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Preliminary Water Quality Management Plan

For:

DPC Redlands

CRA 956

APN: 0167-171-15

Prepared for:

Diversified Pacific Communities

10621 Civic Center Drive

Rancho Cucamonga, CA 91730

(909) 481-1150

Prepared by:

Kimley Horn & Associates, Inc.

3880 Lemon Street, Suite 420

Riverside, CA 92501

951-543-9868

Submittal Date: 02/07/2024

Approval Date:_____

Project Owner's Certification

This Water Quality Management Plan (WQMP) has been prepared for Diversified Pacific Communities by Kimley Horn & Associates, Inc.. The WQMP is intended to comply with the requirements of the City of Redlands and the NPDES Areawide Stormwater Program requiring the preparation of a WQMP. 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 San Bernardino County's Municipal Storm Water Management Program and the intent of the NPDES Permit for San Bernardino County and the incorporated cities of San Bernardino County within the Santa Ana Region. Once the undersigned transfers its interest in the property, its successors in interest and the city/county 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."

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Project Data			
Permit/Application Number(s):		Grading Permit Number(s):	
Tract/Parcel Map Number(s):		Building Permit Number(s):	
CUP, SUP, and/or APN (Specify Lot Numbers if Portions of Tract):			0167-171-15

Owner's Signature			
Owner Name: Nolan Leggio			
Title	Director of Forward Planning		
Company	Diversified Pacific Communities		
Address	10621 Civic Center Drive, Rancho Cucamonga, CA 91730		
Email	NLeggio@diversifiedpacific.com		
Telephone #	909-373-2628		
Signature		Date	

Preparer's Certification

Project Data			
Permit/Application Number(s):		Grading Permit Number(s):	
Tract/Parcel Map Number(s):		Building Permit Number(s):	
CUP, SUP, and/or APN (Specify Lot Numbers if Portions of Tract):			0167-171-15

"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 Regional Water Quality Control Board Order No. R8-2010-0036."

Engineer: Robert Otte, P.E.		PE Stamp Below
Title	Project Engineer	
Company	Kimley-Horn Inc.	
Address	3801 University Avenue, Suite 300, Riverside, CA 92501	
Email	rob.otte@Kimley-Horn.com	
Telephone #	909-953-6070	
Signature		
Date		

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Forms

Section 1 Discretionary Permit(s)

Form 1-1 Project Information					
Project Name	DPC Redlands				
Project Owner Contact Name:	Nolan Leggio, Diversified Pacific Communities				
Mailing Address:	10621 Civic Center Drive Rancho Cucamonga, CA 91730	E-mail Address:	NLeggio@diversifiedpacific.com	Telephone:	909-373-2628
Permit/Application Number(s):			Tract/Parcel Map Number(s):		
Additional Information/ Comments:					
Description of Project:	The proposed development includes the construction of 10 high-density residential buildings. The site also includes surface parking, a subsurface parking garage below one building, multiple courtyards, and an outdoor community pool. Improvements within the site will provide parking facilities, driveway entrances connecting to existing roads, site utilities, storm drain systems, and underground detention. The primary structural BMPs include two underground detention systems to address the hydrologic conditions and water quality.				
Provide summary of Conceptual WQMP conditions (if previously submitted and approved). Attach complete copy.	The project is approximately 12.8 acres of undeveloped land. The parcel is bound by Tennessee Street to the west, Pennsylvania to the north, and proposed developments to the east and south. The total project square footage is 557,550 splitting into 46,567 square feet (pervious) and 510,983 square feet (impervious). This is 91.6% impervious on the project site. The proposed drainage matches existing drainage patterns. In the existing condition, stormwater drains generally from the eastern face of the site to the west, ultimately out-falling to Tennessee Street. The stormwater then surface flows across Tennessee St. and flows via a curb cut to the existing stormwater culvert between I-210 and Tennessee St. In the project condition, stormwater is conveyed by a combination of sheet flow, curb and gutter, and valley gutter to various onsite inlets. Stormwater is collected and conveyed to one of two proposed underground infiltration systems sized for the water quality event. The water quality volume is designed to drain within 48 hours. In the case of stormwater events larger than the water quality event, stormwater will fill the underground retention system then outlet via an orifice, sized so that the stormwater leaving the site does not exceed existing conditions. Flow will be conveyed to the north of the site, connecting to a proposed storm drain In Pennsylvania Avenue, as required by the City of Redlands.				

Section 2 Project Description

2.1 Project Information

This section of the WQMP should 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.

Form 2.1-1 Description of Proposed Project

1 Development Category (Select all that apply):

☐ Significant re-development involving the addition or replacement of 5,000 ft² or more of impervious surface on an already developed site	☒ New development involving the creation of 10,000 ft² or more of impervious surface collectively over entire site	☐ Automotive repair shops with standard industrial classification (SIC) codes 5013, 5014, 5541, 7532- 7534, 7536-7539	☐ Restaurants (with SIC code 5812) where the land area of development is 5,000 ft² or more
☐ Hillside developments of 5,000 ft² or more which are located on areas with known erosive soil conditions or where the natural slope is 25 percent or more	☐ Developments of 2,500 ft² of impervious surface or more adjacent to (within 200 ft) or discharging directly into environmentally sensitive areas or waterbodies listed on the CWA Section 303(d) list of impaired waters.	☐ Parking lots of 5,000 ft² or more exposed to storm water	☐ Retail gasoline outlets that are either 5,000 ft² or more, or have a projected average daily traffic of 100 or more vehicles per day

☐ Non-Priority / Non-Category Project *May require source control LID BMPs and other LIP requirements. Please consult with local jurisdiction on specific requirements*.

2 Project Area (ft2):	557,550	**3** Number of Dwelling Units:	460	**4** SIC Code:	1522

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.*

6 Does Project include roads? Yes ☐ No ☒ *If yes, ensure that applicable requirements for transportation projects are addressed (see Appendix A of TGD for WQMP)*

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 proposed project will be maintained by the ultimate owner, Diversified Pacific Community (DPC). DPC will be responsible for maintaining and providing regular inspections on all the post-construction BMPs as well as all private utility infrastructure. All public off-site utility infrastructure maintenance will be deferred to the City of Redlands where applicable.

Diversified Pacific Community
Attention: Nolan Leggio
10621 Civic Center Drive
Rancho Cucamonga, CA 91730

The maintenance of the proposed development is the responsibility of the owner until the property is sold to a new owner and then they assume responsibility of the BMP maintenance and management. There is no homeowner's or property owner's association set up for this proposed development. All of the BMP's are the responsibility of the owner to maintain. BMPs include, but are not limited to, BMP maintenance, e.g. inspection, storm drain stenciling, efficient irrigation and landscape maintenance, BMP maintenance of sub-surface infiltration system and basins.

Infrastructure will not transfer to City of Redlands, or San Bernardino County

2.3 Potential Stormwater Pollutants

Determine and describe expected stormwater pollutants of concern based on land uses and site activities (refer to Table 3-3 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 ☐	Expected in residential development per WQMP TBD Table 3-3
Nutrients - Phosphorous	E ☒	N ☐	Expected in residential development per WQMP TBD Table 3-3
Nutrients - Nitrogen	E ☒	N ☐	Expected in residential development per WQMP TBD Table 3-3
Noxious Aquatic Plants	E ☐	N ☒	Expected in residential development per WQMP TBD Table 3-3
Sediment	E ☒	N ☐	Expected in residential development per WQMP TBD Table 3-3
Metals	E ☐	N ☒	Not expected in residential development per WQMP TBD Table 3-3
Oil and Grease	E ☒	N ☐	Expected in residential development per WQMP TBD Table 3-3
Trash/Debris	E ☒	N ☐	Expected in residential development per WQMP TBD Table 3-3
Pesticides / Herbicides	E ☒	N ☐	Expected in residential development per WQMP TBD Table 3-3
Organic Compounds	E ☒	N ☐	Expected in residential development per WQMP TBD Table 3-3

2.4 Water Quality Credits

A water quality credit program is applicable for certain types of development projects if it is not feasible to meet the requirements for on-site LID. Proponents for eligible projects, as described below, can apply for water quality credits that would reduce project obligations for selecting and sizing other treatment BMP or participating in other alternative compliance programs. Refer to Section 6.2 in the TGD for WQMP to determine if water quality credits are applicable for the project.

Form 2.4-1 Water Quality Credits

1 Project Types that Qualify for Water Quality Credits: *Select all that apply*

☐ Redevelopment projects that reduce the overall impervious footprint of the project site. [Credit = % impervious reduced]	Higher density development projects ☐ Vertical density [20%] ☒ 7 units/ acre [5%]	☐ Mixed use development, (combination of residential, commercial, industrial, office, institutional, or other land uses which incorporate design principles that demonstrate environmental benefits not realized through single use projects) [20%]	☐ Brownfield redevelopment (redevelop real property complicated by presence or potential of hazardous contaminants) [25%]
☐ Redevelopment projects in established historic district, historic preservation area, or similar significant core city center areas [10%]	☐ Transit-oriented developments (mixed use residential or commercial area designed to maximize access to public transportation) [20%]	☐ In-fill projects (conversion of empty lots & other underused spaces < 5 acres, substantially surrounded by urban land uses, into more beneficially used spaces, such as residential or commercial areas) [10%]	☐ Live-Work developments (variety of developments designed to support residential and vocational needs) [20%]

2 Total Credit %: 5% *(Total all credit percentages up to a maximum allowable credit of 50 percent)*

Description of Water Quality Credit Eligibility (if applicable)	The DPC Redlands development includes more than seven units per acre of development. With 12.8 acres of development, 90 units are required.

Section 3 Site and Watershed Description

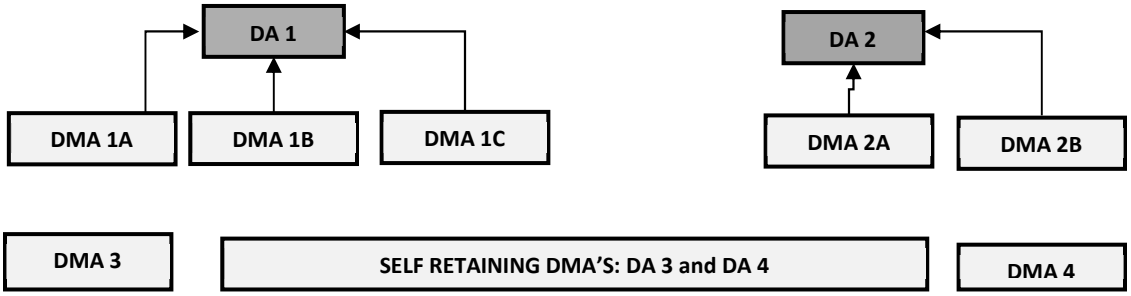
Describe the project site conditions that will facilitate the selection of BMP through an analysis of the physical conditions and limitations of the site and its receiving waters. Identify distinct drainage areas (DA) that collect flow from a portion of the site and describe how runoff from each DA (and sub-watershed 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.***

Form 3-1 Site Location and Hydrologic Features

Site coordinates *take GPS measurement at approximate center of site*	Latitude 34° 4'23.09"N	Longitude 17°11'56.91"W	Thomas Bros Map page 608 c5

1 San Bernardino County climatic region: ☒ Valley ☐ Mountain

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
DMA 1A to Outlet 1	The north easterly portion of the site, DMA 1A has roof drains discharge to pavement, landscape and sheets across the pavement towards onsite catch basins that will filter through CDS units and discharge and infiltrate through an underground retention vault, RV-1. Flows in the retention vault will rise enough to store the DCV for sub-area 1A, sub-area 1B, and sub-area 1C. The water quality event stormwater volume will draw down within 48 hours. Stormwater will fill the vault and is conveyed to an orifice to mitigate post construction flow rate to the pre-construction flow rate. Stormwater will be conveyed to west of the site to 1 (one) onsite proprietary pump system and flow to Tennessee Street, as it does in the existing condition.
DMA 1B to Outlet 1	The small northern portion of the site, DMA 1B stormwater discharge to pavement, landscape and sheets across the pavement towards an onsite catch basin that will filter through CDS units and discharge and infiltrate through an underground retention vault, RV-1. Flows in the retention vault will rise enough to store the DCV for sub-area 1A, sub-area 1B, and sub-area 1C. The water quality event stormwater volume will draw down within 48 hours. Stormwater will fill the vault and is conveyed to an

	orifice to mitigate post construction flow rate to the pre-construction flow rate. Stormwater will be conveyed to west of the site to 1 (one) onsite proprietary pump system and flow to Tennessee Street, as it does in the existing condition.
DMA 1C to Outlet 1	The north westerly portion of the site, DMA 1C has roof drains discharge to pavement, landscape and sheets across the pavement towards trench drains and onsite catch basins that will filter through CDS units and discharge and infiltrate through an underground retention vault, RV-1. Flows in the retention vault will rise enough to store the DCV for sub-area 1A, sub-area 1B, and sub-area 1C. The water quality event stormwater volume will draw down within 48 hours. Stormwater will fill the vault and is conveyed to an orifice to mitigate post construction flow rate to the pre-construction flow rate. Stormwater will be conveyed to west of the site to 1 (one) onsite proprietary pump system and flow to Tennessee Street, as it does in the existing condition.
DMA 2A to Outlet 2	The south easterly portion of the site, DMA 2A has roof drains discharge to pavement, landscape and sheets across the pavement towards onsite catch basins that will filter through CDS units and discharge and infiltrate through an underground retention vault, RV-2. Flows in the retention vault will rise enough to store the DCV for sub-area 2A and sub-area 2B. The water quality event stormwater volume will draw down within 48 hours. Stormwater will fill the vault and is conveyed to an orifice to mitigate post construction flow rate to the pre-construction flow rate. Stormwater will be conveyed to west of the site to 1 (one) onsite proprietary pump system and flow to Tennessee Street, as it does in the existing condition.
DMA 2B to Outlet 2	The south westerly portion of the site, DMA 2B has roof drains discharge to pavement, landscape and sheets across the pavement towards onsite catch basins that will filter through CDS units and discharge and infiltrate through an underground retention vault, RV-2. Flows in the retention vault will rise enough to store the DCV for sub-area 2A and sub-area 2B. The water quality event stormwater volume will draw down within 48 hours. Stormwater will fill the vault and is conveyed to an orifice to mitigate post construction flow rate to the pre-construction flow rate. Stormwater will be conveyed to west of the site to 1 (one) onsite proprietary pump system and flow to Tennessee Street, as it does in the existing condition.
DMA 3	DMA 3 is located along the north and west edge of the site and consists of landscape setback, driveways, and sidewalks. This DMA is self-retaining.
DMA 4	DMA 4 is located along the south and west edge of the site and consists of landscape setback, driveways, and sidewalks.

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)	557,550	N/A	N/A	N/A
2 Existing site impervious area (ft^2)	0	N/A	N/A	N/A
3 Antecedent moisture condition *For desert areas, use http://www.sbcounty.gov/dpw/floodcontrol/pdf/20100412_map.pdf*	II	N/A	N/A	N/A
4 Hydrologic soil group *Refer to Watershed Mapping Tool – http://permitrack.sbcounty.gov/wap/*	A	N/A	N/A	N/A
5 Longest flowpath length (ft)	1055	N/A	N/A	N/A
6 Longest flowpath slope (ft/ft)	0.016	N/A	N/A	N/A
7 Current land cover type(s) *Select from Fig C-3 of Hydrology Manual*	Chaparral	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*	Good	N/A	N/A	N/A

Form 3-2 Existing Hydrologic Characteristics for Drainage Area 2				
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)	232,610	N/A	N/A	N/A
2 Existing site impervious area (ft^2)	0	N/A	N/A	N/A
3 Antecedent moisture condition *For desert areas, use http://www.sbcounty.gov/dpw/floodcontrol/pdf/20100412_map.pdf*	II	N/A	N/A	N/A
4 Hydrologic soil group *Refer to Watershed Mapping Tool – http://permitrack.sbcounty.gov/wap/*	A	N/A	N/A	N/A
5 Longest flowpath length (ft)	805	N/A	N/A	N/A
6 Longest flowpath slope (ft/ft)	0.018	N/A	N/A	N/A
7 Current land cover type(s) *Select from Fig C-3 of Hydrology Manual*	Chaparral	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*	Good	N/A	N/A	N/A

Please refer to the photos taken below as a demonstration of site conditions:

The photos were taken along Tennessee Street and provide an accurate description of the existing conditions.

Zone 1:

Zone 2:

Zone 3:

Form 3-3 Watershed Description for Drainage Area

Receiving waters *Refer to Watershed Mapping Tool - http://permitrack.sbcounty.gov/wap/ See 'Drainage Facilities" link at this website*	Tennessee St, San Bernardino County storm Drain, Santa Ana River Reach 5-1, Prado Dam
Applicable TMDLs *Refer to Local Implementation Plan*	Santa Ana River: Indicator Bacteria, Nitrate
303(d) listed impairments *Refer to Local Implementation Plan and Watershed Mapping Tool – http://permitrack.sbcounty.gov/wap/ and State Water Resources Control Board website – http://www.waterboards.ca.gov/santaana/water_issues/programs/tmdl/index.shtml*	Santa Ana River, Reach 3: Copper, Lead Santa Ana River, Reach 2: Indicator Bacteria
Environmentally Sensitive Areas (ESA) *Refer to Watershed Mapping Tool – http://permitrack.sbcounty.gov/wap/*	None
Unlined Downstream Water Bodies *Refer to Watershed Mapping Tool – http://permitrack.sbcounty.gov/wap/*	None
Hydrologic Conditions of Concern	☐ Yes *Complete Hydrologic Conditions of Concern (HCOC) Assessment. Include Forms 4.2-2 through Form 4.2-5 and Hydromodification BMP Form 4.3-10 in submittal* ☒ No
Watershed–based BMP included in a RWQCB approved WAP	☐ Yes *Attach verification of regional BMP evaluation criteria in WAP* • *More Effective than On-site LID* • *Remaining Capacity for Project DCV* • *Upstream of any Water of the US* • *Operational at Project Completion* • *Long-Term Maintenance Plan* ☒ No

Section 4 Best Management Practices (BMP)

4.1 Source Control BMP

4.1.1 Pollution Prevention

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.

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	☒	☐	Owner shall familiarize him/herself with the contents of this WQMP and furnish copies of BMP factsheets to all future tenants.
N2	Activity Restrictions	☐	☒	Any activities that are in violation of the City of Redlands ordinances and Codes shall also be restricted, specifically those that would violate the ordinanaces in Chapter 13.54 of the City of Redlands Municipal Codes. Additionally, activities for which adequate BMPs have not been provided are restricted.
N3	Landscape Management BMPs	☒	☐	Landscape crews contracted shall inspect irrigation system and health of landscaping and shall report all repairs or problems to owner. Routine landscaping maintenance shall be done according to CASQA SC-73 fact sheet.
N4	BMP Maintenance	☒	☐	The building site owners or contracted license crews shall inspect the infiltration basins after each landscape procedure and shall report all drainage problems to owner. The owner shall also check the basins for erosion and sediment buildup and standing water 48 hours after storm events. Building site owner or contracted maintenance crew shall inspect underground infiltration system annually prior to the rainy season. Sediment buildup shall be removed as necessary. The filter in the inlet shall be inspected annually and replaced as necessary. Building site owner or contracted maintenance crew shall inspect the underground infiltration system annually prior to the rainy season. BMP maintenance shall be performed per the schedule in Form 5-1 of this WQMP.
N5	Title 22 CCR Compliance (How development will comply)	☐	☒	No hazardous waste is defined for site.

Form 4.1-1 Non-Structural Source Control BMPs				
N6	Local Water Quality Ordinances	☒	☐	Owner shall ensure business activities at the site comply with the City's Stormwater Ordinance through the implementation of BMP's included in this report. Owner must comply with ordinance Chapter 13.54 of the City of Redlands Ordinances and can be found on the City's web site, www.cityofredlands.org.
N7	Spill Contingency Plan	☒	☒	A spill contingency plan shall be performed according to CASQA BMP SC-11.
N8	Underground Storage Tank Compliance	☒	☐	Building site owner or contracted maintenance crew shall inspect the underground infiltration system annually prior to the rainy season.
N9	Hazardous Materials Disclosure Compliance	☐	☒	N/A - No hazardous materials affiliated with proposed development

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	☐	☒	N/A - No hazardous materials affiliated with proposed development UFC article 80 is not applicable.
N11	Litter/Debris Control Program	☒	☐	A program shall be implemented to pick up litter and sweep and clean the existing trash enclosures on a daily basis. Trash enclosures are designed to divert all flows around the enclosure. All dumpsters will have lids installed and will be inspected to ensure that the dumpsters remain covered and leak-proof. The owner shall ensure tenants contract with a refuse company to have the dumpsters emptied on a weekly basis, at a minimum.
N12	Employee Training	☒	☐	Property owner shall establish an educational program for site employees and contractors to inform and train personnel engaged in maintenance activities regarding the impact of dumping oil, paint, solvents, or other potentially harmful chemicals into the storm drain system; the use of fertilizers and pesticides in landscaping maintenance practices; and the impacts of litter and improper waste disposal.
N13	Housekeeping of Loading Docks	☐	☒	N/A - No proposed loading docks onsite.
N14	Catch Basin Inspection Program	☒	☐	The on-site catch basins shall be inspected monthly during the rainy season (October-May) and before and after each storm to ensure proper operation. The owner shall contract with a qualified landscape contractor to inspect and clean out accumulation of trash, litter, and sediment and check for evidence of illegal dumping of waste materials into on-site drains.
N15	Vacuum Sweeping of Private Streets and Parking Lots	☒	☐	Parking lots shall be swept weekly to prevent sediment, garden waste, and trash, or other pollutants from entering on-site drains and public storm channels. Sweeping will be done by a landscape contractor or other contractor provided by the owner.
N16	Other Non-structural Measures for Public Agency Projects	☐	☒	N/A – Proposed project is not a Public Agency Project.

N17	Comply with all other applicable NPDES permits	☒	☐	The developer of this site shall comply with the state's General Construction Stormwater Permit by filling an NOI to obtain a permit WDID number prior to start of grading/construction. All future occupants requiring coverage under the NPDES General Industrial Activities Permit shall comply with the permit requirements by filing an NOI to obtain a permit WDID number or No Exposure Certification (NEC) with the state prior to commencement of industrial activities covered under the permit.

Form 4.1-2 Structural Source Control BMPs

Identifier	Name	Check One		Describe BMP Implementation OR, If not applicable, state reason
		Included	Not Applicable	
S1	Provide storm drain system stencilling and signage (CASQA New Development BMP Handbook SD-13)	☒	☐	A painted message shall be blue on a white background with lettering 2-1/2" in heigh and reading "No Dumping-Drains to River" shall be placed on each catch basin. The message shall be inspected annually & repainted as necessary. A fish or similar water dependent creature silhouette may be included subject to City approval. In lieu of a stencil, a catch basin curb marker circular or rectangular, at least 4" in height or diameter, may be used. The message will be the same and is subject to City approval. A painted circular stencil shall not be bigger than 8" in diameter. Legibility will be checked and repainted annually.
S2	Design and construct outdoor material storage areas to reduce pollution introduction (CASQA New Development BMP Handbook SD-34)	☐	☒	N/A – No outdoor storage areas are proposed within this project.
S3	Design and construct trash and waste storage areas to reduce pollution introduction (CASQA New Development BMP Handbook SD-32)	☒	☐	Stormwater flows are not allowed to flow through existing waste areas under existing conditions. All dumpsters shall have working lids which shall be kept closed, at all times. Trash enclosure shall comply with CASQA SD-32 and shall have doors and a roof.
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 irrigation system will include devices to prevent low head drainage, overspray and run off through the use of pressure regulating devices, check valves, rain shutoff valves, flow sensors, pressure drop sensors, proper spacing, low precipitation emissions devises and ET or weather based controllers. Landscape and irrigation shall be consistent with the State Model Water Efficient landscape Ordinance. Plants installed will be arranged according to similar hydrozones and meet the required water budget for the site. Landscape areas used for water quality swales or infiltration areas shall have proper plants for saturated soils, drought tolerance and erosion control qualities. Shade trees shall be used to intercept rainwater and reduce gain on paving.
S5	Finish grade of landscaped areas at a minimum of 1-2 inches below top of curb, sidewalk, or pavement	☒	☐	Landscape complies with depressed area requirements.

S6	Protect slopes and channels and provide energy dissipation (CASQA New Development BMP Handbook SD-10)	☐	☒	No slopes or channels are proposed on the project site.
S7	Covered dock areas (CASQA New Development BMP Handbook SD-31)	☐	☒	N/A – no dock areas proposed onsite.
S8	Covered maintenance bays with spill containment plans (CASQA New Development BMP Handbook SD-31)	☐	☒	N/A – No maintenance bays are proposed within this project.
S9	Vehicle wash areas with spill containment plans (CASQA New Development BMP Handbook SD-33)	☐	☒	N/A – Vehicle washing is not an intended use for the proposed project.
S10	Covered outdoor processing areas (CASQA New Development BMP Handbook SD-36)	☐	☒	N/A – No outdoor processing areas are proposed within this project.

Form 4.1-2 Structural Source Control BMPs

Identifier	Name	Check One		Describe BMP Implementation OR, If not applicable, state reason
		Included	Not Applicable	
S11	Equipment wash areas with spill containment plans (CASQA New Development BMP Handbook SD-33)	☐	☒	N/A No equipment wash areas are being proposed.
S12	Fueling areas (CASQA New Development BMP Handbook SD-30)	☐	☒	N/A – No fueling areas are being proposed.
S13	Hillside landscaping (CASQA New Development BMP Handbook SD-10)	☐	☒	N/A – No hillside landscaping is being proposed.
S14	Wash water control for food preparation areas	☐	☒	N/A – No food preparation area is being proposed.
S15	Community car wash racks (CASQA New Development BMP Handbook SD-33)	☐	☒	N/A – No carwash activities are expected for the proposed project.

4.1.2 Preventative LID Site Design Practices

Site design practices associated with new LID requirements in the MS4 Permit should be considered in the earliest phases of a project. Preventative site design practices can result in smaller DCV for LID BMP and hydromodification control BMP by reducing runoff generation. 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 Preventative LID 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: Landscaping will be installed and implemented wherever possible onsite.
Maximize natural infiltration capacity: Yes ☒ No ☐ Explanation: Landscaping will be installed and implemented wherever possible onsite.
Preserve existing drainage patterns and time of concentration: Yes ☒ No ☐ Explanation: Existing drainage patterns are to be maintained and onsite stormwater features are to improve the time of concentration.
Disconnect impervious areas: Yes ☒ No ☐ Explanation: Vegetated swales, filter strips, roof drains to landscaping. Disconnection of impervious areas so that stormwater runoff is directed to on-site pervious surfaces than off-site streets and storm drains.
Protect existing vegetation and sensitive areas: Yes ☐ No ☒ Explanation:
Re-vegetate disturbed areas: Yes ☒ No ☐ Explanation: All disturbed areas are to be re-vegetated.
Minimize unnecessary compaction in stormwater retention/infiltration basin/trench areas: Yes ☒ No ☐ Explanation: Unnecessary compaction surrounding stormwater retention/infiltration basin/trench areas to be minimized in order to maximize infiltration.
Utilize vegetated drainage swales in place of underground piping or imperviously lined swales: Yes ☒ No ☐ Explanation: Vegetated swales to be installed and implemented whenever possible onsite.
Stake off areas that will be used for landscaping to minimize compaction during construction : Yes ☐ No ☒ Explanation: N/A

4.2 Project Performance Criteria

The purpose of this section of the Project WQMP is to establish targets for post-development hydrology based on performance criteria specified in the 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 of any downstream waterbody segments with a HCOC. ***If the project has more than one outlet for stormwater runoff, then complete additional versions of these forms for each DA / outlet.***

Methods applied in the following forms include:

- For LID BMP Design Capture Volume (DCV), the San Bernardino County Stormwater Program requires use of the P_6 method (MS4 Permit Section XI.D.6a.ii) – Form 4.2-1
- For HCOC pre- and post-development hydrologic calculation, the San Bernardino County Stormwater Program 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 HCOC 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 DMA 1 (ft^2): 281,441	**2** Imperviousness after applying preventative site design practices (Imp%): 93.1%	**3** Runoff Coefficient (Rc): 0.78 *$R_c = 0.858(Imp\%)^{\wedge 3}-0.78(Imp\%)^{\wedge 2}+0.774(Imp\%)+0.04$*
4 Determine 1-hour rainfall depth for a 2-year return period $P_{2yr\text{-}1hr}$ (in): 0.472 *http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html*		
5 Compute P_6, Mean 6-hr Precipitation (inches): 0.698 *P_6 = Item 4 *C_1, where C_1 is a function of site climatic region specified in Form 3-1 Item 1 (Valley = 1.4807; Mountain = 1.909; 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): 25,065 *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 4.2-1 LID BMP Performance Criteria for Design Capture Volume (DA 2)

1 Project area DMA 2 (ft^2): 232,493	2 Imperviousness after applying preventative site design practices (Imp%): 93.3%	3 Runoff Coefficient (Rc): 0.78 *$R_c = 0.858(Imp\%)^{\wedge 3}-0.78(Imp\%)^{\wedge 2}+0.774(Imp\%)+0.04$*

4 Determine 1-hour rainfall depth for a 2-year return period $P_{2yr\text{-}1hr}$ (in): 0.472 http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html

5 Compute P_6, Mean 6-hr Precipitation (inches): 0.698

*P_6 = Item 4 *C_1, where C_1 is a function of site climatic region specified in Form 3-1 Item 1 (Valley = 1.4807; Mountain = 1.909; 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): 20,555

*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 4.2-1 LID BMP Performance Criteria for Design Capture Volume (DA 3)

1 Project area DMA 2 (ft^2): 39974	2 Imperviousness after applying preventative site design practices (Imp%): 20%	3 Runoff Coefficient (Rc): 0.21 *$R_c = 0.858(Imp\%)^{\wedge 3}-0.78(Imp\%)^{\wedge 2}+0.774(Imp\%)+0.04$*

4 Determine 1-hour rainfall depth for a 2-year return period $P_{2yr\text{-}1hr}$ (in): 0.472 http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html

5 Compute P_6, Mean 6-hr Precipitation (inches): 0.698

*P_6 = Item 4 *C_1, where C_1 is a function of site climatic region specified in Form 3-1 Item 1 (Valley = 1.4807; Mountain = 1.909; 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): 963

*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 4.2-1 LID BMP Performance Criteria for Design Capture Volume (DA 4)

1 Project area DMA 2 (ft^2): 3532	**2** Imperviousness after applying preventative site design practices (Imp%): 20%	**3** Runoff Coefficient (Rc): 0.21 *$R_c = 0.858(Imp\%)^{\wedge 3} - 0.78(Imp\%)^{\wedge 2} + 0.774(Imp\%) + 0.04$*
4 Determine 1-hour rainfall depth for a 2-year return period $P_{2yr\text{-}1hr}$ (in): 0.472 *http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html*		
5 Compute P_6, Mean 6-hr Precipitation (inches): 0.698 *P_6 = Item 4 *C_1, where C_1 is a function of site climatic region specified in Form 3-1 Item 1 (Valley = 1.4807; Mountain = 1.909; 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): 84.7 *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 HCOC Assessment (DA 1 and DA 2)

Does project have the potential to cause or contribute to an HCOC in a downstream channel: Yes ☐ No ☒

Go to: *http://permitrack.sbcounty.gov/wap/*

If "Yes", then complete HCOC assessment of site hydrology for 2yr 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)

If "No," then proceed to Section 4.3 Project Conformance Analysis

Condition	Runoff Volume (ft^3)	Time of Concentration (min)	Peak Runoff (cfs)
Pre-developed	**1** *Form 4.2-3 Item 12*	**2** *Form 4.2-4 Item 13*	**3** *Form 4.2-5 Item 10*
Post-developed	**4** *Form 4.2-3 Item 13*	**5** *Form 4.2-4 Item 14*	**6** *Form 4.2-5 Item 14*
Difference	**7** *Item 4 – Item 1*	**8** *Item 2 – Item 5*	**9** *Item 6 – Item 3*
Difference (as % of pre-developed)	**10** % *Item 7 / Item 1*	**11** % *Item 8 / Item 2*	**12** % *Item 9 / Item 3*

Form 4.2-3 HCOC Assessment for Runoff Volume (DA 1 and DA 2)

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								
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 2 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 HCOC Requirement, (ft^3):
*V_{HCOC} = (Item 13 * 0.95) – Item 12*

Form 4.2-4 HCOC Assessment for Time of Concentration (DMA 1 and DMA 2)

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*								
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 HCOC requirement (min): $T_{C\text{-}HCOC}$ *= (Item 13 * 0.95) – Item 14*								

Form 4.2-5 HCOC Assessment for Peak Runoff (DMA 1 and DMA 2)

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 - 0.6 LOG Form 4.2-4 Item 5 /60)*							
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 HCOC Requirement (cfs):	$Q_{p\text{-}HCOC}$ = *(Item 14 * 0.95) – Item 10*	

4.3 Project Conformance Analysis

Complete the following forms for each project site DA to document that the proposed LID BMPs conform to the project DCV developed to meet performance criteria specified in the 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 MS4 Permit (see Section 5.3.1 in the TGD for WQMP). The forms compute the following for on-site LID BMP:

- Site Design and Hydrologic Source Controls (Form 4.3-2)
- Retention and Infiltration (Form 4.3-3)
- Harvested and Use (Form 4.3-4) or
- Biotreatment (Form 4.3-5).

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 5.3.2.1 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 Forms 4.3-2 and 4.3-4 to determine the feasibility of applicable HSC and harvest and use 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 HSC 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 LID HSC, retention and infiltration, and harvest and use BMPs are unable to mitigate the entire DCV, then biotreatment BMPs may be implemented by the project proponent. If biotreatment BMPs are used, then they must be sized to provide sufficient capacity for effective treatment of the remainder of the volume-based performance criteria that cannot be achieved with LID BMPs (TGD for WQMP Section 5.4.4.2). **Under no circumstances shall any portion of the DCV be released from the site without effective mitigation and/or treatment**.

Form 4.3-1 Infiltration BMP Feasibility (DMA 1 and DMA 2)

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 eight 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, Harvest and Use 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, Hydrologic Source Control BMP.
If no, then proceed to Item 9, below.

[9] All answers to Item 1 through Item 6 are "No": Yes ☒ 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, Hydrologic Source Control BMP.

4.3.1 Site Design Hydrologic Source Control BMP

Section XI.E. of the Permit emphasizes the use of LID preventative measures; and the use of LID HSC BMPs reduces the portion of the DCV that must be addressed in downstream BMPs. Therefore, all applicable HSC 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 HSC, if a project cannot feasibly meet BMP sizing requirements or cannot fully address HCOCs, feasibility of all applicable HSC 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 HSC BMP. Refer to Section 5.4.1 in the TGD for more detailed guidance.

Form 4.3-2 Site Design Hydrologic Source Control BMPs (DMA 1 and DMA 2)

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

Form 4.3-2 cont. Site Design Hydrologic Source Control BMPs (DMA 1 and DMA 2)

14 Implementation of evapotranspiration BMP (green, brown, or blue roofs): Yes ☐ No ☒ *If yes, complete Items 15-20. If no, proceed to Item 21*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
15 Rooftop area planned for ET BMP (ft^2)			
16 Average wet season ET demand (in/day) *Use local values, typical ~ 0.1*			
17 Daily ET demand (ft^3/day) *Item 15 * (Item 16 / 12)*			
18 Drawdown time (hrs) *Copy Item 6 in Form 4.2-1*			
19 Retention Volume (ft^3) $V_{retention}$ *= Item 17 * (Item 18 / 24)*			
20 Runoff volume retention from evapotranspiration BMPs (ft^3): $V_{retention}$ *=Sum of Item 19 for all BMPs*			
21 Implementation of Street Trees: Yes ☒ No ☐ *If yes, complete Items 22-25. If no, proceed to Item 26*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
22 Number of Street Trees	702		
23 Average canopy cover over impervious area (ft^2)	12		
24 Runoff volume retention from street trees (ft^3) $V_{retention}$ *= Item 22 * Item 23 * (0.05/12) assume runoff retention of 0.05 inches*	35.1		
25 Runoff volume retention from street tree BMPs (ft^3): 35 $V_{retention}$ *= Sum of Item 24 for all BMPs*			
26 Implementation of residential rain barrel/cisterns: Yes☐ No ☒ *If yes, complete Items 27-29; If no, proceed to Item 30*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
27 Number of rain barrels/cisterns			
28 Runoff volume retention from rain barrels/cisterns (ft^3) $V_{retention}$ *= Item 27 * 3*			
29 Runoff volume retention from residential rain barrels/Cisterns (ft3): $V_{retention}$ *=Sum of Item 28 for all BMPs*			

Form 4.3-2 Site Design Hydrologic Source Control BMPs (DMA 1 and DMA 2)
30 Total Retention Volume from Site Design Hydrologic Source Control BMPs: 35 *Sum of Items 5, 13, 20, 25 and 29*

4.3.2 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 D 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 5.5.1 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).

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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 HSC BMP (ft^3): 25,049 *V_{unmet} = Form 4.2-1 Item 7 - Form 4.3-2 Item 30 (38/2 = 17 CF)*

BMP Type *Use columns to the right to compute runoff volume retention from proposed infiltration BMP (select BMP from Table 5-4 in TGD for WQMP) - Use additional forms for more BMPs*	DA DMA BMP Type HSC BMP	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 D of the TGD for WQMP for minimum requirements for assessment methods*	13.9		
3 Infiltration safety factor *See TGD Section 5.4.2 and Appendix D*	2.0		
4 Design percolation rate (in/hr) *P_{design} = Item 2 / Item 3*	6.95		
5 Ponded water drawdown time (hr) *Copy Item 6 in Form 4.2-1*	48 hours		
6 Maximum ponding depth (ft) *BMP specific, see Table 5-4 of the TGD for WQMP for BMP design details*	10		
7 Ponding Depth (ft) *d_{BMP} = Minimum of (1/12*Item 4*Item 5) or Item 6*	10		
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*	0		
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*	0		
10 Amended soil porosity	0		
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		
12 Gravel porosity	0		
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*	25,049		

16 Total Retention Volume from LID Infiltration BMPs: 25,049 *(Sum of Items 14 and 15 for all infiltration BMP included in plan)*

17 Fraction of DCV achieved with infiltration BMP: 100% *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.

Form 4.3-3 Infiltration LID BMP - including underground BMPs (DMA 2)

1 Remaining LID DCV not met by site design HSC BMP (ft^3): 20,556 *V_{unmet} = Form 4.2-1 Item 7 - Form 4.3-2 Item 30 (38/2 = 17 CF)*

BMP Type *Use columns to the right to compute runoff volume retention from proposed infiltration BMP (select BMP from Table 5-4 in TGD for WQMP) - Use additional forms for more BMPs*	DA DMA BMP Type HSC BMP	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 D of the TGD for WQMP for minimum requirements for assessment methods*	13.9		
3 Infiltration safety factor *See TGD Section 5.4.2 and Appendix D*	2.0		
4 Design percolation rate (in/hr) *P_{design} = Item 2 / Item 3*	6.95		
5 Ponded water drawdown time (hr) *Copy Item 6 in Form 4.2-1*	48 hours		
6 Maximum ponding depth (ft) *BMP specific, see Table 5-4 of the TGD for WQMP for BMP design details*	10		
7 Ponding Depth (ft) *d_{BMP} = Minimum of (1/12*Item 4*Item 5) or Item 6*	10		
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*	0		
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*	0		
10 Amended soil porosity	0		
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		
12 Gravel porosity	0		
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*	20,556		

16 Total Retention Volume from LID Infiltration BMPs: 20,556 *(Sum of Items 14 and 15 for all infiltration BMP included in plan)*

17 Fraction of DCV achieved with infiltration BMP: 100% *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.

4.3.3 Harvest and Use BMP

Harvest and use BMP may be considered if the full LID DCV cannot be met by maximizing infiltration BMPs. Use Form 4.3-4 to compute on-site retention of runoff from proposed harvest and use BMPs.

Form 4.3-4 Harvest and Use BMPs (DMA 1 AND DMA 2)

1 Remaining LID DCV not met by site design HSC or infiltration BMP (ft^3): 0

V_{unmet} = Form 4.2-1 Item 7 - Form 4.3-2 Item 30 – Form 4.3-3 Item 16

BMP Type(s) *Compute runoff volume retention from proposed harvest and use BMP (Select BMPs from Table 5-4 of the TGD for WQMP) - Use additional forms for more BMPs*	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type *(Use additional forms for more BMPs)*
2 Describe cistern or runoff detention facility			
3 Storage volume for proposed detention type (ft^3) *Volume of cistern*			
4 Landscaped area planned for use of harvested stormwater (ft^2)			
5 Average wet season daily irrigation demand (in/day) Use local values, typical ~ 0.1 in/day			
6 Daily water demand (ft^3/day) *Item 4 * (Item 5 / 12)*			
7 Drawdown time (hrs) *Copy Item 6 from Form 4.2-1*			
8 Retention Volume (ft^3) *$V_{retention}$ = Minimum of (Item 3) or (Item 6 * (Item 7 / 24))*			

9 Total Retention Volume (ft^3) from Harvest and Use BMP *Sum of Item 8 for all harvest and use BMP included in plan*

10 Is the full DCV retained with a combination of LID HSC, retention and infiltration, and harvest & use BMPs? Yes ☐ No ☐

If yes, demonstrate conformance using Form 4.3-10. If no, then re-evaluate combinations of all LID BMP and optimize their implementation such that the maximum portion of the DCV is retained on-site (using a single BMP type or combination of BMP types). If the full DCV cannot be mitigated after this optimization process, proceed to Section 4.3.4.

4.3.4 Biotreatment BMP

Biotreatment BMPs may be considered if the full LID DCV cannot be met by maximizing retention and infiltration, and harvest and use BMPs. 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 4.3-5 to summarize the potential for volume based and/or flow based biotreatment options to biotreat the remaining unmet LID DCV w. Biotreatment computations are included as follows:

- Use Form 4.3-6 to compute biotreatment in small volume based biotreatment BMP (e.g. bioretention w/underdrains);
- Use Form 4.3-7 to compute biotreatment in large volume based biotreatment BMP (e.g. constructed wetlands);
- Use Form 4.3-8 to compute sizing criteria for flow-based biotreatment BMP (e.g. bioswales)

Form 4.3-5 Selection and Evaluation of Biotreatment BMP (DMA 1 AND DMA 2)

1 Remaining LID DCV not met by site design HSC, infiltration, or harvest and use BMP for potential biotreatment (ft^3): 0 *Form 4.2-1 Item 7 - Form 4.3-2 Item 30 – Form 4.3-3 Item 16- Form 4.3-4 Item 9*	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 4.3-6 and 4.3-7 to compute treated volume* ☐ Bioretention with underdrain ☐ Planter box with underdrain ☐ Constructed wetlands ☐ Wet extended detention ☐ Dry extended detention	Flow-based biotreatment *Use Form 4.3-8 to compute treated volume* ☐ Vegetated swale ☐ Vegetated filter strip ☐ Proprietary biotreatment
3 Volume biotreated in volume based biotreatment BMP (ft^3): *Form 4.3-6 Item 15 + Form 4.3-7 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 4.3-6 Volume Based Biotreatment (DMA 1 AND DMA 2) – Bioretention and Planter Boxes with Underdrains

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

Form 4.3-7 Volume Based Biotreatment (DMA 1 AND DMA 2) – Constructed Wetlands and Extended Detention

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

Form 4.3-8 Flow Based Biotreatment (DMA 1 AND DMA 2)

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 4.3-9 to demonstrate how on-site LID DCV is met with proposed site design hydrologic source control, infiltration, harvest and use, 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 4.3-9 Conformance Summary and Alternative Compliance Volume Estimate (DMA 1 AND DMA 2)

1 Total LID DCV for the Project DA-1 (ft^3): 45,621 *Copy Item 7 in Form 4.2-1*

2 On-site retention with site design hydrologic source control LID BMP (ft^3): 35 CF *Copy Item 30 in Form 4.3-2*

3 On-site retention with LID infiltration BMP (ft^3): 45,586 *Copy Item 16 in Form 4.3-3*

4 On-site retention with LID harvest and use BMP (ft^3): 0 *Copy Item 9 in Form 4.3-4*

5 On-site biotreatment with volume based biotreatment BMP (ft^3): 0 *Copy Item 3 in Form 4.3-5*

6 Flow capacity provided by flow based biotreatment BMP (cfs): 0 *Copy Item 6 in Form 4.3-5*

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

- Full retention of LID DCV with site design HSC, infiltration, or harvest and use 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 and biotreatment BMP provide 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

8 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 HSC, retention and infiltration, harvest and use, and biotreatment BMPs provide less than full LID DCV capture: ☐
  Checked yes for Form 4.3-5 Item 7, 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)%*
- An approved Watershed Action Plan (WAP) demonstrates that water quality and hydrologic impacts of urbanization are more effective when managed in at an off-site facility: ☐
  Attach appropriate WAP section, including technical documentation, showing effectiveness comparisons for the project site and regional watershed

4.3.6 Hydromodification Control BMP

Use Form 4.3-10 to compute the remaining runoff volume retention, after LID BMP are implemented, needed to address HCOC, and the increase in time of concentration and decrease in peak runoff necessary to meet targets for protection of waterbodies with a potential HCOC. Describe hydromodification control BMP that address HCOC, which may include off-site BMP and/or in-stream controls. Section 5.6 of the TGD for WQMP provides additional details on selection and evaluation of hydromodification control BMP.

Form 4.3-10 Hydromodification Control BMPs (DMA 1 AND DMA 2)

1 Volume reduction needed for HCOC 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 hydrologic source control, infiltration, and harvest and use LID BMP (ft^3): 0 *Sum of Form 4.3-9 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 HCOC volume reduction*
3 Remaining volume for HCOC volume capture (ft^3): *Item 1 – Item 2*	**4** Volume capture provided by incorporating additional on-site or off-site retention BMPs (ft^3): *Existing downstream BMP may be used to demonstrate additional volume capture (if so, attach to this WQMP a hydrologic analysis showing how the additional volume would be retained during a 2-yr storm event for the regional watershed)*

5 If Item 4 is less than Item 3, incorporate in-stream controls on downstream waterbody segment to prevent impacts due to hydromodification ☐ *Attach in-stream control BMP selection and evaluation to this WQMP*

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

If yes, HCOC 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 or off-site retention BMP ☐
  BMP upstream of a waterbody segment with a potential HCOC may be used to demonstrate increased time of concentration through hydrograph attenuation (if so, show that the hydraulic residence time provided in BMP for a 2-year storm event is equal or greater than the addition time of concentration requirement in Form 4.2-4 Item 15)
- 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 ☐
- Incorporate appropriate in-stream controls for downstream waterbody segment to prevent impacts due to hydromodification, in a plan approved and signed by a licensed engineer in the State of California ☐

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

If yes, HCOC 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 or off-site retention BMPs ☐
  BMPs upstream of a waterbody segment with a potential HCOC may be used to demonstrate additional peak runoff reduction through hydrograph attenuation (if so, attach to this WQMP, a hydrograph analysis showing how the peak runoff would be reduced during a 2-yr storm event)
- Incorporate appropriate in-stream controls for downstream waterbody segment to prevent impacts due to hydromodification, in a plan approved and signed by a licensed engineer in the State of California ☐

4.4 Alternative Compliance Plan (Not applicable)

Since the project was fully able to retain and infiltrate the DCV through on site BMP's, an alternative compliance plan to address the remainder of the LID DCV is not necessary.

Section 5 Inspection and Maintenance Responsibility for Post Construction BMP

All BMP 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 may require a Maintenance Agreement (consult the jurisdiction's LIP). If a Maintenance Agreement is required, it must also be attached to the WQMP.

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

BMP	Reponsible Party(s)	Inspection/ Maintenance Activities Required	Minimum Frequency of Activities
Subsurface System	Diversified Pacific Communities	Check for ponding water longer than 72 hours, inspect outlet structure and fix if necessary, remove litter and debris, remove sediment volume and additional tasks specified by manufacturer.	After storm event to bi-annually
Inlet Stencils	Diversified Pacific Communities	Check that signage is visible; remove/replace sign if illegible.	Minimum of twice annually, repair as needed.
Trash Receptacles	Diversified Pacific Communities	Trash shall be closed or covered at all times. Ensure regular waste pick-up	As needed, with minimum weekly inspections.
Litter/Debris Control Program	Diversified Pacific Communities	Litter shall be picked up, trash enclosure areas shall be swept and cleaned, dumpsters shall be emptied.	Weekly
Parking Lot Sweeping	Diversified Pacific Communities	Parking lots must be swept	Quarterly (minimum), Weekly during rainy season (Oct-May)
Landscape Management	Diversified Pacific Communities	Gardening and lawn care practices to prevent landscape waster to exit project site per SC-73	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 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

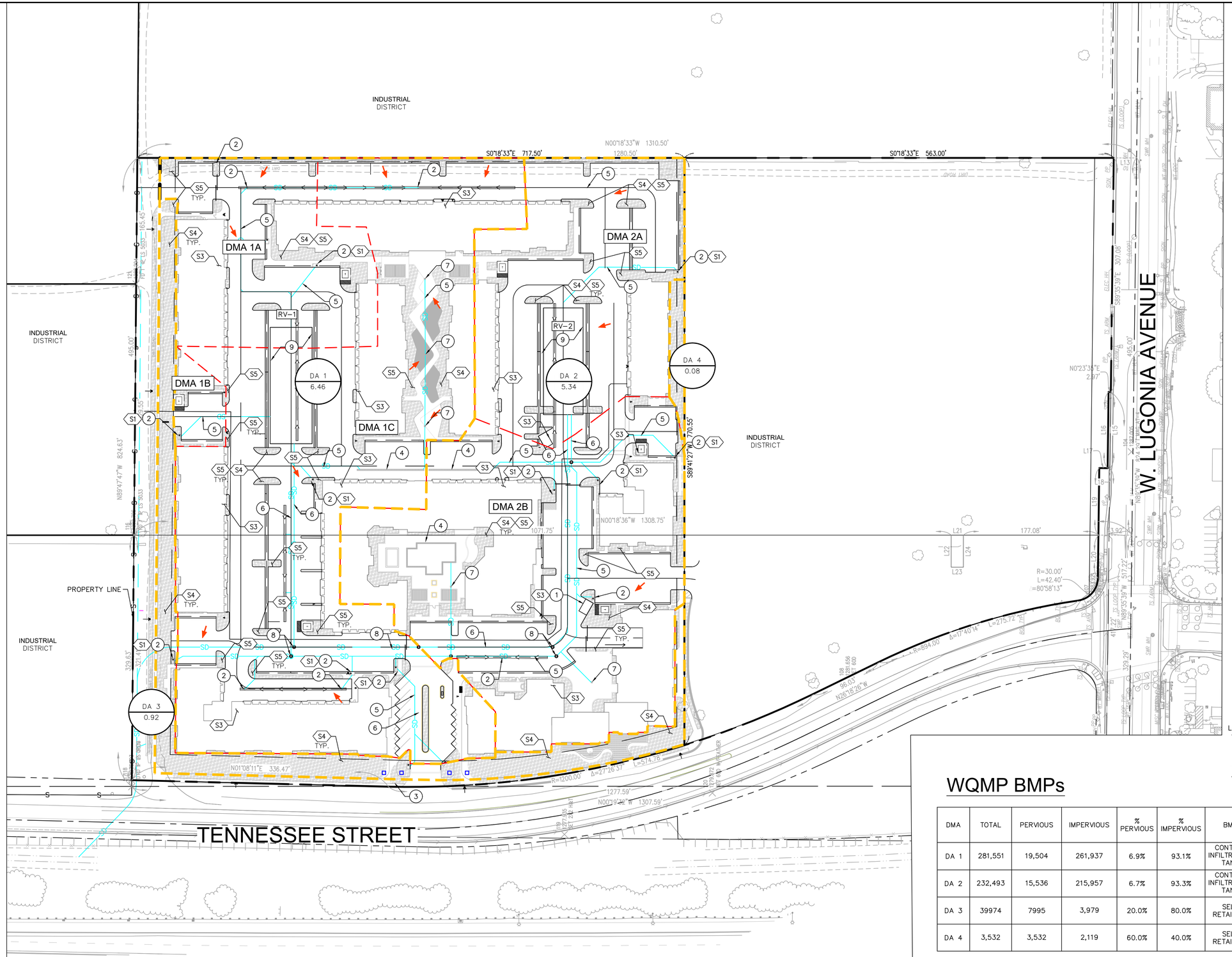
Attach all O&M Plans and Maintenance Agreements for BMP to the WQMP.

6.4 Other Supporting Documentation

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

Section 6.1

Site Plan and Drainage Plan



LEGEND

- CENTER LINE
- PROPERTY LINE
- EASEMENT LINE
- LIMITS OF DRAINAGE AREA AND APPROXIMATE LIMITS OF DISTURBANCE
- DRAINAGE SUB AREA DELINEATION
- SD — PROPOSED STORM DRAIN PIPE
- PROPOSED STORM DRAIN INLET
- PROPOSED LANDSCAPING / PERVIOUS SURFACE
- IMPERVIOUS SURFACE
- DA ID / ACRES — DRAINAGE AREA LABEL

FLOOD ZONE

FLOOD ZONE X : AREA OF MINIMAL FLOOD HAZARD

CONCEPTUAL WQMP NOTES

1. TRASH ENCLOSURE AREA PER ARCHITECTURAL PLAN.
2. INSTALL 24" X 24" JENSEN PRECAST DROP INLET. ALL DROP INLETS SHALL HAVE "OLDCASTLE FLOGARD CATCH BASIN FILTER INSERTS". ALL GRATES SHALL BE TRAFFIC RATED. PAINT "NO DUMPING–DRAINS TO RIVER" ON CURB ADJACENT TO CATCH BASIN.
3. PROPOSED PROPRIETARY PUMP.
4. PROPOSED TRENCH DRAIN
5. 6" SDR–35 PVC STORM DRAIN PIPE SLOPED AT 0.5% MIN.
6. 12" SDR–35 PVC STORM DRAIN PIPE SLOPED AT 0.5% MIN.
7. INSTALL 4" NDS ADA COMPLIANT AREA DRAIN.
8. PROPOSED STORM DRAIN MANHOLE
9. PROPOSED CONTECH UNDERGROUND INFILTRATION TANK FOR WATER QUALITY AND STORMWATER RETENTION.

STRUCTURAL SOURCE CONTROL BMP NOTES

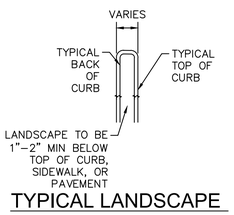
- S1 STORM DRAIN SYSTEM STENCILING AND SIGNAGE (CASQA HANDBOOK SD–13)
- S3 TRASH AND WASTE STORAGE AREAS (CASQA HANDBOOK SD–32)
- S4 IRRIGATION SYSTEMS AND LANDSCAPE DESIGN (CASQA HANDBOOK SD–12)
- S5 COMPLIANT FINISHED GRADES OF LANDSCAPED AREAS

GENERAL NOTES

1. DRAWDOWN IS 48 HRS; A=1.9632.
2. 2–YEAR, 1–HR PRECIPITATION DEPTH = 0.472 INCHES
3. INFILTRATION RATE = 6.95 INCHES/HR PER GEOTECH REPORT PREPARED BY PETRA GEOSCIENCES DATED 02/15/2022 AND SAFETY FACTOR OF 2.

TYPICAL N.T.S.

NOTE: CONTRACTOR TO CONFIRM/VERIFY INFILTRATION RATES WITH SOILS ENGINEER AFTER THE GRADING OPERATION AND PRIOR TO INSTALLATION OF THE UNDERGROUND CHAMBERS. THE CITY SHALL BE NOTIFIED IF THE INFILTRATION RATES DEVIATE FROM THE ORIGINAL INFILTRATION REPORT.



TYPICAL LANDSCAPE AREA DETAIL

NORTH

GRAPHIC SCALE IN FEET
0 30 60 120

WQMP BMPs

DMA	TOTAL	PERVIOUS	IMPERVIOUS	% PERVIOUS	% IMPERVIOUS	BMP	BMP ID	C_{BMP}	P_6	DESIGN CAPTURE VOLUME (CF)	DRAWDOWN	STORAGE VOLUME REQUIRED (CF)	STORAGE VOLUME PROVIDED (CF)
DA 1	281,551	19,504	261,937	6.9%	93.1%	CONTECH INFILTRATION TANK	RV–1	0.78	0.699	25,409	48 HR	25,409	25,446
DA 2	232,493	15,536	215,957	6.7%	93.3%	CONTECH INFILTRATION TANK	RV–2	0.78	0.699	20,556	48 HR	20,556	21,677
DA 3	39974	7995	3,979	20.0%	80.0%	SELF RETAINING	—	0.78	0.699	963	48 HR	963	3000
DA 4	3,532	3,532	2,119	60.0%	40.0%	SELF RETAINING	—	0.78	0.699	221	48 HR	221	325

No.	REVISIONS	DATE	BY

Kimley»Horn

3801 UNIVERSITY AVENUE, SUITE 300, RIVERSIDE, CA 92501
PHONE: 760-565-5103
WWW.KIMLEY-HORN.COM

PRELIMINARY
NOT FOR CONSTRUCTION

PROJECT:
DPC REDLANDS MARKETPLACE
REDLANDS, CALIFORNIA
APN 0167-171-015

DRAWING NAME:
WQMP EXHIBIT

ISSUE: CONCEPTUAL
DATE: 2022–08–31
CHECKED: DRAWN:
DRAWING FILE:
PROJECT NO.:
SCALE: AS SHOWN

SHEET NUMBER
1.0

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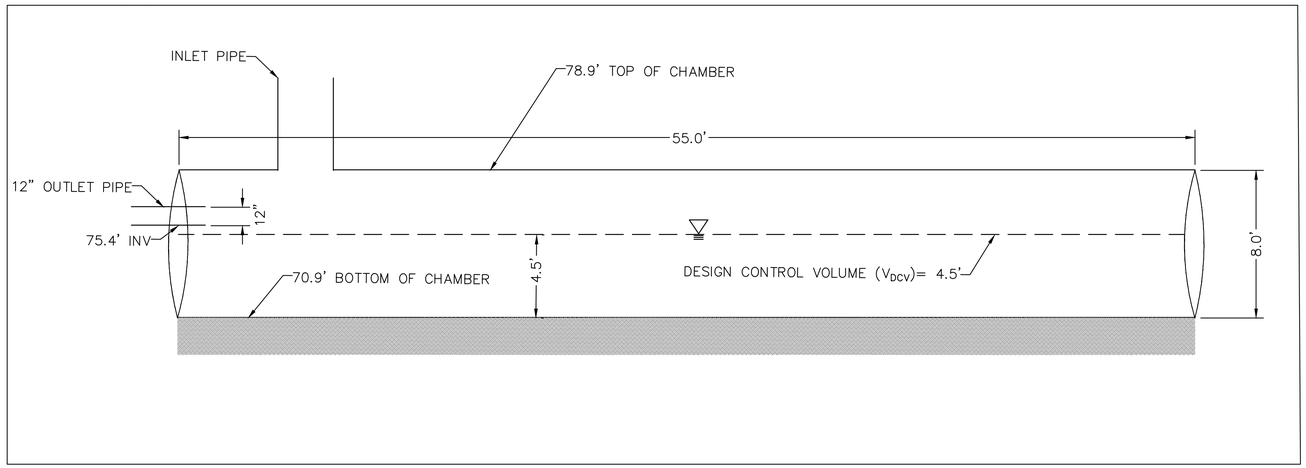
BMP CHAMBER CROSS SECTION

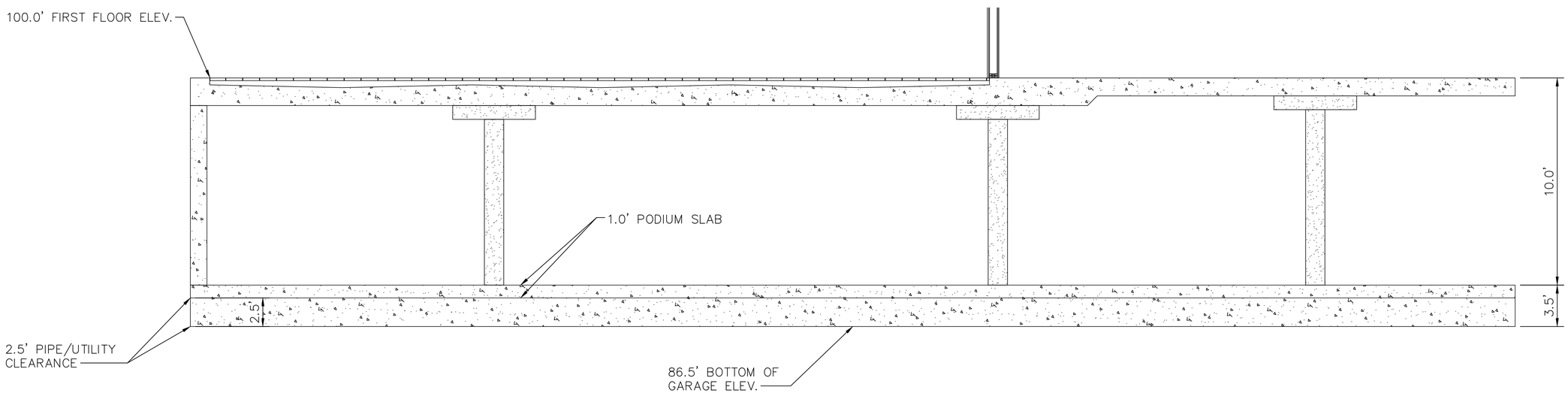
NOT TO SCALE (NTS).



STORM DRAIN STENCIL

UNDERGROUND GARAGE CROSS SECTION

NOT TO SCALE (NTS).



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PROJECT:
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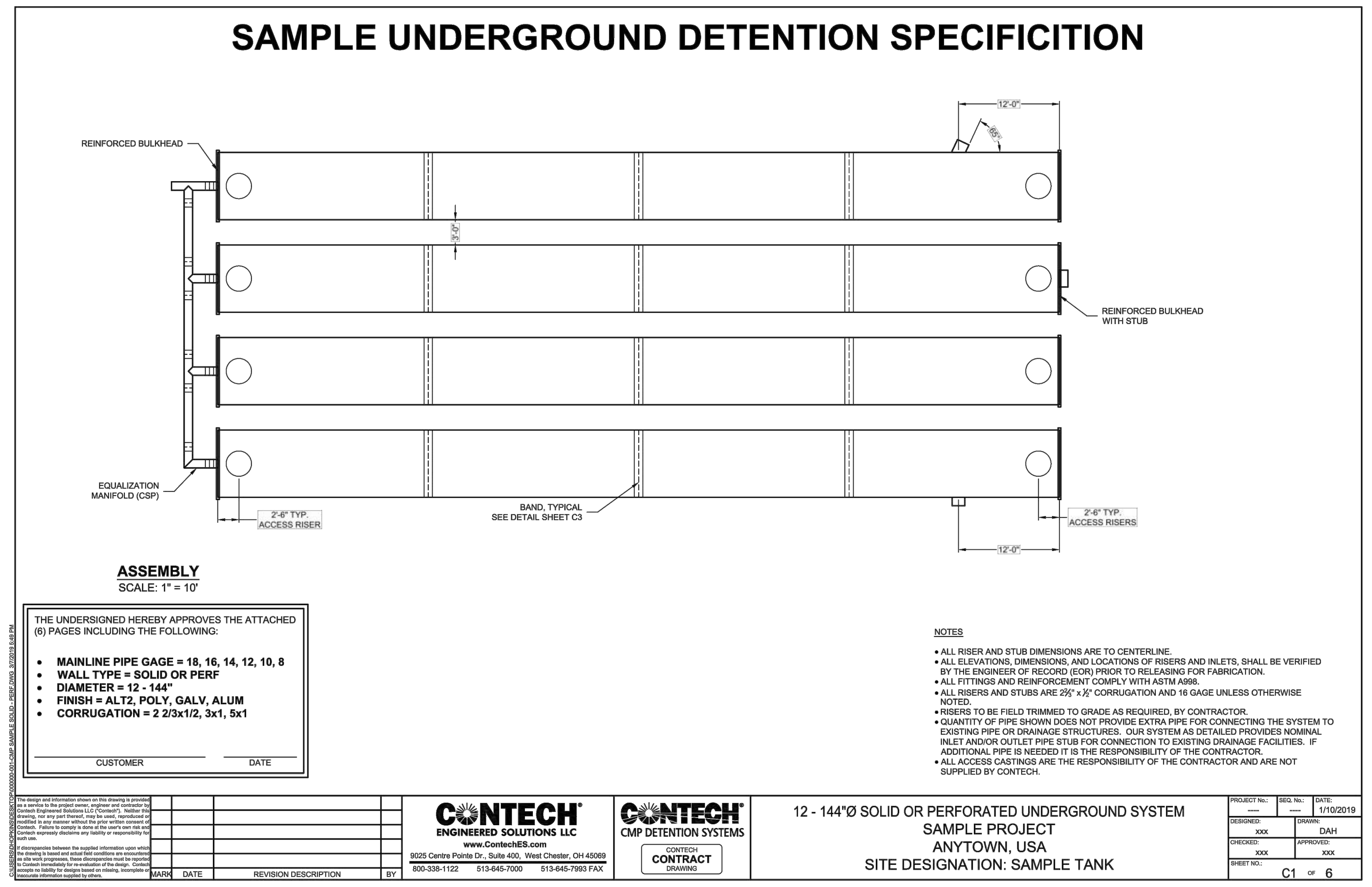
REDLANDS, CALIFORNIA
APN 0167-171-015

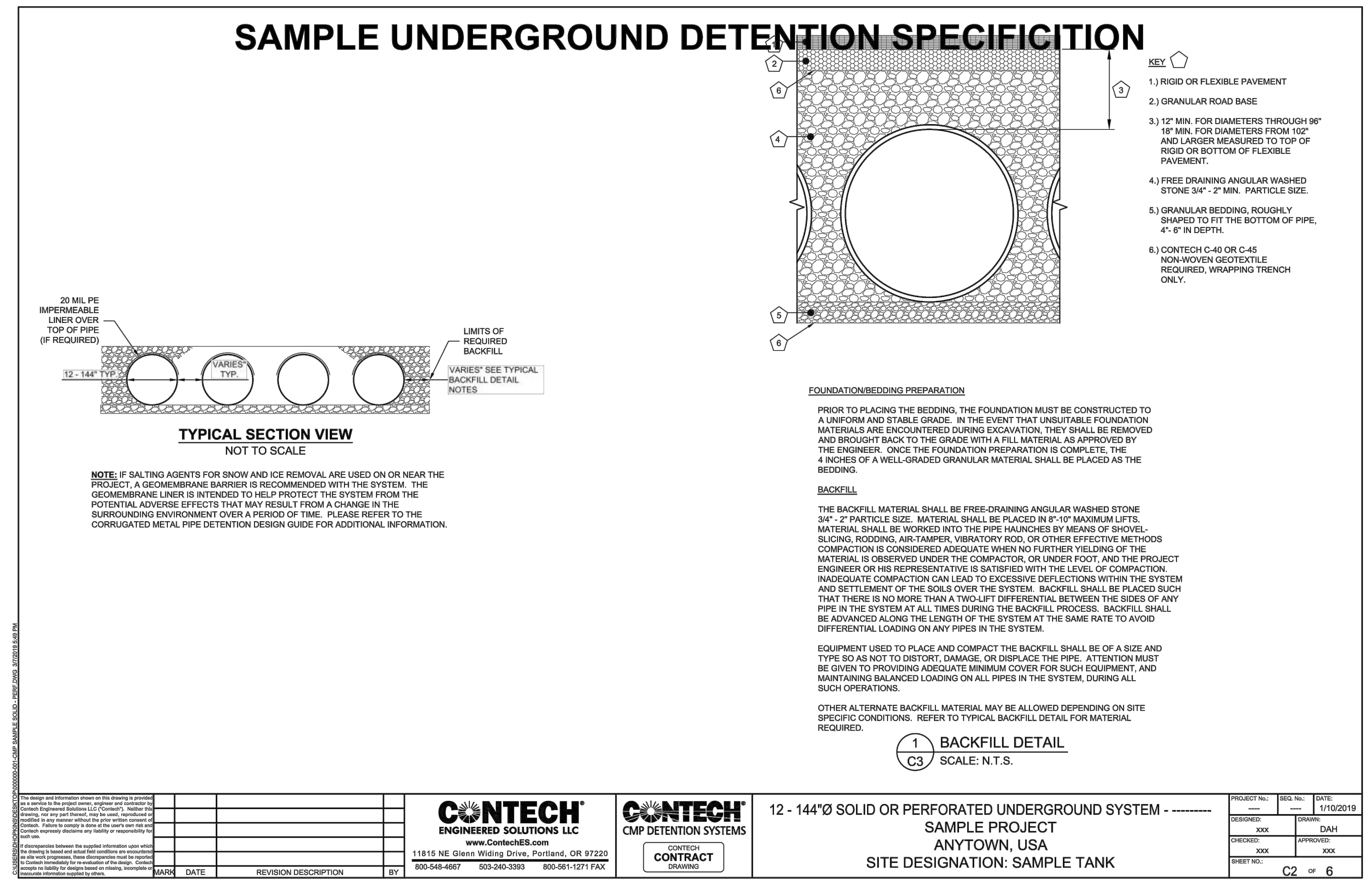
DRAWING NAME: WQMP EXHIBIT: SECTIONS

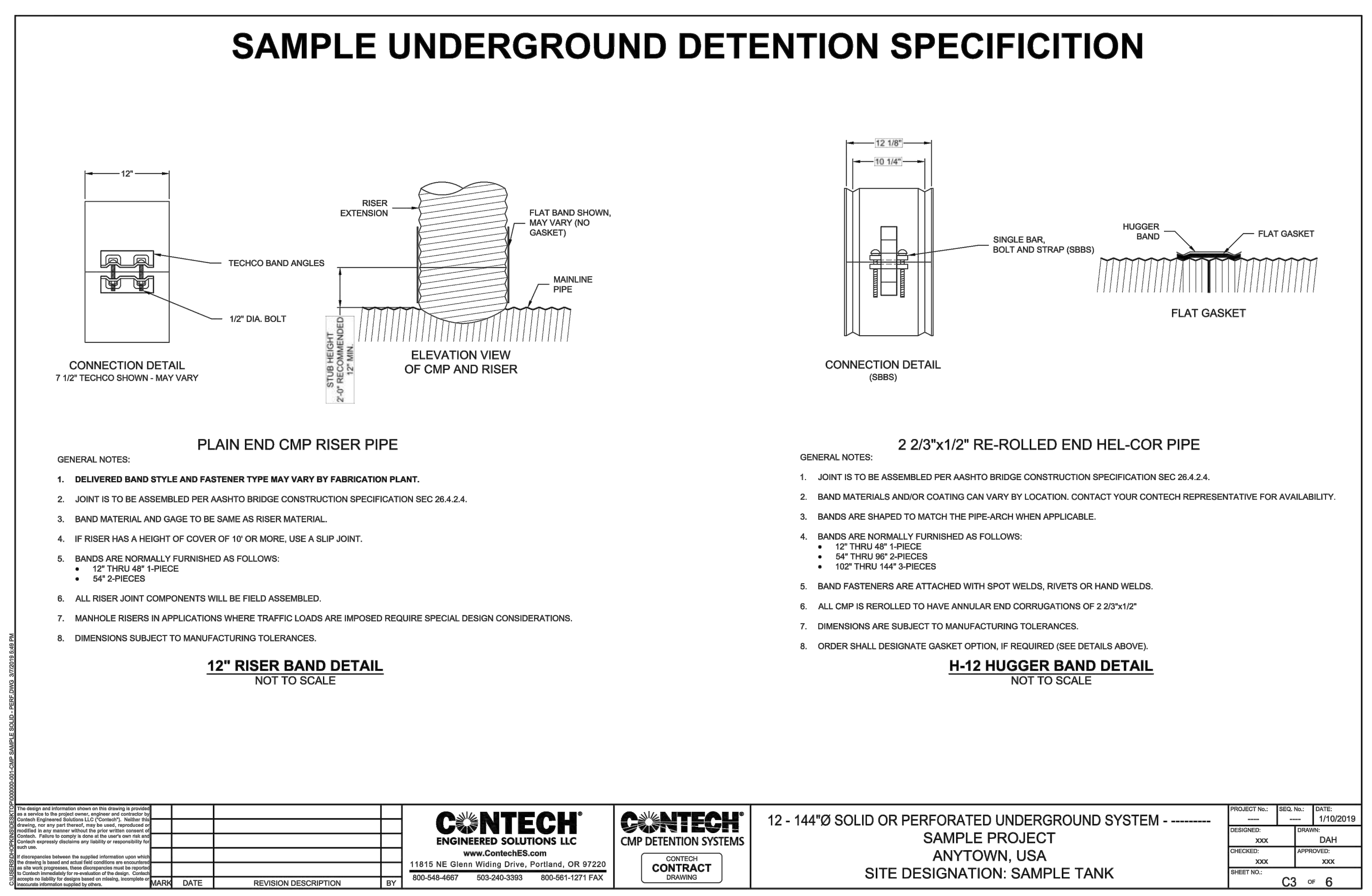
ISSUE: CONCEPTUAL
DATE: 2022-08-31
CHECKED: DRAWN:
DRAWING FILE:
PROJECT NO.:
SCALE: AS SHOWN

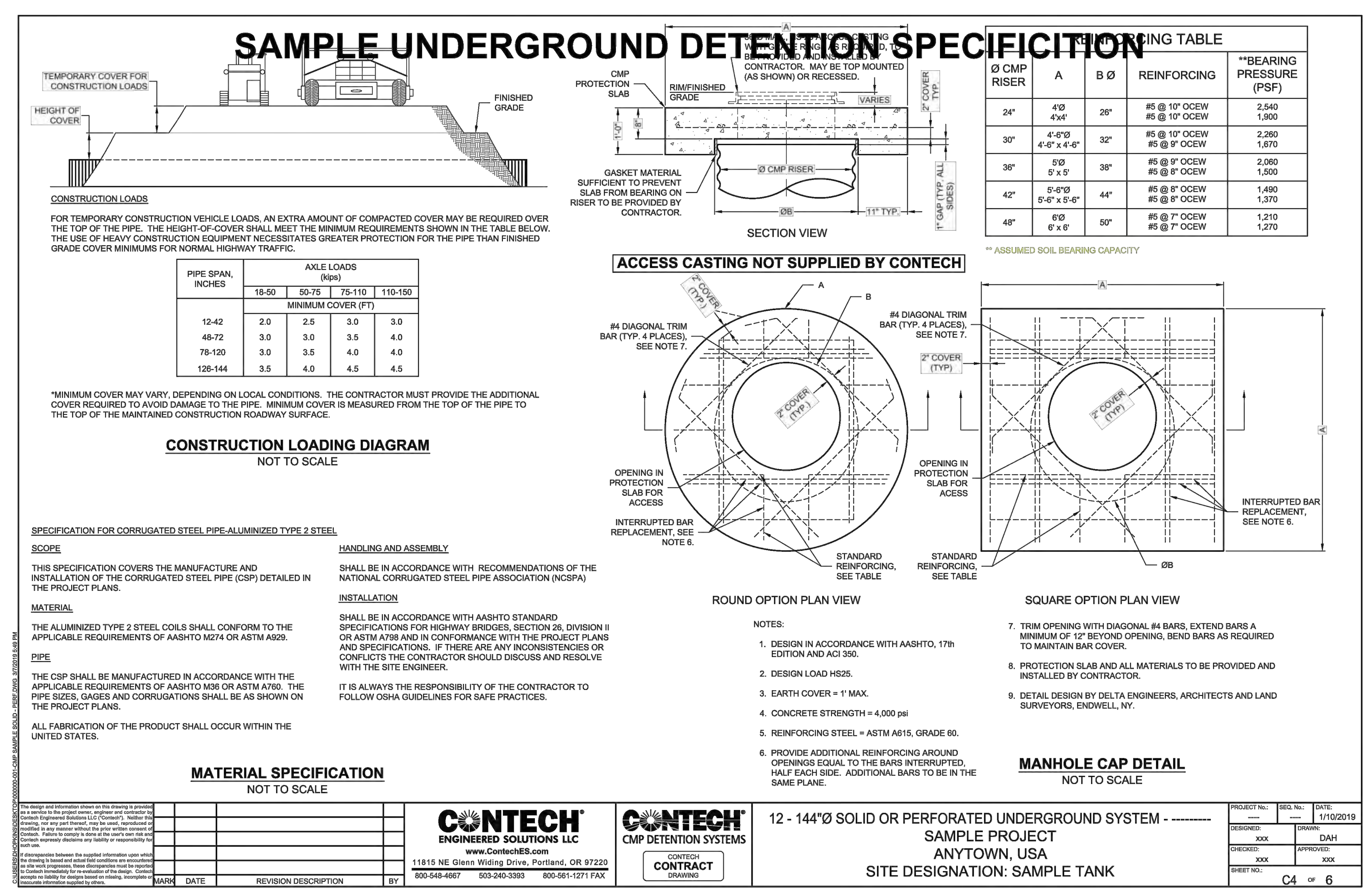
SHEET NUMBER
2.0

UNDERGROUND DETENTION SYSTEM DETAILS









No.	REVISIONS	DATE	BY

Kimley»Horn
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PRELIMINARY
NOT FOR CONSTRUCTION

PROJECT:
DPC REDLANDS MARKETPLACE
REDLANDS, CALIFORNIA
APN 0167-171-015

DRAWING NAME: WQMP EXHIBIT: BMP DETAILS

ISSUE: CONCEPTUAL
DATE: 2022-08-31
CHECKED: DRAWN:
DRAWING FILE:
PROJECT NO.:
SCALE: AS SHOWN

SHEET NUMBER
3.0

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Section 6.2

Electronic Data Submittal

Section 6.3

Post Construction (O&M and BMP Agreement)

Section 6.4

Other Supporting Materials

Section 6.4.1

Soil Report and Precipitation

NOAA Atlas 14, Volume 6, Version 2
Location name: Redlands, California, USA*
Latitude: 34.072°, Longitude: -117.1983°
Elevation: 1287.05 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

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

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

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

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.098** (0.081-0.118)	**0.126** (0.105-0.153)	**0.164** (0.136-0.200)	**0.196** (0.161-0.241)	**0.240** (0.190-0.305)	**0.274** (0.213-0.356)	**0.310** (0.235-0.413)	**0.347** (0.256-0.476)	**0.399** (0.282-0.571)	**0.440** (0.300-0.652)
10-min	**0.140** (0.116-0.170)	**0.181** (0.150-0.220)	**0.235** (0.195-0.287)	**0.281** (0.231-0.345)	**0.344** (0.273-0.437)	**0.393** (0.305-0.511)	**0.444** (0.337-0.592)	**0.498** (0.366-0.682)	**0.572** (0.404-0.818)	**0.631** (0.430-0.935)
15-min	**0.169** (0.141-0.205)	**0.219** (0.182-0.266)	**0.285** (0.236-0.347)	**0.340** (0.279-0.417)	**0.416** (0.330-0.528)	**0.475** (0.369-0.617)	**0.537** (0.407-0.715)	**0.602** (0.443-0.825)	**0.691** (0.488-0.989)	**0.763** (0.520-1.13)
30-min	**0.251** (0.209-0.305)	**0.325** (0.270-0.395)	**0.423** (0.351-0.516)	**0.505** (0.415-0.620)	**0.618** (0.490-0.785)	**0.706** (0.549-0.918)	**0.798** (0.605-1.06)	**0.894** (0.659-1.23)	**1.03** (0.725-1.47)	**1.13** (0.772-1.68)
60-min	**0.365** (0.304-0.444)	**0.472** (0.393-0.574)	**0.615** (0.510-0.750)	**0.733** (0.603-0.901)	**0.898** (0.713-1.14)	**1.03** (0.798-1.33)	**1.16** (0.879-1.55)	**1.30** (0.957-1.78)	**1.49** (1.05-2.14)	**1.65** (1.12-2.44)
2-hr	**0.520** (0.433-0.632)	**0.668** (0.555-0.812)	**0.863** (0.716-1.05)	**1.02** (0.842-1.26)	**1.25** (0.991-1.59)	**1.42** (1.10-1.85)	**1.60** (1.21-2.13)	**1.78** (1.31-2.45)	**2.04** (1.44-2.92)	**2.24** (1.53-3.32)
3-hr	**0.640** (0.533-0.777)	**0.820** (0.681-0.996)	**1.06** (0.876-1.29)	**1.25** (1.03-1.54)	**1.52** (1.21-1.93)	**1.73** (1.34-2.25)	**1.94** (1.47-2.59)	**2.16** (1.59-2.97)	**2.47** (1.74-3.53)	**2.71** (1.84-4.01)
6-hr	**0.899** (0.748-1.09)	**1.15** (0.955-1.40)	**1.48** (1.23-1.80)	**1.75** (1.44-2.15)	**2.12** (1.68-2.69)	**2.40** (1.87-3.12)	**2.69** (2.04-3.59)	**2.99** (2.20-4.10)	**3.40** (2.40-4.87)	**3.72** (2.54-5.51)
12-hr	**1.20** (0.998-1.46)	**1.54** (1.28-1.87)	**1.98** (1.64-2.42)	**2.34** (1.93-2.88)	**2.84** (2.25-3.61)	**3.21** (2.50-4.17)	**3.59** (2.72-4.79)	**3.99** (2.94-5.47)	**4.52** (3.19-6.47)	**4.93** (3.36-7.31)
24-hr	**1.61** (1.42-1.85)	**2.08** (1.84-2.40)	**2.69** (2.37-3.11)	**3.19** (2.79-3.71)	**3.86** (3.27-4.64)	**4.37** (3.63-5.37)	**4.89** (3.96-6.16)	**5.42** (4.27-7.01)	**6.14** (4.64-8.27)	**6.69** (4.89-9.33)
2-day	**1.99** (1.76-2.29)	**2.60** (2.30-3.00)	**3.41** (3.01-3.95)	**4.08** (3.57-4.75)	**4.98** (4.22-6.00)	**5.67** (4.71-6.98)	**6.38** (5.17-8.04)	**7.11** (5.61-9.21)	**8.10** (6.13-10.9)	**8.88** (6.49-12.4)
3-day	**2.15** (1.90-2.48)	**2.86** (2.53-3.30)	**3.80** (3.35-4.39)	**4.57** (4.00-5.33)	**5.65** (4.78-6.80)	**6.48** (5.38-7.97)	**7.35** (5.95-9.25)	**8.25** (6.50-10.7)	**9.49** (7.18-12.8)	**10.5** (7.66-14.6)
4-day	**2.32** (2.05-2.67)	**3.11** (2.75-3.58)	**4.16** (3.67-4.81)	**5.04** (4.41-5.87)	**6.26** (5.30-7.54)	**7.22** (5.99-8.87)	**8.21** (6.65-10.3)	**9.25** (7.30-12.0)	**10.7** (8.10-14.4)	**11.9** (8.67-16.5)
7-day	**2.68** (2.38-3.09)	**3.62** (3.20-4.18)	**4.88** (4.31-5.65)	**5.94** (5.19-6.92)	**7.40** (6.27-8.92)	**8.56** (7.10-10.5)	**9.76** (7.90-12.3)	**11.0** (8.68-14.3)	**12.8** (9.66-17.2)	**14.2** (10.4-19.8)
10-day	**2.91** (2.57-3.35)	**3.94** (3.49-4.55)	**5.34** (4.71-6.18)	**6.51** (5.69-7.59)	**8.13** (6.89-9.80)	**9.42** (7.81-11.6)	**10.7** (8.71-13.5)	**12.2** (9.58-15.7)	**14.1** (10.7-19.0)	**15.7** (11.5-21.8)
20-day	**3.59** (3.18-4.14)	**4.91** (4.35-5.67)	**6.70** (5.91-7.76)	**8.20** (7.18-9.57)	**10.3** (8.73-12.4)	**12.0** (9.94-14.7)	**13.7** (11.1-17.3)	**15.6** (12.3-20.1)	**18.1** (13.7-24.4)	**20.2** (14.8-28.1)
30-day	**4.22** (3.74-4.87)	**5.79** (5.12-6.68)	**7.92** (6.99-9.16)	**9.71** (8.50-11.3)	**12.2** (10.4-14.7)	**14.2** (11.8-17.5)	**16.3** (13.2-20.6)	**18.6** (14.6-24.0)	**21.7** (16.4-29.2)	**24.2** (17.7-33.7)
45-day	**5.05** (4.47-5.82)	**6.91** (6.11-7.98)	**9.45** (8.33-10.9)	**11.6** (10.1-13.5)	**14.6** (12.4-17.6)	**17.0** (14.1-20.9)	**19.5** (15.8-24.6)	**22.2** (17.5-28.7)	**26.0** (19.7-35.0)	**29.0** (21.2-40.4)
60-day	**5.91** (5.23-6.81)	**8.05** (7.12-9.29)	**11.0** (9.67-12.7)	**13.4** (11.7-15.7)	**16.9** (14.3-20.4)	**19.7** (16.3-24.2)	**22.6** (18.3-28.5)	**25.7** (20.3-33.3)	**30.0** (22.7-40.5)	**33.6** (24.6-46.8)

[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.

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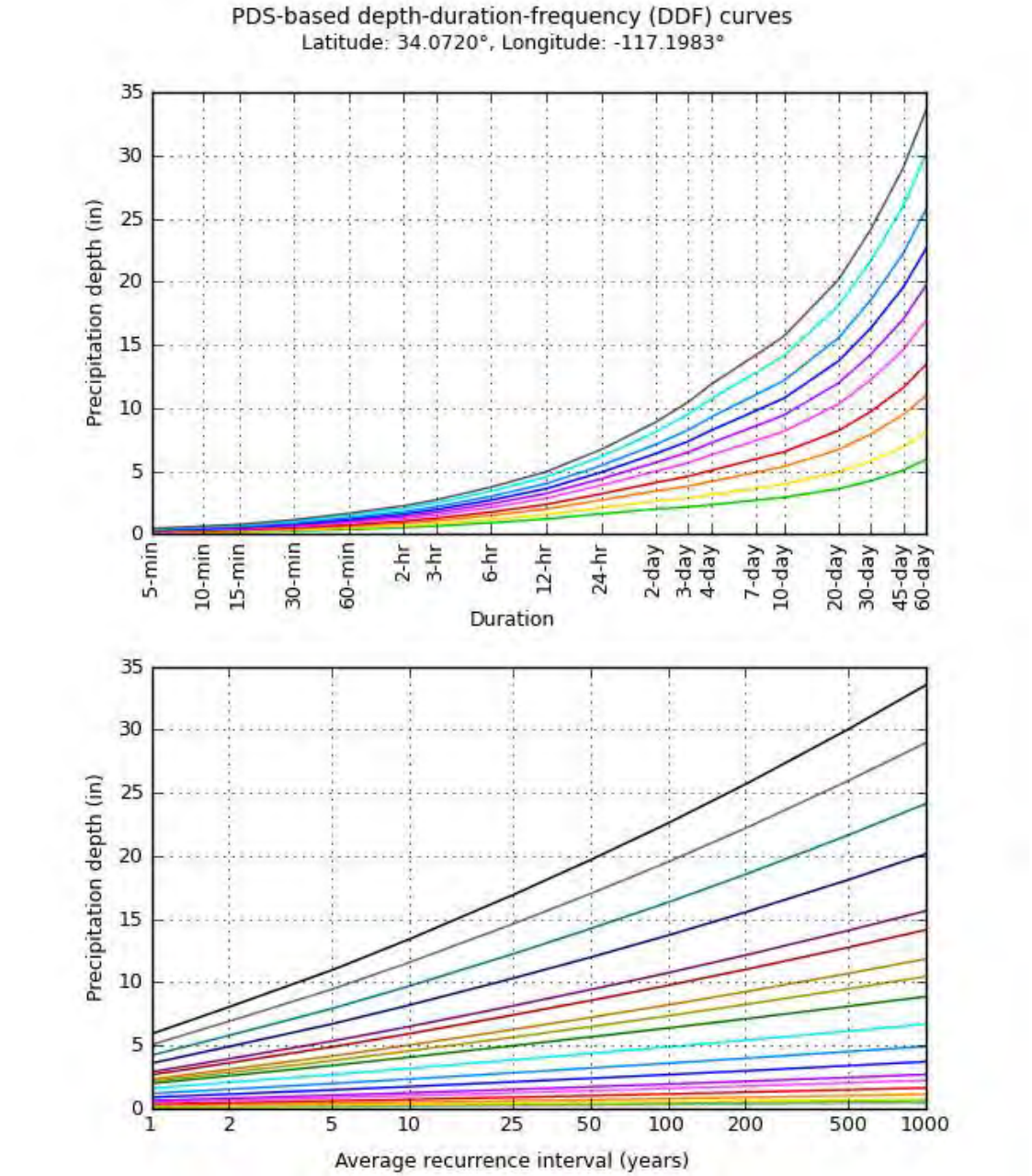
PF graphical



NOAA Atlas 14, Volume 6, Version 2

Created (GMT): Thu Aug 11 18:22:48 2022

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Maps & aerials

Small scale terrain

Large scale terrain

Large scale map

Large scale aerial

Back to Top

US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

San Bernardino County Southwestern Part, California

HbA—Hanford sandy loam, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 2y8tv
Elevation: 790 to 1,610 feet
Mean annual precipitation: 10 to 19 inches
Mean annual air temperature: 65 to 65 degrees F
Frost-free period: 345 to 365 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

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

Description of Hanford

Setting

Landform: Alluvial fans
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from granite

Typical profile

A - 0 to 12 inches: sandy loam
C - 12 to 60 inches: fine sandy loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: RareNone
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Moderate (about 7.8 inches)

Interpretive groups

Land capability classification (irrigated): 1
Land capability classification (nonirrigated): 3c
Hydrologic Soil Group: A
Ecological site: R019XG911CA - Loamy Fan
Hydric soil rating: No

Minor Components

Hanford, steeper slopes
Percent of map unit: 5 percent
Landform: Alluvial fans
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Greenfield, sandy loam
Percent of map unit: 5 percent
Landform: Alluvial fans
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Unnamed
Percent of map unit: 5 percent
Hydric soil rating: No

Data Source Information

Soil Survey Area: San Bernardino County Southwestern Part, California
Survey Area Data: Version 13, Sep 13, 2021

Map Scale: 1:2,340 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 30 60 120 180

Feet: 0 100 200 400 600

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

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Unit Polygons

Soil Map Unit Lines

Soil Map Unit Points

Special Point Features

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

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

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

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: San Bernardino County Southwestern Part, California
Survey Area Data: Version 13, Sep 13, 2021

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

Date(s) aerial images were photographed: Nov 11, 2020—Nov 15, 2020

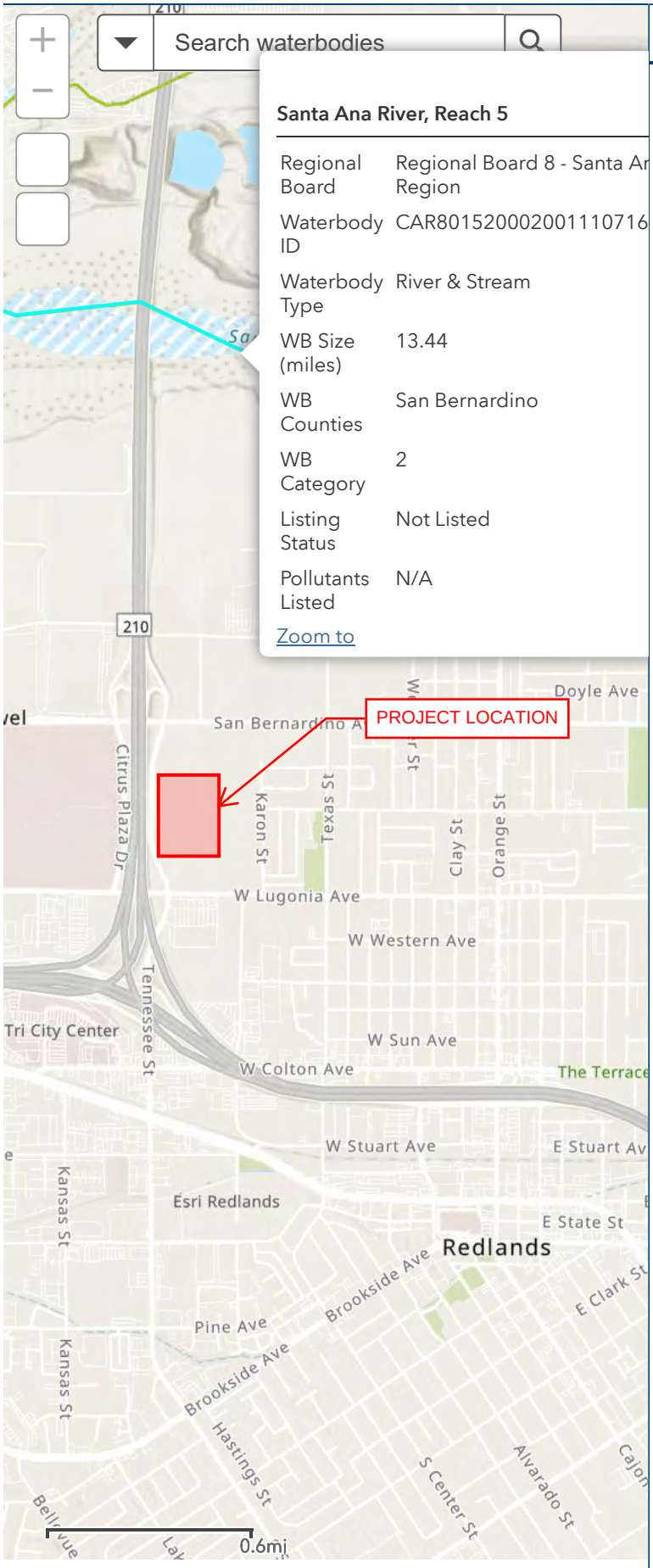
The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
HbA	Hanford sandy loam, 0 to 2 percent slopes	23.7	81.6%
TuB	Tujunga loamy sand, 0 to 5 percent slopes	5.3	18.4%
Totals for Area of Interest		**29.0**	**100.0%**

Section 6.4.2

HCOC and Pollutants of Concern



Legend

2020-22 Integrated Report Lines

- Not Listed
- Listed

2020-22 Integrated Report Polygons

- Listed
- Not Listed

CATEGORY 5

Final 2010 Integrated Report (CWA Section 303(d) List / 305(b) Report)
USEPA Final Approval: October 11, 2011

2010 SANTA ANA REGION 303(d) LIST OF WATER QUALITY LIMITED SEGMENTS*

Category 5 criteria: 1) A water segment where standards are not met and a TMDL is required, but not yet completed, for at least one of the pollutants being listed for this segment.
* USGS HUC = US Geological Survey Hydrologic Unit Code. Calwater = State Water Resources Control Board hydrological subunit area or even smaller planning watershed.
** TMDL requirement status definitions for listed pollutants are: A= TMDL still required, B= being addressed by USEPA approved TMDL, C= being addressed by action other than a TMDL
*** Dates relate to the TMDL requirement status, so a date for A= TMDL scheduled completion date, B= Date USEPA approved TMDL, and C= Completion date for action other than a TMDL

REGION	WATER BODY NAME	WATER TYPE	WATERSHED CALWATER/ USGS HUC	• POLLUTANT • POTENTIAL SOURCES	ESTIMATED AREA ASSESSED	FIRST YEAR LISTED	TMDL REQUIREMENT STATUS	DATE
8	Anaheim Bay	Bay & Harbor	80111000 / 18070201	• Dieldrin (tissue) Source Unknown *This listing was made by USEPA.*	402 Acres	2006	5A	2019
				• Nickel Source Unknown *This listing was made by USEPA.*	402 Acres	2002	5A	2019
				• PCBs (Polychlorinated biphenyls) (tissue) Source Unknown *This listing was made by USEPA.*	402 Acres	2002	5A	2019
				• Sediment Toxicity Source Unknown	402 Acres	2006	5A	2019
8	Balboa Beach	Coastal & Bay Shoreline	80114000 / 18070201	• DDT (Dichlorodiphenyltrichloroethane) Source Unknown	1.8 Miles	2006	5A	2019

REGION	WATER BODY NAME	WATER TYPE	WATERSHED CALWATER/ USGS HUC	POLLUTANT POTENTIAL SOURCES	ESTIMATED AREA ASSESSED	FIRST YEAR LISTED	TMDL REQUIREMENT STATUS	DATE
				• Dieldrin Source Unknown	1.8 Miles	2006	5A	2019
				• PCBs (Polychlorinated biphenyls) Source Unknown	1.8 Miles	2006	5A	2019
8	Big Bear Lake	Lake & Reservoir	80171000 / 18070203	• Mercury Resource Extraction	2865 Acres	1994	5A	2007
				• Noxious aquatic plants Construction/Land Development Unknown Nonpoint Source	2865 Acres	1994	5B	2007
				• Nutrients Construction/Land Development Snow skiing activities	2865 Acres	1994	5B	2007
				• PCBs (Polychlorinated biphenyls) Source Unknown	2865 Acres	2006	5A	2019
8	Bolsa Chica Channel	River & Stream	80111000 / 18070201	• Ammonia (Unionized) Other Urban Runoff Storm sewers Surface Runoff Unknown Nonpoint Source	5.1 Miles	2010	5A	2021
				• Indicator Bacteria Source Unknown	5.1 Miles	2010	5A	2021
				• pH Source Unknown	5.1 Miles	2010	5A	2021
8	Bolsa Chica State Beach	Coastal & Bay Shoreline	80111000 / 18070201	• Copper Source Unknown	2.6 Miles	2002	5A	2019

REGION	WATER BODY NAME	WATER TYPE	WATERSHED CALWATER/ USGS HUC	• POLLUTANT • POTENTIAL SOURCES	ESTIMATED AREA ASSESSED	FIRST YEAR LISTED	TMDL REQUIREMENT STATUS	DATE
				This listing was made by USEPA.				
				• Nickel Source Unknown	2.6 Miles	2002	5A	2019
				This listing was made by USEPA.				
8	Borrego Creek (from Irvine Blvd to San Diego Creek Reach 2)	River & Stream	80111000 / 18070203	• Ammonia (Unionized) Other Urban Runoff Storm sewers Surface Runoff Unknown Nonpoint Source	3.2 Miles	2010	5A	2021
				• Indicator Bacteria Source Unknown	3.2 Miles	2010	5A	2021
8	Buck Gully Creek	River & Stream	80111000 / 18070201	• Fecal Coliform Source Unknown	0.3 Miles	2002	5A	2019
				Listing is downstream of Pacific Coast Highway.				
				• Total Coliform Source Unknown	0.3 Miles	2002	5A	2019
				Listing is downstream of Pacific Coast Highway.				
8	Canyon Lake (Railroad Canyon Reservoir)	Lake & Reservoir	80211000 / 18070202	• Nutrients Nonpoint Source	453 Acres	1998	5B	2005
				• Pathogens Nonpoint Source	453 Acres	1998	5A	2006

REGION	WATER BODY NAME	WATER TYPE	WATERSHED CALWATER/ USGS HUC	POLLUTANT POTENTIAL SOURCES	ESTIMATED AREA ASSESSED	FIRST YEAR LISTED	TMDL REQUIREMENT STATUS	DATE
8	Chino Creek Reach 1A (Santa Ana River R5 confl to just downstream of confl with Mill Creek)	River & Stream	80121000 / 18070203	• Nutrients Agriculture Dairies	0.79 Miles	2010	5A	2019
				• Pathogens Agriculture Dairies Urban Runoff/Storm Sewers	0.79 Miles	2010	5B	2007
8	Chino Creek Reach 1B (Mill Creek confl to start of concrete lined channel)	River & Stream	80121000 / 18070203	• Chemical oxygen demand (COD) Source Unknown	7 Miles	2010	5A	2021
				• Nutrients Agriculture	7 Miles	2010	5A	2019
				• Pathogens Agriculture Dairies Urban Runoff/Storm Sewers	7 Miles	2010	5B	2007
8	Chino Creek Reach 2 (Beginning of concrete channel to confl w San Antonio Creek)	River & Stream	80121000 / 18070203	• Coliform Bacteria Unknown Nonpoint Source	2.5 Miles	1998	5B	2007
				• pH Source Unknown	2.5 Miles	2010	5A	2021
8	Cucamonga Creek Reach 1 (Valley Reach)	River & Stream	80121000 / 18070203	• Cadmium Source Unknown	9.6 Miles	2010	5A	2021
				• Coliform Bacteria Unknown Nonpoint Source	9.6 Miles	1998	5B	2007

REGION	WATER BODY NAME	WATER TYPE	WATERSHED CALWATER/ USGS HUC	POLLUTANT POTENTIAL SOURCES	ESTIMATED AREA ASSESSED	FIRST YEAR LISTED	TMDL REQUIREMENT STATUS	DATE
				• Copper Source Unknown	9.6 Miles	2010	5A	2021
				• Lead Source Unknown	9.6 Miles	2010	5A	2021
				• Zinc Source Unknown	9.6 Miles	2010	5A	2021
8	Cucamonga Creek Reach 2 (Mountain Reach)	River & Stream	80124020 / 18070203	• pH Source Unknown	13 Miles	2010	5A	2021
8	East Garden Grove Wintersburg Channel	River & Stream	80111000 / 18070201	• Ammonia (Unionized) Source Unknown	2.9 Miles	2010	5A	2021
8	Elsinore, Lake	Lake & Reservoir	80231000 / 18070202	• Nutrients Unknown Nonpoint Source	2431 Acres	1994	5B	2005
				• Organic Enrichment/Low Dissolved Oxygen Unknown Nonpoint Source	2431 Acres	1994	5B	2005
				• PCBs (Polychlorinated biphenyls) Source Unknown	2431 Acres	2006	5A	2019
				• Sediment Toxicity Source Unknown	2431 Acres	2010	5A	2021
				• Unknown Toxicity Source Unknown	2431 Acres	1994	5A	2007
8	Fulmor, Lake	Lake & Reservoir	80221000 / 18070202	• Pathogens Unknown Nonpoint Source	4.2 Acres	1998	5A	2019

REGION	WATER BODY NAME	WATER TYPE	WATERSHED CALWATER/ USGS HUC	POLLUTANT POTENTIAL SOURCES	ESTIMATED AREA ASSESSED	FIRST YEAR LISTED	TMDL REQUIREMENT STATUS	DATE
8	Goldenstar Creek	River & Stream	80126000 / 18070203	• Indicator Bacteria Source Unknown	2.4 Miles	2010	5A	2021
8	Grout Creek	River & Stream	80171000 / 18070203	• Nutrients Unknown Nonpoint Source	3.5 Miles	1994	5A	2008
8	Huntington Beach State Park	Coastal & Bay Shoreline	80111000 / 18070201	• PCBs (Polychlorinated biphenyls) Source Unknown	5.8 Miles	2006	5A	2019
8	Huntington Harbour	Bay & Harbor	80111000 / 18070201	• Chlordane Source Unknown	221 Acres	2006	5A	2019
				• Copper Source Unknown	221 Acres	2002	5A	2019
				This listing was made by USEPA.				
				• Lead Source Unknown	221 Acres	2006	5A	2019
				• Nickel Source Unknown	221 Acres	2002	5A	2019
				This listing was made by USEPA.				
				• PCBs (Polychlorinated biphenyls) (tissue) Source Unknown	221 Acres	2002	5A	2019
				This listing was made by USEPA.				

REGION	WATER BODY NAME	WATER TYPE	WATERSHED CALWATER/ USGS HUC	POLLUTANT POTENTIAL SOURCES	ESTIMATED AREA ASSESSED	FIRST YEAR LISTED	TMDL REQUIREMENT STATUS	DATE
				• Pathogens Urban Runoff/Storm Sewers	221 Acres	1992	5A	2019
				The data shows that the impairment is focused at the 11th Street, Anderson Street Marina, Clubhouse Marina and Sunset Aquatic Park locations. These locations exceed mainly the enterococcus standard.				
				• Sediment Toxicity Source Unknown	221 Acres	2006	5A	2019
8	Knickerbocker Creek	River & Stream	80171000 / 18070203	• Pathogens Unknown Nonpoint Source	2 Miles	2006	5A	2005
				For 2006, pathogens was moved by USEPA from the being addressed list back to the 303(d) list pending completion and USEPA approval of a TMDL.				
8	Los Trancos Creek (Crystal Cove Creek)	River & Stream	80111000 / 18070201	• Fecal Coliform Source Unknown	0.19 Miles	2006	5A	2019
				Listing is downstream of Pacific Coast Highway.				
				• Total Coliform Source Unknown	0.19 Miles	2006	5A	2019
				Listing is downstream of Pacific Coast Highway.				
8	Lytle Creek	River & Stream	80141000 / 18070203	• Pathogens Unknown Nonpoint Source	41 Miles	2006	5A	2019
8	Mill Creek (Prado Area)	River & Stream	80121000 / 18070203	• Nutrients Agriculture Dairies	1.6 Miles	1996	5A	2019

REGION	WATER BODY NAME	WATER TYPE	WATERSHED CALWATER/ USGS HUC	POLLUTANT POTENTIAL SOURCES	ESTIMATED AREA ASSESSED	FIRST YEAR LISTED	TMDL REQUIREMENT STATUS	DATE
				• Pathogens Dairies	1.6 Miles	1996	5B	2007
				• Total Suspended Solids (TSS) Dairies	1.6 Miles	1996	5A	2019
8	Mill Creek Reach 1	River & Stream	80156000 / 180 70203	• Pathogens Unknown Nonpoint Source	12 Miles	1998	5A	2019
8	Mill Creek Reach 2	River & Stream	80158000 / 18070203	• Pathogens Unknown Nonpoint Source	12 Miles	1998	5A	2019
8	Morning Canyon Creek	River & Stream	80111000 / 18070201	• Indicator Bacteria Source Unknown	1.1 Miles	2010	5A	2021
8	Mountain Home Creek	River & Stream	80158000 / 18070203	• Pathogens Unknown Nonpoint Source	3.7 Miles	1998	5A	2019
8	Mountain Home Creek, East Fork	River & Stream	80158000 / 18070203	• Pathogens Unknown Nonpoint Source	5.1 Miles	1998	5A	2019
8	Newport Bay, Lower (entire lower bay, including Rhine Channel, Turning Basin and South Lido Channel to east end of H-J Moorings)	Bay & Harbor	80114000 / 18070201	• Chlordane Source Unknown	767 Acres	2006	5A	2019
				• Copper Source Unknown	767 Acres	2006	5A	2007
				• DDT (Dichlorodiphenyltrichloroethane) Source Unknown	767 Acres	1990	5A	2019

REGION	WATER BODY NAME	WATER TYPE	WATERSHED CALWATER/ USGS HUC	POLLUTANT POTENTIAL SOURCES	ESTIMATED AREA ASSESSED	FIRST YEAR LISTED	TMDL REQUIREMENT STATUS	DATE
				• Indicator Bacteria Source Unknown	767 Acres		5B	2000
				• Nutrients Source Unknown	767 Acres	1992	5B	1999
				• PCBs (Polychlorinated biphenyls) Source Unknown	767 Acres	1990	5A	2019
				• Pesticides Agriculture Contaminated Sediments	767 Acres	1990	5B	2004
				• Sediment Toxicity Source Unknown	767 Acres	2006	5A	2019
8	Newport Bay, Upper (Ecological Reserve)	Estuary	80111000 / 18070201	• Chlordane Source Unknown	653 Acres	2006	5A	2019
				• Copper Source Unknown	653 Acres	2006	5A	2007
				• DDT (Dichlorodiphenyltrichloroethane) Source Unknown	653 Acres	2006	5A	2019
				• Indicator Bacteria Source Unknown	653 Acres		5B	2000
				• Metals Urban Runoff/Storm Sewers	653 Acres	1992	5A	2019
				• Nutrients Source Unknown	653 Acres	2006	5B	1999
				• PCBs (Polychlorinated biphenyls) Source Unknown	653 Acres	2006	5A	2019

REGION	WATER BODY NAME	WATER TYPE	WATERSHED CALWATER/ USGS HUC	POLLUTANT POTENTIAL SOURCES	ESTIMATED AREA ASSESSED	FIRST YEAR LISTED	TMDL REQUIREMENT STATUS	DATE
				• Pesticides Agriculture Unknown Nonpoint Source	653 Acres	1992	5B	2004
				• Sediment Toxicity Source Unknown	653 Acres	2006	5A	2019
				• Sedimentation/Siltation Agriculture Channel Erosion Construction/Land Development Erosion/Siltation	653 Acres	2006	5B	1999
8	Newport Slough	River & Stream	80111000 / 18070201	• Enterococcus Source Unknown	1.3 Miles	2010	5A	2021
				• Fecal Coliform Source Unknown	1.3 Miles	2010	5A	2021
				• Total Coliform Source Unknown	1.3 Miles	2010	5A	2021
8	Peters Canyon Channel	River & Stream	80111000 / 18070201	• DDT (Dichlorodiphenyltrichloroethane) Source Unknown	3 Miles	2006	5A	2019
				• Indicator Bacteria Source Unknown	3 Miles	2010	5A	2021
				• Toxaphene Source Unknown	3 Miles	2006	5A	2019
				• pH Unknown Nonpoint Source Urban Runoff/Storm Sewers	3 Miles	2010	5A	2021

REGION	WATER BODY NAME	WATER TYPE	WATERSHED CALWATER/ USGS HUC	• POLLUTANT • POTENTIAL SOURCES	ESTIMATED AREA ASSESSED	FIRST YEAR LISTED	TMDL REQUIREMENT STATUS	DATE
8	Prado Park Lake	Lake & Reservoir	80121000 / 18070203	• Nutrients Nonpoint Source	90 Acres	1998	5A	2019
				• Pathogens Nonpoint Source	90 Acres	1998	5B	2007
8	Rathbone (Rathbun) Creek	River & Stream	80171000 / 18070203	• Cadmium Source Unknown	4.7 Miles	2010	5A	2021
				• Copper Source Unknown	4.7 Miles	2010	5A	2021
				• Nutrients Snow skiing activities Unknown Nonpoint Source	4.7 Miles	1994	5A	2008
				• Sedimentation/Siltation Snow skiing activities Unknown Nonpoint Source	4.7 Miles	1994	5A	2006
8	Rhine Channel	Bay & Harbor	80114000 / 18070201	• Copper Source Unknown	20 Acres	2006	5A	2019
				• Lead Source Unknown	20 Acres	2006	5A	2019
				• Mercury Source Unknown	20 Acres	2006	5A	2019
				• PCBs (Polychlorinated biphenyls) Source Unknown	20 Acres	2006	5A	2019
				• Sediment Toxicity Source Unknown	20 Acres	2006	5A	2019

REGION	WATER BODY NAME	WATER TYPE	WATERSHED CALWATER/ USGS HUC	POLLUTANT POTENTIAL SOURCES	ESTIMATED AREA ASSESSED	FIRST YEAR LISTED	TMDL REQUIREMENT STATUS	DATE
				• Zinc Source Unknown	20 Acres	2006	5A	2019
8	San Antonio Creek	River & Stream	80121000 / 18070203	• pH Source Unknown	23 Miles	2010	5A	2021
8	San Diego Creek Reach 1	River & Stream	80111000 / 18070201	• Fecal Coliform Other Urban Runoff Urban Runoff/Storm Sewers	7.8 Miles	2002	5A	2019
				• Nutrients Source Unknown	7.8 Miles	1996	5B	1999
				• Pesticides Unknown Nonpoint Source	7.8 Miles	1990	5B	2004
				• Sedimentation/Siltation Source Unknown	7.8 Miles	1996	5B	1999
				• Selenium Source Unknown	7.8 Miles	2006	5A	2007
				• Toxaphene Source Unknown	7.8 Miles	2006	5A	2019
8	San Diego Creek Reach 2	River & Stream	80111000 / 18070201	• Indicator Bacteria Source Unknown	6.3 Miles	2010	5A	2021
				• Nutrients Agriculture Groundwater Loadings Urban Runoff/Storm Sewers	6.3 Miles	1996	5B	1999

REGION	WATER BODY NAME	WATER TYPE	WATERSHED CALWATER/ USGS HUC	POLLUTANT POTENTIAL SOURCES	ESTIMATED AREA ASSESSED	FIRST YEAR LISTED	TMDL REQUIREMENT STATUS	DATE
				• Sedimentation/Siltation Agriculture Channel Erosion Construction/Land Development Erosion/Siltation	6.3 Miles	1996	5B	1999
				• Unknown Toxicity Unknown Nonpoint Source	6.3 Miles	1996	5B	2004
8	Santa Ana Delhi Channel	River & Stream	80111000 / 18070201	• Indicator Bacteria Source Unknown	6.8 Miles	2010	5A	2021
8	Santa Ana River Reach 6	River & Stream	80157000 / 18070203	• Cadmium Source Unknown	27 Miles	2010	5A	2021
				• Copper Source Unknown	27 Miles	2010	5A	2021
				• Lead Source Unknown	27 Miles	2010	5A	2021
8	Santa Ana River, Reach 2	River & Stream	80113000 / 18070201	• Indicator Bacteria Source Unknown	20 Miles	2010	5A	2021
8	Santa Ana River, Reach 3	River & Stream	80121000 / 18070203	• Copper Source Unknown	26 Miles	2010	5A	2021
				The impairment is during the wet season only.				
				• Lead Source Unknown	26 Miles	2010	5A	2021

REGION	WATER BODY NAME	WATER TYPE	WATERSHED CALWATER/ USGS HUC	POLLUTANT POTENTIAL SOURCES	ESTIMATED AREA ASSESSED	FIRST YEAR LISTED	TMDL REQUIREMENT STATUS	DATE
				• Pathogens Dairies	26 Miles	1994	5B	2007
8	Santa Ana River, Reach 4	River & Stream	80127000 / 18070203	• Pathogens Nonpoint Source	14 Miles	1994	5A	2019
8	Santiago Creek, Reach 4	River & Stream	80112000 / 18070203	• Salinity/TDS/Chlorides Source Unknown	9.8 Miles	1996	5A	2019
8	Seal Beach	Coastal & Bay Shoreline	80111000 / 18070201	• Enterococcus Urban Runoff/Storm Sewers	0.53 Miles	2002	5A	2019
				Impaired 50 yards around drain at 1st Street.				
				• PCBs (Polychlorinated biphenyls) Source Unknown	0.53 Miles	2006	5A	2019
8	Serrano Creek	River & Stream	80111000 / 18070201	• Ammonia (Unionized) Source Unknown	7.2 Miles	2010	5A	2021
				• Indicator Bacteria Source Unknown	7.2 Miles	2010	5A	2021
				• pH Source Unknown	7.2 Miles	2010	5A	2021
8	Silverado Creek	River & Stream	80112000 / 18070203	• Pathogens Unknown Nonpoint Source	11 Miles	1998	5A	2019
				• Salinity/TDS/Chlorides Unknown Nonpoint Source	11 Miles	1996	5A	2019

REGION	WATER BODY NAME	WATER TYPE	WATERSHED CALWATER/ USGS HUC	• POLLUTANT • POTENTIAL SOURCES	ESTIMATED AREA ASSESSED	FIRST YEAR LISTED	TMDL REQUIREMENT STATUS	DATE
8	Summit Creek	River & Stream	80171000 / 18070203	• Nutrients Construction/Land Development	1.5 Miles	1998	5A	2008
8	Temescal Creek, Reach 1	River & Stream	80125000 / 18070203	• pH Source Unknown	2.3 Miles	2010	5A	2021
8	Temescal Creek, Reach 6 (Elsinore Groundwater sub basin boundary to Lake Elsinore Outlet)	River & Stream	80135000 / 18070202	• Indicator Bacteria Source Unknown	5.4 Miles	2010	5A	2021

Final California 2020 Integrated Report (303(d) List/305(b) Report)

Supporting Information

Regional Board 8 - Santa Ana Region

Water Body Name: **Santa Ana River, Reach 5**
Water Body ID: **CAR8015200020011107163238**
Water Body Type: **River & Stream**

DECISION ID **73933** **Region 8**

Santa Ana River, Reach 5

Pollutant:	**Alachlor | Atrazine | Azinphos-methyl (Guthion) | Carbaryl | Carbofuran | Chlorpyrifos | DDE (Dichlorodiphenyldichloroethylene) | Diazinon | Dieldrin | Disulfoton | Malathion | Methyl Parathion | Molinate | Simazine | Thiobencarb/Bolero**
Final Listing Decision:	**Do Not List on 303(d) list (TMDL required list)**
Last Listing Cycle's Final Listing Decision:	Do Not List on 303(d) list (TMDL required list)(2016)
Revision Status	Original
Impairment from Pollutant or Pollution:	Pollutant
Regional Board Conclusion:	There was no new data considered in the 2014 Listing Cycle, this previously made decision will carryover. The following description applies to an earlier Listing Cycle. This pollutant is being considered for placement on the section 303(d) list under section 3.1 of the Listing Policy. Under section 3.1 a single line of evidence is necessary to assess listing status. One (1) line of evidence is available in the administrative record to assess this pollutant. None of the samples exceed the water quality objective. Based on the readily available data and information, the weight of evidence indicates that there is sufficient justification against placing this water segment-pollutant combination on the section 303(d) list in the Water Quality Limited Segments category. This conclusion is based on the staff findings that: 1. The data used satisfies the data quality requirements of section 6.1.4 of the Policy. 2. The data used satisfies the data quantity requirements of section 6.1.5 of the Policy. 3. None of eight (8) samples exceeded the US EPA National Recommended Ambient Water Quality Criteria Aquatic Life Protection Instantaneous Maximum

	and this does not exceed the allowable frequency listed in Table 3.1 of the Listing Policy. 4. Pursuant to section 3.11 of the Listing Policy, no additional data and information are available indicating that standards are not met.
Regional Board Decision Recommendation:	This is a decision previously approved by the State Water Resources Control Board and the USEPA. No new data were assessed by the Regional Board for the current. The decision has not changed.
State Board Review of Regional Board Conclusion and Recommendation:	
State Board Decision Recommendation:	After review of this Regional Board decision, SWRCB staff recommend the decision be approved by the State Board.

Line of Evidence (LOE) for Decision ID 73933, Multiple Pollutants **Region 8**

Santa Ana River, Reach 5

LOE ID:	7837
Pollutant:	Alachlor | Atrazine | Azinphos-methyl (Guthion) | Carbaryl | Carbofuran | Chlorpyrifos | DDE (Dichlorodiphenyldichloroethylene) | Diazinon | Dieldrin | Disulfoton | Malathion | Methyl Parathion | Molinate | Simazine | Thiobencarb/Bolero
LOE Subgroup:	Pollutant-Water
Matrix:	Water
Fraction:	None
Beneficial Use:	Warm Freshwater Habitat
Number of Samples:	8
Number of Exceedances:	0
Data and Information Type:	PHYSICAL/CHEMICAL MONITORING
Data Used to Assess Water Quality:	Of the eight samples collected none exceeded the guidelines.
Data Reference:	Concentrations of Pesticides in the waterbodies in the Santa Ana Region
SWAMP Data:	Non-SWAMP
Water Quality Objective/Criterion:	Santa Ana Region¿s Basin Plan Narrative Objective: The concentrations of toxic pollutants in the water column, sediments or biota shall not adversely affect beneficial uses.
Objective/Criterion Reference:	Water Quality Control Plan for the Santa Ana River Basin
Evaluation Guideline:	USEPA National Recommended Ambient Water Quality Criteria Aquatic Life Protection Instantaneous Max - alachlor: 76 ppb, atrazine: 1 ppb, azinphos methyl: 0.01 ppb, carbaryl: 0.02 ppb, disulfoton: 0.05 ppb, simazine: 10 ppb, carbofuran: 0.5 ppb. California Department of Fish and Game: chlropyrifos: 0.014 ppb, parathion: 0.08 ppb, permethrin: 0.03 ppb, diazinon: 0.08 ppb. CTR Freshwater aquatic life protection Cont Conc 4 day ave - dieldrin: 0.056 ppb, DDE: 0.001 ppb,

Guideline Reference:	National recommended water quality criteria: 2002. EPA-822-R-02-047 Washington, D.C. USEPA
Guideline Reference:	Compilation of Water Quality Goals
Guideline Reference:	Water quality criteria for diazinon and chlorpyrifos. Administrative Report 00-3. Rancho Cordova, CA: Pesticide Investigations Unit, Office of Spills and Response. CA Department of Fish and Game
Guideline Reference:	Water Quality Standards 2000. Establishment of numeric criteria for priority toxic pollutants for the State of California: Rules and regulations. Federal Register Vol. 65, No. 97. Washington, D.C.: Environmental Protection Agency
Spatial Representation:	Santa Ana River Near Mentone California_USGS NAWQA site
Temporal Representation:	2/20/01, 3/22/01, 4/16/01, 5/17/01, 6/14/01, 7/10/01, 8/13/01, 9/13/01.
Environmental Conditions:	
QAPP Information:	The data's quality is deemed appropriate because it came from the Department of Pesticide Regulation.
QAPP Information Reference(s):	

DECISION ID **94268** **Region 8**

Santa Ana River, Reach 5

Pollutant:	**Chloride**
Final Listing Decision:	**Do Not List on 303(d) list (TMDL required list)**
Last Listing Cycle's Final Listing Decision:	Do Not List on 303(d) list (TMDL required list)(2016)
Revision Status	Original
Impairment from Pollutant or Pollution:	Pollutant

Regional Board Conclusion:

This pollutant is being considered for placement on the CWA section 303(d) List under section 3.1of the Listing Policy. Under section 3.1 a single line of evidence are necessary to assess listing status.

One (1) line of evidence is available in the administrative record to assess this pollutant. One (1) of the one sample exceed the OBJECTIVE.

Based on the readily available data and information, the weight of evidence indicates that there is sufficient justification against placing this water segment-pollutant combination on the CWA section 303(d) List.

This conclusion is based on the staff findings that:
1. The data used satisfies the data quality requirements of section 6.1.4 of the Policy.
2. The data used satisfies the data quantity requirements of section 6.1.5 of the Policy.
3. One (1) of one sample exceeded the OBJECTIVE and this sample size is insufficient to determine, with the power and confidence of the Listing Policy, the applicable beneficial use support rating. A minimum of 16 samples is needed to determine if a beneficial use is fully supported using table 3.1.
4. Pursuant to SECTION 3.11 of the Listing Policy, no additional data and information are available indicating that standards are not met.

Regional Board Decision After review of the available data and information, RWQCB staff concludes that the

Recommendation:	water body-pollutant combination should not be placed on the section 303(d) list. The readily available data and information is insufficient to determine, with the power and confidence of the Listing Policy, the applicable beneficial use support rating.
State Board Review of Regional Board Conclusion and Recommendation:	
State Board Decision Recommendation:	After review of this Regional Board decision, SWRCB staff recommend the decision be approved by the State Board.

Line of Evidence (LOE) for Decision ID 94268, Chloride **Region 8**

Santa Ana River, Reach 5

LOE ID:	82359
Pollutant:	Chloride
LOE Subgroup:	Pollutant-Water
Matrix:	Water
Fraction:	Total Dissolved
Beneficial Use:	Warm Freshwater Habitat
Number of Samples:	1
Number of Exceedances:	1
Data and Information Type:	PHYSICAL/CHEMICAL MONITORING
Data Used to Assess Water Quality:	Numeric data generated from 1 sample collected had 1 exceedence of the site-specific objective.
Data Reference:	Data for Various Pollutants in the Streams of Region 8, 2009.
SWAMP Data:	Non-SWAMP
Water Quality Objective/Criterion:	The site-pecific objective for Chloride at Santa Ana River Reach 5 according to table 4-1 of the Santa Ana Basin plan is 20 mg/L.
Objective/Criterion Reference:	Water Quality Control Plan, Santa Ana River Basin
Evaluation Guideline:	
Guideline Reference:	
Spatial Representation:	Data was collected from the SMCR8_572 station.
Temporal Representation:	Data was collected on the following dates: 6/30/2009
Environmental Conditions:	
QAPP Information:	The data was analyzed by CSULB and follows California's Surface Water Ambient Monitoring Program protocols. No QAPP provided.
QAPP Information Reference(s):	

Pollutant:	**Sulfates**
Final Listing Decision:	**Do Not List on 303(d) list (TMDL required list)**
Last Listing Cycle's Final Listing Decision:	Do Not List on 303(d) list (TMDL required list)(2016)
Revision Status	Original
Impairment from Pollutant or Pollution:	Pollutant

Regional Board Conclusion:

This pollutant is being considered for placement on the CWA section 303(d) List under section 3.1 of the Listing Policy. Under section 3.1, a single line of evidence is necessary to assess listing status.

One (1) lines of evidence is available in the administrative record to assess this pollutant. One (1) of the one (1) sample exceeds the water quality objective.

Based on the readily available data and information, the weight of evidence indicates that there is sufficient justification against placing this water segment-pollutant combination on the CWA section 303(d) List.

This conclusion is based on the staff findings that:
1. The data used satisfies the data quality requirements of section 6.1.4 of the Policy.
2. The data used satisfies the data quantity requirements of section 6.1.5 of the Policy.
3. One (1) of the one (1) sample exceeds the water quality objective and this sample size is insufficient to determine, with the power and confidence of the Listing Policy, the applicable beneficial use support rating. A minimum of 16 samples is needed to determine if a beneficial use is fully supported using table 3.1.
4. Pursuant to section 3.11 of the Listing Policy, no additional data and information are available indicating that standards are not met.

Regional Board Decision Recommendation:

After review of the available data and information, RWQCB staff concludes that the water body-pollutant combination should not be placed on the section 303(d) list. The readily available data and information is insufficient to determine, with the power and confidence of the Listing Policy, the applicable beneficial use support rating.

State Board Review of Regional Board Conclusion and Recommendation:

State Board Decision Recommendation:

After review of this Regional Board decision, SWRCB staff recommend the decision be approved by the State Board.

Line of Evidence (LOE) for Decision ID 95161, Sulfates **Region 8**

Santa Ana River, Reach 5

LOE ID:	82360
Pollutant:	Sulfates
LOE Subgroup:	Pollutant-Water

Matrix:	Water
Fraction:	Total Dissolved
Beneficial Use:	Warm Freshwater Habitat
Number of Samples:	1
Number of Exceedances:	1
Data and Information Type:	PHYSICAL/CHEMICAL MONITORING
Data Used to Assess Water Quality:	Numeric data generated from 1 sample collected had 1 exceedence of the site-specific objective.
Data Reference:	Data for Various Pollutants in the Streams of Region 8, 2009.
SWAMP Data:	Non-SWAMP
Water Quality Objective/Criterion:	The objectives listed in Table 4-1 shall not be exceeded as a result of controllable water quality factors. The site-specific objective for Sulfates at Santa Ana River, Reach 5 according to table 4-1 of the Santa Ana Basin plan is 60 mg/L.
Objective/Criterion Reference:	Water Quality Control Plan, Santa Ana River Basin
Evaluation Guideline:	
Guideline Reference:	
Spatial Representation:	Data was collected from the SMCR8_572 station.
Temporal Representation:	Data was collected on the following dates: 6/30/2009.
Environmental Conditions:	
QAPP Information:	The data was analyzed by CSULB and follows California's Surface Water Ambient Monitoring Program protocols. No QAPP provided.
QAPP Information Reference(s):	

DECISION ID **96158** **Region 8**

Santa Ana River, Reach 5

Pollutant:	**Toxicity**
Final Listing Decision:	**Do Not List on 303(d) list (TMDL required list)**
Last Listing Cycle's Final Listing Decision:	Do Not List on 303(d) list (TMDL required list)(2016)
Revision Status	Original
Impairment from Pollutant or Pollution:	Pollutant
Regional Board Conclusion:	This pollutant is being considered for placement on the CWA section 303(d) List under section 3.6 of the Listing Policy. Under section 3.6 at least one line of evidence is necessary to assess listing status for toxicity, and waters may be placed on the CWA section 303(d) List for toxicity alone. One line of evidence is available in the administrative record to assess this pollutant. Zero of the 1 samples exhibit water toxicity. Based on the readily available data and information, the weight of evidence indicates that there is sufficient justification against placing this water segment-pollutant combination on the CWA section 303(d) List.

This conclusion is based on the staff findings that:
1. The data used satisfies the data quality requirements of section 6.1.4 of the Policy.
2. The data used satisfies the data quantity requirements of section 6.1.5 of the Policy.
3. Zero of the 1 samples exhibit water toxicity and this sample size is insufficient to determine, with the power and confidence of the Listing Policy, the applicable beneficial use support rating. A minimum of 16 samples is needed to determine if a beneficial use is fully supported using table 3.1.
4. Pursuant to SECTION 3.11 of the Listing Policy, no additional data and information are available indicating that standards are not met.

Regional Board Decision Recommendation: After review of the available data and information, RWQCB staff concludes that the water body-pollutant combination should not be placed on the section 303(d) list. The readily available data and information is insufficient to determine, with the power and confidence of the Listing Policy, the applicable beneficial use support rating.

State Board Review of Regional Board Conclusion and Recommendation:

State Board Decision Recommendation: After review of this Regional Board decision, SWRCB staff recommend the decision be approved by the State Board.

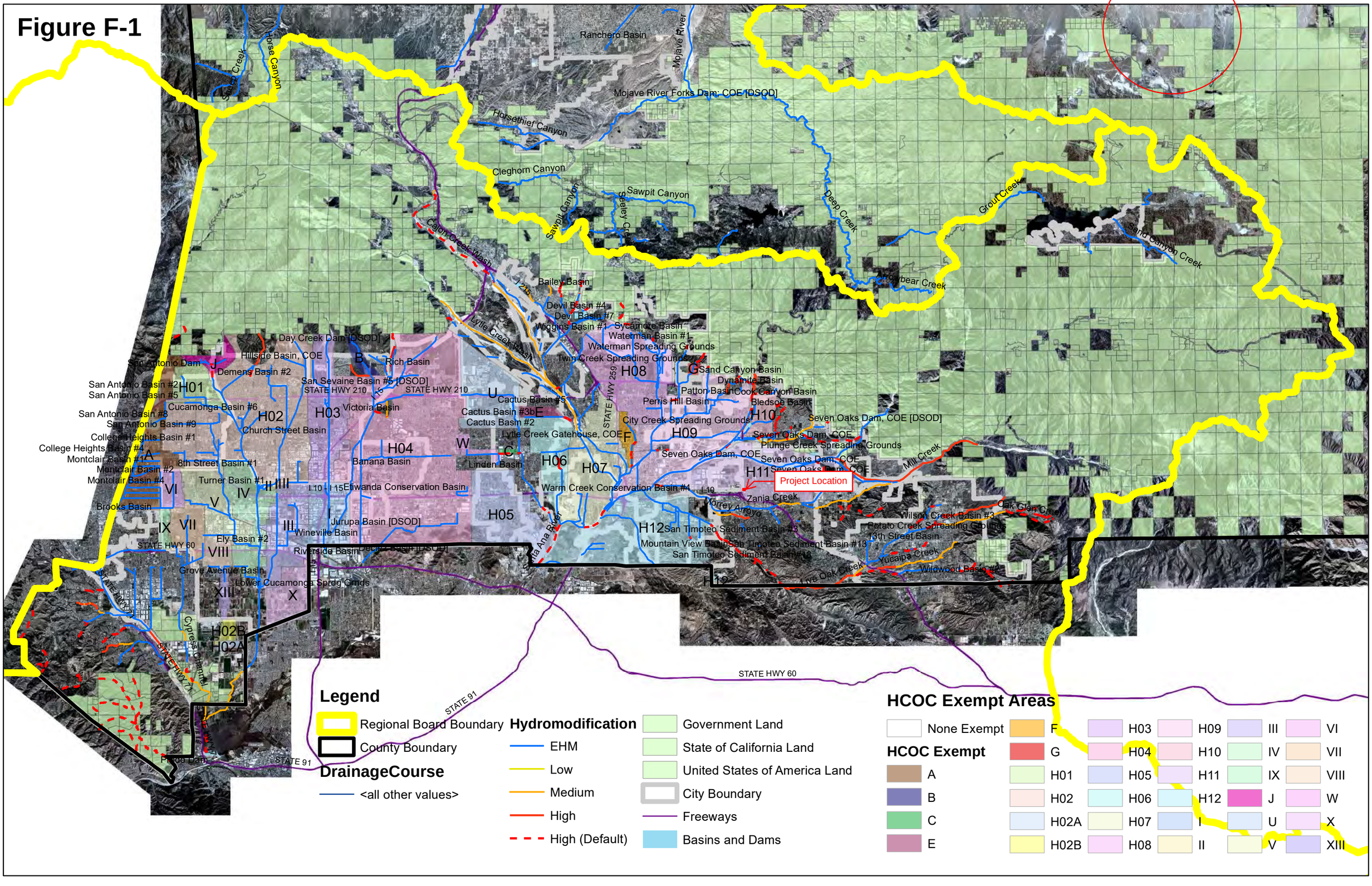
Line of Evidence (LOE) for Decision ID 96158, Toxicity **Region 8**

Santa Ana River, Reach 5

LOE ID:	82361
Pollutant:	Toxicity
LOE Subgroup:	Toxicity
Matrix:	Water
Fraction:	None
Beneficial Use:	Warm Freshwater Habitat
Number of Samples:	1
Number of Exceedances:	0
Data and Information Type:	TOXICITY TESTING
Data Used to Assess Water Quality:	One sample was collected to evaluate water toxicity. The one sample did not exhibit significant toxicity. The toxicity tests included survival and reproduction of Ceriodaphnia dubia.
Data Reference:	Data for Various Pollutants in the Streams of Region 8, 2009.
SWAMP Data:	Non-SWAMP
Water Quality Objective/Criterion:	Toxic substances shall not be discharged at levels that will bioaccumulate in aquatic resources to levels which are harmful to human health. Region 8 Basin Plan.

Objective/Criterion Reference:	Water Quality Control Plan, Santa Ana River Basin
Evaluation Guideline:	Toxicity is defined as a statistically significant effect in the sample exposure compared to the control using EPA-recommended hypothesis testing. The t-test is used to determine if there is a statistically significant decrease in organism response in the sample as compared to the control.
Guideline Reference:	Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms. Fourth Edition. Office of Water, U.S. Environmental Protection Agency. Washington, D.C. EPA-821-R-02-013
Spatial Representation:	The samples were collected in Santa Ana River, Reach 5 at this site SMCR8_572.
Temporal Representation:	The samples were collected in June 2009.
Environmental Conditions:	
QAPP Information:	The data was analyzed by CSULB and follows California's Surface Water Ambient Monitoring Program protocols. No QAPP provided.
QAPP Information Reference(s):	

Figure F-1



Legend

- Regional Board Boundary
- County Boundary

DrainageCourse

- <all other values>

Hydromodification

- EHM
- Low
- Medium
- High
- High (Default)

- Government Land
- State of California Land
- United States of America Land
- City Boundary
- Freeways
- Basins and Dams

HCOC Exempt Areas

- None Exempt

HCOC Exempt

A, B, C, E, F, G, H01, H02, H02A, H02B, H03, H04, H05, H06, H07, H08, H09, H10, H11, H12, I, II, III, IV, V, VI, VII, VIII, IX, J, U, W, X, XIII

Hydromodification

A.1 Hydrologic Conditions of Concern (HCOC) Analysis

HCOC Exemption:

1. **Sump Condition:** All downstream conveyance channel to an adequate sump (for example, Prado Dam, Santa Ana River, or other Lake, Reservoir or naturally erosion resistant feature) that will receive runoff from the project are engineered and regularly maintained to ensure design flow capacity; no sensitive stream habitat areas will be adversely affected; or are not identified on the Co-Permittees Hydromodification Sensitivity Maps.

2. **Pre = Post**: The runoff flow rate, volume and velocity for the post-development condition of the Priority Development Project do not exceed the pre-development (i.e, naturally occurring condition for the 2-year, 24-hour rainfall event utilizing latest San Bernardino County Hydrology Manual.

    a. Submit a substantiated hydrologic analysis to justify your request.

3. **Diversion to Storage Area**: The drainage areas that divert to water storage areas which are considered as control/release point and utilized for water conservation.

    a. See Appendix F for the HCOC Exemption Map and the on-line Watershed Geodatabase (http://sbcounty.permitrack.com/wap) for reference.

4. **Less than One Acre**: The Priority Development Project disturbs less than one acre. The Co-permittee has the discretion to require a Project Specific WQMP to address HCOCs on projects less than one acre on a case by case basis. The project disturbs less than one acre and is not part of a common plan of development.

5. **Built Out Area**: The contributing watershed area to which the project discharges has a developed area percentage greater than 90 percent.

    a. See Appendix F for the HCOC Exemption Map and the on-line Watershed Geodatabase (http://sbcounty.permitrack.com/wap) for reference.

Summary of HCOC Exempted Area

	HCOC Exemption reasoning				
	1	2	3	4	5
Area					
A			X		X
B			X		
C					X
E			X		
F					X
G			X		X
H01	X		X		
H02	X		X		
H02A	X		X		
H02B			X		
H03			X		
H04	X		X		
H05	X				
H06			X		
H07	X				
H08	X		X		
H09	X				
H10	X		X		
H11	X		X		
H12	X				
J			X		
U			X		
W			X		
I			X		
II			X		
III					X
IV			X		X
V			X*		
VI					X
VII					X
VIII			X		
IX					X
X			X		
XIII			X		

*Detention/Conservation Basin

Section 6.4.3

Geotechnical Report

PETRA GEOSCIENCES INC.

SOLID AS A ROCK

ENGINEERS + GEOLOGISTS + ENVIRONMENTAL SCIENTISTS

DESIGN-LEVEL GEOTECHNICAL EVALUATION RESIDENTIAL PORTION OF THE PROPOSED LPA REDLANDS PROJECT 16-ACRES± LOCATED AT THE SE CORNER OF TENNESSEE STREET AND FUTURE PENNSYLVANIA AVENUE CITY OF REDLANDS, SAN BERNARDINO COUNTY, CALIFORNIA

DIVERSIFIED PACIFIC COMMUNITIES

February 15, 2022
J.N. 21-458

February 15, 2022
J.N. 21-458

DIVERSIFIED PACIFIC COMMUNITIES
10621 Civic Center Drive
Rancho Cucamonga, California 91730

Attention: Mr. Nolan C. Leggio

Subject: **Design-Level Geotechnical Evaluation, Residential Portion of the Proposed *LPA Redlands Project,* 16-Acre± Site Located at the SEC of Tennessee Street and Future Pennsylvania Avenue, City of Redlands, San Bernardino County, California**

Dear Mr. Leggio:

Petra Geosciences, Inc. (Petra) is submitting herewith our design level geotechnical evaluation report for the residential portion of the proposed LPA Redlands project located at the southeast corner of Tennessee Street and future Pennsylvania Avenue in the city of Redlands, San Bernardino County, California. This evaluation does not include the 8-acre± commercial portion of the LPA Redlands project located to the south at the northeast corner of Tennessee Street and W. Lugonia Avenue. This work was performed in general accordance with the scope of work outlined in our Revised Proposal No. 21-458P dated December 21, 2021. This report presents the results of our current field explorations, infiltration evaluation, the requirements of the 2019 California Building Code (CBC) and our engineering judgment, opinions, conclusions, and recommendations pertaining to geotechnical design aspects for the proposed development.

It has been a pleasure to be of service to you on this project. Should you have questions regarding the contents of this report or should you require additional information, please contact this office.

Respectfully submitted,

PETRA GEOSCIENCES, INC.

Edward Lump, CEG
Associate Geologist

Grayson R. Walker, GE
Principal Engineer

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DESIGN-LEVEL GEOTECHNICAL EVALUATION
RESIDENTIAL PORTION OF THE PROPOSED LPA REDLANDS PROJECT
16-ACRES± LOCATED AT THE SOUTHEAST CORNER OF TENNESSEE STREET AND FUTURE PENNSYLVANIA AVENUE
CITY OF REDLANDS, SAN BERNARDINO COUNTY, CALIFORNIA

INTRODUCTION

Petra Geosciences, Inc. (Petra) is presenting herein the results of our design level geotechnical evaluation of the subject 16±-acre undeveloped property. Our geotechnical evaluation included a review of regional geological maps published by the California Geological Survey (CGS) and other sources that encompass the site, including review of limited historic aerial photos (EDR, 1938-2016) and online imagery (Google Earth Imagery, 1994-2021) in proximity of the project site. The current phase of work included the drilling of four exploratory borings and three infiltration test borings within the proposed residential portion of the LPA Redlands project. No subsurface exploration was conducted in the proposed commercial portion of the project located directly south of the subject site.

PURPOSE AND SCOPE OF SERVICES

The purposes of this geotechnical evaluation were to obtain information on the subsurface geologic and soil conditions within the project area, assess infiltration rates (locations and depths chosen by the design civil engineer), evaluate the field and laboratory data, and provide conclusions and recommendations for design and construction of the proposed building and other site improvements as influenced by the subsurface conditions.

The scope of our recent evaluation consisted of the following:

- Reconnaissance of the site to evaluate existing conditions, mark-out borings for DigAlert notification, and contact DigAlert.
- Review of available published and unpublished data and maps concerning geologic and soil conditions within and adjacent to the site, which could have an impact on the proposed improvements.
- Excavation of a total of seven exploratory borings, utilizing a truck-mounted hollow-stem auger drill rig, to evaluate the stratigraphy of the subsurface soils and collect representative undisturbed and bulk samples for laboratory testing. Three of the borings were subsequently utilized as percolation test borings to measure infiltration rates.
- Log and visually classify soil materials encountered in the borings in accordance with the Unified Soil Classification System.
- Conduct laboratory testing of representative samples (bulk and undisturbed) obtained from the hollow-stem auger borings to determine their engineering properties.

- Perform engineering and geologic analysis of the data with respect to the proposed improvements.

- Preparation of this report, including pertinent figures and appendices, presenting the results of our evaluation and recommendations for the proposed improvements in general conformance with the requirements of the 2019 California Building Code (CBC), as well as in accordance with applicable local jurisdictional requirements.

SITE LOCATION

The subject property, designated as the residential portion of the LPA Redlands project, is located north of W. Lugonia Avenue at the southeast corner of S. Tennessee Street, and the future extension of Pennsylvania Avenue in the city of Redlands, San Bernardino County, California. Overall, the *LPA Redlands Project* consists of approximately 16 acres of residential development on the north and approximately 8 acres of commercial development on the south. No physical markers designated the site boundary on the north, east and south. Vacant agricultural land is situated to the north, east and south. Tennessee Street bounds the subject property on the west, with a drainage channel and the 210 Freeway beyond. A site location map is included as Figure 1.

SITE DESCRIPTION

The subject site is comprised of vacant land within a portion of contiguous Assessor Parcel Numbers (APN's) 0167-171-07, -11, -12, and -14. The site slopes gently to the west with existing elevations on the order of approximately 1,280± feet above mean sea level (msl) along the west portion of the site, to 1,290± feet above msl along the east portion of the site.

Vehicular access to the subject property is via S. Tennessee Street, which is an improved road along the western boundary of the site. Secondary access is via a dirt road (future Pennsylvania Avenue) along the northern boundary of the subject property, with vacant land beyond. South of the subject property is vacant land comprising the commercial portion of the LPA Redlands Project (not a part of this assessment) with W. Lugonia Avenue beyond. To the east is a dirt road, with vacant land and a residential tract beyond. The surface of the subject property is slightly hummocky, consisting of loose silty sands and sands with a sparse growth of weeds. Minor amounts of exposed cobbles and concrete fragments were observed.

Based on aerial photographic information obtained (DER, 2021), the site appears to have been used for agricultural purposes use since at least 1938 until sometime between/during 1994 and 2002. Between 1975 and 1985, the orchards were removed from the subject property and replaced with irrigated crops. Between 1994 and 2002, the subject site appeared to be fallow land and has remained vacant land to present day.

Historical information reviewed during this assessment includes aerial photographs dating back to 1938 and USGS topographical maps dating back to 1899 (EDR, 2021).

PROPOSED DEVELOPMENT

Petra was provided with a Conceptual Land Use-Site Plan by AO Architects (plot-dated October 25, 2021) depicting 14, three-story apartment buildings, leasing/club/fitness center, pool and cabana area, and interior drive isles and parking areas. Access to the apartment complex area is proposed via Tennessee Street and future Pennsylvania Avenue. A boundary is proposed between the north residential area and the south commercial area of the project. Based upon percolation test borings request by the design civil engineer, some sort of near surface or subsurface water quality structures are proposed for the western portion of subject residential development.

It is expected that the buildings will be of wood-frame construction supported on conventional slab-on-ground foundations. Appurtenant structures will likely include paved access streets and driveways, concrete patio-type slabs and walkways, masonry block walls, surface and subsurface drainage control devices, landscaped areas, and above- and below-ground utilities Given the relatively level topography within the proposed development, earthwork within the site is generally expected to entail minor cuts and fills up to approximately 5 feet, except for water quality structures. It should be noted, however, that the ultimate amount of fill required throughout the project will be greater than the calculated raw yardage, due to the required remedial grading (i.e., removal and re-compaction of existing unsuitable surficial soils).

Literature Review

Petra was not provided geotechnical reports for review pertaining to the subject property by the client. Petra researched and reviewed available published and unpublished geologic data pertaining to regional geology, groundwater, faulting and geologic hazards that may affect the site. The results of this review are discussed under the Findings and Conclusions sections presented in this report.

Subsurface Exploration

A subsurface exploration program was performed by an engineering geologist from Petra on January 6, 2022. The exploration involved the drilling of four exploratory borings (B-1 through B-4) to a maximum depth of approximately 51.5 feet below existing grade (bgs). Additionally, three test borings (P-1 through P-3), drilled to a maximum depth of approximately 15 or 25 feet bgs, were sampled and logged prior to conversation to percolation test holes. Earth materials encountered within the seven exploratory borings were classified and logged by a professional geologist in accordance with the visual-manual procedures of

the Unified Soil Classification System. The approximate locations of the exploratory borings are shown on Figure 2 (Field Exploration Map). The boring logs are presented in Appendix A.

Disturbed bulk samples and relatively undisturbed ring samples of soil materials were collected for classification, laboratory testing and engineering analyses. Undisturbed samples were obtained using a 3-inch outside diameter modified California split-spoon soil sampler lined with brass rings. The soil sampler was driven with successive 30-inch drops of a free-fall, 140-pound automatic trip hammer. The central portions of the driven-core samples were placed in sealed containers and transported to our laboratory for testing. The number of blows required to drive the split-spoon sampler 18 inches into the soil were recorded for each 6-inch driving increment; however, the number of blows required to drive the sampler for the final 12 inches was noted in the boring logs as *Blows per Foot*.

Standard Penetration Tests (SPT) were also performed at selected depth intervals in accordance with ASTM D 1586. This method consists of mechanically driving an unlined, 2.5-inch outside diameter (OD) standard split-barrel sampler 18 inches into the soil with successive 30-inch drops of the 140-pound automatic trip hammer. Blow counts for each 6-inch driving increment were recorded on the exploration logs. The number of blows required to drive the standard split-spoon sampler for the last 12 of the 18 inches was identified as the uncorrected standard penetration resistance (N). Disturbed soil samples from the unlined standard split-spoon samplers were placed in sealed plastic bags and transported to our laboratory for testing.

Laboratory Testing

In-situ dry density and moisture content, maximum dry density and optimum moisture content, expansion index, consolidation and collapse potential, corrosivity (sulfate and chloride content, pH, and resistivity), and shear strength for selected samples of onsite soils materials was conducted. A description of laboratory test methods and summaries of the laboratory test data are presented in Appendix B. The in-site dry density and moisture content results are presented on the boring logs (Appendix A).

FINDINGS

Regional Geologic Setting

The site lies within the northern portion of the Peninsular Ranges Geomorphic Province (CGS, 2002). The Peninsular Range Province extends from the tip of Baja California north to the Transverse Ranges Geomorphic Province and is characterized by northwest trending mountain ranges separated by subparallel fault zones. The San Bernardino Mountains, located on the north side of the valley, provides the boundary between the Peninsula Range Province and the Transverse Ranges Province. In general, the province is

underlain primarily of plutonic rock of the Southern California Batholith. These rocks formed from the cooling of molten magma deep within the earth's crust. Intense heat associated with the plutonic magma metamorphosed the ancient sedimentary rocks into which the plutons intruded. The Peninsular Range Geomorphic Province is generally characterized by alluviated basins and elevated erosion surfaces.

More specifically, the subject site is mapped as middle-Holocene Young Axial-Valley Deposits, Unit 3 (Matti, Morton, Cox, and Kendrick 2003). These soils are described as unconsolidated to moderately consolidated silt, sand, and gravel deposits. Where encountered in borings on the subject property, alluvial soils consisted of moist to slightly moist, loose to medium dense, silty fine- to course-grain sand. No groundwater was encountered to the maximum depth of our borings (51.5 feet).

The site does not lie within an Alquist-Priolo Earthquake Fault Zone (Bryant and Hart, 2007) or a San Bernardino County Geologic Hazards Zone (San Bernardino County, 2009).

Local Geology and Subsurface Soil Conditions

Earth units encountered onsite consisted of disturbed topsoil and young alluvial deposits. The site is covered by approximately 2 to 3 feet of topsoil and disturbed alluvium generally consisting of loose, moist, silty sands. Below the topsoil, alluvial deposits were observed to consist predominately of olive gray/gray brown/gray, moist to slightly moist, loose to medium dense, silty fine- to medium-grain sand. Interbeds of coarse-grain sand and gravels were observed. Moist surficial soils were likely due to recent precipitation. Generally, the upper four to five feet of soils encountered within the subject property were loose. Logs of exploratory borings are presented in Appendix A and boring locations are presented on the Geotechnical Map (Figure 2).

Groundwater

The site is located within the San Bernardino Sub-Basin of the Bunker Hill (8-002.06) Groundwater Basin. The site and vicinity are located within the upper Santa Ana Valley Basin of the South Coast Hydrologic Region (California Department of Water Resources, [CDWR], 2003). In general, groundwater depth varies within the area and, though flow direction specifically beneath the subject property is unknown, it is reasonable to estimate flow to follow regional topography from east to the west–southwest. The high groundwater depth within the site vicinity, between 1973 and 1983, is reported to be approximately 95 feet below the ground surface (Matti and Carson, 1991). Groundwater was not encountered in any of our geotechnical borings drilled to a maximum depth of 51.5 feet bgs.

Groundwater depths in wells located in the vicinity of the subject property were reviewed on the California Department of Water Resources website (DWR, 2021). No public or municipal wells were mapped within the property. The closest well in alluvial areas is located east of the property in Texonia Park on Texas Street and reports depths greater than 170 feet since January 2012. The memorandum documenting this inquiry is included in Appendix B.

Data from groundwater measured in Spring 2021 (Tetra Tech, 2021) reported a depth of approximately 194 feet below the ground surface in two monitoring wells approximately 1,700 feet east of the subject property.

Groundwater in the central portion of the Bunker Hill Groundwater Basin occurs under unconfined water table conditions; however, groundwater along the western portion occurs under confined conditions (Tetra Tech, 2015). The basin contains three hydro stratigraphic units defined as containing productive water-bearing units. In the central basin (where the subject site is located), groundwater flow within the middle aquifer is in a west to southwesterly direction towards Colton Narrows. The Basin boundary between the Bunker Hill and Colton-Rialto is the San Jacinto Fault. Colton Narrows is an alluvium- and gouge-filled notch within the fault zone that allows surface water and shallow groundwater to exit the Bunker Hill Basin and enter the Colton-Rialto Basin. Deeper groundwater is inhibited from flowing through the fault zone.

Faulting

Based on our review of the referenced geologic maps and literature, no active faults are known to project through the property. Furthermore, the site does not lie within the boundaries of an "Earthquake Fault Zone" as defined by the State of California in the Alquist-Priolo Earthquake Fault Zoning Act (CGS, 2018). The Alquist-Priolo Earthquake Fault Zoning Act (AP Act) defines an *active fault* as one that "has had surface displacement within Holocene time (about the last 11,000 years)." The main objective of the AP Act is to prevent the construction of dwellings on top of active faults that could displace the ground surface resulting in loss of life and property.

However, it should be noted that according to the USGS Unified Hazard Tool website and/or 2010 CGS Fault Activity Map of California, the San Bernardino segment of the San Jacinto Fault zone, located approximately 6.75 kilometers (4.2± miles) southwest of the site, would probably generate the most severe site ground motions and, therefore, is the majority contributor to the deterministic minimum component of the ground motion models. The subject site is located at less than 5 miles (8 km) from the surface projection of this fault system, which is capable of producing a magnitude 8.02 or larger events with a slip rate along the fault greater than 0.04 inch per year. As such, the site should be considered as a **Near-Fault Site** in accordance with ASCE 7-16, Section 11.4.1.

Seismic Design Parameters

Earthquake loads on earthen structures and buildings are a function of ground acceleration which may be determined from the site-specific ground motion analysis. Alternatively, a design response spectrum can be developed for certain sites based on the code guidelines. To provide the design team with the parameters necessary to construct the design acceleration response spectrum for this project, we used two computer applications. Specifically, the first computer application, which was jointly developed by Structural Engineering Association of California (SEAOC) and California's Office of Statewide Health Planning and Development (OSHPD), the SEA/OSHPD Seismic Design Maps Tool website, https://seismicmaps.org, is used to calculate the ground motion parameters. The second computer application, the United Stated Geological Survey (USGS) Unified Hazard Tool website, https://earthquake.usgs.gov/hazards/interactive/, is used to estimate the earthquake magnitude and the distance to surface projection of the fault.

To run the above computer applications, site latitude and longitude, seismic risk category and knowledge of site class are required. The site class definition depends on the direct measurement and the ASCE 7-16 recommended procedure for calculating average small-strain shear wave velocity, Vs30, within the upper 30 meters (approximately 100 feet) of site soils.

A seismic risk category of II was assigned to the proposed buildings in accordance with 2019 CBC, Table 1604.5. No shear wave velocity measurement was performed at the site, however, the subsurface materials at the site appears to exhibit the characteristics of stiff soils condition for Site Class D designation. Therefore, an average shear wave velocity of 259 meters per second (850 feet per second) for the upper 100 feet was assigned to the site based on engineering judgment and geophysical experience. As such, in accordance with ASCE 7-16, Table 20.3-1, Site Class D (D- Default as per SEA/OSHPD software) has been assigned to the subject site.

The following table, Table 1, provides parameters required to construct the seismic response coefficient, C_s, curve based on ASCE 7-16, Article 12.8 guidelines. A printout of the computer output is attached in Appendix C.

TABLE 1

Seismic Design Parameters

Ground Motion Parameters	Specific Reference	Parameter Value	Unit
Site Latitude (North)	-	34.0726	°
Site Longitude (West)	-	-117. 1987	°
Site Class Definition	Section 1613.2.2 (1), Chapter 20 (2)	D-Default(4)	-
Assumed Seismic Risk Category	Table 1604.5 (1)	II	-
M_w - Earthquake Magnitude	USGS Unified Hazard Tool (3)	8.02 (3)	-
R – Distance to Surface Projection of Fault	USGS Unified Hazard Tool (3)	6.75 (3)	km
S_s - Mapped Spectral Response Acceleration Short Period (0.2 second)	Figure 1613.2.1(1) (1)	1.831 (4)	g
S_1 - Mapped Spectral Response Acceleration Long Period (1.0 second)	Figure 1613.2.1(2) (1)	0.73 (4)	g
F_a – Short Period (0.2 second) Site Coefficient	Table 1613.2.3(1) (1)	1.2 (4)	-
F_v – Long Period (1.0 second) Site Coefficient	Table 1613.2.3(2) (1)	Null (4)	-
S_{MS} – MCE_R Spectral Response Acceleration Parameter Adjusted for Site Class Effect (0.2 second)	Equation 16-36 (1)	2.197 (4)	g
S_{M1} - MCE_R Spectral Response Acceleration Parameter Adjusted for Site Class Effect (1.0 second)	Equation 16-37 (1)	Null (4)	g
S_{DS} - Design Spectral Response Acceleration at 0.2-s	Equation 16-38 (1)	1.464 (4)	g
S_{D1} - Design Spectral Response Acceleration at 1-s	Equation 16-39 (1)	Null (4)	g
$T_o = 0.2\ S_{D1}/\ S_{DS}$	Section 11.4.6 (2)	Null	s
$T_s = S_{D1}/\ S_{DS}$	Section 11.4.6 (2)	Null	s
T_L - Long Period Transition Period	Figure 22-14 (2)	8 (4)	s
PGA - Peak Ground Acceleration at MCE_G (*)	Figure 22-9 (2)	0.767	g
F_{PGA} - Site Coefficient Adjusted for Site Class Effect (2)	Table 11.8-1 (2)	1.2 (4)	-
PGA_M –Peak Ground Acceleration (2) Adjusted for Site Class Effect	Equation 11.8-1 (2)	0.92 (4)	g
Design PGA ≈ (⅔ PGA_M) - Slope Stability (†)	Similar to Eqs. 16-38 & 16-39 (2)	0.613	g
Design PGA ≈ (0.4 S_{DS}) – Short Retaining Walls (‡)	Equation 11.4-5 (2)	0.586	g
C_{RS} - Short Period Risk Coefficient	Figure 22-18A (2)	0.917 (4)	-
C_{R1} - Long Period Risk Coefficient	Figure 22-19A (2)	0.891 (4)	-
SDC - Seismic Design Category (§)	Section 1613.2.5 (1)	Null (4)	-

References:
(1) California Building Code (CBC), 2019, California Code of Regulations, Title 24, Part 2, Volume I and II.
(2) American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI), 2016, Minimum Design Loads and Associated Criteria for Buildings and Other Structures, Standards 7-16.
(3) USGS Unified Hazard Tool - https://earthquake.usgs.gov/hazards/interactive/
(4) SEI/OSHPD Seismic Design Map Application – https://seismicmaps.org

Related References:
Federal Emergency Management Agency (FEMA), 2015, NEHERP (National Earthquake Hazards Reduction Program) Recommended Seismic Provision for New Building and Other Structures (FEMA P-1050).

Notes:
* PGA Calculated at the MCE return period of 2475 years (2 percent chance of exceedance in 50 years).
† PGA Calculated at the Design Level of ⅔ of MCE; approximately equivalent to a return period of 475 years (10 percent chance of exceedance in 50 years).
‡ PGA Calculated for short, stubby retaining walls with an infinitesimal (zero) fundamental period.
§ The designation provided herein may be superseded by the structural engineer in accordance with Section 1613.2.5.1, if applicable.

Discussion - General

Owing to the characteristics of the subsurface soils, as defined by Site Class D-Default designation, and proximity of the site to the sources of major ground shaking, the site is expected to experience strong ground shaking during its anticipated life span. Under these circumstances, where the code-specified design response spectrum may not adequately characterize site response, the 2019 CBC typically requires a site-specific seismic response analysis to be performed. This requirement is signified/identified by the "null" values that are output using SEA/OSHPD software in determination of short period, but mostly, in determination of long period seismic parameters, see Table 1.

For conditions where a "null" value is reported for the site, a variety of design approaches are permitted by 2019 CBC and ASCE 7-16 in lieu of a site-specific seismic hazard analysis. For any specific site, these alternative design approaches, which include Equivalent Lateral Force (ELF) procedure, Modal Response Spectrum Analysis (MRSA) procedure, Linear Response History Analysis (LRHA) procedure and Simplified Design procedure, among other methods, are expected to provide results that may or may not be more economical than those that are obtained if a site-specific seismic hazards analysis is performed. These design approaches and their limitations should be evaluated by the project structural engineer.

Discussion – Seismic Design Category

Please note that the Seismic Design Category, SDC, is also designated as "null" in Table 1. For condition where the mapped spectral response acceleration parameter at 1 – second period, S_1, is less than 0.75, the 2019 CBC, Section 1613.2.5.1 allows that seismic design category to be determined from Table 1613.2.5(1) alone provided that all four requirements concerning fundamental period of structure, story drift, seismic response coefficient, and relative rigidity of the diaphragms are met. Our interpretation of ASCE 7-16 is that for conditions where one or more of these 4 conditions are not met, seismic design category should be assigned based on: 1) 2019 CBC, Table 1613.2.5(1), 2) structure's risk category and 3) the value of S_{DS}, at the discretion of the project structural engineer.

Discussion – Equivalent Lateral Force Method

Should the Equivalent Lateral Force (ELF) method be used for seismic design of structural elements, the value of Constant Velocity Domain Transition Period, T_s, is estimated to be 0.565 second and the value of Long Period Transition Period, T_L, is provided in Table 1 for construction of Seismic Response Coefficient – Period (C_s -T) curve that is used in the ELF procedure.

As stated herein, the subject site is considered to be within a Site Class D-Default. A site-specific ground motion hazard analysis is not required for structures on Site Class D-Default with $S_1 \geq 0.2$ provided that the Seismic Response Coefficient, C_s, is determined in accordance with ASCE 7-16, Article 12.8 and structural design is performed in accordance with Equivalent Lateral Force (ELF) procedure.

CONCLUSIONS

Site Suitability

From a geotechnical engineering and engineering geologic point of view, the subject property is considered suitable for the proposed development provided the following conclusions and recommendations are incorporated into the design criteria and project specifications.

Primary Geologic/Geotechnical Considerations

Groundwater

Regional groundwater or perched groundwater was not encountered in any of our exploratory borings, drilled to a maximum depth of 51.5 feet below the ground surface. Data provided in a nearby well indicates groundwater is currently at depths exceeding 190 feet bgs. The high groundwater depth within the site vicinity, between 1973 and 1983, is reported approximately 95 feet below the ground surface (Matti and Carson, 1991). Regional groundwater is not anticipated to affect the subject development.

Fault Rupture

The site is not located within a currently designated State of California Alquist-Priolo Earthquake Fault Zone (CGS, 2021), nor is it within a San Bernardino County Geologic Hazard Zone (San Bernardino County, 2009). In addition, no known active faults have been identified on the site. While fault rupture would most likely occur along previously established fault traces, fault rupture could occur at other locations. However, the potential for active fault rupture at the site is considered to be very low.

Strong Ground Motions

The site is located in a seismically active area of southern California and will likely be subjected to very strong seismically related ground shaking during the anticipated life span of the project. Structures within the site should therefore be designed and constructed to resist the effects of strong ground motion in accordance with the 2019 California Building Code (CBC) and the seismic parameters included in Table 1 above.

Liquefaction, Landslides and Secondary Seismic Effects

The proposed residential development is not mapped within a San Bernadino County zone of suspected liquefaction susceptibility (San Bernardino County, 2009).

The site and immediate area exhibit level topography that is not prone to landsliding. Secondary effects of seismic activity normally considered as possible hazards to a site include several types of ground failure. Such ground failures, which might occur as a consequence of severe ground shaking at the site, include ground subsidence, ground lurching and lateral spreading. The probability of occurrence of each type of ground failure depends on the severity of the earthquake, distance from faults, topography, subsoils, and groundwater conditions, in addition to other factors. Based on the site conditions, proposed grading, depth to groundwater exceeding 100 feet, and gentle topography across the site, landsliding, liquefaction, ground subsidence, ground lurching and lateral spreading are considered unlikely at the site. The potential for seismic flooding due to a tsunami or seiche is considered negligible.

Compressible Soils

The most significant geotechnical factor affecting the project site is the presence of near-surface compressible soil materials. Such native materials consist of surficial topsoil and disturbed alluvium (due to former orchard and crop cultivation) as well as highly weathered young alluvium, which are not considered suitable for support of fill or structural loads in their present condition. Based on our subsurface assessment and laboratory test results, remedial removal depths on the order of 4 to 5 feet below existing grades are expected. Accordingly, these materials will require removal to competent alluvial soils and replacement with properly compacted fill.

Flooding

The subject property is depicted in Zone X (FEMA, 2008) on Map Number 06071C8704H (dated August 28, 2008). This zone is defined as "0.2% Annual Chance Flood Hazard. Areas of 1% annual chance flood with average depths less than one foot with drainage areas of less than one square mile."

EARTHWORK RECOMMENDATIONS

General Earthwork Recommendations

Earthwork should be performed in accordance with the Grading Code of the City of Redlands and/or County of San Bernardino, in addition to the applicable provisions of the 2019 CBC. Grading should also be performed in accordance with the following site-specific recommendations prepared by Petra based on the proposed construction.

Geotechnical Observations and Testing

Prior to the start of earthwork, a meeting should be held at the site with the owner, contractor, and geotechnical consultant to discuss the work schedule and geotechnical aspects of the grading. Earthwork, which in this instance will generally entail removal and re-compaction of the near surface soils, should be accomplished under full-time observation and testing of the geotechnical consultant. A representative of the project geotechnical consultant should be present onsite during all earthwork operations to document proper placement and compaction of fills, as well as to document compliance with the other recommendations presented herein.

Clearing and Grubbing

All existing weeds, grasses, brush, shrubs, trees/tree stumps, root balls, and similar vegetation existing within areas to be graded should be stripped and removed from the site. Clearing operations should also include the demolition and removal of all existing improvements (irrigation lines, valve risers, concrete water distribution boxes, concrete and brick irrigation channels, wind machines slabs, etc.), any remaining trash, debris, vegetation, and similar deleterious materials. Any cavities or excavations created upon removal of buried structures or root balls or any unknown subsurface structures should be cleared of loose soil, shaped to provide access for backfilling and compaction equipment and then backfilled with properly compacted (engineered) fill. Note that deleterious materials may be encountered within the site and may need to be removed by hand, i.e., root pickers, during the grading operations.

The project geotechnical consultant should provide periodic observation and testing services during clearing and grubbing operations to document compliance with the above recommendations. In addition, should unusual or adverse soil conditions or buried structures be encountered during grading that are not described herein, these conditions should be brought to the immediate attention of the project geotechnical consultant for corrective recommendations.

Excavation Characteristics

The existing site soils are expected to be readily excavated with conventional earthmoving equipment. If oversize rocks (i.e., 12-inches in one dimension or greater) are encountered they should either be disposed of either offsite or properly buried within the planned deeper fills in an approved engineered fashion, a minimum of 10 feet below finish pad grades.

Ground Preparation - General

Our field evaluation revealed that near-surface soils within the areas of proposed construction generally exhibit low to moderate in-place densities, may contain some rootlets and other isolated organic material, and have been locally disturbed from previous agricultural activities such as tree orchards. These soils are subject to compression and settlement under the proposed foundation and slab loadings and, if left unmitigated and may result in excessive differential settlement beneath the proposed structures, associated foundations, and/or associated appurtenant improvements.

To create a uniform compacted fill mat below the proposed improvements and reduce the potential for distress due to excessive differential settlement, it is recommended that all near surface low-density native materials be removed to underlying competent alluvial materials and replaced as properly compacted fill materials. Based on our subsurface exploration and laboratory test results, remedial removal depths on the order of 4 to 5 feet below existing grades are expected. The horizontal limits of removal and re-compaction should extend to a minimum distance of 5 feet beyond the proposed improvements.

It must be noted that the depths of remedial grading provided herein are estimates only and are based on conditions observed at the boring locations. Subsurface conditions can and usually do vary between points of exploration. For this reason, the actual removal depths will have to be determined on the basis of in-grading observations and testing performed by a representative of the project geotechnical consultant. The Client, civil engineer, and project grading contractor should allow contingencies for additional earthwork quantities should adverse conditions and deeper removals be required.

Unsuitable Soil Removals

Existing surficial soils including disturbed topsoil, alluvium, and upper highly weathered alluvium deposits that are considered unsuitable for support of proposed fills, structures, flatwork, pavement, or other improvements in their existing condition, should be removed to underlying competent alluvial deposit materials. All existing low-density, compressible surficial soils in areas to receive compacted fill or to support the residential building pads should be removed to underlying competent soils as approved by the project geotechnical consultant.

Based on our subsurface assessment and laboratory test results, remedial removal depths on the order 4 to 5 feet below existing grades are expected. Unsuitable soil removals may also need to be locally deeper, depending on the exposed conditions encountered during grading. The actual depths and horizontal limits

of removals and over-excavations should be evaluated during grading on the basis of observations and testing performed by the project geotechnical consultant.

Prior to placing engineered fill, all exposed bottom surfaces in the removal areas should be approved by a representative of the project geotechnical consultant and then scarified to a minimum depth of 12 inches, flooded with water and compacted with heavy vibratory equipment to achieve near-optimum moisture conditions and then compacted in-place to no less than 90 percent relative compaction.

Ground Preparation - Roadways

For proposed roadways/drive isles/parking areas, the existing ground surfaces should be over-excavated to a minimum depth of 12 inches below the existing ground surface or 2 feet below the proposed subgrade elevations, whichever is deeper. After completion of over-excavation, the areas should be scarified to a minimum depth of 6 inches, moisture-conditioned, and re-compacted to a minimum 90 percent relative compaction during rough grading activities. The excavated materials may be replaced as properly compacted fill. The horizontal limits of over-excavation should extend to a minimum horizontal distance of 12 inches beyond the perimeter of the proposed improvements.

All fills should be placed in 6- to 8-inch-thick maximum lifts, watered or air dried as necessary to achieve slightly above-optimum moisture conditions, and then compacted to a minimum relative compaction of 90 percent per ASTM D 1557. Prior to paving, the pavement subgrade soils will require rework to a depth of 12 inches to achieve no less than 95 percent relative compaction. The laboratory maximum dry density and optimum moisture content for each change in soil type should be determined in accordance with Test Method ASTM D 1557.

Cut Lots

Lots located entirely in cut exceeding 1 foot should be over-excavated a minimum of 3 feet below the bottom of the proposed foundations and replaced as properly compacted fill. Cut lots with less than 1 foot of cut should be over-excavated to a minimum depth of 4 feet below existing grade. Prior to placing engineered fill, all exposed over-excavation bottom surfaces in the building pad areas should be first scarified to a depth of 12 inches, moisture-conditioned, as needed, and compacted with heavy vibratory equipment to achieve near-optimum moisture conditions and then compacted in-place to no less than 90 percent relative compaction.

Cut-Fill Transition Lots/Building Pads

Cut/fill transitions should be eliminated from building-pad areas to reduce the detrimental effects of differential settlement. This should be accomplished by over-excavating the "cut" or shallow-fill portions to a minimum depth of 3 feet below the bottom of the proposed foundations and replacing the excavated materials as properly compacted fill.

Horizontal limits of over-excavation should extend at least 5 feet outside the entire level portion of the building pad. Prior to placing engineered fill, all exposed over-excavation bottom surfaces in the removal areas should be first scarified to a depth of 12 inches, moisture-conditioned, as needed, and compacted with heavy vibratory equipment to achieve near-optimum moisture conditions and then compacted in-place to no less than 90 percent relative compaction.

Suitability of Site Soils as Fill

Site soils are suitable for use in engineered fills provided they are clean from organics and/or debris. Wet alluvial soils may also be encountered during site grading (depending upon the time of year grading occurs) and may require drying back before being reused as fill. Oversize rock, that exceeding 12 inches, should be excluded from placement in the upper 10 feet of the building pads.

Fill Placement

Fill materials should be placed in approximately 6- to 8-inch-thick loose lifts, watered or air-dried as necessary to achieve a moisture content approximately 2 percent above optimum moisture condition, and then compacted in-place to no less than 90 percent relative compaction. Where clean sands are encountered, moisture-conditioning may entail heavy watering to facilitate compaction. The laboratory maximum dry density and optimum moisture content for each major soil type should be determined in accordance with ASTM D 1557.

Import Soils for Grading

If import soils are needed to achieve final design grades, import soils should be free of deleterious materials, oversize rock, and any hazardous materials. The soils should also be non-expansive and essentially non-corrosive and approved by the project geotechnical consultant *prior* to being brought onsite. The geotechnical consultant should inspect the potential borrow site and conduct testing of the soil at least three days before the commencement of import operations.

Shrinkage and Subsidence

Volumetric changes in earth quantities will occur when excavated onsite soils are replaced as properly compacted fill. Following is an estimate of shrinkage factors for the alluvial soil present onsite. These estimates are based on in-place densities of the various materials and on the estimated average degree of relative compaction achieved during grading.

- Disturbed Surface Soils (0-2± feet)..…… Shrinkage of 15 to 20%±
- Alluvium (Upper 2-7± ft.) ……..... Shrinkage of 10 to 15%±

Subsidence from scarification and re-compaction of exposed bottom surfaces in removal areas to receive fill is expected to vary from negligible to approximately 0.1 foot. The above estimates of shrinkage and subsidence are intended as an aid for project engineers in determining earthwork quantities. However, these estimates should not be considered as absolute values and should be used with some caution. Contingencies should be made for balancing earthwork quantities based on actual shrinkage and subsidence that occurs during the grading operations.

Temporary Excavations

Temporary excavations to a depth possibly as much as 10± feet below existing grades may be required to accommodate the recommended over-excavation of unsuitable materials or to construct subsurface storm water disposal structures. Based on the physical properties of the onsite cohesionless soils, temporary excavations which are constructed exceeding 4 feet in height should be cut back to a ratio of 1:1 (h:v) or flatter for the duration of the over-excavation of unsuitable soil material and replacement as compacted fill, as well as placement of underground utilities. However, the temporary excavations should be observed by a representative of the project geotechnical consultant for evidence of potential instability. Depending on the results of these observations, revised slope configurations may be necessary. Other factors which should be considered with respect to the stability of the temporary slopes include construction traffic and/or storage of materials on or near the tops of the slopes, construction scheduling, presence of nearby walls or structures on adjacent properties and weather conditions at the time of construction. Applicable requirements of the California Construction and General Industry Safety Orders, the Occupational Safety and Health act of 1970 and the Construction Safety Act should also be followed.

FOUNDATION DESIGN RECOMMENDATIONS

Allowable Soil Bearing Capacities

Pad Footings

An allowable soil bearing capacity of 1,500 pounds per square foot may be utilized for design of isolated 24-inch-square footings founded at a minimum depth of 12 inches below the lowest adjacent final grade for pad footings that are not a part of the slab system and are used for support of such features as roof overhang, second-story decks, patio covers, etc. This value may be increased by 20 percent for each additional foot of depth and by 10 percent for each additional foot of width, to a maximum value of 2,500 pounds per square foot. The recommended allowable bearing value includes both dead and live loads and may be increased by one-third for short duration wind and seismic forces.

Continuous Footings

An allowable soil bearing capacity of 1,500 pounds per square foot may be utilized for design of continuous footings founded at a minimum depth of 12 inches below the lowest adjacent final grade. This value may be increased by 20 percent for each additional foot of depth and by 10 percent for each additional foot of width, to a maximum value of 2,500 pounds per square foot. The recommended allowable bearing value includes both dead and live loads and may be increased by one-third for short duration wind and seismic forces.

Estimated Footing Settlement

Based on the allowable bearing values provided above, total static settlement of the footings under the anticipated loads is expected to be on the order of 3/4 inch. Differential settlement is expected to be less than 1/2 inch over a horizontal span of 20 feet. The majority of settlement is likely to take place as footing loads are applied or shortly thereafter.

Lateral Resistance

A passive earth pressure of 250 pounds per square foot per foot of depth, to a maximum value of 2,500 pounds per square foot, may be used to determine lateral bearing resistance for footings. In addition, a coefficient of friction of 0.30 times the dead load forces may be used between concrete and the supporting soils to determine lateral sliding resistance. The above values may be increased by one-third when designing for transient wind or seismic forces. It should be noted that the above values are based on the condition where footings are cast in direct contact with compacted fill or competent native soils. In cases where the footing sides are formed, all backfill placed against the footings upon removal of forms should be compacted to at least 90 percent of the applicable maximum dry density.

Guidelines for Footings and Slabs on-Grade Design and Construction

The results of our laboratory tests performed on representative samples of near-surface soils within the site during our evaluation indicate that these materials predominantly exhibit expansion indices that are less than 20. As indicated in Section 1803.5.3 of 2019 California Building Code (2019 CBC), these soils are considered non-expansive and, as such, the design of slabs on-grade is considered to be exempt from the procedures outlined in Sections 1808.6.2 of the 2019 CBC and may be performed using any method deemed rational and appropriate by the project structural engineer. However, the following minimum recommendations are presented herein for conditions where the project design team may require geotechnical engineering guidelines for design and construction of footings and slabs on-grade the project site.

The design and construction guidelines that follow are based on the above soil conditions and may be considered for reducing the effects of variability in fabric, composition and, therefore, the detrimental behavior of the site soils such as excessive short- and long-term total and differential heave or settlement. These guidelines have been developed on the basis of the previous experience of this firm on projects with similar soil conditions. Although construction performed in accordance with these guidelines has been found to reduce post-construction movement and/or distress, they generally do not positively eliminate all potential effects of variability in soils characteristics and future heave or settlement.

It should also be noted that the suggestions for dimension and reinforcement provided herein are performance-based and intended only as preliminary guidelines to achieve adequate performance under the anticipated soil conditions. However, they should not be construed as replacement for structural engineering analyses, experience, and judgment. The project structural engineer, architect and/or civil engineer should make appropriate adjustments to slab and footing dimensions, and reinforcement type, size and spacing to account for internal concrete forces (e.g., thermal, shrinkage and expansion) as well as external forces (e.g., applied loads) as deemed necessary. Consideration should also be given to minimum design criteria as dictated by local building code requirements.

Conventional Slabs on-Grade System

Given the expansion index of less than 20, as exhibited by onsite soils, we recommend that footings and floor slabs be designed and constructed in accordance with the following minimum criteria.

Footings

1. Exterior continuous footings supporting one- and two-story structures should be founded at a minimum depth of 12 inches below the lowest adjacent final grade, respectively. Exterior continuous footings supporting three-and four-story structures should be founded at a minimum depth of 18 inches below the lowest adjacent final grade, respectively. Interior continuous footings may be founded at a minimum depth of 10 inches below the top of the adjacent finish floor slabs.

2. In accordance with Table 1809.7 of 2019 CBC for light-frame construction, all continuous footings should have minimum widths of 12 inches for one- and two-story construction. All continuous footings should have minimum widths of 15 and 18 inches for three and four-story construction, respectively. We recommend all continuous footings should be reinforced with a minimum of two No. 4 bars, one top and one bottom.

3. A minimum 12-inch-wide grade beam founded at the same depth as adjacent footings should be provided across the garage entrances or similar openings (such as large doors or bay windows). The grade beam should be reinforced with a similar manner as provided above.

4. Interior isolated pad footings, if required, should be a minimum of 24 inches square and founded at a minimum depth of 12 inches below the bottoms of the adjacent floor slabs for one- and two-story buildings. Interior isolated pad footings for three- and four-story buildings should be a minimum of 24 inches square and founded at a minimum depth of 15 inches below the bottoms of the adjacent floor slabs. Pad footings should be reinforced with No. 4 bars spaced a maximum of 18 inches on centers, both ways, placed near the bottoms of the footings.

5. Exterior isolated pad footings intended for support of roof overhangs such as second-story decks, patio covers and similar construction for one- and two-story buildings should be a minimum of 24 inches square and founded at a minimum depth of 18 inches below the lowest adjacent final grade. Exterior isolated pad footings for three- and four-story buildings should be a minimum of 24 inches square and founded at a minimum depth of 24 inches below the lowest adjacent final grade. The pad footings should be reinforced with No. 4 bars spaced a maximum of 18 inches on centers, both ways, placed near the bottoms of the footings. Exterior isolated pad footings may need to be connected to adjacent pad and/or continuous footings via tie beams at the discretion of the project structural engineer.

6. The minimum footing dimensions and reinforcement recommended herein may be modified (increased or decreased subject to the constraints of Chapter 18 of the 2019 CBC) by the structural engineer responsible for foundation design based on his/her calculations, engineering experience and judgment.

Building Floor Slabs

1. Concrete floor slabs should be a minimum 4 inches thick and reinforced with No. 3 bars spaced a maximum of 24 inches on centers, both ways. All slab reinforcement should be supported on concrete chairs or brick to ensure the desired placement near mid-depth.

   Slab dimension, reinforcement type, size and spacing need to account for internal concrete forces (e.g., thermal, shrinkage and expansion) as well as external forces (e.g., applied loads), as deemed necessary.

2. Living area concrete floor slabs and areas to receive moisture sensitive floor covering should be underlain with a moisture vapor retarder consisting of a minimum 10-mil-thick polyethylene or polyolefin membrane that meets the minimum requirements of ASTM E96 and ASTM E1745 for vapor

retarders (such as Husky Yellow Guard®, Stego® Wrap, or equivalent). All laps within the membrane should be sealed, and at least 2 inches of clean sand should be placed over the membrane to promote uniform curing of the concrete. To reduce the potential for punctures, the membrane should be placed on a pad surface that has been graded smooth without any sharp protrusions. If a smooth surface cannot be achieved by grading, consideration should be given to lowering the pad finished grade an additional inch and then placing a 1-inch-thick leveling course of sand across the pad surface prior to the placement of the membrane.

At the present time, some slab designers, geotechnical professionals and concrete experts view the sand layer below the slab (blotting sand) as a place for entrapment of excess moisture that could adversely impact moisture-sensitive floor coverings. As a preventive measure, the potential for moisture intrusion into the concrete slab could be reduced if the concrete is placed directly on the vapor retarder. However, if this sand layer is omitted, appropriate curing methods must be implemented to ensure that the concrete slab cures uniformly. A qualified materials engineer with experience in slab design and construction should provide recommendations for alternative methods of curing and supervise the construction process to ensure uniform slab curing. Additional steps would also need to be taken to prevent puncturing of the vapor retarder during concrete placement.

3. Garage floor slabs should be a minimum 4 inches thick and reinforced in a similar manner as living area floor slabs. Garage slabs should also be poured separately from adjacent wall footings with a positive separation maintained using ¾-inch-minimum felt expansion joint material. To control the propagation of shrinkage cracks, garage floor slabs should be quartered with weakened plane joints. Consideration should be given to placement of a moisture vapor retarder below the garage slab, similar to that provided in Item 2 above, should the garage slab be overlain with moisture sensitive floor covering.

4. Presaturation of the subgrade below floor slabs will not be required; however, prior to placing concrete, the subgrade below all dwelling and garage floor slab areas should be thoroughly moistened to achieve a moisture content that is at least equal to or slightly greater than optimum moisture content. This moisture content should penetrate to a minimum depth of 12 inches below the bottoms of the slabs.

5. The minimum dimensions and reinforcement recommended herein for building floor slabs may be modified (increased or decreased subject to the constraints of Chapter 18 of the 2019 CBC) by the structural engineer responsible for foundation design based on his/her calculations, engineering experience and judgment.

Post-Tensioned Slab-on-Ground System (Optional)

The use of a post-tension system should be viewed as optional in this instance. In consideration of the expansion index of less than 20, as predominantly exhibited by onsite soils, any rational and appropriate procedure may be chosen by the project structural engineer for the design of post-tensioned slab-on-ground system. Should the design engineer choose to follow the latest Code-adopted edition of the procedure published by the Post-Tensioning Institute (PTI DC 10.5), the following minimum design criteria are provided Table 2, below.

TABLE 2

Presumptive Post-Tensioned Slab on-Grade Design Parameters for PTI Procedure

Soil Information	
Approximate Depth of Constant Suction, feet	9
Approximate Soil Suction, pF	3.9
Inferred Thornthwaite Index:	-20
Average Edge Moisture Variation Distance, e_m in feet: Center Lift Edge Lift	 9.0 4.7
Anticipated Swell, y_m in inches: Center Lift Edge Lift	 0.25 0.45

Modulus of Subgrade Reaction

The modulus of subgrade reaction for design of load bearing elements depends on the size of the element and soil-structure interaction. However, as a first level of approximation, this value may be assumed to be 125 pounds per cubic inch.

Minimum Design Recommendations

The soil values provided above may be utilized by the project structural engineer to design post-tensioned slabs on-ground in accordance with Section 1808.6.2 of the 2019 CBC and the PTI publication. Thicker floor slabs and larger footing sizes may be required for structural reasons and should govern the design if more restrictive than the minimum recommendations provided below:

1. Exterior continuous footings for one- and two-story structures should be founded at a minimum depth of 12 inches below the lowest adjacent finished ground surface. Exterior continuous footings for three- and four-story structures should be founded at a minimum depth of 18 inches below the lowest adjacent finished ground surface. Interior footings may be founded at a minimum depth of 10 inches below the tops of the adjacent finish floor slabs.

2. In accordance with Table 1809.7 of 2019 CBC for light-frame construction, all continuous footings should have minimum widths of 12 inches for one- and two-story construction. All continuous footings should have minimum widths of 15 and 18 inches for three-and four-story construction. We recommend all continuous footings should be reinforced with a minimum of two No. 4 bars, one top and one bottom. Alternatively, post-tensioned tendons may be utilized in the perimeter continuous footings in lieu of the reinforcement bars.

3. A minimum 12-inch-wide grade beam founded at the same depth as adjacent footings should be provided across the garage entrances or similar openings (such as large doors or bay windows). The grade beam should be reinforced in a similar manner as provided above.

4. Interior isolated pad footings, if required, should be a minimum of 24 inches square and founded at a minimum depth of 12 inches below the bottoms of the adjacent floor slabs for one- and two-story buildings. Interior isolated pad footings should be a minimum of 24 inches square and founded at a minimum depth of 15 inches below the bottoms of the adjacent floor slabs for three- and four-story buildings. Pad footings should be reinforced with No. 4 bars spaced a maximum of 18 inches on centers, both ways, placed near the bottoms of the footings.

5. Exterior isolated pad footings intended for support of roof overhangs such as second-story decks, patio covers and similar construction for one- and two-story buildings should be a minimum of 24 inches square and founded at a minimum depth of 18 inches below the lowest adjacent final grade. Exterior isolated pad footings for three- and four-story buildings should be a minimum of 24 inches square and founded at a minimum depth of 24 inches below the lowest adjacent final grade. The pad footings should be reinforced with No. 4 bars spaced a maximum of 18 inches on centers, both ways, placed near the bottoms of the footings. Exterior isolated pad footings may need to be connected to adjacent pad and/or continuous footings via tie beams at the discretion of the project structural engineer.

6. The thickness of the floor slabs should be determined by the project structural engineer with consideration given to the expansion index of the onsite soils; however; we recommend that a minimum slab thickness of 4 inches be considered.

7. As an alternative to designing 4-inch-thick post-tensioned slabs with perimeter footings as described in Items 1 and 2 above, the structural engineer may design the foundation system using a thickened slab design. The minimum thickness of this uniformly thick slab should be 7.5 inches. The engineer in charge of post-tensioned slab design may also opt to use any combination of slab thickness and footing embedment depth as deemed appropriate based on their engineering experience and judgment.

8. Living area concrete floor slabs and areas to receive moisture sensitive floor covering should be underlain with a moisture vapor retarder consisting of a minimum 10-mil-thick polyethylene or polyolefin membrane that meets the minimum requirements of ASTM E96 and ASTM E1745 for vapor retarders (such as Husky Yellow Guard®, Stego® Wrap, or equivalent). All laps within the membrane should be sealed, and at least 2 inches of clean sand should be placed over the membrane to promote uniform curing of the concrete. To reduce the potential for punctures, the membrane should be placed on a pad surface that has been graded smooth without any sharp protrusions. If a smooth surface cannot be achieved by grading, consideration should be given to lowering the pad finished grade an additional inch and then placing a 1-inch-thick leveling course of sand across the pad surface prior to the placement of the membrane.

   At the present time, some slab designers, geotechnical professionals and concrete experts view the sand layer below the slab (blotting sand) as a place for entrapment of excess moisture that could adversely impact moisture-sensitive floor coverings. As a preventive measure, the potential for moisture intrusion into the concrete slab could be reduced if the concrete is placed directly on the vapor retarder. However, if this sand layer is omitted, appropriate curing methods must be implemented to ensure that the concrete slab cures uniformly. A qualified materials engineer with experience in slab design and construction should provide recommendations for alternative methods of curing and supervise the construction process to ensure uniform slab curing. Additional steps would also need to be taken to prevent puncturing of the vapor retarder during concrete placement.

9. Garage floor slabs should be designed in a similar manner as living area floor slabs. Consideration should be given to placement of a moisture vapor retarder below the garage slab, similar to that provided in Item 6 above, should the garage slab be overlain with moisture sensitive floor covering.

10. Presaturation of the subgrade below floor slabs will not be required; however, prior to placing concrete, the subgrade below all dwelling and garage floor slab areas should be thoroughly moistened to achieve a moisture content that is at least equal to or slightly greater than optimum moisture content. This moisture content should penetrate to a minimum depth of 12 inches below the bottoms of the slabs.

11. The minimum footing dimensions and reinforcement recommended herein may be modified (increased or decreased subject to the constraints of Chapter 18 of the 2019 CBC) by the structural engineer responsible for foundation design based on his/her calculations, engineering experience and judgment.

Footing Observations

Foundation footing trenches should be observed by the project geotechnical consultant to document into competent bearing-soils. The foundation excavations should be observed prior to the placement of forms, reinforcement, or concrete. The excavations should be trimmed neat, level, and square. Prior to placing concrete, all loose, sloughed, or softened soils and/or construction debris should be removed. Excavated soils derived from footing and utility trench excavations should not be placed in slab-on-grade areas unless the soils are compacted to a relative compaction of 90 percent or more.

Preliminary Pavement Design Recommendations

Based upon our experience in Redlands, an R-value of 50 was estimated for the subject site. A traffic index (TI) of 4.5 was assumed for interior drive isles and parking, 5.5 was assumed for local streets (such as Pennsylvania Avenue extension) and 7.0 for minor arterial streets (such as Tennessee Street) in accordance with City of Redlands Standard Specifications and Details (2020). The traffic indices, along with the estimated design R-value, were utilized for preliminary pavement section design. The following pavement section has been computed in accordance with Caltrans design procedures and presented in the following table, Table 3. Based upon our experience, the thicker pavement section is provided below is recommended due to increased performance and life.

TABLE 3

Preliminary Pavement Design

Location	Design R-value	Traffic Index	Pavement Section
Interior Drive Aisles and Parking	50	4.5	3 in. AC / 4 in. AB[1]
Local Streets	50	5.5	3 in. AC / 4 in. AB[1]
Minor Arterial Streets	50	7.0	4 in. AC / 5 in. AB

Notes:
AC = Asphalt Concrete
AB = Aggregate Base
[1] = Min. section per Redlands standards

Subgrade soils immediately below the base should be compacted to 95 percent or more relative compaction based on ASTM D 1557 to a depth of 12 inches or more. Final subgrade compaction should be performed prior to placing base or asphalt-concrete and after utility-trench backfills have been compacted and tested. Subgrade should be firm and unyielding, as exhibited by proof-rolling, prior to placement of aggregate base.

Base materials should consist of Caltrans Class 2 aggregate base. Base materials should be compacted to 95 percent or more relative compaction based on ASTM D 1557. The base materials should be near optimum-moisture content when compacted. Asphalt concrete materials should conform to Section 203-6 of the most recent Standard Specifications for Public Works Construction (Greenbook) or as required by the City of Redlands Public Works Department - Standard Specifications and Detail Drawings.

General Corrosivity Screening

As a screening level study, limited chemical and electrical tests were performed on samples considered representative of the onsite soils to identify potential corrosive characteristics of these soils. The common indicators that are generally associated with soil corrosivity, among other indicators, include water-soluble sulfate (a measure of soil corrosivity on concrete), water-soluble chloride (a measure of soil corrosivity on metals embedded in concrete), pH (a measure of soil acidity), and minimum electrical resistivity (a measure of corrosivity on metals embedded in soils). Test methodology and results are presented in Appendix B.

It should be noted that Petra does not practice corrosion engineering; therefore, the test results, opinion and engineering judgment provided herein should be considered as general guidelines only. Additional analyses, and/or determination of other indicators, would be warranted, especially, for cases where buried metallic building materials (such as copper and cast or ductile

iron pipes) in contact with site soils are planned for the project. In many cases, the project geotechnical engineer may not be informed of these choices. Therefore, for conditions where such elements are considered, we recommend that other, relevant project design professionals (e.g., the architect, landscape architect, civil and/or structural engineer, etc.) to be involved. We also recommend considering a qualified corrosion engineer to conduct additional sampling and testing of near-surface soils during the final stages of site grading to provide a complete assessment of soil corrosivity. Recommendations to mitigate the detrimental effects of corrosive soils on buried metallic and other building materials that may be exposed to corrosive soils should be provided by the corrosion engineer as deemed appropriate.

In general, a soil's water-soluble sulfate levels and pH relate to the potential for concrete degradation; water-soluble chlorides in soils impact ferrous metals embedded or encased in concrete, e.g., reinforcing steel; and electrical resistivity is a measure of a soil's corrosion potential to a variety of buried metals used in the building industry, such as copper tubing and cast or ductile iron pipes. Table 4, below, presents test results with an interpretation of current code approach and guidelines that are commonly used in building construction industry. The table includes the code-related classifications of the soils as they relate to the various tests, as well as a general recommendation for possible mitigation measures in view of the potential adverse impact of corrosive soils on various components of the proposed structures in direct contact with site soils. The guidelines provided herein should be evaluated and confirmed, or modified, in their entirety by the project structural engineer, corrosion engineer and/or the contractor responsible for concrete placement for structural concrete used in exterior and interior footings, interior slabs on-ground, garage slabs, wall foundations and concrete exposed to weather such as driveways, patios, porches, walkways, ramps, steps, curbs, etc.

TABLE 4

Soil Corrosivity Screening Results

Test (Test Method Designation)	Test Results	Classification	General Recommendations
Soluble Sulfate (Cal 417)	SO_4^{2-} < 0.10 % by weight	**S0(1) - Not Applicable**	Type II cement; minimum f_c' = 2,500 psi; no water/cement ratio restrictions.
pH (Cal 643)	7.9 – 8.4	**Moderately Alkaline**	No special recommendations
Soluble Chloride (Cal 422)	Cl^{1-} < 500 ppm	**C1(2) - Moderate**	Residence: No special recommendations; f_c' should not be less than 2,500 psi.
Soluble Chloride (Cal 422)	< 500 ppm	**C2(4) - Severe**	Pools/Decking: Increase concrete cover thickness; maximum water/cement ratio of the fresh concrete should not exceed 0.40; f_c'(2) should not be less than 5,000 psi.
Resistivity (Cal 643)	10,000 – 20,000	**Mildly Corrosive(5)**	Protective wrapping/coating of buried pipes; corrosion resistant materials

Notes:
1. ACI 318-14, Section 19.3
2. ACI 318-14, Section 19.3
3. Pierre R. Roberge, "Handbook of Corrosion Engineering"
4. Exposure classification C2 applies specifically to swimming pools and appurtenant concrete elements
5. f_c': 28-day unconfined compressive strength of concrete

INFILTRATION TEST RESULTS

Three infiltration test holes (P-1 through P-3) were completed within the subject property at depths of 15 feet bgs or 25 feet bgs to assess infiltration rates of the near-surface onsite soils for preliminary design of detention basins to manage storm water runoff.

These tests used the Falling Head Test Method (RCFCD, 2011). Infiltration rates were then calculated using the Porchet Method (RCFCD, 2011), commonly called the "inversed auger-hole method." The infiltration tests were conducted in the lower five feet of each boring corresponding to five feet below the bottom elevation of the proposed basin. Each test hole consisted of an eight-inch diameter boring drilled with a truck-mounted hollow-stem auger drill rig. The holes were pre-soaked immediately after drilling.

Soils encountered in test locations consisted of fine- to medium-grained silty sand. Test locations are shown on Figure 2. Boring logs are provided in Appendix A. The un-factored infiltration rate results are summarized below in Table 5, and are provided in Appendix D.

TABLE 5

Summary of Infiltration Rates

Percolation Test Designation	Depth of Test Boring (feet below surface)	Percolation Rate (gallons/day/ft^2)	Infiltration Rate (inches/hour)
P-1	25’	104.9	14.5
P-2	15’	100.4	13.9
P-3	15’	43.5	6.0

POST-GRADING RECOMMENDATIONS

Site Drainage

Surface drainage systems consisting of sloping concrete flatwork, graded earth swales and/or an underground area drain system are anticipated to be constructed to collect and direct all surface waters to the adjacent streets and storm drain facilities. In addition, the ground surface around the proposed buildings should be sloped at a positive gradient away from the structures. The purpose of the precise grading is to prevent ponding of surface water within the level areas of the site and against building foundations and associated site improvements. The drainage systems should be properly maintained throughout the life of the proposed development.

It should be emphasized that the slopes away from the structures area drain inlets and storm drain structures to be properly maintained, not to be obstructed, and that future improvements not to alter established gradients unless replaced with suitable alternative drainage systems.

Slope Landscaping and Maintenance

Adequate slope and pad drainage facilities are essential in the design of grading for the subject site. An anticipated rainfall equivalency on the order of 60 to 100 inches per year at the site can result due to irrigation. The overall stability of the graded slopes should not be adversely affected provided drainage provisions are properly constructed and maintained thereafter and provided engineered slopes are landscaped immediately following grading with a deep-rooted, drought-tolerant, and maintenance-free plant species, as recommended by the project landscape architect. Additional comments and recommendations are presented below with respect to slope drainage, landscaping, and irrigation.

A common type of slope failure in hillside areas is the surficial instability and usually involves the upper 1 to 6 feet. For a given gradient, these surficial slope failures are generally caused by a wide variety of

conditions, such as overwatering, cyclic changes in moisture content and density of slope soils from both seasonal and irrigation-induced wetting and drying, soil expansiveness, time lapse between slope construction and slope planting, type and spacing of plant materials used for slope protection, rainfall intensity and/or lack of a proper maintenance program. Based on this discussion, the following recommendations are presented to mitigate potential surficial slope failures.

- Proper drainage provisions for engineered slopes should consist of concrete terrace drains, downdrains and energy dissipaters (where required) constructed in accordance with the Grading Code of the City of Redlands. Provisions should also be made for construction of compacted-earth berms along the tops of engineered slopes.

- Permanent engineered slopes should be landscaped as soon as practical at the completion of grading. As noted, the landscaping should consist of a deep-rooted, drought-tolerant, and maintenance-free plant species. If landscaping cannot be provided within a reasonable period of time, jute matting (or equivalent) or a spray-on product designed to seal slope surfaces should be considered as a temporary measure to inhibit surface erosion until such time permanent landscape plants have become well-established.

- Irrigation systems should be installed on the engineered slopes and a watering program then implemented which maintains a uniform, near-optimum moisture condition in the soils. Overwatering and subsequent saturation of the slope soils should be avoided. On the other hand, allowing the soils to dry-out is also detrimental to slope performance.

- Irrigation systems should be constructed at the surface only. Construction of sprinkler lines in trenches should not be allowed without prior approval from the geotechnical engineer and engineering geologist.

- A permanent slope-maintenance program should be initiated for major slopes not maintained by individual homeowners. Proper slope maintenance should include the care of drainage- and erosion-control provisions, rodent control, and repair of leaking or damaged irrigation systems.

- Homeowners should be advised of the potential problems that can develop when drainage on the pads and slopes is altered. Drainage can be altered due to the placement of fill and construction of garden walls, retaining walls, walkways, patios, swimming pools, spas, and planters.

Utility Trenches

Utility-trench backfill within street rights-of-way, utility easements, under sidewalks, driveways and building-floor slabs should be compacted to a relative compaction of 90 percent or more. Where onsite soils are utilized as backfill, mechanical compaction should be used. Density testing, along with probing, should be performed by the project geotechnical consultant or his representative to document adequate compaction. Utility-trench sidewalls deeper than about 4 feet should be laid back at a ratio of 1:1 (h:v) or flatter or shored. A trench box may be used in lieu of shoring. If shoring is anticipated, the project geotechnical consultant should be contacted to provide design parameters.

For trenches with vertical walls, backfill should be placed in approximately 1- to 2-foot-thick loose lifts and then mechanically compacted with a hydra-hammer, pneumatic tampers, or similar compaction equipment. For deep trenches with sloped walls, backfill materials should be placed in approximately 8- to 12-inch-thick loose lifts and then compacted by rolling with a sheepsfoot tamper or similar equipment.

Where utility trenches are proposed in a direction that parallels any building footing (interior and/or exterior trenches), the bottom of the trench should not be located within a 1:1 (h:v) plane projected downward from the outside bottom edge of the adjacent footing.

EXTERIOR CONCRETE FLATWORK

Non-Expansive Soils (Expansion Index, EI ≤ 20)

General

Near-surface compacted fill soils within the site are variable in fines content and expansion behavior, however, they are expected to exhibit a range of expansion indices that classify them as non-expansive, i.e., Expansion Index, EI, ≤ 20. Therefore, we recommend that all exterior concrete flatwork such as sidewalks, patio slabs, large decorative slabs, concrete subslabs that will be covered with decorative pavers, private and/or public vehicular parking, driveways and/or access roads within and adjacent to the site be designed by the project architect, civil and/or structural engineer with consideration given to mitigating the potential for cracking, curling, etc. that can potentially develop as a result of being underlain with soils that essentially exhibiting expansion index values that fall in the non-expansive category.

The guidelines that follow should be considered as minimums and are subject to review and revision by the project architect, civil engineer, structural engineer and/or landscape consultant as deemed appropriate.

Subgrade Preparation

Compaction

To reduce the potential for distress to concrete flatwork, the subgrade soils below concrete flatwork areas to a minimum depth of 12 inches (or deeper, as either prescribed elsewhere in this report or determined in the field) should be moisture conditioned to at least equal to, or slightly greater than, the optimum moisture content and then compacted to no less than 90 percent relative compaction. Where concrete public roads, concrete segments of roads and/or concrete access driveways and heavy recreational vehicles parking are proposed, the upper 6 inches of subgrade soil should be compacted to no less than 95 percent relative compaction.

Pre-Moistening

As a further measure to reduce the potential for concrete flatwork distress, subgrade soils should be thoroughly moistened prior to placing concrete. The moisture content of the soils should be at least 1.1 times the optimum moisture content and penetrate to a minimum depth of 12 inches into the subgrade. Flooding or ponding of the subgrade is not considered feasible to achieve the above moisture conditions since this method would likely require construction of numerous earth berms to contain the water. Therefore, moisture conditioning may be achieved with sprinklers or a light spray applied to the subgrade over a period of several hours to few days just prior to pouring concrete. Pre-watering of the soils is intended to promote uniform curing of the concrete, reduce the development of shrinkage cracks, and reduce the potential for differential expansion pressure on freshly poured flatwork. A representative of the project geotechnical consultant should observe and verify the density and moisture content of the soils, and the depth of moisture penetration prior to pouring concrete.

Thickness and Joint Spacing

To reduce the potential of unsightly cracking, concrete walkways, patio-type slabs, large decorative slabs and concrete subslabs to be covered with decorative pavers should be at least 4 inches thick and provided with construction joints or expansion joints every 6 feet or less. Private driveways that will be designed for the use of passenger cars for access to private garages should also be at least 4 inches thick and provided with construction joints or expansion joints every 10 feet or less. Concrete pavement that will be designed based on an unlimited number of applications of an 18-kip single-axle load in public access areas, segments of road that will be paved with concrete (such as bus stops and cross-walks) or access roads and driveways, which serve multiple residential units or garages, that will be subject to heavy truck loadings and parking of recreational vehicles should have a minimum thickness of 5 inches and be provided with control joints spaced at maximum 10-foot intervals. A modulus of subgrade reaction of 125 pounds per cubic foot may be used for design of the public and access roads.

Reinforcement

All concrete flatwork having their largest plan-view panel dimensions exceeding 10 feet should be reinforced with a minimum of No. 3 bars spaced 18 inches for 4-inch-thick slabs and No. 4 bars spaced 24 inches for 5-inch-thick slabs on centers, both ways. Alternatively, the slab reinforcement may consist of welded wire mesh of the sheet type (not rolled) with 6x6/W1.4xW1.4 WWF designations for 4-inch-thick slabs and 6x6/W2.9xW2.9 designations for 5-inch-thick slabs in accordance with the Wire Reinforcement Institute (WRI). The reinforcement should be properly positioned near the middle of the slabs. All foot and equipment traffic on the reinforcement should be avoided or reduced to a minimum.

The reinforcement recommendations provided herein are intended as a guideline to achieve adequate performance for anticipated soil conditions. As such, this guideline may not satisfy certain acceptable approaches, e.g., the area of reinforcement to be equal to or greater that 0.2 percent of the area of concrete. The project architect, civil and/or structural engineer should make appropriate adjustments in reinforcement type, size and spacing to account for concrete internal (e.g., shrinkage and thermal) and external (e.g., applied loads) forces as deemed necessary.

Edge Beams (Optional)

Where the outer edges of concrete flatwork are to be bordered by landscaping, it is recommended that considerations be given to the use of edge beams (thickened edges) to prevent excessive infiltration and accumulation of water under the slabs. Edge beams, if used, should be 6 to 8 inches wide, extend 8 inches below the tops of the finish slab surfaces. Edge beams are not mandatory; however, their inclusion in flatwork construction adjacent to landscaped areas is intended to reduce the potential for vertical and horizontal movement and subsequent cracking of the flatwork related to uplift forces that can develop in expansive soils.

Drainage

Drainage from patios and other flatwork areas should be directed to local area drains and/or graded earth swales designed to carry runoff water to the adjacent streets or other approved drainage structures. The concrete flatwork should be sloped at a minimum gradient of one percent, or as prescribed by project civil engineer or local codes, away from building foundations, retaining walls, masonry garden walls and slope areas.

Tree Wells

Tree wells are not recommended in concrete flatwork areas because they typically introduce excessive water into the subgrade soils and allow root invasion, both of which can cause heaving and cracking of the flatwork.

Retaining Walls

Footing Embedment

The base of retaining-wall footings constructed on level ground may be founded at a depth of 12 inches or more below the lowest adjacent final grade for low height walls. Where retaining walls are proposed on or within 15 feet from the top of adjacent descending fill slope, the footings should be deepened such that a

horizontal clearance of 7 feet or more is maintained between the outside bottom edges of the footings and the face of the slope. The above-recommended footing setback is preliminary and may be revised based on site-specific soil conditions. Footing trenches should be observed by the project geotechnical representative to document that the footing trenches have been excavated into competent bearing soils and to the embedments recommended above. These observations should be performed prior to placing forms or reinforcing steel.

Allowable Bearing Values and Lateral Resistance

Retaining wall footings may be designed using the allowable bearing values and lateral resistance values provided previously for building foundations; however, when calculating passive resistance, the resistance of the upper 6 inches of the soil cover in front of the wall should be ignored in areas where the front of the wall will not be covered with concrete flatwork.

Active Earth Pressures

As of the date of this report, it is uncertain whether the proposed retaining walls will be backfilled with on-site soils or imported granular materials. For this reason, active and at-rest earth pressures are provided below for both conditions. However, considering that the onsite earth materials have an expansion index of 0 to 20, the use of imported granular materials for backfilling behind the retaining walls as described in the following sections is optional.

1. Onsite Soils Used for Backfill

   Onsite soils have an expansion index of 0 to 20. Therefore, active earth pressures equivalent to fluids having a density of 35 psf/ft and 51 psf/ft should be used for design of cantilevered walls retaining a level backfill and ascending 2:1 backfill, respectively. For walls that are restrained at the top, at-rest earth pressures of 53 pounds per cubic foot (equivalent fluid pressures) should be used. The above values are for retaining walls that have been supplied with a proper subdrain system (see Figure RW-1). All walls should be designed to support any adjacent structural surcharge loads imposed by other nearby walls or footings in addition to the above recommended active and at-rest earth pressures.

2. Imported Sand, Pea Gravel or Rock Used for Wall Backfill

   Imported clean sand exhibiting a sand equivalent value (SE) of 30 or greater, pea gravel or crushed rock may be used for wall backfill to reduce the lateral earth pressures provided these granular backfill materials extend behind the walls to a minimum horizontal distance equal to one-half the wall height. In addition, the sand, pea gravel or rock backfill materials should extend behind the walls to a minimum horizontal distance of 2 feet at the base of the wall or to a horizontal distance equal to the heel width of the footing, whichever is greater (see Figures RW-2 and RW-3). For the above conditions, cantilevered walls retaining a level backfill and ascending 2:1 backfill may be designed to resist active earth pressures equivalent to fluids having densities of 30 and 41 pounds per cubic foot, respectively. For

walls that are restrained at the top, at-rest earth pressures equivalent to fluids having densities of 45 and 62 pounds per cubic foot are recommended for design of restrained walls supporting a level backfill and ascending 2:1 backfill, respectively. These values are also for retaining walls supplied with a proper subdrain system. Furthermore, as with native soil backfill, the walls should be designed to support any adjacent structural surcharge loads imposed by other nearby walls or footings in addition to the recommended active and at-rest earth pressures.

All structural calculations and details should be provided to the project geotechnical consultant for verification purposes prior to grading and construction phases.

Earthquake Loads

It is our understanding that retaining wall plans are not available at the time of this report. Section 1803.5.12 of the 2019 CBC requires the determination of lateral loads on retaining walls from earthquake forces for structures in seismic design categories D through E that are supporting more than six feet of backfill height. Recommendations for design of walls exceeding six feet in height can be provided once retaining walls plans are available for review.

Geotechnical Observation and Testing

All grading associated with retaining wall construction, including backcut excavations, observation of the footing trenches, installation of the subdrainage systems, and placement of backfill should be provided by a representative of the project geotechnical consultant.

Backdrains

To reduce the likelihood of the entrapment of water in the backfill soils, weepholes or open vertical masonry joints may be considered for retaining walls not exceeding a height of 3 feet. Weepholes, if used, should be 3-inches minimum diameter and provided at intervals of 6 feet or less along the wall. Open vertical masonry joints, if used, should be provided at 32-inch intervals. A continuous gravel fill, 3 inches by 12 inches, should be placed behind the weepholes or open masonry joints. The gravel should be wrapped in filter fabric to prevent infiltration of fines and subsequent clogging of the gravel. Filter fabric may consist of Mirafi 140N or equivalent.

A perforated pipe-and-gravel backdrain should be constructed behind retaining walls exceeding a height of 3 feet (see Figure RW-1). Perforated pipe should consist of 4-inch-minimum diameter PVC Schedule 40, or ABS SDR-35, with the perforations laid down. The pipe should be encased in a 1-foot-wide column of ¾-inch to 1½-inch open-graded gravel. If on-site soils are used as backfill, the open-graded gravel should extend above the wall footings to a minimum height equal to one-third the wall height or to a minimum

height of 1.5 feet above the footing, whichever is greater. The open-graded gravel should be completely wrapped in filter fabric consisting of Mirafi 140N or equivalent. Solid outlet pipes should be connected to the subdrains and then routed to a suitable area for discharge of accumulated water.

Waterproofing

The backfilled sides of retaining walls should be coated with an approved waterproofing compound or covered with a similar material to inhibit migration of moisture through the walls.

Temporary Excavations

Temporary slopes may be cut at a gradient no steeper than 1:1 (h:v). However, the project geotechnical engineer should observe temporary slopes for evidence of potential instability. Depending on the results of these observations, flatter slopes may be necessary. The potential effects of various parameters such as weather, heavy equipment travel, storage near the tops of the temporary excavations and construction scheduling should also be considered in the stability of temporary slopes.

Wall Backfill

Recommended active and at-rest earth pressures for design of retaining walls are based on the physical and mechanical properties of the onsite soil materials. The backfill behind the proposed retaining walls, they should be placed in approximately 6- to 8-inch-thick maximum lifts, watered as necessary to achieve near optimum moisture conditions, and then mechanically compacted in place to a minimum relative compaction of 90 percent. Flooding or jetting of the backfill materials should be avoided. A representative of the project geotechnical consultant should observe the backfill procedures and test the wall backfill to verify adequate compaction.

Masonry Block Screen Walls

Construction On or Near the Tops of Descending Slopes

Continuous footings for masonry walls proposed on or within 5 feet from the top of a descending cut or fill slope should be deepened such that a horizontal clearance of 5 feet is maintained between the outside bottom edge of the footing and the slope face. The footings should be reinforced with two No. 4 bars, one top and one bottom. Plans for top-of-slope masonry walls proposing pier and grade beam footings should be reviewed by the project geotechnical consultant prior to construction.

Construction on Level Ground

Where masonry walls are proposed on level ground and 5 feet or more from the tops of descending slopes, the footings for these walls may be founded 18 inches or more below the lowest adjacent final grade. These footings should also be reinforced with two No. 4 bars, one top and one bottom.

Construction Joints

In order to reduce the potential for unsightly cracking related to the effects of differential settlement, positive separations (construction joints) should be provided in the walls at horizontal intervals of approximately 20 to 25 feet and at each corner. The separations should be provided in the blocks only and not extend through the footings. The footings should be placed monolithically with continuous rebars to serve as effective "grade beams" along the full lengths of the walls.

Construction Services

This report has been prepared for the exclusive use of Diversified Pacific Communities to assist the project engineers and architect in the design of the proposed development. It is recommended that Petra be engaged to review the final-design drawings and specifications prior to construction. This is to document that the recommendations contained in this report have been properly interpreted and are incorporated into the project specifications. If Petra is not accorded the opportunity to review these documents, we can take no responsibility for misinterpretation of our recommendations.

We recommend that Petra be retained to provide soil-engineering services during construction of the excavation and foundation phases of the work. This is to observe compliance with the design, specifications, or recommendations and to allow design changes if subsurface conditions differ from those anticipated prior to start of construction.

If the project plans change significantly (e.g., building loads or type of structures), we should be retained to review our original design recommendations and their applicability to the revised construction. If conditions are encountered during construction that appears to be different than those indicated in this report, this office should be notified immediately. Design and construction revisions may be required.

LIMITATIONS

This report is based on the project, as described and the geotechnical data obtained from the field tests performed and our laboratory test data. The materials encountered on the project site and utilized in our

laboratory evaluation are believed representative of the total area. However, soil materials can vary in characteristics between excavations, both laterally and vertically.

The conclusions and opinions contained in this report are based on the results of the described geotechnical evaluations and represent our professional judgment. The findings, conclusions and opinions contained in this report are to be considered tentative only and subject to confirmation by the undersigned during the construction process. Without this confirmation, this report is to be considered incomplete and Petra or the undersigned professionals assume no responsibility for its use. In addition, this report should be reviewed and updated after a period of 1 year or if the site ownership or project concept changes from that described herein.

The professional opinions contained herein have been derived in accordance with current standards of practice and no warranty is expressed or implied.

Respectfully submitted,

PETRA GEOSCIENCES, INC.

2/15/22

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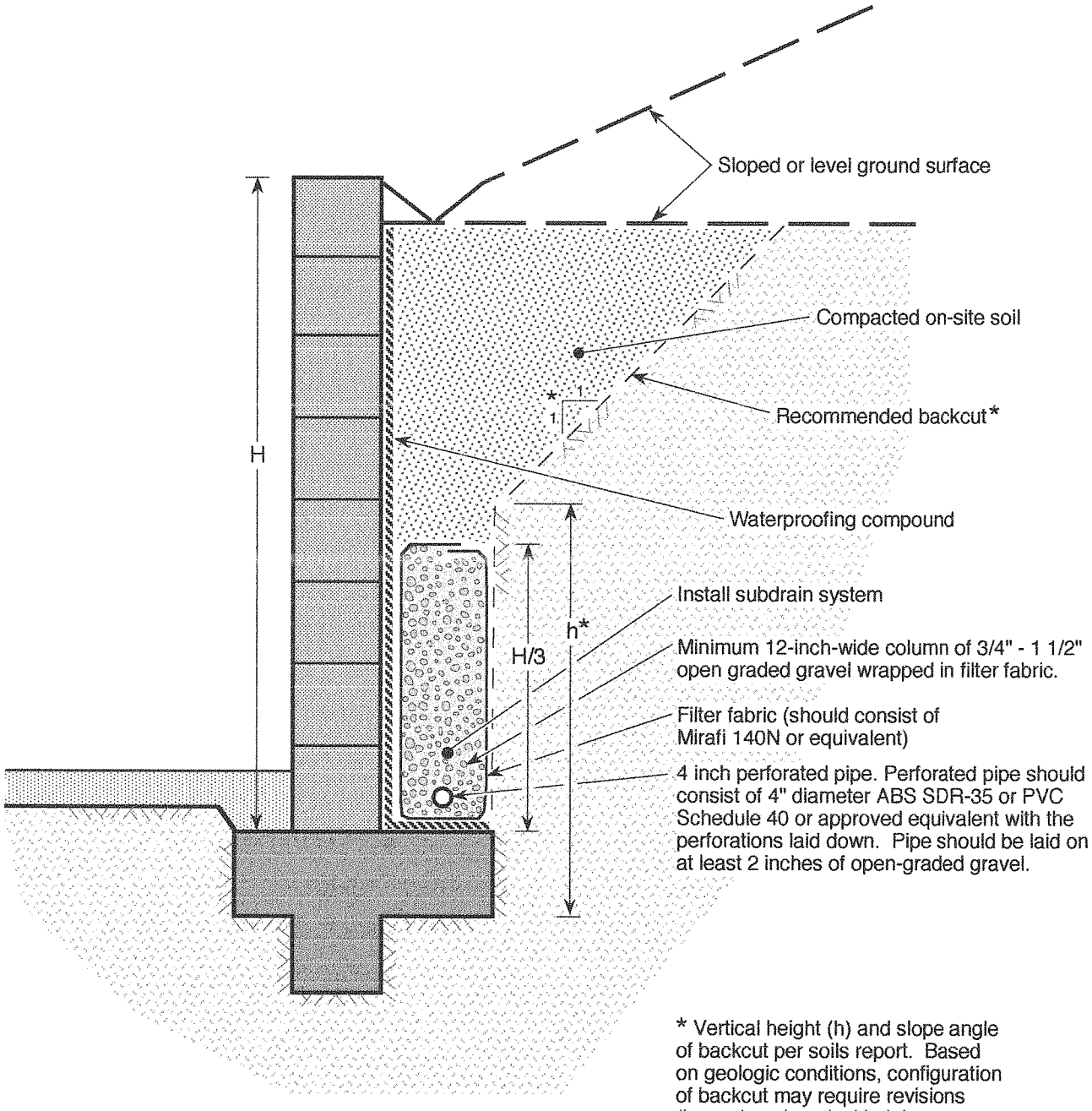
FIGURES

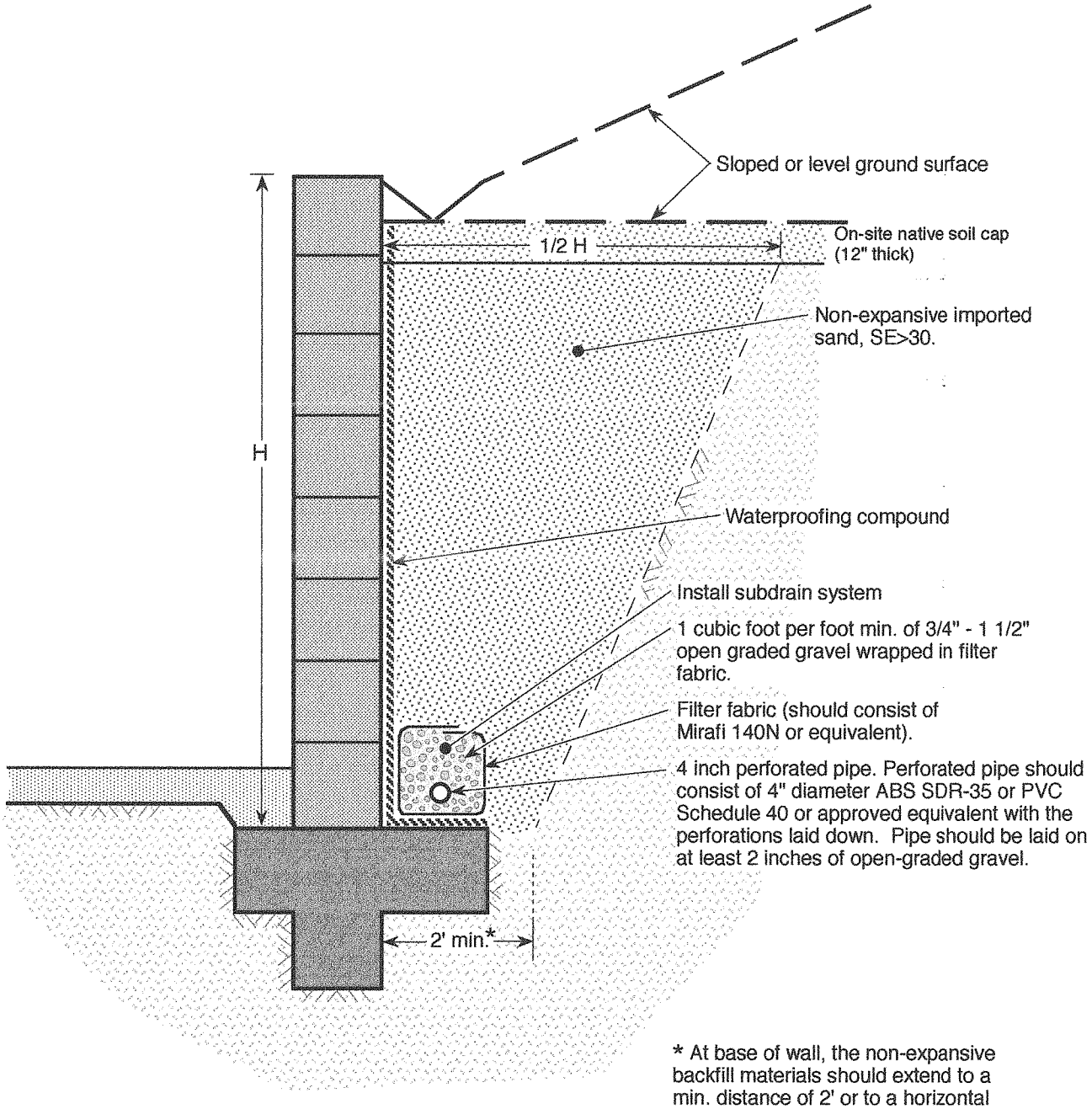
NATIVE SOIL BACKFILL



* Vertical height (h) and slope angle of backcut per soils report. Based on geologic conditions, configuration of backcut may require revisions (i.e. reduced vertical height, revised slope angle, etc.)

PETRA	RETAINING WALL BACKFILL AND SUBDRAIN DETAILS	FIGURE RW-1

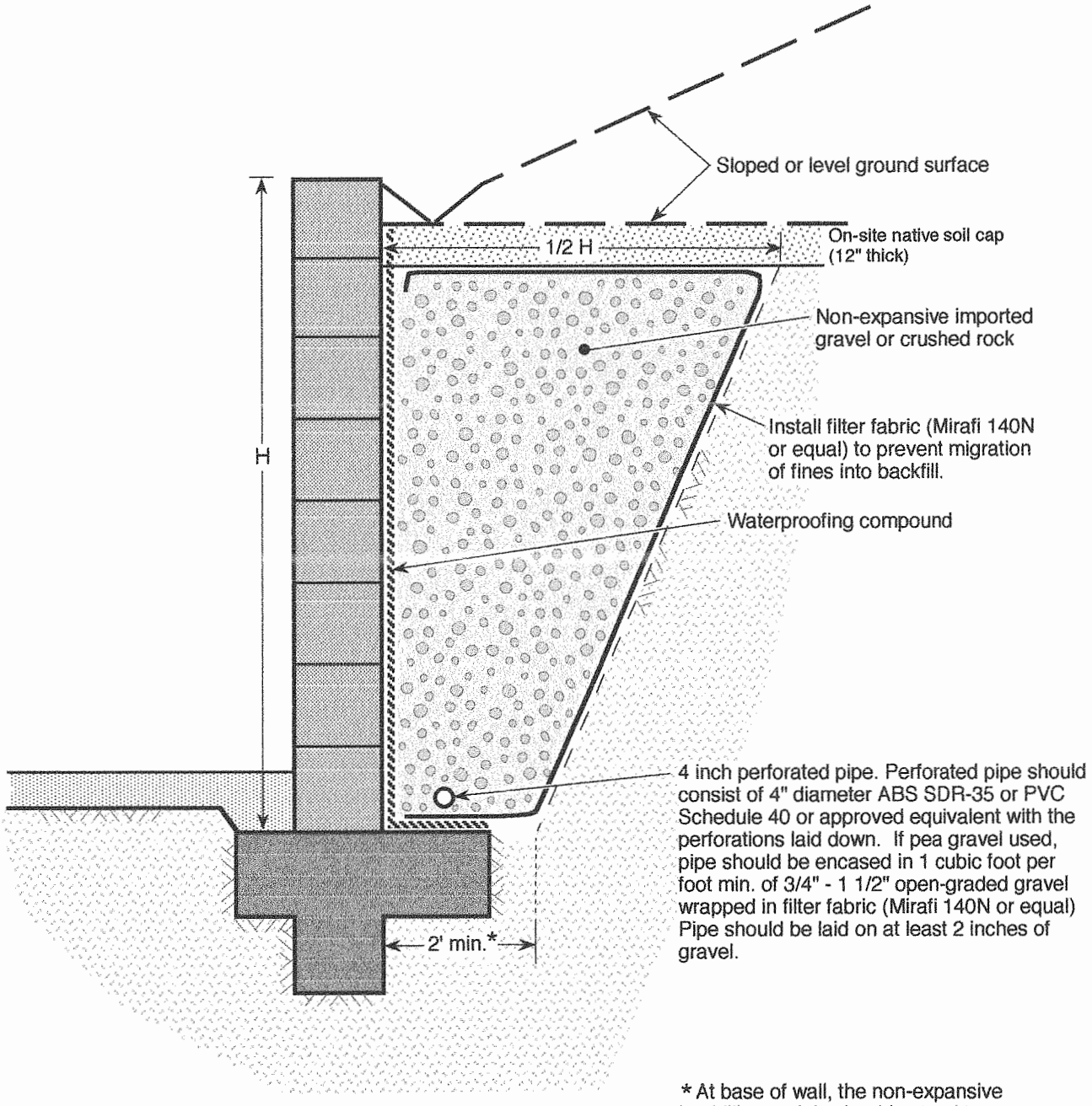
IMPORTED SAND BACKFILL



* At base of wall, the non-expansive backfill materials should extend to a min. distance of 2' or to a horizontal distance equal to the heel width of the footing, whichever is greater.

PETRA	RETAINING WALL BACKFILL AND SUBDRAIN DETAILS	FIGURE RW-2

IMPORTED GRAVEL OR CRUSHED ROCK BACKFILL



* At base of wall, the non-expansive backfill materials should extend to a min. distance of 2' or to a horizontal distance equal to the heel width of the footing, whichever is greater.

PETRA	RETAINING WALL BACKFILL AND SUBDRAIN DETAILS	FIGURE RW-3

- Reproduced from: USGS, 2021, The National Map Viewer

LEGEND

- Approximate Site Location

PETRA GEOSCIENCES, INC.
40880 COUNTY CENTER DRIVE, SUITE M
TEMECULA, CALIFORNIA 92591
PHONE: (951) 600-9271
COSTA MESA MURRIETA PALM DESERT SANTA CLARITA

Site Location Map

LPA Redlands Project: Tennessee St. & Lugonia Ave.
Redlands, San Bernardino County, California

DATE: February 2022	J.N.: 21-458	**Figure 1**
DWG BY: epl	SCALE: NTS	

LEGEND

- - - - - Approximate Limits of Subject Property

P-3 ● - Approximate Location of Sample Boring (Percolation)

B-4 ● - Approximate Location of Sample Boring (Geotechnical)

Base Map Reference: Google Earth, 2021, Photograph dated August.

PETRA GEOSCIENCES, INC.
40880 County Center Drive, Suite M
Temecula, California 92591
PHONE: (714) 549-8921
COSTA MESA TEMECULA VALENCIA PALM DESERT CORONA

Boring and Sample Location Map

LPA Property, Tennessee St. & W. Lugonia Ave.
Redlands, San Bernardino County, California

PETRA GEOSCIENCES INC

DATE: February, 2022

J.N.: 21-458

Figure 2

APPENDIX A

EXPLORATION LOGS

EXPLORATION LOG

Project:	**NEC Tennessee and Lugonia Ave**		Boring No.: **B-1**
Location:	**Redlands, California**		Elevation:
Job No.:	**21-458**	Client: **Diversified Pacific**	Date: **January 6, 2022**
Drill Method:	**Truck Mounted CME-75 Hollowstem**	Driving Weight: **140lbs**	Logged By: **BR**

Depth (Feet)	Lith-ology	Material Description	WATER	Samples: Blows per 6 in.	Samples: Core	Samples: Bulk	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Dry Density (pcf)	Laboratory Tests: Other Lab Tests
0		Topsoil Silty Sand (SM): Olive gray, moist, loose, silty fine to medium grained sand.		2 3 2					
		Olive gray, moist, loose, silty fine to medium sand.		2 4 4			1.8	107.4	
		Alluvium (Qal) Silty Sand (SM): Olive gray, moist, loose, silty fine to medium grained sand.		5					
5		Gray brown, moist, medium dense, silty fine to medium grained sand.		6 7 8			2.8	107.8	
		Gray, medium dense, silty fine to medium grained sand.		7 9 9			2.7	112.3	
		Gray, medium dense, silty fine to medium sand.		6 8 12			15.4	99.1	
10		Olive gray, moist, medium dense, silty fine grained sand.					2.3	102.8	
		Sand (SW): Gray, moist, medium dense, well graded fine to medium grained sand.		15 15 21			1.5	109.4	
15		Gray, moist, medium dense, well graded fine to medium grained sand.		11 15 16			2.8	99.9	
20		Gray brown, moist, medium dense, well graded fine to coarse grained sand.		8 8 8					
25		Silty Sand (SM): Gray brown, moist, medium dense, silty fine grained sand.		8 10 14			18.4	93.8	
30		Olive gray, moist, medium dense, silty fine to medium grained sand.		5 5 6					
35		Interbedded Sand and Silt (SW-SM): Olive brown to gray, moist, medium		14					

PLATE

Petra Geosciences, Inc.

EXPLORATION LOG

Project:	**NEC Tennessee and Lugonia Ave**		Boring No.: **B-1**
Location:	**Redlands, California**		Elevation:
Job No.:	**21-458**	Client: **Diversified Pacific**	Date: **January 6, 2022**
Drill Method:	**Truck Mounted CME-75 Hollowstem**	Driving Weight: **140lbs**	Logged By: **BR**

Depth (Feet)	Lith-ology	Material Description	WATER	Samples: Blows per 6 in.	Samples: Core	Samples: Bulk	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Dry Density (pcf)	Laboratory Tests: Other Lab Tests
		dense, interbedded silty silty fine grained sand and well graded fine to coarse grained sand.		16 17	■		9.3	106.1	
40		Silty Sand (SM): Gray brown, moist, medium dense, silty fine to medium grained sand.		7 9 12	◪				
45		Sand (SW): Gray, dry, medium dense, well graded fine to coarse grained sand.		20 21 26	■		5.1	118.9	
50		Gray, damp, dense, well graded fine to coarse grained sand.		12 14 21	◪				
		Total depth 51.5 feet. No groundwater or seepage. Backfilled with cuttings.							
55									
60									
65									
70									

PLATE

Petra Geosciences, Inc.

EXPLORATION LOG

Project:	**NEC Tennessee and Lugonia Ave**		Boring No.: **B-2**
Location:	**Redlands, California**		Elevation:
Job No.:	**21-458**	Client: **Diversified Pacific**	Date: **January 6, 2022**
Drill Method:	**Truck Mounted CME-75 Hollowstem**	Driving Weight: **140lbs**	Logged By: **BR**

Depth (Feet)	Lith-ology	Material Description	WATER	Samples: Blows per 6 in.	Samples: Core	Samples: Bulk	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Dry Density (pcf)	Laboratory Tests: Other Lab Tests
0		Topsoil Silty Sand (SM): Dark olive gray, moist, loose, silty fine to medium grained sand. loose.		2 3 4	◪				
		Alluvium (Qal) Sand (SW): Gray, damp, medium dense, well graded fine to medium grained sand.		4 7 7 10	■		5.2	107.6	
5		Gray, moist, medium dense, well graded fine to coarse grained sand.		8 9 10	■		1.8	110.1	
		Gray, moist, medium dense, well graded fine to medium grained sand.		10 15 18	■		2.0	109.6	
		Gray, moist, medium dense, well graded fine to coarse grained sand.		3 12 15	■		2.3	110.2	
10		Gray, moist, medium dense, well graded fine to coarse grained sand.		12 16 30	■		2.6	118.7	
		Light gray, moist, medium dense, well graded fine to coarse grained sand, with scattered sub rounded fine grained gravels.		13 16 20	■		1.7	108.1	
15		Light gray, moist, dense, well graded fine to coarse grained sand.		15 21 34	■		1.8	126.0	
20		Interbedded Silt and Sand (SW-SM): Olive brown to gray, damp, loose, interbedded silty fine grained sand and well graded fine to coarse grained sand.		7 5 7	■				
25		Silty Sand (SM): Gray, damp, medium dense, silty fine to medium grained sand.		9 12 18	◪		7.7	108.1	
30									
35									

PLATE

Petra Geosciences, Inc.

EXPLORATION LOG

Project:	**NEC Tennessee and Lugonia Ave**		Boring No.: **B-3**
Location:	**Redlands, California**		Elevation:
Job No.:	**21-458**	Client: **Diversified Pacific**	Date: **January 6, 2022**
Drill Method:	**Truck Mounted CME-75 Hollowstem**	Driving Weight: **140lbs**	Logged By: **BR**

Depth (Feet)	Lith-ology	Material Description	WATER	Samples: Blows per 6 in.	Samples: Core	Samples: Bulk	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Dry Density (pcf)	Laboratory Tests: Other Lab Tests
0		Silty Sand (SM): Dark olive brown to brown, moist, loose, silty fine to medium grained sand.		1 1 2					
		Olive brown, moist, loose, silty fine to medium grained sand, with scattered coarse sand grains.		2 4 5 7			5.0	108.2	
		Alluvium (Qal) Silty Sand (SM): Gray brown, moist, loose, silty fine to medium grained sand.							
5		Light olive, moist, medium dense, silty fine sand.		8 9 11			2.0	100.6	
		Light brown, dry, medium dense, silty fine sand.		7 9 12			2.2	108.5	
		Sand (SW): Gray, damp, medium dense, well graded fine to coarse sand, with sub rounded fine grained gravel.		6 10 13			1.4	105.6	
10		Gray, damp, medium dense, well graded fine to coarse grained sand, with sub rounded fine grained gravel.		13 14 13			1.2	106.9	
15		Silty Sand (SM): Olive gray to gray, moist, medium dense, silty fine to medium grained sand.		7 6 11					
20		Interbedded Silt and Sand (SW-SM): Olive gray and gray, moist, medium dense, interbedded sandy silt and well graded fine to coarse grained sand.		8 11 15					
25		Olive brown to gray, moist, medium dense, interbedded sandy silt and well graded fine to coarse grained sand.		7 12 13					
		Total depth 26.5 feet. No groundwater or seepage. Backfilled with cuttings.							
30									
35									

PLATE

Petra Geosciences, Inc.

EXPLORATION LOG

Project:	**NEC Tennessee and Lugonia Ave**		Boring No.: **B-4**
Location:	**Redlands, California**		Elevation:
Job No.:	**21-458**	Client: **Diversified Pacific**	Date: **January 6, 2022**
Drill Method:	**Truck Mounted CME-75 Hollowstem**	Driving Weight: **140lbs**	Logged By: **BR**

Depth (Feet)	Lith-ology	Material Description	WATER	Samples: Blows per 6 in.	Samples: Core	Samples: Bulk	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Dry Density (pcf)	Laboratory Tests: Other Lab Tests
0		Topsoil Silty Sand (SM): Dark olive brown, damp to moist, loose, silty fine to medium grained sand, with scattered coarse grains.		2 4 3					
		Olive brown, damp, loose, silty fine to medium grained sand.		4 10 7			7.3	103.3	
		Alluvium (Qal) Silty Sand: Olive gray, damp to moist, loose, silty fine to medium grained sand.		7					
5		Olive gray to gray, damp, medium dense, silty fine to medium grained sand.		6 8 10			1.6	106.7	
		Sand (SW): gray brown to gray, damp, medium dense, well graded fine to medium grained sand sand.		6 7 12			1.6	107.2	
		Gray brown, damp, medium dense, well graded fine to coarse grained sand.		8 11 26			3.5	110.5	
10		Silty Sand (SM): Gray, moist, medium dense, silty fine to medium grained sand.		12 11 19			1.6	96.4	
		Gray, moist, medium dense, silty fine to medium grained sand.		10 10 14			3.5	110.2	
15									
		damp to moist, medium dense, silty fine to medium sand, with scattered coarse sand grains.		7 6 9			8.0	91.5	
20									
		Gray, moist, medium dense, silty fine to medium grained sand, with scattered coarse sand grains.		9 9 7					
25		Total depth 26.5 feet. No groundwater or seepage. Backfilled with cuttings.							
30									
35									

PLATE

Petra Geosciences, Inc.

EXPLORATION LOG

Project:	**NEC Tennessee and Lugonia Ave**		Boring No.: **P-1**
Location:	**Redlands, California**		Elevation:
Job No.:	**21-458**	Client: **Diversified Pacific**	Date: **January 6, 2022**
Drill Method:	**Truck Mounted CME-75**	Driving Weight: **140lbs**	Logged By: **BR**

Depth (Feet)	Lith-ology	Material Description	WATER	Samples: Blows per 6 in.	Samples: Core	Samples: Bulk	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Dry Density (pcf)	Laboratory Tests: Other Lab Tests
0		Topsoil Silty Sand (SM): Dark Olive brown, damp, loost, silty fine to medium grained sand, with scattered organics.		2 3					
		Sand (SW-SM): Olive brown, loose, well graded fine to medium grained, with scattered coarse sand grains.		2 3					
		Alluvium (Qal) Sand (SW): Olive gray to gray, moist, medium dense, well graded fine to coarse grained sand.		3 6 9			5.8	109.2	
5		Gray, moist, medium dense, well graded fine to coarse grained sand, with scattered sub rounded fine gravels.		3 6 9 9 12			1.2	122.7	
		Gray, moist, medium dense, well graded fine to coarse grained sand.		17 11 12			2.1	104.7	
		Gray, moist, dense, well graded fine to coarse grained sand, with scattered sub rounded fin to coarse gravels.		16 7 17			2.0	119.8	
10		Gray, moist, dense, well graded fine to coarse grained, with scattered sub rounded fine to coarse grained gravels.		21 15 17 23			2.2	115.1	
15		Light gray, damp, dense, well graded fine to coarse grained sand.		14 19 32			1.5	108.0	
20		Gray, damp, very dense, well graded fine to coarse grained sand.		15 22 41			2.3	118.9	
		Gray, damp, medium dense, well graded fine to coarse grained sand.		17 10 8					
25		Total depth 25.0 feet. No groundwater or seepage. Backfilled with cuttings.							
30									
35									

PLATE

Petra Geosciences, Inc.

EXPLORATION LOG

Project:	**NEC Tennessee and Lugonia Ave**		Boring No.: **P-2**
Location:	**Redlands, California**		Elevation:
Job No.:	**21-458**	Client: **Diversified Pacific**	Date: **January 6, 2022**
Drill Method:	**CME75**	Driving Weight: **140lbs**	Logged By: **BR**

Depth (Feet)	Lith-ology	Material Description	WATER	Samples: Blows per 6 in.	Samples: Core	Samples: Bulk	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Dry Density (pcf)	Laboratory Tests: Other Lab Tests
0		Topsoil Silty Sand (SM): Dark olive brown, moist, loose, silty fine to medium grained. Olive gray, moist, loose, silty fine to medium grained.		1 2 2					
		Alluvium (Qal) Sand (SW): Olive gray, moist, loose, well graded fine to coarse grained.		3 2 3			1.8	111.0	
5		Gray, damp, medium dense, well graded fine to coarse grained.		6 8 11			1.1	98.4	
		Gray brown, moist, dense, well graded fine to coarse grained sand.		8 11 18			2.0	105.7	
10		Gray, moist, medium dense, well graded fine to coarse grained sand.		12 13 18			2.1	107.6	
		Gray to gray brown, moist, medium dense, well graded fine to coarse rained.		14 20 30			1.8	116.1	
		Gray, moist, medium dense, well graded fine to coarse grained sand, with scattered sub rounded gravel.		7 12 15					
15		Total depth 15.0 feet. No groundwater or seepage. Converted to percolation test boring.							
20									
25									
30									
35									

PLATE

Petra Geosciences, Inc.

EXPLORATION LOG

Project:	**NEC Tennessee and Lugonia Ave**		Boring No.: **P-3**
Location:	**Redlands, California**		Elevation:
Job No.:	**21-458**	Client: **Diversified Pacific**	Date: **January 6, 2022**
Drill Method:	**Truck Mounted CME-75 Hollowstem**	Driving Weight: **140lbs**	Logged By: **BR**

Depth (Feet)	Lith-ology	Material Description	WATER	Samples: Blows per 6 in.	Samples: Core	Samples: Bulk	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Dry Density (pcf)	Laboratory Tests: Other Lab Tests
0		Topsoil Silty Sand (SM): Dark olive brown, moist, loose, silty fine to medium grained.		2 3					
		Olive gray, moist, loose, silty fine to medium grained.		2 2 4			1.9	110.2	
		Alluvium (Qal) Silty Sand (SM): Gray, moist, silty fine to medium grained sand.		4 5					
5		Silty Sand (SM): Gray, dry, medium dense, silty fine to coarse grained sand.		6 10 16			1.6	106.9	
		Gray, moist, medium dense, silty fine to medium grained sand.		8 11 11			1.8	105.2	
10		Gray, moist, medium dense, well graded fine to medium grained sand.		7 15 20			2.6	114.6	
		Sand (SW): Gray, damp, medium dense, well graded fine to medium grained sand, with scattered coarse sand grains.		17 19 20			0.9	109.6	
		Silty Sand (SM): Gray brown, damp, loose, silty fine to medium grained.		4 6 8					
15		Total depth 15.0 feet. No groundwater or seepage. Converted to percolation test boring.							
20									
25									
30									
35									

PLATE

Petra Geosciences, Inc.

APPENDIX B

LABORATORY TEST PROCEDURES

LABORATORY DATA SUMMARY

LABORATORY TEST PROCEDURES

Soil Classification

Soils encountered within the exploratory borings were initially classified in the field in general accordance with the visual-manual procedures of the Unified Soil Classification System (ASTM D 2488). The samples were re-examined in the laboratory and the classifications reviewed and then revised where appropriate. The assigned group symbols are presented in the Boring Logs (Appendix A).

In-Situ Moisture and Density

Moisture content and unit dry density of in-place soils were determined in representative strata. Test data are summarized in the Boring Logs (Appendix A).

Maximum Dry Density and Optimum Moisture Content

The maximum dry density and optimum moisture content of the on-site soils were determined for selected bulk samples in accordance with current version of ASTM D 1557. The results of these tests are presented on Plate B-1.

Expansion Index

The expansion index of onsite soils was determined per ASTM D 4829. The expansion index and expansion potential are presented in Plate B-1.

Corrosivity Tests

Chemical analyses were performed on a selected sample to determine concentrations of soluble sulfate and chloride, as well as pH and resistivity. These tests were performed in accordance with California Test Method Nos. 417 (sulfate), 422 (chloride) and 643 (pH and resistivity). Test results are presented in Plate B-1.

Consolidation Potential

Consolidation potential tests were performed in general accordance with ASTM D 2435-03. The test samples were inundated at 1.4 kips per square foot in order to evaluate the effects of a sudden increase in moisture content (hydro-collapse potential). Results of these tests in terms of percent consolidation are presented on Plates B-2 and B-3.

Single-Point Collapse

Volume change (collapse) characteristics of selected undisturbed soil samples were determined by one-dimensional single-point collapse test. This test was performed in general accordance with the latest version of the Test Method ASTM D 5333. Axial loads were applied to laterally restrained 1-inch-high samples. The resulting deformation was recorded at selected time intervals. At a load approximately corresponding to the existing overburden pressure or the anticipated future load, the test samples were inundated in order to evaluate the effect of an increase in moisture content, e.g., hydro-consolidation potential (or heave). Results of this test are graphically presented on Plate B-4.

Direct Shear

A direct shear test was run on a selected sample of soil in accordance with ASTM D 3030-03. Test values are given on Plate B-5.

Percent Passing No. 200 Sieve

Selected samples from the percolation test borings were run through a number 200 sieve in general accordance with the latest version of Test Method ASTM D 1140. The results of these tests are included on Plate B-1.

LABORATORY DATA SUMMARY

Laboratory Maximum Dry Density

Sample Location	Soil Type	Optimum Moisture (%)	Maximum Dry Density (pcf)
B-1 @ 2 – 5’	Grayish brown, silty fine- to medium grain SAND	7.5	126.5
B-2 @ 0 – 3’	Grayish brown, silty fine- to medium grain SAND	8.2	123.5

PER ASTM D 1557

Corrosivity

Sample Location	Sulfate[1] (%)	Chloride[2] (ppm)	pH[3]	Resistivity[3] (ohm-cm)
B-1 @ 2 – 5’	0.0039	255	7.96	13,000

(1) PER CALIFORNIA TEST METHOD NO. 417
(2) PER CALIFORNIA TEST METHOD NO. 422
(3) PER CALIFORNIA TEST METHOD NO. 643

Expansion Index

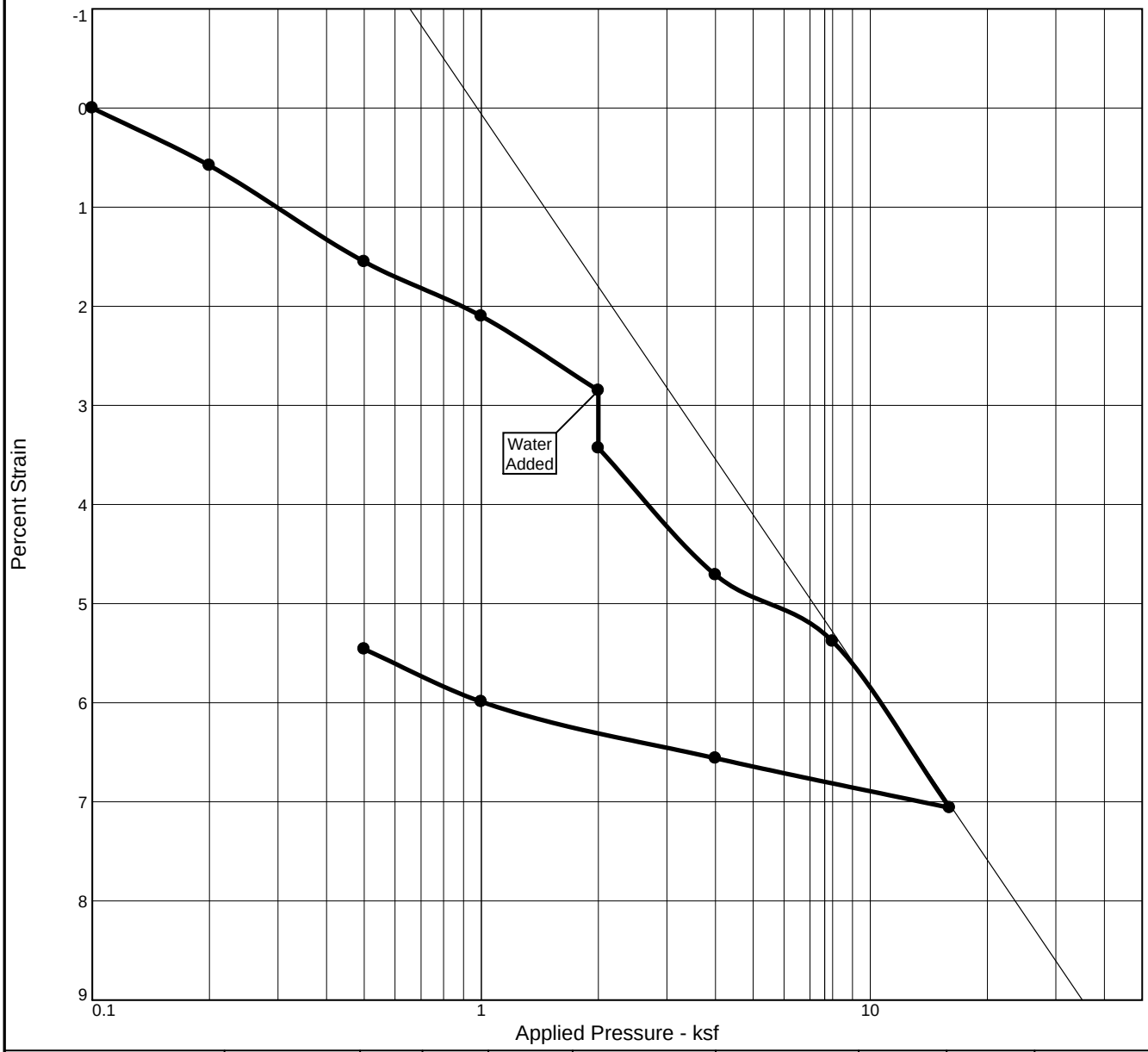
Sample Location Depth (feet)	Soil Type	Expansion[1] Index	Expansion Potential
B-1 @ 2 – 5’	Grayish brown, silty fine- to medium-grain SAND	0	Very Low

(1) PER ASTM D 4829

Percent Passing No. 200 Sieve

Sample Location & Depth (feet)	Percent Passing No. 200 Sieve
P-1 @ 11’	6.4
P-1 @ 20’	8.5
P-2 @ 7’	7.2
P-3 @ 7’	5.9

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	P_c (ksf)	C_c	C_r	Initial Void Ratio
Saturation	Moisture									
12.7 %	2.8 %	103.8			2.65	.43	8.3	0.09	0.02	0.593

MATERIAL DESCRIPTION	USCS	AASHTO
Olive Brown, fine to coarse Sand with Silt		

Project No. 21-458 **Client:** Diversified Pacific

Project: Redlands

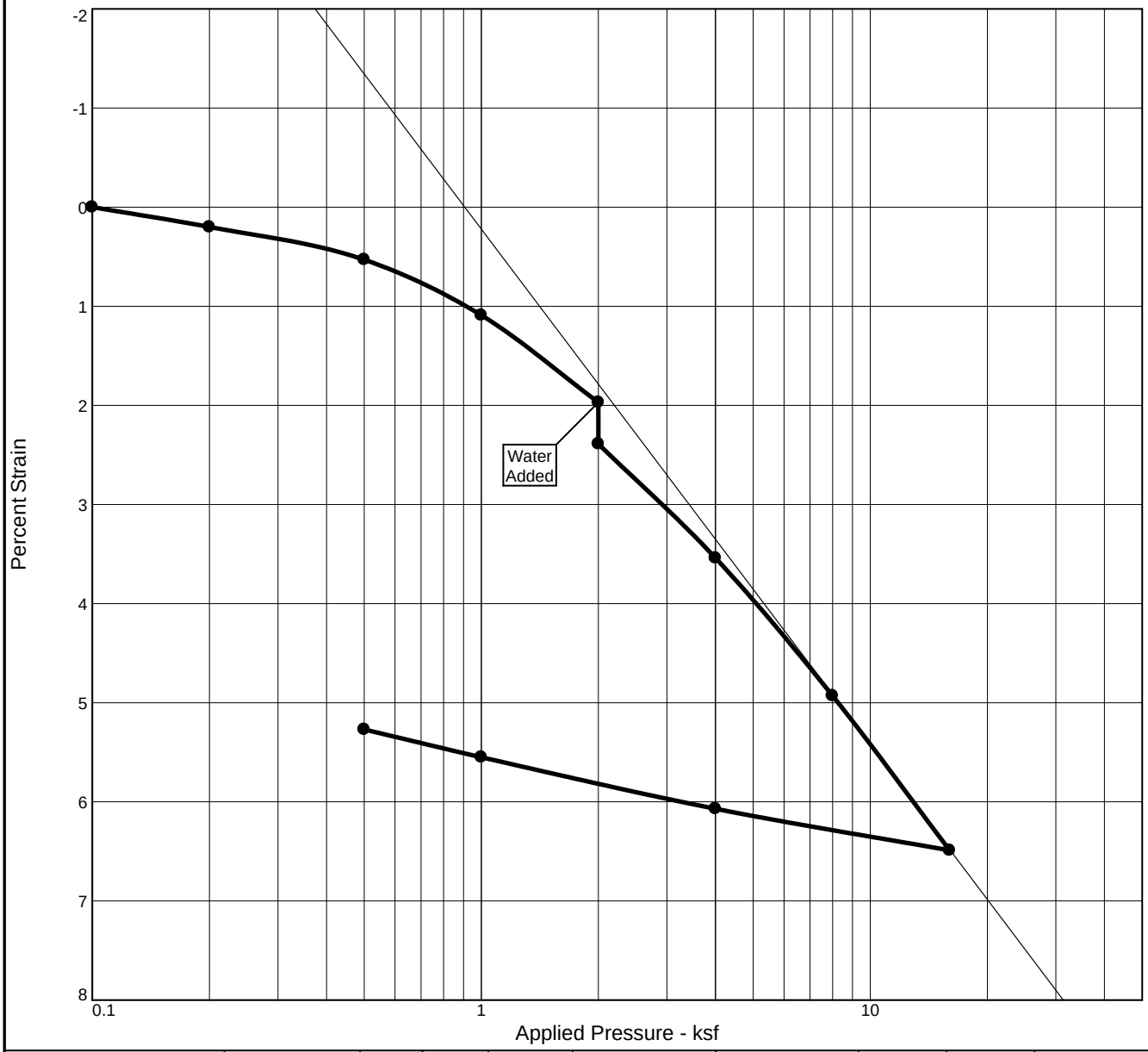
Source of Sample: 22L003 **Depth:** 4 **Sample Number:** B-1

Remarks:

PETRA GEOSCIENCES INC.

Figure B-2

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	P_c (ksf)	C_c	C_r	Initial Void Ratio
Saturation	Moisture									
7.1 %	1.6 %	104.3			2.65	.53	4.6	0.08	0.01	0.586

MATERIAL DESCRIPTION	USCS	AASHTO
Light Gray, fine to coarse Sand		

Project No. 21-458 **Client:** Diversified Pacific

Project: Redlands

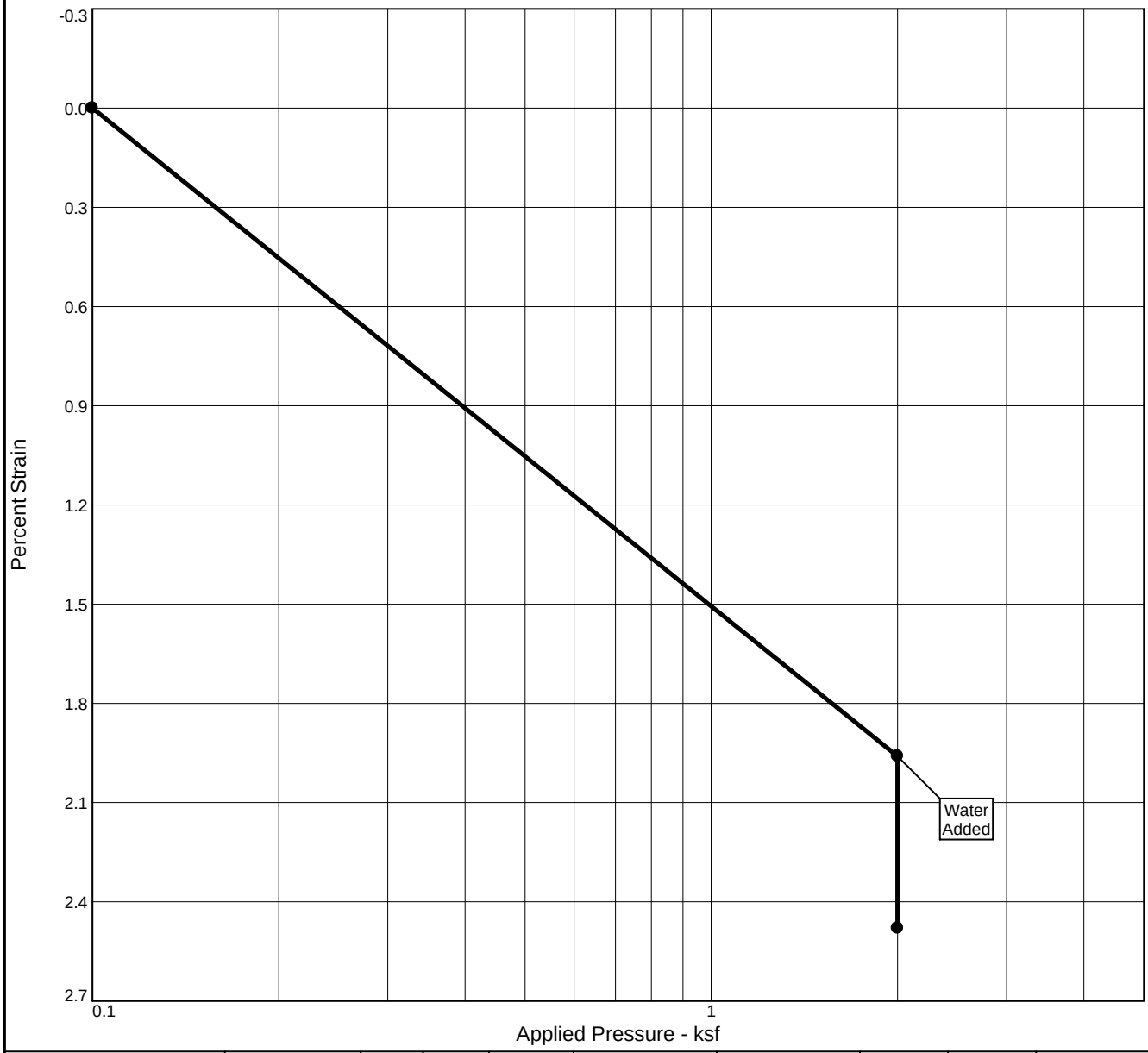
Source of Sample: 22L003 **Depth:** 5 **Sample Number:** B-4

Remarks:

PETRA GEOSCIENCES INC.

Figure B-3

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	P_c (ksf)	C_c	C_r	Initial Void Ratio
Saturation	Moisture									
77.8 %	5.6 %	103.8			2.65	0.22				0.191

MATERIAL DESCRIPTION	USCS	AASHTO
Light Gray, fine to coarse Sand	SP	

Project No. 21-458 **Client:** Diversified Pacific

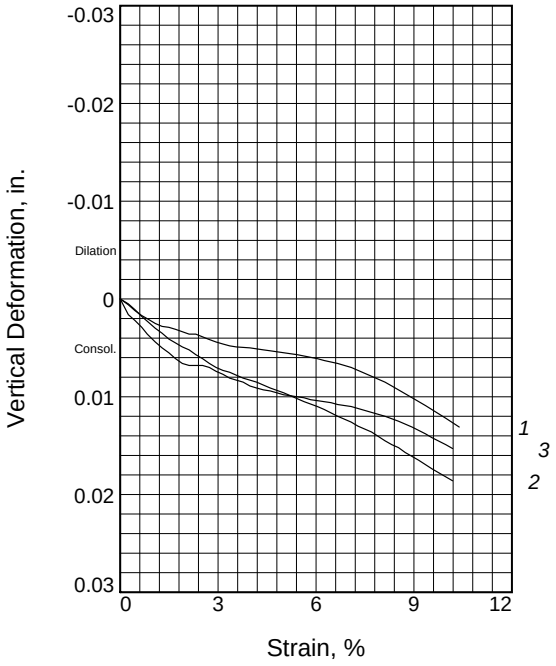
Project: Redlands

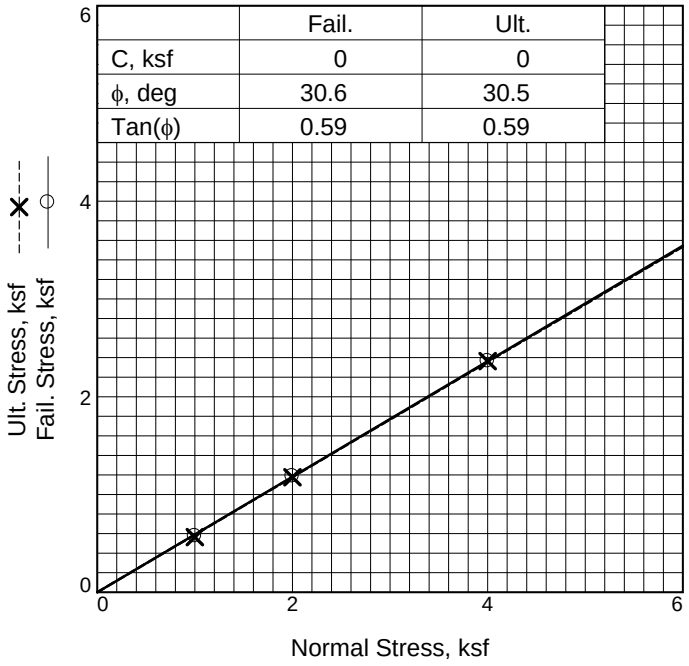
Source of Sample: 22L003 **Depth:** 2 **Sample Number:** P-2

Remarks:

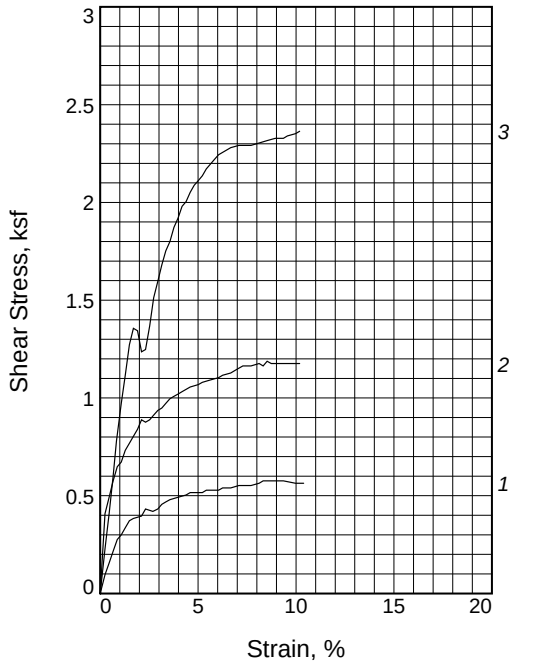
PETRA GEOSCIENCES INC.

Figure B-4





	Fail.	Ult.
C, ksf	0	0
ϕ, deg	30.6	30.5
Tan(ϕ)	0.59	0.59



Sample No.		1	2	3
Initial	Water Content, %	2.0	2.0	2.0
	Dry Density, pcf	95.7	99.0	99.2
	Saturation, %	7.4	8.1	8.1
	Void Ratio	0.7290	0.6707	0.6680
	Diameter, in.	2.42	2.42	2.42
	Height, in.	1.00	1.00	1.00
At Test	Water Content, %	24.9	21.8	20.5
	Dry Density, pcf	99.6	104.6	107.1
	Saturation, %	99.8	99.6	100.0
	Void Ratio	0.6610	0.5813	0.5444
	Diameter, in.	2.42	2.42	2.42
	Height, in.	0.96	0.95	0.93
Normal Stress, ksf		1.00	2.00	4.00
Fail. Stress, ksf		0.58	1.19	2.36
Strain, %		8.3	8.5	10.2
Ult. Stress, ksf		0.56	1.18	2.36
Strain, %		10.0	8.7	10.2
Strain rate, in./min.		0.040	0.040	0.040

Sample Type: Undisturbed
Description: Light Brown, fine to medium Sandy Silt

Specific Gravity= 2.65
Remarks:

Client: Diversified Pacific

Project: Redlands

Source of Sample: 22L003 **Depth:** 5
Sample Number: B-3
Proj. No.: 21-458 **Date Sampled:** 1/18/2022

PETRA GEOSCIENCES INC.

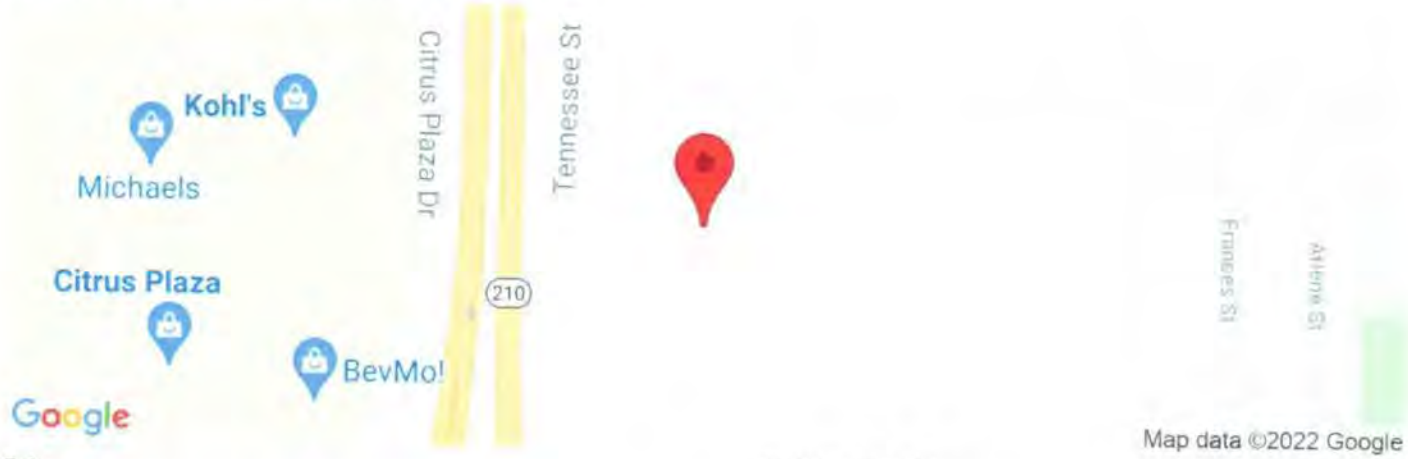
Figure B-5

APPENDIX C

SEISMIC DESIGN PARAMETERS

21-458 Redlands, CA

Latitude, Longitude: 34.072613, -117.198658



Date	1/7/2022, 8:50:04 AM
Design Code Reference Document	ASCE7-16
Risk Category	II
Site Class	D - Default (See Section 11.4.3)

Type	Value	Description
S_S	1.831	MCE_R ground motion. (for 0.2 second period)
S_1	0.73	MCE_R ground motion. (for 1.0s period)
S_{MS}	2.197	Site-modified spectral acceleration value
S_{M1}	null -See Section 11.4.8	Site-modified spectral acceleration value
S_{DS}	1.464	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	1.2	Site amplification factor at 0.2 second
F_v	null -See Section 11.4.8	Site amplification factor at 1.0 second
PGA	0.767	MCE_G peak ground acceleration
F_{PGA}	1.2	Site amplification factor at PGA
PGA_M	0.92	Site modified peak ground acceleration
T_L	8	Long-period transition period in seconds
SsRT	2.582	Probabilistic risk-targeted ground motion. (0.2 second)
SsUH	2.815	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration
SsD	1.831	Factored deterministic acceleration value. (0.2 second)
S1RT	1.017	Probabilistic risk-targeted ground motion. (1.0 second)
S1UH	1.141	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration.
S1D	0.73	Factored deterministic acceleration value. (1.0 second)
PGAd	0.767	Factored deterministic acceleration value. (Peak Ground Acceleration)
C_{RS}	0.917	Mapped value of the risk coefficient at short periods
C_{R1}	0.891	Mapped value of the risk coefficient at a period of 1 s

DISCLAIMER

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APPENDIX D

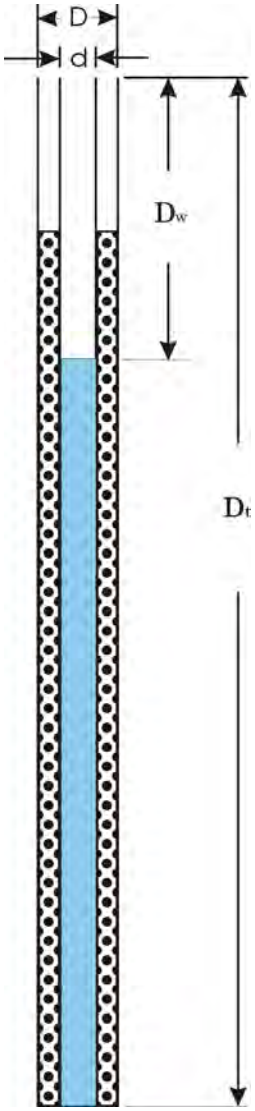
INFILTRATION TEST RESULTS

Test Number: P-1

Shallow Percolation Test Method

Total Depth of Boring, D_t (ft): 25.25
Diameter of Hole, D (in): 8
Diameter of Pipe, d (in): 3
Agg. Correction (% Voids): 40
Pre-soak depth (ft): 10

Time Interval (min)	Depth to Water Surface D_w (ft)		Change in Head (in)	Perc. Rate (min/in)	Perc. Rate (gal/day/ft^2)
	1st Reading	2nd Reading			
10	19.31	24.12	57.72	0.17	113.02
10	18.10	23.95	70.20	0.14	115.86
10	18.40	23.80	64.80	0.15	108.81
10	20.21	23.97	45.12	0.22	98.31
10	18.55	23.85	63.60	0.16	109.33
10	19.50	23.95	53.40	0.19	104.85



Percolation Rate: **0.19** **min/in**
104.9 **gal/day/ft^2**

Infiltration Rate: **14.5** **in/hr***
(Porchet Method)

where Infiltration Rate, $I_t = \Delta H\ (60r) / \Delta t\ (r + 2H_{avg})$

$r = D / 2$
$H_o = D_t - D_o$
$H_f = D_t - D_f$
$\Delta H = \Delta D = H_o - H_f$
$H_{avg} = (H_o + H_f) / 2$

*Raw Number, Does Not Include a Factor of Safety

Reference: RCFCWCD, Design Handbook for LIDBMP, dated September, 2011

PETRA GEOSCIENCES, INC.
40880 County Center Drive, Suite M
Temecula, CA 92591
PHONE: (951) 600-9271
COSTA MESA TEMECULA VALENCIA PALM DESERT CORONA SAN DIEGO

PERCOLATION TEST SUMMARY

Diversified Pacific, LPA Redlands
Redlands, California

DATE: Jan 2022
J.N.: 21-458

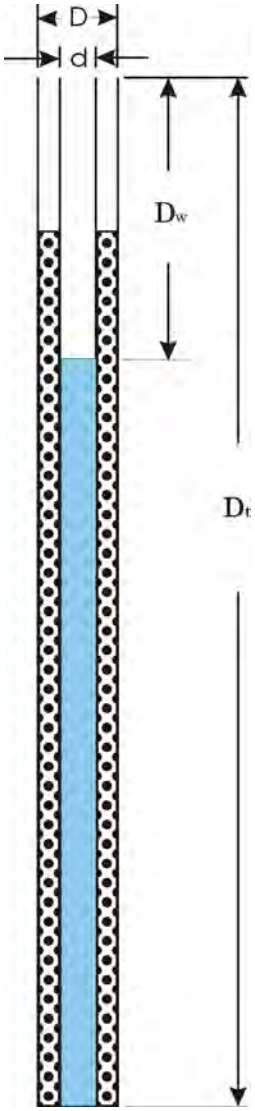
Figure 1

Test Number: P-2

Shallow Percolation Test Method

Total Depth of Boring, D_t (ft): 15.5
Diameter of Hole, D (in): 8
Diameter of Pipe, d (in): 3
Agg. Correction (% Voids): 40
Pre-soak depth (ft): 5

Time Interval (min)	Depth to Water Surface D_w (ft)		Change in Head (in)	Perc. Rate (min/in)	Perc. Rate (gal/day/ft^2)
	1st Reading	2nd Reading			
10	10.30	13.83	42.36	0.24	85.25
10	10.30	13.80	42.00	0.24	84.18
10	9.60	13.70	49.20	0.20	88.79
10	8.00	13.30	63.60	0.16	91.89
10	8.50	13.72	62.64	0.16	99.64
10	8.70	13.80	61.20	0.16	100.44



Percolation Rate: **0.16** **min/in**
100.4 **gal/day/ft^2**

Infiltration Rate: **13.9** **in/hr***
(Porchet Method)

where Infiltration Rate, $I_t = \Delta H\ (60r) / \Delta t\ (r + 2H_{avg})$

$r = D / 2$
$H_o = D_t - D_o$
$H_f = D_t - D_f$
$\Delta H = \Delta D = H_o - H_f$
$H_{avg} = (H_o + H_f) / 2$

*Raw Number, Does Not Include a Factor of Safety

Reference: RCFCWCD, Design Handbook for LIDBMP, dated September, 2011

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PERCOLATION TEST SUMMARY

Diversified Pacific, LPA Redlands
Redlands, California

DATE: Jan 2022
J.N.: 21-458

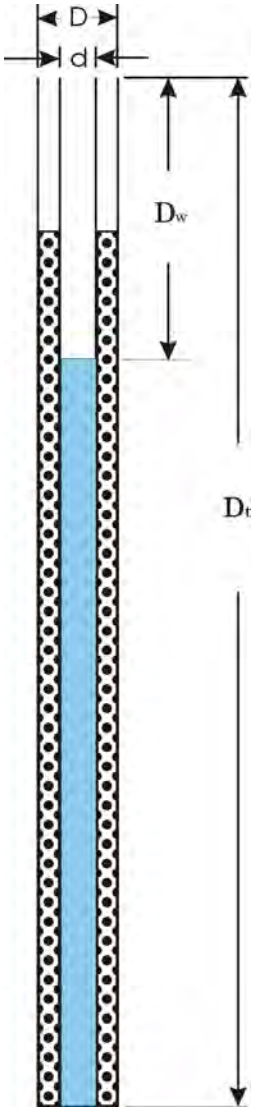
Figure 2

Test Number: P-3

Shallow Percolation Test Method

Total Depth of Boring, D_t (ft): 15.33
Diameter of Hole, D (in): 8
Diameter of Pipe, d (in): 3
Agg. Correction (% Voids): 40
Pre-soak depth (ft): 5

Time Interval (min)	Depth to Water Surface D_w (ft)		Change in Head (in)	Perc. Rate (min/in)	Perc. Rate (gal/day/ft^2)
	1st Reading	2nd Reading			
10	7.00	11.40	52.80	0.19	60.78
10	5.90	11.30	64.80	0.15	68.11
10	4.75	10.92	74.04	0.14	70.05
10	4.90	10.60	68.40	0.15	64.00
10	4.50	10.20	68.40	0.15	60.86
10	7.00	10.40	40.80	0.25	43.51



Percolation Rate: **0.25** **min/in**
43.5 **gal/day/ft^2**

Infiltration Rate: **6.0** **in/hr***
(Porchet Method)

where Infiltration Rate, $I_t = \Delta H\ (60r) / \Delta t\ (r + 2H_{avg})$

$r = D / 2$
$H_o = D_t - D_o$
$H_f = D_t - D_f$
$\Delta H = \Delta D = H_o - H_f$
$H_{avg} = (H_o + H_f) / 2$

*Raw Number, Does Not Include a Factor of Safety

Reference: RCFCWCD, Design Handbook for LIDBMP, dated September, 2011

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PERCOLATION TEST SUMMARY

Diversified Pacific, LPA Redlands
Redlands, California

DATE: Jan 2022
J.N.: 21-458

Figure 3

APPENDIX E

STANDARD GRADING SPECIFICATIONS

STANDARD GRADING SPECIFICATIONS

These specifications present the usual and minimum requirements for projects on which Petra Geosciences, Inc. (Petra) is the geotechnical consultant. No deviation from these specifications will be allowed, except where specifically superseded in the preliminary geology and soils report, or in other written communication signed by the Soils Engineer and Engineering Geologist of record (Geotechnical Consultant).

I. GENERAL

A. The Geotechnical Consultant is the Owner's or Builder's representative on the project. For the purpose of these specifications, participation by the Geotechnical Consultant includes that observation performed by any person or persons employed by, and responsible to, the licensed Soils Engineer and Engineering Geologist signing the soils report.

B. The contractor should prepare and submit to the Owner and Geotechnical Consultant a work plan that indicates the sequence of earthwork grading, the number of "spreads" and the estimated quantities of daily earthwork to be performed prior to the commencement of grading. This work plan should be reviewed by the Geotechnical Consultant to schedule personnel to perform the appropriate level of observation, mapping, and compaction testing as necessary.

C. All clearing, site preparation, or earthwork performed on the project shall be conducted by the Contractor in accordance with the recommendations presented in the geotechnical report and under the observation of the Geotechnical Consultant.

D. It is the Contractor's responsibility to prepare the ground surface to receive the fills to the satisfaction of the Geotechnical Consultant and to place, spread, mix, water, and compact the fill in accordance with the specifications of the Geotechnical Consultant. The Contractor shall also remove all material considered unsatisfactory by the Geotechnical Consultant.

E. It is the Contractor's responsibility to have suitable and sufficient compaction equipment on the job site to handle the amount of fill being placed. If necessary, excavation equipment will be shut down to permit completion of compaction to project specifications. Sufficient watering apparatus will also be provided by the Contractor, with due consideration for the fill material, rate of placement, and time of year.

F. After completion of grading a report will be submitted by the Geotechnical Consultant.

II. SITE PREPARATION

A. Clearing and Grubbing

1. All vegetation such as trees, brush, grass, roots, and deleterious material shall be disposed of offsite. This removal shall be concluded prior to placing fill.

2. Any underground structures such as cesspools, cisterns, mining shafts, tunnels, septic tanks, wells, pipe lines, etc., are to be removed or treated in a manner prescribed by the Geotechnical Consultant.

III. FILL AREA PREPARATION

A. Remedial Removals/Overexcavations

1. Remedial removals, as well as overexcavation for remedial purposes, shall be evaluated by the Geotechnical Consultant. Remedial removal depths presented in the geotechnical report and shown on the geotechnical plans are estimates only. The actual extent of removal should be determined by the Geotechnical Consultant based on the conditions exposed during grading. All soft, loose, dry, saturated, spongy, organic-rich, highly fractured or otherwise unsuitable ground shall be overexcavated to competent ground as determined by the Geotechnical Consultant.

2. Soil, alluvium, or bedrock materials determined by the Soils Engineer as being unsuitable for placement in compacted fills shall be removed from the site. Any material incorporated as a part of a compacted fill must be approved by the Geotechnical Consultant.

3. Should potentially hazardous materials be encountered, the Contractor should stop work in the affected area. An environmental consultant specializing in hazardous materials should be notified immediately for evaluation and handling of these materials prior to continuing work in the affected area.

B. Evaluation/Acceptance of Fill Areas

All areas to receive fill, including removal and processed areas, key bottoms, and benches, shall be observed, mapped, elevations recorded, and/or tested prior to being accepted by the Geotechnical Consultant as suitable to receive fill. The contractor shall obtain a written acceptance from the Geotechnical Consultant prior to fill placement. A licensed surveyor shall provide sufficient survey control for determining locations and elevations of processed areas, keys, and benches.

C. Processing

After the ground surface to receive fill has been declared satisfactory for support of fill by the Geotechnical Consultant, it shall be scarified to a minimum depth of 6 inches and until the ground surface is uniform and free from ruts, hollows, hummocks, or other uneven features which may prevent uniform compaction.

The scarified ground surface shall then be brought to optimum moisture, mixed as required, and compacted to a minimum relative compaction of 90 percent.

D. Subdrains

Subdrainage devices shall be constructed in compliance with the ordinances of the controlling governmental agency, and/or with the recommendations of the Geotechnical Consultant. (Typical Canyon Subdrain details are given on Plate SG-1).

E. Cut/Fill & Deep Fill/Shallow Fill Transitions

In order to provide uniform bearing conditions in cut/fill and deep fill/shallow fill transition lots, the cut and shallow fill portions of the lot should be overexcavated to the depths and the horizontal limits discussed in the approved geotechnical report and replaced with compacted fill. (Typical details are given on Plate SG-7.)

STANDARD GRADING SPECIFICATIONS

IV. COMPACTED FILL MATERIAL

A. General

Materials excavated on the property may be utilized in the fill, provided each material has been determined to be suitable by the Geotechnical Consultant. Material to be used for fill shall be essentially free of organic material and other deleterious substances. Roots, tree branches, and other matter missed during clearing shall be removed from the fill as recommended by the Geotechnical Consultant. Material that is spongy, subject to decay, or otherwise considered unsuitable shall not be used in the compacted fill.

Soils of poor quality, such as those with unacceptable gradation, high expansion potential, or low strength shall be placed in areas acceptable to the Geotechnical Consultant or mixed with other soils to achieve satisfactory fill material.

B. Oversize Materials

Oversize material defined as rock, or other irreducible material with a maximum dimension greater than 12 inches in diameter, shall be taken offsite or placed in accordance with the recommendations of the Geotechnical Consultant in areas designated as suitable for rock disposal (Typical details for Rock Disposal are given on Plate SG-4).

Rock fragments less than 12 inches in diameter may be utilized in the fill provided, they are not nested or placed in concentrated pockets; they are surrounded by compacted fine grained soil material and the distribution of rocks is approved by the Geotechnical Consultant.

C. Laboratory Testing

Representative samples of materials to be utilized as compacted fill shall be analyzed by the laboratory of the Geotechnical Consultant to determine their physical properties. If any material other than that previously tested is encountered during grading, the appropriate analysis of this material shall be conducted by the Geotechnical Consultant as soon as possible.

D. Import

If importing of fill material is required for grading, proposed import material should meet the requirements of the previous section. The import source shall be given to the Geotechnical Consultant at least 2 working days prior to importing so that appropriate tests can be performed and its suitability determined.

V. FILL PLACEMENT AND COMPACTION

A. Fill Layers

Material used in the compacting process shall be evenly spread, watered, processed, and compacted in thin lifts not to exceed 6 inches in thickness to obtain a uniformly dense layer. The fill shall be placed and compacted on a horizontal plane, unless otherwise approved by the Geotechnical Consultant.

B. Moisture Conditioning

Fill soils shall be watered, dried back, blended, and/or mixed, as necessary to attain a relatively uniform moisture content at or slightly above optimum moisture content.

C. Compaction

Each layer shall be compacted to 90 percent of the maximum density in compliance with the testing method specified by the controlling governmental agency. (In general, ASTM D 1557-02, will be used.)

If compaction to a lesser percentage is authorized by the controlling governmental agency because of a specific land use or expansive soils condition, the area to received fill compacted to less than 90 percent shall either be delineated on the grading plan or appropriate reference made to the area in the soils report.

D. Failing Areas

If the moisture content or relative density varies from that required by the Geotechnical Consultant, the Contractor shall rework the fill until it is approved by the Geotechnical Consultant.

E. Benching

All fills shall be keyed and benched through all topsoil, colluvium, alluvium or creep material, into sound bedrock or firm material where the slope receiving fill exceeds a ratio of 5 horizontal to 1 vertical, in accordance with the recommendations of the Geotechnical Consultant.

VI. SLOPES

A. Fill Slopes

The contractor will be required to obtain a minimum relative compaction of 90 percent out to the finish slope face of fill slopes, buttresses, and stabilization fills. This may be achieved by either overbuilding the slope and cutting back to the compacted core, or by direct compaction of the slope face with suitable equipment, or by any other procedure that produces the required compaction.

B. Side Hill Fills

The key for side hill fills shall be a minimum of 15 feet within bedrock or firm materials, unless otherwise specified in the soils report. (See detail on Plate SG-5.)

C. Fill-Over-Cut Slopes

Fill-over-cut slopes shall be properly keyed through topsoil, colluvium or creep material into rock or firm materials, and the transition shall be stripped of all soils prior to placing fill. (see detail on Plate SG-6).

D. Landscaping

All fill slopes should be planted or protected from erosion by other methods specified in the soils report.

E. Cut Slopes

1. The Geotechnical Consultant should observe all cut slopes at vertical intervals not exceeding 10 feet.

2. If any conditions not anticipated in the preliminary report such as perched water, seepage, lenticular or confined strata of a potentially adverse nature, unfavorably inclined bedding, joints or fault planes are encountered during grading, these conditions shall be evaluated by the Geotechnical Consultant, and recommendations shall be made to treat these problems (Typical details for stabilization of a portion of a cut slope are given in Plates SG-2 and SG-3.).

3. Cut slopes that face in the same direction as the prevailing drainage shall be protected from slope wash by a non-erodible interceptor swale placed at the top of the slope.

4. Unless otherwise specified in the soils and geological report, no cut slopes shall be excavated higher or steeper than that allowed by the ordinances of controlling governmental agencies.

5. Drainage terraces shall be constructed in compliance with the ordinances of controlling governmental agencies, or with the recommendations of the Geotechnical Consultant.

VII. GRADING OBSERVATION

A. General

All cleanouts, processed ground to receive fill, key excavations, subdrains, and rock disposals must be observed and approved by the Geotechnical Consultant prior to placing any fill. It shall be the Contractor's responsibility to notify the Geotechnical Consultant when such areas are ready.

B. Compaction Testing

Observation of the fill placement shall be provided by the Geotechnical Consultant during the progress of grading. Location and frequency of tests shall be at the Consultants discretion based on field conditions encountered. Compaction test locations will not necessarily be selected on a random basis. Test locations may be selected to verify adequacy of compaction levels in areas that are judged to be susceptible to inadequate compaction.

C. Frequency of Compaction Testing

In general, density tests should be made at intervals not exceeding 2 feet of fill height or every 1000 cubic yards of fill placed. This criteria will vary depending on soil conditions and the size of the job. In any event, an adequate number of field density tests shall be made to verify that the required compaction is being achieved.

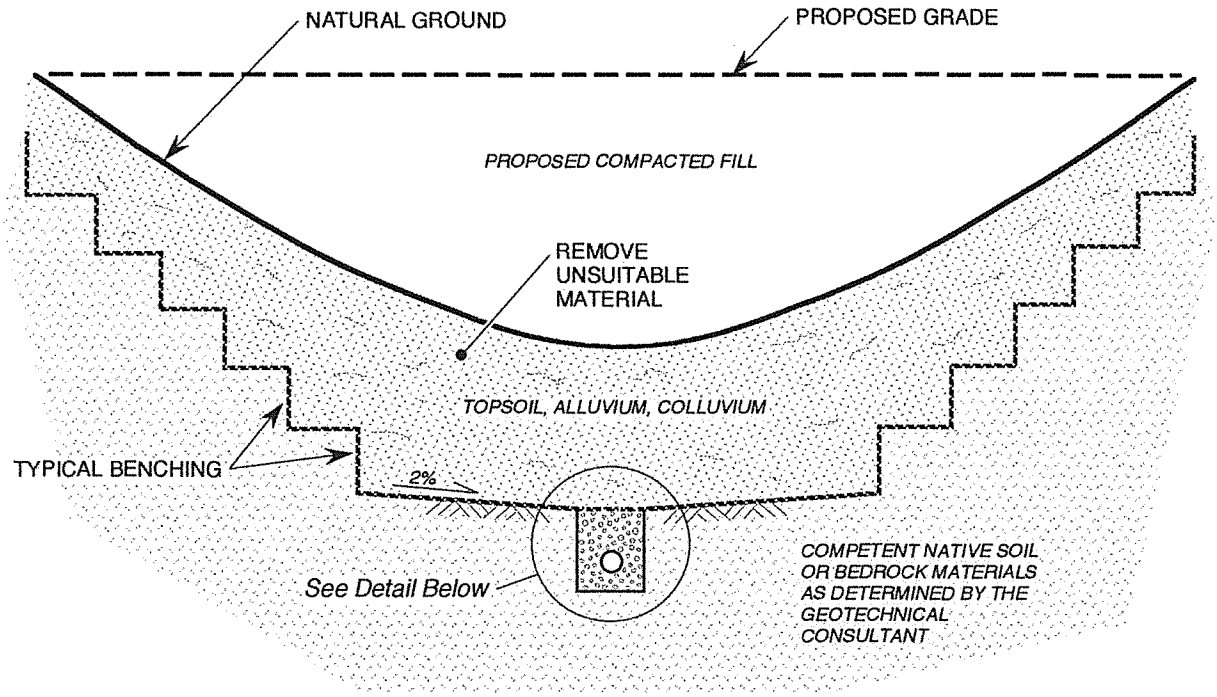
VIII. CONSTRUCTION CONSIDERATIONS

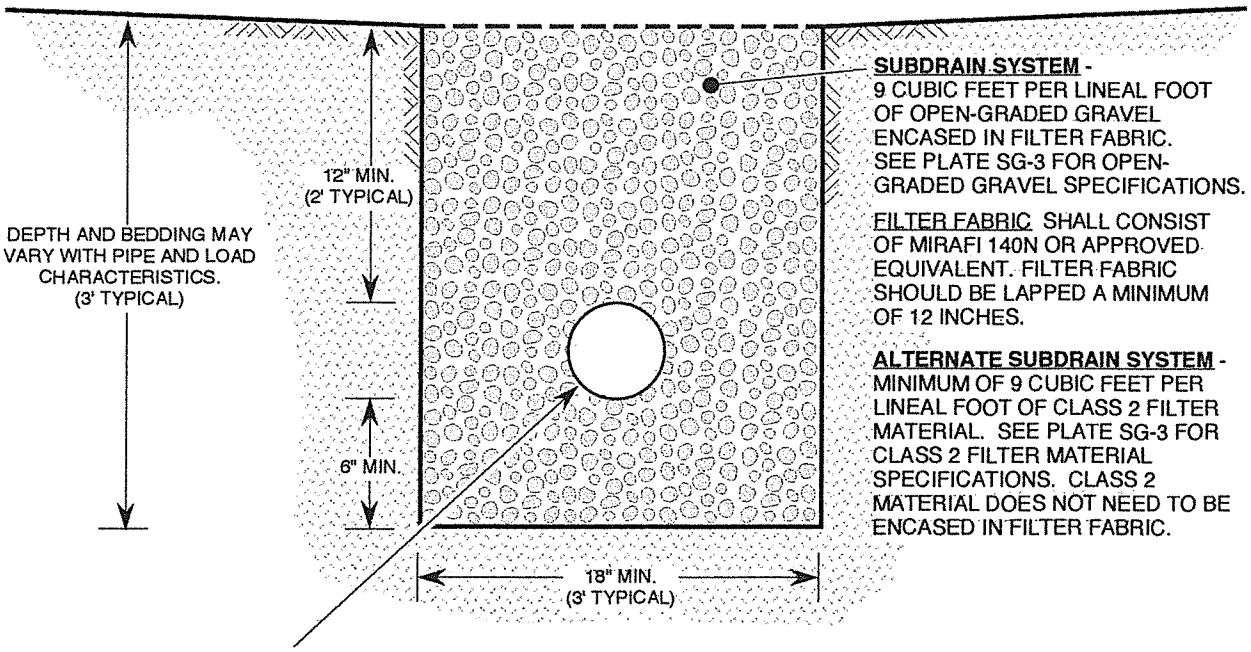
A. Erosion control measures, when necessary, shall be provided by the Contractor during grading and prior to the completion and construction of permanent drainage controls.

B. Upon completion of grading and termination of observations by the Geotechnical Consultant, no further filling or excavating, including that necessary for footings, foundations, large tree wells, retaining walls, or other features shall be performed without the approval of the Geotechnical Consultant.

C. Care shall be taken by the Contractor during final grading to preserve any berms, drainage terraces, interceptor swales, or other devices of permanent nature on or adjacent to the property.

S:\!BOILERS-WORK\REPORT INSERTS\STANDARD GRADING SPECS





SUBDRAIN SYSTEM - 9 CUBIC FEET PER LINEAL FOOT OF OPEN-GRADED GRAVEL ENCASED IN FILTER FABRIC. SEE PLATE SG-3 FOR OPEN-GRADED GRAVEL SPECIFICATIONS.

FILTER FABRIC SHALL CONSIST OF MIRAFI 140N OR APPROVED EQUIVALENT. FILTER FABRIC SHOULD BE LAPPED A MINIMUM OF 12 INCHES.

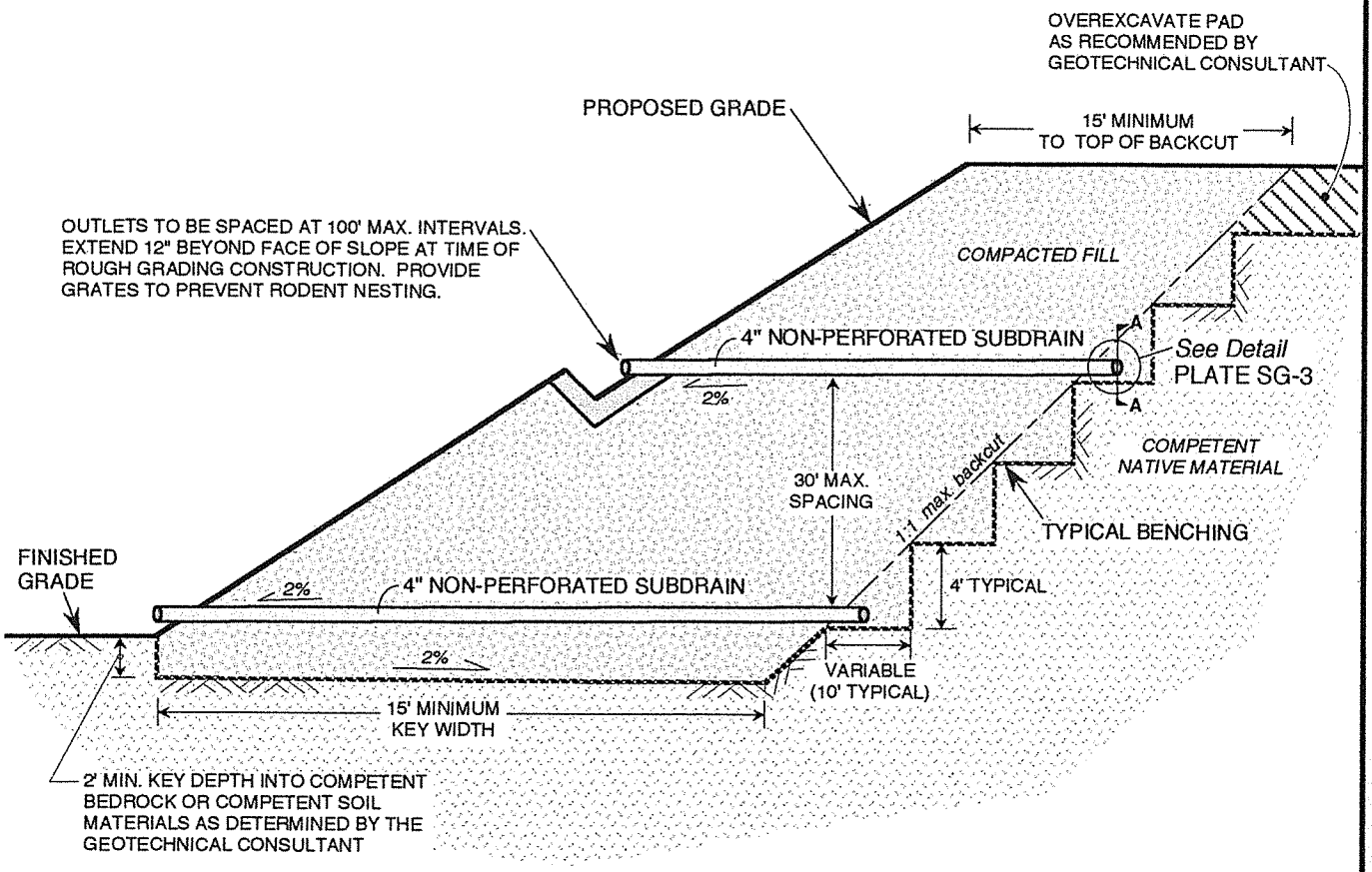
ALTERNATE SUBDRAIN SYSTEM - MINIMUM OF 9 CUBIC FEET PER LINEAL FOOT OF CLASS 2 FILTER MATERIAL. SEE PLATE SG-3 FOR CLASS 2 FILTER MATERIAL SPECIFICATIONS. CLASS 2 MATERIAL DOES NOT NEED TO BE ENCASED IN FILTER FABRIC.

MINIMUM 6-INCH DIAMETER PVC SCHEDULE 40, OR ABS SDR-35 WITH A MINIMUM OF EIGHT 1/4-INCH DIAMETER PERFORATIONS PER LINEAL FOOT IN BOTTOM HALF OF PIPE. PIPE TO BE LAID WITH PERFORATIONS FACING DOWN.

NOTES:

1. FOR CONTINUOUS RUNS IN EXCESS OF 500 FEET USE 8-INCH DIAMETER PIPE.
2. FINAL 20 FEET OF PIPE AT OUTLET SHALL BE NON-PERFORATED AND BACKFILLED WITH FINE-GRAINED MATERIAL.

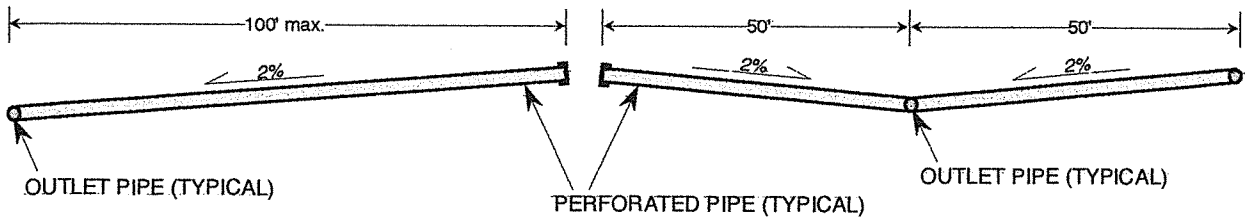
PETRA	CANYON SUBDRAIN DETAIL	PLATE SG-1



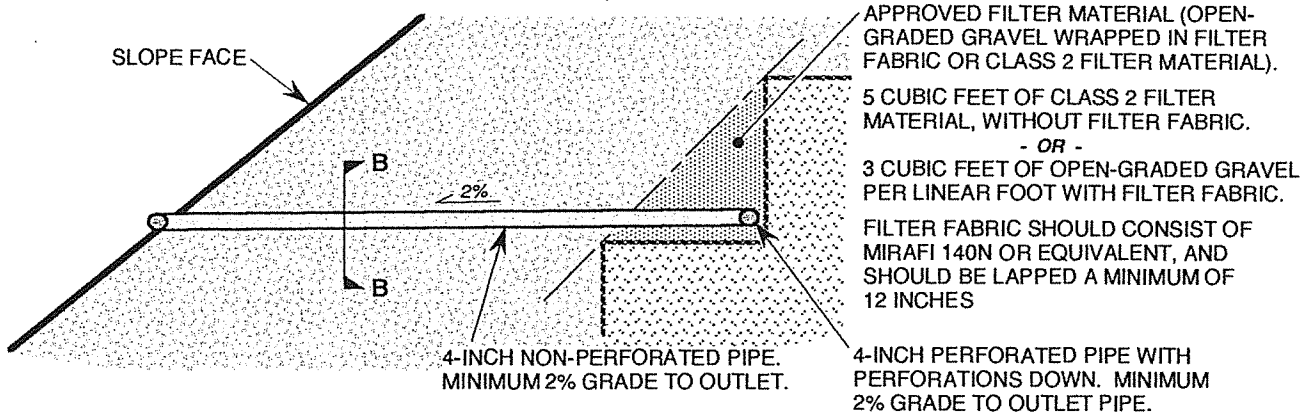
NOTES:

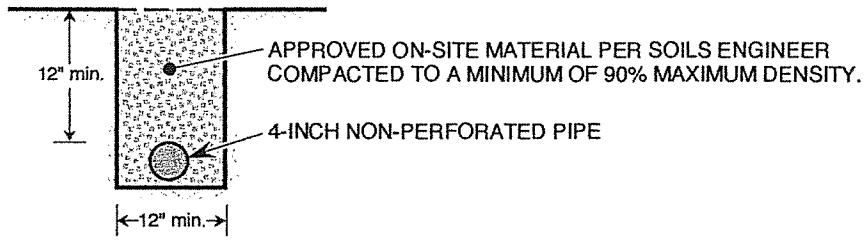
1. 30' MAXIMUM VERTICAL SPACING BETWEEN SUBDRAIN SYSTEMS.
2. 100' MAXIMUM HORIZONTAL DISTANCE BETWEEN NON-PERFORATED OUTLET PIPES. *(See Below)*
3. MINIMUM GRADIENT OF 2% FOR ALL PERFORATED AND NON-PERFORATED PIPE.

SECTION A-A (PERFORATED PIPE PROFILE)



PETRA	BUTTRESS OR STABILIZATION FILL DETAIL	PLATE SG-2





SECTION B-B (OUTLET PIPE)

PIPE SPECIFICATIONS:

1. 4-INCH MINIMUM DIAMETER, PVC SCHEDULE 40 OR ABS SDR-35.
2. FOR PERFORATED PIPE, MINIMUM 8 PERFORATIONS PER FOOT ON BOTTOM HALF OF PIPE.

FILTER MATERIAL/FABRIC SPECIFICATIONS:

OPEN-GRADED GRAVEL ENCASED IN FILTER FABRIC.
(MIRAFI 140N OR EQUIVALENT)

OPEN-GRADED GRAVEL

SIEVE SIZE	PERCENT PASSING
1 1/2-INCH	88 - 100
1-INCH	5 - 40
3/4-INCH	0 - 17
3/8-INCH	0 - 7
No. 200	0 - 3

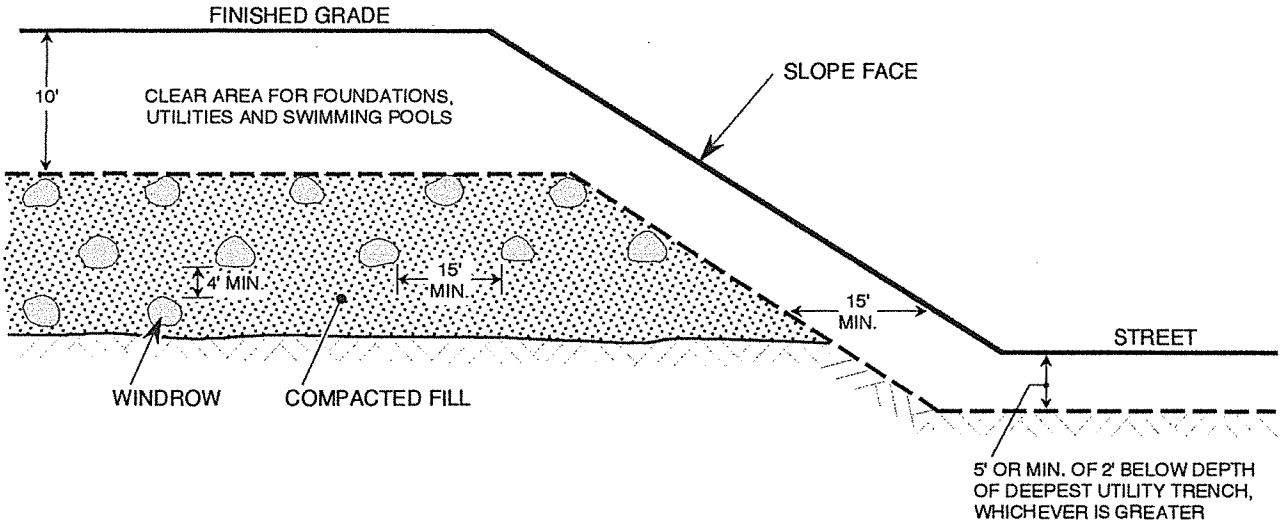
ALTERNATE:

CLASS 2 PERMEABLE FILTER MATERIAL PER CALTRANS STANDARD SPECIFICATION 68-1.025.

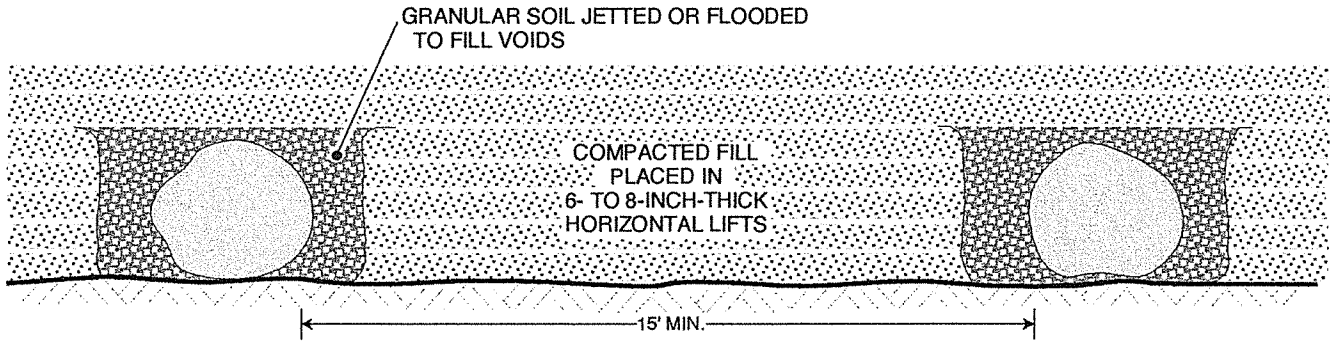
CLASS 2 FILTER MATERIAL

SIEVE SIZE	PERCENT PASSING
1-INCH	100
3/4-INCH	90 - 100
3/8-INCH	40 - 100
No. 4	25 - 40
No. 8	18 - 33
No. -30	5 - 15
No. -50	0 - 7
No. 200	0 - 3

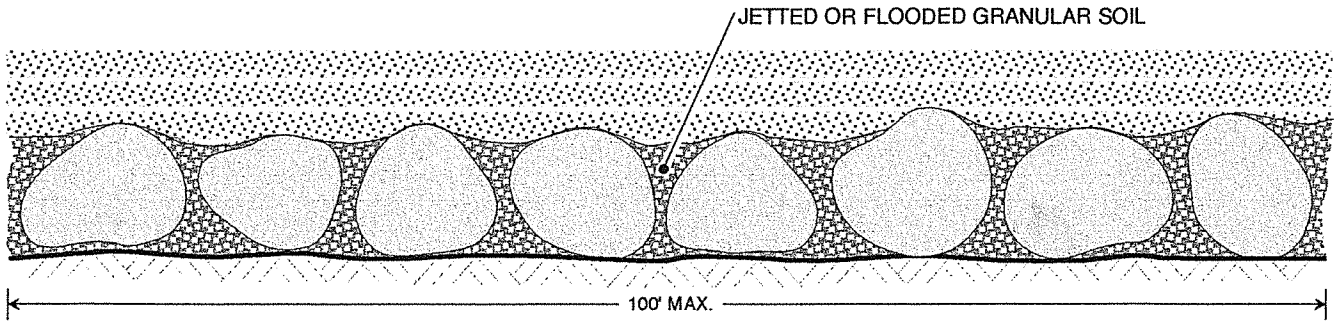
PETRA	BUTTRESS OR STABILIZATION FILL SUBDRAIN	PLATE SG-3



TYPICAL WINDROW DETAIL (END VIEW)

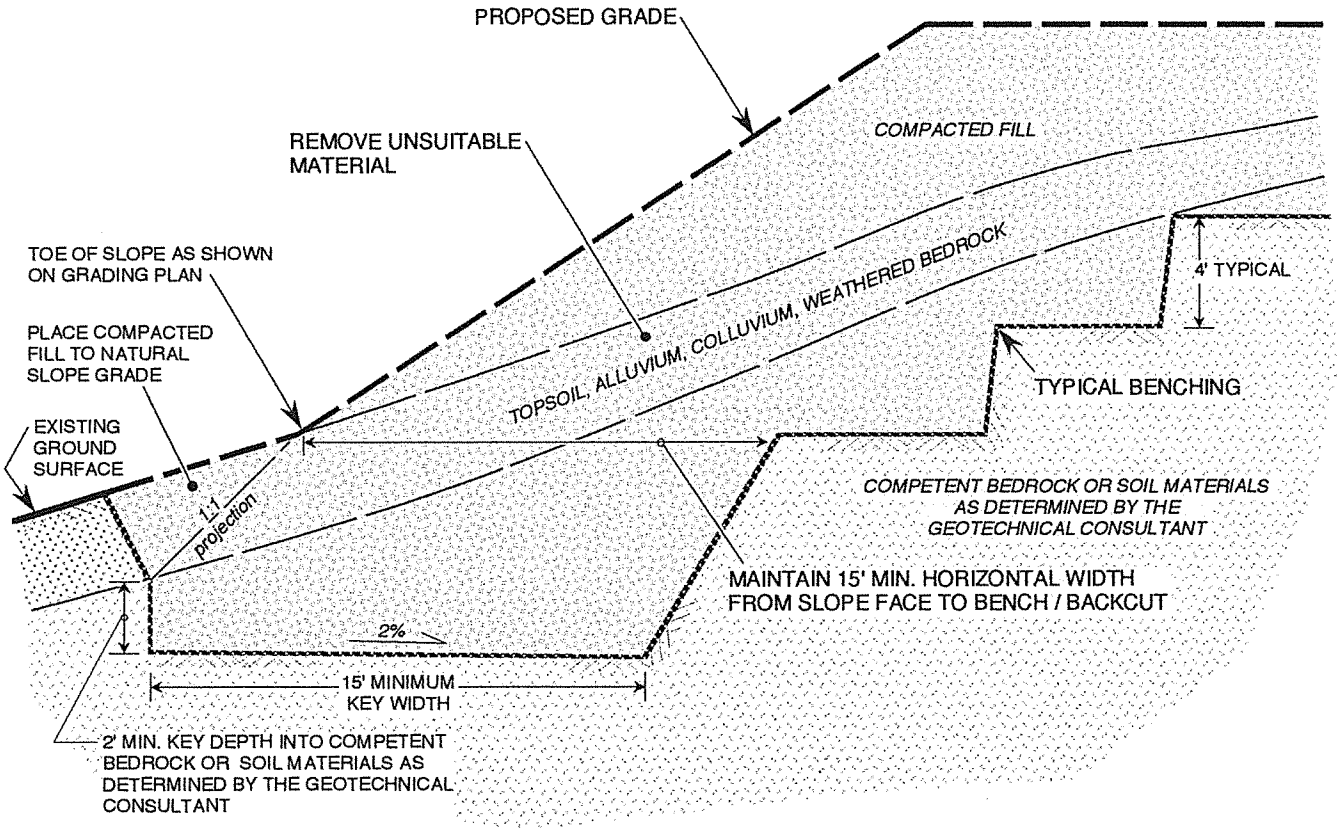


TYPICAL WINDROW DETAIL (PROFILE VIEW)



NOTE: OVERSIZE ROCK IS DEFINED AS CLASTS HAVING A MAXIMUM DIMENSION OF 12" OR LARGER

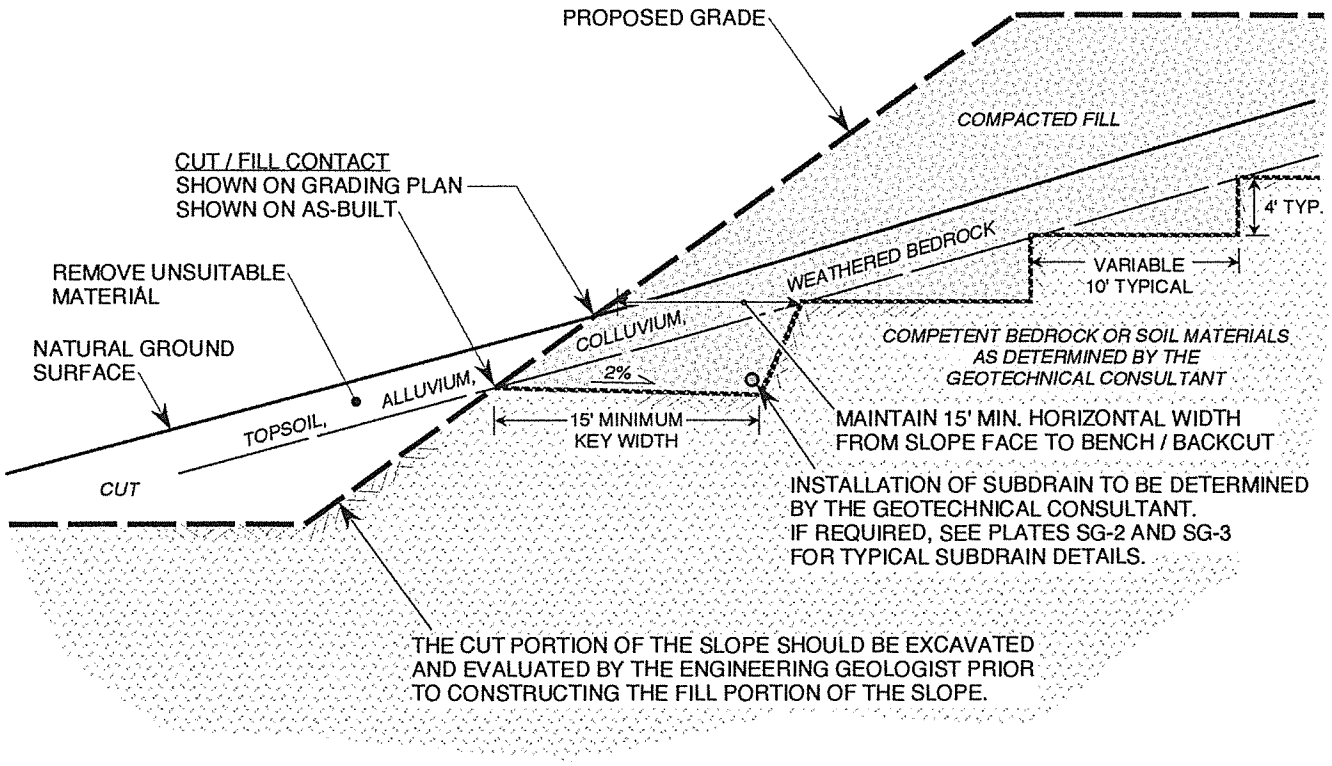
PETRA	TYPICAL ROCK DISPOSAL DETAIL	PLATE SG-4



NOTES:

1. WHERE NATURAL SLOPE GRADIENT IS 5:1 OR LESS, BENCHING IS NOT NECESSARY; HOWEVER, FILL IS NOT TO BE PLACED ON COMPRESSIBLE OR UNSUITABLE MATERIAL.
2. SOILS ENGINEER TO DETERMINE IF SUBDRAIN IS REQUIRED.

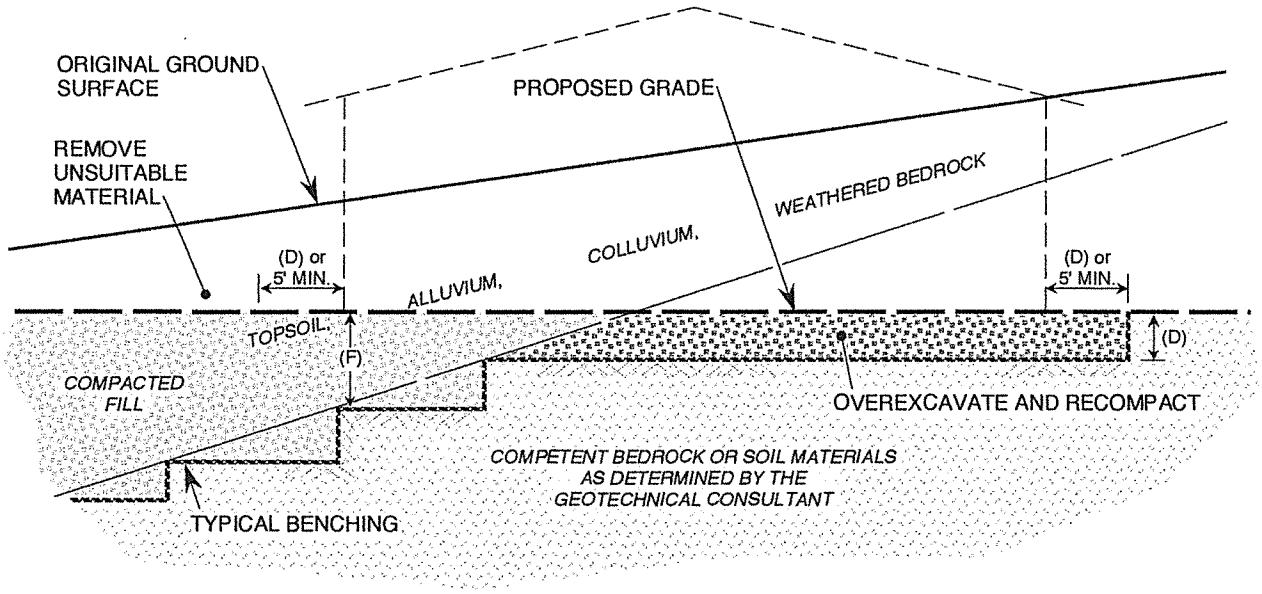
PETRA	FILL SLOPE ABOVE NATURAL SLOPE	PLATE SG-5



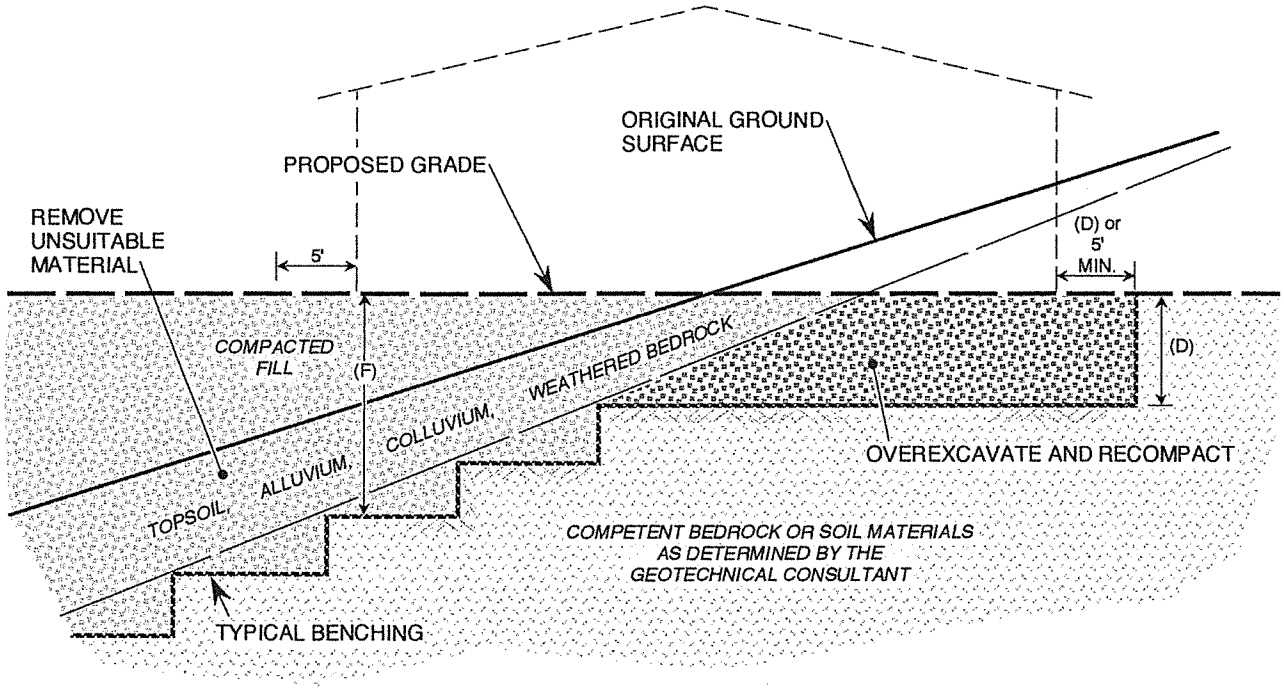
PETRA	FILL SLOPE ABOVE CUT SLOPE	PLATE SG-6

CUT LOT

UNSUITABLE MATERIAL EXPOSED IN PORTION OF CUT PAD

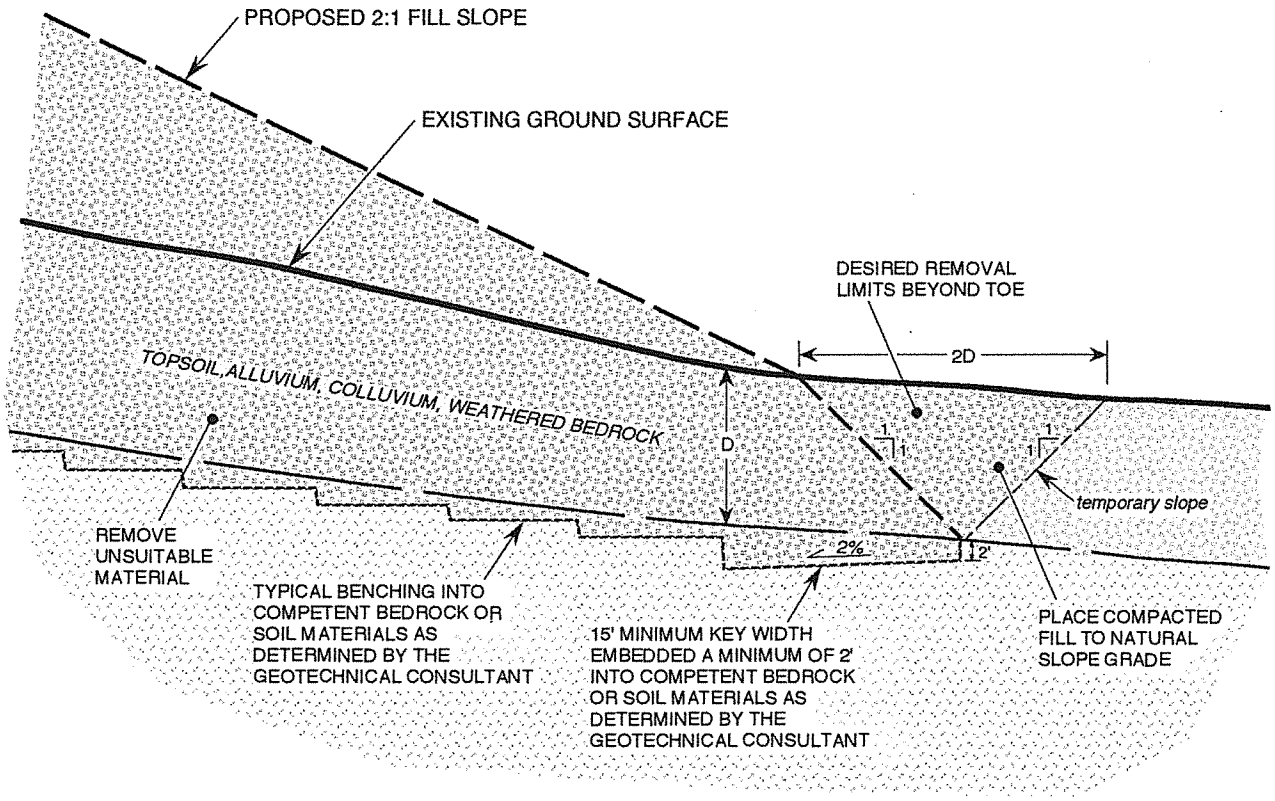


CUT-FILL TRANSITION LOT



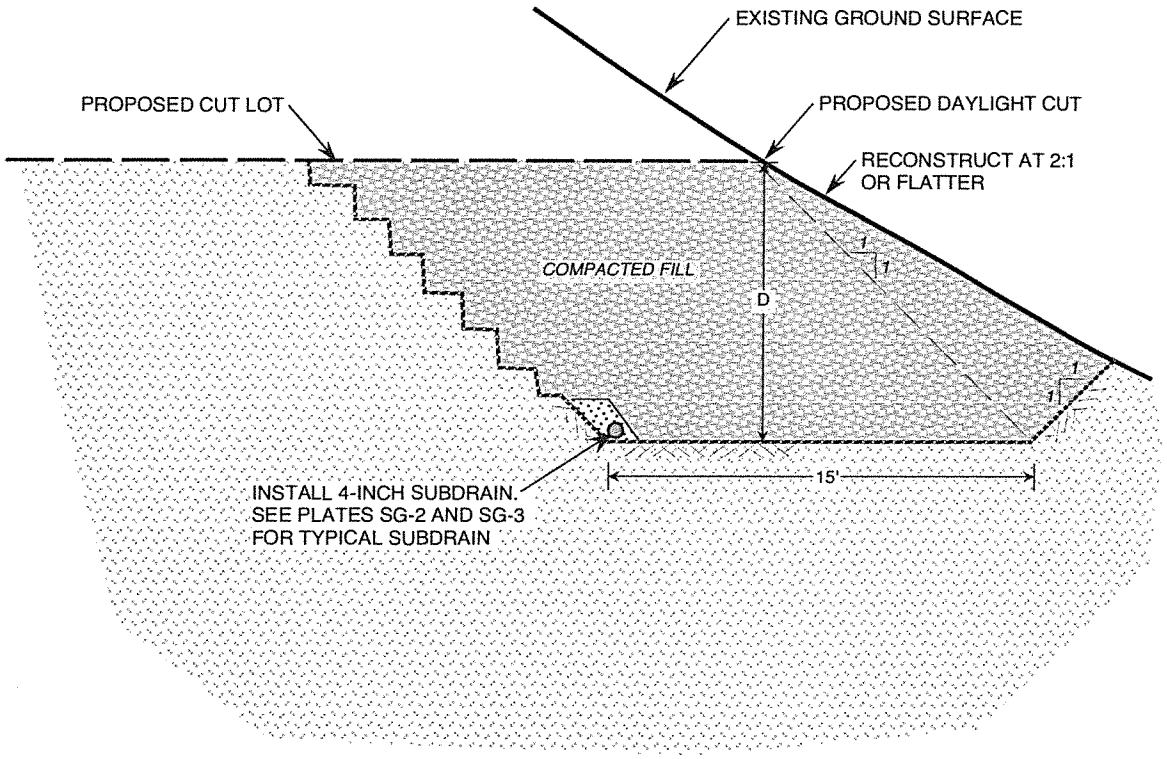
MAXIMUM FILL THICKNESS (F)	DEPTH OF OVEREXCAVATION (D)
FOOTING DEPTH TO 3 FEET	EQUAL DEPTH
3 TO 6 FEET	3 FEET
GREATER THAN 6 FEET	1/2 THE THICKNESS OF DEEPEST FILL PLACED WITHIN THE "FILL" PORTION (F) TO 15 FEET MAXIMUM

PETRA	CUT LOTS AND CUT-FILL TRANSITION LOTS	PLATE SG-7



D = RECOMMENDED DEPTH OF REMOVAL
PER GEOTECHNICAL REPORT

PETRA	TYPICAL REMOVALS BEYOND TOE OF PROPOSED FILL SLOPE	PLATE SG-8



NOTE:

1. "D" SHALL BE 10 FEET MINIMUM OR AS DETERMINED BY SOILS ENGINEER.

PETRA	SHEAR KEY ON DAYLIGHT CUT LOTS	PLATE SG-9

Section 6.4.4

BMP Calculations

Detention Calculations

Drainage Area	i watershed imperviousness ratio	C_{BMP}	Detention Volume P_0	a drawdown coeficient	P_6	A	Design Capture Volume V_0 (CF)
DMA 1	0.93	0.780	1.069	1.963	0.698	6.46	25,065
DMA 2	0.93	0.780	1.069	1.963	0.698	5.30	20,555

notes:
1. Drawdown is 48 hrs; a=1.963
2. 2-year, 1-hr precipitation depth = 0.472 inches
3. infiltration rate = 2.6 inches/hr per Geotech report prepared by Petra Geosciences dated 02/15/2022 with Factor of Safety of 2

Treatment flows

				C	I (INTNSITY FROM NOAA ATLAS) (2YR 1HR)	A
25,062	-	0%	DMA 1	0.930	0.472	6.46
20,561	-	0%	DMA 2	0.930	0.472	5.30

Q
2.84
2.33

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	1	.25
		Predominant soil texture	0.25	1	.25
		Site soil variability	0.25	1	.25
		Depth to groundwater / impervious layer	0.25	1	.25
		Suitability Assessment Safety Factor, $S_A = \Sigma p$			1
B	Design	Tributary area size	0.25	2	.5
		Level of pretreatment/ expected sediment loads	0.25	2	.5
		Redundancy	0.25	2	.5
		Compaction during construction	0.25	2	.5
		Design Safety Factor, $S_B = \Sigma p$			2
Combined Safety Factor, $S_{TOT} = S_A \times S_B$					2
Measured Infiltration Rate, inch/hr, K_M (corrected for test-specific bias)					13.9
Design Infiltration Rate, in/hr, $K_{DESIGN} = S_{TOT} \times K_M$					6.95

Supporting Data

Briefly describe infiltration test and provide reference to test forms:

All infiltration tests and results are provided in the Geotechnical report.

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

Detention Tank Sizing
DPC Redlands DMA 1

Orifice Calculations

Project Summary	
Title	
Engineer	
Company	
Date	1/3/2017

Notes

Table of Contents

Orifice Calculations

Subsection: User Notifications

User Notifications?	No user notifications generated.

Orifice Calculations

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ft³)	Time to Peak (min)	Peak Flow (ft³/s)
DA1	Base	0	105,132.00	960.300	21.27

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ft³)	Time to Peak (min)	Peak Flow (ft³/s)
O-1	Base	0	98,076.00	970.200	6.58

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ft³)	Time to Peak (min)	Peak Flow (ft³/s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ft³)
RDF-1 (IN)	Base	0	105,132.00	960.300	21.27	(N/A)	(N/A)
RDF-1 (OUT)	Base	0	97,812.00	970.200	6.58	3.53	15,910.00

Orifice Calculations

Subsection: Read Hydrograph
Scenario: Base
Label: DA1

Peak Discharge	21.27 ft³/s
Time to Peak	960.300 min
Hydrograph Volume	105,132.06 ft³

HYDROGRAPH ORDINATES (ft³/s)
Output Time Increment = 9.900 min
Time on left represents time for first value in each row.

Time (min)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)
0.000	0.00	0.51	0.51	0.52	0.52
49.500	0.52	0.53	0.53	0.53	0.54
99.000	0.54	0.55	0.55	0.55	0.56
148.500	0.56	0.56	0.57	0.57	0.58
198.000	0.58	0.59	0.59	0.59	0.60
247.500	0.60	0.61	0.61	0.62	0.62
297.000	0.63	0.63	0.64	0.65	0.65
346.500	0.66	0.66	0.67	0.67	0.68
396.000	0.69	0.70	0.70	0.71	0.72
445.500	0.73	0.73	0.74	0.75	0.76
495.000	0.77	0.78	0.79	0.80	0.81
544.500	0.82	0.83	0.85	0.85	0.87
594.000	0.88	0.90	0.91	0.93	0.94
643.500	0.96	0.97	1.00	1.01	1.04
693.000	1.05	1.08	1.10	1.24	1.26
742.500	1.30	1.32	1.37	1.39	1.45
792.000	1.48	1.54	1.58	1.66	1.70
841.500	1.79	1.85	1.98	2.05	2.24
891.000	2.35	2.63	2.81	3.80	4.16
940.500	5.37	6.89	21.27	4.68	3.04
990.000	2.48	2.14	1.91	1.75	1.62
1,039.500	1.51	1.42	1.34	1.28	1.12
1,089.000	1.07	1.02	0.98	0.95	0.92
1,138.500	0.89	0.86	0.84	0.81	0.79
1,188.000	0.77	0.76	0.74	0.72	0.71
1,237.500	0.69	0.68	0.67	0.65	0.64
1,287.000	0.63	0.62	0.61	0.60	0.59
1,336.500	0.58	0.57	0.57	0.56	0.55
1,386.000	0.54	0.54	0.53	0.52	0.52
1,435.500	0.51	0.00	0.00	(N/A)	(N/A)

Orifice Calculations

Subsection: Time vs. Elevation
Scenario: Base
Label: RDF-1 (IN)

Time vs. Elevation (ft)

Output Time increment = 9.900 min
Time on left represents time for first value in each row.

Time (min)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)
0.000	0.00	0.03	0.10	0.16	0.21
49.500	0.25	0.29	0.32	0.34	0.36
99.000	0.37	0.38	0.39	0.40	0.40
148.500	0.41	0.41	0.41	0.41	0.42
198.000	0.42	0.42	0.42	0.42	0.43
247.500	0.43	0.43	0.43	0.43	0.43
297.000	0.44	0.44	0.44	0.44	0.44
346.500	0.45	0.45	0.45	0.45	0.45
396.000	0.46	0.46	0.46	0.46	0.47
445.500	0.47	0.47	0.47	0.48	0.48
495.000	0.48	0.49	0.49	0.49	0.50
544.500	0.50	0.51	0.51	0.51	0.52
594.000	0.52	0.52	0.53	0.53	0.54
643.500	0.54	0.55	0.55	0.56	0.56
693.000	0.57	0.58	0.58	0.60	0.61
742.500	0.63	0.64	0.65	0.66	0.67
792.000	0.68	0.69	0.71	0.72	0.74
841.500	0.75	0.77	0.79	0.81	0.84
891.000	0.87	0.91	0.95	1.03	1.16
940.500	1.33	1.62	2.77	3.53	3.06
990.000	2.56	2.11	1.74	1.43	1.18
1,039.500	0.99	0.86	0.79	0.74	0.69
1,089.000	0.66	0.63	0.61	0.59	0.57
1,138.500	0.56	0.55	0.54	0.53	0.52
1,188.000	0.51	0.51	0.50	0.49	0.49
1,237.500	0.48	0.48	0.47	0.46	0.46
1,287.000	0.45	0.45	0.45	0.44	0.44
1,336.500	0.43	0.43	0.43	0.42	0.42
1,386.000	0.42	0.41	0.41	0.41	0.41
1,435.500	0.40	0.37	0.37	(N/A)	(N/A)

Orifice Calculations

Subsection: Time vs. Volume
Scenario: Base
Label: RDF-1

Time vs. Volume (ft³)

Output Time increment = 9.900 min
Time on left represents time for first value in each row.

Time (min)	Volume (ft³)	Volume (ft³)	Volume (ft³)	Volume (ft³)	Volume (ft³)
0.000	0.00	148.00	437.00	706.00	942.00
49.500	1,139.00	1,300.00	1,430.00	1,529.00	1,606.00
99.000	1,667.00	1,715.00	1,753.00	1,782.00	1,806.00
148.500	1,826.00	1,840.00	1,853.00	1,864.00	1,874.00
198.000	1,884.00	1,893.00	1,902.00	1,908.00	1,915.00
247.500	1,922.00	1,930.00	1,938.00	1,946.00	1,954.00
297.000	1,962.00	1,970.00	1,978.00	1,989.00	1,999.00
346.500	2,009.00	2,018.00	2,027.00	2,036.00	2,044.00
396.000	2,055.00	2,068.00	2,080.00	2,090.00	2,102.00
445.500	2,116.00	2,128.00	2,139.00	2,152.00	2,165.00
495.000	2,180.00	2,196.00	2,211.00	2,227.00	2,243.00
544.500	2,260.00	2,275.00	2,293.00	2,309.00	2,325.00
594.000	2,342.00	2,361.00	2,381.00	2,401.00	2,421.00
643.500	2,442.00	2,463.00	2,486.00	2,512.00	2,538.00
693.000	2,565.00	2,592.00	2,622.00	2,681.00	2,758.00
742.500	2,820.00	2,874.00	2,924.00	2,972.00	3,021.00
792.000	3,073.00	3,128.00	3,185.00	3,248.00	3,314.00
841.500	3,384.00	3,461.00	3,551.00	3,652.00	3,771.00
891.000	3,910.00	4,080.00	4,272.00	4,641.00	5,206.00
940.500	6,008.00	7,300.00	12,468.00	15,910.00	13,780.00
990.000	11,523.00	9,520.00	7,819.00	6,423.00	5,314.00
1,039.500	4,465.00	3,897.00	3,554.00	3,320.00	3,129.00
1,089.000	2,962.00	2,834.00	2,733.00	2,652.00	2,585.00
1,138.500	2,527.00	2,474.00	2,427.00	2,385.00	2,345.00
1,188.000	2,309.00	2,278.00	2,250.00	2,222.00	2,194.00
1,237.500	2,167.00	2,141.00	2,118.00	2,094.00	2,070.00
1,287.000	2,048.00	2,028.00	2,008.00	1,990.00	1,972.00
1,336.500	1,955.00	1,937.00	1,923.00	1,910.00	1,896.00
1,386.000	1,881.00	1,869.00	1,857.00	1,844.00	1,833.00
1,435.500	1,822.00	1,680.00	1,680.00	(N/A)	(N/A)

Orifice Calculations

Subsection: Outlet Input Data Scenario: Base

Label: Composite Outlet Structure - 1

Requested Pond Water Surface Elevations	
Minimum (Headwater)	0.00 ft
Increment (Headwater)	0.10 ft
Maximum (Headwater)	6.00 ft

Outlet Connectivity

Structure Type	Outlet ID	Direction	Outfall	E1 (ft)	E2 (ft)
Orifice-Circular	Orifice - 1	Forward	TW	0.00	6.00
Tailwater Settings	Tailwater			(N/A)	(N/A)

Orifice Calculations

Subsection: Outlet Input Data Scenario: Base

Label: Composite Outlet Structure - 1

Structure ID: Orifice - 1 Structure Type: Orifice-Circular	
Number of Openings	1
Elevation	0.00 ft
Orifice Diameter	12.0 in
Orifice Coefficient	0.600

Structure ID: TW Structure Type: TW Setup, DS Channel	
Tailwater Type	Free Outfall

Convergence Tolerances	
Maximum Iterations	30
Tailwater Tolerance (Minimum)	0.01 ft
Tailwater Tolerance (Maximum)	0.50 ft
Headwater Tolerance (Minimum)	0.01 ft
Headwater Tolerance (Maximum)	0.50 ft
Flow Tolerance (Minimum)	0.001 ft³/s
Flow Tolerance (Maximum)	10.000 ft³/s

Orifice Calculations

Subsection: Elevation-Volume-Flow Table (Pond) Scenario: Base

Label: RDF-1

Infiltration	
Infiltration Method (Computed)	Average Infiltration Rate
Infiltration Rate (Average)	6.9500 in/h

Initial Conditions	
Elevation (Water Surface, Initial)	0.00 ft
Volume (Initial)	0.00 ft³
Flow (Initial Outlet)	0.00 ft³/s
Flow (Initial Infiltration)	0.00 ft³/s
Flow (Initial, Total)	0.00 ft³/s
Time Increment	9.900 min

Elevation (ft)	Outflow (ft³/s)	Storage (ft³)	Area (ft²)	Infiltration (ft³/s)	Flow (Total) (ft³/s)	2S/t + O (ft³/s)
0.00	0.00	0.00	0.000	0.00	0.00	0.00
0.10	0.03	450.54	6.448	0.00	0.03	1.55
0.20	0.13	901.09	25.794	0.00	0.14	3.17
0.30	0.29	1,351.63	58.035	0.01	0.30	4.85
0.40	0.50	1,802.17	103.174	0.02	0.52	6.59
0.50	0.76	2,252.71	161.210	0.03	0.79	8.37
0.60	1.07	2,703.26	232.142	0.04	1.11	10.21
0.70	1.41	3,153.80	315.971	0.05	1.46	12.08
0.80	1.78	3,604.34	412.697	0.07	1.85	13.98
0.90	2.17	4,054.89	522.319	0.08	2.26	15.91
1.00	2.67	4,505.43	644.839	0.10	2.78	17.95
1.10	2.93	4,955.97	780.255	0.13	3.05	19.74
1.20	3.16	5,406.51	928.568	0.15	3.31	21.52
1.30	3.38	5,857.06	1,089.777	0.18	3.56	23.28
1.40	3.59	6,307.60	1,263.884	0.20	3.79	25.03
1.50	3.78	6,758.14	1,450.887	0.23	4.01	26.77
1.60	3.96	7,208.69	1,650.787	0.27	4.23	28.50
1.70	4.14	7,659.23	1,863.584	0.30	4.44	30.23
1.80	4.31	8,109.77	2,089.277	0.34	4.65	31.95
1.90	4.47	8,560.31	2,327.868	0.37	4.85	33.67
2.00	4.63	9,010.86	2,579.355	0.41	5.04	35.38
2.10	4.78	9,461.40	2,843.739	0.46	5.24	37.10
2.20	4.93	9,911.94	3,121.019	0.50	5.43	38.80
2.30	5.07	10,362.49	3,411.197	0.55	5.62	40.51
2.40	5.21	10,813.03	3,714.271	0.60	5.81	42.22
2.50	5.35	11,263.57	4,030.242	0.65	5.99	43.92
2.60	5.48	11,714.11	4,359.110	0.70	6.18	45.62
2.70	5.61	12,164.66	4,700.874	0.76	6.36	47.32

Orifice Calculations

Subsection: Elevation-Volume-Flow Table (Pond) Scenario: Base

Label: RDF-1

Elevation (ft)	Outflow (ft³/s)	Storage (ft³)	Area (ft²)	Infiltration (ft³/s)	Flow (Total) (ft³/s)	2S/t + O (ft³/s)
2.80	5.73	12,615.20	5,055.536	0.81	6.55	49.02
2.90	5.86	13,065.74	5,423.094	0.87	6.73	50.72
3.00	5.98	13,516.29	5,803.548	0.93	6.91	52.42
3.10	6.10	13,966.83	6,196.900	1.00	7.09	54.12
3.20	6.21	14,417.37	6,603.148	1.06	7.27	55.82
3.30	6.33	14,867.91	7,022.294	1.13	7.46	57.52
3.40	6.44	15,318.46	7,454.336	1.20	7.64	59.21
3.50	6.55	15,769.00	7,899.274	1.27	7.82	60.91
3.60	6.66	16,219.54	8,357.110	1.34	8.00	62.61
3.70	6.76	16,670.09	8,827.842	1.42	8.18	64.31
3.80	6.87	17,120.63	9,311.471	1.50	8.37	66.01
3.90	6.97	17,571.17	9,807.997	1.58	8.55	67.71
4.00	7.07	18,021.71	10,317.419	1.66	8.73	69.41
4.10	7.17	18,392.97	10,610.725	1.71	8.88	70.81
4.20	7.27	18,764.23	10,908.142	1.75	9.03	72.21
4.30	7.37	19,135.49	11,209.670	1.80	9.17	73.60
4.40	7.47	19,506.75	11,515.308	1.85	9.32	75.00
4.50	7.56	19,878.01	11,825.058	1.90	9.46	76.39
4.60	7.65	20,249.27	12,138.918	1.95	9.61	77.79
4.70	7.75	20,620.53	12,456.889	2.00	9.75	79.18
4.80	7.84	20,991.79	12,778.971	2.06	9.89	80.57
4.90	7.93	21,363.05	13,105.164	2.11	10.04	81.97
5.00	8.02	21,734.31	13,435.467	2.16	10.18	83.36
5.10	8.11	22,105.57	13,769.882	2.22	10.32	84.75
5.20	8.20	22,476.83	14,108.407	2.27	10.46	86.14
5.30	8.28	22,848.09	14,451.043	2.32	10.61	87.54
5.40	8.37	23,219.34	14,797.790	2.38	10.75	88.93
5.50	8.45	23,590.60	15,148.648	2.44	10.89	90.32
5.60	8.54	23,961.86	15,503.617	2.49	11.03	91.71
5.70	8.62	24,333.12	15,862.696	2.55	11.17	93.10
5.80	8.70	24,704.38	16,225.887	2.61	11.31	94.49
5.90	8.78	25,075.64	16,593.188	2.67	11.45	95.88
6.00	8.87	25,446.90	16,964.600	2.73	11.59	97.27

Orifice Calculations

Subsection: Pond Infiltration Calculations
Scenario: Base
Label: RDF-1 (IN)

Average Infiltration Rating Table

Elevation (Water Surface) (ft)	Area (Total) (ft²)	Flow (Infiltration) (ft³/s)
0.00	0.0	0.00
0.10	6.4	0.00
0.20	25.8	0.00
0.30	58.0	0.01
0.40	103.2	0.02
0.50	161.2	0.03
0.60	232.1	0.04
0.70	316.0	0.05
0.80	412.7	0.07
0.90	522.3	0.08
1.00	644.8	0.10
1.10	780.3	0.13
1.20	928.6	0.15
1.30	1,089.8	0.18
1.40	1,263.9	0.20
1.50	1,450.9	0.23
1.60	1,650.8	0.27
1.70	1,863.6	0.30
1.80	2,089.3	0.34
1.90	2,327.9	0.37
2.00	2,579.4	0.41
2.10	2,843.7	0.46
2.20	3,121.0	0.50
2.30	3,411.2	0.55
2.40	3,714.3	0.60
2.50	4,030.2	0.65
2.60	4,359.1	0.70
2.70	4,700.9	0.76
2.80	5,055.5	0.81
2.90	5,423.1	0.87
3.00	5,803.5	0.93
3.10	6,196.9	1.00
3.20	6,603.1	1.06
3.30	7,022.3	1.13
3.40	7,454.3	1.20
3.50	7,899.3	1.27
3.60	8,357.1	1.34
3.70	8,827.8	1.42
3.80	9,311.5	1.50
3.90	9,808.0	1.58
4.00	10,317.4	1.66
4.10	10,610.7	1.71
4.20	10,908.1	1.75

Orifice Calculations

Subsection: Pond Infiltration Calculations
Scenario: Base
Label: RDF-1 (IN)

Average Infiltration Rating Table

Elevation (Water Surface) (ft)	Area (Total) (ft^2)	Flow (Infiltration) (ft^3/s)
4.30	11,209.7	1.80
4.40	11,515.3	1.85
4.50	11,825.1	1.90
4.60	12,138.9	1.95
4.70	12,456.9	2.00
4.80	12,779.0	2.06
4.90	13,105.2	2.11
5.00	13,435.5	2.16
5.10	13,769.9	2.22
5.20	14,108.4	2.27
5.30	14,451.0	2.32
5.40	14,797.8	2.38
5.50	15,148.6	2.44
5.60	15,503.6	2.49
5.70	15,862.7	2.55
5.80	16,225.9	2.61
5.90	16,593.2	2.67
6.00	16,964.6	2.73

Orifice Calculations

Subsection: Level Pool Pond Routing Summary | Scenario: Base

Label: RDF-1 (IN)

Infiltration	
Infiltration Method (Computed)	Average Infiltration Rate
Infiltration Rate (Average)	6.9500 in/h

Initial Conditions	
Elevation (Water Surface, Initial)	0.00 ft
Volume (Initial)	0.00 ft³
Flow (Initial Outlet)	0.00 ft³/s
Flow (Initial Infiltration)	0.00 ft³/s
Flow (Initial, Total)	0.00 ft³/s
Time Increment	9.900 min

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	21.27 ft³/s	Time to Peak (Flow, In)	960.300 min
Infiltration (Peak)	1.29 ft³/s	Time to Peak (Infiltration)	970.200 min
Flow (Peak Outlet)	6.58 ft³/s	Time to Peak (Flow, Outlet)	970.200 min

Elevation (Water Surface, Peak)	3.53 ft
Volume (Peak)	15,910.09 ft³

Mass Balance (ft³)	
Volume (Initial)	0.00 ft³
Volume (Total Inflow)	105,132.00 ft³
Volume (Total Infiltration)	5,648.00 ft³
Volume (Total Outlet Outflow)	97,812.00 ft³
Volume (Retained)	1,441.00 ft³
Volume (Unrouted)	-231.00 ft³
Error (Mass Balance)	0.2 %

Orifice Calculations

Subsection: Pond Inflow Summary
Scenario: Base
Label: RDF-1 (IN)

Summary for Hydrograph Addition at 'RDF-1'

Upstream Link	Upstream Node
<Catchment to Outflow Node>	DA1

Node Inflows

Inflow Type	Element	Volume (ft³)	Time to Peak (min)	Flow (Peak) (ft³/s)
Flow (From)	DA1	105,132.06	960.300	21.27
Flow (In)	RDF-1	105,132.06	960.300	21.27

Orifice Calculations

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Orifice Calculations

Project Summary	
Title	
Engineer	
Company	
Date	1/3/2017

Notes

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Orifice Calculations

Subsection: User Notifications

User Notifications

Message Id	-1
Scenario	Base
Element Type	Scenario
Element Id	1
Label	Base
Time	(N/A)
Message	The output increment (0.130 hours) is not an equal interval of the simulation duration (24.120 hours). The actual simulation duration is 24.050 hours.
Source	Precalculation

Orifice Calculations

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ft³)	Time to Peak (hours)	Peak Flow (ft³/s)
DA1	Base	0	85,873.00	15.930	20.54

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ft³)	Time to Peak (hours)	Peak Flow (ft³/s)
O-1	Base	0	80,899.00	16.120	5.89

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ft³)	Time to Peak (hours)	Peak Flow (ft³/s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ft³)
RDF-1 (IN)	Base	0	85,881.00	15.990	13.00	(N/A)	(N/A)
RDF-1 (OUT)	Base	0	80,899.00	16.120	5.89	2.93	12,128.00

Orifice Calculations

Subsection: Read Hydrograph
Scenario: Base
Label: DA1

Peak Discharge	20.54 ft³/s
Time to Peak	15.930 hours
Hydrograph Volume	85,873.32 ft³

HYDROGRAPH ORDINATES (ft³/s)
Output Time Increment = 0.130 hours
Time on left represents time for first value in each row.

Time (hours)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)
0.070	0.42	0.42	0.42	0.42	0.43
0.720	0.43	0.43	0.43	0.44	0.44
1.370	0.44	0.44	0.44	0.45	0.45
2.020	0.45	0.45	0.46	0.46	0.46
2.670	0.46	0.47	0.47	0.47	0.47
3.320	0.48	0.48	0.48	0.49	0.49
3.970	0.49	0.49	0.50	0.50	0.50
4.620	0.51	0.51	0.51	0.52	0.52
5.270	0.53	0.53	0.53	0.54	0.54
5.920	0.54	0.55	0.55	0.56	0.56
6.570	0.57	0.57	0.57	0.58	0.58
7.220	0.59	0.59	0.60	0.61	0.61
7.870	0.62	0.62	0.63	0.63	0.64
8.520	0.64	0.65	0.66	0.67	0.67
9.170	0.68	0.69	0.70	0.70	0.71
9.820	0.72	0.73	0.74	0.75	0.76
10.470	0.77	0.78	0.79	0.80	0.82
11.120	0.82	0.84	0.85	0.87	0.88
11.770	0.90	0.91	1.02	1.03	1.06
12.420	1.07	1.10	1.12	1.15	1.17
13.070	1.21	1.23	1.27	1.29	1.34
13.720	1.37	1.43	1.46	1.53	1.57
14.370	1.66	1.71	1.84	1.91	2.08
15.020	2.18	2.44	2.84	3.47	3.80
15.670	4.92	6.31	20.54	4.20	3.21
16.320	2.30	1.99	1.77	1.61	1.49
16.970	1.40	1.32	1.25	1.19	1.13
17.620	1.09	1.05	0.97	0.89	0.86
18.270	0.83	0.81	0.78	0.76	0.74
18.920	0.73	0.71	0.69	0.68	0.66
19.570	0.65	0.64	0.62	0.61	0.60
20.220	0.59	0.58	0.57	0.56	0.55
20.870	0.55	0.54	0.53	0.52	0.52
21.520	0.51	0.50	0.50	0.49	0.48
22.170	0.48	0.47	0.47	0.46	0.46
22.820	0.45	0.45	0.44	0.44	0.43
23.470	0.43	0.43	0.42	0.00	(N/A)

Orifice Calculations

Subsection: Time vs. Elevation
Scenario: Base
Label: RDF-1 (IN)

Time vs. Elevation (ft)

Output Time increment = 0.130 hours
Time on left represents time for first value in each row.

Time (hours)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)
0.000	0.00	0.02	0.07	0.11	0.15
0.650	0.19	0.22	0.25	0.27	0.29
1.300	0.31	0.32	0.33	0.34	0.34
1.950	0.35	0.35	0.36	0.36	0.36
2.600	0.37	0.37	0.37	0.37	0.37
3.250	0.37	0.38	0.38	0.38	0.38
3.900	0.38	0.38	0.38	0.39	0.39
4.550	0.39	0.39	0.39	0.39	0.39
5.200	0.40	0.40	0.40	0.40	0.40
5.850	0.40	0.41	0.41	0.41	0.41
6.500	0.41	0.41	0.42	0.42	0.42
7.150	0.42	0.42	0.42	0.43	0.43
7.800	0.43	0.43	0.43	0.44	0.44
8.450	0.44	0.44	0.44	0.45	0.45
9.100	0.45	0.45	0.46	0.46	0.46
9.750	0.46	0.47	0.47	0.47	0.48
10.400	0.48	0.48	0.49	0.49	0.50
11.050	0.50	0.50	0.51	0.51	0.52
11.700	0.52	0.52	0.53	0.54	0.55
12.350	0.56	0.57	0.58	0.59	0.59
13.000	0.60	0.61	0.62	0.63	0.64
13.650	0.65	0.66	0.67	0.68	0.69
14.300	0.71	0.72	0.74	0.76	0.78
14.950	0.81	0.84	0.88	0.94	1.03
15.600	1.14	1.31	1.88	2.72	2.93
16.250	2.57	2.20	1.86	1.56	1.31
16.900	1.11	0.95	0.84	0.77	0.72
17.550	0.68	0.66	0.63	0.61	0.59
18.200	0.57	0.55	0.54	0.53	0.52
18.850	0.51	0.50	0.49	0.49	0.48
19.500	0.47	0.47	0.46	0.46	0.45
20.150	0.44	0.44	0.44	0.43	0.43
20.800	0.42	0.42	0.42	0.41	0.41
21.450	0.41	0.41	0.40	0.40	0.40
22.100	0.39	0.39	0.39	0.39	0.38
22.750	0.38	0.38	0.38	0.37	0.37
23.400	0.37	0.37	0.37	0.35	0.32
24.050	0.29	(N/A)	(N/A)	(N/A)	(N/A)

Orifice Calculations

Subsection: Time vs. Volume
Scenario: Base
Label: RDF-1

Time vs. Volume (ft³)

Output Time increment = 0.130 hours
Time on left represents time for first value in each row.

Time (hours)	Volume (ft³)	Volume (ft³)	Volume (ft³)	Volume (ft³)	Volume (ft³)
0.000	0.00	96.00	285.00	465.00	631.00
0.650	781.00	913.00	1,025.00	1,118.00	1,198.00
1.300	1,264.00	1,318.00	1,360.00	1,394.00	1,422.00
1.950	1,446.00	1,464.00	1,479.00	1,493.00	1,505.00
2.600	1,515.00	1,523.00	1,532.00	1,540.00	1,546.00
3.250	1,552.00	1,559.00	1,565.00	1,571.00	1,578.00
3.900	1,584.00	1,589.00	1,594.00	1,600.00	1,606.00
4.550	1,611.00	1,617.00	1,624.00	1,629.00	1,636.00
5.200	1,643.00	1,651.00	1,658.00	1,664.00	1,671.00
5.850	1,677.00	1,683.00	1,689.00	1,695.00	1,702.00
6.500	1,709.00	1,716.00	1,723.00	1,728.00	1,734.00
7.150	1,741.00	1,748.00	1,755.00	1,763.00	1,772.00
7.800	1,781.00	1,789.00	1,798.00	1,806.00	1,814.00
8.450	1,822.00	1,830.00	1,838.00	1,849.00	1,860.00
9.100	1,870.00	1,880.00	1,892.00	1,903.00	1,914.00
9.750	1,925.00	1,937.00	1,950.00	1,963.00	1,977.00
10.400	1,992.00	2,006.00	2,021.00	2,036.00	2,052.00
11.050	2,069.00	2,085.00	2,102.00	2,119.00	2,137.00
11.700	2,155.00	2,174.00	2,201.00	2,244.00	2,290.00
12.350	2,330.00	2,366.00	2,400.00	2,433.00	2,466.00
13.000	2,500.00	2,534.00	2,569.00	2,604.00	2,640.00
13.650	2,679.00	2,721.00	2,767.00	2,816.00	2,869.00
14.300	2,928.00	2,992.00	3,063.00	3,146.00	3,241.00
14.950	3,350.00	3,479.00	3,654.00	3,913.00	4,249.00
15.600	4,709.00	5,450.00	7,808.00	11,261.00	12,128.00
16.250	10,666.00	9,139.00	7,713.00	6,477.00	5,436.00
16.900	4,587.00	3,941.00	3,500.00	3,207.00	2,996.00
17.550	2,839.00	2,717.00	2,617.00	2,522.00	2,432.00
18.200	2,352.00	2,286.00	2,229.00	2,181.00	2,138.00
18.850	2,101.00	2,069.00	2,039.00	2,010.00	1,983.00
19.500	1,957.00	1,932.00	1,909.00	1,886.00	1,864.00
20.150	1,844.00	1,825.00	1,807.00	1,789.00	1,772.00
20.800	1,757.00	1,743.00	1,731.00	1,717.00	1,704.00
21.450	1,692.00	1,681.00	1,669.00	1,659.00	1,648.00
22.100	1,636.00	1,624.00	1,613.00	1,603.00	1,592.00
22.750	1,582.00	1,572.00	1,562.00	1,552.00	1,542.00
23.400	1,532.00	1,523.00	1,516.00	1,467.00	1,340.00
24.050	1,192.00	(N/A)	(N/A)	(N/A)	(N/A)

Orifice Calculations

Subsection: Outlet Input Data Scenario: Base

Label: Composite Outlet Structure - 1

Requested Pond Water Surface Elevations	
Minimum (Headwater)	0.00 ft
Increment (Headwater)	0.10 ft
Maximum (Headwater)	6.00 ft

Outlet Connectivity

Structure Type	Outlet ID	Direction	Outfall	E1 (ft)	E2 (ft)
Orifice-Circular	Orifice - 1	Forward	TW	0.00	6.00
Tailwater Settings	Tailwater			(N/A)	(N/A)

Orifice Calculations

Subsection: Outlet Input Data
Scenario: Base
Label: Composite Outlet Structure - 1

Structure ID: Orifice - 1 Structure Type: Orifice-Circular	
Number of Openings	1
Elevation	0.00 ft
Orifice Diameter	12.0 in
Orifice Coefficient	0.600

Structure ID: TW Structure Type: TW Setup, DS Channel	
Tailwater Type	Free Outfall

Convergence Tolerances	
Maximum Iterations	30
Tailwater Tolerance (Minimum)	0.01 ft
Tailwater Tolerance (Maximum)	0.50 ft
Headwater Tolerance (Minimum)	0.01 ft
Headwater Tolerance (Maximum)	0.50 ft
Flow Tolerance (Minimum)	0.001 ft^3/s
Flow Tolerance (Maximum)	10.000 ft^3/s

Orifice Calculations

Subsection: Elevation-Volume-Flow Table (Pond) Scenario: Base

Label: RDF-1

Infiltration	
Infiltration Method (Computed)	Average Infiltration Rate
Infiltration Rate (Average)	6.9500 in/h

Initial Conditions	
Elevation (Water Surface, Initial)	0.00 ft
Volume (Initial)	0.00 ft³
Flow (Initial Outlet)	0.00 ft³/s
Flow (Initial Infiltration)	0.00 ft³/s
Flow (Initial, Total)	0.00 ft³/s
Time Increment	0.130 hours

Elevation (ft)	Outflow (ft³/s)	Storage (ft³)	Area (ft²)	Infiltration (ft³/s)	Flow (Total) (ft³/s)	2S/t + O (ft³/s)
0.00	0.00	0.00	0.000	0.00	0.00	0.00
0.10	0.03	414.50	5.933	0.00	0.03	1.81
0.20	0.13	829.00	23.730	0.00	0.14	3.68
0.30	0.29	1,243.50	53.393	0.01	0.30	5.62
0.40	0.50	1,658.00	94.920	0.02	0.52	7.60
0.50	0.76	2,072.50	148.313	0.02	0.79	9.64
0.60	1.07	2,487.00	213.571	0.03	1.10	11.73
0.70	1.41	2,901.50	290.693	0.05	1.46	13.86
0.80	1.78	3,316.00	379.681	0.06	1.84	16.01
0.90	2.17	3,730.49	480.534	0.08	2.25	18.19
1.00	2.67	4,144.99	593.252	0.10	2.77	20.48
1.10	2.93	4,559.49	717.834	0.12	3.04	22.53
1.20	3.16	4,973.99	854.282	0.14	3.30	24.56
1.30	3.38	5,388.49	1,002.595	0.16	3.54	26.57
1.40	3.59	5,802.99	1,162.773	0.19	3.77	28.57
1.50	3.78	6,217.49	1,334.816	0.21	3.99	30.57
1.60	3.96	6,631.99	1,518.724	0.24	4.21	32.55
1.70	4.14	7,046.49	1,714.497	0.28	4.42	34.53
1.80	4.31	7,460.99	1,922.135	0.31	4.62	36.50
1.90	4.47	7,875.49	2,141.638	0.34	4.82	38.47
2.00	4.63	8,289.99	2,373.006	0.38	5.01	40.44
2.10	4.78	8,704.49	2,616.240	0.42	5.20	42.40
2.20	4.93	9,118.99	2,871.338	0.46	5.39	44.36
2.30	5.07	9,533.49	3,138.301	0.50	5.58	46.32
2.40	5.21	9,947.99	3,417.129	0.55	5.76	48.27
2.50	5.35	10,362.49	3,707.823	0.60	5.94	50.23
2.60	5.48	10,776.98	4,010.381	0.65	6.12	52.18
2.70	5.61	11,191.48	4,324.804	0.70	6.30	54.13

Orifice Calculations

Subsection: Elevation-Volume-Flow Table (Pond) Scenario: Base

Label: RDF-1

Elevation (ft)	Outflow (ft³/s)	Storage (ft³)	Area (ft²)	Infiltration (ft³/s)	Flow (Total) (ft³/s)	2S/t + O (ft³/s)
2.80	5.73	11,605.98	4,651.093	0.75	6.48	56.08
2.90	5.86	12,020.48	4,989.246	0.80	6.66	58.03
3.00	5.98	12,434.98	5,339.265	0.86	6.84	59.98
3.10	6.10	12,849.48	5,701.148	0.92	7.01	61.92
3.20	6.21	13,263.98	6,074.897	0.98	7.19	63.87
3.30	6.33	13,678.48	6,460.510	1.04	7.36	65.82
3.40	6.44	14,092.98	6,857.989	1.10	7.54	67.77
3.50	6.55	14,507.48	7,267.332	1.17	7.72	69.71
3.60	6.66	14,921.98	7,688.541	1.24	7.89	71.66
3.70	6.76	15,336.48	8,121.615	1.31	8.07	73.61
3.80	6.87	15,750.98	8,566.553	1.38	8.25	75.56
3.90	6.97	16,165.48	9,023.357	1.45	8.42	77.51
4.00	7.07	16,579.98	9,492.026	1.53	8.60	79.45
4.10	7.17	16,921.54	9,761.867	1.57	8.74	81.06
4.20	7.27	17,263.09	10,035.491	1.61	8.89	82.66
4.30	7.37	17,604.65	10,312.896	1.66	9.03	84.26
4.40	7.47	17,946.21	10,594.084	1.70	9.17	85.86
4.50	7.56	18,287.77	10,879.053	1.75	9.31	87.46
4.60	7.65	18,629.33	11,167.804	1.80	9.45	89.06
4.70	7.75	18,970.89	11,460.338	1.84	9.59	90.66
4.80	7.84	19,312.45	11,756.653	1.89	9.73	92.26
4.90	7.93	19,654.00	12,056.750	1.94	9.87	93.86
5.00	8.02	19,995.56	12,360.630	1.99	10.01	95.46
5.10	8.11	20,337.12	12,668.291	2.04	10.15	97.06
5.20	8.20	20,678.68	12,979.734	2.09	10.28	98.65
5.30	8.28	21,020.24	13,294.960	2.14	10.42	100.25
5.40	8.37	21,361.80	13,613.967	2.19	10.56	101.85
5.50	8.45	21,703.36	13,936.756	2.24	10.69	103.44
5.60	8.54	22,044.91	14,263.327	2.29	10.83	105.04
5.70	8.62	22,386.47	14,593.681	2.35	10.97	106.64
5.80	8.70	22,728.03	14,927.816	2.40	11.10	108.23
5.90	8.78	23,069.59	15,265.733	2.46	11.24	109.83
6.00	8.87	23,411.15	15,607.432	2.51	11.38	111.42

Orifice Calculations

Subsection: Pond Infiltration Calculations
Scenario: Base
Label: RDF-1 (IN)

Average Infiltration Rating Table

Elevation (Water Surface) (ft)	Area (Total) (ft²)	Flow (Infiltration) (ft³/s)
0.00	0.0	0.00
0.10	5.9	0.00
0.20	23.7	0.00
0.30	53.4	0.01
0.40	94.9	0.02
0.50	148.3	0.02
0.60	213.6	0.03
0.70	290.7	0.05
0.80	379.7	0.06
0.90	480.5	0.08
1.00	593.3	0.10
1.10	717.8	0.12
1.20	854.3	0.14
1.30	1,002.6	0.16
1.40	1,162.8	0.19
1.50	1,334.8	0.21
1.60	1,518.7	0.24
1.70	1,714.5	0.28
1.80	1,922.1	0.31
1.90	2,141.6	0.34
2.00	2,373.0	0.38
2.10	2,616.2	0.42
2.20	2,871.3	0.46
2.30	3,138.3	0.50
2.40	3,417.1	0.55
2.50	3,707.8	0.60
2.60	4,010.4	0.65
2.70	4,324.8	0.70
2.80	4,651.1	0.75
2.90	4,989.2	0.80
3.00	5,339.3	0.86
3.10	5,701.1	0.92
3.20	6,074.9	0.98
3.30	6,460.5	1.04
3.40	6,858.0	1.10
3.50	7,267.3	1.17
3.60	7,688.5	1.24
3.70	8,121.6	1.31
3.80	8,566.6	1.38
3.90	9,023.4	1.45
4.00	9,492.0	1.53
4.10	9,761.9	1.57
4.20	10,035.5	1.61

Orifice Calculations

Subsection: Pond Infiltration Calculations
Scenario: Base
Label: RDF-1 (IN)

Average Infiltration Rating Table

Elevation (Water Surface) (ft)	Area (Total) (ft^2)	Flow (Infiltration) (ft^3/s)
4.30	10,312.9	1.66
4.40	10,594.1	1.70
4.50	10,879.1	1.75
4.60	11,167.8	1.80
4.70	11,460.3	1.84
4.80	11,756.7	1.89
4.90	12,056.8	1.94
5.00	12,360.6	1.99
5.10	12,668.3	2.04
5.20	12,979.7	2.09
5.30	13,295.0	2.14
5.40	13,614.0	2.19
5.50	13,936.8	2.24
5.60	14,263.3	2.29
5.70	14,593.7	2.35
5.80	14,927.8	2.40
5.90	15,265.7	2.46
6.00	15,607.4	2.51

Orifice Calculations

Subsection: Level Pool Pond Routing Summary Scenario: Base

Label: RDF-1 (IN)

Infiltration	
Infiltration Method (Computed)	Average Infiltration Rate
Infiltration Rate (Average)	6.9500 in/h

Initial Conditions	
Elevation (Water Surface, Initial)	0.00 ft
Volume (Initial)	0.00 ft³
Flow (Initial Outlet)	0.00 ft³/s
Flow (Initial Infiltration)	0.00 ft³/s
Flow (Initial, Total)	0.00 ft³/s
Time Increment	0.130 hours

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	13.00 ft³/s	Time to Peak (Flow, In)	15.990 hours
Infiltration (Peak)	0.82 ft³/s	Time to Peak (Infiltration)	16.120 hours
Flow (Peak Outlet)	5.89 ft³/s	Time to Peak (Flow, Outlet)	16.120 hours

Elevation (Water Surface, Peak)	2.93 ft
Volume (Peak)	12,128.19 ft³

Mass Balance (ft³)	
Volume (Initial)	0.00 ft³
Volume (Total Inflow)	85,881.00 ft³
Volume (Total Infiltration)	3,793.00 ft³
Volume (Total Outlet Outflow)	80,899.00 ft³
Volume (Retained)	1,072.00 ft³
Volume (Unrouted)	-117.00 ft³
Error (Mass Balance)	0.1 %

Orifice Calculations

Subsection: Pond Inflow Summary
Scenario: Base
Label: RDF-1 (IN)

Summary for Hydrograph Addition at 'RDF-1'

Upstream Link	Upstream Node
<Catchment to Outflow Node>	DA1

Node Inflows

Inflow Type	Element	Volume (ft³)	Time to Peak (hours)	Flow (Peak) (ft³/s)
Flow (From)	DA1	85,873.32	15.930	20.54
Flow (In)	RDF-1	85,880.88	15.990	13.00

Orifice Calculations

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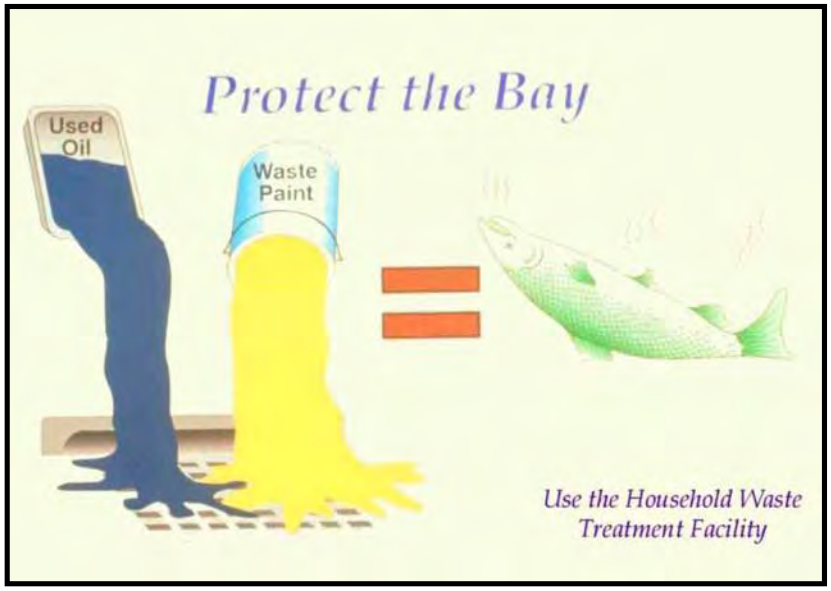
Section 6.4.5

BMP Education Materials/Fact Sheets

Non-Stormwater Discharges SC-10



Objectives

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

Description

Non-stormwater discharges are those flows that do not consist entirely of stormwater. Some non-stormwater discharges do not include pollutants and may be discharged to the storm drain. These include uncontaminated groundwater and natural springs. There are also some non-stormwater discharges that typically do not contain pollutants and may be discharged to the storm drain with conditions. These include car washing, air conditioner condensate, etc. However there are certain non-stormwater discharges that pose environmental concern. These discharges may originate from illegal dumping or from internal floor drains, appliances, industrial processes, sinks, and toilets that are connected to the nearby storm drainage system. These discharges (which may include: process waste waters, cooling waters, wash waters, and sanitary wastewater) can carry substances such as paint, oil, fuel and other automotive fluids, chemicals and other pollutants into storm drains. They can generally be detected through a combination of detection and elimination. The ultimate goal is to effectively eliminate non-stormwater discharges to the stormwater drainage system through implementation of measures to detect, correct, and enforce against illicit connections and illegal discharges of pollutants on streets and into the storm drain system and creeks.

Targeted Constituents

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

Approach

Initially the industry must make an assessment of non-stormwater discharges to determine which types must be eliminated or addressed through BMPs. The focus of the following approach is in the elimination of non-stormwater discharges.

CASQA California Stormwater Quality Association

Pollution Prevention

- Ensure that used oil, used antifreeze, and hazardous chemical recycling programs are being implemented. Encourage litter control.

Suggested Protocols

Recommended Complaint Investigation Equipment

- Field Screening Analysis
  - pH paper or meter
  - Commercial stormwater pollutant screening kit that can detect for reactive phosphorus, nitrate nitrogen, ammonium nitrogen, specific conductance, and turbidity
  - Sample jars
  - Sample collection pole
  - A tool to remove access hole covers
- Laboratory Analysis
  - Sample cooler
  - Ice
  - Sample jars and labels
  - Chain of custody forms
- Documentation
  - Camera
  - Notebook
  - Pens
  - Notice of Violation forms
  - Educational materials

General

- Develop clear protocols and lines of communication for effectively prohibiting non-stormwater discharges, especially those that are not classified as hazardous. These are often not responded to as effectively as they need to be.
- Stencil or demarcate storm drains, where applicable, to prevent illegal disposal of pollutants. Storm drain inlets should have messages such as "Dump No Waste Drains to Stream" stenciled or demarcated next to them to warn against ignorant or intentional dumping of pollutants into the storm drainage system.

- See SC44 Stormwater Drainage System Maintenance for additional information.

Illicit Connections

- Locate discharges from the industrial storm drainage system to the municipal storm drain system through review of "as-built" piping schematics.
- Isolate problem areas and plug illicit discharge points.
- Locate and evaluate all discharges to the industrial storm drain system.

Visual Inspection and Inventory

- Inventory and inspect each discharge point during dry weather.
- Keep in mind that drainage from a storm event can continue for a day or two following the end of a storm and groundwater may infiltrate the underground stormwater collection system. Also, non-stormwater discharges are often intermittent and may require periodic inspections.

Review Infield Piping

- A review of the "as-built" piping schematic is a way to determine if there are any connections to the stormwater collection system.
- Inspect the path of floor drains in older buildings.

Smoke Testing

- Smoke testing of wastewater and stormwater collection systems is used to detect connections between the two systems.
- During dry weather the stormwater collection system is filled with smoke and then traced to sources. The appearance of smoke at the base of a toilet indicates that there may be a connection between the sanitary and the stormwater system.

Dye Testing

- A dye test can be performed by simply releasing a dye into either your sanitary or process wastewater system and examining the discharge points from the stormwater collection system for discoloration.

TV Inspection of Drainage System

- TV Cameras can be employed to visually identify illicit connections to the industrial storm drainage system.

Illegal Dumping

- Regularly inspect and clean up hot spots and other storm drainage areas where illegal dumping and disposal occurs.
- On paved surfaces, clean up spills with as little water as possible. Use a rag for small spills, a damp mop for general cleanup, and absorbent material for larger spills. If the spilled material is hazardous, then the used cleanup materials are also hazardous and must be sent to a certified laundry (rags) or disposed of as hazardous waste.

- Never hose down or bury dry material spills. Sweep up the material and dispose of properly.
- Use adsorbent materials on small spills rather than hosing down the spill. Remove the adsorbent materials promptly and dispose of properly.
- For larger spills, a private spill cleanup company or Hazmat team may be necessary.

Once a site has been cleaned:

- Post "No Dumping" signs with a phone number for reporting dumping and disposal.
- Landscaping and beautification efforts of hot spots may also discourage future dumping, as well as provide open space and increase property values.
- Lighting or barriers may also be needed to discourage future dumping.
- See fact sheet SC11 Spill Prevention, Control, and Cleanup.

Inspection

- Regularly inspect and clean up hot spots and other storm drainage areas where illegal dumping and disposal occurs.
- Conduct field investigations of the industrial storm drain system for potential sources of non-stormwater discharges.
- Pro-actively conduct investigations of high priority areas. Based on historical data, prioritize specific geographic areas and/or incident type for pro-active investigations.

Reporting

- A database is useful for defining and tracking the magnitude and location of the problem.
- Report prohibited non-stormwater discharges observed during the course of normal daily activities so they can be investigated, contained, and cleaned up or eliminated.
- Document that non-stormwater discharges have been eliminated by recording tests performed, methods used, dates of testing, and any on-site drainage points observed.
- Document and report annually the results of the program.
- Maintain documentation of illicit connection and illegal dumping incidents, including significant conditionally exempt discharges that are not properly managed.

Training

- Training of technical staff in identifying and documenting illegal dumping incidents is required.
- Consider posting the quick reference table near storm drains to reinforce training.
- Train employees to identify non-stormwater discharges and report discharges to the appropriate departments.

- Educate employees about spill prevention and cleanup.
- Well-trained employees can reduce human errors that lead to accidental releases or spills. The employee should have the tools and knowledge to immediately begin cleaning up a spill should one occur. Employees should be familiar with the Spill Prevention Control and Countermeasure Plan.
- Determine and implement appropriate outreach efforts to reduce non-permissible non-stormwater discharges.
- Conduct spill response drills annually (if no events occurred to evaluate your plan) in cooperation with other industries.
- When a responsible party is identified, educate the party on the impacts of his or her actions.

Spill Response and Prevention

- See SC11 Spill Prevention Control and Cleanup.

Other Considerations

- Many facilities do not have accurate, up-to-date schematic drawings.

Requirements

Costs (including capital and operation & maintenance)

- The primary cost is for staff time and depends on how aggressively a program is implemented.
- Cost for containment and disposal is borne by the discharger.
- Illicit connections can be difficult to locate especially if there is groundwater infiltration.
- Indoor floor drains may require re-plumbing if cross-connections to storm drains are detected.

Maintenance (including administrative and staffing)

- Illegal dumping and illicit connection violations requires technical staff to detect and investigate them.

Supplemental Information

Further Detail of the BMP

Illegal Dumping

- Substances illegally dumped on streets and into the storm drain systems and creeks include paints, used oil and other automotive fluids, construction debris, chemicals, fresh concrete, leaves, grass clippings, and pet wastes. All of these wastes cause stormwater and receiving water quality problems as well as clog the storm drain system itself.
- Establish a system for tracking incidents. The system should be designed to identify the following:
  - Illegal dumping hot spots

- Types and quantities (in some cases) of wastes
- Patterns in time of occurrence (time of day/night, month, or year)
- Mode of dumping (abandoned containers, "midnight dumping" from moving vehicles, direct dumping of materials, accidents/spills)
- Responsible parties

One of the keys to success of reducing or eliminating illegal dumping is increasing the number of people at the facility who are aware of the problem and who have the tools to at least identify the incident, if not correct it. Therefore, train field staff to recognize and report the incidents.

What constitutes a "non-stormwater" discharge?

- Non-stormwater discharges to the stormwater collection system may include any water used directly in the manufacturing process (process wastewater), air conditioning condensate and coolant, non-contact cooling water, cooling equipment condensate, outdoor secondary containment water, vehicle and equipment wash water, sink and drinking fountain wastewater, sanitary wastes, or other wastewaters.

Permit Requirements

- Facilities subject to stormwater permit requirements must include a certification that the stormwater collection system has been tested or evaluated for the presence of non-stormwater discharges. The State's General Industrial Stormwater Permit requires that non-stormwater discharges be eliminated prior to implementation of the facility's SWPPP.

Performance Evaluation

- Review annually internal investigation results; assess whether goals were met and what changes or improvements are necessary.
- Obtain feedback from personnel assigned to respond to, or inspect for, illicit connections and illegal dumping incidents.

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/

Spill Prevention, Control & Cleanup SC-11

Objectives

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

Description

Many activities that occur at an industrial or commercial site have the potential to cause accidental or illegal spills. Preparation for accidental or illegal spills, with proper training and reporting systems implemented, can minimize the discharge of pollutants to the environment.

Spills and leaks are one of the largest contributors of stormwater pollutants. Spill prevention and control plans are applicable to any site at which hazardous materials are stored or used. An effective plan should have spill prevention and response procedures that identify potential spill areas, specify material handling procedures, describe spill response procedures, and provide spill clean-up equipment. The plan should take steps to identify and characterize potential spills, eliminate and reduce spill potential, respond to spills when they occur in an effort to prevent pollutants from entering the stormwater drainage system, and train personnel to prevent and control future spills.

Targeted Constituents

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

Approach

Pollution Prevention

- Develop procedures to prevent/mitigate spills to storm drain systems. Develop and standardize reporting procedures, containment, storage, and disposal activities, documentation, and follow-up procedures.

- Develop a Spill Prevention Control and Countermeasure (SPCC) Plan. The plan should include:

- Description of the facility, owner and address, activities and chemicals present
- Facility map
- Notification and evacuation procedures
- Cleanup instructions
- Identification of responsible departments
- Identify key spill response personnel

- Recycle, reclaim, or reuse materials whenever possible. This will reduce the amount of process materials that are brought into the facility.

Suggested Protocols (including equipment needs)

Spill Prevention

- Develop procedures to prevent/mitigate spills to storm drain systems. Develop and standardize reporting procedures, containment, storage, and disposal activities, documentation, and follow-up procedures.

- If consistent illegal dumping is observed at the facility:
  - Post "No Dumping" signs with a phone number for reporting illegal dumping and disposal. Signs should also indicate fines and penalties applicable for illegal dumping.
  - Landscaping and beautification efforts may also discourage illegal dumping.
  - Bright lighting and/or entrance barriers may also be needed to discourage illegal dumping.

- Store and contain liquid materials in such a manner that if the tank is ruptured, the contents will not discharge, flow, or be washed into the storm drainage system, surface waters, or groundwater.

- If the liquid is oil, gas, or other material that separates from and floats on water, install a spill control device (such as a tee section) in the catch basins that collects runoff from the storage tank area.

- Routine maintenance:
  - Place drip pans or absorbent materials beneath all mounted taps, and at all potential drip and spill locations during filling and unloading of tanks. Any collected liquids or soiled absorbent materials must be reused/recycled or properly disposed.
  - Store and maintain appropriate spill cleanup materials in a location known to all near the tank storage area; and ensure that employees are familiar with the site's spill control plan and/or proper spill cleanup procedures.
  - Sweep and clean the storage area monthly if it is paved, *do not hose down the area to a storm drain.*

  - Check tanks (and any containment sumps) daily for leaks and spills. Replace tanks that are leaking, corroded, or otherwise deteriorating with tanks in good condition. Collect all spilled liquids and properly dispose of them.

- Label all containers according to their contents (e.g., solvent, gasoline).
- Label hazardous substances regarding the potential hazard (corrosive, radioactive, flammable, explosive, poisonous).
- Prominently display required labels on transported hazardous and toxic materials (per US DOT regulations).
- Identify key spill response personnel.

Spill Control and Cleanup Activities

- Follow the Spill Prevention Control and Countermeasure Plan.
- Clean up leaks and spills immediately.
- Place a stockpile of spill cleanup materials where it will be readily accessible (e.g., near storage and maintenance areas).
- On paved surfaces, clean up spills with as little water as possible. Use a rag for small spills, a damp mop for general cleanup, and absorbent material for larger spills. If the spilled material is hazardous, then the used cleanup materials are also hazardous and must be sent to a certified laundry (rags) or disposed of as hazardous waste. Physical methods for the cleanup of dry chemicals include the use of brooms, shovels, sweepers, or plows.
- Never hose down or bury dry material spills. Sweep up the material and dispose of properly.
- Chemical cleanups of material can be achieved with the use of adsorbents, gels, and foams. Use adsorbent materials on small spills rather than hosing down the spill. Remove the adsorbent materials promptly and dispose of properly.
- For larger spills, a private spill cleanup company or Hazmat team may be necessary.

Reporting

- Report spills that pose an immediate threat to human health or the environment to the Regional Water Quality Control Board.
- Federal regulations require that any oil spill into a water body or onto an adjoining shoreline be reported to the National Response Center (NRC) at 800-424-8802 (24 hour).
- Report spills to local agencies, such as the fire department; they can assist in cleanup.
- Establish a system for tracking incidents. The system should be designed to identify the following:

  - Types and quantities (in some cases) of wastes

  - Patterns in time of occurrence (time of day/night, month, or year)

- Mode of dumping (abandoned containers, "midnight dumping" from moving vehicles, direct dumping of materials, accidents/spills)

- Responsible parties

Training

- Educate employees about spill prevention and cleanup.

- Well-trained employees can reduce human errors that lead to accidental releases or spills:

  - The employee should have the tools and knowledge to immediately begin cleaning up a spill should one occur.

  - Employees should be familiar with the Spill Prevention Control and Countermeasure Plan.

- Employees should be educated about aboveground storage tank requirements. Employees responsible for aboveground storage tanks and liquid transfers should be thoroughly familiar with the Spill Prevention Control and Countermeasure Plan and the plan should be readily available.

- Train employees to recognize and report illegal dumping incidents.

Other Considerations (Limitations and Regulations)

- State regulations exist for facilities with a storage capacity of 10,000 gallons or more of petroleum to prepare a Spill Prevention Control and Countermeasure (SPCC) Plan (Health & Safety Code Chapter 6.67).

- State regulations also exist for storage of hazardous materials (Health & Safety Code Chapter 6.95), including the preparation of area and business plans for emergency response to the releases or threatened releases.

- Consider requiring smaller secondary containment areas (less than 200 sq. ft.) to be connected to the sanitary sewer, prohibiting any hard connections to the storm drain.

Requirements

Costs (including capital and operation & maintenance)

- Will vary depending on the size of the facility and the necessary controls.

- Prevention of leaks and spills is inexpensive. Treatment and/or disposal of contaminated soil or water can be quite expensive.

Maintenance (including administrative and staffing)

- This BMP has no major administrative or staffing requirements. However, extra time is needed to properly handle and dispose of spills, which results in increased labor costs.

Supplemental Information

Further Detail of the BMP

Reporting

Record keeping and internal reporting represent good operating practices because they can increase the efficiency of the facility and the effectiveness of BMPs. A good record keeping system helps the facility minimize incident recurrence, correctly respond with appropriate cleanup activities, and comply with legal requirements. A record keeping and reporting system should be set up for documenting spills, leaks, and other discharges, including discharges of hazardous substances in reportable quantities. Incident records describe the quality and quantity of non-stormwater discharges to the storm sewer. These records should contain the following information:

- Date and time of the incident
- Weather conditions
- Duration of the spill/leak/discharge
- Cause of the spill/leak/discharge
- Response procedures implemented
- Persons notified
- Environmental problems associated with the spill/leak/discharge

Separate record keeping systems should be established to document housekeeping and preventive maintenance inspections, and training activities. All housekeeping and preventive maintenance inspections should be documented. Inspection documentation should contain the following information:

- The date and time the inspection was performed
- Name of the inspector
- Items inspected
- Problems noted
- Corrective action required
- Date corrective action was taken

Other means to document and record inspection results are field notes, timed and dated photographs, videotapes, and drawings and maps.

Aboveground Tank Leak and Spill Control

Accidental releases of materials from aboveground liquid storage tanks present the potential for contaminating stormwater with many different pollutants. Materials spilled, leaked, or lost from

tanks may accumulate in soils or on impervious surfaces and be carried away by stormwater runoff.

The most common causes of unintentional releases are:

- Installation problems
- Failure of piping systems (pipes, pumps, flanges, couplings, hoses, and valves)
- External corrosion and structural failure
- Spills and overfills due to operator error
- Leaks during pumping of liquids or gases from truck or rail car to a storage tank or vice versa

Storage of reactive, ignitable, or flammable liquids should comply with the Uniform Fire Code and the National Electric Code. Practices listed below should be employed to enhance the code requirements:

- Tanks should be placed in a designated area.
- Tanks located in areas where firearms are discharged should be encapsulated in concrete or the equivalent.
- Designated areas should be impervious and paved with Portland cement concrete, free of cracks and gaps, in order to contain leaks and spills.
- Liquid materials should be stored in UL approved double walled tanks or surrounded by a curb or dike to provide the volume to contain 10 percent of the volume of all of the containers or 110 percent of the volume of the largest container, whichever is greater. The area inside the curb should slope to a drain.
- For used oil or dangerous waste, a dead-end sump should be installed in the drain.
- All other liquids should be drained to the sanitary sewer if available. The drain must have a positive control such as a lock, valve, or plug to prevent release of contaminated liquids.
- Accumulated stormwater in petroleum storage areas should be passed through an oil/water separator.

Maintenance is critical to preventing leaks and spills. Conduct routine inspections and:

- Check for external corrosion and structural failure.
- Check for spills and overfills due to operator error.
- Check for failure of piping system (pipes, pumps, flanger, coupling, hoses, and valves).
- Check for leaks or spills during pumping of liquids or gases from truck or rail car to a storage facility or vice versa.

- Visually inspect new tank or container installation for loose fittings, poor welding, and improper or poorly fitted gaskets.
- Inspect tank foundations, connections, coatings, and tank walls and piping system. Look for corrosion, leaks, cracks, scratches, and other physical damage that may weaken the tank or container system.
- Frequently relocate accumulated stormwater during the wet season.
- Periodically conduct integrity testing by a qualified professional.

Vehicle Leak and Spill Control

Major spills on roadways and other public areas are generally handled by highly trained Hazmat teams from local fire departments or environmental health departments. The measures listed below pertain to leaks and smaller spills at vehicle maintenance shops.

In addition to implementing the spill prevention, control, and clean up practices above, use the following measures related to specific activities:

Vehicle and Equipment Maintenance

- Perform all vehicle fluid removal or changing inside or under cover to prevent the run-on of stormwater and the runoff of spills.
- Regularly inspect vehicles and equipment for leaks, and repair immediately.
- Check incoming vehicles and equipment (including delivery trucks, and employee and subcontractor vehicles) for leaking oil and fluids. Do not allow leaking vehicles or equipment onsite.
- Always use secondary containment, such as a drain pan or drop cloth, to catch spills or leaks when removing or changing fluids.
- Immediately drain all fluids from wrecked vehicles.
- Store wrecked vehicles or damaged equipment under cover.
- Place drip pans or absorbent materials under heavy equipment when not in use.
- Use adsorbent materials on small spills rather than hosing down the spill.
- Remove the adsorbent materials promptly and dispose of properly.
- Promptly transfer used fluids to the proper waste or recycling drums. Don't leave full drip pans or other open containers lying around.
- Oil filters disposed of in trashcans or dumpsters can leak oil and contaminate stormwater. Place the oil filter in a funnel over a waste oil recycling drum to drain excess oil before disposal. Oil filters can also be recycled. Ask your oil supplier or recycler about recycling oil filters.

- Store cracked batteries in a non-leaking secondary container. Do this with all cracked batteries, even if you think all the acid has drained out. If you drop a battery, treat it as if it is cracked. Put it into the containment area until you are sure it is not leaking.

Vehicle and Equipment Fueling

- Design the fueling area to prevent the run-on of stormwater and the runoff of spills:
  - Cover fueling area if possible.
  - Use a perimeter drain or slope pavement inward with drainage to a sump.
  - Pave fueling area with concrete rather than asphalt.
- If dead-end sump is not used to collect spills, install an oil/water separator.
- Install vapor recovery nozzles to help control drips as well as air pollution.
- Discourage "topping-off' of fuel tanks.
- Use secondary containment when transferring fuel from the tank truck to the fuel tank.
- Use adsorbent materials on small spills and general cleaning rather than hosing down the area. Remove the adsorbent materials promptly.
- Carry out all Federal and State requirements regarding underground storage tanks, or install above ground tanks.
- Do not use mobile fueling of mobile industrial equipment around the facility; rather, transport the equipment to designated fueling areas.
- Keep your Spill Prevention Control and Countermeasure (SPCC) Plan up-to-date.
- Train employees in proper fueling and cleanup procedures.

Industrial Spill Prevention Response

For the purposes of developing a spill prevention and response program to meet the stormwater regulations, facility managers should use information provided in this fact sheet and the spill prevention/response portions of the fact sheets in this handbook, for specific activities. The program should:

- Integrate with existing emergency response/hazardous materials programs (e.g., Fire Department)
- Develop procedures to prevent/mitigate spills to storm drain systems
- Identify responsible departments
- Develop and standardize reporting procedures, containment, storage, and disposal activities, documentation, and follow-up procedures
- Address spills at municipal facilities, as well as public areas

- Provide training concerning spill prevention, response and cleanup to all appropriate personnel

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 Stormwater Managers Resource Center http://www.stormwatercenter.net/

Contaminated or Erodible Areas SC-40

Description

Areas within an industrial site that are bare of vegetation or are subject to activities that promote the suppression of vegetation are often subject to erosion. In addition, they may or may not be contaminated from past or current activities. If the area is temporarily bare because of construction, see SC-42, Building Repair, Remodeling, and Construction. Sites with excessive erosion or the potential for excessive erosion should consider employing the soil erosion BMPs identified in the Construction BMP Handbook. Note that this fact sheet addresses soils that are not so contaminated as to exceed hazardous waste criteria (see Title 22 California Code of Regulations for Hazardous Waste Criteria).

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

Preserve natural vegetation whenever possible. See also EC-2, Preservation of Existing Vegetation, in the Construction BMP Handbook.

Suggested Protocols

- Preserve natural vegetation.
- Analyze soil conditions.
- Re-vegetate when necessary.
- Remove contaminated soil.
- Utilize chemical stabilization when needed. See also EC-5, Soil Binders, and EC-13, Polyacrylamide, in the Construction BMP Handbook.
- Use geosynthetic membranes to control erosion if feasible. See also EC-7, Geotextiles and Mats, in the Construction BMP Handbook.

Training

Training is not a significant element of this best management practice.

Objectives

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

Targeted Constituents

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

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Other Considerations

- Disadvantages of preserving natural vegetation or revegetation include:
  - Requires substantial planning to preserve and maintain the existing vegetation
  - May not be cost-effective with high land costs
  - Lack of rainfall, inadequate irrigation and/or poor soils may limit the success of re-vegetated areas
- Disadvantages of chemical stabilization include:
  - Creation of impervious surfaces
  - May cause harmful effects on water quality
  - Is usually more expensive than vegetative cover

Requirements

Costs

Except for preservation of natural vegetation, each of the above solutions can be quite expensive depending upon the size of the area.

Maintenance

Maintenance should be minimal, except possibly if irrigation of vegetation is necessary.

Supplemental Information

Preserving Vegetation to Minimize Erosion

Preserving stabilized areas minimizes erosion potential, protects water quality, and provides aesthetic benefits. The most effective way to control erosion is to preserve existing vegetation. Preservation of natural vegetation provides a natural buffer zone and an opportunity for infiltration of stormwater and capture of pollutants in the soil matrix. This practice can be used as a permanent source control measure.

Vegetation preservation should be incorporated into the site. Preservation requires good site management to minimize the impact of construction when construction is underway and exposure of soils after construction. Proper maintenance is important to ensure healthy vegetation that can control erosion. Different species, soil types, and climatic conditions will require different maintenance activities such as mulching, fertilizing, liming, irrigation, pruning and weed and pest control. Maintenance should be performed regularly especially during construction phases.

The preferred approach is to leave as much native vegetation on-site as possible, thereby reducing or eliminating any erosion problem. However, assuming the site already has contaminated or erodible surface areas, there are four possible courses of action which can be taken:

- The area can be revegetated if it is not in use and therefore not subject to damage from site activities. In as much as the area is already devoid of vegetation, special measures are likely

necessary. Lack of vegetation may be due to the lack of water and/or poor soils. The latter can perhaps be solved with fertilization, or the ground may simply be too compacted from prior use. Improving soil conditions may be sufficient to support the recovery of vegetation. Use process wastewater for irrigation if possible. Finally, see the Construction BMP Handbook for further procedures on establishing vegetation.

- Chemical stabilization can be used as an alternate method in areas where temporary seeding practices cannot be used because of season or climate. It can provide immediate, effective, and inexpensive erosion control. Application rates and procedures recommended by the manufacturer should be followed as closely as possible to prevent the products from forming ponds and creating large areas where moisture cannot penetrate the soil. See also EC-5, Soil Binders, and EC-13, Polyacrylamide, in the Construction BMP Handbook for more information. Advantages of chemical stabilization include:

  - Applied easily to the surface
  - Stabilizes areas effectively
  - Provides immediate protection to soils that are in danger of erosion

- Contaminated soils can be removed, however this is a last resort and quite expensive. The level and extent of the contamination must be determined. This determination and removal must comply with State and Federal regulations, permits must be acquired and fees paid.

- Geosynthetics may be used. Geosynthetics include those materials that are designed as an impermeable barrier to contain or control large amounts of liquid or solid matter. Geosynthetics have been developed primarily for use in landfills and surface impoundments, and the technology is well established. There are two general types of geosynthetics: geomembranes (impermeable) and geotextiles (permeable). Geomembranes are composed of one of three types of impermeable materials: elastomers (rubbers), thermoplasics (plastics), or a combination of these two types of materials. See also EC-7, Geotextiles and Mats, in the Construction BMP Handbook for more information. The advantages of these materials include:

  - A variety of compounds are available
  - Sheeting is produced in a factory environment
  - Polymeric membranes are flexible
  - Installation is simple

  Disadvantages include:

  - Chemical resistance must be determined for each application
  - Seaming systems may be a weak link in the system
  - Many materials are subject to attack from biotic, mechanical, or environmental sources

Geotextiles are uncoated synthetic textile products that are not watertight. They are composed of a variety of materials, most commonly polypropylene and polyester. Geotextiles serve five basic functions:

- Filtration
- Drainage
- Separation
- Reinforcement
- Armoring

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/

Building Repair and Construction SC-42

Objectives

- Cover
- Contain
- Educate
- Reduce/Minimize
- Recycle

Targeted Constituents

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

Description

Modifications are common particularly at large industrial sites. The activity may vary from minor and normal building repair to major remodeling, or the construction of new facilities. These activities can generate pollutants including solvents, paints, paint and varnish removers, finishing residues, spent thinners, soap cleaners, kerosene, asphalt and concrete materials, adhesive residues, and old asbestos installation. Protocols in this fact sheet are intended to prevent or reduce the discharge of pollutants to stormwater from building repair, remodeling, and construction by using soil erosion controls, enclosing or covering building material storage areas, using good housekeeping practices, using safer alternative products, and training employees.

Approach

Pollution Prevention

- Recycle residual paints, solvents, lumber, and other materials to the maximum extent practical.
- Buy recycled products to the maximum extent practical.
- Inform on-site contractors of company policy on these matters and include appropriate provisions in their contract to ensure certain proper housekeeping and disposal practices are implemented.

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- Make sure that nearby storm drains are well marked to minimize the chance of inadvertent disposal of residual paints and other liquids.

Suggested Protocols

Repair & Remodeling

- Follow BMPs identified in Construction BMP Handbook.
- Maintain good housekeeping practices while work is underway.
- Keep the work site clean and orderly. Remove debris in a timely fashion. Sweep the area.
- Cover materials of particular concern that must be left outside, particularly during the rainy season.
- Do not dump waste liquids down the storm drain.
- Dispose of wash water, sweepings, and sediments properly.
- Store materials properly that are normally used in repair and remodeling such as paints and solvents.
- Sweep out the gutter or wash the gutter and trap the particles at the outlet of the downspout if when repairing roofs, small particles have accumulated in the gutter. A sock or geofabric placed over the outlet may effectively trap the materials. If the downspout is tight lined, place a temporary plug at the first convenient point in the storm drain and pump out the water with a vactor truck, and clean the catch basin sump where you placed the plug.
- Properly store and dispose waste materials generated from construction activities. See Construction BMP Handbook.
- Clean the storm drain system in the immediate vicinity of the construction activity after it is completed.

Painting

- Enclose painting operations consistent with local air quality regulations and OSHA.
- Local air pollution regulations may, in many areas of the state, specify painting procedures which if properly carried out are usually sufficient to protect water quality.
- Develop paint handling procedures for proper use, storage, and disposal of paints.
- Transport paint and materials to and from job sites in containers with secure lids and tied down to the transport vehicle.
- Test and inspect spray equipment prior to starting to paint. Tighten all hoses and connections and do not overfill paint containers.
- Mix paint indoors before using so that any spill will not be exposed to rain. Do so even during dry weather because cleanup of a spill will never be 100% effective.
- Transfer and load paint and hot thermoplastic away from storm drain inlets.

- Do not transfer or load paint near storm drain inlets.
- Plug nearby storm drain inlets prior to starting painting and remove plugs when job is complete when there is significant risk of a spill reaching storm drains.
- Cover nearby storm drain inlets prior to starting work if sand blasting is used to remove paint.
- Use a ground cloth to collect the chips if painting requires scraping or sand blasting of the existing surface. Dispose the residue properly.
- Cover or enclose painting operations properly to avoid drift.
- Clean the application equipment in a sink that is connected to the sanitary sewer if using water based paints.
- Capture all cleanup-water and dispose of properly.
- Dispose of paints containing lead or tributyl tin and considered a hazardous waste properly.
- Store leftover paints if they are to be kept for the next job properly, or dispose properly.
- Recycle paint when possible. Dispose of paint at an appropriate household hazardous waste facility.

Training

Proper education of off-site contractors is often overlooked. The conscientious efforts of well trained employees can be lost by unknowing off-site contractors, so make sure they are well informed about what they are expected to do.

Spill Response and Prevention

- Keep your Spill Prevention Control and Countermeasure (SPCC) Plan up-to-date.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- Clean up spills immediately.
- Excavate and remove the contaminated (stained) soil if a spill occurs on dirt.

Limitations

- This BMP is for minor construction only. The State's General Construction Activity Stormwater Permit has more requirements for larger projects. The companion "Construction Best Management Practice Handbook" contains specific guidance and best management practices for larger-scale projects.
- Hazardous waste that cannot be reused or recycled must be disposed of by a licensed hazardous waste hauler.
- Be certain that actions to help stormwater quality are consistent with Cal- and Fed-OSHA and air quality regulations.

SC-42 Building Repair and Construction

Requirements

Costs

These BMPs are generally low to modest in cost.

Maintenance

N/A

Supplemental Information

Further Detail of the BMP

Soil/Erosion Control

If the work involves exposing large areas of soil, employ the appropriate soil erosion and control techniques. See the Construction Best Management Practice Handbook. If old buildings are being torn down and not replaced in the near future, stabilize the site using measures described in SC-40 Contaminated or Erodible Areas.

If a building is to be placed over an open area with a storm drainage system, make sure the storm inlets within the building are covered or removed, or the storm line is connected to the sanitary sewer. If because of the remodeling a new drainage system is to be installed or the existing system is to be modified, consider installing catch basins as they serve as effective "in-line" treatment devices. See Treatment Control Fact Sheet TC-20 Wet Pond/Basin in Section 5 of the New Development and Redevelopment Handbook regarding design criteria. Include in the catch basin a "turn-down" elbow or similar device to trap floatables.

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

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

Parking/Storage Area Maintenance SC-43

Objectives

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

Targeted Constituents

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

Description

Parking lots and storage areas can contribute a number of substances, such as trash, suspended solids, hydrocarbons, oil and grease, and heavy metals that can enter receiving waters through stormwater runoff or non-stormwater discharges. The protocols in this fact sheet are intended to prevent or reduce the discharge of pollutants from parking/storage areas and include using good housekeeping practices, following appropriate cleaning BMPs, and training employees.

Approach

The goal of this program is to ensure stormwater pollution prevention practices are considered when conducting activities on or around parking areas and storage areas to reduce potential for pollutant discharge to receiving waters. Successful implementation depends on effective training of employees on applicable BMPs and general pollution prevention strategies and objectives.

Pollution Prevention

- Encourage alternative designs and maintenance strategies for impervious parking lots. (See New Development and Redevelopment BMP Handbook)
- Keep accurate maintenance logs to evaluate BMP implementation.

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SC-43 Parking/Storage Area Maintenance

Suggested Protocols

General

- Keep the parking and storage areas clean and orderly. Remove debris in a timely fashion.
- Allow sheet runoff to flow into biofilters (vegetated strip and swale) and/or infiltration devices.
- Utilize sand filters or oleophilic collectors for oily waste in low quantities.
- Arrange rooftop drains to prevent drainage directly onto paved surfaces.
- Design lot to include semi-permeable hardscape.
- Discharge soapy water remaining in mop or wash buckets to the sanitary sewer through a sink, toilet, clean-out, or wash area with drain.

Controlling Litter

- Post "No Littering" signs and enforce anti-litter laws.
- Provide an adequate number of litter receptacles.
- Clean out and cover litter receptacles frequently to prevent spillage.
- Provide trash receptacles in parking lots to discourage litter.
- Routinely sweep, shovel, and dispose of litter in the trash.

Surface Cleaning

- Use dry cleaning methods (e.g., sweeping, vacuuming) to prevent the discharge of pollutants into the stormwater conveyance system if possible.
- Establish frequency of public parking lot sweeping based on usage and field observations of waste accumulation.
- Sweep all parking lots at least once before the onset of the wet season.
- Follow the procedures below if water is used to clean surfaces:
  - Block the storm drain or contain runoff.
  - Collect and pump wash water to the sanitary sewer or discharge to a pervious surface. Do not allow wash water to enter storm drains.
  - Dispose of parking lot sweeping debris and dirt at a landfill.
- Follow the procedures below when cleaning heavy oily deposits:
  - Clean oily spots with absorbent materials.
  - Use a screen or filter fabric over inlet, then wash surfaces.

- Do not allow discharges to the storm drain.
- Vacuum/pump discharges to a tank or discharge to sanitary sewer.
- Appropriately dispose of spilled materials and absorbents.

Surface Repair

- Preheat, transfer or load hot bituminous material away from storm drain inlets.
- Apply concrete, asphalt, and seal coat during dry weather to prevent contamination from contacting stormwater runoff.
- Cover and seal nearby storm drain inlets where applicable (with waterproof material or mesh) and manholes before applying seal coat, slurry seal, etc. Leave covers in place until job is complete and all water from emulsified oil sealants has drained or evaporated. Clean any debris from these covered manholes and drains for proper disposal.
- Use only as much water as necessary for dust control, to avoid runoff.
- Catch drips from paving equipment that is not in use with pans or absorbent material placed under the machines. Dispose of collected material and absorbents properly.

Inspection

- Have designated personnel conduct inspections of parking facilities and stormwater conveyance systems associated with parking facilities on a regular basis.
- Inspect cleaning equipment/sweepers for leaks on a regular basis.

Training

- Provide regular training to field employees and/or contractors regarding cleaning of paved areas and proper operation of equipment.
- Train employees and contractors in proper techniques for spill containment and cleanup.

Spill Response and Prevention

- Keep your Spill Prevention Control and Countermeasure (SPCC) Plan up-to-date.
- Place a stockpile of spill cleanup materials where it will be readily accessible or at a central location.
- Clean up fluid spills immediately with absorbent rags or material.
- Dispose of spilled material and absorbents properly.

Other Considerations

Limitations related to sweeping activities at large parking facilities may include high equipment costs, the need for sweeper operator training, and the inability of current sweeper technology to remove oil and grease.

SC-43 Parking/Storage Area Maintenance

Requirements

Costs

Cleaning/sweeping costs can be quite large. Construction and maintenance of stormwater structural controls can be quite expensive as well.

Maintenance

- Sweep parking lot regularly to minimize cleaning with water.
- Clean out oil/water/sand separators regularly, especially after heavy storms.
- Clean parking facilities regularly to prevent accumulated wastes and pollutants from being discharged into conveyance systems during rainy conditions.

Supplemental Information

Further Detail of the BMP

Surface Repair

Apply concrete, asphalt, and seal coat during dry weather to prevent contamination from contacting stormwater runoff. Where applicable, cover and seal nearby storm drain inlets (with waterproof material or mesh) and manholes before applying seal coat, slurry seal, etc. Leave covers in place until job is complete and all water from emulsified oil sealants has drained or evaporated. Clean any debris from these covered manholes and drains for proper disposal. Only use only as much water as is necessary for dust control to avoid runoff.

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

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

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

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

Drainage System Maintenance SC-44

Objectives

- Cover
- Contain
- Educate
- Reduce/Minimize

Description

As a consequence of its function, the stormwater conveyance system collects and transports urban runoff and stormwater that may contain certain pollutants. The protocols in this fact sheet are intended to reduce pollutants reaching receiving waters through proper conveyance system operation and maintenance.

Targeted Constituents

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

Approach

Pollution Prevention

Maintain catch basins, stormwater inlets, and other stormwater conveyance structures on a regular basis to remove pollutants, reduce high pollutant concentrations during the first flush of storms, prevent clogging of the downstream conveyance system, restore catch basins' sediment trapping capacity, and ensure the system functions properly hydraulically to avoid flooding.

Suggested Protocols

Catch Basins/Inlet Structures

- Staff should regularly inspect facilities to ensure compliance with the following:
  - Immediate repair of any deterioration threatening structural integrity.
  - Cleaning before the sump is 40% full. Catch basins should be cleaned as frequently as needed to meet this standard.
  - Stenciling of catch basins and inlets (see SC34 Waste Handling and Disposal).

- Clean catch basins, storm drain inlets, and other conveyance structures before the wet season to remove sediments and debris accumulated during the summer.
- Conduct inspections more frequently during the wet season for problem areas where sediment or trash accumulates more often. Clean and repair as needed.
- Keep accurate logs of the number of catch basins cleaned.
- Store wastes collected from cleaning activities of the drainage system in appropriate containers or temporary storage sites in a manner that prevents discharge to the storm drain.
- Dewater the wastes if necessary with outflow into the sanitary sewer if permitted. Water should be treated with an appropriate filtering device prior to discharge to the sanitary sewer. If discharge to the sanitary sewer is not allowed, water should be pumped or vacuumed to a tank and properly disposed. Do not dewater near a storm drain or stream.

Storm Drain Conveyance System

- Locate reaches of storm drain with deposit problems and develop a flushing schedule that keeps the pipe clear of excessive buildup.
- Collect and pump flushed effluent to the sanitary sewer for treatment whenever possible.

Pump Stations

- Clean all storm drain pump stations prior to the wet season to remove silt and trash.
- Do not allow discharge to reach the storm drain system when cleaning a storm drain pump station or other facility.
- Conduct routine maintenance at each pump station.
- Inspect, clean, and repair as necessary all outlet structures prior to the wet season.

Open Channel

- Modify storm channel characteristics to improve channel hydraulics, increase pollutant removals, and enhance channel/creek aesthetic and habitat value.
- Conduct channel modification/improvement in accordance with existing laws. Any person, government agency, or public utility proposing an activity that will change the natural (emphasis added) state of any river, stream, or lake in California, must enter into a Steam or Lake Alteration Agreement with the Department of Fish and Game. The developer-applicant should also contact local governments (city, county, special districts), other state agencies (SWRCB, RWQCB, Department of Forestry, Department of Water Resources), and Federal Corps of Engineers and USFWS.

Illicit Connections and Discharges

- Look for evidence of illegal discharges or illicit connections during routine maintenance of conveyance system and drainage structures:
  - Is there evidence of spills such as paints, discoloring, etc?

- Are there any odors associated with the drainage system?
- Record locations of apparent illegal discharges/illicit connections?
- Track flows back to potential dischargers and conduct aboveground inspections. This can be done through visual inspection of upgradient manholes or alternate techniques including zinc chloride smoke testing, fluorometric dye testing, physical inspection testing, or television camera inspection.
- Eliminate the discharge once the origin of flow is established.

- Stencil or demarcate storm drains, where applicable, to prevent illegal disposal of pollutants. Storm drain inlets should have messages such as "Dump No Waste Drains to Stream" stenciled next to them to warn against ignorant or intentional dumping of pollutants into the storm drainage system.
- Refer to fact sheet SC-10 Non-Stormwater Discharges.

Illegal Dumping

- Inspect and clean up hot spots and other storm drainage areas regularly where illegal dumping and disposal occurs.
- Establish a system for tracking incidents. The system should be designed to identify the following:
  - Illegal dumping hot spots
  - Types and quantities (in some cases) of wastes
  - Patterns in time of occurrence (time of day/night, month, or year)
  - Mode of dumping (abandoned containers, "midnight dumping" from moving vehicles, direct dumping of materials, accidents/spills)
  - Responsible parties
- Post "No Dumping" signs in problem areas with a phone number for reporting dumping and disposal. Signs should also indicate fines and penalties for illegal dumping.
- Refer to fact sheet SC-10 Non-Stormwater Discharges.

Training

- Train crews in proper maintenance activities, including record keeping and disposal.
- Allow only properly trained individuals to handle hazardous materials/wastes.
- Have staff involved in detection and removal of illicit connections trained in the following:
  - OSHA-required Health and Safety Training (29 CFR 1910.120) plus annual refresher training (as needed).

- OSHA Confined Space Entry training (Cal-OSHA Confined Space, Title 8 and Federal OSHA 29 CFR 1910.146).

- Procedural training (field screening, sampling, smoke/dye testing, TV inspection).

Spill Response and Prevention

- Investigate all reports of spills, leaks, and/or illegal dumping promptly.

- Clean up all spills and leaks using "dry" methods (with absorbent materials and/or rags) or dig up, remove, and properly dispose of contaminated soil.

- Refer to fact sheet SC-11 Spill Prevention, Control, and Cleanup.

Other Considerations (Limitations and Regulations)

- Clean-up activities may create a slight disturbance for local aquatic species. Access to items and material on private property may be limited. Trade-offs may exist between channel hydraulics and water quality/riparian habitat. If storm channels or basins are recognized as wetlands, many activities, including maintenance, may be subject to regulation and permitting.

- Storm drain flushing is most effective in small diameter pipes (36-inch diameter pipe or less, depending on water supply and sediment collection capacity). Other considerations associated with storm drain flushing may include the availability of a water source, finding a downstream area to collect sediments, liquid/sediment disposal, and prohibition against disposal of flushed effluent to sanitary sewer in some areas.

- Regulations may include adoption of substantial penalties for illegal dumping and disposal.

- Local municipal codes may include sections prohibiting discharge of soil, debris, refuse, hazardous wastes, and other pollutants into the storm drain system.

Requirements

Costs

- An aggressive catch basin cleaning program could require a significant capital and O&M budget.

- The elimination of illegal dumping is dependent on the availability, convenience, and cost of alternative means of disposal. The primary cost is for staff time. Cost depends on how aggressively a program is implemented. Other cost considerations for an illegal dumping program include:

  - Purchase and installation of signs.

  - Rental of vehicle(s) to haul illegally-disposed items and material to landfills.

  - Rental of heavy equipment to remove larger items (e.g., car bodies) from channels.

  - Purchase of landfill space to dispose of illegally-dumped items and material.

- Methods used for illicit connection detection (smoke testing, dye testing, visual inspection, and flow monitoring) can be costly and time-consuming. Site-specific factors, such as the level of impervious area, the density and ages of buildings, and type of land use will determine the level of investigation necessary.

Maintenance

- Two-person teams may be required to clean catch basins with vactor trucks.
- Teams of at least two people plus administrative personnel are required to identify illicit discharges, depending on the complexity of the storm sewer system.
- Arrangements must be made for proper disposal of collected wastes.
- Technical staff are required to detect and investigate illegal dumping violations.

Supplemental Information

Further Detail of the BMP

Storm Drain Flushing

Flushing is a common maintenance activity used to improve pipe hydraulics and to remove pollutants in storm drainage systems. Flushing may be designed to hydraulically convey accumulated material to strategic locations, such as an open channel, another point where flushing will be initiated, or the sanitary sewer and the treatment facilities, thus preventing resuspension and overflow of a portion of the solids during storm events. Flushing prevents "plug flow" discharges of concentrated pollutant loadings and sediments. Deposits can hinder the designed conveyance capacity of the storm drain system and potentially cause backwater conditions in severe cases of clogging.

Storm drain flushing usually takes place along segments of pipe with grades that are too flat to maintain adequate velocity to keep particles in suspension. An upstream manhole is selected to place an inflatable device that temporarily plugs the pipe. Further upstream, water is pumped into the line to create a flushing wave. When the upstream reach of pipe is sufficiently full to cause a flushing wave, the inflated device is rapidly deflated with the assistance of a vacuum pump, thereby releasing the backed up water and resulting in the cleaning of the storm drain segment.

To further reduce impacts of stormwater pollution, a second inflatable device placed well downstream may be used to recollect the water after the force of the flushing wave has dissipated. A pump may then be used to transfer the water and accumulated material to the sanitary sewer for treatment. In some cases, an interceptor structure may be more practical or required to recollect the flushed waters.

It has been found that cleansing efficiency of periodic flush waves is dependent upon flush volume, flush discharge rate, sewer slope, sewer length, sewer flow rate, sewer diameter, and population density. As a rule of thumb, the length of line to be flushed should not exceed 700 feet. At this maximum recommended length, the percent removal efficiency ranges between 65-75% for organics and 55-65% for dry weather grit/inorganic material. The percent removal efficiency drops rapidly beyond that. Water is commonly supplied by a water truck, but fire hydrants can also supply water. To make the best use of water, it is recommended that reclaimed water be used or that fire hydrant line flushing coincide with storm sewer flushing.

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

Ferguson, B.K. 1991. Urban Stream Reclamation, p. 324-322, Journal of Soil and Water Conservation.

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

Oregon Association of Clean Water Agencies. Oregon Municipal Stormwater Toolbox for Maintenance Practices. June 1998.

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

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

United States Environmental Protection Agency (USEPA). 2002. Pollution Prevention/Good Housekeeping for Municipal Operations Storm Drain System Cleaning. On line:
http://www.epa.gov/npdes/menuofbmps/poll_16.htm

Landscape Maintenance SC-73

Objectives

- Contain
- Educate
- Reduce/Minimize
- Product Substitution

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	
Bacteria	
Oil and Grease	
Organics	
Oxygen Demanding	☑

Description

Landscape maintenance activities include vegetation removal; herbicide and insecticide application; fertilizer application; watering; and other gardening and lawn care practices. Vegetation control typically involves a combination of chemical (herbicide) application and mechanical methods. All of these maintenance practices have the potential to contribute pollutants to the storm drain system. The major objectives of this BMP are to minimize the discharge of pesticides, herbicides and fertilizers to the storm drain system and receiving waters; prevent the disposal of landscape waste into the storm drain system by collecting and properly disposing of clippings and cuttings, and educating employees and the public.

Approach

Pollution Prevention

- Implement an integrated pest management (IPM) program. IPM is a sustainable approach to managing pests by combining biological, cultural, physical, and chemical tools.
- Choose low water using flowers, trees, shrubs, and groundcover.
- Consider alternative landscaping techniques such as naturescaping and xeriscaping.
- Conduct appropriate maintenance (i.e. properly timed fertilizing, weeding, pest control, and pruning) to help preserve the landscapes water efficiency.

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- Consider grass cycling (grass cycling is the natural recycling of grass by leaving the clippings on the lawn when mowing. Grass clippings decompose quickly and release valuable nutrients back into the lawn).

Suggested Protocols

Mowing, Trimming, and Weeding

- Whenever possible use mechanical methods of vegetation removal (e.g mowing with tractor-type or push mowers, hand cutting with gas or electric powered weed trimmers) rather than applying herbicides. Use hand weeding where practical.
- Avoid loosening the soil when conducting mechanical or manual weed control, this could lead to erosion. Use mulch or other erosion control measures when soils are exposed.
- Performing mowing at optimal times. Mowing should not be performed if significant rain events are predicted.
- Mulching mowers may be recommended for certain flat areas. Other techniques may be employed to minimize mowing such as selective vegetative planting using low maintenance grasses and shrubs.
- Collect lawn and garden clippings, pruning waste, tree trimmings, and weeds. Chip if necessary, and compost or dispose of at a landfill (see waste management section of this fact sheet).
- Place temporarily stockpiled material away from watercourses, and berm or cover stockpiles to prevent material releases to storm drains.

Planting

- Determine existing native vegetation features (location, species, size, function, importance) and consider the feasibility of protecting them. Consider elements such as their effect on drainage and erosion, hardiness, maintenance requirements, and possible conflicts between preserving vegetation and the resulting maintenance needs.
- Retain and/or plant selected native vegetation whose features are determined to be beneficial, where feasible. Native vegetation usually requires less maintenance (e.g., irrigation, fertilizer) than planting new vegetation.
- Consider using low water use groundcovers when planting or replanting.

Waste Management

- Compost leaves, sticks, or other collected vegetation or dispose of at a permitted landfill. Do not dispose of collected vegetation into waterways or storm drainage systems.
- Place temporarily stockpiled material away from watercourses and storm drain inlets, and berm or cover stockpiles to prevent material releases to the storm drain system.
- Reduce the use of high nitrogen fertilizers that produce excess growth requiring more frequent mowing or trimming.

- Avoid landscape wastes in and around storm drain inlets by either using bagging equipment or by manually picking up the material.

Irrigation

- Where practical, use automatic timers to minimize runoff.
- Use popup sprinkler heads in areas with a lot of activity or where there is a chance the pipes may be broken. Consider the use of mechanisms that reduce water flow to sprinkler heads if broken.
- Ensure that there is no runoff from the landscaped area(s) if re-claimed water is used for irrigation.
- If bailing of muddy water is required (e.g. when repairing a water line leak), do not put it in the storm drain; pour over landscaped areas.
- Irrigate slowly or pulse irrigate to prevent runoff and then only irrigate as much as is needed.
- Apply water at rates that do not exceed the infiltration rate of the soil.

Fertilizer and Pesticide Management

- Utilize a comprehensive management system that incorporates integrated pest management (IPM) techniques. There are many methods and types of IPM, including the following:
  - Mulching can be used to prevent weeds where turf is absent, fencing installed to keep rodents out, and netting used to keep birds and insects away from leaves and fruit.
  - Visible insects can be removed by hand (with gloves or tweezers) and placed in soapy water or vegetable oil. Alternatively, insects can be sprayed off the plant with water or in some cases vacuumed off of larger plants.
  - Store-bought traps, such as species-specific, pheromone-based traps or colored sticky cards, can be used.
  - Slugs can be trapped in small cups filled with beer that are set in the ground so the slugs can get in easily.
  - In cases where microscopic parasites, such as bacteria and fungi, are causing damage to plants, the affected plant material can be removed and disposed of (pruning equipment should be disinfected with bleach to prevent spreading the disease organism).
  - Small mammals and birds can be excluded using fences, netting, tree trunk guards.
  - Beneficial organisms, such as bats, birds, green lacewings, ladybugs, praying mantis, ground beetles, parasitic nematodes, trichogramma wasps, seed head weevils, and spiders that prey on detrimental pest species can be promoted.
- 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 pesticides only if there is an actual pest problem (not on a regular preventative schedule).
- Do not use pesticides if rain is expected. Apply pesticides only when wind speeds are low (less than 5 mph).
- Do not mix or prepare pesticides for application near storm drains.
- Prepare the minimum amount of pesticide needed for the job and use the lowest rate that will effectively control the pest.
- Employ techniques to minimize off-target application (e.g. spray drift) of pesticides, including consideration of alternative application techniques.
- Fertilizers should be worked into the soil rather than dumped or broadcast onto the surface.
- Calibrate fertilizer and pesticide application equipment to avoid excessive application.
- Periodically test soils for determining proper fertilizer use.
- Sweep pavement and sidewalk if fertilizer is spilled on these surfaces before applying irrigation water.
- Purchase only the amount of pesticide that you can reasonably use in a given time period (month or year depending on the product).
- Triple rinse containers, and use rinse water as product. Dispose of unused pesticide as hazardous waste.
- Dispose of empty pesticide containers according to the instructions on the container label.

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.
- Inspect pesticide/fertilizer equipment and transportation vehicles daily.

Training

- Educate and train employees on use of pesticides and in pesticide application techniques to prevent pollution. Pesticide application must be under the supervision of a California qualified pesticide applicator.
- Train/encourage municipal maintenance crews to use IPM techniques for managing public green areas.
- Annually train employees within departments responsible for pesticide application on the appropriate portions of the agency's IPM Policy, SOPs, and BMPs, and the latest IPM techniques.

- Employees who are not authorized and trained to apply pesticides should be periodically (at least annually) informed that they cannot use over-the-counter pesticides in or around the workplace.
- Use a training log or similar method to document training.

Spill Response and Prevention

- Refer to SC-11, Spill Prevention, Control & Cleanup
- Have spill cleanup materials readily available and in a know in location
- Cleanup spills immediately and use dry methods if possible.
- Properly dispose of spill cleanup material.

Other Considerations

- The Federal Pesticide, Fungicide, and Rodenticide Act and California Title 3, Division 6, Pesticides and Pest Control Operations place strict controls over pesticide application and handling and specify training, annual refresher, and testing requirements. The regulations generally cover: a list of approved pesticides and selected uses, updated regularly; general application information; equipment use and maintenance procedures; and record keeping. The California Department of Pesticide Regulations and the County Agricultural Commission coordinate and maintain the licensing and certification programs. All public agency employees who apply pesticides and herbicides in "agricultural use" areas such as parks, golf courses, rights-of-way and recreation areas should be properly certified in accordance with state regulations. Contracts for landscape maintenance should include similar requirements.
- All employees who handle pesticides should be familiar with the most recent material safety data sheet (MSDS) files.
- Municipalities do not have the authority to regulate the use of pesticides by school districts, however the California Healthy Schools Act of 2000 (AB 2260) has imposed requirements on California school districts regarding pesticide use in schools. Posting of notification prior to the application of pesticides is now required, and IPM is stated as the preferred approach to pest management in schools.

Requirements

Costs

Additional training of municipal employees will be required to address IPM techniques and BMPs. IPM methods will likely increase labor cost for pest control which may be offset by lower chemical costs.

Maintenance

Not applicable

Supplemental Information

Further Detail of the BMP

Waste Management

Composting is one of the better disposal alternatives if locally available. Most municipalities either have or are planning yard waste composting facilities as a means of reducing the amount of waste going to the landfill. Lawn clippings from municipal maintenance programs as well as private sources would probably be compatible with most composting facilities

Contractors and Other Pesticide Users

Municipal agencies should develop and implement a process to ensure that any contractor employed to conduct pest control and pesticide application on municipal property engages in pest control methods consistent with the IPM Policy adopted by the agency. Specifically, municipalities should require contractors to follow the agency's IPM policy, SOPs, and BMPs; provide evidence to the agency of having received training on current IPM techniques when feasible; provide documentation of pesticide use on agency property to the agency in a timely manner.

References and Resources

King County Stormwater Pollution Control Manual. Best Management Practices for Businesses. 1995. King County Surface Water Management. July. On-line: http://dnr.metrokc.gov/wlr/dss/spcm.htm

Los Angeles County Stormwater Quality Model Programs. Public Agency Activities http://ladpw.org/wmd/npdes/model_links.cfm

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.

Orange County Stormwater Program http://www.ocwatersheds.com/StormWater/swp_introduction.asp

Santa Clara Valley Urban Runoff Pollution Prevention Program. 1997 Urban Runoff Management Plan. September 1997, updated October 2000.

United States Environmental Protection Agency (USEPA). 2002. Pollution Prevention/Good Housekeeping for Municipal Operations Landscaping and Lawn Care. Office of Water. Office of Wastewater Management. On-line: http://www.epa.gov/npdes/menuofbmps/poll_8.htm

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.

- 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.

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.

- 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.

Section 5
Monitoring, Reporting, and Program Evaluation

Conducting a monitoring program, reviewing the monitoring information, evaluating BMPs, and record keeping and reporting are all important elements of the implementation phase of the SWPPP. The success of the SWPPP depends upon the thorough implementation of the monitoring plan and evaluation of the effectiveness of the plan elements once they have been implemented.

Monitoring, Reporting, and Evaluation Elements

- Conduct monitoring program
- Conduct record keeping and reporting
- Conduct annual site evaluation
  - Review monitoring information
  - Evaluate BMPs
  - Review and revise the SWPPP as necessary

5.1 Conduct Monitoring Program

The General Permit requires that a monitoring program be a component of the SWPPP. The program has the following objectives:

- To monitor the quality of the stormwater discharge
- To aid in SWPPP implementation
- To measure the BMP effectiveness

To meet these objectives the monitoring effort has these elements:

- Training
- Visual observations
- Stormwater monitoring
- Authorized non-stormwater discharges

5.1.1 Training

Familiarity with the requirements of the stormwater monitoring plan and competence in the techniques and protocols specified in the plan are essential to ensure that stormwater samples are collected in a manner that meets the goals of the plan, while protecting the health and safety of the monitoring team members. It is recommended that all stormwater monitoring personnel receive training prior to conducting any stormwater monitoring activities. Stormwater monitoring training should include the following basic elements:

- Review of the Monitoring Plan and Health and Safety Plan

- Classroom training session
- Field training and sampling simulation (dry run)
- Annual refresher training

5.1.2 Visual Observations

Visual observations of both stormwater and non-stormwater discharges should be made at all facilities to document the presence of any discolorations, odors, floating and suspended material, oil and grease, etc., and to identify the source of any pollutants and non-stormwater flows. Visual observations should be made under the leadership of the SWPPP Leader, with appropriate members of the Pollution Prevention Team, according to the following schedule:

- All drainage areas within the facility should be checked for the presence of unauthorized non-stormwater discharges on a quarterly basis, during daylight hours, on days with no stormwater discharges.
- All authorized non-stormwater discharges and their sources should be observed quarterly during daylight hours, on days with no stormwater discharges.
- One storm event per month during the wet season (October 1-May 30) should be visually observed during the first hour of discharge at all discharge locations. These observations are only required of stormwater discharges that occur during daylight hours that are preceded by at least three working days without stormwater discharges and that occur during scheduled facility operating hours.

The results of the visual observations should be recorded and include: the date of the observation, locations observed, observations, response taken to eliminate unauthorized non-stormwater discharges, and actions taken to reduce or prevent pollutants from contacting non-stormwater or stormwater discharges. Results are included in the Annual Report.

5.1.3 Stormwater Monitoring

Each facility should either conduct an individual monitoring plan or participate in a group-sampling program. A group-monitoring program may be developed either by an entity representing a group of similar facilities or by a local stormwater agency that holds its own NPDES permit. According to the General Permit, the monitoring plan is to contain the rationale and description of the visual observation methods, location, and frequency; and the analytical methods and corresponding method detection limits used to detect constituents.

Selection of sites for industrial stormwater monitoring will depend on many factors including the following:

Representativeness

It is important to select sites that are representative of typical site operations.

- Runoff from the facility should combine to form a definable runoff stream.

- The runoff stream should represent the full range of activities at the facility.
- Runoff from the facility should not combine with runoff from other sources.
- Adequate flow volume must be available for sample collection.

Personal Safety

Development of a health and safety plan is recommended. Site selection should insure monitoring personnel from the following potential hazards:

- Traffic
- Uneven or slippery footing surface
- Poor night visibility (lighting)

Site Access

Ease of monitoring site access for monitoring personnel and vehicles parking is essential. Also, for sites that require installation of sample collection or flow metering equipment, adequate equipment access for maintenance and monitoring activities must be available.

Equipment Security

Permanently installed monitoring equipment must be located at a site that will minimize potential vandalism and other possible damage.

Adequate Flow Volume

Monitoring sites should be configured such that adequate flow volume is present for sample collection. Hydraulic conditions should be well mixed and free flowing.

Utility Access

If automated monitoring equipment is required, electrical power should be readily available at selected monitoring sites. Additionally, telephone service may be required for off-site station controlling and data transfer.

Stormwater samples should be collected during the first hour of discharge from (1) the first storm event of the wet season, and (2) at least one other storm event in the wet season. If the first event is missed, sampling of two events during the wet season is still required. Furthermore, a justification for failing to sample the first event should be provided in the Annual Report. Sample collection is only required of stormwater discharges that occur during scheduled facility operating hours and that are preceded by at least three working days without stormwater discharge. Sample collection is not required if dangerous weather conditions are present (e.g., flooding, electrical storm, etc.), when stormwater discharges begin after scheduled facility operating hours or when stormwater discharges are not preceded by three working days without discharge. When the required samples are not collected due to these exceptions, an explanation must be provided in the Annual Report. Visual observations and sample collection may be conducted more than one hour after discharge begins if it is determined that the

monitoring objectives will be better satisfied. If this occurs, an explanation should be provided in the Annual Report.

Specific sampling and analysis requirements include the following:

- All sampling and sample preservation should be in accordance with the current edition of "Standard Methods for the Examination of Water and Wastewater".
- All monitoring instruments and equipment should be calibrated and maintained in accordance with manufacturers' specifications to ensure accurate measurements.
- All laboratory analyses should be conducted according to test procedures under 40 CFR Part 136, unless other test procedures have been specified by the RWQCB.
- Analyze samples for total suspended solids (TSS), pH, specific conductance, and total organic carbon (TOC). Oil and grease (O&G) may be substituted for TOC.
- Analyze toxic chemicals and other pollutants that are likely to be present in stormwater discharges. Any of these pollutants that are not detected in significant quantities after two consecutive sampling events may be eliminated from future sampling analysis until the pollutant is likely to be present again. (According to the definitions section of the General Permit, "significant quantities" is defined as the volume, concentration, or mass of a pollutant that can cause or threaten to cause pollution, contamination, or nuisance; adversely impact human health or the environment; and/or cause or contribute to a violation of any applicable water quality standards for the receiving water.)
- Other analytical parameters should be included based on the facility's standard industrial classification (see Table D of the General Permit).

Rules to Follow to Reduce Potential Sample Contamination

1. No smoking.
2. Never sample near a running vehicle. Do not park vehicles in immediate sample collection area (even non-running vehicles)
3. Always wear clean, powder-free nitrile gloves when handling composite bottles, lids, sterile grab sample bottles, tubing, or strainers.
4. Never touch the inside surface of a sample bottle or lid, even with gloved hands.
5. Never touch the exposed end of a sampling tube.
6. Never allow the inner surface of a sample bottle, lid, or sampling tube to be contacted by any material other than the sample water.
7. Never allow any object or material to fall into or contact the collected sample water.
8. Avoid allowing rain water to drip from rain gear or other surfaces into sample bottles.
9. Do not eat or drink during sample collection.
10. Do not breathe, sneeze or cough in the direction of an open sample bottle.

In addition to the requirements above, which are outlined in the General Permit, the following procedures are recommended to maximize the ability of sampling personnel to collect samples reliably and with minimal sample contamination.

- Before stormwater samples are collected, personnel must ensure the safety of such activities at each sampling location.

- Select the appropriate sample bottles and equipment for each parameter to be measured. As general guidelines, all sampling equipment and sample bottles used for trace metals determination should be nonmetallic and free from any material that may contain metals. Only high-density plastic or Teflon containers should be used for metals analytical sample storage bottles. All sampling equipment and sample bottles used for trace organics determination should be glass or Teflon. Nutrients and most "conventional" parameters may be sampled using plastic or glass bottles.

- Employ "clean" sampling techniques to minimize potential sources of sample contamination, particularly from trace pollutants. Experience has shown that when clean sampling techniques are used, detected concentrations of constituents tend to be lower.

5.2 Conduct Record Keeping and Reporting

Records of all stormwater monitoring information, inspections and visual observations, certifications, corrective actions and follow-up activities, and copies of all reports should be retained for a period of at least five years. These records should include:

- The date, place, and time of site inspections, sampling, visual observations, and measurements

- The individual(s) who performed the site inspections, sampling, visual observations, and measurements

- Flow measurements or estimates (as required by Section B.6 of the General Permit)

- The date and approximate time of analyses

- The individual who performed the analyses

- Analytical results, method detection limits, and the analytical techniques or methods used

- Quality assurance and quality control records and results

- Non-stormwater discharge inspections and visual observations and stormwater discharge visual observation records

- Visual observations and sample collection exception records

- All calibration and maintenance records of onsite instruments used

- All sampling and analysis exemption and reduction certifications and supporting documentation

- The records of any corrective actions and follow-up activities that resulted from the visual observations

It is also recommended that information regarding the rain event be collected. A nearby recording gage should be identified and used to document the start and stop times and date of precipitation event. Some industries may want to consider installing a recording gage at the monitoring site.

Photographs can be useful. Also keep a record of maintenance activities or any other BMPs that are of an "action" nature. It is easy to demonstrate that a BMP that involves a physical change, such as berming or covering, has been accomplished. But actions that relate to good housekeeping can only be demonstrated by record keeping. Keeping a record of catch basin cleaning, for example, also provides insight into how soon it takes for the catch basin sump to refill.

An Annual Report including the items listed below should be submitted by July 1 of each year to the Executive Officer of the appropriate RWQCB.

- Summary of visual observations and sampling results

- Evaluation of the visual observations and sampling and analysis results

- Documentation that the BMPs in the SWPPP are being implemented and properly maintained as necessary

- Laboratory reports (including detection limits for each analytical parameter)

- The Annual Comprehensive Site Compliance Evaluation Report (as described below)

- Documentation, including the justification, of any deviations from the General Permit requirements (if not already included in the Evaluation Report)

- Records

- Detection limits for each analytical parameter

5.3 Conduct Annual Site Evaluation

All facilities should conduct an annual comprehensive site compliance evaluation. It may be helpful to involve the Pollution Prevention Team (PPT) in this effort (see Section 2). The SWPPP should be revised within 90 days of the evaluation based on the evaluation and the revisions implemented. Evaluations should include the following:

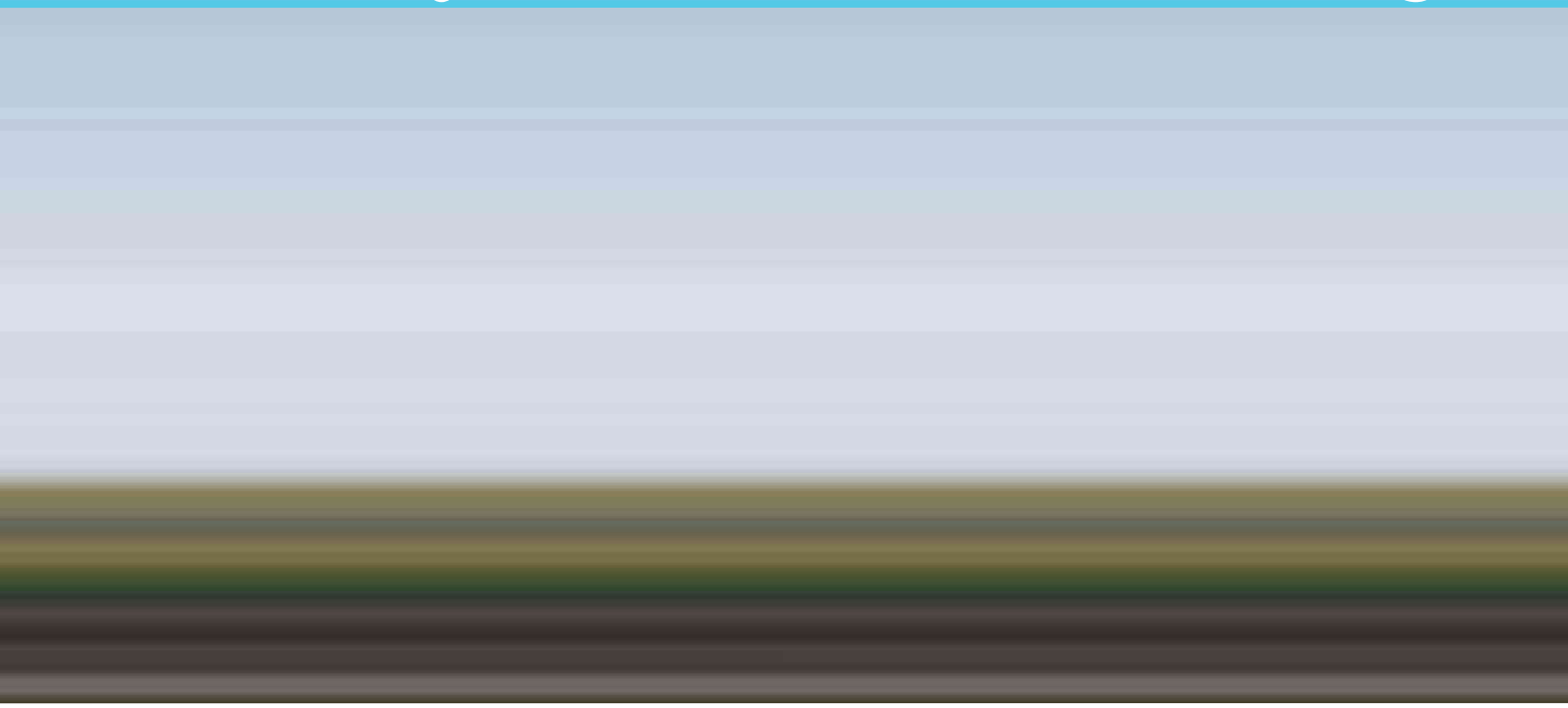
- A review of the results of visual inspections of potential pollutant sources for evidence of, or the potential for, pollutants entering the drainage system

- A review of visual observation records, inspection records, and sampling and analysis results
- A review and evaluation of each BMP to determine whether it is adequate, properly implemented, and maintained
- A review of site activities to ascertain if change has occurred, and if so, whether new or modified BMPs are needed
- A review of the list of significant materials to ascertain if the list has changed, and if so, whether new or modified BMPs are needed
- A review of spills that have occurred over the past 12 months, with a determination of cause(s) and possible solutions, including modified or new BMPs
- A determination of whether each BMP must be modified, replaced, and whether additional BMPs are needed
- An evaluation report

CONTECH®
ENGINEERED SOLUTIONS

Corrugated Metal Pipe
Detention & Infiltration

The experts you need to solve your stormwater challenges



Contech is the leader in stormwater 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.

REGULATORY MANAGER

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

Subsurface Infiltration as a Stormwater Management Strategy

CMP Infiltration is used at Long Beach City College in Long Beach, California.

The only sure way to eliminate stormwater pollution is to eliminate stormwater runoff. In recognition of this fact, Green Infrastructure and Low Impact Development based stormwater management regulations prioritizing runoff reduction have proliferated throughout the United States.

Where site conditions allow, infiltration is typically the most cost effective and reliable runoff reduction approach. In urban environments where there are competing demands for land, subsurface infiltration can provide many of the benefits of landscape based systems but without requiring dedicated land area.

Infiltration systems are commonly comprised of a pretreatment component designed to remove sediment, trash, and oil, followed by plastic, metal or concrete storage units surrounded by permeable stone creating a high voids storage gallery.

Infiltration systems are typically designed to support vehicular loading and to withstand lateral pressures from surrounding soil that allows the overlying land to be used for virtually any non-building application.

Corrugated Metal Pipe
The “Go To” Material for Stormwater Detention

For the majority of applications, corrugated metal pipe (CMP) is the “go to” material for stormwater detention and infiltration. With its low cost, a wide variety of diameters, layout configurations and coatings, no other material can match CMP’s flexibility and versatility.

- NCSPA service life guidance of 75+ years for certain materials in recommended environments. Please refer to the Corrugated Metal Pipe Detention Design Guide for additional information.
- Various pipe coatings and materials are available to accommodate site-specific needs: Aluminized Steel Type 2 (ALT2), Galvanized, CORLIX® Aluminum, and Polymeric.
- Wide range of gages, corrugations, and shapes, diameters 12”– 144”
- Pipe can be fully or partially perforated for infiltration or groundwater recharge applications
- Custom risers and manifolds provide direct access for maintenance
- Outlet control devices can be incorporated within the system, eliminating the need for a separate structure
- Customizable - a variety of fittings allow CMP to match most layout configurations
- May be designed for heavy loading and high maximum cover
- Contributes to LEED points
- Available locally; quick turnaround time
- The most economical installed solution

No other material can match the flexibility and versatility of CMP

Service Life for Corrugated Metal Pipe

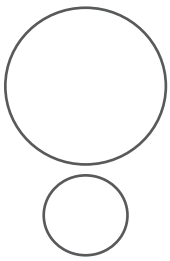
The durability of steel ...

Some engineers are hesitant to use corrugated metal pipe (CMP) for infiltration because they have heard about CMP drainage culverts that have corroded due to abrasion. Factors affecting longevity differ between culvert and infiltration applications. Culverts experience high velocity flows carrying abrasive sediment, which can wear off galvanized coatings used in older CMP culverts. Infiltration systems are designed for storage rather than conveyance, so velocity and abrasive forces are minimized. In addition, improved CMP coatings, such as Aluminized Type 2 (ALT2), are more abrasion resistant and have demonstrated superior in-ground performance against abrasion in long-term durability studies. Field studies also have indicated that ALT2 coating may extend service life in wider pH and resistivity ranges than galvanized coatings. Confirming and maintaining recommended environmental conditions helps ensure system longevity projected by the long term studies. Finally, properly designed infiltration systems include pretreatment, flow control and a stone backfill envelope that can reduce exposure to abrasion

Learn More:
www.ncspa.org

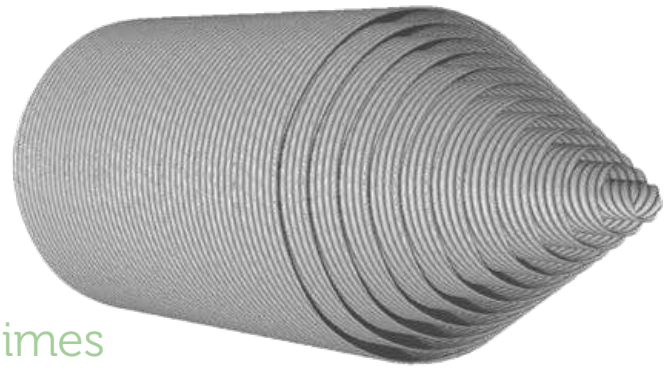
Maximizing Vertical Space: Every Inch Counts

One of the most overlooked advantages of CMP is its ability to maximize vertical storage space. Increasing the depth of a CMP infiltration system allows for more water storage in the same footprint. For example, doubling the diameter of pipe yields four times as much storage volume in the pipe. This provides a significant cost savings per cubic foot of storage. In addition, more vertical storage space means a smaller footprint, less excavation, and lower project costs.



96" diameter - 50.2 ft^3/ft

48" diameter - 12.5 ft^3/ft



Twice the diameter provides four times the storage space.

System Sizing

APPLICATION TIPS

- Use the largest diameter pipe possible to maximize vertical storage space and minimize the overall footprint. Doing so will reduce material, excavation, and backfill costs.
- Single manifold systems are most cost effective as they reduce the amount of fabrication needed.
- Incorporating flow controls into the CMP system can reduce costs by eliminating the need for additional concrete structures.
- The Contech MOBILE PIPE® mill can be delivered to remote locations and assembled on-site for fast and cost effective steel pipe manufacturing.

DIAMETER (IN)	VOLUME (FT^3/FT)	MIN. COVER HEIGHT
6	0.20	12″
8	0.35	12″
10	0.55	12″
12	0.78	12″
15	1.22	12″
18	1.76	12″
21	2.40	12″
24	3.14	12″
30	4.90	12″
36	7.10	12″
42	9.60	12″
48	12.60	12″
54	15.90	12″
60	19.60	12″
66	23.80	12″
72	28.30	12″
78	33.20	12″
84	38.50	12″
90	44.20	12″
96	50.30	12″
102	56.80	18″
108	63.60	18″
114	70.90	18″
120	78.50	18″
126	86.60	18″
132	95.00	18″
138	103.90	18″
144	113.10	18″

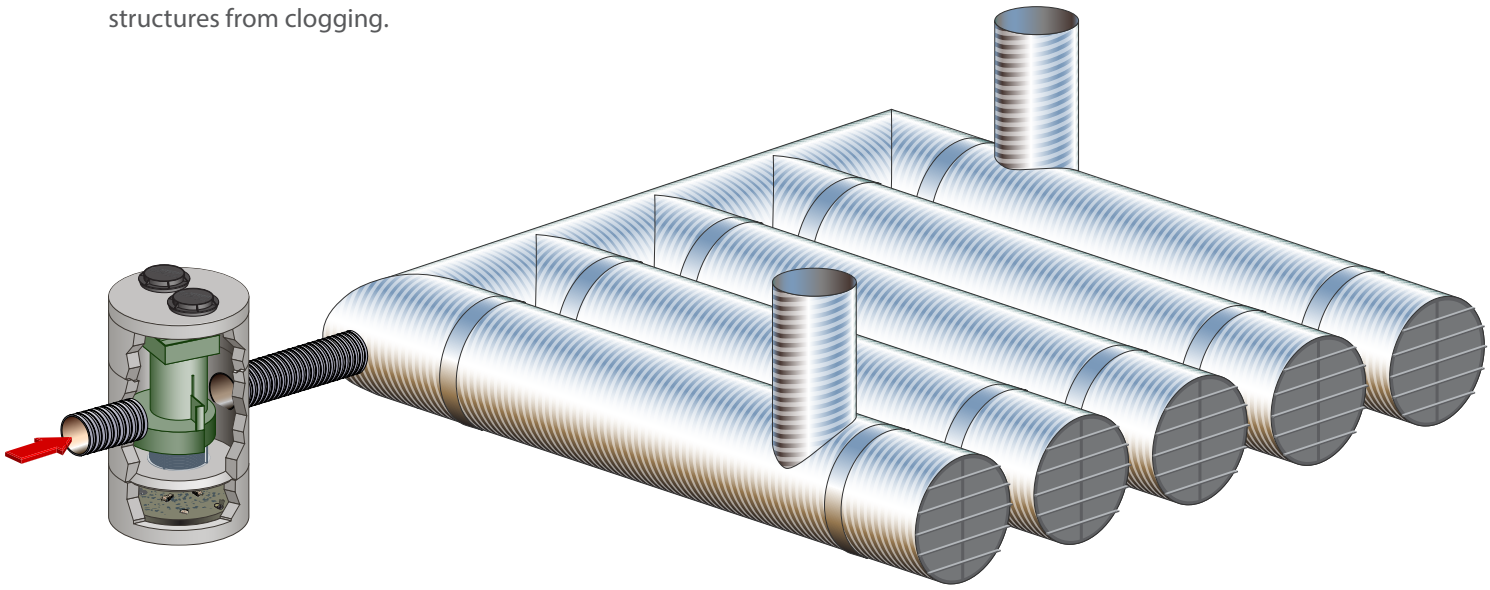
Because of its low cost and flexible configurations, CMP is the ‘go to’ material for stormwater detention and filtration.

Contech’s CMP Detention systems maximize vertical storage space

The Need for Effective Pretreatment

Infiltration systems have multiple components, and one of the most important is pretreatment. The purpose of a pretreatment device is to prolong the life of the infiltration system by removing debris and sediment that can collect on the invert and within the stone backfill voids. Pretreatment will maintain the efficiency of an infiltration system as well as extend the life cycle, therefore preventing a premature replacement. Pretreatment also offers these additional benefits:

- Easier to clean and maintain compared to the infiltration system itself.
- Cost savings due to the extended service life of the system.
- Removing trash and debris protects downstream outlet control structures from clogging.



Pretreatment systems that are easy to maintain and do not rely on the use of geotextile fabric are preferred.

Pretreatment Design Considerations

When choosing a pretreatment system, consider the following ...

- Downstream outlet control structures may require protection from a pretreatment device that screens trash and debris.
- Pretreatment system selection depends on pollutant targets. Trash, debris, and larger particles can be removed with hydrodynamic separators. Removing high percentages of fine particles and associated heavy metals and nutrients requires filtration.
- Reduced long term maintenance or replacement cost of the infiltration system can help justify pretreatment construction costs.
- Inlet and pipe layout will influence the number and type of pretreatment systems used. A combination of different systems may be appropriate for the various inlet locations and flows.

The CDS® provides direct access to cleaning, using a combination of swirl concentration and indirect screening.

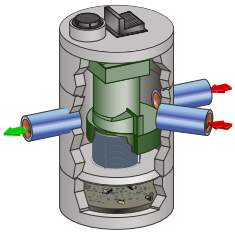
Learn More:
www.ContechES.com/cmp-detention

Reduce long term maintenance of an infiltration system with pretreatment.

Pretreatment options extend the life of subsurface infiltration

Pretreatment Options

Contech offers a number of pretreatment options, all of which will extend the life of subsurface infiltration systems and improve water quality. The type of system chosen will depend on a number of factors including footprint, soil conditions, local regulations, and the desired level of pretreatment.



Hydrodynamic Separation

Hydrodynamic Separation (HDS) provides a basic level of pretreatment by capturing and retaining trash and debris, sediment, and oil from stormwater runoff.

CDS®

CDS provides superior trash and sediment removal, and is much easier to clean and maintain compared to the infiltration system itself.

Cascade Separator™

The Cascade Separator uses advanced sediment capture technology to provide the highest sediment removal efficiency to protect the stone backfill voids of infiltration systems, thus extending the life of the system.

Filtration

Filtration provides a higher level of pretreatment and improved water quality by removing trash and debris, oil, fine solids, and dissolved pollutants such as metals, hydrocarbons, and nutrients.

Filterra® Bioretention System

Filterra is an engineered bioretention system that has been optimized for high volume/flow treatment and high pollutant removal.

The Stormwater Management StormFilter®

The StormFilter system is comprised of a structure that houses rechargeable, media-filled cartridges. The media can be customized to target site-specific pollutants.

Jellyfish® Filter

The Jellyfish filter uses membrane filtration in a compact footprint to remove a high level and a wide variety of stormwater pollutants such as fine particulates, oil, trash and debris, metals, and nutrients.

Alternative Materials for Subsurface Infiltration

There may be instances where alternative materials are needed for subsurface infiltration due to site specific needs ...

Plastic Chambers

Plastic chambers are best suited to shallow depth applications; minimum cover is 18 inches, and maximum cover is 96 inches. Some benefits of chambers are:

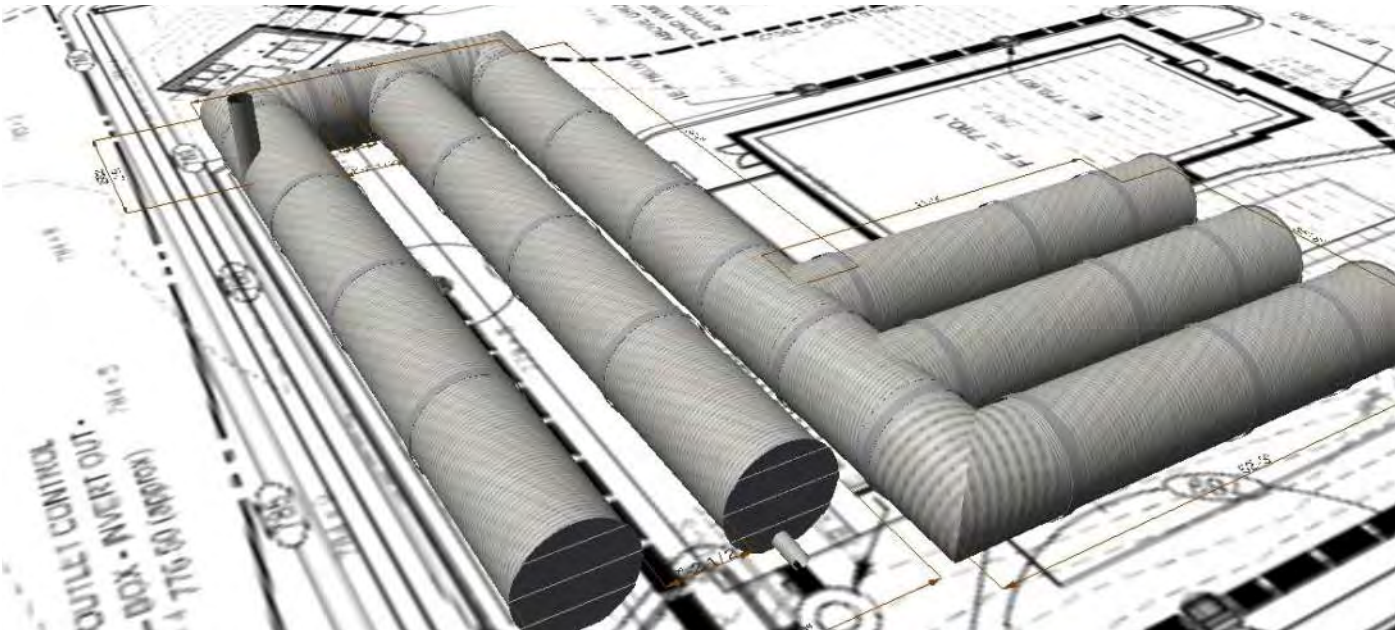
- Chambers may be beneficial for sites with limited vertical storage.
- Lightweight and installed by hand.
- Heavy equipment is not required to set units into place.
- Centralized stocking locations for short lead times.

Concrete Structures/Vaults

Some concrete structures and vaults are best suited for high loading applications such as railroads or airports. Concrete units are also ideal in corrosive environments or areas with high salinity. Some benefits of concrete structures are:

- Wide range of spans and heights.
- Greater underground infiltration storage in a smaller footprint.
- Ample and easy maintenance access.
- Fast installation.

Design Your Own Detention System (DYODS®)



Learn More:
www.ContechES.com/designcenter

Quickly prepare designs for estimates and project meetings ...

Engineers are always looking for new ways to quickly prepare designs for estimates and project meetings. We have a tool that does just that… the Design Your Own Detention System (DYODS®) tool.

Part of the Contech Design Center, this free, online tool fully automates the layout process for stormwater detention and infiltration systems. The tool allows you to design systems using corrugated metal pipe (CMP), ChamberMaxx® plastic chambers, or DuroMaxx® steel reinforced polyethylene (SRPE). You can also create multiple systems for each project while saving all project information for future use.

- "Drag and drop" feature allows users to customize layout
- A 2D/3D design environment with high-resolution graphics including BIM model output
- Optimize designs for the storage requirement or maximize storage for a given footprint
- Import a PDF site plan, scale and design a system over the plan and view the overlay in 2D
- Instant access to customized, project specific drawings, and CAD files
- Ability to co-workers or Contech design engineers to your project with the new Collaborator feature

CONTECH® DESIGNCENTER
DESIGN MADE EASY

A free, online tool that fully automates the layout process for stormwater detention systems.

A partner you can rely on

STORMWATER SOLUTIONS

PIPE SOLUTIONS

STRUCTURES SOLUTIONS

Few companies offer the wide range of high-quality stormwater resources you can find with us — state-of-the-art products, decades of expertise, and all the maintenance support you need to operate your system cost-effectively.

THE CONTECH WAY

Contech® Engineered Solutions provides innovative, cost-effective site solutions to engineers, contractors, and developers on projects across North America. Our portfolio includes bridges, drainage, erosion control, retaining wall, sanitary sewer and stormwater management products.

TAKE THE NEXT STEP

For more information: www.ContechES.com

CONTECH® ENGINEERED SOLUTIONS

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