3(2) in Section 16.4.4 of the 2022 CBC using the value of S1 obtained from the Seismic Design Maps Tool. **The values of SM1 and SD1 tabulated below** were evaluated using equations 11.4-2 and 11.4-4 of ASCE 7-16 (Equations 16-20 and 16-23, respectively, of the 2022 CBC) and **do not include a 50 percent increase.** As discussed above, if a ground motion hazard analysis has not been performed, SM1 and SD1 must be increased by 50 percent for all applications with respect to ASCE 7-16.

2022 CBC SEISMIC DESIGN PARAMETERS

Parameter		Value
Mapped Spectral Acceleration at 0.2 sec Period	S_S	1.500
Mapped Spectral Acceleration at 1.0 sec Period	S_1	0.600
Site Class	---	D
Site Modified Spectral Acceleration at 0.2 sec Period	S_{MS}	1.500
Site Modified Spectral Acceleration at 1.0 sec Period	S_{M1}	1.020*
Design Spectral Acceleration at 0.2 sec Period	S_{DS}	1.000
Design Spectral Acceleration at 1.0 sec Period	S_{D1}	0.680*

*Note: These values must be increased by 50 percent if a site-specific ground motion hazard analysis has not been performed. However, this increase is not expected to affect the design of the structure type proposed for this site. This assumption should be confirmed by the project structural engineer. The values presented in the table above do not include a 50-percent increase.

Liquefaction

Liquefaction is the loss of the strength in generally cohesionless, saturated soils when the pore-water pressure induced in the soil by a seismic event becomes equal to or exceeds the overburden pressure. The primary factors which influence the potential for liquefaction include groundwater table elevation, soil type and grain size characteristics, relative density of the soil, initial confining pressure, and intensity and duration of ground shaking. The depth within which the occurrence of liquefaction may impact surface improvements is generally identified as the upper 50 feet below the existing ground surface. Liquefaction potential is greater in saturated, loose, poorly graded fine sands with a mean (d_{50}) grain size in the range of 0.075 to 0.2 mm (Seed and Idriss, 1971). Clayey (cohesive) soils or soils which possess clay particles (d<0.005mm) in excess of 20 percent (Seed and Idriss, 1982) are generally not considered to be susceptible to liquefaction, nor are those soils which are above the historic static groundwater table.

The California Geological Survey (CGS) has not yet conducted detailed seismic hazards mapping in the area of the subject site. The general liquefaction susceptibility of the site was determined by research of the San Bernardino County Land Use Plan, General Plan, Geologic Hazard Overlays. Map FH05 for the Baldy Mesa 7.5-Minute Quadrangle indicates that the subject site is not located within an area of liquefaction susceptibility. Based on the mapping performed by the county of San Bernardino, the subsurface profile identified in this report, which includes moderate to high strength older alluvium, and the lack of a historic high groundwater table within the upper 50± feet, liquefaction is not considered to be a design concern for this project.

6.2 Geotechnical Design Considerations

General

The near-surface soils encountered at the boring locations consist of native younger alluvium, which possesses variable densities and strengths. The results of laboratory testing indicate that some of the near-surface soils possess unfavorable consolidation/collapse characteristics. Based on their variable strengths and densities and their potential for collapse, the near-surface younger

alluvial soils, in their present condition, are not considered suitable for the support of the new foundations and floor slab. The younger alluvial soils are underlain by moderate strength older alluvium which possesses more favorable consolidation/collapse characteristics. Remedial grading is recommended within the area of the proposed building, in order to remove and replace a portion of the near-surface younger alluvial soils as compacted structural fill.

Settlement

Laboratory testing indicates that some samples of soils taken from the near-surface native alluvial soils possess a minor collapse potential when exposed to moisture infiltration. The proposed remedial grading will remove the near-surface collapsible native soils from within the proposed building area. Therefore, following completion of the recommended grading, post-construction settlements are expected to be within tolerable limits.

Expansion

Laboratory testing performed on a representative sample of the near surface soils indicates that these materials possess a non-expansion potential (EI = 0). Therefore, no design considerations related to expansive soils are considered warranted for this site. It is recommended that additional expansion index testing be conducted at the completion of rough grading to verify the expansion potential of the as-graded building pad.

Soluble Sulfates

The result of the soluble sulfate testing indicates that the tested soil sample possesses a level of soluble sulfates that is considered to be "not applicable" (S0) with respect to the American Concrete Institute (ACI) Publication 318-14 Building Code Requirements for Structural Concrete and Commentary, Section 4.3. Therefore, specialized concrete mix designs are not considered to be necessary, with regard to sulfate protection purposes. It is, however, recommended that additional soluble sulfate testing be conducted at the completion of rough grading to verify the soluble sulfate concentrations of the soils which are present at pad grade within the building expansion area.

Corrosion Potential

The results of laboratory testing indicate that the tested sample of the on-site soils possesses a minimum resistivity of 13,400 ohm-cm, and a pH value of 8.2. These soils possess a redox potential of 140 mV and a sulfide concentration of about 1.3 parts per million. These test results have been evaluated in accordance with guidelines published by the Ductile Iron Pipe Research Association (DIPRA). The DIPRA guidelines consist of a point system by which characteristics of the soils are used to quantify the corrosivity characteristics of the site. Resistivity, pH, sulfide concentration, redox potential, and moisture content are the five factors that enter into the evaluation procedure. Based on these factors, the on-site soils are not considered to be corrosive to ferrous materials. Therefore, corrosion protection is not expected to be required for cast iron or ductile iron pipes.

A low concentration (14.5 mg/kg) of chlorides was detected in the sample submitted for corrosivity testing. In general, soils possessing chloride concentrations in excess of 500 parts per million (ppm) are considered to be corrosive with respect to steel reinforcement within reinforced

concrete. Based on these test results, the site is considered to have a C1 chloride exposure in accordance with the American Concrete Institute (ACI) Publication 318 Building Code Requirements for Structural Concrete and Commentary. Therefore, a specialized concrete mix design for reinforced concrete for protection against chloride exposure is not considered warranted.

Nitrates present in soil can be corrosive to copper tubing at concentrations greater than 50 mg/kg. The tested sample possesses a nitrate concentration of 9.0 mg/kg. Based on this test result, the on-site soils are not considered to be corrosive to copper pipe.

It should be noted that SCG does not practice in the field of corrosion engineering. Therefore, the client may wish to contact a corrosion engineer to provide a more thorough evaluation.

Shrinkage/Subsidence

Removal and recompaction of the near-surface alluvial soils is estimated to result in an average shrinkage of 3 to 11± percent, based on the results of density testing and the assumption that the onsite soils will be compacted to about 92 percent of the ASTM D-1557 maximum dry density. However, the estimated shrinkage of the individual soil layers at the site is highly variable, locally ranging from a minimum shrinkage value of 0 percent to a maximum shrinkage of 16 percent at varying sample depths and locations. It should be noted that the potential shrinkage estimate is based on dry density testing performed on small-diameter samples taken at the boring locations. If a more accurate and precise shrinkage estimate is desired, SCG can perform a shrinkage study involving several excavated test-pits where in-place densities are evaluated using in-situ testing methods instead of laboratory density testing on small-diameter samples. Please contact SCG for details and a cost estimate regarding a shrinkage study, if desired.

Minor ground subsidence is expected to occur in the soils below the zone of removal, due to settlement and machinery working. The subsidence is estimated to be 0.1± feet. This estimate may be used for grading in areas that are underlain by native alluvial soils.

These estimates are based on previous experience and the subsurface conditions encountered at the boring locations. The actual amount of subsidence is expected to be variable and will be dependent on the type of machinery used, repetitions of use, and dynamic effects, all of which are difficult to assess precisely.

Slope Stability

Newly constructed fill slopes, comprised of properly compacted engineered fill, at inclinations of 2h:1v will possess adequate gross stability. Cut slopes excavated within the existing granular alluvial soils may be subject to surficial instability due to the lack of cohesion within these materials. Therefore, stability fills may be required within these areas. This condition may affect the proposed cut slopes at the site. The need for stability fills should be determined by SCG as part of the future detailed grading plan review.

Grading and Foundation Plan Review

No grading or foundation plans were available at the time of this report. It is therefore recommended that we be provided with copies of the preliminary plans, when they become

available, for review with regard to the conclusions, recommendations, and assumptions contained within this report.

6.3 Site Grading Recommendations

The grading recommendations presented below are based on the subsurface conditions encountered at the boring locations and our understanding of the proposed development. We recommend that all grading activities be completed in accordance with the Grading Guide Specifications included as Appendix D of this report, unless superseded by site-specific recommendations presented below.

Site Stripping

Vegetation including grasses, shrubs, and weeds on the site should be stripped and disposed of off-site. Stripping should include any organic soils and any root masses from trees. The actual extent of site stripping should be determined in the field by the geotechnical engineer, based on the organic content and stability of the materials encountered.

Treatment of Existing Soils: Building Pad

Remedial grading should be performed within the proposed building area in order to remove a portion of the near-surface native alluvial soils. Based on conditions encountered at the boring locations, the existing soils within the proposed building area are recommended to be overexcavated to a depth of at least 5 feet below existing grade and to a depth of at least 3 feet below proposed building pad subgrade elevation, whichever is greater.

Additional overexcavation should be performed within the influence zones of the new foundations, to provide for a new layer of compacted structural fill extending to a depth of 3 feet below proposed foundation bearing grade.

The overexcavation area should extend at least 5 feet beyond the building foundations and perimeters. If the proposed structure incorporates any exterior columns (such as for a canopy or overhang) the area of overexcavation should also encompass these areas.

Following completion of the overexcavation, the subgrade soils within the building area should be evaluated by the geotechnical engineer to verify their suitability to serve as the structural fill subgrade, as well as to support the foundation loads of the new structure. This evaluation should include proofrolling and probing to identify any soft, loose, or otherwise unstable soils that must be removed. Some localized areas of deeper excavation may be required if loose, porous, or low-density native soils are encountered at the base of the overexcavation.

After a suitable overexcavation subgrade has been achieved, the exposed soils should be scarified to a depth of at least 12 inches, moisture conditioned to achieve a moisture content of 0 to 4 percent above optimum moisture content. The moisture conditioning of the overexcavation subgrade soils should be verified by the geotechnical engineer. The subgrade soils should then be recompacted to at least 90 percent of the ASTM D-1557 maximum dry density. The previously excavated soils may then be replaced as compacted structural fill.

Treatment of Existing Soils: Cut and Fill Slopes

New cut and fill slopes are expected to be constructed around the perimeter of the project. All slopes should be at a maximum inclination of 2h:1v. A keyway should be excavated at the toe of new fill slopes which are not located in fill areas. The keyway should be at least 15 feet wide and 3 feet deep. The recommended width of the keyway is based on 1.5 times the width of typical grading equipment. If smaller equipment is utilized, a smaller keyway may be suitable, at the discretion of the geotechnical engineer. The base of the keyway should slope at least 1 foot downward into the slope. Following completion of the keyway cut, the subgrade soils should be evaluated by the geotechnical engineer to verify that the keyway is founded into competent materials. The resulting subgrade soils should then be scarified to a depth of 10 to 12 inches, moisture conditioned to 0 to 4 percent above optimum moisture content and recompacted. During construction of the new fill slope, the existing slope should be benched in accordance with the detail presented on Plate D-4. Benches less than 4 feet in height may be used at the discretion of the geotechnical engineer.

Stability fills for cut slopes will provide a more uniform appearance and allow landscaping on the slope. Should a stability fill for cut slope be necessary, the recommendations for the stability fill will be the same as the recommendations for the fill slopes, mentioned above.

Treatment of Existing Soils: Retaining Walls and Site Walls

The existing soils within the areas of any proposed retaining walls and non-retaining site walls should be overexcavated to a depth of 3 feet below foundation bearing grade and replaced as compacted structural fill, as discussed above for the proposed building pad. Any undocumented fill soils within any of these foundation areas should be removed in their entirety. The overexcavation areas should extend at least 5 feet beyond the foundation perimeters, and to an extent equal to the depth of fill below the new foundations. Any erection pads used to construct the walls are considered to be part of the foundation system with respect to these remedial grading recommendations. The overexcavation subgrade soils should be evaluated by the geotechnical engineer prior to scarifying, moisture conditioning, and recompacting the upper 12 inches of exposed subgrade soils. The previously excavated soils may then be replaced as compacted structural fill.

Treatment of Existing Soils: Parking and Drive Areas

Based on economic considerations, overexcavation of the existing variable strength alluvium soils in the new parking and drive areas is not considered warranted, with the exception of areas where lower strength or unstable soils are identified by the geotechnical engineer during grading.

Subgrade preparation in the new parking and drive areas should initially consist of removal of all soils disturbed during stripping and demolition operations. The geotechnical engineer should then evaluate the subgrade to identify any areas of additional unsuitable soils. The subgrade soils should then be scarified to a depth of 12± inches, moisture conditioned to 0 to 4 percent above optimum, and recompacted to at least 90 percent of the ASTM D-1557 maximum dry density. Based on the presence of variable strength alluvial soils throughout the site, it is expected that some isolated areas of additional overexcavation may be required to remove zones of lower strength, unsuitable soils.

The grading recommendations presented above for the proposed parking and drive areas assume that the owner and/or developer can tolerate minor amounts of settlement within the proposed parking areas. The grading recommendations presented above do not completely mitigate the extent of existing fill soils and loose native soils in the parking areas. As such, settlement and associated pavement distress could occur. Typically, repair of such distressed areas involves significantly lower costs than completely mitigating these soils at the time of construction. If the owner cannot tolerate the risk of such settlements, the parking and drive areas should be overexcavated to a depth of 2 feet below proposed pavement subgrade elevation, with the resulting soils replaced as compacted structural fill.

Fill Placement

- Fill soils should be placed in thin (6± inches), near-horizontal lifts, moisture conditioned to within 0 to 4 percent above the optimum moisture content, and compacted.
- On-site soils may be used for fill provided they are cleaned of any debris to the satisfaction of the geotechnical engineer.
- All grading and fill placement activities should be completed in accordance with the requirements of the 2022 CBC and the grading code of the city of Hesperia.
- All fill soils should be compacted to at least 90 percent of the ASTM D-1557 maximum dry density.
- Compaction tests should be performed periodically by the geotechnical engineer as random verification of compaction and moisture content. These tests are intended to aid the contractor. Since the tests are taken at discrete locations and depths, they may not be indicative of the entire fill and therefore should not relieve the contractor of his responsibility to meet the job specifications.

Imported Structural Fill

All imported structural fill should consist of very low expansive (EI < 20), well graded soils possessing at least 10 percent fines (that portion of the sample passing the No. 200 sieve). Additional specifications for structural fill are presented in the Grading Guide Specifications, included as Appendix D.

Utility Trench Backfill

In general, all utility trench backfill soils should be compacted to at least 90 percent of the ASTM D-1557 maximum dry density. It is recommended that materials in excess of 3 inches in size not be used for utility trench backfill. Compacted trench backfill should conform to the requirements of the local grading code, and more restrictive requirements may be indicated by city of Hesperia. All utility trench backfills should be witnessed by the geotechnical engineer. The trench backfill soils should be compaction tested where possible; probed and visually evaluated elsewhere.

Utility trenches which parallel a footing, and extending below a 1h:1v plane projected from the outside edge of the footing should be backfilled with structural fill soils, compacted to at least 90 percent of the ASTM D-1557 standard. Pea gravel backfill should not be used for these trenches.

6.4 Construction Considerations

Moisture Sensitive Subgrade Soils

Occasional samples of the near-surface soils consist predominately of silty sands. These soils may become unstable if exposed to significant moisture infiltration or disturbance by construction traffic. If grading occurs during a period of relatively wet weather, an increase in subgrade instability in localized areas should also be expected. The site should, therefore, be graded to prevent ponding of surface water and to prevent water from running into excavations.

Excavation Considerations

The near surface soils are predominately granular in composition. These materials will likely be subject to caving within shallow excavations. Where caving occurs within shallow excavations, flattened excavation slopes may be sufficient to provide excavation stability. On a preliminary basis, the inclination of temporary slopes should not exceed 2h:1v. Maintaining adequate moisture content within the near-surface soils will improve excavation stability. All excavation activities on this site should be conducted in accordance with Cal-OSHA regulations.

Groundwater

Based on the conditions encountered at the boring locations, the static groundwater table at this site is considered to exist at a depth greater than 25± feet. Therefore, groundwater is not expected to impact the grading or foundation construction activities.

6.5 Foundation Design and Construction

Based on the preceding grading recommendations, it is assumed that the new building pad will be underlain by structural fill soils used to replace the upper portion of the existing variable strength alluvial soils. These new structural fill soils are expected to extend to depths of at least 3 feet below proposed foundation bearing grade. Based on this subsurface profile, the proposed structure may be supported on conventional shallow foundations.

Foundation Design Parameters

New square and rectangular footings may be designed as follows:

- Maximum, net allowable soil bearing pressure: 3,000 lbs/ft^2.
- Minimum wall/column footing width: 14 inches/24 inches.
- Minimum longitudinal steel reinforcement within strip footings: Two (2) No. 5 rebars (1 top and 1 bottom).
- Minimum foundation embedment: 12 inches into suitable structural fill soils, and at least 18 inches below adjacent exterior grade. Interior column footings may be placed immediately beneath the floor slab.

- It is recommended that the perimeter building foundations be continuous across all exterior doorways. Any flatwork adjacent to the exterior doors should be doweled into the perimeter foundations in a manner determined by the structural engineer.

The allowable bearing pressure presented above may be increased by one-third when considering short duration wind or seismic loads. The minimum steel reinforcement recommended above is based on geotechnical considerations; additional reinforcement may be necessary for structural considerations. The actual design of the foundations should be determined by the structural engineer.

Foundation Construction

The foundation subgrade soils should be evaluated at the time of overexcavation, as discussed in Section 6.3 of this report. It is further recommended that the foundation subgrade soils be evaluated by the geotechnical engineer immediately prior to steel or concrete placement. Soils suitable for direct foundation support should consist of newly placed structural fill, compacted to at least 90 percent of the ASTM D-1557 maximum dry density. Any unsuitable materials should be removed to a depth of suitable bearing compacted structural fill, with the resulting excavations backfilled with compacted fill soils. As an alternative, lean concrete slurry (500 to 1,500 psi) may be used to backfill such isolated overexcavations.

The foundation subgrade soils should also be properly moisture conditioned to 0 to 4 percent above the Modified Proctor optimum, to a depth of at least 12 inches below bearing grade. Since it is typically not feasible to increase the moisture content of the floor slab and foundation subgrade soils once rough grading has been completed, care should be taken to maintain the moisture content of the building pad subgrade soils throughout the construction process.

Estimated Foundation Settlements

Post-construction total and differential settlements of shallow foundations designed and constructed in accordance with the previously presented recommendations are estimated to be less than 1.0 and 0.5 inches, respectively. Differential movements are expected to occur over a 50-foot span, thereby resulting in an angular distortion of less than 0.002 inches per inch.

Lateral Load Resistance

Lateral load resistance will be developed by a combination of friction acting at the base of foundations and slabs and the passive earth pressure developed by footings below grade. The following friction and passive pressure may be used to resist lateral forces:

- Passive Earth Pressure: 300 lbs/ft^3
- Friction Coefficient: 0.30

These are allowable values, and include a factor of safety. When combining friction and passive resistance, the passive pressure component should be reduced by one-third. These values assume that footings will be poured directly against compacted structural fill. The maximum allowable passive pressure is 2,500 lbs/ft^2.

6.6 Floor Slab Design and Construction

Subgrades which will support new floor slab should be prepared in accordance with the recommendations contained in the ***Site Grading Recommendations*** section of this report. Based on the anticipated grading which will occur at this site, the floor of the new structure may be constructed as a conventional slab-on-grade supported on newly placed structural fill soils. These fill soils are expected to extend to a depth of at least 3 feet below finished pad grade. Based on geotechnical considerations, the floor slabs may be designed as follows:

- Minimum slab thickness: 6 inches.

- Modulus of Subgrade Reaction: k = 150 psi/in

- Minimum slab reinforcement: Reinforcement is not required for geotechnical conditions. The actual floor slab reinforcement should be determined by the structural engineer, based upon the imposed loading.

- Slab underlayment: If moisture sensitive floor coverings will be used the minimum slab underlayment should consist of a moisture vapor barrier constructed below the entire area where such moisture sensitive floor coverings are anticipated. The moisture vapor barrier should meet or exceed the Class A rating as defined by ASTM E 1745-97 and have a permeance rating less than 0.01 perms as described in ASTM E 96-95 and ASTM E 154-88. A polyolefin material such as a 15 mil. Stego® Wrap Vapor Barrier or equivalent will meet these specifications. The moisture vapor barrier should be properly constructed in accordance with all applicable manufacturer specifications. The need for sand and/or the amount of sand above the moisture vapor barrier should be specified by the structural engineer or concrete contractor. The selection of sand above the barrier is not a geotechnical engineering issue and hence outside our purview.

- Moisture condition the floor slab subgrade soils to 0 to 4 percent above the Modified Proctor optimum moisture content, to a depth of 12 inches. The moisture content of the floor slab subgrade soils should be verified by the geotechnical engineer within 24 hours prior to concrete placement.

- Proper concrete curing techniques should be utilized to reduce the potential for slab curling or the formation of excessive shrinkage cracks.

The actual design of the floor slab should be completed by the structural engineer to verify adequate thickness and reinforcement.

6.7 Retaining Wall Design and Construction

Small retaining walls are expected to be necessary in the area of the new truck loading docks and may also be required to facilitate the new site grades. The parameters recommended for use in the design of these walls are presented below.

Retaining Wall Design Parameters

Based on the soil conditions encountered at the boring locations, the following parameters may be used in the design of new retaining walls for this site. We have provided parameters assuming the use of on-site soils for retaining wall backfill. The near-surface soils generally consist of well-silty sands and clayey sands. Based on the results of laboratory testing, these materials re expected to possess an internal angle of friction of at least 32 degrees when compacted to 90 percent of the ASTM D-1557 maximum dry density.

If desired, SCG could provide design parameters for an alternative select backfill material behind the retaining walls. The use of select backfill material could result in lower lateral earth pressures. In order to use the design parameters for the imported select fill, this material must be placed within the entire active failure wedge. This wedge is defined as extending from the heel of the retaining wall upwards at an angle of approximately 60° from horizontal. If select backfill material behind the retaining wall is desired, SCG should be contacted for supplementary recommendations.

RETAINING WALL DESIGN PARAMETERS

Design Parameter		**Soil Type**
		On-Site Silty Sands
Internal Friction Angle (ϕ)		32°
Unit Weight		133 lbs/ft^3
Equivalent Fluid Pressure:	Active Condition (level backfill)	41 lbs/ft^3
	Active Condition (2h:1v backfill)	63 lbs/ft^3
	At-Rest Condition (level backfill)	63 lbs/ft^3

The walls should be designed using a soil-footing coefficient of friction of 0.30 and an equivalent passive pressure of 300 lbs/ft^3. The structural engineer should incorporate appropriate factors of safety in the design of the retaining walls.

The active earth pressure may be used for the design of retaining walls that do not directly support structures or support soils that in turn support structures and which will be allowed to deflect. The at-rest earth pressure should be used for walls that will not be allowed to deflect such as those which will support foundation bearing soils, or which will support foundation loads directly.

Where the soils on the toe side of the retaining wall are not covered by a "hard" surface such as a structure or pavement, the upper 1 foot of soil should be neglected when calculating passive resistance due to the potential for the material to become disturbed or degraded during the life of the structure.

Retaining Wall Foundation Design

The retaining wall foundations should be supported within newly placed structural fill. Foundations to support new retaining walls should be designed in accordance with the general Foundation Design Parameters presented in a previous section of this report.

Seismic Lateral Earth Pressures

In accordance with the 2022 CBC, any retaining walls more than 6 feet in height must be designed for seismic lateral earth pressures. The recommended seismic pressure distribution is triangular in shape, assumed to occur at the top of the wall, decreasing to 0 at the base of the wall. For a level backfill condition behind the top of the wall, the seismic lateral earth pressure is 18H lbs/ft^2, where H is the overall height of the wall. Where the ground surface above the wall consists of a 2h:1v (horizontal to vertical) sloping condition, the seismic lateral earth pressure is 57H lbs/ft^2. The seismic pressure distribution is based on the Mononobe-Okabe equation, utilizing a design acceleration of 0.368g. The 2022 CBC does not provide definitive guidance on determination of the design acceleration to be used in generating the seismic lateral earth pressure. In accordance with standard geotechnical practice, we have calculated the design acceleration as $^2/_3$ of the PGA_M. However, for combinations of high ground motion and steep slopes above the wall, the Mononobe-Okabe equation gives unrealistic high estimates of active earth pressures. Therefore, the seismic earth pressure for the sloping condition presented above was derived using a design acceleration equal to 50% of the PGA_M.

Backfill Material

On-site soils may be used to backfill the retaining walls. However, all backfill material placed within 3 feet of the back-wall face should have a particle size no greater than 3 inches. The retaining wall backfill materials should be well graded.

It is recommended that a properly installed prefabricated drainage composite such as the MiraDRAIN 6000XL (or approved equivalent), which is specifically designed for use behind retaining walls, be placed against the face on the back side of the retaining walls. This material should extend from the top of the retaining wall footing to within 1 foot of the ground surface on the back side of the retaining wall. A 12-inch-thick layer of a low permeability soil should be placed over the backfill to reduce surface water migration to the underlying soils.

All retaining wall backfill should be placed and compacted under engineering-controlled conditions in the necessary layer thicknesses to ensure an in-place density between 90 and 93 percent of the maximum dry density as determined by the Modified Proctor test (ASTM D1557-91). Care should be taken to avoid over-compaction of the soils behind the retaining walls, and the use of heavy compaction equipment should be avoided.

Subsurface Drainage

As previously indicated, the retaining wall design parameters are based upon drained backfill conditions. Consequently, some form of permanent drainage system will be necessary in conjunction with the appropriate backfill material. Subsurface drainage may consist of either:

- A weep hole drainage system typically consisting of a series of 4-inch diameter holes in the wall situated slightly above the ground surface elevation on the exposed side of the wall and at an approximate 8-foot on-center spacing. The weep holes should include a 2 cubic foot pocket of open graded gravel, surrounded by an approved geotextile fabric, at each weep hole location.

- A 4-inch diameter perforated pipe surrounded by 2 cubic feet of gravel per linear foot of drain placed behind the wall, above the retaining wall footing. The gravel layer should be wrapped in a suitable geotextile fabric to reduce the potential for migration of fines. The footing drain should be extended to daylight or tied into a storm drainage system.

6.8 Pavement Design Parameters

Site preparation in the pavement area should be completed as previously recommended in the ***Site Grading Recommendations*** section of this report. The subsequent pavement recommendations assume proper drainage and construction monitoring, and are based on either PCA or CALTRANS design parameters for a twenty (20) year design period. However, these designs also assume a routine pavement maintenance program to obtain the anticipated 20-year pavement service life.

Pavement Subgrades

It is anticipated that the new pavements will be primarily supported on a layer of compacted structural fill, consisting of scarified, thoroughly moisture conditioned and recompacted existing soils. The on-site soils generally consist of silty sands, with varying gravel and clay content. Based on their classification, these materials are expected to possess good to excellent pavement support characteristics, with R-values in the range of 40 to 50. Since R-value testing was not included in the scope of services for this project, the subsequent pavement design is based upon an assumed R-value of 40. Any fill material imported to the site should have support characteristics equal to or greater than that of the on-site soils and be placed and compacted under engineering-controlled conditions. It is recommended that R-value testing be performed after completion of rough grading. Depending upon the results of the R-value testing, it may be feasible to use thinner pavement sections in some areas of the site.

Asphaltic Concrete

Presented below are the recommended thicknesses for new flexible pavement structures consisting of asphaltic concrete over a granular base. The pavement designs are based on the traffic indices (TI's) indicated. The client and/or civil engineer should verify that these TI's are representative of the anticipated traffic volumes. If the client and/or civil engineer determine that the expected traffic volume will exceed the applicable traffic index, we should be contacted for supplementary recommendations. The design traffic indices equate to the following approximate daily traffic volumes over a 20-year design life, assuming six operational traffic days per week.

Traffic Index	No. of Heavy Trucks per Day
4.0	0
5.0	1
6.0	3
7.0	11
8.0	35
9.0	93

For the purpose of the traffic volumes indicated above, a truck is defined as a 5-axle tractor trailer unit with one 8-kip axle and two 32-kip tandem axles. All of the traffic indices allow for 1,000 automobiles per day.

ASPHALT PAVEMENTS (R=40)					
Materials	**Thickness (inches)**				
	Auto Parking and Auto Drive Lanes (TI = 4.0 to 5.0)	Truck Traffic			
		TI = 6.0	TI = 7.0	TI = 8.0	TI = 9.0
Asphalt Concrete	3	3½	4	5	5½
Aggregate Base	4	6	7	8	10
Compacted Subgrade	12	12	12	12	12

The aggregate base course should be compacted to at least 95 percent of the ASTM D-1557 maximum dry density. The asphaltic concrete should be compacted to at least 95 percent of the Marshall maximum density, as determined by ASTM D-2726. The aggregate base course may consist of crushed aggregate base (CAB) or crushed miscellaneous base (CMB), which is a recycled gravel, asphalt and concrete material. The gradation, R-Value, Sand Equivalent, and Percentage Wear of the CAB or CMB should comply with appropriate specifications contained in the current edition of the "Greenbook" Standard Specifications for Public Works Construction.

Portland Cement Concrete

The preparation of the subgrade soils within concrete pavement areas should be performed as previously described for proposed asphalt pavement areas. The minimum recommended thicknesses for the Portland Cement Concrete pavement sections are as follows:

PORTLAND CEMENT CONCRETE PAVEMENTS (R=40)				
Materials	**Thickness (inches)**			
	Autos and Light Truck Traffic (TI = 6.0)	Truck Traffic		
		TI = 7.0	TI = 8.0	TI = 9.0
PCC	5	5½	6½	8
Compacted Subgrade (95% minimum compaction)	12	12	12	12

The concrete should have a 28-day compressive strength of at least 3,000 psi. Any reinforcement within the PCC pavements should be determined by the project structural engineer. The maximum joint spacing within all of the PCC pavements is recommended to be equal to or less than 30 times the pavement thickness.

7.0 GENERAL COMMENTS

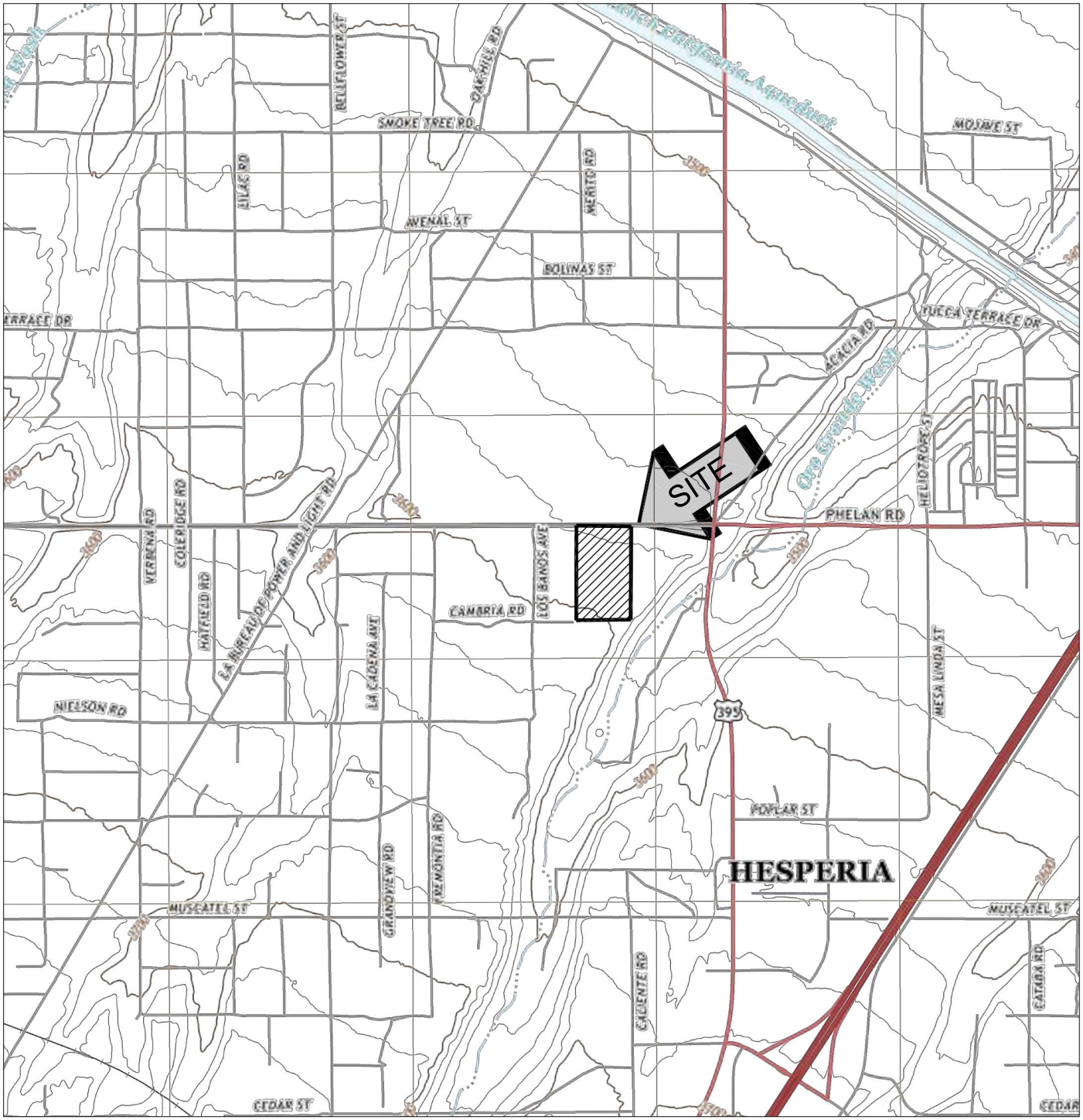
This report has been prepared as an instrument of service for use by the client, in order to aid in the evaluation of this property and to assist the architects and engineers in the design and preparation of the project plans and specifications. This report may be provided to the contractor(s) and other design consultants to disclose information relative to the project. However, this report is not intended to be utilized as a specification in and of itself, without appropriate interpretation by the project architect, civil engineer, and/or structural engineer. The reproduction and distribution of this report must be authorized by the client and Southern California Geotechnical, Inc. Furthermore, any reliance on this report by an unauthorized third party is at such party's sole risk, and we accept no responsibility for damage or loss which may occur. The client(s)' reliance upon this report is subject to the Engineering Services Agreement, incorporated into our proposal for this project.

The analysis of this site was based on a subsurface profile interpolated from limited discrete soil samples. While the materials encountered in the project area are considered to be representative of the total area, some variations should be expected between boring locations and sample depths. If the conditions encountered during construction vary significantly from those detailed herein, we should be contacted immediately to determine if the conditions alter the recommendations contained herein.

This report has been based on assumed or provided characteristics of the proposed development. It is recommended that the owner, client, architect, structural engineer, and civil engineer carefully review these assumptions to ensure that they are consistent with the characteristics of the proposed development. If discrepancies exist, they should be brought to our attention to verify that they do not affect the conclusions and recommendations contained herein. We also recommend that the project plans and specifications be submitted to our office for review to verify that our recommendations have been correctly interpreted.

The analysis, conclusions, and recommendations contained within this report have been promulgated in accordance with generally accepted professional geotechnical engineering practice. No other warranty is implied or expressed.

APPENDIX A



SOURCE: USGS TOPOGRAPHIC MAP OF THE BALDY MESA QUADRANGLE, SAN BERNARDINO COUNTY, CALIFORNIA, 2021.

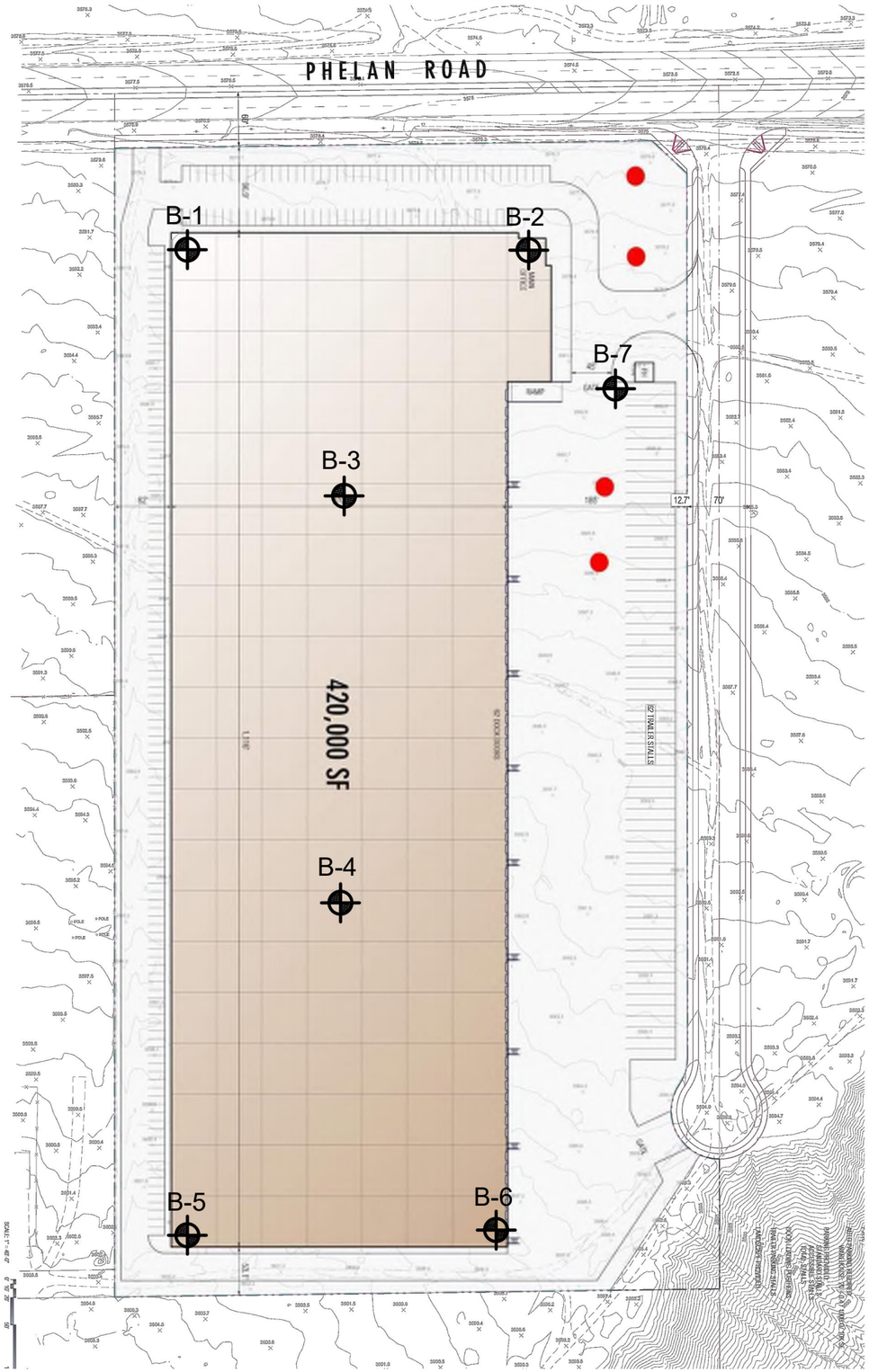
SITE LOCATION MAP

PHELAN 20 INDUSTRIAL BUILDING

HESPERIA, CALIFORNIA

SCALE: 1" = 2000'	
DRAWN: MK CHKD: RGT	
SCG PROJECT 23G131-1	
PLATE 1	

SOUTHERN CALIFORNIA GEOTECHNICAL



NORTH

SoCalGeo

GEOTECHNICAL LEGEND

APPROXIMATE BORING LOCATION

NOTE: CONCEPTUAL SITE PLAN PROVIDED BY RGA, OFFICE OF ARCHITECTURAL DESIGN

BORING LOCATION PLAN

PHELAN 20 INDUSTRIAL BUILDING

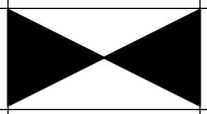
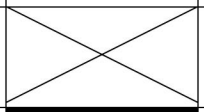
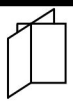
HESPERIA, CALIFORNIA

SCALE: 1" = 150'	
DRAWN: MK CHKD: RGT	
SCG PROJECT 23G131-1	
PLATE 2	

SOUTHERN CALIFORNIA GEOTECHNICAL

APPENDIX B

BORING LOG LEGEND

SAMPLE TYPE	GRAPHICAL SYMBOL	SAMPLE DESCRIPTION
AUGER		SAMPLE COLLECTED FROM AUGER CUTTINGS, NO FIELD MEASUREMENT OF SOIL STRENGTH. (DISTURBED)
CORE		ROCK CORE SAMPLE: TYPICALLY TAKEN WITH A DIAMOND-TIPPED CORE BARREL. TYPICALLY USED ONLY IN HIGHLY CONSOLIDATED BEDROCK.
GRAB		SOIL SAMPLE TAKEN WITH NO SPECIALIZED EQUIPMENT, SUCH AS FROM A STOCKPILE OR THE GROUND SURFACE. (DISTURBED)
CS		CALIFORNIA SAMPLER: 2-1/2 INCH I.D. SPLIT BARREL SAMPLER, LINED WITH 1-INCH HIGH BRASS RINGS. DRIVEN WITH SPT HAMMER. (RELATIVELY UNDISTURBED)
NSR		NO RECOVERY: THE SAMPLING ATTEMPT DID NOT RESULT IN RECOVERY OF ANY SIGNIFICANT SOIL OR ROCK MATERIAL.
SPT		STANDARD PENETRATION TEST: SAMPLER IS A 1.4 INCH INSIDE DIAMETER SPLIT BARREL, DRIVEN 18 INCHES WITH THE SPT HAMMER. (DISTURBED)
SH		SHELBY TUBE: TAKEN WITH A THIN WALL SAMPLE TUBE, PUSHED INTO THE SOIL AND THEN EXTRACTED. (UNDISTURBED)
VANE		VANE SHEAR TEST: SOIL STRENGTH OBTAINED USING A 4 BLADED SHEAR DEVICE. TYPICALLY USED IN SOFT CLAYS-NO SAMPLE RECOVERED.

COLUMN DESCRIPTIONS

DEPTH: Distance in feet below the ground surface.

SAMPLE: Sample Type as depicted above.

BLOW COUNT: Number of blows required to advance the sampler 12 inches using a 140 lb hammer with a 30-inch drop. 50/3" indicates penetration refusal (>50 blows) at 3 inches. WH indicates that the weight of the hammer was sufficient to push the sampler 6 inches or more.

POCKET PEN.: Approximate shear strength of a cohesive soil sample as measured by pocket penetrometer.

GRAPHIC LOG: Graphic Soil Symbol as depicted on the following page.

DRY DENSITY: Dry density of an undisturbed or relatively undisturbed sample in lbs/ft^3.

MOISTURE CONTENT: Moisture content of a soil sample, expressed as a percentage of the dry weight.

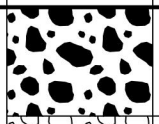
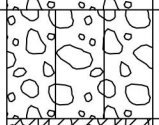
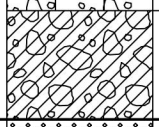
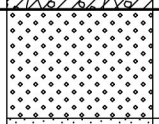
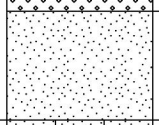
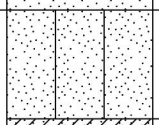
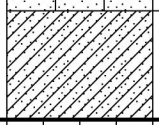
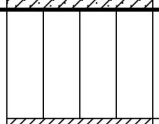
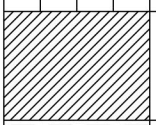
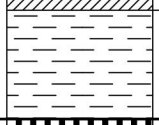
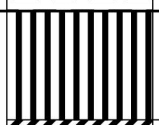
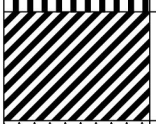
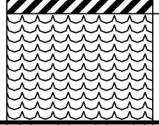
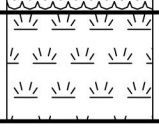
LIQUID LIMIT: The moisture content above which a soil behaves as a liquid.

PLASTIC LIMIT: The moisture content above which a soil behaves as a plastic.

PASSING #200 SIEVE: The percentage of the sample finer than the #200 standard sieve.

UNCONFINED SHEAR: The shear strength of a cohesive soil sample, as measured in the unconfined state.

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS
			GRAPH	LETTER	
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 (LITTLE OR NO FINES)		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 (APPRECIABLE AMOUNT OF 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 ON NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
		SANDS 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 OR 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
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

BORING NO. B-1

JOB NO.: 23G131-1
PROJECT: Phelan 20 Industrial Building
LOCATION: Hesperia, California

DRILLING DATE: 4/18/23
DRILLING METHOD: Hollow Stem Auger
LOGGED BY: Michelle Krizek

WATER DEPTH: Dry
CAVE DEPTH: 19 feet
READING TAKEN: At Completion

FIELD RESULTS						LABORATORY RESULTS						
DEPTH (FEET)	SAMPLE	BLOW COUNT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION SURFACE ELEVATION: --- MSL	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PASSING #200 SIEVE (%)	ORGANIC CONTENT (%)	COMMENTS
		5			ALLUVIUM: Brown Silty fine to medium Sand, little coarse Sand, trace fine Gravel, trace fine root fibers, very loose to loose-damp	115	6					
		13				115	5					
5		17			Light Brown Silty fine to coarse Sand, trace to little fine Gravel, medium dense-dry		2					Disturbed Sample
		50/5"			OLDER ALLUVIUM: Light Red Brown Silty fine to coarse Sand, trace fine Gravel, trace Clay, medium dense to very dense-dry to damp	109	3					
10		25				114	1					
		42			@ 13½ feet, trace to little Clay		4					
15												
		35					3					
20												
		39					3					
25					Boring Terminated at 25 feet							

TBL 23G131-1.GPJ SOCALGEO.GDT 5/23/23

TEST BORING LOG

PLATE B-1

SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

BORING NO. B-2

JOB NO.: 23G131-1
PROJECT: Phelan 20 Industrial Building
LOCATION: Hesperia, California

DRILLING DATE: 4/18/23
DRILLING METHOD: Hollow Stem Auger
LOGGED BY: Michelle Krizek

WATER DEPTH: Dry
CAVE DEPTH: 16 feet
READING TAKEN: At Completion

FIELD RESULTS					DESCRIPTION	LABORATORY RESULTS						
DEPTH (FEET)	SAMPLE	BLOW COUNT	POCKET PEN. (TSF)	GRAPHIC LOG	SURFACE ELEVATION: --- MSL	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PASSING #200 SIEVE (%)	ORGANIC CONTENT (%)	COMMENTS
		8			ALLUVIUM: Brown Silty fine to medium Sand, little coarse Sand, trace fine to coarse Gravel, loose-damp	119	5					
		12			@ 3 feet, Light Brown, trace Clay	118	6					
5		15			Light Brown Silty fine to coarse Sand, trace fine Gravel, medium dense-dry to damp	116	3					
		26			OLDER ALLUVIUM: Light Red Brown Silty fine Sand, little medium Sand, trace Clay, medium dense-damp @ 7 feet, Light Red Brown, trace Clay	120	5					
10		27				121	3					
		27			Red Brown Silty fine to coarse Sand, trace fine Gravel, trace to little Clay, medium dense to dense-damp		5					
15												
		30					4					
20					Boring Terminated at 20 feet							

TBL 23G131-1.GPJ SOCALGEO.GDT 5/23/23

TEST BORING LOG

PLATE B-2

SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

BORING NO. B-3

JOB NO.: 23G131-1
PROJECT: Phelan 20 Industrial Building
LOCATION: Hesperia, California

DRILLING DATE: 4/18/23
DRILLING METHOD: Hollow Stem Auger
LOGGED BY: Michelle Krizek

WATER DEPTH: Dry
CAVE DEPTH: 10 feet
READING TAKEN: At Completion

FIELD RESULTS						LABORATORY RESULTS						
DEPTH (FEET)	SAMPLE	BLOW COUNT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION SURFACE ELEVATION: --- MSL	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PASSING #200 SIEVE (%)	ORGANIC CONTENT (%)	COMMENTS
		3			ALLUVIUM: Dark Brown Silty fine Sand, little medium to coarse Sand, trace fine Gravel, trace fine root fibers, very loose to loose-damp		6					
		8					3					
5		31			OLDER ALLUVIUM: Light Red Brown Silty fine to medium Sand, little coarse Sand, trace Clay, trace to little fine Gravel, medium dense to dense-damp		3					
		39					4					
10												
		26					5					
15					Boring Terminated at 15 feet							

TBL 23G131-1.GPJ SOCALGEO.GDT 5/23/23

TEST BORING LOG

PLATE B-3

SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

BORING NO. B-4

JOB NO.: 23G131-1
PROJECT: Phelan 20 Industrial Building
LOCATION: Hesperia, California

DRILLING DATE: 4/18/23
DRILLING METHOD: Hollow Stem Auger
LOGGED BY: Michelle Krizek

WATER DEPTH: Dry
CAVE DEPTH: 16 feet
READING TAKEN: At Completion

FIELD RESULTS						LABORATORY RESULTS						
DEPTH (FEET)	SAMPLE	BLOW COUNT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION SURFACE ELEVATION: --- MSL	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PASSING #200 SIEVE (%)	ORGANIC CONTENT (%)	COMMENTS
		14			ALLUVIUM: Dark Brown Silty fine Sand, little medium to coarse Sand, trace Clay, trace fine root fibers, loose to medium dense-damp	125	7					
		24			@ 3 feet, trace fine Gravel	123	8					
5		25			Light Brown Silty fine to coarse Sand, trace to little fine Gravel, medium dense-dry to damp	115	4					
		23				115	2					
		15				112	3					
10												
		18			OLDER ALLUVIUM: Red Brown Silty fine to medium Sand, trace Clay, trace to little coarse Sand, trace fine to coarse Gravel, medium dense-damp		7					
15												
		26					7					
20					Boring Terminated at 20 feet							

TBL 23G131-1.GPJ SOCALGEO.GDT 5/23/23

TEST BORING LOG

PLATE B-4

SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

BORING NO. B-5

JOB NO.: 23G131-1
PROJECT: Phelan 20 Industrial Building
LOCATION: Hesperia, California

DRILLING DATE: 4/18/23
DRILLING METHOD: Hollow Stem Auger
LOGGED BY: Michelle Krizek

WATER DEPTH: Dry
CAVE DEPTH: 11 feet
READING TAKEN: At Completion

FIELD RESULTS					DESCRIPTION	LABORATORY RESULTS						
DEPTH (FEET)	SAMPLE	BLOW COUNT	POCKET PEN. (TSF)	GRAPHIC LOG	SURFACE ELEVATION: --- MSL	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PASSING #200 SIEVE (%)	ORGANIC CONTENT (%)	COMMENTS
		3			ALLUVIUM: Dark Brown Silty fine to medium Sand, trace coarse Sand, trace fine Gravel, trace fine root fibers, very loose-damp to moist		7					
		8			Light Red Brown Silty fine to coarse Sand, trace fine Gravel, loose-dry to damp		3					
5		8					3					
		24			OLDER ALLUVIUM: Red Brown Silty fine to medium Sand, trace to little coarse Sand, trace to little fine Gravel, trace to little Clay, medium dense to dense-damp		3					
10												
		32					7					
15					Boring Terminated at 15 feet							

TBL 23G131-1.GPJ SOCALGEO.GDT 5/23/23

TEST BORING LOG

PLATE B-5

SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

BORING NO. B-6

JOB NO.: 23G131-1
PROJECT: Phelan 20 Industrial Building
LOCATION: Hesperia, California

DRILLING DATE: 4/18/23
DRILLING METHOD: Hollow Stem Auger
LOGGED BY: Michelle Krizek

WATER DEPTH: Dry
CAVE DEPTH: 17 feet
READING TAKEN: At Completion

FIELD RESULTS					DESCRIPTION	LABORATORY RESULTS						
DEPTH (FEET)	SAMPLE	BLOW COUNT	POCKET PEN. (TSF)	GRAPHIC LOG	SURFACE ELEVATION: --- MSL	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PASSING #200 SIEVE (%)	ORGANIC CONTENT (%)	COMMENTS
		8			ALLUVIUM: Dark Brown Silty fine to medium Sand, trace coarse Sand, trace fine Gravel, trace fine root fibers, loose-damp	119	6					
		10				118	7					
5		10			Red Brown Silty fine to coarse Sand, little fine Gravel, loose-damp	105	5					
		17			OLDER ALLUVIUM: Red Brown fine to coarse Sand, trace Silt, little fine Gravel, medium dense-dry	115	1					
10		25				102	1					
		14					2					
15					Red Brown Silty fine to medium Sand, little coarse Sand, trace fine Gravel, trace Clay, weakly cemented, very dense-damp							
		59					4					
20												
		63					5					
25					Boring Terminated at 25 feet							

TBL 23G131-1.GPJ SOCALGEO.GDT 5/23/23

TEST BORING LOG

PLATE B-6

SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

BORING NO. B-7

JOB NO.: 23G131-1
PROJECT: Phelan 20 Industrial Building
LOCATION: Hesperia, California

DRILLING DATE: 4/18/23
DRILLING METHOD: Hollow Stem Auger
LOGGED BY: Michelle Krizek

WATER DEPTH: Dry
CAVE DEPTH: 14 feet
READING TAKEN: At Completion

FIELD RESULTS					DESCRIPTION	LABORATORY RESULTS						
DEPTH (FEET)	SAMPLE	BLOW COUNT	POCKET PEN. (TSF)	GRAPHIC LOG	SURFACE ELEVATION: --- MSL	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PASSING #200 SIEVE (%)	ORGANIC CONTENT (%)	COMMENTS
		9			ALLUVIUM: Brown Silty fine to medium Sand, little coarse Sand, trace fine Gravel, trace Clay, loose to medium dense-damp		7					EI = 0 @ 1 to 5 feet
		27					4					
5												
		8			Light Red Brown Silty fine to coarse Sand, trace fine Gravel, loose-damp		3					
		24			OLDER ALLUVIUM: Light Red Brown Silty fine to medium Sand, little coarse Sand, little Clay, little Calcareous nodules, weakly cemented, medium dense-damp		4					
10												
		60			Red Brown Clayey fine to medium Sand, little coarse Sand, trace fine Gravel, little Silt, weakly cemented, very dense-damp to moist		8					
15												
		23			Red Brown Silty fine to medium Sand, trace coarse Sand, trace Clay, trace fine to coarse Gravel, medium dense-damp		5					
20					Boring Terminated at 20 feet							

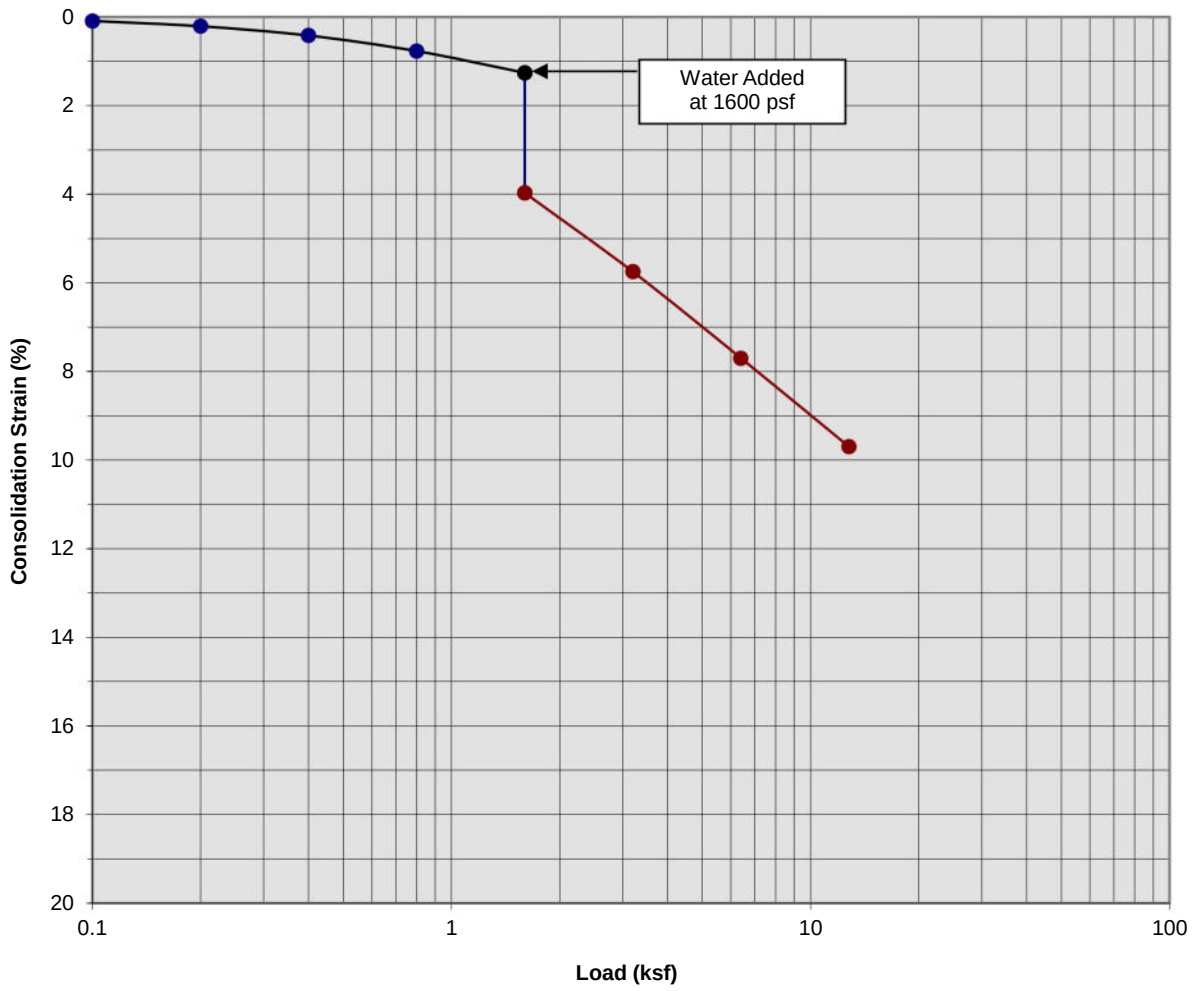
TBL 23G131-1.GPJ SOCALGEO.GDT 5/23/23

TEST BORING LOG

PLATE B-7

APPENDIX C

Consolidation/Collapse Test Results



Classification: Brown Silty fine to medium Sand, little coarse Sand, trace fine Gravel

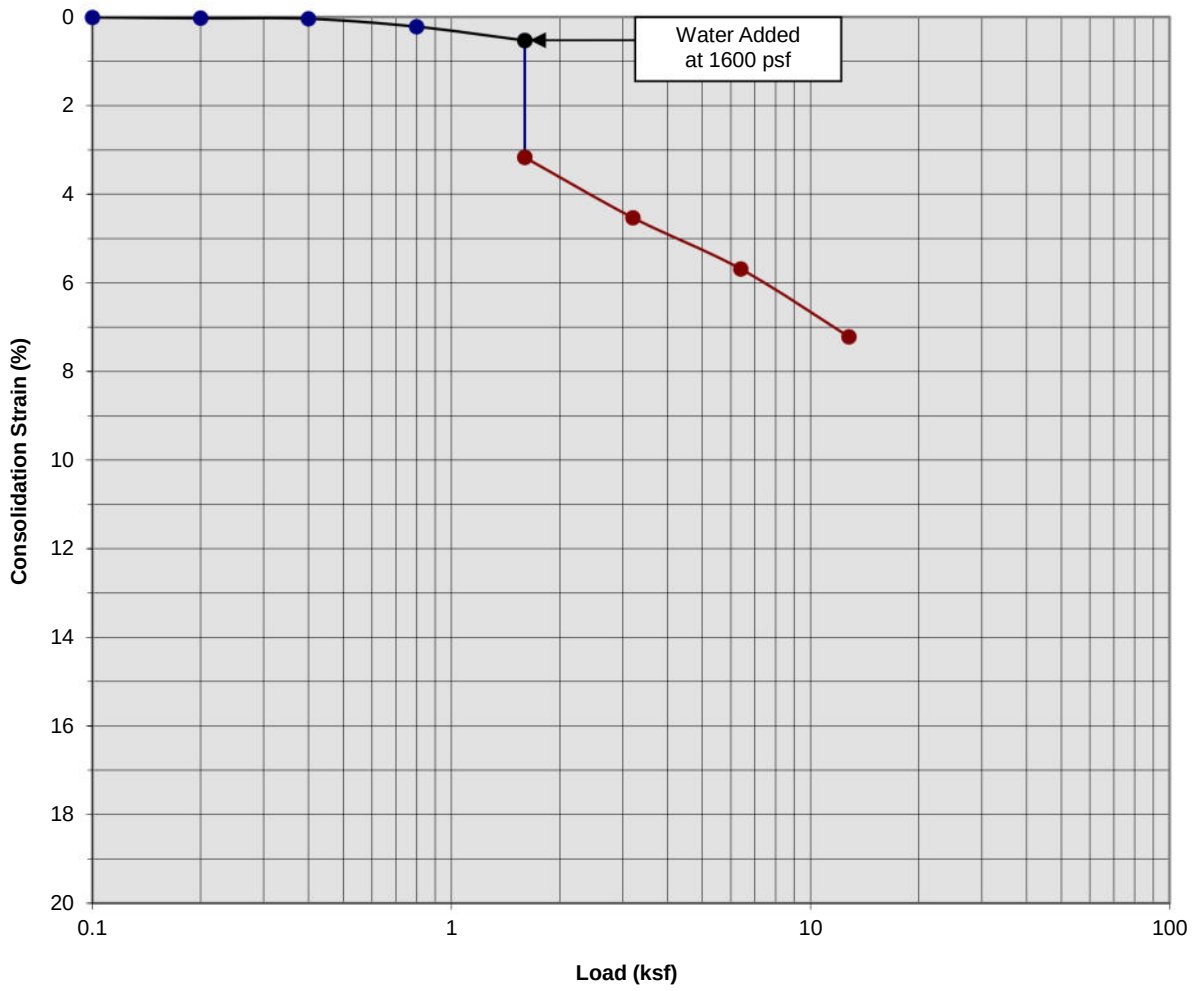
Boring Number:	B-2	Initial Moisture Content (%)	6
Sample Number:	---	Final Moisture Content (%)	11
Depth (ft)	3 to 4	Initial Dry Density (pcf)	118.0
Specimen Diameter (in)	2.4	Final Dry Density (pcf)	130.1
Specimen Thickness (in)	1.0	Percent Collapse (%)	2.71

Phelan 20 Industrial Building
Hesperia, California
Project No. 23G131-1

PLATE C- 1

SoCalGeo
SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

Consolidation/Collapse Test Results



Classification: Light Brown Silty fine to coarse Sand, trace fine Gravel

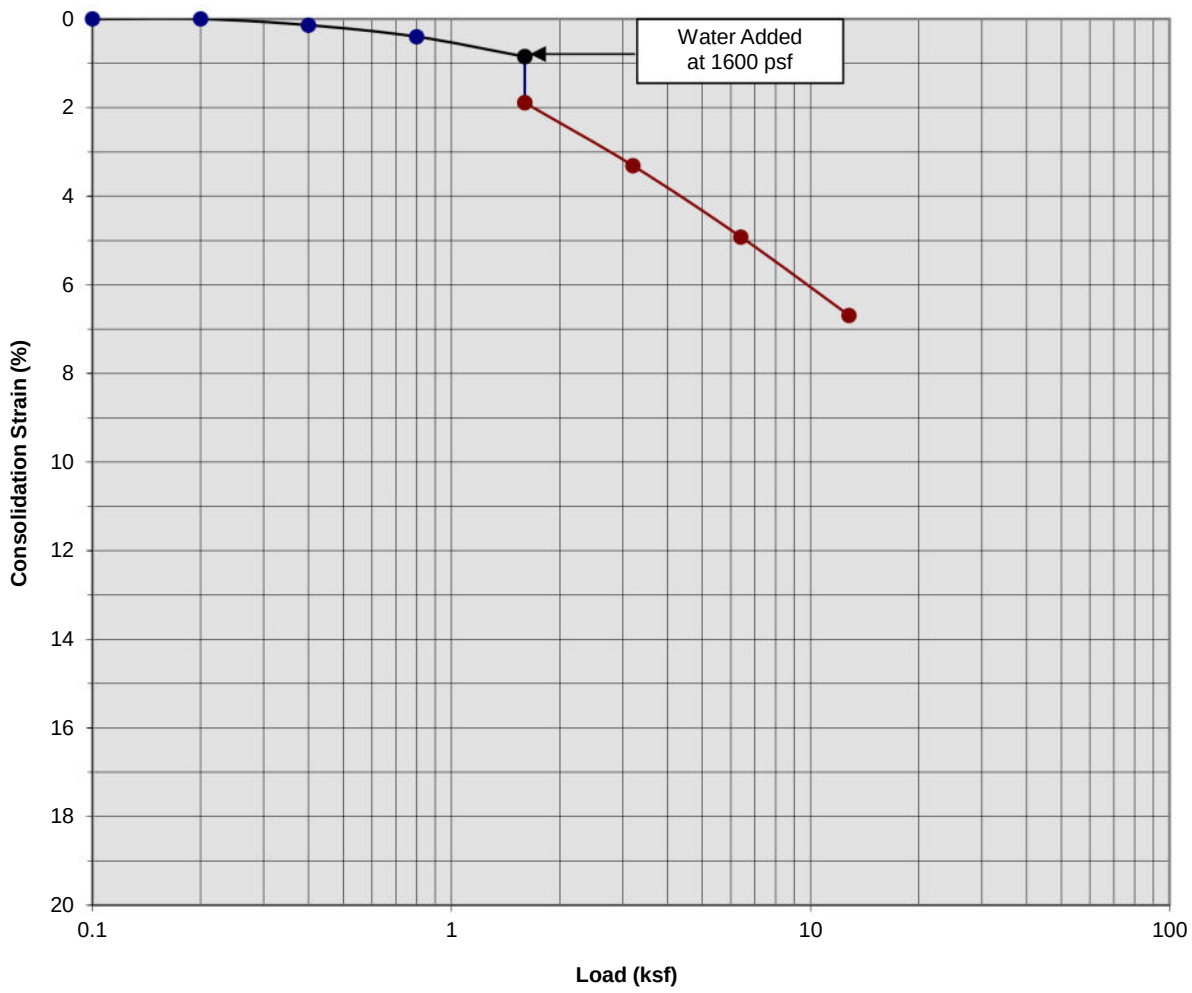
Boring Number:	B-2	Initial Moisture Content (%)	3
Sample Number:	---	Final Moisture Content (%)	12
Depth (ft)	5 to 6	Initial Dry Density (pcf)	116.0
Specimen Diameter (in)	2.4	Final Dry Density (pcf)	125.0
Specimen Thickness (in)	1.0	Percent Collapse (%)	2.64

Phelan 20 Industrial Building
Hesperia, California
Project No. 23G131-1

PLATE C- 2

SoCalGeo
SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

Consolidation/Collapse Test Results



Classification: Light Red Brown Silty fine Sand, little medium Sand, trace Clay

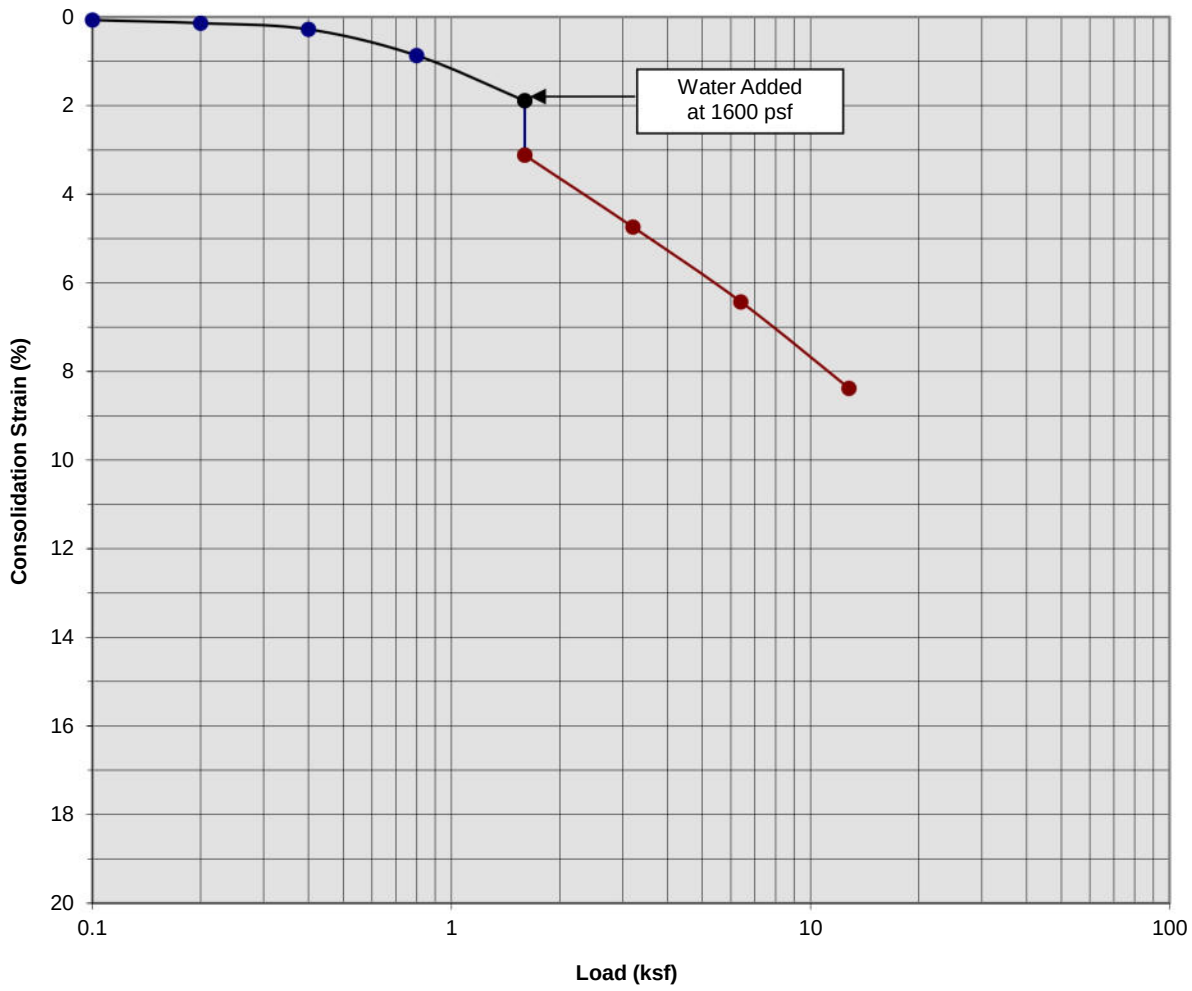
Boring Number:	B-2	Initial Moisture Content (%)	5
Sample Number:	---	Final Moisture Content (%)	12
Depth (ft)	7 to 8	Initial Dry Density (pcf)	120.0
Specimen Diameter (in)	2.4	Final Dry Density (pcf)	128.5
Specimen Thickness (in)	1.0	Percent Collapse (%)	1.04

Phelan 20 Industrial Building
Hesperia, California
Project No. 23G131-1

PLATE C- 3

SoCalGeo
SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

Consolidation/Collapse Test Results



Classification: Light Red Brown Silty fine Sand, little medium Sand, trace Clay

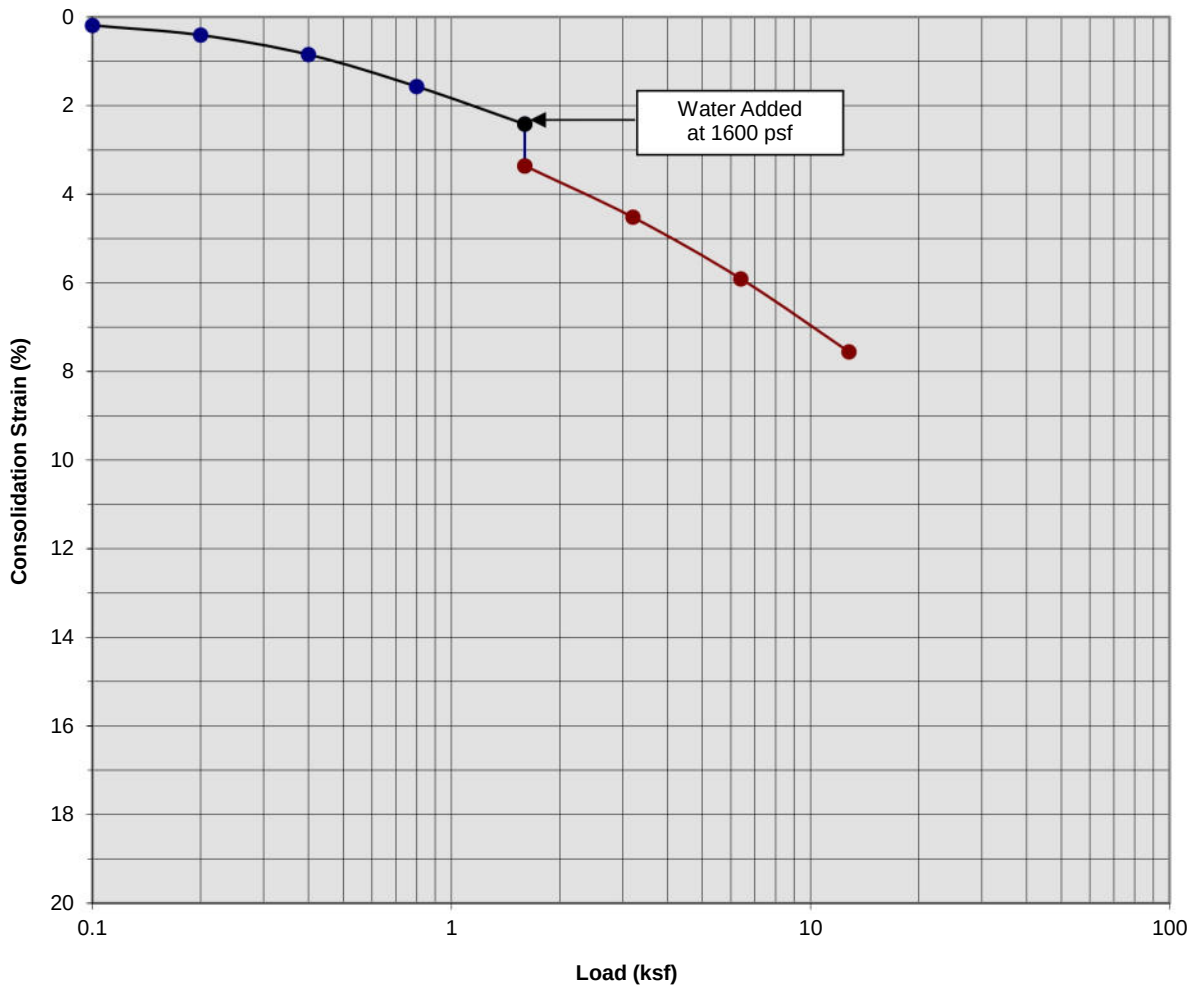
Boring Number:	B-2	Initial Moisture Content (%)	3
Sample Number:	---	Final Moisture Content (%)	12
Depth (ft)	9 to 10	Initial Dry Density (pcf)	121.0
Specimen Diameter (in)	2.4	Final Dry Density (pcf)	132.1
Specimen Thickness (in)	1.0	Percent Collapse (%)	1.23

Phelan 20 Industrial Building
Hesperia, California
Project No. 23G131-1

PLATE C- 4

SoCalGeo
SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

Consolidation/Collapse Test Results



Classification: Dark Brown Silty fne Sand, little medium to coarse Sand, trace Clay

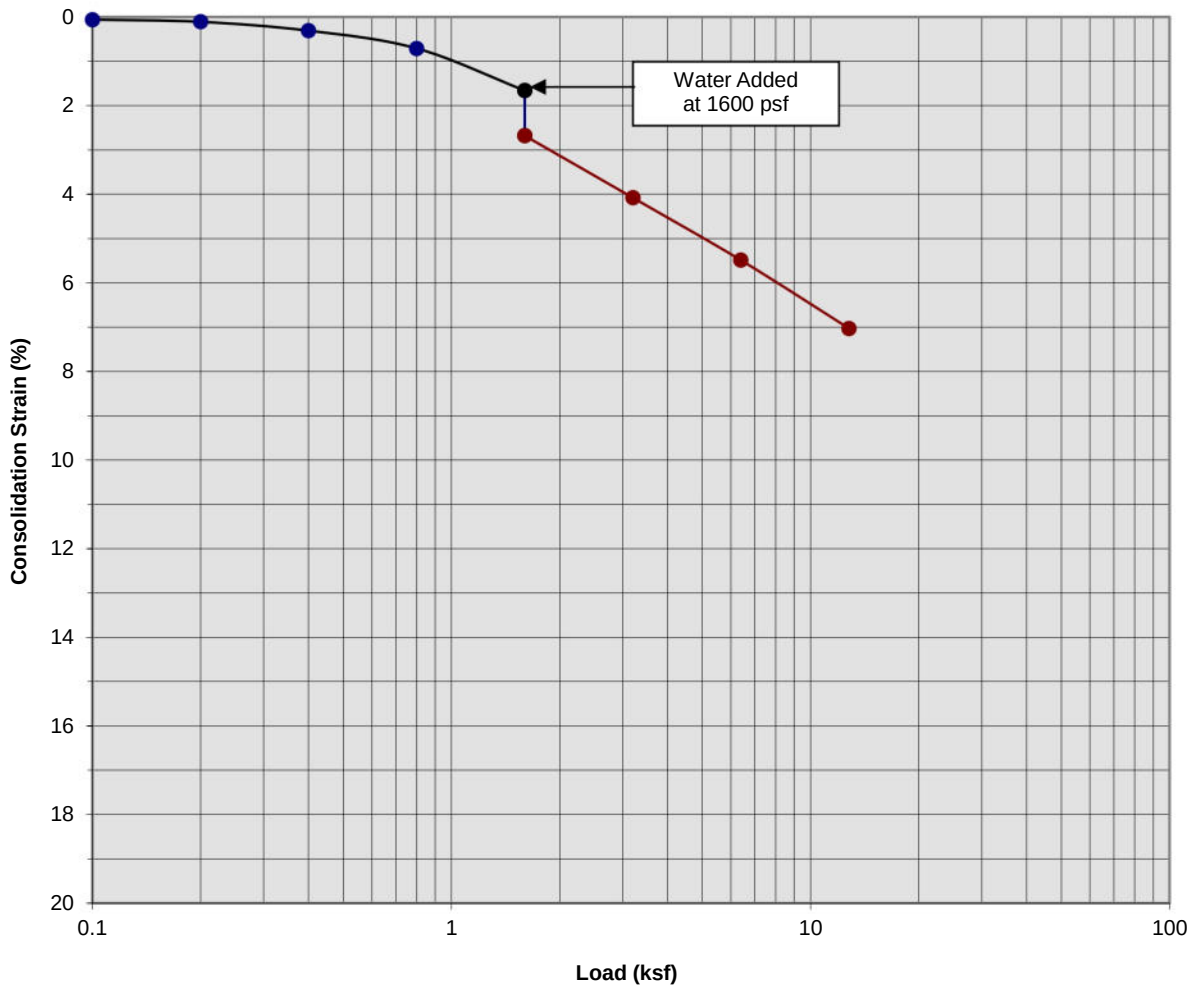
Boring Number:	B-4	Initial Moisture Content (%)	8
Sample Number:	---	Final Moisture Content (%)	10
Depth (ft)	3 to 4	Initial Dry Density (pcf)	123.0
Specimen Diameter (in)	2.4	Final Dry Density (pcf)	132.9
Specimen Thickness (in)	1.0	Percent Collapse (%)	0.94

Phelan 20 Industrial Building
Hesperia, California
Project No. 23G131-1

PLATE C- 5

SoCalGeo
SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

Consolidation/Collapse Test Results



Classification: Light Brown Silty fine to coarse Sand, trace to little fine Gravel

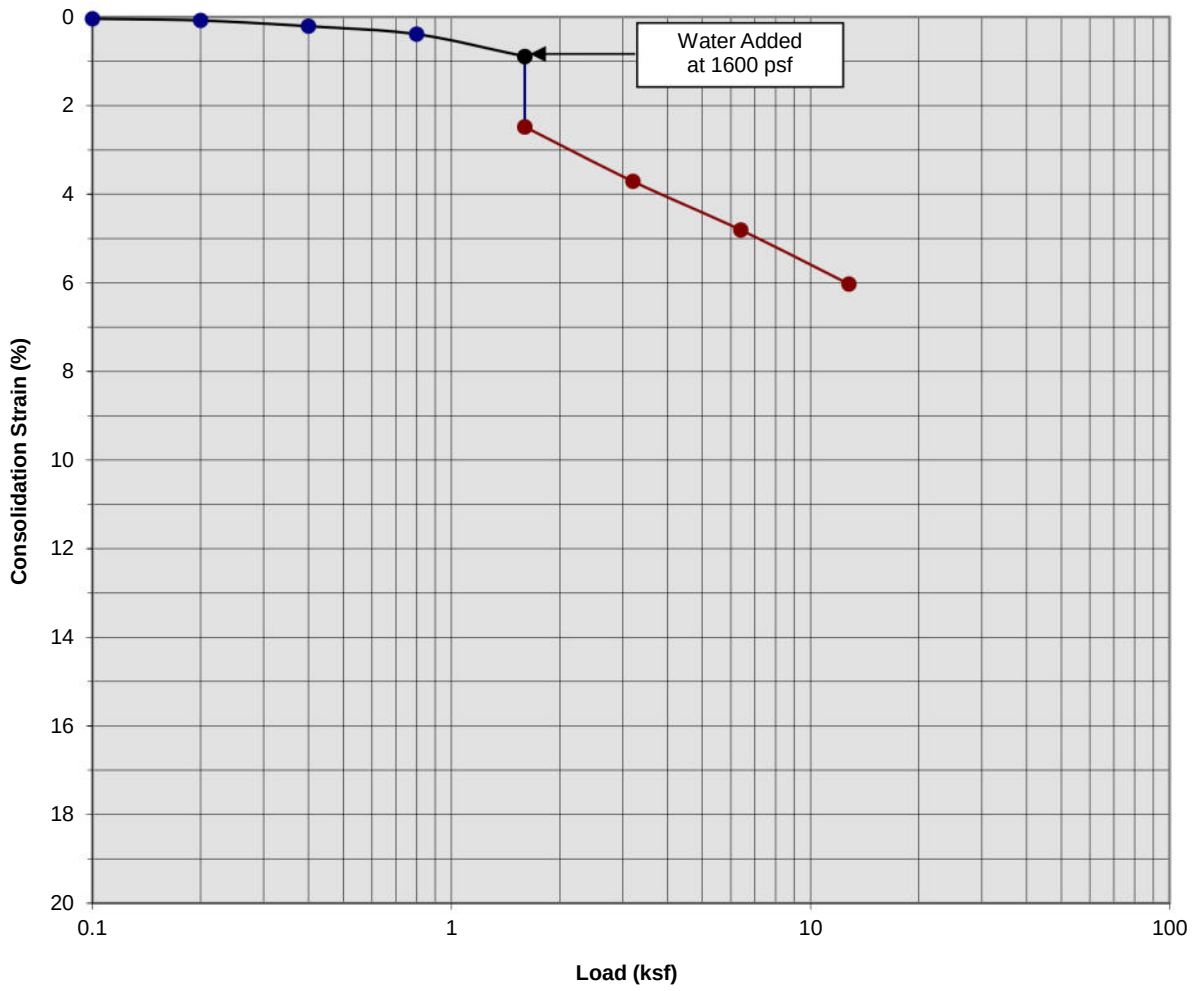
Boring Number:	B-4	Initial Moisture Content (%)	4
Sample Number:	---	Final Moisture Content (%)	11
Depth (ft)	5 to 6	Initial Dry Density (pcf)	115.0
Specimen Diameter (in)	2.4	Final Dry Density (pcf)	123.0
Specimen Thickness (in)	1.0	Percent Collapse (%)	1.02

Phelan 20 Industrial Building
Hesperia, California
Project No. 23G131-1

PLATE C- 6

SoCalGeo
SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

Consolidation/Collapse Test Results



Classification: Light Brown Silty fine to coarse Sand, trace to little fine Gravel

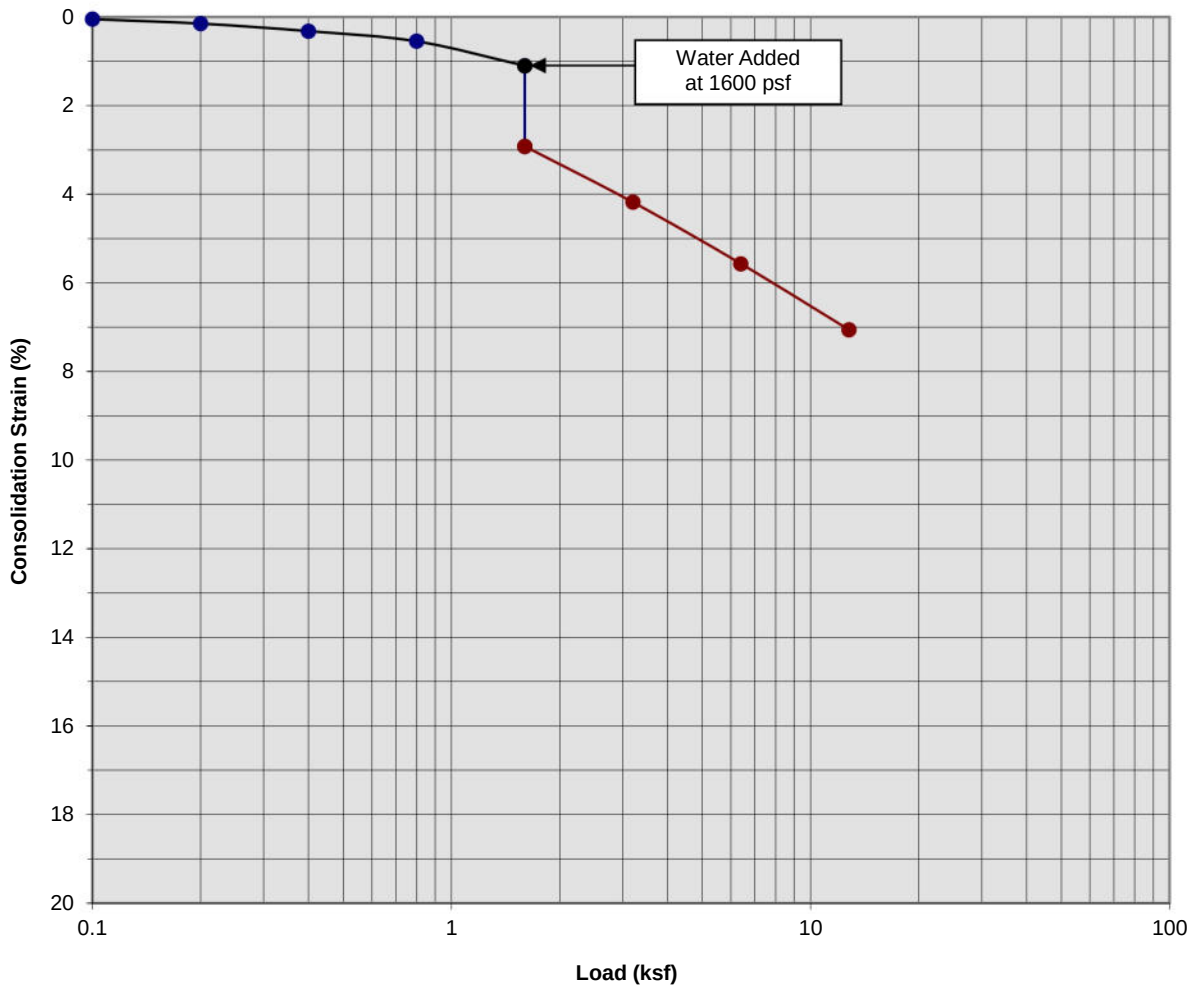
Boring Number:	B-4	Initial Moisture Content (%)	2
Sample Number:	---	Final Moisture Content (%)	13
Depth (ft)	7 to 8	Initial Dry Density (pcf)	115.0
Specimen Diameter (in)	2.4	Final Dry Density (pcf)	122.2
Specimen Thickness (in)	1.0	Percent Collapse (%)	1.59

Phelan 20 Industrial Building
Hesperia, California
Project No. 23G131-1

PLATE C- 7

SoCalGeo
SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

Consolidation/Collapse Test Results



Classification: Light Brown Silty fine to coarse Sand, trace to little fine Gravel

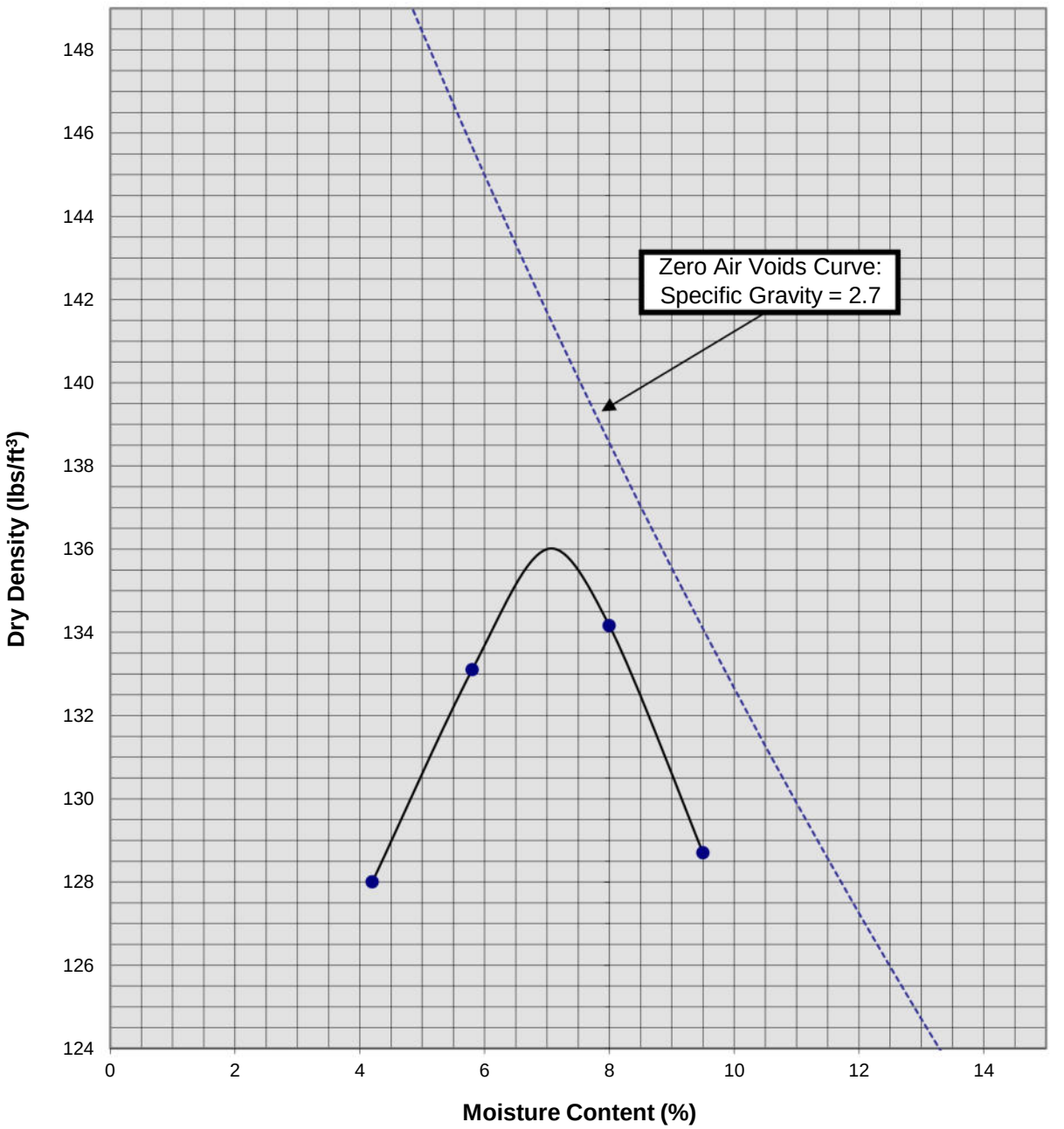
Boring Number:	B-4	Initial Moisture Content (%)	3
Sample Number:	---	Final Moisture Content (%)	14
Depth (ft)	9 to 10	Initial Dry Density (pcf)	112.0
Specimen Diameter (in)	2.4	Final Dry Density (pcf)	120.4
Specimen Thickness (in)	1.0	Percent Collapse (%)	1.82

Phelan 20 Industrial Building
Hesperia, California
Project No. 23G131-1

PLATE C- 8

SoCalGeo
SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

Moisture/Density Relationship
ASTM D-1557



Soil ID Number	B-1 @ 1-5'
Optimum Moisture (%)	7
Maximum Dry Density (pcf)	136
Soil Classification	Brown Silty fine to medium Sand, little coarse Sand, trace fine Gravel

Phelan 20 Industrial Building
Hesperia, California
Project No. 23G131-1

PLATE C-9

SoCalGeo
SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

APPENDIX D

GRADING GUIDE SPECIFICATIONS

These grading guide specifications are intended to provide typical procedures for grading operations. They are intended to supplement the recommendations contained in the geotechnical investigation report for this project. Should the recommendations in the geotechnical investigation report conflict with the grading guide specifications, the more site specific recommendations in the geotechnical investigation report will govern.

General

- The Earthwork Contractor is responsible for the satisfactory completion of all earthwork in accordance with the plans and geotechnical reports, and in accordance with city, county, and applicable building codes.

- The Geotechnical Engineer is the representative of the Owner/Builder for the purpose of implementing the report recommendations and guidelines. These duties are not intended to relieve the Earthwork Contractor of any responsibility to perform in a workman-like manner, nor is the Geotechnical Engineer to direct the grading equipment or personnel employed by the Contractor.

- The Earthwork Contractor is required to notify the Geotechnical Engineer of the anticipated work and schedule so that testing and inspections can be provided. If necessary, work may be stopped and redone if personnel have not been scheduled in advance.

- The Earthwork Contractor is required to have suitable and sufficient equipment on the job-site to process, moisture condition, mix and compact the amount of fill being placed to the approved compaction. In addition, suitable support equipment should be available to conform with recommendations and guidelines in this report.

- Canyon cleanouts, overexcavation areas, processed ground to receive fill, key excavations, subdrains and benches should be observed by the Geotechnical Engineer prior to placement of any fill. It is the Earthwork Contractor's responsibility to notify the Geotechnical Engineer of areas that are ready for inspection.

- Excavation, filling, and subgrade preparation should be performed in a manner and sequence that will provide drainage at all times and proper control of erosion. Precipitation, springs, and seepage water encountered shall be pumped or drained to provide a suitable working surface. The Geotechnical Engineer must be informed of springs or water seepage encountered during grading or foundation construction for possible revision to the recommended construction procedures and/or installation of subdrains.

Site Preparation

- The Earthwork Contractor is responsible for all clearing, grubbing, stripping and site preparation for the project in accordance with the recommendations of the Geotechnical Engineer.

- If any materials or areas are encountered by the Earthwork Contractor which are suspected of having toxic or environmentally sensitive contamination, the Geotechnical Engineer and Owner/Builder should be notified immediately.

- Major vegetation should be stripped and disposed of off-site. This includes trees, brush, heavy grasses and any materials considered unsuitable by the Geotechnical Engineer.

- Underground structures such as basements, cesspools or septic disposal systems, mining shafts, tunnels, wells and pipelines should be removed under the inspection of the Geotechnical Engineer and recommendations provided by the Geotechnical Engineer and/or city, county or state agencies. If such structures are known or found, the Geotechnical Engineer should be notified as soon as possible so that recommendations can be formulated.

- Any topsoil, slopewash, colluvium, alluvium and rock materials which are considered unsuitable by the Geotechnical Engineer should be removed prior to fill placement.

- Remaining voids created during site clearing caused by removal of trees, foundations basements, irrigation facilities, etc., should be excavated and filled with compacted fill.

- Subsequent to clearing and removals, areas to receive fill should be scarified to a depth of 10 to 12 inches, moisture conditioned and compacted

- The moisture condition of the processed ground should be at or slightly above the optimum moisture content as determined by the Geotechnical Engineer. Depending upon field conditions, this may require air drying or watering together with mixing and/or discing.

Compacted Fills

- Soil materials imported to or excavated on the property may be utilized in the fill, provided each material has been determined to be suitable in the opinion of the Geotechnical Engineer. Unless otherwise approved by the Geotechnical Engineer, all fill materials shall be free of deleterious, organic, or frozen matter, shall contain no chemicals that may result in the material being classified as “contaminated,” and shall be very low to non-expansive with a maximum expansion index (EI) of 50. The top 12 inches of the compacted fill should have a maximum particle size of 3 inches, and all underlying compacted fill material a maximum 6-inch particle size, except as noted below.

- All soils should be evaluated and tested by the Geotechnical Engineer. Materials with high expansion potential, low strength, poor gradation or containing organic materials may require removal from the site or selective placement and/or mixing to the satisfaction of the Geotechnical Engineer.

- Rock fragments or rocks less than 6 inches in their largest dimensions, or as otherwise determined by the Geotechnical Engineer, may be used in compacted fill, provided the distribution and placement is satisfactory in the opinion of the Geotechnical Engineer.

- Rock fragments or rocks greater than 12 inches should be taken off-site or placed in accordance with recommendations and in areas designated as suitable by the Geotechnical Engineer. These materials should be placed in accordance with Plate D-8 of these Grading Guide Specifications and in accordance with the following recommendations:

    - Rocks 12 inches or more in diameter should be placed in rows at least 15 feet apart, 15 feet from the edge of the fill, and 10 feet or more below subgrade. Spaces should be left between each rock fragment to provide for placement and compaction of soil around the fragments.

    - Fill materials consisting of soil meeting the minimum moisture content requirements and free of oversize material should be placed between and over the rows of rock or

concrete. Ample water and compactive effort should be applied to the fill materials as they are placed in order that all of the voids between each of the fragments are filled and compacted to the specified density.

- Subsequent rows of rocks should be placed such that they are not directly above a row placed in the previous lift of fill. A minimum 5-foot offset between rows is recommended.

- To facilitate future trenching, oversized material should not be placed within the range of foundation excavations, future utilities or other underground construction unless specifically approved by the soil engineer and the developer/owner representative.

- Fill materials approved by the Geotechnical Engineer should be placed in areas previously prepared to receive fill and in evenly placed, near horizontal layers at about 6 to 8 inches in loose thickness, or as otherwise determined by the Geotechnical Engineer for the project.

- Each layer should be moisture conditioned to optimum moisture content, or slightly above, as directed by the Geotechnical Engineer. After proper mixing and/or drying, to evenly distribute the moisture, the layers should be compacted to at least 90 percent of the maximum dry density in compliance with ASTM D-1557-78 unless otherwise indicated.

- Density and moisture content testing should be performed by the Geotechnical Engineer at random intervals and locations as determined by the Geotechnical Engineer. These tests are intended as an aid to the Earthwork Contractor, so he can evaluate his workmanship, equipment effectiveness and site conditions. The Earthwork Contractor is responsible for compaction as required by the Geotechnical Report(s) and governmental agencies.

- Fill areas unused for a period of time may require moisture conditioning, processing and recompaction prior to the start of additional filling. The Earthwork Contractor should notify the Geotechnical Engineer of his intent so that an evaluation can be made.

- Fill placed on ground sloping at a 5-to-1 inclination (horizontal-to-vertical) or steeper should be benched into bedrock or other suitable materials, as directed by the Geotechnical Engineer. Typical details of benching are illustrated on Plates D-2, D-4, and D-5.

- Cut/fill transition lots should have the cut portion overexcavated to a depth of at least 3 feet and rebuilt with fill (see Plate D-1), as determined by the Geotechnical Engineer.

- All cut lots should be inspected by the Geotechnical Engineer for fracturing and other bedrock conditions. If necessary, the pads should be overexcavated to a depth of 3 feet and rebuilt with a uniform, more cohesive soil type to impede moisture penetration.

- Cut portions of pad areas above buttresses or stabilizations should be overexcavated to a depth of 3 feet and rebuilt with uniform, more cohesive compacted fill to impede moisture penetration.

- Non-structural fill adjacent to structural fill should typically be placed in unison to provide lateral support. Backfill along walls must be placed and compacted with care to ensure that excessive unbalanced lateral pressures do not develop. The type of fill material placed adjacent to below grade walls must be properly tested and approved by the Geotechnical Engineer with consideration of the lateral earth pressure used in the design.

Foundations

- The foundation influence zone is defined as extending one foot horizontally from the outside edge of a footing, and proceeding downward at a ½ horizontal to 1 vertical (0.5:1) inclination.

- Where overexcavation beneath a footing subgrade is necessary, it should be conducted so as to encompass the entire foundation influence zone, as described above.

- Compacted fill adjacent to exterior footings should extend at least 12 inches above foundation bearing grade. Compacted fill within the interior of structures should extend to the floor subgrade elevation.

Fill Slopes

- The placement and compaction of fill described above applies to all fill slopes. Slope compaction should be accomplished by overfilling the slope, adequately compacting the fill in even layers, including the overfilled zone and cutting the slope back to expose the compacted core

- Slope compaction may also be achieved by backrolling the slope adequately every 2 to 4 vertical feet during the filling process as well as requiring the earth moving and compaction equipment to work close to the top of the slope. Upon completion of slope construction, the slope face should be compacted with a sheepsfoot connected to a sideboom and then grid rolled. This method of slope compaction should only be used if approved by the Geotechnical Engineer.

- Sandy soils lacking in adequate cohesion may be unstable for a finished slope condition and therefore should not be placed within 15 horizontal feet of the slope face.

- All fill slopes should be keyed into bedrock or other suitable material. Fill keys should be at least 15 feet wide and inclined at 2 percent into the slope. For slopes higher than 30 feet, the fill key width should be equal to one-half the height of the slope (see Plate D-5).

- All fill keys should be cleared of loose slough material prior to geotechnical inspection and should be approved by the Geotechnical Engineer and governmental agencies prior to filling.

- The cut portion of fill over cut slopes should be made first and inspected by the Geotechnical Engineer for possible stabilization requirements. The fill portion should be adequately keyed through all surficial soils and into bedrock or suitable material. Soils should be removed from the transition zone between the cut and fill portions (see Plate D-2).

Cut Slopes

- All cut slopes should be inspected by the Geotechnical Engineer to determine the need for stabilization. The Earthwork Contractor should notify the Geotechnical Engineer when slope cutting is in progress at intervals of 10 vertical feet. Failure to notify may result in a delay in recommendations.

- Cut slopes exposing loose, cohesionless sands should be reported to the Geotechnical Engineer for possible stabilization recommendations.

- All stabilization excavations should be cleared of loose slough material prior to geotechnical inspection. Stakes should be provided by the Civil Engineer to verify the location and dimensions of the key. A typical stabilization fill detail is shown on Plate D-5.

- Stabilization key excavations should be provided with subdrains. Typical subdrain details are shown on Plates D-6.

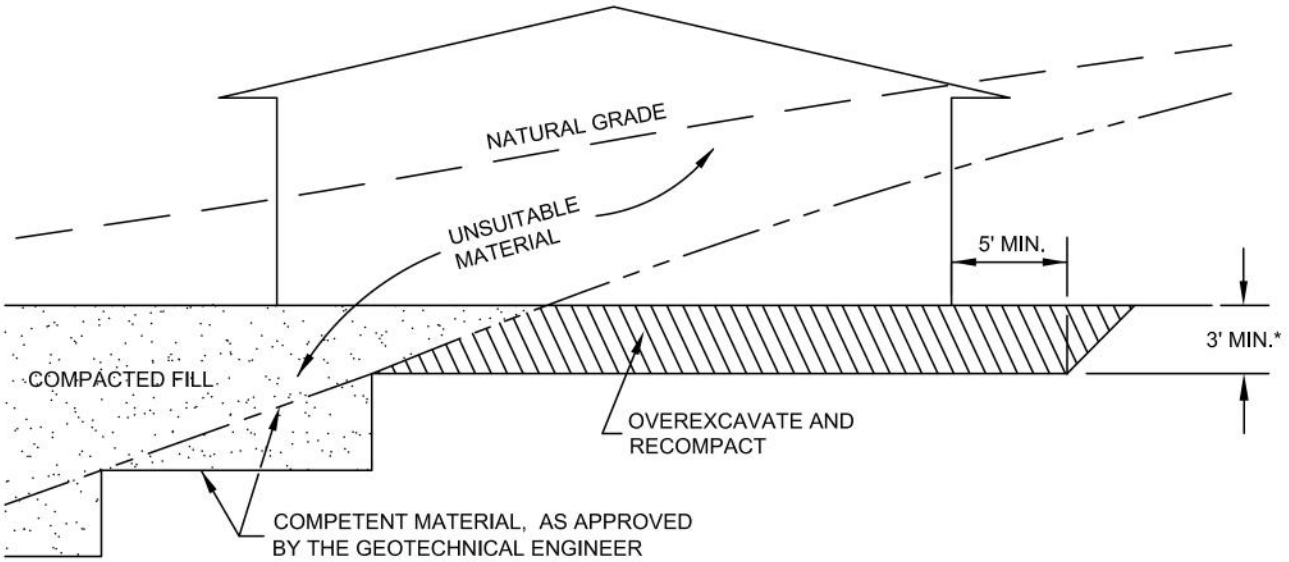
Subdrains

- Subdrains may be required in canyons and swales where fill placement is proposed. Typical subdrain details for canyons are shown on Plate D-3. Subdrains should be installed after approval of removals and before filling, as determined by the Soils Engineer.

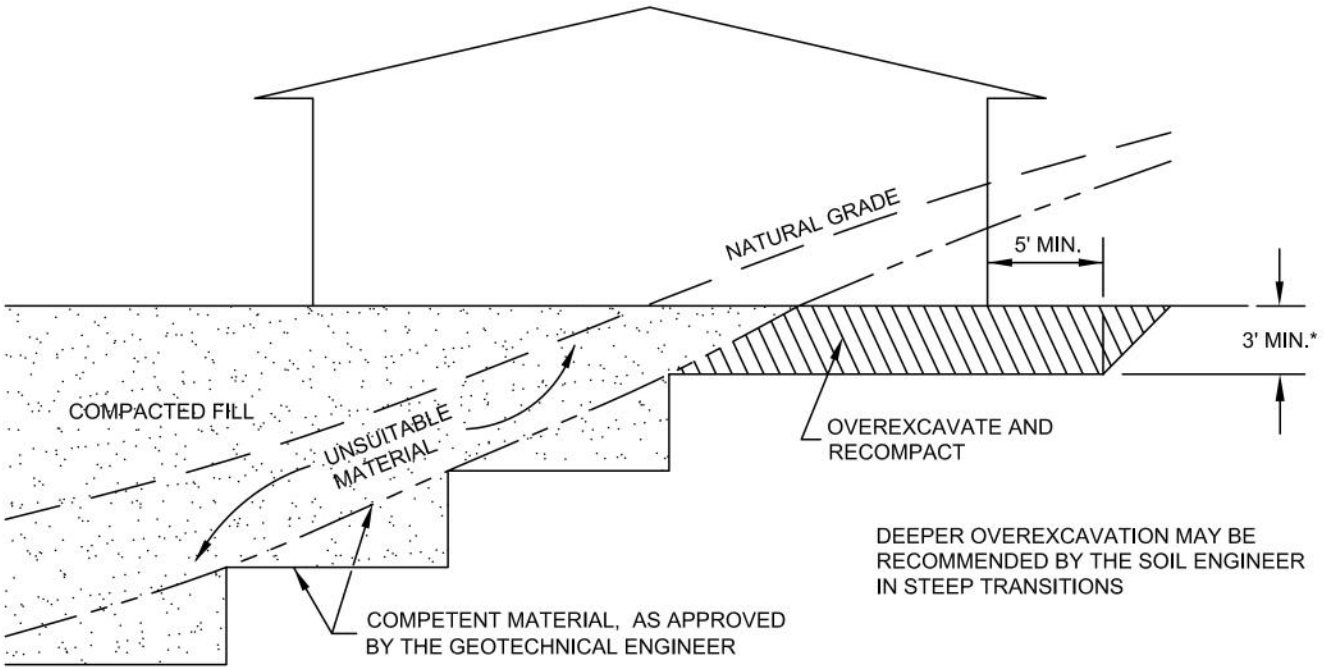
- Plastic pipe may be used for subdrains provided it is Schedule 40 or SDR 35 or equivalent. Pipe should be protected against breakage, typically by placement in a square-cut (backhoe) trench or as recommended by the manufacturer.

- Filter material for subdrains should conform to CALTRANS Specification 68-1.025 or as approved by the Geotechnical Engineer for the specific site conditions. Clean ¾-inch crushed rock may be used provided it is wrapped in an acceptable filter cloth and approved by the Geotechnical Engineer. Pipe diameters should be 6 inches for runs up to 500 feet and 8 inches for the downstream continuations of longer runs. Four-inch diameter pipe may be used in buttress and stabilization fills.

CUT LOT



CUT/FILL LOT (TRANSITION)



*SEE TEXT OF REPORT FOR SPECIFIC RECOMMENDATION. ACTUAL DEPTH OF OVEREXCAVATION MAY BE GREATER.

TRANSITION LOT DETAIL

GRADING GUIDE SPECIFICATIONS

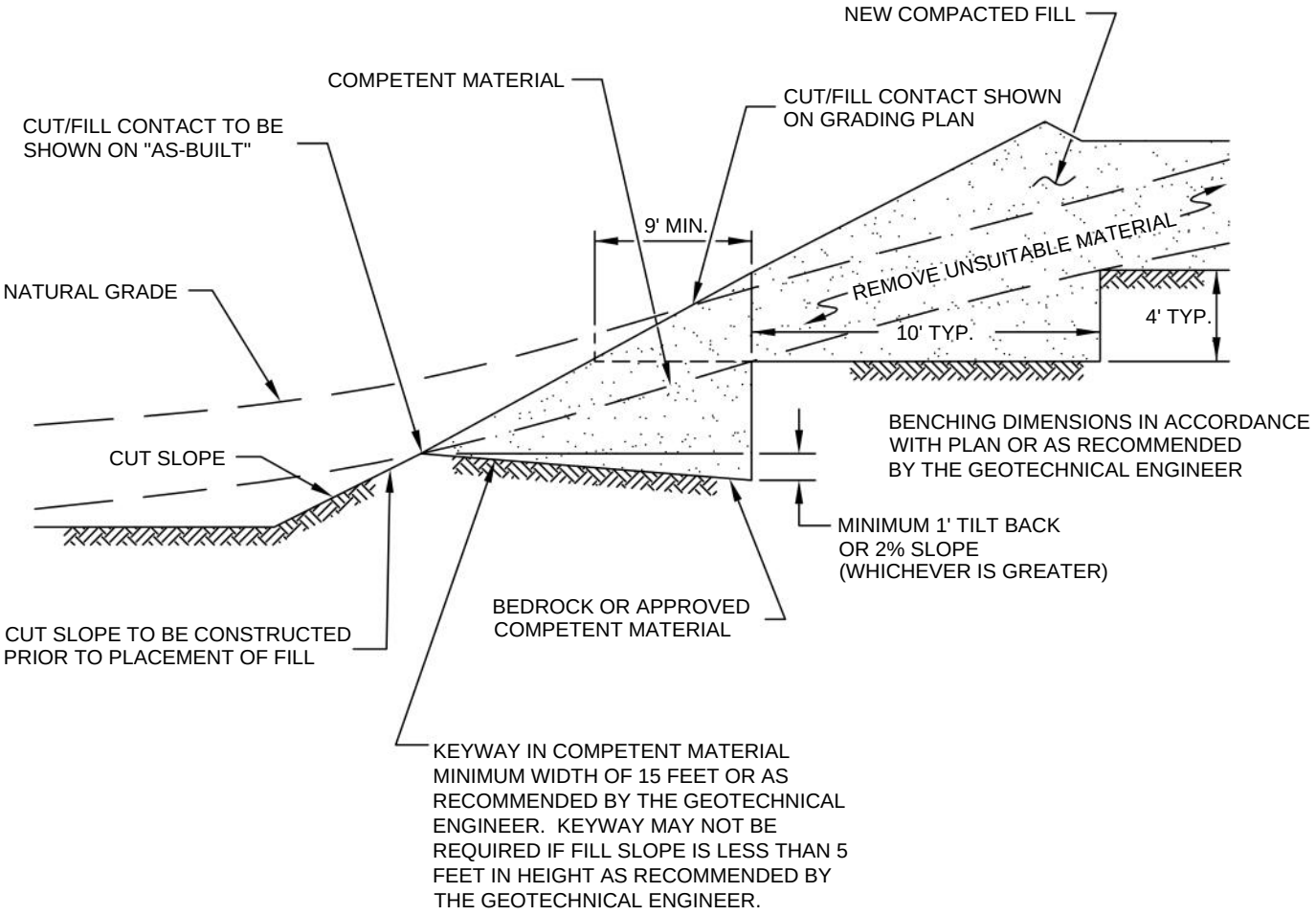
NOT TO SCALE

DRAWN: JAS
CHKD: GKM

PLATE D-1

SoCalGeo

SOUTHERN CALIFORNIA GEOTECHNICAL



FILL ABOVE CUT SLOPE DETAIL

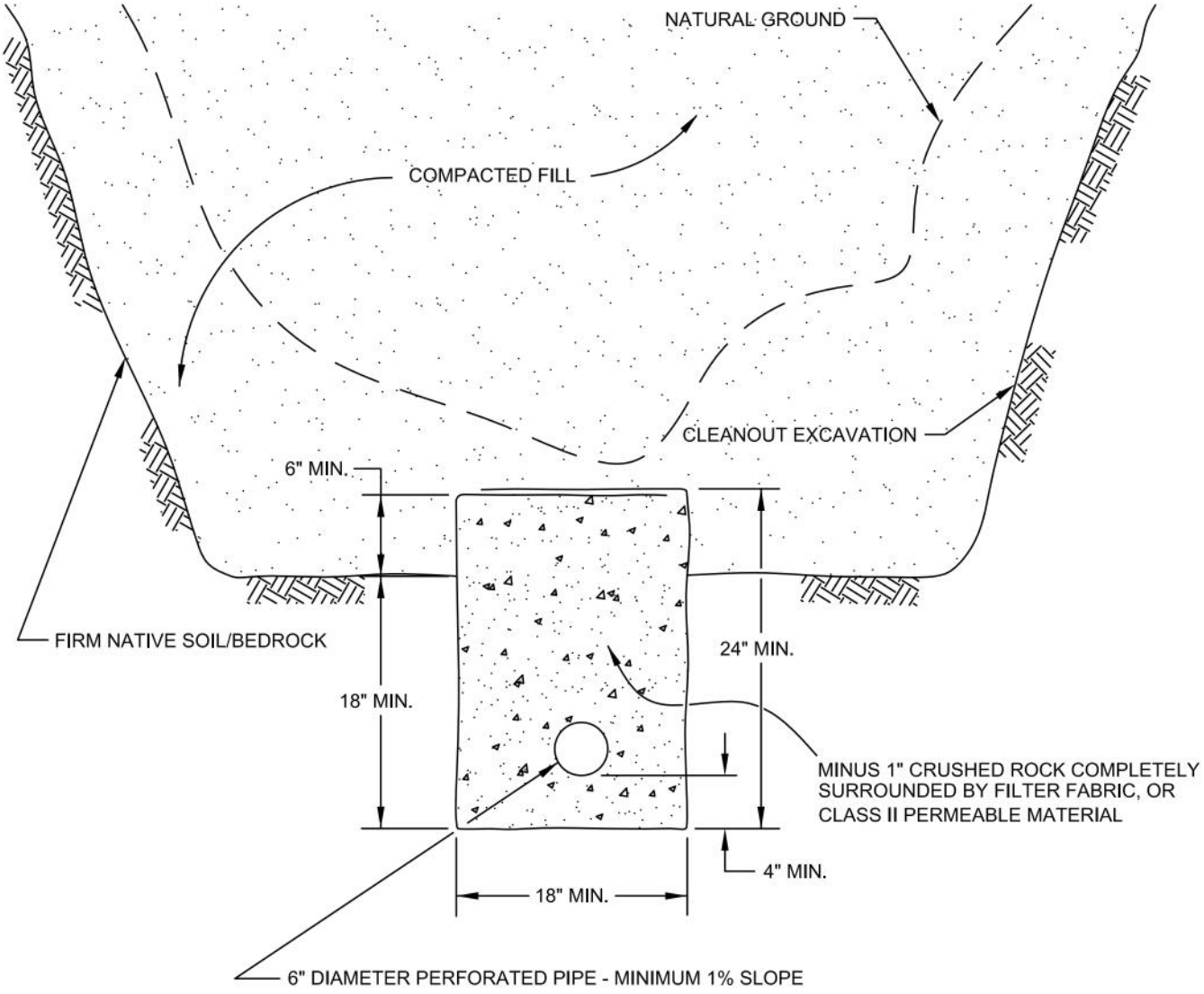
GRADING GUIDE SPECIFICATIONS

NOT TO SCALE

DRAWN: JAS
CHKD: GKM

PLATE D-2

SoCalGeo
SOUTHERN CALIFORNIA GEOTECHNICAL



PIPE MATERIAL	DEPTH OF FILL OVER SUBDRAIN
ADS (CORRUGATED POLETHYLENE)	8
TRANSITE UNDERDRAIN	20
PVC OR ABS: SDR 35	35
SDR 21	100

SCHEMATIC ONLY
NOT TO SCALE

CANYON SUBDRAIN DETAIL

GRADING GUIDE SPECIFICATIONS

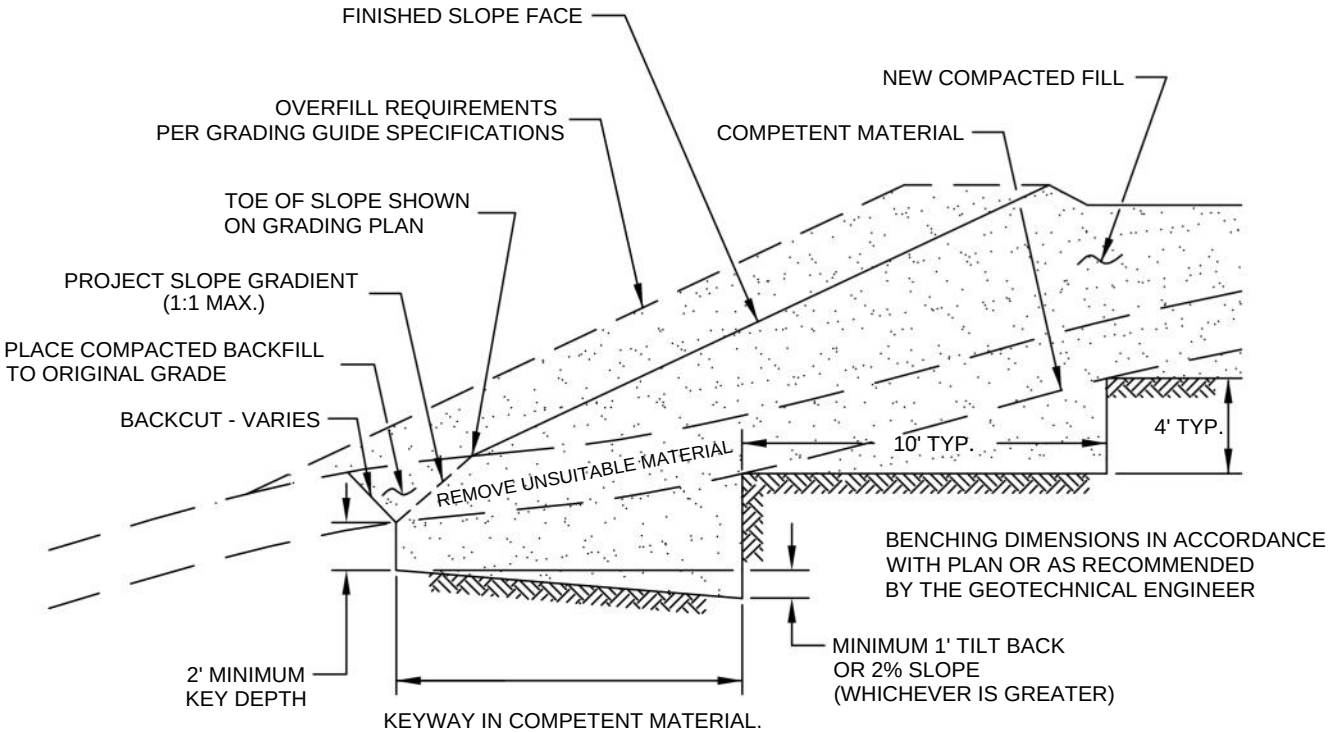
NOT TO SCALE

DRAWN: JAS
CHKD: GKM

PLATE D-3

SoCalGeo

SOUTHERN CALIFORNIA GEOTECHNICAL



NOTE:
BENCHING SHALL BE REQUIRED
WHEN NATURAL SLOPES ARE
EQUAL TO OR STEEPER THAN 5:1
OR WHEN RECOMMENDED BY
THE GEOTECHNICAL ENGINEER.

FILL ABOVE NATURAL SLOPE DETAIL

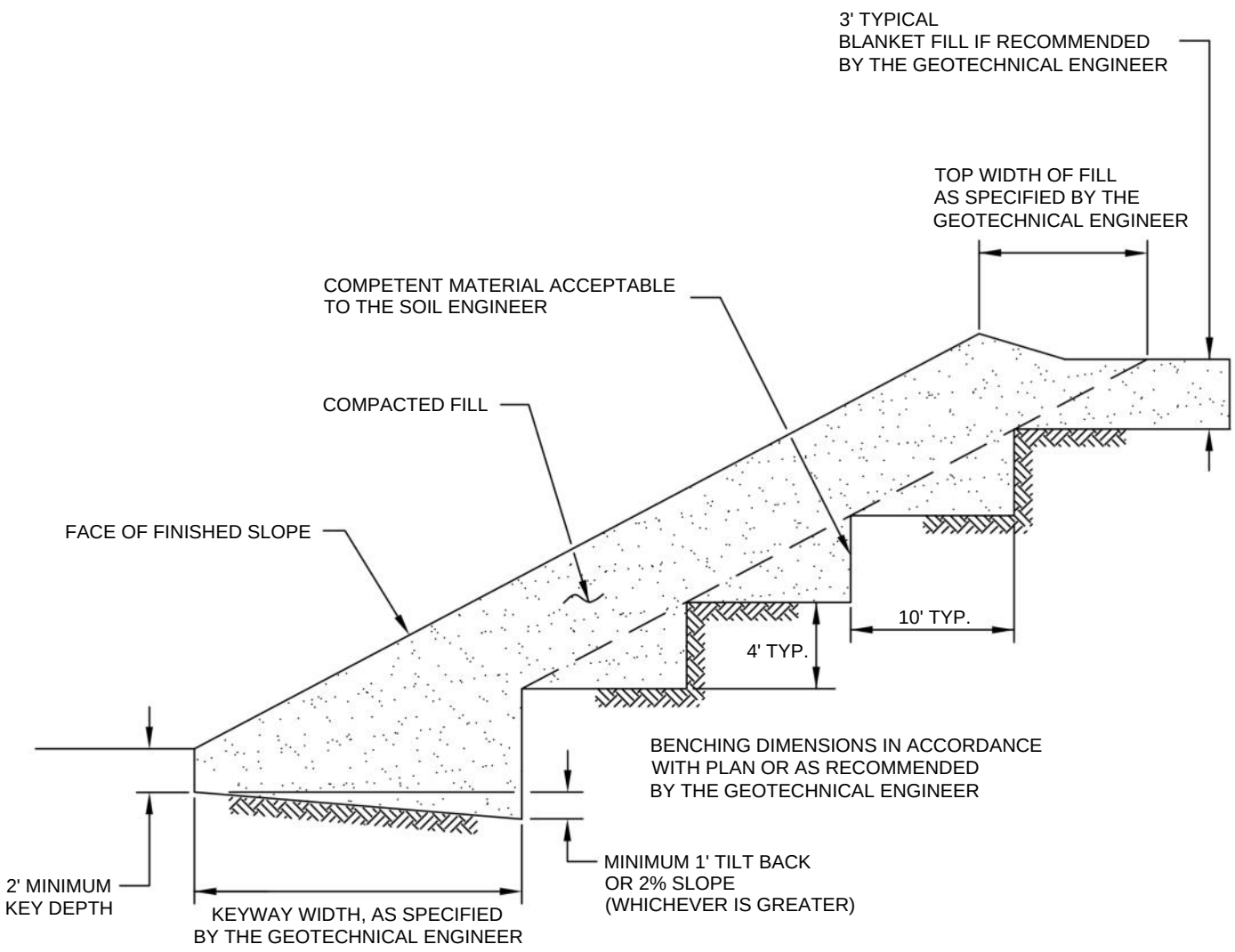
GRADING GUIDE SPECIFICATIONS

NOT TO SCALE

DRAWN: JAS
CHKD: GKM

PLATE D-4

SoCalGeo
SOUTHERN
CALIFORNIA
GEOTECHNICAL



STABILIZATION FILL DETAIL

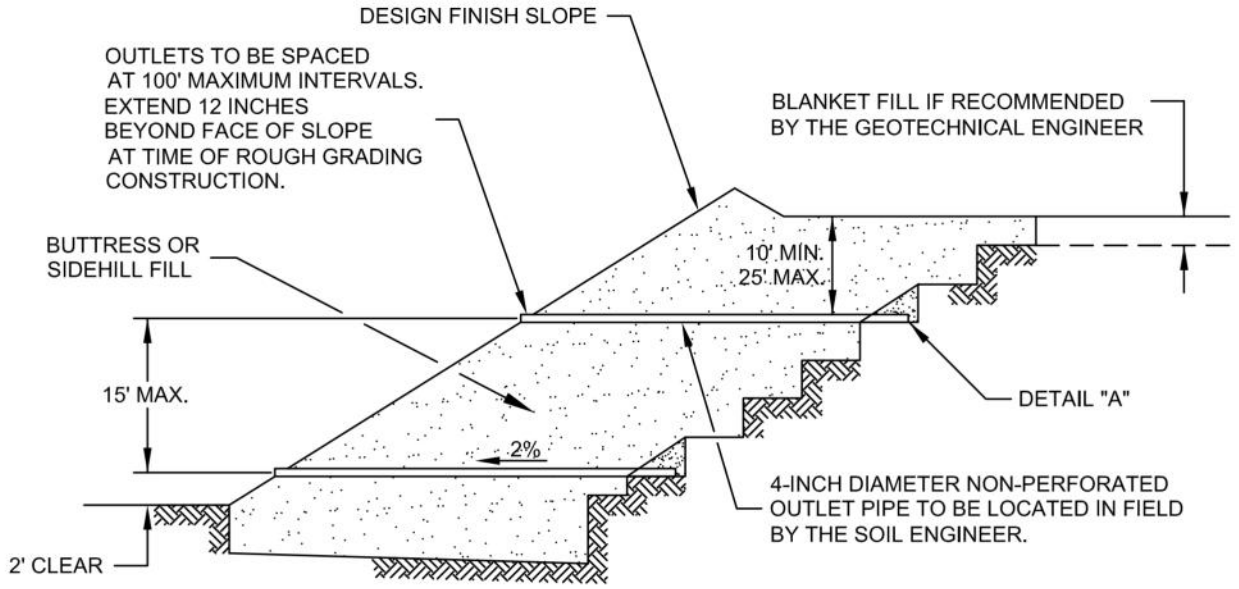
GRADING GUIDE SPECIFICATIONS

NOT TO SCALE

DRAWN: JAS
CHKD: GKM

PLATE D-5

SoCalGeo
SOUTHERN CALIFORNIA GEOTECHNICAL



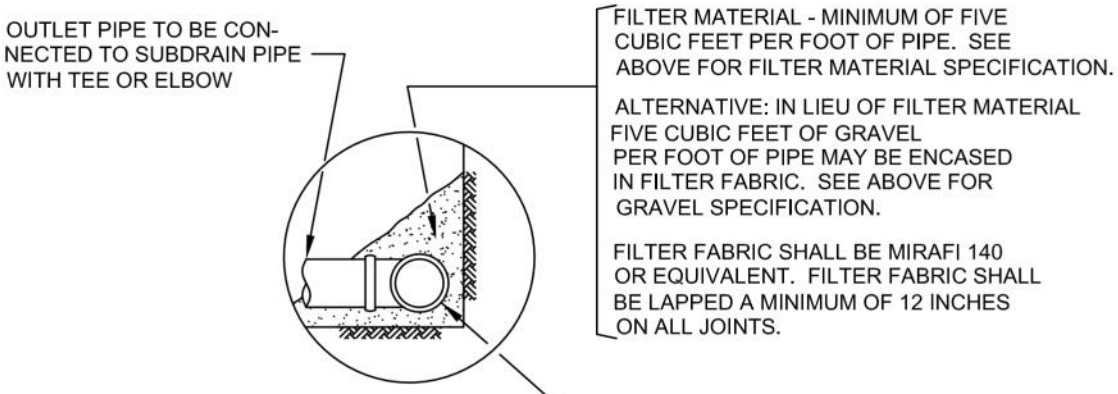
"FILTER MATERIAL" TO MEET FOLLOWING SPECIFICATION OR APPROVED EQUIVALENT: (CONFORMS TO EMA STD. PLAN 323)

SIEVE SIZE	PERCENTAGE PASSING
1"	100
3/4"	90-100
3/8"	40-100
NO. 4	25-40
NO. 8	18-33
NO. 30	5-15
NO. 50	0-7
NO. 200	0-3

"GRAVEL" TO MEET FOLLOWING SPECIFICATION OR APPROVED EQUIVALENT:

SIEVE SIZE	MAXIMUM PERCENTAGE PASSING
1 1/2"	100
NO. 4	50
NO. 200	8

SAND EQUIVALENT = MINIMUM OF 50



DETAIL "A"

NOTES:
1. TRENCH FOR OUTLET PIPES TO BE BACKFILLED WITH ON-SITE SOIL.

SLOPE FILL SUBDRAINS

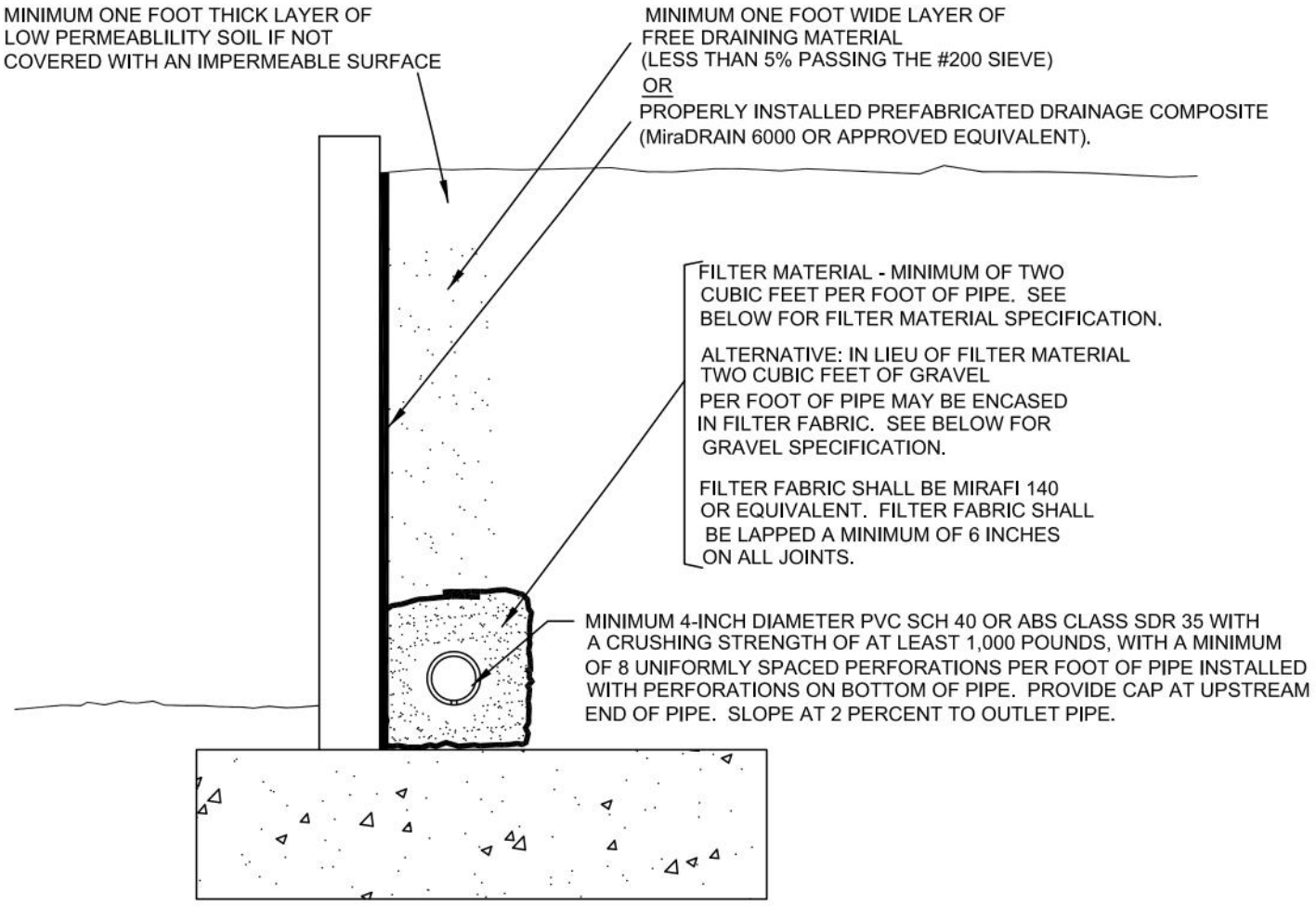
GRADING GUIDE SPECIFICATIONS

NOT TO SCALE

DRAWN: JAS
CHKD: GKM

PLATE D-6

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SOUTHERN CALIFORNIA GEOTECHNICAL



"FILTER MATERIAL" TO MEET FOLLOWING SPECIFICATION OR APPROVED EQUIVALENT: (CONFORMS TO EMA STD. PLAN 323)

SIEVE SIZE	PERCENTAGE PASSING
1"	100
3/4"	90-100
3/8"	40-100
NO. 4	25-40
NO. 8	18-33
NO. 30	5-15
NO. 50	0-7
NO. 200	0-3

"GRAVEL" TO MEET FOLLOWING SPECIFICATION OR APPROVED EQUIVALENT:

SIEVE SIZE	MAXIMUM PERCENTAGE PASSING
1 1/2"	100
NO. 4	50
NO. 200	8

SAND EQUIVALENT = MINIMUM OF 50

RETAINING WALL BACKDRAINS

GRADING GUIDE SPECIFICATIONS

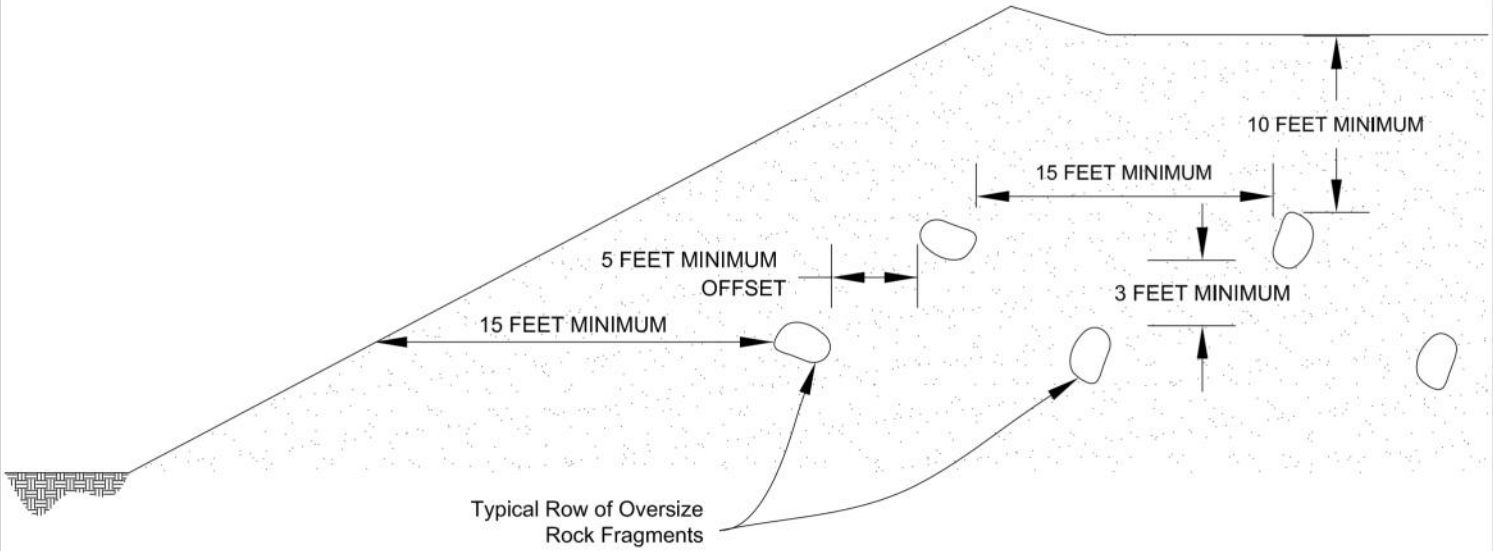
NOT TO SCALE

DRAWN: JAS
CHKD: GKM

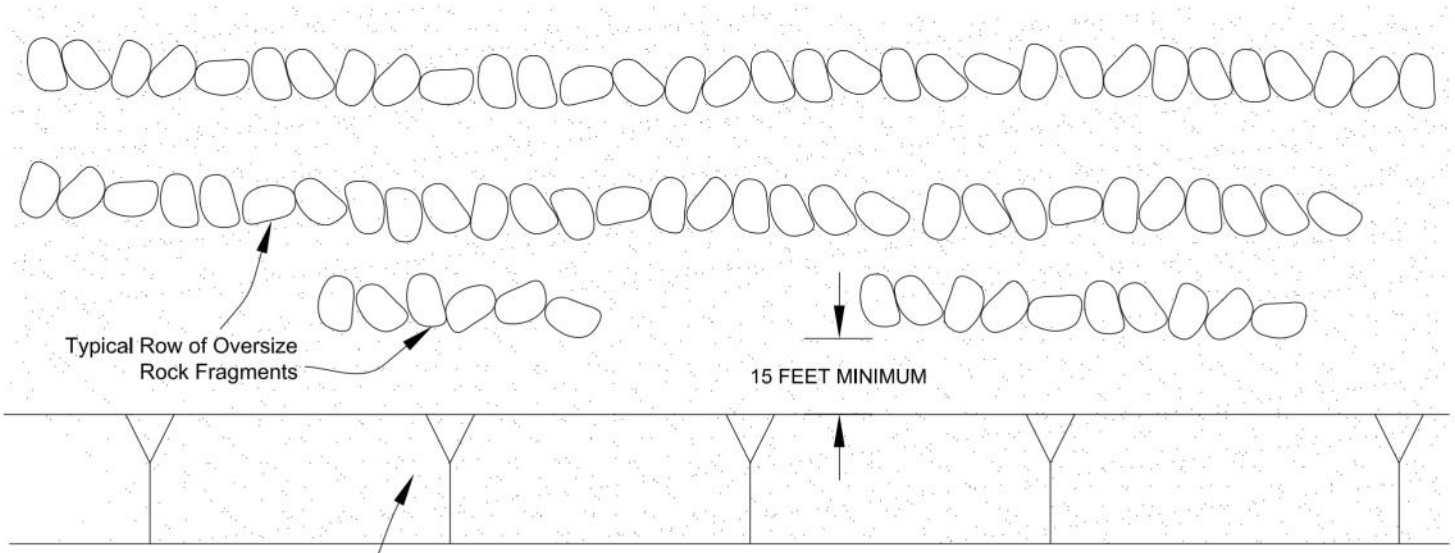
PLATE D-7

SoCalGeo

SOUTHERN CALIFORNIA GEOTECHNICAL



Section View



Plan View

PLACEMENT OF OVERSIZED MATERIAL

GRADING GUIDE SPECIFICATIONS

NOT TO SCALE

DRAWN: PM
CHKD: GKM

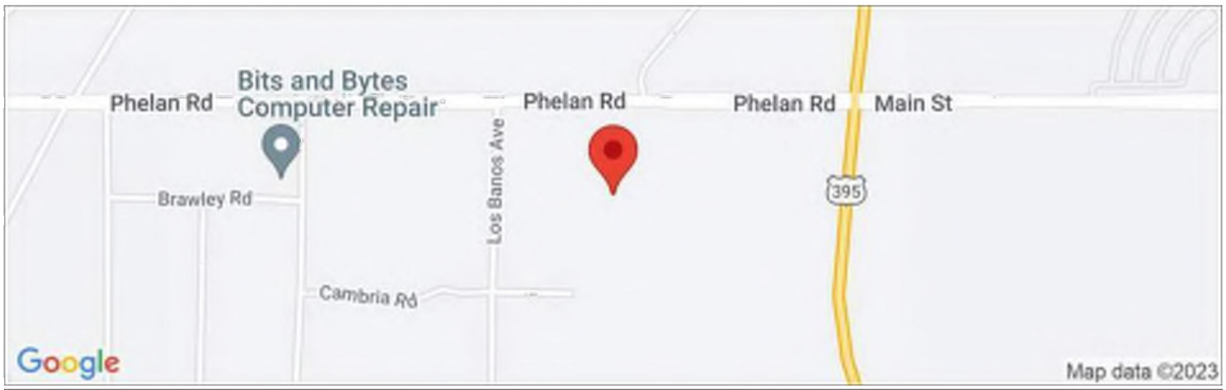
PLATE D-8

SoCalGeo

SOUTHERN CALIFORNIA GEOTECHNICAL

APPENDIX E

Latitude, Longitude: 34.42497086, -117.40549142



Date	4/25/2023, 3:48:24 PM
Design Code Reference Document	ASCE7-16
Risk Category	III
Site Class	D - Stiff Soil

Type	Value	Description
S_S	1.5	MCE_R ground motion. (for 0.2 second period)
S_1	0.6	MCE_R ground motion. (for 1.0s period)
S_{MS}	1.5	Site-modified spectral acceleration value
S_{M1}	null -See Section 11.4.8	Site-modified spectral acceleration value
S_{DS}	1	Numeric seismic design value at 0.2 second SA
S_{D1}	null -See Section 11.4.8	Numeric seismic design value at 1.0 second SA

Type	Value	Description
SDC	null -See Section 11.4.8	Seismic design category
F_a	1	Site amplification factor at 0.2 second
F_v	null -See Section 11.4.8	Site amplification factor at 1.0 second
PGA	0.502	MCE_G peak ground acceleration
F_{PGA}	1.1	Site amplification factor at PGA
PGA_M	0.552	Site modified peak ground acceleration
T_L	12	Long-period transition period in seconds
SsRT	1.581	Probabilistic risk-targeted ground motion. (0.2 second)
SsUH	1.706	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration
SsD	1.5	Factored deterministic acceleration value. (0.2 second)
S1RT	0.616	Probabilistic risk-targeted ground motion. (1.0 second)
S1UH	0.68	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration.
S1D	0.6	Factored deterministic acceleration value. (1.0 second)
PGAd	0.502	Factored deterministic acceleration value. (Peak Ground Acceleration)
PGA_{UH}	0.677	Uniform-hazard (2% probability of exceedance in 50 years) Peak Ground Acceleration
C_{RS}	0.927	Mapped value of the risk coefficient at short periods
C_{R1}	0.905	Mapped value of the risk coefficient at a period of 1 s
C_V	1.4	Vertical coefficient

SOURCE: SEAOC/OSHPD Seismic Design Maps Tool
<https://seismicmaps.org/>

SEISMIC DESIGN PARAMETERS - 2022 CBC

PHELAN 20 INDUSTRIAL BUILDING

HESPERIA, CALIFORNIA

DRAWN: MK
CHKD: RGT

SCG PROJECT
23G131-1

PLATE E-1

SOUTHERN CALIFORNIA GEOTECHNICAL