Preliminary Water Quality Management Plan (WQMP)

Project Name:

4665 Lampson Avenue

Los Alamitos, California 90720

APN: 130-012-35

TTM 19263

Prepared for:

MJW Investments, LLC

27702 Crown Valley Parkway

Suite D-4-197

Ladera Ranch, Ca 92694

Prepared by:

C&V Consulting, Inc.

Engineer Phil Malcomson Registration No. 67819

9830 Irvine Center Drive

Irvine, CA 92618

(949) 916-3800

Prepared: October 7, 2022

Revised: March 13, 2024

Project Owner's Certification

Permit/Application No.	TBD	Grading Permit No.	TBD
Tract/Parcel Map No.	TTM 19263	Building Permit No.	TBD
CUP, SUP, and/or APN (Specify Lot Numbers if Portions of Tract)			APN: 130-012-35

This Preliminary Water Quality Management Plan (WQMP) has been prepared for MJW Investments by C&V Consulting, Inc. The WQMP is intended to comply with the requirements of the local NPDES Stormwater Program requiring the preparation of the plan.

The undersigned, while it owns the subject property, is responsible for the implementation of the provisions of this plan and will ensure that this plan is amended as appropriate to reflect up-to-date conditions on the site consistent with the current Orange County Drainage Area Management Plan (DAMP) and the intent of the non-point source NPDES Permit for Waste Discharge Requirements for the County of Orange, Orange County Flood Control District and the incorporated Cities of Orange County within the Santa Ana Region. Once the undersigned transfers its interest in the property, its successors-in-interest shall bear the aforementioned responsibility to implement and amend the WQMP. An appropriate number of approved and signed copies of this document shall be available on the subject site in perpetuity.

Owner:			
Title			
Company	MJW Investments, LLC		
Address	27702 Crown Valley Parkway Suite D-4-197 Ladera Ranch, CA 92694		
Email			
Telephone #			
I understand my responsibility to implement the provisions of this Preliminary WQMP including the ongoing operation and maintenance of the best management practices (BMPs) described herein.			
Signature		Date	

Preparer (Engineer): Philip Malcomson, P.E.			
Title	Principal	PE Registration #	67819
Company	C&V Consulting, Inc.		
Address	9830 Irvine Center Drive, Irvine, CA 92618		
Email	pmalcomson@cvc-inc.net		
Telephone #	(949) 916-3800		

I hereby certify that this Preliminary Water Quality Management Plan is in compliance with, and meets the requirements set forth in, Order No. R8-2009-0030/NPDES No. CAS618030, of the Santa Ana Regional Water Quality Control Board.

Preparer Signature		Date	
Place Stamp Here			

Contents

Page No.

Attachments

Section I Discretionary Permit(s) and Water Quality Conditions

Project Infomation			
Permit/Application No.	TBD	Tract/Parcel Map No.	TTM 19263
Additional Information/ Comments:	4665 Lampson Avenue Los Alamitos, California 90720 APN: 130-012-35		
Water Quality Conditions			
Water Quality Conditions (list verbatim)	Conditions of Approval are not available at this time. This section will be completed as part of final engineering.		
Watershed-Based Plan Conditions			
Provide applicable conditions from watershed - based plans including WIHMPs and TMDLS.	Copper, Diazinon, Indicator Bacteria, Lead, PH, and Toxicity (Coyote Creek Channel) Coliform Bacteria and PH (San Gabriel) Copper, Dioxin, Nickel, and Oxygen (San Gabriel River Estuary)		

Section II Project Description

II.1 Project Description

Description of Proposed Project		
Development Category (Verbatim from WQMP):	All significant redevelopment projects, where significant redevelopment is defined as the addition or replacement of 5,000 or more square feet of impervious surface on an already developed site. Redevelopment does not include routine maintenance activities that are conducted to maintain original line and grade, hydraulic capacity, original purpose of the facility, or emergency redevelopment activity required to protect public health and safety. If the redevelopment results in the addition or replacement of less than 50 percent of the impervious area on-site and the existing development was not subject to WQMP requirement, the numeric sizing criteria discussed in Section 7.II-2.0 only applies to the addition or the replacement area. If the addition or replacement accounts for 50 percent or more of the impervious area, the Project WQMP requirements apply to the entire development.	
Project Area (ft^2): 527,945.599*	Number of Dwelling Units: 246	SIC Code: _____
Narrative Project Description:	The proposed project consists of approximately 12.12* acres located at 4665 Lampson Avenue in the City of Los Alamitos, California. The site is bounded to the south by Lampson Avenue, to the east by a golf course, to the north by a park, and to the west by the Seal Beach Joint Forces Training base and vacant land. The site is currently occupied by the California Department of Fish and Wildlife with an associated parking lot and open space. Per the City of Los Alamitos General Plan dated March 2015, Existing Land Use exhibit the site is located within the General Office designation. According to the city of Los Alamitos Zoning Map the site is located within the C-F Community Facilities designation. There are 3 driveways that provide access to the site from Lampson Avenue. Approximately 1/3 of the site consists of a paved parking lot. Along the west and northern property lines there is a drive aisle and head in parking that appears to serve the park to the north. The rest of the site consists of one large building, associated concrete sidewalks, and a large grassy/ brush filled open space. The site is bounded on the North, West, and East Property lines with a chain link fence.	

<table>
<tr><td></td><td colspan="4">The existing building coverage is approximately 44,960 square feet, the existing landscaping coverage is approximately 340,276 square feet, and the AC coverage is 153,471 square feet.

The proposed development will consist of 76 buildings consisting of 2- and 3-story detached single family homes, 3 story townhomes, and 3 story apartment buildings for a total of 246 dwelling units.

The Single Family Detached buildings and the townhome buildings will have side-by-side parking and the apartment buildings will have tuck under parking on the first level.

The proposed building coverage is approximately 336,374 square feet, the drive aisle and open parking coverage is approximately 155,691 square feet, and the open space (public and private) lot coverage is approximately 46,641 square feet.

The site proposes 133 open parking spaces (69 for the apartment buildings and 69 for the townhomes and single family homes), 55 driveway parking spaces, and 368 garage parking spaces (30 for the apartment buildings and 338 for the townhomes and single family homes. The open space areas will be maintained by the appointed Homeowners Association (HOA).

The project proposes onsite private drive aisles, parking areas, hardscape and landscaped areas, and is accessed by two entrances along Lampson Avenue. Drive aisles and parking areas will consist of asphalt concrete pavement and sidewalks comprised of Portland concrete cement (PCC). Decorative hardscape is proposed within the walkways, common areas and portions of the drive aisles. Landscaping will be incorporated in open space areas including vegetation and street trees.

*Note that the project area excludes the proposed 10' dedication for the use of parks along the northern property line which consists of approximately 10,761 square feet.</td></tr>
<tr><td rowspan="2">Project Area</td><td colspan="2">Pervious</td><td colspan="2">Impervious</td></tr>
<tr><td>Area
(acres or sq ft)</td><td>Percentage</td><td>Area
(acres or sq ft)</td><td>Percentage</td></tr>
<tr><td>Pre-Project Conditions</td><td>7.18 ac</td><td>58%</td><td>5.19 AC</td><td>42%</td></tr>
<tr><td>Post-Project Conditions*</td><td>1.21 ac</td><td>10%</td><td>10.91</td><td>90%</td></tr>
<tr><td>Drainage Patterns/Connections</td><td colspan="4">The existing site at Parcel 130-012-35 is generally flat and sheet flows to the south west towards Lampson Avenue. According to existing topography, the site elevations range from approximately 21.5 feet to 26.5 feet.

Per the existing topography, the site elevations range from approximately 21 feet to 26 feet. The existing site generally flows in a north to south direction into an</td></tr>
</table>

existing westerly flowing concrete channel along the site's southerly property line. The westerly flowing channel outlets to an 18-inch diameter corrugated metal pipe (CMP) with headwall that flows under the offsite driveway to Arbor Park and discharges into an offsite earthen channel on the west side of the park driveway. Stormwater runoff flows within this earthen channel converge with runoff flows from portions of Arbor Park and JFTB and are then collected by an existing 24-inch CMP that flows westerly through the Joint Forces Training Base (JFTB), then discharge into a westerly flowing earthen channel within the JFTB, and then drain to the Old Ranch Country Club to the south. Stormwater runoff is ultimately conveyed downstream into the San Gabriel River.

Per C&V Consulting conducted field observations, the existing concrete channel along the site's southerly property line currently ponds back to the existing driveway and may overflow onto Lampson Avenue. Based on conversations with City of Seal Beach staff, historical stormwater flows in Lampson Avenue exceed the top of curb elevation during large storm events. Based on the existing topography of the site, in the event the outlet pipe were to become clogged, the existing overflows from the property would flow onto Lampson Avenue at the low point at the southwest corner of the site.

Runoff appears to run along Lampson Avenue until it reaches an existing Orange County Flood Control Facility east of Seal Beach Blvd. After entering this facility runoff is conveyed downstream into the San Gabriel River and eventually into the Pacific Ocean.

The proposed residential development will be divided into seven (7) Drainage Management Areas (DMA) which will be graded to match the existing drainage condition. The storm water runoff will be collected and conveyed by a series of area drains and street flow, towards curb inlet bio-filtration vaults. The bio-filtration vaults will be equipped with an internal bypass that will allow runoff to bypass treatment when the treatment capacity is exceeded. Once through the biofiltration vault, runoff will be conveyed into an underground detention system that will detain the runoff. From the detention system, a stormwater sump pump located in the southwest corner of the site will outlet flows into the existing 18" storm drain pipe at the southwest corner of the site to outlet to the JFTB. The detention system and pump will be sized so that the outlet flows from the developed site will be equal to, or less than, existing flows. In the event the stormwater pump fails or the outlet pipe becomes clogged, the emergency overflow for the site will flow onto Lampson Avenue matching historical drainage patterns.

<u>Alternative Drainage System Outlets to Lampson Avenue:</u>

There is no current cross lot drainage agreement between the JFTB and the subject property allowing for the proposed development's flows to outlet onto the JFTB. The JFTB controls all improvements on their property. If, for whatever reason, proposed flows from the project are not allowed to outlet to the JFTB,

	then an alternate design is proposed to outlet surface flows onto Lampson Avenue gutter via a parkway culvert. Due to existing flooding concerns on Lampson Avenue, the onsite detention and pump system will be designed to allow for low flows to enter Lampson Avenue up until the time that the flows begin to exceed the allowable Q25 on Lampson. Once the peak storm event flows have subsided and flows are no longer above the allowed Q25, it will resume pumping to Lampson Avenue. Refer to Attachment B of this report for the Preliminary WQMP Exhibit. Refer to Attachment D of this report for a copy of the OCFCD Drainage Facilities Maps. Refer to separately prepared Hydrology Report for additional drainage information. **Post-Project perviousness was assumed to be 10% to produce a conservative value for preliminary design. During final engineering, actual pervious coverage will be calculated as landscape plans become available. A thorough review will take place in the final design stages once an impervious percentage is determined and the BMP size may be affected due to the change.

II.2 Potential Stormwater Pollutants

Pollutants of Concern			
Pollutant	Circle One: E=Expected to be of concern N=Not Expected to be of concern		Additional Information and Comments
Suspended-Solid/ Sediment	E X	N	Tributary by proposed landscaped areas.
Nutrients	E X	N	Tributary by proposed landscaped areas.
Heavy Metals	E	N X	Per TGD, Table 2.1 this pollutant is not expected for attached residential developments.
Pathogens (Bacteria/Virus)	E X	N	Tributary by proposed residence and pets.
Pesticides	E X	N	Tributary by proposed landscaped areas.
Oil and Grease	E X	N	Tributary by uncovered parking areas.
Toxic Organic Compounds	E	N X	Per TGD, Table 2.1 this pollutant is nto expected for attached residential developments.
Trash and Debris	E X	N	Tributary by proposed residence.

II.3 Hydrologic Conditions of Concern

☒ No – Map shown in Attachment A

☐ Yes – Describe applicable hydrologic conditions of concern below. *Refer to Section 2.2.3 in the TGD.*

Refer to Attachment A of this report for a copy of the Susceptibility Analysis of San Gabriel-Coyote Creek, HCOC Map. The proposed drainage path of travel has been indicated by arrows on the map. Downstream waters are not considered susceptible to hydromodification.

II.4 Post Development Drainage Characteristics

The proposed residential development will be divided into seven (7) Drainage Management Areas (DMA) which will be graded to match the existing drainage condition. The storm water runoff will be collected and conveyed by a series of area drains and street flow, towards curb inlet bio-filtration vaults. These devices will be sized to treat the required stormwater runoff and have been designed conservatively. The bio-filtration chambers will contain an internal bypass to allow the conveyance of larger storm events. Once through the biofiltration vault, runoff will be conveyed into an underground detention system that will detain the runoff. From the detention system, a stormwater sump pump located in the southwest corner of the site will outlet flows into the existing 18" storm drain pipe at the southwest corner of the site to outlet to the JFTB. The detention system and pump will be sized so that the outlet flows from the developed site will be equal to, or less than, existing flows. In the event the stormwater pump fails or the outlet pipe becomes clogged, the emergency overflow for the site will flow onto Lampson Avenue matching historical drainage patterns.

Alternative Drainage System Outlets to Lampson Avenue:

There is no current cross lot drainage agreement between the JFTB and the subject property allowing for the proposed development's flows to outlet onto the JFTB. The JFTB controls all improvements on their property. If, for whatever reason, proposed flows from the project are not allowed to outlet to the JFTB, then an alternate design is proposed to outlet surface flows onto Lampson Avenue gutter via a parkway culvert.

Due to existing flooding concerns on Lampson Avenue, the onsite detention and pump system will be designed to allow for low flows to enter Lampson Avenue up until the time that the flows begin to exceed the allowable Q25 on Lampson. Once the peak storm event flows have subsided and flows are no longer above the allowed Q25, it will resume pumping to Lampson Avenue.

II.5 Property Ownership/Management

The proposed project will be maintained by an appointed Homeowners Association (HOA) selected by the Developer, MJW Investments, LLC. The HOA will be responsible for maintaining and providing regular inspections on the post-construction BMPs.

MJW Investments, LLC
27702 Crown Valley Parkway
Suite D-4-197
Ladera Ranch, Ca 92694

Section III Site Description

III.1 Physical Setting

Planning Area/ Community Name	n/a
Location/Address	4665 Lampson Avenue
	Los Alamitos, CA 90631
Land Use	Existing Land Use: General Office Proposed Land Use: Residential Multi-Family
Zoning	C-F Community Facilities
Acreage	12.12 ac
Predominant Soil Type	Soil Type A

III.2 Site Characteristics

Precipitation Zone	The site falls under the 0.8" per the TGD, Figure XVI-1, Rainfall Zones Map. Refer to Attachment B of this report for a copy of the map.
Topography	The site is generally flat and sheet flows to the south west towards Lampson Avenue. According to existing topography, the site elevations range from approximately 21.5 feet to 26.5 feet.
Drainage Patterns/Connections	According to existing topography runoff generally surface flows south and west onsite. There is an existing headwall near the eastern most existing driveway. It appears runoff from the adjacent onsite grass area is conveyed towards the headwall that connects to an open drainage channel that slopes to the west along the southern property line. The drainage channel terminates into an existing headwall at the southwest corner of the site. Existing onsite gutters convey runoff into the existing drainage channel. There are two existing trench drains in the two eastern driveways that appear to connect to the existing drainage channel as well. Runoff appears to run along Lampson Avenue until it reaches an existing Orange County Flood Control Facility east of Seal Beach Blvd. After entering this facility runoff is conveyed downstream into the San Gabriel River and eventually into the Pacific Ocean. The proposed drainage design will follow the existing drainage pattern with surface flows to onsite drainage facilities that will ultimately outlet into the existing headwall on the southwest corner of the site.
Soil Type, Geology, and Infiltration Properties	Per the Preliminary Geotechnical Evaluation and Design Recommendations Report prepared by LGC Geotechnical, Inc. Dated December 21, 2021, the site's geotechnical properties are described as the following: "Based on the results of our subsurface investigation, the site is underlain by a thin veneer of topsoil and older artificial fill over young alluvial deposits of Holocene age, per regional geologic mapping (USGS, 2016). The young alluvial sediments encountered during our subsurface exploration generally consist of interbedded layer of gray and brown, silty clay, clay silty sand, and clayey sand. The materials were observed to be very moist to wet with depth, soft to very stiff and medium dense to dense." "In general, our borings indicate the site is underlain by young alluvial fan deposits to the maximum explored depth of approximately 46.5 feet below existing grade. The material consists of clay, clayey sand, silty clay, and silty sand. The material was observed to be very moist to wet with depth and soft to stiff and medium dense to dense." Refer to Attachment F of this report for a copy of the Geotechnical Report.

Hydrogeologic (Groundwater) Conditions

Per the Preliminary Geotechnical Evaluation and Design Recommendations Report prepared by LGC Geotechnical, Inc. Dated December 21, 2021, the the site's groundwater conditions are described as the following:

"*Groundwater was encountered in three of our borings (HS-1 through HS-3) at depths of approximately 11 to 13 feet below existing grade. Additionally, historic high groundwater is estimated to be about 10 feet below existing grade. The location and approximate depth of groundwater is summarized in Table 1 below.*

Boring Number	Total Drilled Depth of Boring (ft)	Groundwater Depth Below Existing Grade (ft)
HS-1	*21.5*	*13*
HS-2	*46.5*	*11.5*
HS-3	*21.5*	*11*

Seasonal fluctuations of groundwater elevations should be expected over time. In general, groundwater levels fluctuate with the seasons and local zones of perched groundwater may be present due to local seepage caused by irrigation and/ or recent precipitation. Local perched groundwater conditions or surface seepage may develop once site development is completed."

Refer to Attachment F of this report for a copy of the Geotechnical Report.

Geotechnical Conditions (relevant to infiltration)

Per the Preliminary Geotechnical Evaluation and Design Recommendations Report prepared by LGC Geotechnical, Inc. Dated December 21, 2021, the site's geotechnical infiltration properties are described as the following:

"Two field percolation tests were performed in locations and depths per the direction of the project civil engineer, the location is depicted on Figure 2 – Boring Location Map. Test well installation consisted of placing a 3-inch diameter perforated PVC pipe in the excavated 8-inch diameter borehole and backfilling the annulus with crushed rock including the placement of approximately 2 inches of crushed rock at the bottom of the borehole. The infiltration test wells were presoaked the day of installation and testing took place within 24 hours of presoaking. During the pre-test, the water level was observed to drop less than 6 inches in 25 minutes for two consecutive readings. Therefore, the test procedure for fine-grained soils or "slow test" was followed. Test well installation and the estimation of infiltration rates were accomplished in general accordance with the guidelines set forth by the County of Orange (2013). In general, three-dimensional flow out of the test well (percolation), as observed in the field, is mathematically reduced to one-dimensional flow out of the bottom of the test well (infiltration). Infiltration tests are performed using relatively clean water, free of particulates, silt, etc. The results of our recent field infiltration testing are presented in Appendix D and summarized below.

TABLE 2
Summary of Field Infiltration Testing

Infiltration Test *Identification*	**Approx. Depth Below Existing Grade (ft)**	**Observed Infiltration Rate* (in./hr.)**
I-1	5	**0.03**
I-2	**5**	**0.04**

*Observed Infiltration Rates Do Not Include Factor of Safety.

The tested infiltration rates provided in this report are considered a general representation of the infiltration rates at the location of the proposed infiltration boring. Please note, the testing of infiltration rates is highly dependent upon the materials encountered at the point of testing (i.e., location and depth of testing). Varying subsurface conditions may exist outside of the test location which could alter the calculated infiltration rate."

"Geotechnical stability and integrity of the project site is reliant upon appropriate handling of surface water. Due to the extremely low measured infiltration rate, low permeability fine-grained soils at depth, shallow groundwater and site liquefaction potential, we strongly recommend against the intentional infiltration of storm water into subsurface soils."

Refer to Attachment F of this report for a copy of the Geotechnical Report.

Per GeoTracker, there are no Leaking Underground Storage Tank (LUST) Cleanup Sites within 1,000 feet of the project site. There is a public water well operated by the City of Seal Beach approximately 1,800 feet west of the site. The well is listed as an active, raw groundwater well operated by the city of Seal Beach. Refer to Attachment F for the GeoTracker printout of the site.

Off-Site Drainage	The site does not experience any off-site run-on
Utility and Infrastructure Information	Utilities are proposed to be underground. No special setbacks are needed or proposed.

III.3 Watershed Description

Receiving Waters	The project site is located within the San Gabriel-Coyote Creek Watershed. The site discharges into the Federal Storm Channel, converges with the San Gabriel River and outlets to the Pacific Ocean.
303(d) Listed Impairments	San Gabriel River Estuary is listed for Copper, Dioxin, Indicator Bacteria, Nickel and Oxygen, Dissolved. San Pedro Bay Near/Off Shore Zones is listed for Chlordane, PCBs, Total DDT, Toxicity.
Applicable TMDLs	TMDLs are listed for the water bodies Coyote Creek Channel for Copper, Lead, and Zinc. San Gabriel TMDLs are for Indicator Bacteria. These TMDLs have been adopted for Coyote Creek/ San Gabriel River by the Los Angeles Regional Water Quality Control Board (Region 4); however, it applies to the areas of Orange County that drain to the Coyote Creek and San Gabriel River.
Pollutants of Concern for the Project	Suspended solid/ sediments, Nutrients, Pathogens (Bacteria/ Virus), Pesticides, Oil & Grease and Trash & Debris
Environmentally Sensitive and Special Biological Significant Areas	n/a

Section IV Best Management Practices (BMPs)

IV. 1 Project Performance Criteria

(NOC Permit Area only) Is there an approved WIHMP or equivalent for the project area that includes more stringent LID feasibility criteria or if there are opportunities identified for implementing LID on regional or sub-regional basis?		YES ☐	NO ☒
If yes, describe WIHMP feasibility criteria or regional/sub-regional LID opportunities.	n/a		

Project Performance Criteria (continued)	
If HCOC exists, list applicable hydromodification control performance criteria (Section 7.II-2.4.2.2 in MWQMP)	Per 7.II-2.4.2.2 of the Model WQMP, HCOC exists for when the post-construction time of concentration and volume of storm water increases beyond 5% of a 2-year storm event thus potentially increasing the downstream erosion and adversely impacts on physical structure, aquatic, and riparian habitat.
List applicable LID performance criteria (Section 7.II-2.4.3 from MWQMP)	Per 7.II-2.4.3 of the Model WQMP, the available LID Treatment BMPs to be utilized in reducing the post-development impacts include infiltration, harvest and use, evapotranspiration, or biotreat/biofilter, the 85th percentile of a 24-hour storm event (Design Capture Volume).
List applicable treatment control BMP performance criteria (Section 7.II-3.2.2 from MWQMP)	Per 7.II-3.2.2 of the Model WQMP, if the LID performance criteria is not feasibly met by retention and/or biotreatment, then sizing of onsite treatment control BMPs are required. Sizing of these treatment control BMPs will include, if applicable any Water Quality credits as calculated per the Technical Guidance Document. The project proposes to satisfy LID performance criteria, therefore treatment control performance criteria is also fully satisfied.
Calculate LID design storm capture volume for Project.	The proposed project residential site will generate a total DCV of 29,213 cf. The DCV for each DMA was calculated as follows: DMA 1: V_{design} = 0.83*0.8*2.160 acres*43,560 (sf/acre)*(1 foot/12 inches) = 5,206 cf DMA 2: V_{design} = 0.83*0.8*2.093 acres*43,560 (sf/acre)*(1 foot/12 inches) = 5,045 cf DMA 3: V_{design} = 0.83*0.8*2.809 acres*43,560 (sf/acre)*(1 foot/12 inches) = 6,771 cf DMA 4: V_{design} = 0.83*0.8*1.806 acres*43,560 (sf/acre)*(1 foot/12 inches) = 4,352 cf DMA 5: V_{design} = 0.83*0.8*0.507 acres*43,560 (sf/acre)*(1 foot/12 inches) = 1,223 cf DMA 6: V_{design} = 0.83*0.8*0.504 acres*43,560 (sf/acre)*(1 foot/12 inches) = 1,214 cf DMA 7: V_{design} = 0.83*0.8*2.241 acres*43,560 (sf/acre)*(1 foot/12 inches) = 5,401 cf

	As flow-based Bio-filtration BMPs are proposed for project site. The design flowrates corresponding to surface flows from streets and drive aisles within each DMA were calculated as follows: DMA 1: Q_{design} = 0.83*0.26 (in/hr)*2.160 acres = 0.466 cfs DMA 2: Q_{design} = 0.83*0.26 (in/hr)*2.093 acres = 0.452 cfs DMA 3: Q_{design} = 0.83*0.26 (in/hr)*2.809 acres = 0.606 cfs DMA 4: Q_{design} = 0.83*0.26 (in/hr)*1.806 acres = 0.390 cfs DMA 5: Q_{design} = 0.83*0.26 (in/hr)*0.507 acres = 0.110 cfs DMA 6: Q_{design} = 0.83*0.26 (in/hr)*0.504 acres = 0.109 cfs DMA 7: Q_{design} = 0.83*0.26 (in/hr)*2.241 acres = 0.484 cfs * Refer to Worksheet B in Attachment B of this report.

IV.2. SITE DESIGN AND DRAINAGE PLAN

The site is divided into seven (7) Drainage Management Areas (DMA) as indicated on the Preliminary WQMP Exhibit. Each drainage area will have an area drain system to convey runoff from landscape and roof drainage along with curb inlet Modular Wetlands Systems to intercept surface runoff form surrounding walkways and drive aisles. The area drain system design for the project will be determined during final engineering and will connect directly to the proposed water quality treatment devices.

Stormwater runoff will be collected and conveyed through curb inlet Modular Wetlands Systems for water quality treatment of the Design Capture Volume (DCV). The overall project treatment flow rate for the site is 2.615 cfs, per Worksheet D in Attachment D of this report. Refer to the DMA Table below for area designation.

The Modular Wetland System (MWS) Biofiltration vaults are designed to provide a 3-phase treatment train. Initially, when the stormwater enters the system, a trash rack, filter media and settling chamber will capture large trash/ debris and sediment in the stormwater before entering the planting media. This system is designed to treat stormwater flow horizontally. Before the stormwater enters the planting or "wetland" chamber, the runoff flows through the 2nd phase, a pre-filter cartridge which captures fines TSS, metals, nutrients and bacteria. The pre-filter chamber eliminates additional maintenance of the planting area. The wetland chamber is the 3rd phase of the system which provides final treatment through a combination of physical, chemical and biological processes. Refer to Section IV.3.4 of this report for sizing information of the Biofiltration Vaults.

In the 7 DMAs, street runoff and landscape area runoff will be conveyed into the Modular Wetlands System where it will be treated for Water Quality. In the event that the design capture flowrate is exceeded, runoff will flow through the internal bypass and be conveyed into the underground detention system. The underground detention system meters flows offsite through an existing 18" storm drain pipe.

Runoff that enters the existing 18" storm drain pipe will follow historic drainage patterns and will drain into the San Gabriel River which eventually outlets into the Pacific Ocean.

Drainage from upstream offsite areas that run onto the site will be collected and conveyed in separate underground storm drain pipes that will direct flows to overflow parkway drains to discharge into the existing 18" storm drain pipe. Offsite and onsite runoff flows will not co-mingle prior to onsite treatment runoff.

Drainage Management Areas (DMA) Table:

Refer to the Preliminary WQMP Exhibit within this report for referenced area designations.

Drainage Area No. (DMA)	Area (ac)	DCV (cf)	Design Flow Rate (cfs)	Proposed BMPs
1	2.15978	5,206	0.466	BIO-7 Biofiltration System
2	2.09320	5,045	0.452	BIO-7 Biofiltration System
3	2.80935	6,771	0.606	BIO-7 Biofiltration System
4	1.80556	4,352	0.390	BIO-7 Biofiltration System
5	0.50746	1,223	0.110	BIO-7 Biofiltration System

6	0.50365	1,214	0.109	BIO-7 Biofiltration System
7	2.24081	5,401	0.484	BIO-7 Biofiltration System
∑	12.12	29,213	2.615	

* Refer to Worksheets B and D in Attachment B of this report.

IV.3 LID BMP SELECTION AND PROJECT CONFORMANCE ANALYSIS

IV.3.1 Hydrologic Source Controls

Name	Included?
Localized on-lot infiltration	☐
Impervious area dispersion (e.g. roof top disconnection)	☐
Street trees (canopy interception)	☐
Residential rain barrels (not actively managed)	☐
Green roofs/Brown roofs	☐
Blue roofs	☐
Impervious area reduction (e.g. permeable pavers, site design)	☐
Other:	☐
Other:	☐
Other:	☐
Other:	☐
Other:	☐
Other:	☐
Other:	☐
Other:	☐

**HSC BMPs are not required since the site is HCOC exempt*

IV.3.2 Infiltration BMPs

Name	Included?
Bioretention without underdrains	☐
Rain gardens	☐
Porous landscaping	☐
Infiltration planters	☐
Retention swales	☐
Infiltration trenches	☐
Infiltration basins	☐
Drywells	☐
Subsurface infiltration galleries	☐
French drains	☐
Permeable asphalt	☐
Permeable concrete	☐
Permeable concrete pavers	☐
Other:	☐
Other:	☐

Per TGD Figure XVI-2A the site falls under Soil Type "A".

Due to the high groundwater levels and very low infiltration rates, infiltration is not feasible for this site.

IV.3.3 Evapotranspiration, Rainwater Harvesting BMPs

Name	Included?
All HSCs; *See Section IV.3.1*	☐
Surface-based infiltration BMPs	☐
Biotreatment BMPs	☒
Above-ground cisterns and basins	☐
Underground detention	☐
Other:	☐
Other:	☐
Other:	☐

The entire DCV is being treated by Biotreatment BMPs. Harvested Water Demand and Feasibility assessment was performed per Worksheet J, which indicated that Evapotranspiration or Rainwater Harvesting BMPs are infeasible.

IV.3.4 Biotreatment BMPs

Name	Included?
Bioretention with underdrains	☐
Stormwater planter boxes with underdrains	☐
Rain gardens with underdrains	☐
Constructed wetlands	☐
Vegetated swales	☐
Vegetated filter strips	☐
Proprietary vegetated biotreatment systems	☒
Wet extended detention basin	☐
Dry extended detention basins	☐
Other:	☐
Other:	☐

Modular Wetland System (MWS) Biofiltration vaults will be utilized to treat runoff prior to discharging offsite. The MWS Biofiltration vaults utilize a 3-phase treatment train by collecting the stormwater runoff in a Pre-Treatment Chamber, Planting or "Wetland" Chamber and Discharge Chamber. Treated runoff outlets to existing Caltrans catch basins.

The MWS Biofiltration vaults were sized separately per DMA using the treatment flow rate method per the Orange County Technical Guidance Document worksheets. Note that the tributary treatment area used for MWS sizing calculations refers to the entire DMA. Landscape areas will have area drains to convey runoff through the MWS systems.

Refer to Worksheet D in Attachment A for calculations.

DMA	Acreage Tributary to Proposed Catch Basins (ac)	Design Flow Rate (cfs)	MWS Model	Treatment Capacity, Q (cfs)
1	2.15978	0.466	MWS-L-8-20-V	0.620
2	2.09320	0.452	MWS-L-8-16-C	0.462
3	2.80935	0.606	MWS-L-8-20-C	0.620
4	1.80556	0.390	MWS-L-8-16-C	0.462
5	0.50746	0.110	MWS-L-4-8-C	0.115
6	0.50365	0.109	MWS-L-4-8-C	0.115

7	2.24081	0.484	MWS-L-8-16-C	0.489
Total	12.12	2.615		2.725

** Project-specific details will be provided during final engineering. Refer to Attachment C for additional manufacturer information.*

Conclusion:

The utilization of a MWS Biofiltration vaults will provide more than the required pre-treatment flow rate for their tributary drainage areas.

	Easting	***Northing***
MWS #1	*6014531.4995'*	*2232655.3917'*
MWS #2	*6014932.0452'*	*2232907.6932'*
MWS #3	*6014965.4528'*	*2232807.1811'*
MWS #4	*6014903.1336'*	*2232808.1092'*
MWS #5	*6014677.7325'*	*2232684.9774'*
MWS #6	*6014814.9612'*	*2232681.4795'*
MWS #7	*6014894.1135'*	*2232648.0694'*

IV.3.5 Hydromodification Control BMPs

Hydromodification Control BMPs	
BMP Name	**BMP Description**
n/a	n/a

IV.3.6 Regional/Sub-Regional LID BMPs

Regional/Sub-Regional LID BMPs
n/a

IV.3.7 Treatment Control BMPs

Treatment Control BMPs	
BMP Name	**BMP Description**
n/a	n/a

IV.3.8 Non-structural Source Control BMPs

Non-Structural Source Control BMPs				
Identifier	**Name**	**Check One**		**If not applicable, state brief reason**
		Included	**Not Applicable**	
N1	Education for Property Owners, Tenants and Occupants	☒	☐	
N2	Activity Restrictions	☒	☐	
N3	Common Area Landscape Management	☒	☐	
N4	BMP Maintenance	☒	☐	
N5	Title 22 CCR Compliance (How development will comply)	☒	☐	
N6	Local Industrial Permit Compliance	☐	☒	Proposed residential project.
N7	Spill Contingency Plan	☐	☒	Proposed residential project.
N8	Underground Storage Tank Compliance	☐	☒	No proposed underground storage tanks.
N9	Hazardous Materials Disclosure Compliance	☐	☒	Proposed residential project.
N10	Uniform Fire Code Implementation	☒	☐	
N11	Common Area Litter Control	☒	☐	
N12	Employee Training	☒	☐	
N13	Housekeeping of Loading Docks	☐	☒	Proposed residential project.
N14	Common Area Catch Basin Inspection	☒	☐	
N15	Street Sweeping Private Streets and Parking Lots	☒	☐	
N16	Retail Gasoline Outlets	☐	☒	Proposed residential project.

N1: Education for Property Owners, Tenants & Occupants

Project conditions of approval will require that the Homeowner's Association (HOA) periodically provide environmental awarness education materials, made available bt the municipalities, to all of its members. Among other things, these materials will be descrive the use of chemcials (including household type) that should be limited to the property, with no discharge of wastes via hosing or other direct discharge to gutters, catch basins and storm drains. Educational materials available from the County of Orange can be downloaded here:

http://www.ocwatersheds.com/PublicEd/resources/default.aspx

N2: Activity Restrictions

Conditions, covenants and restrictions (CC&Rs) must be prepared by the developer for the appointed HOA for the purpose of surface water quality protection. The CC&Rs shall incorporate the restrictions based on the Project WQMP.

N3: Common Area Landscape Management

All common landscaping and/ or open space areas shall have on-going landscape maintenance by an appointed professional landscaping maintenance company as selected by the HOA. Maintenance shall incorporate all current County Water Conservation Resolution usage and follow the Management Guidelines for Use of Fertilizers per the DAMP Section 5.5. Refer to Section 5 of this report for additional landscape maintenance requirements.

N4: BMP Maintenance

Refer to Section 5 and Attachment C of this report for additional non-structural BMP maintenance requirements, responsibility and frequency.

N5: Title 22 CCR Compliance

HOA is responsible for compliance with Title 22 of the California Code of Regulations (CCR) and relevant sections of the California Health & Safety Code regarding hazardous waste management is enforced by the County Environmental Heath and behalf of the State. Inforamtion regarding hazardous waste management must be provided to all employees, homeowners, tenants and occupants.

N10: Uniform Fire Code Implementation

HOA is responsible for compliance with Article 80 of the Uniform Fire Code enforced by the local fire protection agency.

N11: Common Area Litter Control

HOA to implement trash management and litter control procedures in the common areas aimed at reducing pollution of drainage water. HOA to contract with landscape maintenance company to provide this service during regularly scheduled maintenance, which will consist of litter patrol,

emptying of trash receptacles in common areas, and noting trash disposals violations by homeowners, tenants or occupants and reporting the violations to the HOA for investigation.

N12: Employee Training

HOA to provide Educational Materials and Property Management manuals to all employees upon initial hiring. Any updated information shall be provided to employees within a timely manner along with information on implementation.

N14: Common Area Catch Basin Inspections

HOA to inspect, clean and repair common area catch basins within the development to verify that the private drainage system is working properly. All trash/ debris and sediment build up is removed and any repairs/ replacements are conducted. Cleaning should take place in late summer/ early fall prior to the start of the raining season. Drainage facilities include catch basins (storm drain inlets), detention basins, retention basins, sediment basins, open drainage channels, area drains, and lift stations. Records shall be kept onsite to document the annual maintenance.

N15: Street Sweeping of Private Streets & Parking Lots

HOA to schedule at a minimum street sweeping of private streets and parking areas prior to the start of the rainy seasons, in late summer or early fall. Additional sweeping may be required to remove landscaping foliage and/ or pollution.

IV.3.9 Structural Source Control BMPs

Structural Source Control BMPs				
Identifier	**Name**	**Check One**		**If not applicable, state brief reason**
		Included	**Not Applicable**	
S1	Provide storm drain system stenciling and signage	☒	☐	
S2	Design and construct outdoor material storage areas to reduce pollution introduction	☐	☒	No proposed outdoor storage areas.
S3	Design and construct trash and waste storage areas to reduce pollution introduction	☒	☐	
S4	Use efficient irrigation systems & landscape design, water conservation, smart controllers, and source control	☒	☐	
S5	Protect slopes and channels and provide energy dissipation	☐	☒	No proposed slopes/channels to be protected.
	Incorporate requirements applicable to individual priority project categories (from SDRWQCB NPDES Permit)	☐	☒	n/a
S6	Dock areas	☐	☒	Proposed residential project.
S7	Maintenance bays	☐	☒	Proposed residential project.
S8	Vehicle wash areas	☐	☒	No proposed vehicle wash areas.
S9	Outdoor processing areas	☐	☒	Proposed residential project.
S10	Equipment wash areas	☐	☒	Proposed residential project.
S11	Fueling areas	☐	☒	Proposed residential project.
S12	Hillside landscaping	☐	☒	Project not located within hillside area.
S13	Wash water control for food preparation areas	☐	☒	Proposed residential project.
S14	Community car wash racks	☐	☒	No proposed community car washing areas.

S1 (SD-13): Provide Storm Drain System Stenciling

Phrase "No Dumping – Drains to Ocean" or equally effective phrase to be stenciled on catch basins to alert the public of the destination of pollutants discharged into storm water. This stenciling will be inspected and re-stenciled on a periodic basis by HOA.

Refer to CASQA BMP Fact Sheet SD-13 for additional information.

S4 (SD-12): Use Efficient Irrigation Systems & Landscape Design

HOA shall implement the timing and application methods of irrigation water to minimize the runoff of excess irrigation water into the storm drain systems. HOA to implement the following methods to reduce excessive irrigation water runoff, where applicable:

- Employ rain shutoff devices to prevent irrigation after precipitation
- Utilizing landscape specific irrigation water requirements
- Utilize flow reducers or shutoff valves triggered by pressure drop to control water loss due to broken sprinkler heads
- Implement landscaping practices per the County Water Conservation Resolution or City agency equivalent
- Group plants or landscaping with similar water consumption in order to promote surface infiltration

Refer to CASQA BMP Fact Sheet SD-12 for additional information.

IV.4 ALTERNATIVE COMPLIANCE PLAN (IF APPLICABLE)

IV.4.1 Water Quality Credits

<table>
<tr><th colspan="5">Description of Proposed Project</th></tr>
<tr><td colspan="5">Project Types that Qualify for Water Quality Credits (Select all that apply):</td></tr>
<tr><td colspan="2">☐Redevelopment projects that reduce the overall impervious footprint of the project site.</td><td colspan="2">☐Brownfield redevelopment, meaning redevelopment, expansion, or reuse of real property which may be complicated by the presence or potential presence of hazardous substances, pollutants or contaminants, and which have the potential to contribute to adverse ground or surface WQ if not redeveloped.</td><td>☐ Higher density development projects which include two distinct categories (credits can only be taken for one category): those with more than seven units per acre of development (lower credit allowance); vertical density developments, for example, those with a Floor to Area Ratio (FAR) of 2 or those having more than 18 units per acre (greater credit allowance).</td></tr>
<tr><td colspan="2">☐ Mixed use development, such as a combination of residential, commercial, industrial, office, institutional, or other land uses which incorporate design principles that can demonstrate environmental benefits that would not be realized through single use projects (e.g. reduced vehicle trip traffic with the potential to reduce sources of water or air pollution).</td><td colspan="2">☐ Transit-oriented developments, such as a mixed use residential or commercial area designed to maximize access to public transportation; similar to above criterion, but where the development center is within one half mile of a mass transit center (e.g. bus, rail, light rail, or commuter train station). Such projects would not be able to take credit for both categories, but may have greater credit assigned</td><td>☐ Redevelopment projects in an established historic district, historic preservation area, or similar significant city area including core City Center areas (to be defined through mapping).</td></tr>
<tr><td>☐Developments with dedication of undeveloped portions to parks, preservation areas and other pervious uses.</td><td>☐ Developments in a city center area.</td><td>☐ Developments in historic districts or historic preservation areas.</td><td>☐ Live-work developments, a variety of developments designed to support residential and vocational needs together – similar to criteria to mixed use development; would not be able to take credit for both categories.</td><td>☐In-fill projects, the conversion of empty lots and other underused spaces into more beneficially used spaces, such as residential or commercial areas.</td></tr>
<tr><td>Calculation of Water Quality Credits
(if applicable)</td><td colspan="4">The entire DCV is being treated by LID BMPs. Water quality credits will not be used.</td></tr>
</table>

IV.4.2 Alternative Compliance Plan Information

n/a

Section V Inspection/Maintenance Responsibility for BMPs

Currently the owner of the property is the California Department of Fish and Wildlife. Upon completion of entitlement, during the process of final engineering, ownership will be transferred to MJW Investments, LLC. Ultimately, the property owner will be responsible for establishing a Homeowner's Association (HOA) for long term BMP operation and maintenance. The owner is aware of the maintenance responsibilities of the proposed BMPs. A funding mechanism is in place to establish an HOA to maintain the BMPs at the frequency stated in the WQMP. Contact information will be updated as part of final engineering.

If ownership is transferred at a later date other than who is listed within the Final report, completion of a Notice of Transfer of Responsibility form is required. A blank form is provided in Attachment G of this report.

For preliminary purposes, MJW Investments will be responsible for the BMP maintenance until the project is sold and/ or transferred to a new Owner, HOA.

MJW Investments, LLC
27702 Crown Valley Parkway
Suite D-4-197
Ladera Ranch, Ca 92694

The following BMP Inspection/ Maintenance table will be completed as part of the final engineering. This table will include BMP description, responsible party(ies), required inspection/ maintenance routine and frequency.

BMP Inspection/Maintenance			
BMP	**Reponsible Party(s)**	**Inspection/ Maintenance Activities Required**	**Minimum Frequency of Activities**
Education for Property Owners, Tenants, Occupants & Employees	Homeowner's Association (HOA)	HOA to provide education material, a copy of the approved WQMP and Operation & Maintenance Plan (O&M) to new property owners, tenants, occupants & employees.	As needed.
Activity Restrictions	HOA	HOA notified of activities that are prohibited by homeowners.	Restrictions identified in Employee Manual and reviewed yearly by employees.
Common Area Landscape Management	HOA	HOA to hire professional landscape company to conduct maintenance of landscaping to meet current water efficiency and keep plants healthy and bio areas maintained with proper soil amendments.	Regular maintenance once a week and monthly inspection to determine deficiencies
Title 22 CCR Compliance	HOA	HOA to comply with Title 22 of the California Code of Regulations (CCR), relevant California Health & Safety Code and keep informed of the latest	As needed.

		requirements. Information regarding hazardous waste management must be provided to all employees, homeowners, tenants & occupants.	
Uniform Fire Code Implementation	HOA	HOA to comply with fire regulations and keep informed of the latest rules and requirements.	Comply with annual fire inspections and maintain building and access per the latest fire codes.
Common Area Litter Control	HOA	HOA to provide litter removal of site parking lot and landscape areas.	Once per week.
Employee Training	HOA	HOA to provide Educational Materials and Property Management manuals to all employees upon initial hiring. Any updated information shall be provided to employees in a timely manner.	As needed.
Common Area Catch Basin Inspections	HOA	HOA to inspect, clean and repair common area catch basins to verify private drainage system functioning properly.	80% of drainage facilities to be inspected, cleaned and maintained on an annual basis and 100% in a two-year period.

Private Street & Parking Lot Sweeping	HOA	HOA to provide maintenance of Parking Lot.	Regular Parking Lot sweeping once a week.
Storm Drain Stencilling and Signage	HOA	HOA to provide maintenance of storm drain stencilling and signage.	Once every 6 months, inspect for re-stencilling needs. Re-stencil as needed immediately.
Use efficient irrigation systems & landscape design, water conservation, smart controllers, and source control	HOA	HOA to provide maintenance of landscaping to meet current water efficiency standards and keep plants healthily.	Regular maintenance once a week and monthly inspection to determine deficiencies.
Modular Wetlands Biofiltration systems	HOA	HOA to provide maintenance of systems. Remove trash debris and sediment accumulation after storm events. Replace media as required. Repair as needed.	Regular maintenance before rainy season. Inspect and clean at least twice per year.

Modular Trough Diversion System	HOA	HOA to inspect system and schedule maintenance when deficiencies are noted. Area near system to be kept free of debris and cleanings shall be scheduled to remove silt from trough as needed	Inspections should occur at least two times per year and one of the inspection must be before the start of the rainy season (October 1st).

Section VI Site Plan and Drainage Plan

VI.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 BMP locations
- Drainage delineations and flow information
- Drainage connections
- BMP details

Section VII Educational Materials

Refer to the Orange County Stormwater Program (ocwatersheds.com) for a library of materials available. For the copy submitted to the Permittee, only attach the educational materials specifically applicable to the project. Other materials specific to the project may be included as well and must be attached.

Education Materials

Residential Material (http://www.ocwatersheds.com)	Check If Applicable	Business Material (http://www.ocwatersheds.com)	Check If Applicable
The Ocean Begins at Your Front Door	☒	Tips for the Automotive Industry	☐
Tips for Car Wash Fund-raisers	☐	Tips for Using Concrete and Mortar	☐
Tips for the Home Mechanic	☒	Tips for the Food Service Industry	☐
Homeowners Guide for Sustainable Water Use	☒	Proper Maintenance Practices for Your Business	☐
Household Tips	☒	**Other Material**	**Check If Attached**
Proper Disposal of Household Hazardous Waste	☒		
Recycle at Your Local Used Oil Collection Center (North County)	☒		☐
Recycle at Your Local Used Oil Collection Center (Central County)	☐		☐
Recycle at Your Local Used Oil Collection Center (South County)	☐		☐
Tips for Maintaining a Septic Tank System	☐		☐
Responsible Pest Control	☒		☐
Sewer Spill	☒		☐
Tips for the Home Improvement Projects	☒		☐
Tips for Horse Care	☐		☐
Tips for Landscaping and Gardening	☒		☐
Tips for Pet Care	☒		☐
Tips for Pool Maintenance	☐		☐
Tips for Residential Pool, Landscape and Hardscape Drains	☒		☐
Tips for Projects Using Paint	☒		☐

Attachment A

Orange County Technical Guidance Document
Worksheets and Figures

Table 2.7: Infiltration BMP Feasibility Worksheet

	Infeasibility Criteria	***Yes***	***No***
1	**Would Infiltration BMPs pose significant risk for groundwater related concerns?** Refer to Appendix VII (Worksheet I) for guidance on groundwater-related infiltration feasibility criteria.	X	
Provide basis: Per the preliminary Geotechnical Evaluation and Design Recommendations Report prepared by LGC Geotechnical, Inc dated December 21, 2021: "Geotechnical stability and integrity of the project site is reliant upon appropriate handling of surface water. Due to the extremely low measured infiltration rate, low permeability fine-grained soils at depth, shallow groundwater and site liquefaction potential, we strongly recommend against the intentional infiltration of storm water into subsurface soils."			
2	Would Infiltration BMPs **pose significant risk of increasing risk of geotechnical hazards that cannot be mitigated to an acceptable level**? (Yes if the answer to any of the following questions is yes, as established by a geotechnical expert): • The BMP can only be located less than 50 feet away from slopes steeper than 15 percent • The BMP can only be located less than eight feet from building foundations or an alternative setback. • A study prepared by a geotechnical professional or an available watershed study substantiates that stormwater infiltration would potentially result in significantly increased risks of geotechnical hazards that cannot be mitigated to an acceptable level.		X
Provide basis:			
3	Would infiltration of the DCV from drainage area **violate downstream water rights**?		X
Provide basis:			

Table 2.7: Infiltration BMP Feasibility Worksheet (continued)

	Partial Infeasibility Criteria	***Yes***	***No***
4	Is proposed infiltration facility **located on HSG D soils** or the site geotechnical investigation identifies presence of soil characteristics which support categorization as D soils?		X
Provide basis:			
5	Is **measured infiltration rate below proposed facility less than 0.3 inches per hour**? This calculation shall be based on the methods described in Appendix VII.	X	
Provide basis:			
6	Would **reduction of over predeveloped conditions cause impairments to downstream beneficial uses, such as change of seasonality of ephemeral washes or increased discharge of contaminated groundwater to surface waters?**		X
Provide citation to applicable study and summarize findings relative to the amount of infiltration that is permissible:			
7	Would **an increase in infiltration over predeveloped conditions cause impairments to downstream beneficial uses, such as change of seasonality of ephemeral washes or increased discharge of contaminated groundwater to surface waters?**		X
Provide citation to applicable study and summarize findings relative to the amount of infiltration that is permissible:			

Table 2.7: Infiltration BMP Feasibility Worksheet (continued)

Infiltration Screening Results (check box corresponding to result):		
8	Is there substantial evidence that infiltration from the project would result in a significant increase in I&I to the sanitary sewer that cannot be sufficiently mitigated? (See Appendix XVII) Provide narrative discussion and supporting evidence:	No
9	If any answer from row 1-3 is yes: infiltration of any volume is **not feasible** within the DMA or equivalent. Provide basis:	Yes
10	If any answer from row 4-7 is yes, infiltration is **permissible but is not presumed to be feasible for the entire DCV.** Criteria for designing biotreatment BMPs to achieve the maximum feasible infiltration and ET shall apply. Provide basis:	No
11	If all answers to rows 1 through 11 are no, infiltration of the full DCV is potentially feasible, BMPs must be designed to infiltrate the full DCV to the maximum extent practicable.	Infiltration is Infeasible

Worksheet B: Simple Design Capture Volume Sizing Method

Step 1: Determine the design capture storm depth used for calculating volume				
1	Enter design capture storm depth from Figure III.1, *d* (inches)	d=	0.80	inches
2	Enter the effect of provided HSCs, d_{HSC} (inches) (Worksheet A)	d_{HSC}=	0	inches
3	Calculate the remainder of the design capture storm depth, $d_{remainder}$ (inches) (Line 1 – Line 2)	$d_{remainder}$=	0.80	inches
Step 2: Calculate the DCV				
1	Enter Project area tributary to BMP (s), *A* (acres)	A=	2.160	acres
2	Enter Project Imperviousness, *imp* (unitless)	imp=	0.9	
3	Calculate runoff coefficient, *C= (0.75 x imp) + 0.15*	C=	0.83	
4	Calculate runoff volume, V_{design}= *(C x* $d_{remainder}$ *x A x 43560 x (1/12))*	V_{design}=	5,206	cu-ft
Step 3: Design BMPs to ensure full retention of the DCV				
Step 3a: Determine design infiltration rate			**N/A**	
1	Enter measured infiltration rate, $K_{measured}$ (in/hr) (Appendix VII)	$K_{measured}$=	NA	In/hr
2	Enter combined safety factor from Worksheet H, S_{final} (unitless)	S_{final}=	NA	
3	Calculate design infiltration rate, $K_{design} = K_{measured} / S_{final}$	K_{design}=	NA	In/hr
Step 3b: Determine minimum BMP footprint				
4	Enter drawdown time, *T* (max 48 hours)	T=	NA	Hours
5	Calculate max retention depth that can be drawn down within the drawdown time (feet), $D_{max} = K_{design} \times T \times (1/12)$	D_{max}=	NA	feet
6	Calculate minimum area required for BMP (sq-ft), $A_{min} = V_{design} / d_{max}$	A_{min}=	NA	sq-ft

Worksheet B: Simple Design Capture Volume Sizing Method

Step 1: Determine the design capture storm depth used for calculating volume				
1	Enter design capture storm depth from Figure III.1, *d* (inches)	d=	0.8	inches
2	Enter the effect of provided HSCs, d_{HSC} (inches) (Worksheet A)	d_{HSC}=	0	inches
3	Calculate the remainder of the design capture storm depth, $d_{remainder}$ (inches) (Line 1 – Line 2)	$d_{remainder}$=	0.8	inches
Step 2: Calculate the DCV				
1	Enter Project area tributary to BMP (s), *A* (acres)	A=	2.093	acres
2	Enter Project Imperviousness, *imp* (unitless)	imp=	0.9	
3	Calculate runoff coefficient, $C= (0.75 \times imp) + 0.15$	C=	0.83	
4	Calculate runoff volume, $V_{design}= (C \times d_{remainder} \times A \times 43560 \times (1/12))$	V_{design}=	5,045	cu-ft
Step 3: Design BMPs to ensure full retention of the DCV				
Step 3a: Determine design infiltration rate			**N/A**	
1	Enter measured infiltration rate, $K_{measured}$ (in/hr) (Appendix VII)	$K_{measured}$=	NA	In/hr
2	Enter combined safety factor from Worksheet H, S_{final} (unitless)	S_{final}=	NA	
3	Calculate design infiltration rate, $K_{design} = K_{measured} / S_{final}$	K_{design}=	NA	In/hr
Step 3b: Determine minimum BMP footprint				
4	Enter drawdown time, *T* (max 48 hours)	T=	NA	Hours
5	Calculate max retention depth that can be drawn down within the drawdown time (feet), $D_{max} = K_{design} \times T \times (1/12)$	D_{max}=	NA	feet
6	Calculate minimum area required for BMP (sq-ft), $A_{min} = V_{design} / d_{max}$	A_{min}=	NA	sq-ft

Worksheet B: Simple Design Capture Volume Sizing Method

Step 1: Determine the design capture storm depth used for calculating volume				
1	Enter design capture storm depth from Figure III.1, *d* (inches)	d=	0.8	inches
2	Enter the effect of provided HSCs, d_{HSC} (inches) (Worksheet A)	d_{HSC}=	0	inches
3	Calculate the remainder of the design capture storm depth, $d_{remainder}$ (inches) (Line 1 – Line 2)	$d_{remainder}$=	0.8	inches
Step 2: Calculate the DCV				
1	Enter Project area tributary to BMP (s), *A* (acres)	A=	2.809	acres
2	Enter Project Imperviousness, *imp* (unitless)	imp=	0.9	
3	Calculate runoff coefficient, $C= (0.75 \times imp) + 0.15$	C=	0.83	
4	Calculate runoff volume, $V_{design}= (C \times d_{remainder} \times A \times 43560 \times (1/12))$	V_{design}=	6,771	cu-ft
Step 3: Design BMPs to ensure full retention of the DCV				
Step 3a: Determine design infiltration rate			**N/A**	
1	Enter measured infiltration rate, $K_{measured}$ (in/hr) (Appendix VII)	$K_{measured}$=	NA	In/hr
2	Enter combined safety factor from Worksheet H, S_{final} (unitless)	S_{final}=	NA	
3	Calculate design infiltration rate, $K_{design} = K_{measured} / S_{final}$	K_{design}=	NA	In/hr
Step 3b: Determine minimum BMP footprint				
4	Enter drawdown time, *T* (max 48 hours)	T=	NA	Hours
5	Calculate max retention depth that can be drawn down within the drawdown time (feet), $D_{max} = K_{design} \times T \times (1/12)$	D_{max}=	NA	feet
6	Calculate minimum area required for BMP (sq-ft), $A_{min} = V_{design} / d_{max}$	A_{min}=	NA	sq-ft

Worksheet B: Simple Design Capture Volume Sizing Method

Step 1: Determine the design capture storm depth used for calculating volume				
1	Enter design capture storm depth from Figure III.1, *d* (inches)	d=	0.8	inches
2	Enter the effect of provided HSCs, d_{HSC} (inches) (Worksheet A)	d_{HSC}=	0	inches
3	Calculate the remainder of the design capture storm depth, $d_{remainder}$ (inches) (Line 1 – Line 2)	$d_{remainder}$=	0.8	inches
Step 2: Calculate the DCV				
1	Enter Project area tributary to BMP (s), *A* (acres)	A=	1.806	acres
2	Enter Project Imperviousness, *imp* (unitless)	imp=	0.9	
3	Calculate runoff coefficient, *C= (0.75 x imp) + 0.15*	C=	0.83	
4	Calculate runoff volume, V_{design}= *(C x* $d_{remainder}$ *x A x 43560 x (1/12))*	V_{design}=	4,352	cu-ft
Step 3: Design BMPs to ensure full retention of the DCV				
Step 3a: Determine design infiltration rate			**N/A**	
1	Enter measured infiltration rate, $K_{measured}$ (in/hr) (Appendix VII)	$K_{measured}$=	NA	In/hr
2	Enter combined safety factor from Worksheet H, S_{final} (unitless)	S_{final}=	NA	
3	Calculate design infiltration rate, $K_{design} = K_{measured} / S_{final}$	K_{design}=	NA	In/hr
Step 3b: Determine minimum BMP footprint				
4	Enter drawdown time, *T* (max 48 hours)	T=	NA	Hours
5	Calculate max retention depth that can be drawn down within the drawdown time (feet), $D_{max} = K_{design} \times T \times (1/12)$	D_{max}=	NA	feet
6	Calculate minimum area required for BMP (sq-ft), $A_{min} = V_{design} / d_{max}$	A_{min}=	NA	sq-ft

Worksheet B: Simple Design Capture Volume Sizing Method

Step 1: Determine the design capture storm depth used for calculating volume				
1	Enter design capture storm depth from Figure III.1, *d* (inches)	d=	0.8	inches
2	Enter the effect of provided HSCs, d_{HSC} (inches) (Worksheet A)	d_{HSC}=	0	inches
3	Calculate the remainder of the design capture storm depth, $d_{remainder}$ (inches) (Line 1 – Line 2)	$d_{remainder}$=	0.8	inches
Step 2: Calculate the DCV				
1	Enter Project area tributary to BMP (s), *A* (acres)	A=	0.507	acres
2	Enter Project Imperviousness, *imp* (unitless)	imp=	0.9	
3	Calculate runoff coefficient, *C= (0.75 x imp) + 0.15*	C=	0.83	
4	Calculate runoff volume, V_{design}= *(C x* $d_{remainder}$ *x A x 43560 x (1/12))*	V_{design}=	1,223	cu-ft
Step 3: Design BMPs to ensure full retention of the DCV				
Step 3a: Determine design infiltration rate			**N/A**	
1	Enter measured infiltration rate, $K_{measured}$ (in/hr) (Appendix VII)	$K_{measured}$=	NA	In/hr
2	Enter combined safety factor from Worksheet H, S_{final} (unitless)	S_{final}=	NA	
3	Calculate design infiltration rate, $K_{design} = K_{measured} / S_{final}$	K_{design}=	NA	In/hr
Step 3b: Determine minimum BMP footprint				
4	Enter drawdown time, *T* (max 48 hours)	T=	NA	Hours
5	Calculate max retention depth that can be drawn down within the drawdown time (feet), $D_{max} = K_{design} \times T \times (1/12)$	D_{max}=	NA	feet
6	Calculate minimum area required for BMP (sq-ft), $A_{min} = V_{design} / d_{max}$	A_{min}=	NA	sq-ft

Worksheet B: Simple Design Capture Volume Sizing Method

Step 1: Determine the design capture storm depth used for calculating volume				
1	Enter design capture storm depth from Figure III.1, *d* (inches)	d=	0.8	inches
2	Enter the effect of provided HSCs, d_{HSC} (inches) (Worksheet A)	d_{HSC}=	0	inches
3	Calculate the remainder of the design capture storm depth, $d_{remainder}$ (inches) (Line 1 – Line 2)	$d_{remainder}$=	0.8	inches
Step 2: Calculate the DCV				
1	Enter Project area tributary to BMP (s), *A* (acres)	A=	0.504	acres
2	Enter Project Imperviousness, *imp* (unitless)	imp=	0.9	
3	Calculate runoff coefficient, *C= (0.75 x imp) + 0.15*	C=	0.83	
4	Calculate runoff volume, V_{design}= *(C x* $d_{remainder}$ *x A x 43560 x (1/12))*	V_{design}=	1,214	cu-ft
Step 3: Design BMPs to ensure full retention of the DCV				
Step 3a: Determine design infiltration rate			**N/A**	
1	Enter measured infiltration rate, $K_{measured}$ (in/hr) (Appendix VII)	$K_{measured}$=	NA	In/hr
2	Enter combined safety factor from Worksheet H, S_{final} (unitless)	S_{final}=	NA	
3	Calculate design infiltration rate, $K_{design} = K_{measured} / S_{final}$	K_{design}=	NA	In/hr
Step 3b: Determine minimum BMP footprint				
4	Enter drawdown time, *T* (max 48 hours)	T=	NA	Hours
5	Calculate max retention depth that can be drawn down within the drawdown time (feet), $D_{max} = K_{design} \times T \times (1/12)$	D_{max}=	NA	feet
6	Calculate minimum area required for BMP (sq-ft), $A_{min} = V_{design} / d_{max}$	A_{min}=	NA	sq-ft

Worksheet B: Simple Design Capture Volume Sizing Method

Step 1: Determine the design capture storm depth used for calculating volume				
1	Enter design capture storm depth from Figure III.1, *d* (inches)	d=	0.8	inches
2	Enter the effect of provided HSCs, d_{HSC} (inches) (Worksheet A)	d_{HSC}=	0	inches
3	Calculate the remainder of the design capture storm depth, $d_{remainder}$ (inches) (Line 1 – Line 2)	$d_{remainder}$=	0.8	inches
Step 2: Calculate the DCV				
1	Enter Project area tributary to BMP (s), *A* (acres)	A=	2.241	acres
2	Enter Project Imperviousness, *imp* (unitless)	imp=	0.9	
3	Calculate runoff coefficient, *C= (0.75 x imp) + 0.15*	C=	0.83	
4	Calculate runoff volume, V_{design}= *(C x* $d_{remainder}$ *x A x 43560 x (1/12))*	V_{design}=	5,401	cu-ft
Step 3: Design BMPs to ensure full retention of the DCV				
Step 3a: Determine design infiltration rate			**N/A**	
1	Enter measured infiltration rate, $K_{measured}$ (in/hr) (Appendix VII)	$K_{measured}$=	NA	In/hr
2	Enter combined safety factor from Worksheet H, S_{final} (unitless)	S_{final}=	NA	
3	Calculate design infiltration rate, $K_{design} = K_{measured} / S_{final}$	K_{design}=	NA	In/hr
Step 3b: Determine minimum BMP footprint				
4	Enter drawdown time, *T* (max 48 hours)	T=	NA	Hours
5	Calculate max retention depth that can be drawn down within the drawdown time (feet), $D_{max} = K_{design} \times T \times (1/12)$	D_{max}=	NA	feet
6	Calculate minimum area required for BMP (sq-ft), $A_{min} = V_{design} / d_{max}$	A_{min}=	NA	sq-ft

Worksheet D: Capture Efficiency Method for Flow-Based BMPs

Step 1: Determine the design capture storm depth used for calculating volume				
1	Enter the time of concentration, T_c (min) (See Appendix IV.2)	T_c=	5.00	
2	Using Figure III.4, determine the design intensity at which the estimated time of concentration (T_c) achieves 80% capture efficiency, I_1	I_1=	0.26	in/hr
3	Enter the effect depth of provided HSCs upstream, d_{HSC} (inches) (Worksheet A)	d_{HSC}=	0	inches
4	Enter capture efficiency corresponding to d_{HSC}, Y_2 (Worksheet A)	Y_2=	0	%
5	Using Figure III.4, determine the design intensity at which the time of concentration (T_c) achieves the upstream capture efficiency(Y_2), I_2	I_2=	0	in/hr
6	Determine the design intensity that must be provided by BMP, $I_{design}= I_1-I_2$	I_{design}=	0.26	in/hr
Step 2: Calculate the design flowrate				
1	Enter Project area tributary to BMP (s), *A* (acres)	A=	2.160	acres
2	Enter Project Imperviousness, *imp* (unitless)	imp=	0.9 *	
3	Calculate runoff coefficient, $C= (0.75 \times imp) + 0.15$	C=	0.83	
4	Calculate design flowrate, $Q_{design}= (C \times i_{design} \times A)$	Q_{design}=	0.466	cfs
Supporting Calculations				

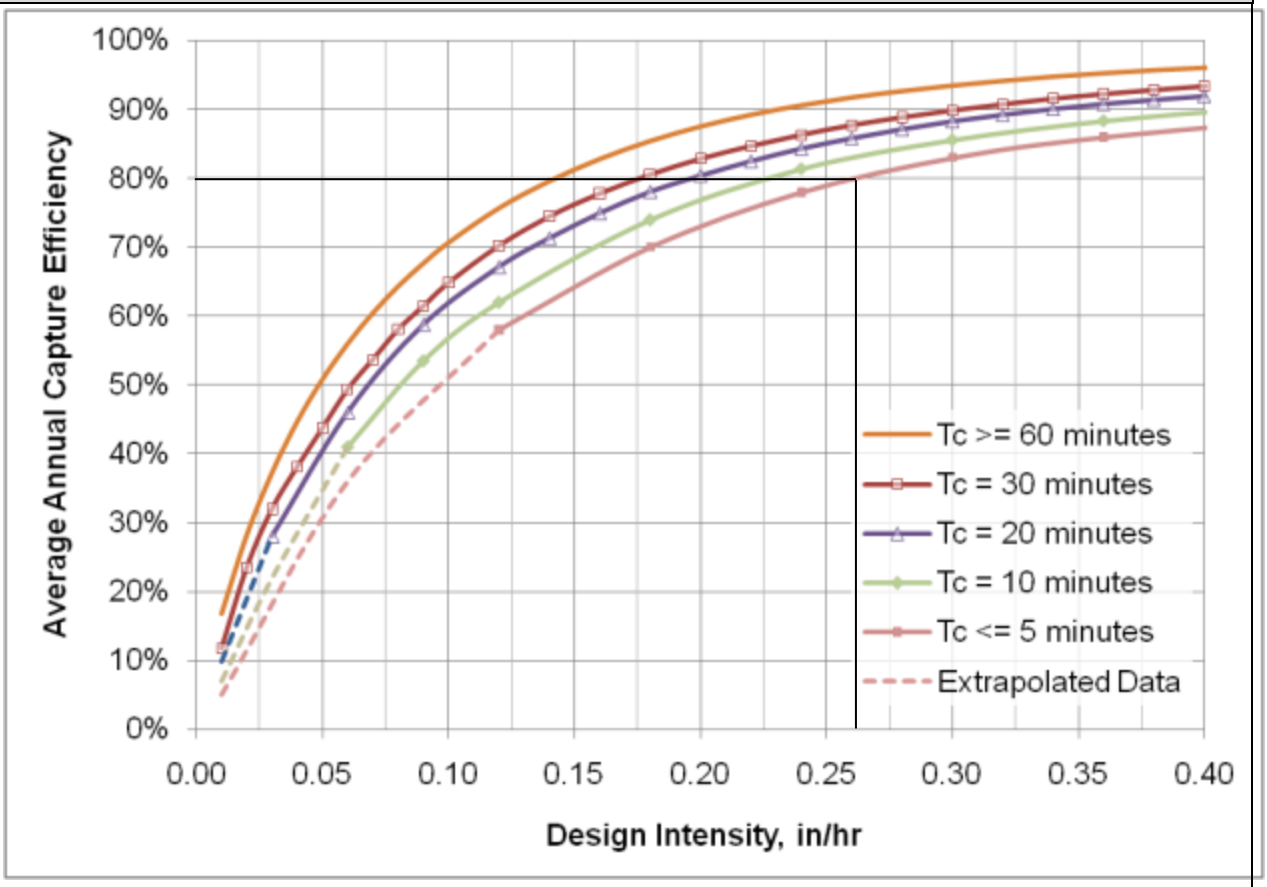
Describe system:
Surface runoff will be conveyed through the private street to proposed curb inlet Biofiltration Vaults for water quality treatment.

*Assumed 90% impervious coverage utilized for preliminary calculations. Actual impervious coverage will be calculated in final engineering.

Provide time of concentration assumptions:
The time of concentration was assumed to be 5 minutes for conservative purposes.

Worksheet D: Capture Efficiency Method for Flow-Based BMPs

Graphical Operations



Provide supporting graphical operations. See Example III.7.

Worksheet D: Capture Efficiency Method for Flow-Based BMPs

Step 1: Determine the design capture storm depth used for calculating volume				
1	Enter the time of concentration, T_c (min) (See Appendix IV.2)	T_c=	5.00	
2	Using Figure III.4, determine the design intensity at which the estimated time of concentration (T_c) achieves 80% capture efficiency, I_1	I_1=	0.26	in/hr
3	Enter the effect depth of provided HSCs upstream, d_{HSC} (inches) (Worksheet A)	d_{HSC}=	0	inches
4	Enter capture efficiency corresponding to d_{HSC}, Y_2 (Worksheet A)	Y_2=	0	%
5	Using Figure III.4, determine the design intensity at which the time of concentration (T_c) achieves the upstream capture efficiency(Y_2), I_2	I_2=	0	in/hr
6	Determine the design intensity that must be provided by BMP, $I_{design}= I_1-I_2$	I_{design}=	0.26	in/hr
Step 2: Calculate the design flowrate				
1	Enter Project area tributary to BMP (s), *A* (acres)	A=	2.093	acres
2	Enter Project Imperviousness, *imp* (unitless)	imp=	0.9 *	
3	Calculate runoff coefficient, $C= (0.75 \times imp) + 0.15$	C=	0.83	
4	Calculate design flowrate, $Q_{design}= (C \times i_{design} \times A)$	Q_{design}=	0.452	cfs

Supporting Calculations

Describe system:
Surface runoff will be conveyed through the private street to proposed curb inlet Biofiltration Vaults for water quality treatment.

*Assumed 90% impervious coverage utilized for preliminary calculations. Actual impervious coverage will be calculated in final engineering.

Provide time of concentration assumptions:
The time of concentration was assumed to be 5 minutes for conservative purposes.

Worksheet D: Capture Efficiency Method for Flow-Based BMPs

Step 1: Determine the design capture storm depth used for calculating volume				
1	Enter the time of concentration, T_c (min) (See Appendix IV.2)	T_c=	5.00	
2	Using Figure III.4, determine the design intensity at which the estimated time of concentration (T_c) achieves 80% capture efficiency, I_1	I_1=	0.26	in/hr
3	Enter the effect depth of provided HSCs upstream, d_{HSC} (inches) (Worksheet A)	d_{HSC}=	0	inches
4	Enter capture efficiency corresponding to d_{HSC}, Y_2 (Worksheet A)	Y_2=	0	%
5	Using Figure III.4, determine the design intensity at which the time of concentration (T_c) achieves the upstream capture efficiency(Y_2), I_2	I_2=	0	in/hr
6	Determine the design intensity that must be provided by BMP, $I_{design}= I_1-I_2$	I_{design}=	0.26	in/hr
Step 2: Calculate the design flowrate				
1	Enter Project area tributary to BMP (s), *A* (acres)	A=	2.809	acres
2	Enter Project Imperviousness, *imp* (unitless)	imp=	0.9 *	
3	Calculate runoff coefficient, $C= (0.75 \times imp) + 0.15$	C=	0.83	
4	Calculate design flowrate, $Q_{design}= (C \times i_{design} \times A)$	Q_{design}=	0.606	cfs

Supporting Calculations

Describe system:
Surface runoff will be conveyed through the private street to proposed curb inlet Biofiltration Vaults for water quality treatment.

*Assumed 90% impervious coverage utilized for preliminary calculations. Actual impervious coverage will be calculated in final engineering.

Provide time of concentration assumptions:
The time of concentration was assumed to be 5 minutes for conservative purposes.

Worksheet D: Capture Efficiency Method for Flow-Based BMPs

Step 1: Determine the design capture storm depth used for calculating volume				
1	Enter the time of concentration, T_c (min) (See Appendix IV.2)	T_c=	5.00	
2	Using Figure III.4, determine the design intensity at which the estimated time of concentration (T_c) achieves 80% capture efficiency, I_1	I_1=	0.26	in/hr
3	Enter the effect depth of provided HSCs upstream, d_{HSC} (inches) (Worksheet A)	d_{HSC}=	0	inches
4	Enter capture efficiency corresponding to d_{HSC}, Y_2 (Worksheet A)	Y_2=	0	%
5	Using Figure III.4, determine the design intensity at which the time of concentration (T_c) achieves the upstream capture efficiency(Y_2), I_2	I_2=	0	in/hr
6	Determine the design intensity that must be provided by BMP, $I_{design}= I_1-I_2$	I_{design}=	0.26	in/hr
Step 2: Calculate the design flowrate				
1	Enter Project area tributary to BMP (s), *A* (acres)	A=	1.806	acres
2	Enter Project Imperviousness, *imp* (unitless)	imp=	0.9 *	
3	Calculate runoff coefficient, $C= (0.75 \times imp) + 0.15$	C=	0.83	
4	Calculate design flowrate, $Q_{design}= (C \times i_{design} \times A)$	Q_{design}=	0.390	cfs

Supporting Calculations

Describe system:
Surface runoff will be conveyed through the private street to proposed curb inlet Biofiltration Vaults for water quality treatment.

*Assumed 90% impervious coverage utilized for preliminary calculations. Actual impervious coverage will be calculated in final engineering.

Provide time of concentration assumptions:
The time of concentration was assumed to be 5 minutes for conservative purposes.

Worksheet D: Capture Efficiency Method for Flow-Based BMPs

Step 1: Determine the design capture storm depth used for calculating volume				
1	Enter the time of concentration, T_c (min) (See Appendix IV.2)	T_c=	5.00	
2	Using Figure III.4, determine the design intensity at which the estimated time of concentration (T_c) achieves 80% capture efficiency, I_1	I_1=	0.26	in/hr
3	Enter the effect depth of provided HSCs upstream, d_{HSC} (inches) (Worksheet A)	d_{HSC}=	0	inches
4	Enter capture efficiency corresponding to d_{HSC}, Y_2 (Worksheet A)	Y_2=	0	%
5	Using Figure III.4, determine the design intensity at which the time of concentration (T_c) achieves the upstream capture efficiency(Y_2), I_2	I_2=	0	in/hr
6	Determine the design intensity that must be provided by BMP, $I_{design}= I_1-I_2$	I_{design}=	0.26	in/hr
Step 2: Calculate the design flowrate				
1	Enter Project area tributary to BMP (s), *A* (acres)	A=	0.507	acres
2	Enter Project Imperviousness, *imp* (unitless)	imp=	0.9 *	
3	Calculate runoff coefficient, $C= (0.75 \times imp) + 0.15$	C=	0.83	
4	Calculate design flowrate, $Q_{design}= (C \times i_{design} \times A)$	Q_{design}=	0.110	cfs

Supporting Calculations

Describe system:
Surface runoff will be conveyed through the private street to proposed curb inlet Biofiltration Vaults for water quality treatment.

*Assumed 90% impervious coverage utilized for preliminary calculations. Actual impervious coverage will be calculated in final engineering.

Provide time of concentration assumptions:
The time of concentration was assumed to be 5 minutes for conservative purposes.

Worksheet D: Capture Efficiency Method for Flow-Based BMPs

Step 1: Determine the design capture storm depth used for calculating volume				
1	Enter the time of concentration, T_c (min) (See Appendix IV.2)	T_c=	5.00	
2	Using Figure III.4, determine the design intensity at which the estimated time of concentration (T_c) achieves 80% capture efficiency, I_1	I_1=	0.26	in/hr
3	Enter the effect depth of provided HSCs upstream, d_{HSC} (inches) (Worksheet A)	d_{HSC}=	0	inches
4	Enter capture efficiency corresponding to d_{HSC}, Y_2 (Worksheet A)	Y_2=	0	%
5	Using Figure III.4, determine the design intensity at which the time of concentration (T_c) achieves the upstream capture efficiency(Y_2), I_2	I_2=	0	in/hr
6	Determine the design intensity that must be provided by BMP, $I_{design}= I_1-I_2$	I_{design}=	0.26	in/hr
Step 2: Calculate the design flowrate				
1	Enter Project area tributary to BMP (s), *A* (acres)	A=	0.504	acres
2	Enter Project Imperviousness, *imp* (unitless)	imp=	0.9 *	
3	Calculate runoff coefficient, $C= (0.75 \times imp) + 0.15$	C=	0.83	
4	Calculate design flowrate, $Q_{design}= (C \times i_{design} \times A)$	Q_{design}=	0.109	cfs

Supporting Calculations

Describe system:
Surface runoff will be conveyed through the private street to proposed curb inlet Biofiltration Vaults for water quality treatment.

*Assumed 90% impervious coverage utilized for preliminary calculations. Actual impervious coverage will be calculated in final engineering.

Provide time of concentration assumptions:
The time of concentration was assumed to be 5 minutes for conservative purposes.

Worksheet D: Capture Efficiency Method for Flow-Based BMPs

Step 1: Determine the design capture storm depth used for calculating volume				
1	Enter the time of concentration, T_c (min) (See Appendix IV.2)	T_c=	5.00	
2	Using Figure III.4, determine the design intensity at which the estimated time of concentration (T_c) achieves 80% capture efficiency, I_1	I_1=	0.26	in/hr
3	Enter the effect depth of provided HSCs upstream, d_{HSC} (inches) (Worksheet A)	d_{HSC}=	0	inches
4	Enter capture efficiency corresponding to d_{HSC}, Y_2 (Worksheet A)	Y_2=	0	%
5	Using Figure III.4, determine the design intensity at which the time of concentration (T_c) achieves the upstream capture efficiency(Y_2), I_2	I_2=	0	in/hr
6	Determine the design intensity that must be provided by BMP, $I_{design}= I_1-I_2$	I_{design}=	0.26	in/hr
Step 2: Calculate the design flowrate				
1	Enter Project area tributary to BMP (s), *A* (acres)	A=	2.241	acres
2	Enter Project Imperviousness, *imp* (unitless)	imp=	0.9 *	
3	Calculate runoff coefficient, $C= (0.75 \times imp) + 0.15$	C=	0.83	
4	Calculate design flowrate, $Q_{design}= (C \times i_{design} \times A)$	Q_{design}=	0.484	cfs

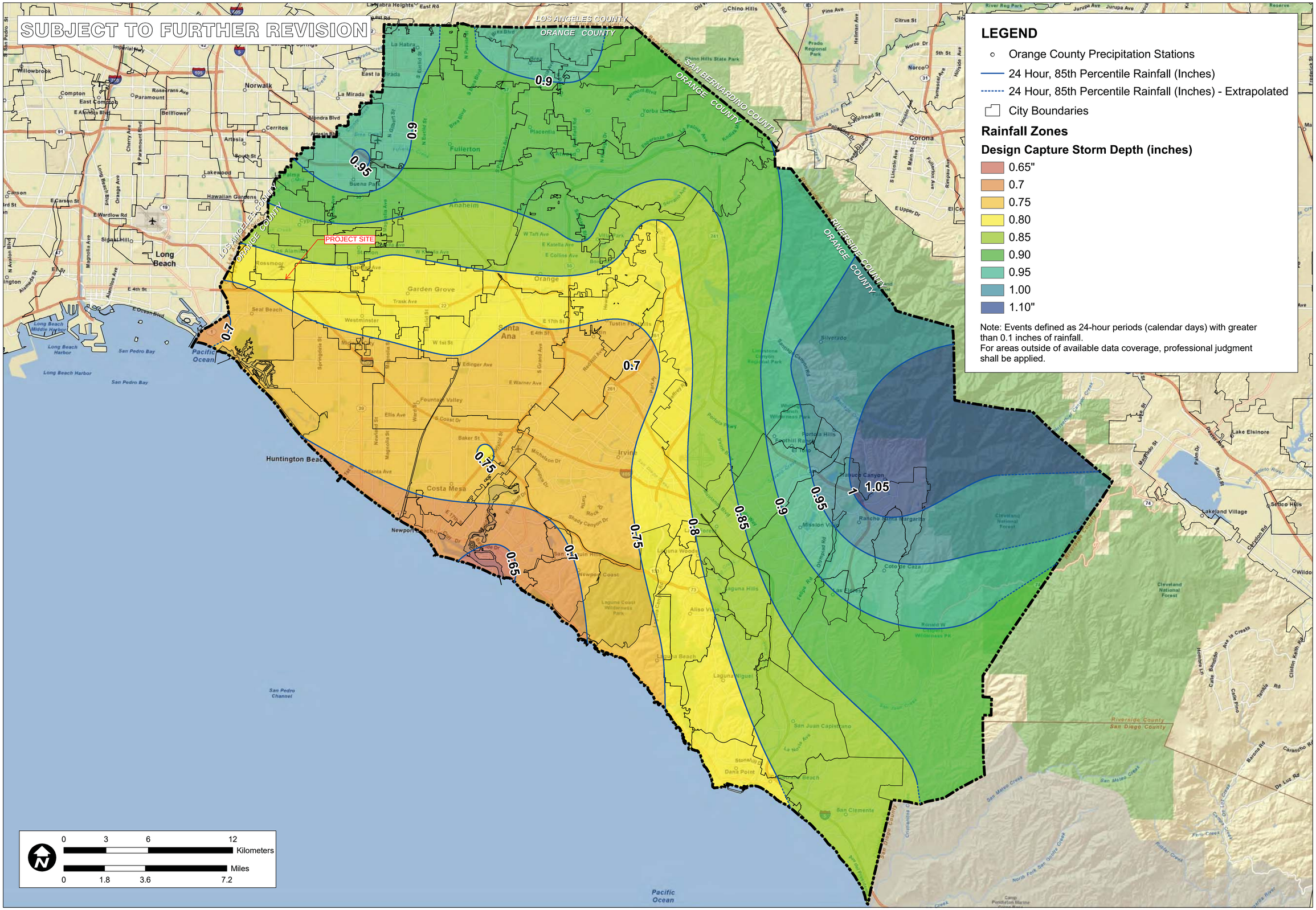
Supporting Calculations

Describe system:
Surface runoff will be conveyed through the private street to proposed curb inlet Biofiltration Vaults for water quality treatment.

*Assumed 90% impervious coverage utilized for preliminary calculations. Actual impervious coverage will be calculated in final engineering.

Provide time of concentration assumptions:
The time of concentration was assumed to be 5 minutes for conservative purposes.

SUBJECT TO FURTHER REVISION



LEGEND

- Orange County Precipitation Stations
- 24 Hour, 85th Percentile Rainfall (Inches)
- 24 Hour, 85th Percentile Rainfall (Inches) - Extrapolated
- City Boundaries

Rainfall Zones

Design Capture Storm Depth (inches)

- 0.65"
- 0.7
- 0.75
- 0.80
- 0.85
- 0.90
- 0.95
- 1.00
- 1.10"

Note: Events defined as 24-hour periods (calendar days) with greater than 0.1 inches of rainfall.
For areas outside of available data coverage, professional judgment shall be applied.

TITLE: RAINFALL ZONES

JOB: ORANGE COUNTY TECHNICAL GUIDANCE DOCUMENT — ORANGE CO. CA

SCALE	1" = 1.8 miles
DESIGNED	TH
DRAWING	TH
CHECKED	BMP
DATE	04/22/10
JOB NO.	9526-E

PACE Advanced Water Engineering

FIGURE XVI-1

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SUBJECT TO FURTHER REVISION

PROJECT SITE

LOS ANGELES COUNTY
ORANGE COUNTY

SAN BERNARDINO COUNTY
ORANGE COUNTY

RIVERSIDE COUNTY
ORANGE COUNTY

LEGEND

City Boundaries

Hydrologic Soil Groups

- A Soils
- B Soils
- C Soils
- D Soils

Source:
Soils: Natural Resources Conservation Service (NRCS)
Soil Survey - soil_ca678, Orange County & Western Riverside
Date of publication: 2006-02-08
http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm

0 2.5 5 10 Kilometers

0 1.8 3.6 7.2 Miles

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TITLE

NRCS HYDROLOGIC SOILS GROUPS

ORANGE COUNTY INFILTRATION STUDY

JOB

ORANGE CO.

CA

SCALE	1" = 1.8 miles
DESIGNED	TH
DRAWING	TH
CHECKED	BMP
DATE	02/09/11
JOB NO.	9526-E

PACE
Advanced Water Engineering

FIGURE

XVI-2a

SUBJECT TO FURTHER REVISION

LEGEND

- Depth To First Groundwater Contours
- City Boundaries
- OCWD Groundwater Basin Protection Boundary

Note: Data are not available for South Orange County at this time.

Source:
Sprotte, Fuller and Greenwood, 1980.
California Division of Mines and Geology;
California Geological Survey

LOS ANGELES COUNTY
ORANGE COUNTY

SAN BERNARDINO COUNTY
ORANGE COUNTY

RIVERSIDE COUNTY
ORANGE COUNTY

PROJECT SITE

0 2 4 8 Kilometers
0 1.25 2.5 5 Miles

TITLE
NORTH ORANGE COUNTY
MAPPED DEPTH TO FIRST
GROUNDWATER

JOB
ORANGE COUNTY
INFILTRATION STUDY
ORANGE CO. CA

SCALE	1" = 1.25 miles
DESIGNED	TH
DRAWING	TH
CHECKED	BMP
DATE	02/09/11
JOB NO.	9526-E

PACE
Advanced Water Engineering

FIGURE
XVI-2d

P:\9526E\6-GIS\Mxds\Reports\InfiltrationFeasability_20110215\9526E_FigureXVI-2d_DepthToGroundwaterOverview_20110215.mxd

SUBJECT TO FURTHER REVISION

LEGEND

- City Boundaries
- OCWD Groundwater Basin Protection Boundary

Plume Protection Boundaries

- North Basin Groundwater Protection Project
- South Basin Groundwater Protection Project
- El Toro Marine Base
- Tustin Marine Air Base
- Approximate Selenium Contamination Area

Note: Individual contamination sites are not plotted.
See State Water Resources Control Board Geotracker database (http://geotracker.waterboards.ca.gov), Department of Toxic Substance Control Envirostor database (http://www.envirostor.dtsc.ca.gov) and other applicable sources for current listing of active contaminated sites.

Groundwater basin and plume protection boundaries for South Orange County are not shown on this exhibit at this time

LOS ANGELES COUNTY
ORANGE COUNTY

SAN BERNARDINO COUNTY
ORANGE COUNTY

RIVERSIDE COUNTY
ORANGE COUNTY

PROJECT SITE

0 2 4 8 Kilometers

0 1.25 2.5 5 Miles

P:\9526E\6-GIS\Mxds\Reports\InfiltrationFeasability_20110215\9526E_FigureXVI-2f_NorthOCGroundwaterProtectionAreasStreetMap_20110215.mxd

TITLE
NORTH ORANGE COUNTY
GROUNDWATER PROTECTION
AREAS

ORANGE COUNTY
INFILTRATION STUDY

JOB
ORANGE CO.

SCALE	1" = 1.25 miles
DESIGNED	TH
DRAWING	TH
CHECKED	BMP
DATE	04/22/10
JOB NO.	9526-E

CA

PACE
Advanced Water Engineering

FIGURE
XVI-2f

Susceptibility

Potential Areas of Erosion, Habitat, & Physical Structure Susceptibility

Channel Type

- Earth (Unstable)
- Earth (Stabilized)
- Stabilized

Tidel Influence

- <= Mean High Water Line (4.28')

Water Body

- Basin
- Lake
- Reservoir

Other Lands

- Airport/Military

Los Angeles County

Santa River Watershed

Anaheim Bay-Huntington Harbor Watershed

Newport Bay-Newport Coastal Streams Watershed

Humble Reservoir

Orange County

Valencia Reservoir

Fullerton Reservoir

Loftus Diversion Channel Desilting Basin

Brea Creek Reservoir

Fullerton Reservoir

Fullerton Reservoir

Hillcrest Park Reservoir

Fullerton Airport

Miller Retarding Basin

La Jolla Recharge Basin

Placentia Retarding Basin

Kraemer Basin

Raymond Retarding Basin

Gilbert Retarding Basin

Crescent Retarding Basin

Cypress Retarding Basin

Channel in Retarding Basin

Rossmoor Retarding Basin

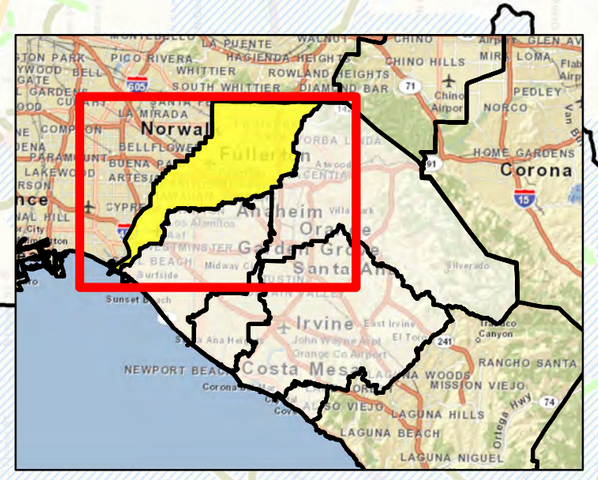
Los Alamitos Naval Air Station

Project Site

Los Alamitos Retarding Basin

Seal Beach Naval Weapons Station

0 8,000 16,000 Feet



TITLE
SUSCEPTIBILITY ANALYIS
SAN GABRIEL-COYOTE CREEK

JOB
ORANGE COUNTY
WATERSHED
MASTER PLANNING
ORANGE CO. CA

SCALE	1" = 8000'
DESIGNED	TH
DRAWING	TH
CHECKED	BMP
DATE	04/30/10
JOB NO.	9526-E

PACE
Advanced Water Engineering

1

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Worksheet I: Summary of Groundwater-related Feasibility Criteria

1	Is project large or small? (as defined by Table VIII.2) circle one	**Large**		Small
2	What is the tributary area to the BMP?	A	12.12	acres
3	What type of BMP is proposed?	Underground infiltration		
4	What is the infiltrating surface area of the proposed BMP?	A_{BMP}		sq-ft
5	What land use activities are present in the tributary area (list all) Multi-Family Residential			
6	What land use-based risk category is applicable?	L	**M**	H
7	If M or H, what pretreatment and source isolation BMPs have been considered and are proposed (describe all): Proposed MWS System Biofiltration Vaults will provide treatment for the required design flow rate.			
8	What minimum separation to mounded seasonally high groundwater applies to the proposed BMP? See Section VIII.2 (circle one)	**5 ft**		10 ft
9	Provide rationale for selection of applicable minimum separation to seasonally high mounded groundwater: Per the TGD Section VIII.2, the following applies to a subsurface infiltration gallery: "Separation to mounded seasonally high groundwater shall be at least 10 feet for infiltration devices that inject water below the subsurface and surface infiltration BMPs with tributary area and land use activities that are considered to pose a more significant risk to groundwater quality."			
10	What is separation from the infiltrating surface to seasonally high groundwater?	SHGWT	<10	ft
11	What is separation from the infiltrating surface to mounded seasonally high groundwater?	Mounded SHGWT	n/a	ft
12	Describe assumptions and methods used for mounding analysis: Groundwater was encountered at 11-13 feet below existing grade			
13	Is the site within a plume protection boundary (See Figure VIII.2)?	Y	**N**	N/A
14	Is the site within a selenium source area or other natural plume area (See Figure VIII.2)?	Y	**N**	N/A
15	Is the site within 250 feet of a contaminated site?	Y	**N**	N/A

Worksheet I: Summary of Groundwater-related Feasibility Criteria

16	If site-specific study has been prepared, provide citation and briefly summarize relevant findings: n/a	
17	Is the site within 100 feet of a water supply well, spring, septic system?	Y **N** N/A
18	Is infiltration feasible on the site relative to groundwater-related criteria?	Y **N**
Provide rationale for feasibility determination: Per the preliminary Geotechnical Evaluation and Design Recommendations Report prepared by LGC Geotechnical, Inc dated December 21, 2021: "Geotechnical stability and integrity of the project site is reliant upon appropriate handling of surface water. Due to the extremely low measured infiltration rate, low permeability fine-grained soils at depth, shallow groundwater and site liquefaction potential, we strongly recommend against the intentional infiltration of storm water into subsurface soils."		

Note: if a single criterion or group of criteria would render infiltration infeasible, it is not necessary to evaluate every question in this worksheet.

Worksheet J: Summary of Harvested Water Demand and Feasibility **Entire Site**

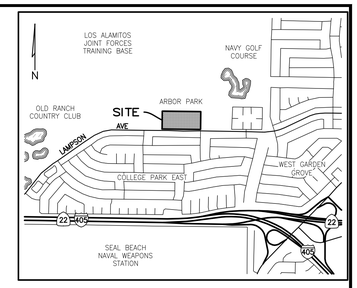
1	What demands for harvested water exist in the tributary area (check all that apply):			
2	Toilet and urinal flushing		□	
3	Landscape irrigation		✓	
4	Other:_____		□	
5	What is the design capture storm depth? (Figure III.1)	d	0.8	inches
6	What is the project size?	A	12.12	ac
7	What is the acreage of impervious area?	* IA	10.91	ac
	For projects with multiple types of demand (toilet flushing, irrigation demand, and/or other demand)			
8	What is the minimum use required for partial capture? (Table X.6)			gpd
9	What is the project estimated wet season total daily use (Section X.2)?			gpd
10	Is partial capture potentially feasible? (Line 9 > Line 8?)			
	For projects with only toilet flushing demand			
11	What is the minimum TUTIA for partial capture? (Table X.7)			
12	What is the project estimated TUTIA?			
13	Is partial capture potentially feasible? (Line 12 > Line 11?)			
	For projects with only irrigation demand			
14	What is the minimum irrigation area required based on conservation landscape design? (Table X.8) [**10.91x0.9**]	9.82		ac
15	What is the proposed project irrigated area? (multiply conservation landscaping by 1; multiply active turf by 2)	0.9		ac
16	Is partial capture potentially feasible? (Line 15 > Line 14?)	No		

Provide supporting assumptions and citations for controlling demand calculation:
Due to the proposed development type, density and amount of available landscaping, Harvest and Use BMPs for irrigation purposes will not be feasible.

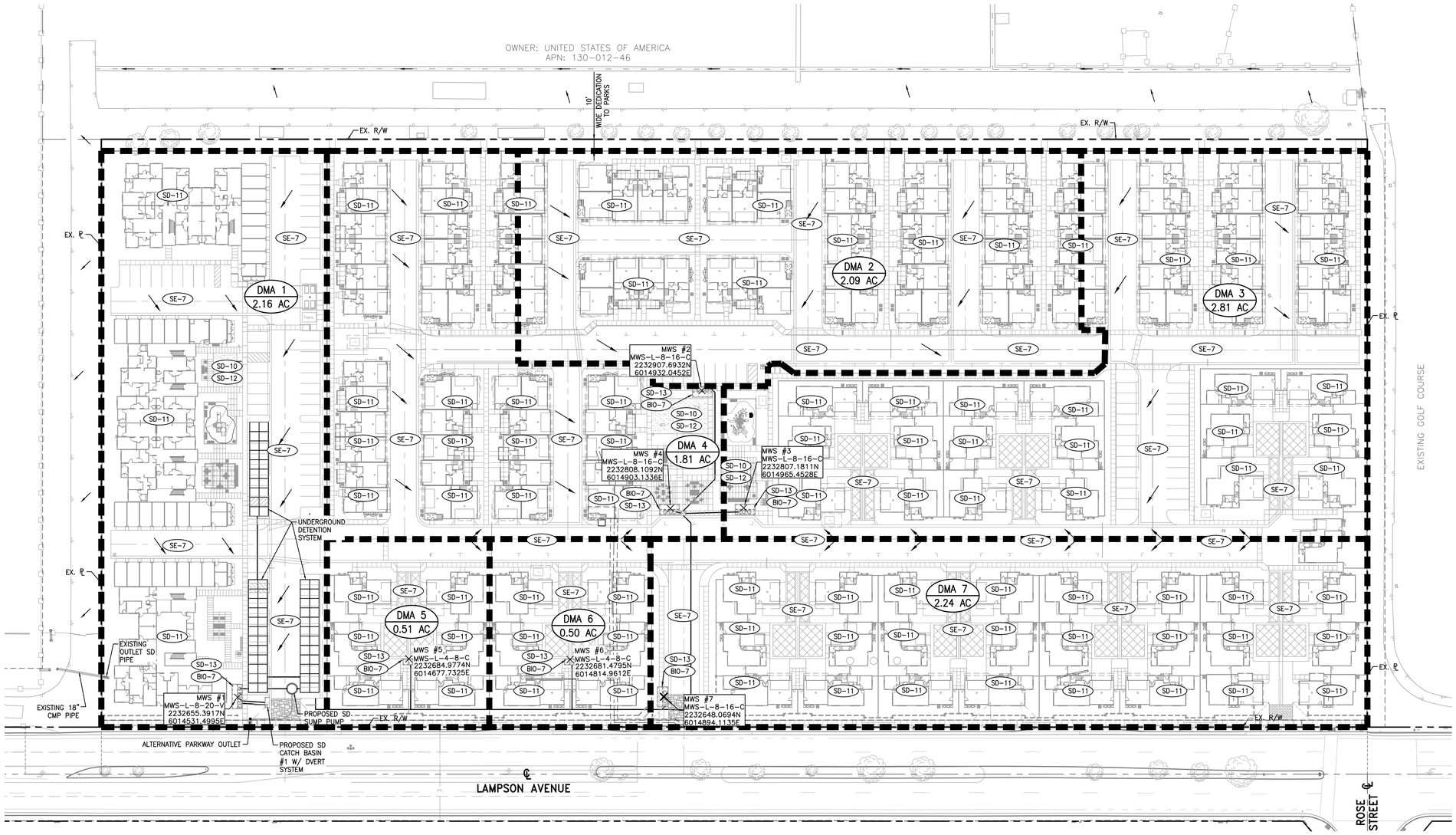
* For preliminary purposes, an assumed 90% impervious coverage based on development type was utilized for these calculations.

Attachment B
Preliminary WQMP Exhibit

WQMP EXHIBIT
TENTATIVE TRACT MAP NO. 19263
4665 LAMPSON AVENUE
CITY OF LOS ALAMITOS, COUNTY OF ORANGE, STATE OF CALIFORNIA



VICINITY MAP
NTS



LEGEND
- DRAINAGE MANAGEMENT AREA (DMA)
- EXISTING RIGHT-OF-WAY/ BOUNDARY
- PROPOSED RIGHT-OF-WAY/ BOUNDARY
- LOT LINE
- LOT LINE
- EXISTING STORM DRAIN
- PROPOSED STORM DRAIN
- DRAINAGE FLOW ARROWS
- PROPOSED CATCH BASIN
- DMA X / X.XX AC — DRAINAGE MANAGEMENT AREA (DMA) / ACREAGE

BEST MANGEMENT PRACTICES (BMPS)
- SD-10 — SITE DESIGN & LANDSCAPE PLANNING
- SD-11 — ROOF RUNOFF CONTROLS
- SD-12 — EFFICIENT IRRIGATION (SITEWIDE)
- SD-13 — STORM DRAIN SIGNAGE
- SE-7 — STREET SWEEPING & VACUUMING
- BIO-7 — PROPRIETARY BIOTREATMENT – MODULAR WETLANDS SYSTEM (MWS) BIOFILTRATION VAULT

STENCILING EXAMPLE
N.T.S.

DMA SUMMARY

DMA	AREA (SF)	AREA (AC)	PERVIOUS AREA (SF)	PERVIOUSNESS	IMPERVIOUS AREA (SF)	IMPERVIOUSNESS	DESIGN CAPTURE VOLUME (CF)	DESIGN TREATMENT FLOW RATE (CFS)	MWS MODEL	MWS TREATMENT CAPACITY (CFS)
1	94,080.01	2.16	9409.00	10%	84672.00	90%	5206	0.47	MWS-L-8-20-V	0.62 (HIGH CAPACITY MODEL)
2	91,179.82	2.09	9117.98	10%	82061.84	90%	5045	.452	MWS-L-8-16-C	0.462
3	122,375.36	2.81	12237.54	10%	110137.82	90%	6771	.606	MWS-L-8-20-C	0.62 (HIGH CAPACITY MODEL)
4	78,650.15	1.81	7865.01	10%	70785.13	90%	4352	.390	MWS-L-8-16-C	0.462
5	22,104.95	.51	2210.49	10%	19894.45	90%	1223	.110	MWS-L-4-8-C	0.115
6	21,939.20	.50	2193.92	10%	19745.28	90%	1214	.109	MWS-L-4-8-C	0.115
7	97,609.65	2.24	9760.96	10%	87848.68	90%	5401	.484	MWS-L-8-16-C	0.489 (HIGH CAPCAITY MODEL)

1" = 40'
0 20 40 80

REVISIONS

NUMBER	DATE	INITIALS	DESCRIPTION	APPROVED	INSTALLED

PLANS PREPARED BY:
C&V CONSULTING, INC.
CIVIL ENGINEERING
LAND PLANNING & SURVEYING
6630 IRVINE CENTER DRIVE
IRVINE, CALIFORNIA 92618
(949) 916-3600
INFO@CVC-INC.NET
WWW.CVC-INC.NET

VESTING TENTATIVE TRACT MAP NO. 19263
PRELIMINARY WQMP EXHIBIT
4665 LAMPSON AVENUE

PUBLIC WORKS AGENCY
CITY OF LOS ALAMITOS

SHEET WQMP

Attachment C
Site BMPs

Site Design & Landscape Planning SD-10

Design Objectives

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

Description

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

Approach

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

Suitable Applications

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

Design Considerations

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

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Designing New Installations

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

- Formulate the plan on the basis of clearly articulated community goals. Carefully identify conflicts and choices between retaining and protecting desired resources and community growth.

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

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

Conserve Natural Areas during Landscape Planning

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

- Cluster development on least-sensitive portions of a site while leaving the remaining land in a natural undisturbed condition.

- Limit clearing and grading of native vegetation at a site to the minimum amount needed to build lots, allow access, and provide fire protection.

- Maximize trees and other vegetation at each site by planting additional vegetation, clustering tree areas, and promoting the use of native and/or drought tolerant plants.

- Promote natural vegetation by using parking lot islands and other landscaped areas.

- Preserve riparian areas and wetlands.

Maximize Natural Water Storage and Infiltration Opportunities Within the Landscape Unit

- Promote the conservation of forest cover. Building on land that is already deforested affects basin hydrology to a lesser extent than converting forested land. Loss of forest cover reduces interception storage, detention in the organic forest floor layer, and water losses by evapotranspiration, resulting in large peak runoff increases and either their negative effects or the expense of countering them with structural solutions.

- Maintain natural storage reservoirs and drainage corridors, including depressions, areas of permeable soils, swales, and intermittent streams. Develop and implement policies and

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

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

Protection of Slopes and Channels during Landscape Design

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

Redeveloping Existing Installations

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

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

Other Resources

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

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

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

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

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

Roof Runoff Controls SD-11

Rain Garden

Design Objectives

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

Description

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

Approach

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

Suitable Applications

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

Design Considerations

Designing New Installations

Cisterns or Rain Barrels

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

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

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

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

Dry wells and Infiltration Trenches

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

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

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

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

Pop-up Drainage Emitter

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

Foundation Planting

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

Redeveloping Existing Installations

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

Supplemental Information

Examples

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

Other Resources

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

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

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

Efficient Irrigation SD-12

Design Objectives

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

Description

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

Approach

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

Suitable Applications

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

Design Considerations

Designing New Installations

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

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

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

Redeveloping Existing Installations

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

Other Resources

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

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

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

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

Storm Drain Signage SD-13

Design Objectives

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

Description

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

Approach

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

Suitable Applications

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

Design Considerations

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

Designing New Installations

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

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

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

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

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

Redeveloping Existing Installations

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

Additional Information

Maintenance Considerations

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

Placement

- Signage on top of curbs tends to weather and fade.

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

Supplemental Information

Examples

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

Other Resources

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

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

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

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

Street Sweeping and Vacuuming SE-7

Objectives

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

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

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

Potential Alternatives

None

Description and Purpose

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

Suitable Applications

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

Limitations

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

Implementation

- Controlling the number of points where vehicles can leave the site will allow sweeping and vacuuming efforts to be focused, and perhaps save money.
- Inspect potential sediment tracking locations daily.
- Visible sediment tracking should be swept or vacuumed on a daily basis.

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- Do not use kick brooms or sweeper attachments. These tend to spread the dirt rather than remove it.
- If not mixed with debris or trash, consider incorporating the removed sediment back into the project

Costs

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

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- When actively in use, points of ingress and egress must be inspected daily.
- When tracked or spilled sediment is observed outside the construction limits, it must be removed at least daily. More frequent removal, even continuous removal, may be required in some jurisdictions.
- Be careful not to sweep up any unknown substance or any object that may be potentially hazardous.
- Adjust brooms frequently; maximize efficiency of sweeping operations.
- After sweeping is finished, properly dispose of sweeper wastes at an approved dumpsite.

References

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

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

BIO-7: Proprietary Biotreatment

Proprietary biotreatment devices are devices that are manufactured to mimic natural systems such as bioretention areas by incorporating plants, soil, and microbes engineered to provide treatment at higher flow rates or volumes and with smaller footprints than their natural counterparts. Incoming flows are typically filtered through a planting media (mulch, compost, soil, plants, microbes, etc.) and either infiltrated or collected by an underdrain and delivered to the storm water conveyance system. Tree box filters are an increasingly common type of proprietary biotreatment device that are installed at curb level and filled with a bioretention type soil. For low to moderate flows they operate similarly to bioretention systems and are bypassed during high flows. Tree box filters are highly adaptable solutions that can be used in all types of development and in all types of soils but are especially applicable to dense urban parking lots, street, and roadways.

Also known as:

- *Catch basin planter box*
- *Bioretention vault*
- *Tree box filter*

Proprietary biotreatment
Source: http://www.americastusa.com /index.php/filterra/

Feasibility Screening Considerations

- Proprietary biotreatment devices that are unlined may cause incidental infiltration. Therefore, an evaluation of site conditions should be conducted to evaluate whether the BMP should include an impermeable liner to avoid infiltration into the subsurface.

Opportunity Criteria

- Drainage areas of 0.25 to 1.0 acres.
- Land use may include commercial, residential, mixed use, institutional, and subdivisions. Proprietary biotreatment facilities may also be applied in parking lot islands, traffic circles, road shoulders, and road medians.
- Must not adversely affect the level of flood protection provided by the drainage system.

OC-Specific Design Criteria and Considerations

☐ Frequent maintenance and the use of screens and grates to keep trash out may decrease the likelihood of clogging and prevent obstruction and bypass of incoming flows.

☐ Consult proprietors for specific criteria concerning the design and performance.

☐ Proprietary biotreatment may include specific media to address pollutants of concern. However, for proprietary device to be considered a biotreatment device the media must be capable of supporting rigorous growth of vegetation.

☐ Proprietary systems must be acceptable to the reviewing agency. Reviewing agencies shall have the discretion to request performance information. Reviewing agencies shall have the discretion to deny the use of a proprietary BMP on the grounds of performance, maintenance considerations, or other relevant factors.

☐ In right of way areas, plant selection should not impair traffic lines of site. Local jurisdictions may also limit plant selection in keeping with landscaping themes.

Computing Sizing Criteria for Proprietary Biotreatment Device

- Proprietary biotreatment devices can be volume based or flow-based BMPs.
- Volume-based proprietary devices should be sized using the Simple Design Capture Volume Sizing Method described in **Appendix III.3.1** or the Capture Efficiency Method for Volume-Based, Constant Drawdown BMPs described in **Appendix III.3.2**.
- The required design flowrate for flow-based proprietary devices should be computed using the Capture Efficiency Method for Flow-based BMPs described in **Appendix III.3.3)**.

In South Orange County, the provided ponding plus pore volume must be checked to demonstrate that it is greater than 0.75 of the remaining DCV that this BMP is designed to address. Many propretary biotreatment BMPs will not be able to meet the definition of "biofiltration" that applies in South Orange County. See Section III.7 and Worksheet SOC-1.

Additional References for Design Guidance

- Los Angeles Unified School District (LAUSD) Stormwater Technical Manual, Chapter 4: **http://www.laschools.org/employee/design/fs-studies-and-reports/download/white_paper_report_material/Storm_Water_Technical_Manual_2009-opt-red.pdf?version_id=76975850**
- Los Angeles County Stormwater BMP Design and Maintenance Manual, Chapter 9: **http://dpw.lacounty.gov/DES/design_manuals/StormwaterBMPDesignandMaintenance.pdf**
- Santa Barbara BMP Guidance Manual, Chapter 6: **http://www.santabarbaraca.gov/NR/rdonlyres/91D1FA75-C185-491E-A882-49EE17789DF8/0/Manual_071008_Final.pdf**

SITE SPECIFIC DATA			
PROJECT NUMBER			
PROJECT NAME			
PROJECT LOCATION			
STRUCTURE ID			
TREATMENT REQUIRED			
VOLUME BASED (CF)		FLOW BASED (CFS)	
TREATMENT HGL AVAILABLE (FT)			
PEAK BYPASS REQUIRED (CFS) – IF APPLICABLE			
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE 1			
INLET PIPE 2			
OUTLET PIPE			
	PRETREATMENT	BIOFILTRATION	DISCHARGE
RIM ELEVATION			
SURFACE LOAD	PARKWAY	OPEN PLANTER	PARKWAY
FRAME & COVER	36" x 36"	N/A	N/A
WETLANDMEDIA VOLUME (CY)			2.37
WETLANDMEDIA DELIVERY METHOD			TBD
ORIFICE SIZE (DIA. INCHES)			ø1.22"
MAXIMUM PICK WEIGHT (LBS)			16500
NOTES:			

INSTALLATION NOTES

1. CONTRACTOR TO PROVIDE ALL LABOR, EQUIPMENT, MATERIALS AND INCIDENTALS REQUIRED TO OFFLOAD AND INSTALL THE SYSTEM AND APPURTENANCES IN ACCORDANCE WITH THIS DRAWING AND THE MANUFACTURERS SPECIFICATIONS, UNLESS OTHERWISE STATED IN MANUFACTURERS CONTRACT.
2. UNIT MUST BE INSTALLED ON LEVEL BASE. MANUFACTURER RECOMMENDS A MINIMUM 6" LEVEL ROCK BASE UNLESS SPECIFIED BY THE PROJECT ENGINEER. CONTRACTOR IS RESPONSIBLE TO VERIFY PROJECT ENGINEERS RECOMMENDED BASE SPECIFICATIONS.
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4. CONTRACTOR TO SUPPLY AND INSTALL ALL EXTERNAL CONNECTING PIPES.
5. CONTRACTOR RESPONSIBLE FOR INSTALLATION OF ALL RISERS, MANHOLES, AND HATCHES. CONTRACTOR TO GROUT ALL MANHOLES AND HATCHES TO MATCH FINISHED SURFACE UNLESS SPECIFIED OTHERWISE.
6. DRIP OR SPRAY IRRIGATION REQUIRED ON ALL UNITS WITH VEGETATION.

GENERAL NOTES

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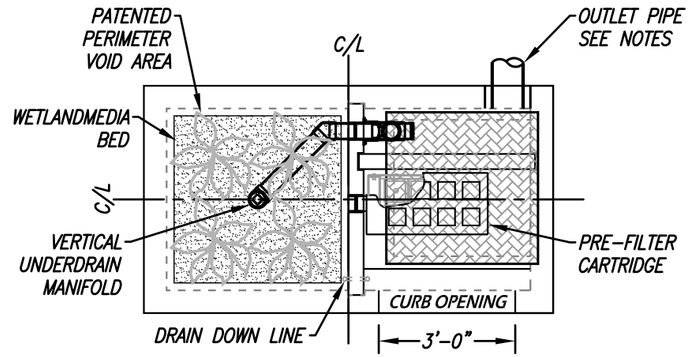
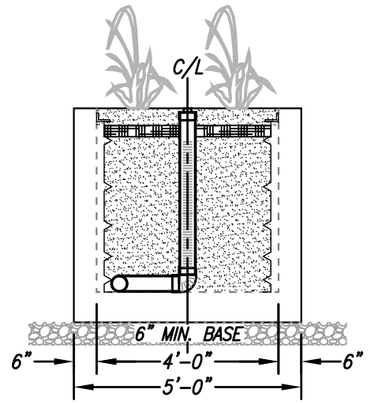
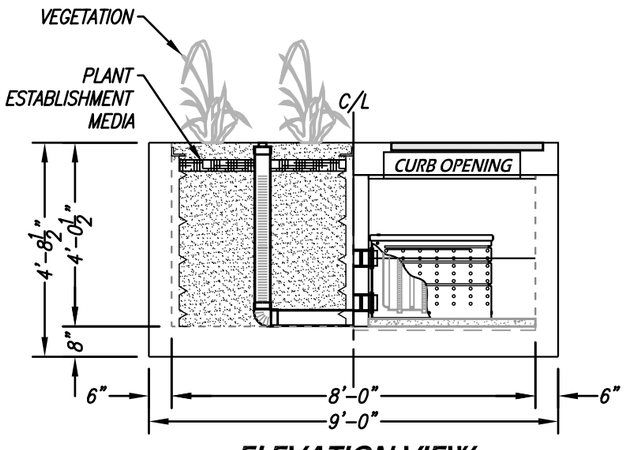


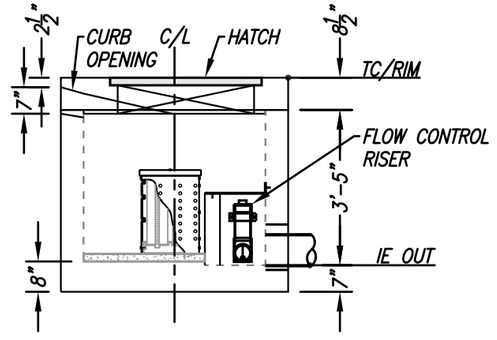
PLAN VIEW



LEFT END VIEW
BIOFILTRATION



ELEVATION VIEW



RIGHT END VIEW
PRETREATMENT/DISCHARGE

TREATMENT FLOW (CFS)	0.115
OPERATING HEAD (FT)	3.4
PRETREATMENT LOADING RATE (GPM/SF)	TBD
WETLAND MEDIA LOADING RATE (GPM/SF)	1.0

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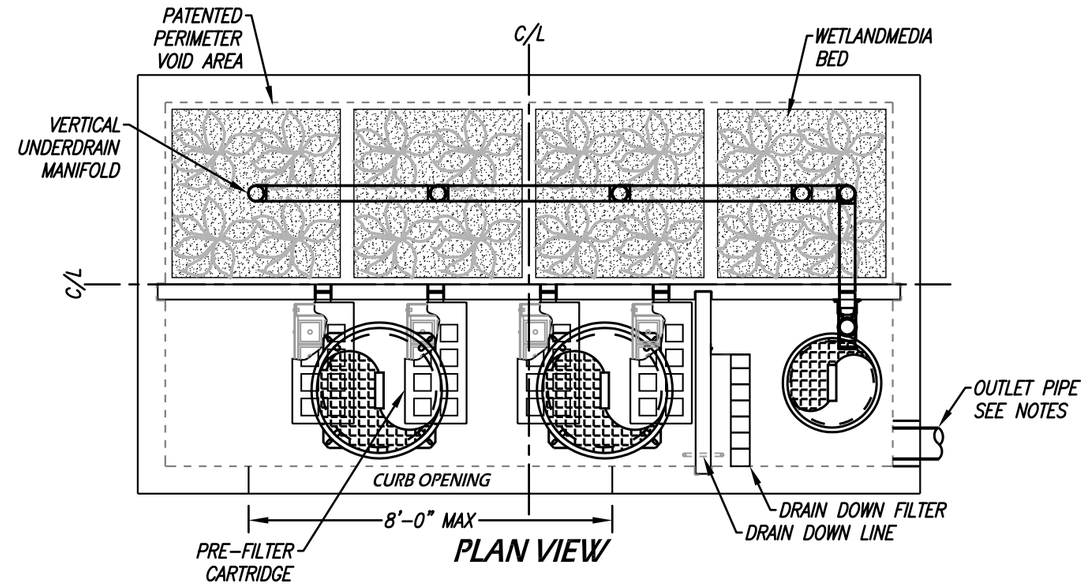
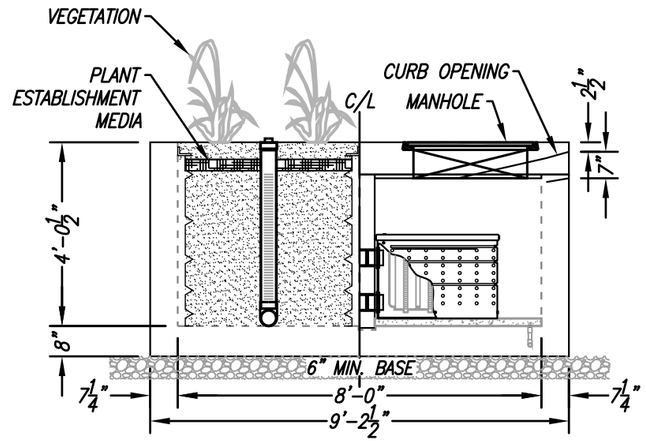
STORMWATER BIOFILTRATION SYSTEM
STANDARD DETAIL

5/1/15/JOHN

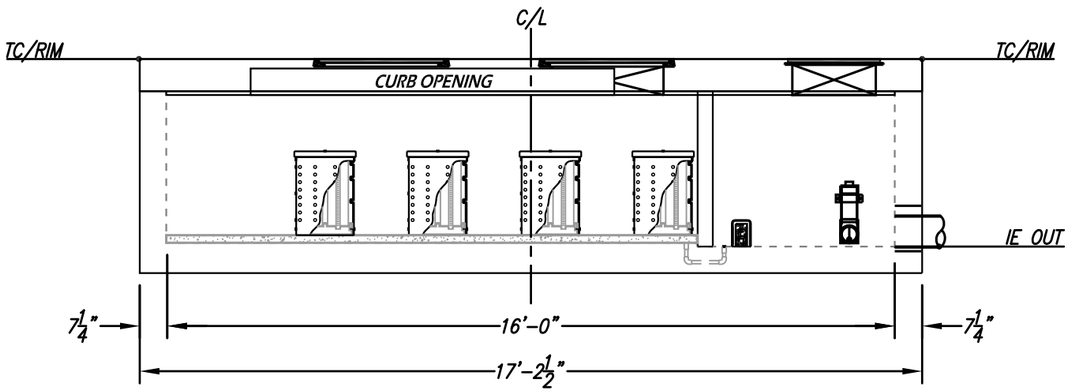
SITE SPECIFIC DATA			
PROJECT NAME			
PROJECT LOCATION			
STRUCTURE ID			
TREATMENT REQUIRED			
VOLUME BASED (CF)		FLOW BASED (CFS)	
TREATMENT HGL AVAILABLE (FT)			
PEAK BYPASS REQUIRED (CFS) – IF APPLICABLE			
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE 1			
INLET PIPE 2			
OUTLET PIPE			
	PRETREATMENT	BIOFILTRATION	DISCHARGE
RIM ELEVATION			
SURFACE LOAD	PARKWAY	OPEN PLANTER	PARKWAY
FRAME & COVER	ø30"	N/A	ø24"
WETLANDMEDIA VOLUME (CY)			9.50
WETLANDMEDIA DELIVERY METHOD			TBD
ORIFICE SIZE (DIA. INCHES)			ø3.07"
MAXIMUM PICK WEIGHT (LBS)			TBD
NOTES:			



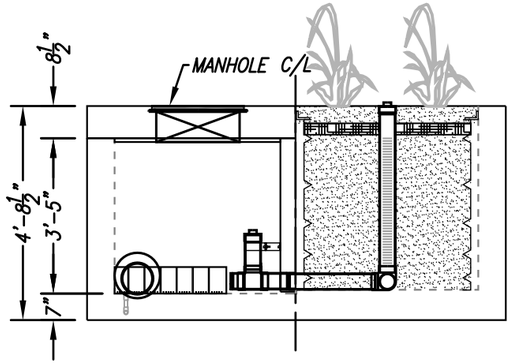
PLAN VIEW



LEFT END VIEW
BIOFILTRATION/PRETREATMENT



ELEVATION VIEW



RIGHT END VIEW
DISCHARGE/BIOFILTRATION

INSTALLATION NOTES

1. CONTRACTOR TO PROVIDE ALL LABOR, EQUIPMENT, MATERIALS AND INCIDENTALS REQUIRED TO OFFLOAD AND INSTALL THE SYSTEM AND APPURTENANCES IN ACCORDANCE WITH THIS DRAWING AND THE MANUFACTURERS SPECIFICATIONS, UNLESS OTHERWISE STATED IN MANUFACTURERS CONTRACT.
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TREATMENT FLOW (CFS)	0.462
OPERATING HEAD (FT)	3.4
PRETREATMENT LOADING RATE (GPM/SF)	TBD
WETLAND MEDIA LOADING RATE (GPM/SF)	1.0

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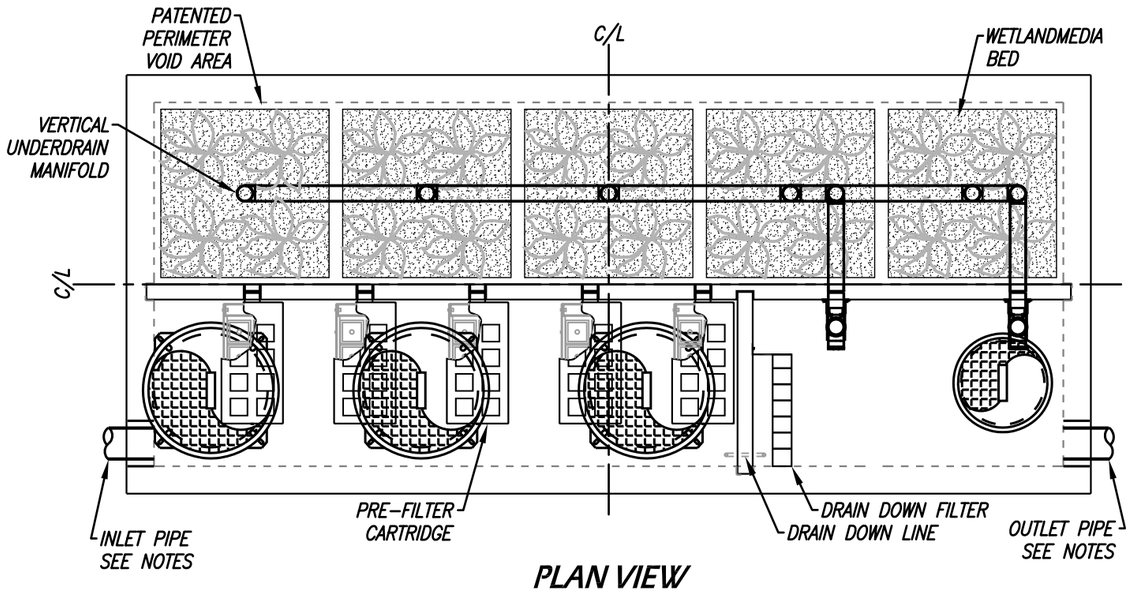
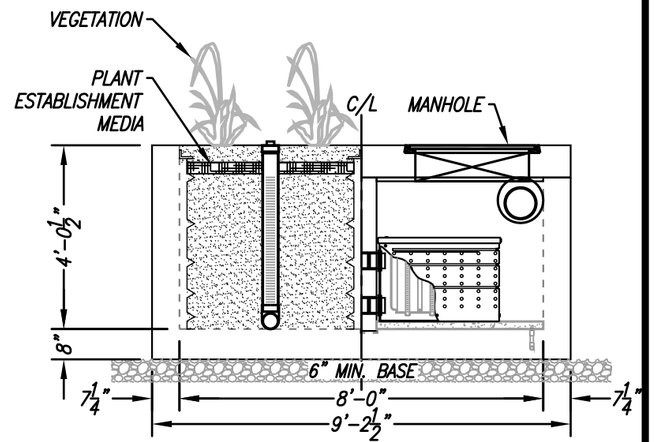
STORMWATER BIOFILTRATION SYSTEM
STANDARD DETAIL

3/11/15/JOHN

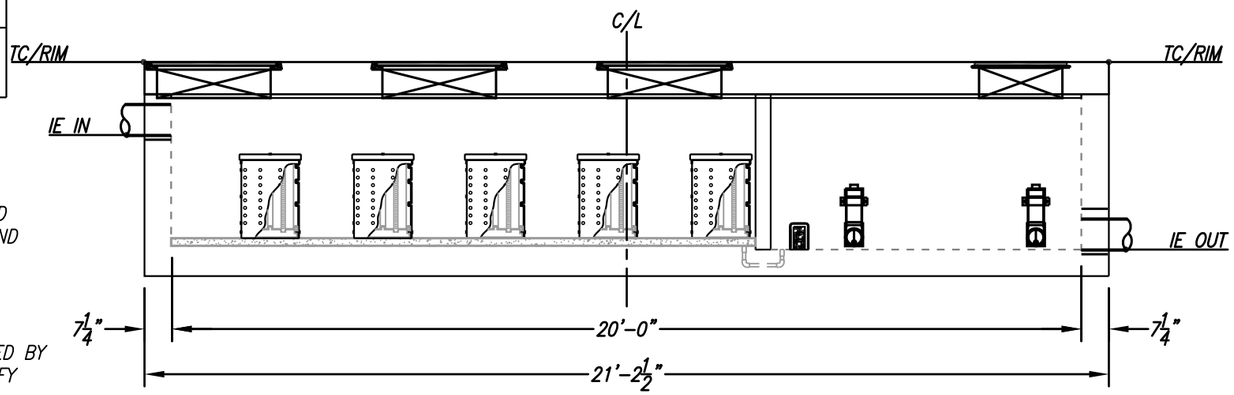
SITE SPECIFIC DATA			
PROJECT NAME			
PROJECT LOCATION			
STRUCTURE ID			
TREATMENT REQUIRED			
VOLUME BASED (CF)		FLOW BASED (CFS)	
TREATMENT HGL AVAILABLE (FT)			
PEAK BYPASS REQUIRED (CFS) – IF APPLICABLE			
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE 1			
INLET PIPE 2			
OUTLET PIPE			
	PRETREATMENT	BIOFILTRATION	DISCHARGE
RIM ELEVATION			
SURFACE LOAD	PARKWAY	OPEN PLANTER	PARKWAY
FRAME & COVER	ø30"	N/A	ø24"
WETLANDMEDIA VOLUME (CY)			11.85
WETLANDMEDIA DELIVERY METHOD			TBD
ORIFICE SIZE (DIA. INCHES)			ø2.43"
MAXIMUM PICK WEIGHT (LBS)			TBD
NOTES:			



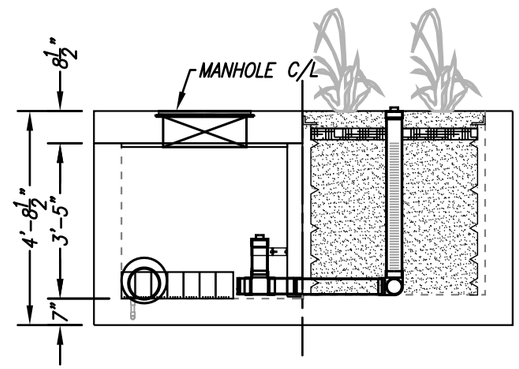
PLAN VIEW



LEFT END VIEW
BIOFILTRATION/PRETREATMENT



ELEVATION VIEW



RIGHT END VIEW
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TREATMENT FLOW (CFS)	0.577
OPERATING HEAD (FT)	3.4
PRETREATMENT LOADING RATE (GPM/SF)	TBD
WETLAND MEDIA LOADING RATE (GPM/SF)	1.0

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STANDARD DETAIL

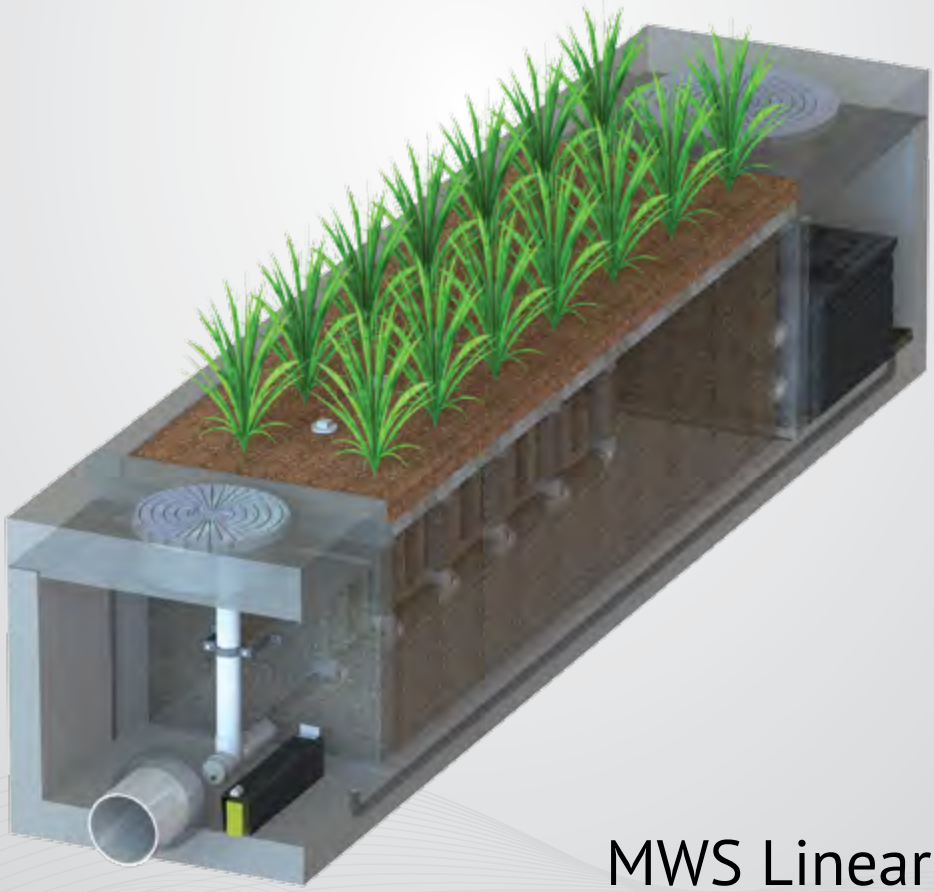
6/2/15/JOHN

MWS Linear 2.0 HGL Sizing Calculations

MWS MODEL SIZE	WETLAND PERMITER LENGTH	LOADING RATE GPM/SF	HGL HEIGHT																												
			SHALLOW MODELS																			STANDARD HEIGHT MODEL	HIGH CAPACITY MODELS									
			1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.65	3.70	3.75	3.80	3.85	3.90	3.95
MWS-L-4-4	6.70	1.0	0.022	0.023	0.025	0.026	0.028	0.029	0.031	0.032	0.034	0.035	0.037	0.038	0.040	0.042	0.043	0.045	0.046	0.048	0.049	0.051	**0.052**	0.054	0.055	0.056	0.057	0.058	0.058	0.059	0.060	0.061
~~**MWS-L-4-6**~~	~~10.00~~	~~1.0~~	~~0.032~~	~~0.035~~	~~0.037~~	~~0.039~~	~~0.042~~	~~0.044~~	~~0.046~~	~~0.048~~	~~0.051~~	~~0.053~~	~~0.055~~	~~0.058~~	~~0.060~~	~~0.062~~	~~0.065~~	~~0.067~~	~~0.069~~	~~0.072~~	~~0.074~~	~~0.076~~	~~**0.078**~~	~~0.081~~	~~0.083~~	~~0.084~~	~~0.085~~	~~0.087~~	~~0.088~~	~~0.089~~	~~0.090~~	~~0.091~~
MWS-L-4-6	9.30	1.0	0.030	0.032	0.034	0.036	0.038	0.041	0.043	0.045	0.047	0.049	0.051	0.053	0.055	0.058	0.060	0.062	0.064	0.066	0.068	0.070	**0.073**	0.075	0.077	0.078	0.079	0.080	0.081	0.082	0.083	0.084
MWS-L-4-8	14.80	1.0	0.048	0.051	0.054	0.058	0.061	0.065	0.068	0.071	0.075	0.078	0.082	0.085	0.088	0.092	0.095	0.099	0.102	0.105	0.109	0.112	**0.115**	0.119	0.122	0.124	0.126	0.127	0.129	0.131	0.132	0.134
MWS-L-4-13	18.40	1.0	0.059	0.063	0.068	0.072	0.076	0.080	0.084	0.089	0.093	0.097	0.101	0.106	0.110	0.114	0.118	0.122	0.127	0.131	0.135	0.139	**0.144**	0.148	0.152	0.154	0.156	0.158	0.160	0.163	0.165	0.167
MWS-L-4-15	22.40	1.0	0.072	0.077	0.082	0.087	0.093	0.098	0.103	0.108	0.113	0.118	0.123	0.129	0.134	0.139	0.144	0.149	0.154	0.159	0.165	0.170	**0.175**	0.180	0.185	0.188	0.190	0.193	0.195	0.198	0.200	0.203
MWS-L-4-17	26.40	1.0	0.085	0.091	0.097	0.103	0.109	0.115	0.121	0.127	0.133	0.139	0.145	0.151	0.158	0.164	0.170	0.176	0.182	0.188	0.194	0.200	**0.206**	0.212	0.218	0.221	0.224	0.227	0.230	0.233	0.236	0.239
MWS-L-4-19	30.40	1.0	0.098	0.105	0.112	0.119	0.126	0.133	0.140	0.147	0.153	0.160	0.167	0.174	0.181	0.188	0.195	0.202	0.209	0.216	0.223	0.230	**0.237**	0.244	0.251	0.255	0.258	0.262	0.265	0.269	0.272	0.276
MWS-L-4-21	34.40	1.0	0.111	0.118	0.126	0.134	0.142	0.150	0.158	0.166	0.174	0.182	0.189	0.197	0.205	0.213	0.221	0.229	0.237	0.245	0.253	0.261	**0.268**	0.276	0.284	0.288	0.292	0.296	0.300	0.304	0.308	0.312
MWS-L-6-8	18.80	1.0	0.060	0.065	0.069	0.073	0.078	0.082	0.086	0.091	0.095	0.099	0.104	0.108	0.112	0.116	0.121	0.125	0.129	0.134	0.138	0.142	**0.147**	0.151	0.155	0.157	0.160	0.162	0.164	0.166	0.168	0.170
MWS-L-8-8	29.60	1.0	0.095	0.102	0.109	0.115	0.122	0.129	0.136	0.143	0.149	0.156	0.163	0.170	0.177	0.183	0.190	0.197	0.204	0.211	0.217	0.224	**0.231**	0.238	0.245	0.248	0.251	0.255	0.258	0.262	0.265	0.268
MWS-L-8-12	44.40	1.0	0.143	0.153	0.163	0.173	0.183	0.194	0.204	0.214	0.224	0.234	0.245	0.255	0.265	0.275	0.285	0.296	0.306	0.316	0.326	0.336	**0.346**	0.357	0.367	0.372	0.377	0.382	0.387	0.392	0.397	0.402
MWS-L-8-16	59.20	1.0	0.190	0.204	0.217	0.231	0.245	0.258	0.272	0.285	0.299	0.312	0.326	0.340	0.353	0.367	0.380	0.394	0.408	0.421	0.435	0.448	**0.462**	0.476	0.489	0.496	0.503	0.509	0.516	0.523	0.530	0.537
MWS-L-8-20	74.00	1.0	0.238	0.255	0.272	0.289	0.306	0.323	0.340	0.357	0.374	0.391	0.408	0.425	0.442	0.459	0.476	0.493	0.509	0.526	0.543	0.560	**0.577**	0.594	0.611	0.620	0.628	0.637	0.645	0.654	0.662	0.671
MWS-L-10-20 or MWS-L-8-24	88.80	1.0	0.285	0.306	0.326	0.346	0.367	0.387	0.408	0.428	0.448	0.469	0.489	0.509	0.530	0.550	0.571	0.591	0.611	0.632	0.652	0.673	**0.693**	0.713	0.734	0.744	0.754	0.764	0.774	0.785	0.795	0.805
4'x'4 media cage	14.80	1.0	0.048	0.051	0.054	0.058	0.061	0.065	0.068	0.071	0.075	0.078	0.082	0.085	0.088	0.092	0.095	0.099	0.102	0.105	0.109	0.112	**0.115**	0.119	0.122	0.124						

MODULAR WETLANDS™

*Advanced **Stormwater** Biofiltration*



MWS Linear

Contents

The Urban Impact

For hundreds of years natural wetlands surrounding our shores have played an integral role as nature's stormwater treatment system. But as our cities grow and develop, these natural wetlands have perished under countless roads, rooftops, and parking lots.

Plant A Wetland

Without natural wetlands our cities are deprived of water purification, flood control, and land stability. Modular Wetlands and the MWS Linear re-establish nature's presence and rejuvenate water ways in urban areas.

MWS Linear

The Modular Wetland System Linear represents a pioneering breakthrough in stormwater technology as the only biofiltration system to utilize patented horizontal flow, allowing for a smaller footprint and higher treatment capacity. While most biofilters use little or no pre-treatment, the MWS Linear incorporates an advanced pre-treatment chamber that includes separation and pre-filter cartridges. In this chamber sediment and hydrocarbons are removed from runoff before it enters the biofiltration chamber, in turn reducing maintenance costs and improving performance.

Applications

The MWS Linear has been successfully used on numerous new construction and retrofit projects. The system's superior versatility makes it beneficial for a wide range of stormwater and waste water applications - treating rooftops, streetscapes, parking lots, and industrial sites.

Industrial

Many states enforce strict regulations for discharges from industrial sites. The MWS Linear has helped various sites meet difficult EPA mandated effluent limits for dissolved metals and other pollutants.

Residential

Low to high density developments can benefit from the versatile design of the MWS Linear. The system can be used in both decentralized LID design and cost-effective end-of-the-line configurations.

Streets

Street applications can be challenging due to limited space. The MWS Linear is very adaptable, and offers the smallest footprint to work around the constraints of existing utilities on retrofit projects.

Parking Lots

Parking lots are designed to maximize space and the MWS Linear's 4 ft. standard planter width allows for easy integration into parking lot islands and other landscape medians.

Commercial

Compared to bioretention systems, the MWS Linear can treat far more area in less space - meeting treatment and volume control requirements.

Mixed Use

The MWS Linear can be installed as a raised planter to treat runoff from rooftops or patios, making it perfect for sustainable "live-work" spaces.

More applications are available on our website: www.ModularWetlands.com/Applications

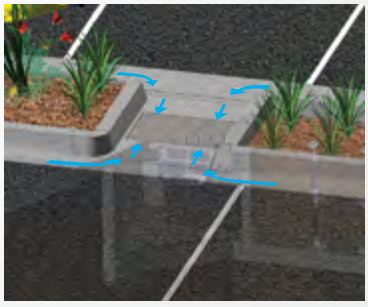
- Agriculture
- Reuse
- Low Impact Development
- Waste Water

Configurations

The MWS Linear is the preferred biofiltration system of Civil Engineers across the country due to its versatile design. This highly versatile system has available "pipe-in" options on most models, along with built-in curb or grated inlets for simple integration into your stormdrain design.

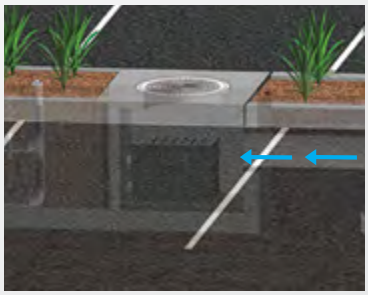
Curb Type

The *Curb Type* configuration accepts sheet flow through a curb opening and is commonly used along road ways and parking lots. It can be used in sump or flow by conditions. Length of curb opening varies based on model and size.



Grate Type

The *Grate Type* configuration offers the same features and benefits as the *Curb Type* but with a grated/drop inlet above the systems pre-treatment chamber. It has the added benefit of allowing for pedestrian access over the inlet. ADA compliant grates are available to assure easy and safe access. The *Grate Type* can also be used in scenarios where runoff needs to be intercepted on both sides of landscape islands.



Vault Type

The system's patented horizontal flow biofilter is able to accept inflow pipes directly into the pre-treatment chamber, meaning the MWS Linear can be used in end-of-the-line installations. This greatly improves feasibility over typical decentralized designs that are required with other biofiltration/bioretention systems. Another benefit of the "pipe in" design is the ability to install the system downstream of underground detention systems to meet water quality volume requirements.

Downspout Type

The *Downspout Type* is a variation of the *Vault Type* and is designed to accept a vertical downspout pipe from roof top and podium areas. Some models have the option of utilizing an internal bypass, simplifying the overall design. The system can be installed as a raised planter and the exterior can be stuccoed or covered with other finishes to match the look of adjacent buildings.

Advantages & Operation

The MWS Linear is the most efficient and versatile biofiltration system on the market, and the only system with horizontal flow which improves performance, reduces footprint, and minimizes maintenance. Figure-1 and Figure-2 illustrate the invaluable benefits of horizontal flow and the multiple treatment stages.

Featured Advantages

- Horizontal Flow Biofiltration
- Greater Filter Surface Area
- Pre-Treatment Chamber
- Patented Perimeter Void Area
- Flow Control
- No Depressed Planter Area

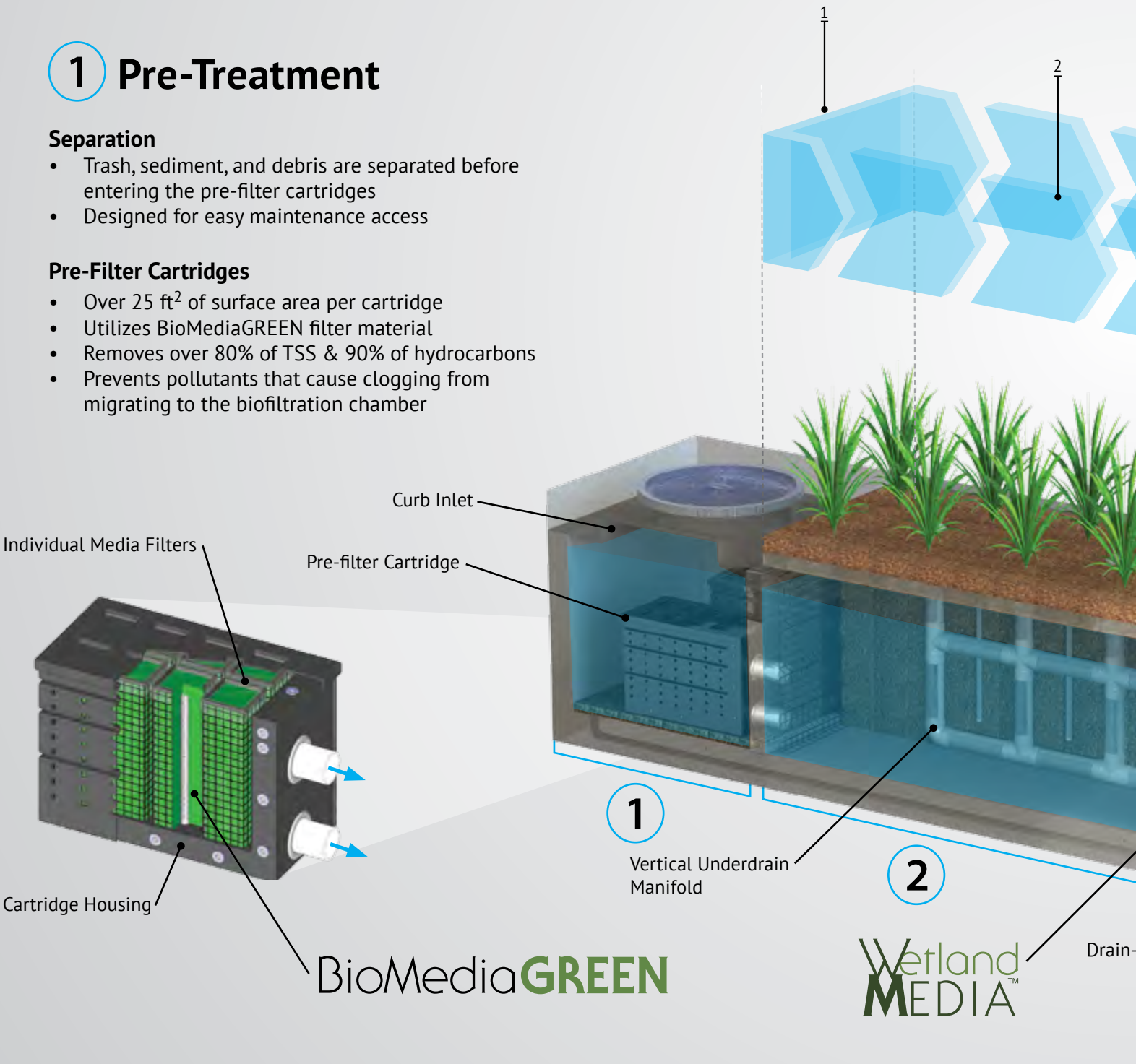
1 Pre-Treatment

Separation

- Trash, sediment, and debris are separated before entering the pre-filter cartridges
- Designed for easy maintenance access

Pre-Filter Cartridges

- Over 25 ft^2 of surface area per cartridge
- Utilizes BioMediaGREEN filter material
- Removes over 80% of TSS & 90% of hydrocarbons
- Prevents pollutants that cause clogging from migrating to the biofiltration chamber



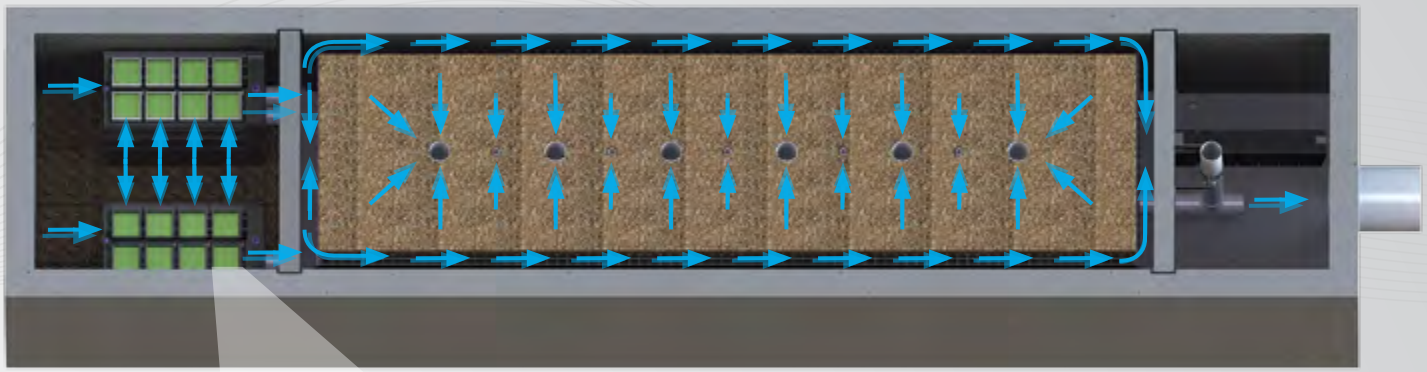


Fig. 2 - Top View

2x to 3x More Surface Area Than Traditional Downward Flow Bioretention Systems.

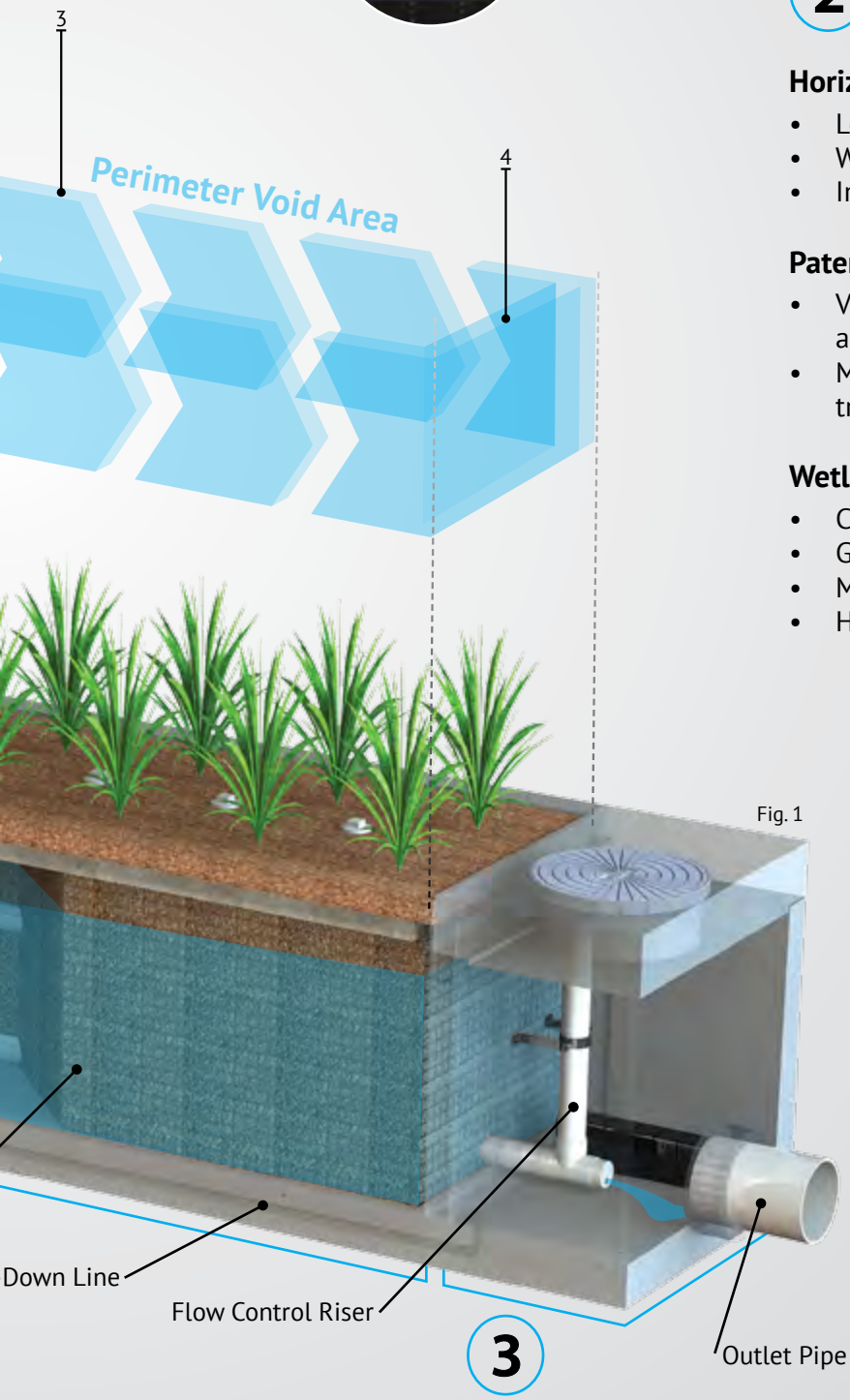


Fig. 1

2 Biofiltration

Horizontal Flow

- Less clogging than downward flow biofilters
- Water flow is subsurface
- Improves biological filtration

Patented Perimeter Void Area

- Vertically extends void area between the walls and the WetlandMEDIA on all four sides.
- Maximizes surface area of the media for higher treatment capacity

WetlandMEDIA

- Contains no organics and removes phosphorus
- Greater surface area and 48% void space
- Maximum evapotranspiration
- High ion exchange capacity and light weight

3 Discharge

Flow Control

- Orifice plate controls flow of water through WetlandMEDIA to a level lower than the media's capacity.
- Extends the life of the media and improves performance

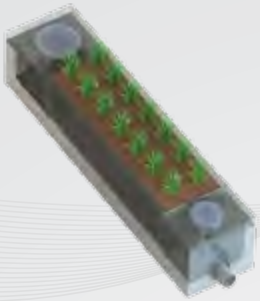
Drain-Down Filter

- The Drain-Down is an optional feature that completely drains the pre-treatment chamber
- Water that drains from the pre-treatment chamber between storm events will be treated

Orientations

Side-By-Side

The *Side-By-Side* orientation places the pre-treatment and discharge chamber adjacent to one another with the biofiltration chamber running parallel on either side. This minimizes the system length, providing a highly compact footprint. It has been proven useful in situations such as streets with directly adjacent sidewalks, as half of the system can be placed under that sidewalk. This orientation also offers internal bypass options as discussed below.



End-To-End

The *End-To-End* orientation places the pre-treatment and discharge chambers on opposite ends of the biofiltration chamber therefore minimizing the width of the system to 5 ft (outside dimension). This orientation is perfect for linear projects and street retrofits where existing utilities and sidewalks limit the amount of space available for installation. One limitation of this orientation is bypass must be external.

Bypass

Internal Bypass Weir (Side-by-Side Only)

The *Side-By-Side* orientation places the pre-treatment and discharge chambers adjacent to one another allowing for integration of internal bypass. The wall between these chambers can act as a bypass weir when flows exceed the system's treatment capacity, thus allowing bypass from the pre-treatment chamber directly to the discharge chamber.

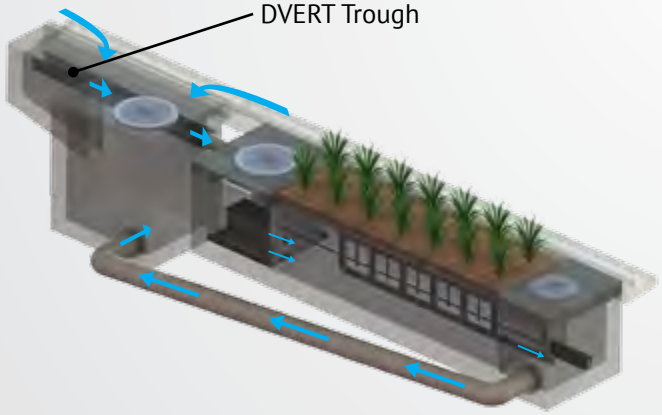
External Diversion Weir Structure

This traditional offline diversion method can be used with the MWS Linear in scenarios where runoff is being piped to the system. These simple and effective structures are generally configured with two outflow pipes. The first is a smaller pipe on the upstream side of the diversion weir - to divert low flows over to the MWS Linear for treatment. The second is the main pipe that receives water once the system has exceeded treatment capacity and water flows over the weir.

Flow By Design

This method is one in which the system is placed just upstream of a standard curb or grate inlet to intercept the first flush. Higher flows simply pass by the MWS Linear and into the standard inlet downstream.

DVERT Low Flow Diversion



This simple yet innovative diversion trough can be installed in existing or new curb and grate inlets to divert the first flush to the MWS Linear via pipe. It works similar to a rain gutter and is installed just below the opening into the inlet. It captures the low flows and channels them over to a connecting pipe exiting out the wall of the inlet and leading to the MWS Linear. The DVERT is perfect for retrofit and green street applications that allows the MWS Linear to be installed anywhere space is available.

Performance

The MWS Linear continues to outperform other treatment methods with superior pollutant removal for TSS, heavy metals, nutrients, hydrocarbons and bacteria. Since 2007 the MWS Linear has been field tested on numerous sites across the country. With it's advanced pre-treatment chamber and innovative horizontal flow biofilter, the system is able to effectively remove pollutants through a combination of physical, chemical, and biological filtration processes. With the same biological processes found in natural wetlands, the MWS Linear harnesses natures ability to process, transform, and remove even the most harmful pollutants.

Approvals

The MWS Linear has successfully met years of challenging technical reviews and testing from some of the most prestigious and demanding agencies in the nation, and perhaps the world.

Washington State DOE Approved

The MWS Linear is approved for General Use Level Designation (GULD) for Basic, Enhanced, and Phosphorus treatment at 1 gpm/ft^2 loading rate. The highest performing BMP on the market for all main pollutant categories.

TSS	Total Phosphorus	Ortho Phosphorus	Nitrogen	Dissolved Zinc	Dissolved Copper	Total Zinc	Total Copper	Motor Oil
85%	64%	67%	45%	66%	38%	69%	50%	95%

DEQ Assignment

The Virginia Department of Environmental Quality assigned the MWS Linear, the highest phosphorus removal rating for manufactured treatment devices to meet the new Virginia Stormwater Management Program (VSMP) Technical Criteria.

MASTEP Evaluation

The University of Massachusetts at Amherst – Water Resources Research Center, issued a technical evaluation report noting removal rates up to 84% TSS, 70% Total Phosphorus, 68.5% Total Zinc, and more.

Rhode Island DEM Approved

Approved as an authorized BMP and noted to achieve the following minimum removal efficiencies: 85% TSS, 60% Pathogens, 30% Total Phosphorus for discharges to freshwater systems, and 30% Total Nitrogen for discharges to saltwater or tidal systems.

Flow Based Sizing

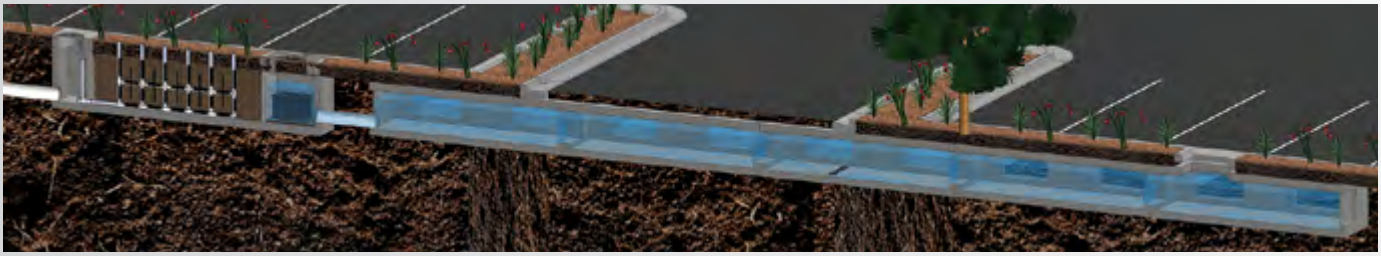
The MWS Linear can be used in stand alone applications to meet treatment flow requirements. Since the MWS Linear is the only biofiltration system that can accept inflow pipes several feet below the surface it can be used not only in decentralized design applications but also as a large central end-of-the-line application for maximum feasibility.

Treatment Flow Sizing Table

Model #	Dimensions	WetlandMedia Surface Area	Treatment Flow Rate (cfs)
MWS-L-4-4	4' x 4'	23 ft^2	0.052
MWS-L-4-6	4' x 6'	32 ft^2	0.073
MWS-L-4-8	4' x 8'	50 ft^2	0.115
MWS-L-4-13	4' x 13'	63 ft^2	0.144
MWS-L-4-15	4' x 15'	76 ft^2	0.175
MWS-L-4-17	4' x 17'	90 ft^2	0.206
MWS-L-4-19	4' x 19'	103 ft^2	0.237
MWS-L-4-21	4' x 21'	117 ft^2	0.268
MWS-L-8-8	8' x 8'	100 ft^2	0.230
MWS-L-8-12	8' x 12'	151 ft^2	0.346
MWS-L-8-16	8' x 16'	201 ft^2	0.462

Volume Based Sizing

Many states require treatment of a water quality volume and do not offer the option of flow based design. The MWS Linear and its unique horizontal flow makes it the only biofilter that can be used in volume based design installed downstream of ponds, detention basins, and underground storage systems.



Treatment Volume Sizing Table

Model #	Treatment Capacity (cu. ft.) @ 24-Hour Drain Down	Treatment Capacity (cu. ft.) @ 48-Hour Drain Down
MWS-L-4-4	1140	2280
MWS-L-4-6	1600	3200
MWS-L-4-8	2518	5036
MWS-L-4-13	3131	6261
MWS-L-4-15	3811	7623
MWS-L-4-17	4492	8984
MWS-L-4-19	5172	10345
MWS-L-4-21	5853	11706
MWS-L-8-8	5036	10072
MWS-L-8-12	7554	15109
MWS-L-8-16	10073	20145

Installation

The MWS Linear is simple, easy to install, and has a space efficient design that offers lower excavation and installation costs compared to traditional tree-box type systems. The structure of the system resembles pre-cast catch basin or utility vaults and is installed in a similar fashion.

The system is delivered fully assembled for quick installation. Generally, the structure can be unloaded and set in place in 15 minutes. Our experienced team of field technicians are available to supervise installations and provide technical support.

Maintenance

Reduce your maintenance costs, man hours, and materials with the MWS Linear. Unlike other biofiltration systems that provide no pre-treatment, the MWS Linear is a self-contained treatment train which incorporates simple and effective pre-treatment.

Maintenance requirements for the biofilter itself are almost completely eliminated, as the pre-treatment chamber removes and isolates trash, sediments, and hydrocarbons. What's left is the simple maintenance of an easily accessible pre-treatment chamber that can be cleaned by hand or with a standard vac truck. Only periodic replacement of low-cost media in the pre-filter cartridges is required for long term operation and there is absolutely no need to replace expensive biofiltration media.

Plant Selection

Abundant plants, trees, and grasses bring value and an aesthetic benefit to any urban setting, but those in the MWS Linear do even more - they increase pollutant removal. What's not seen, but very important, is that below grade the stormwater runoff/flow is being subjected to nature's secret weapon: a dynamic physical, chemical, and biological process working to break down and remove non-point source pollutants. The flow rate is controlled in the MWS Linear, giving the plants more "contact time" so that pollutants are more successfully decomposed, volatilized and incorporated into the biomass of The MWS Linear's micro/macro flora and fauna.

A wide range of plants are suitable for use in the MWS Linear, but selections vary by location and climate. View suitable plants by selecting the list relative to your project location's hardy zone.

Please visit www.ModularWetlands.com/Plants for more information and various plant lists.

SPECIFICATIONS

MWS – Linear

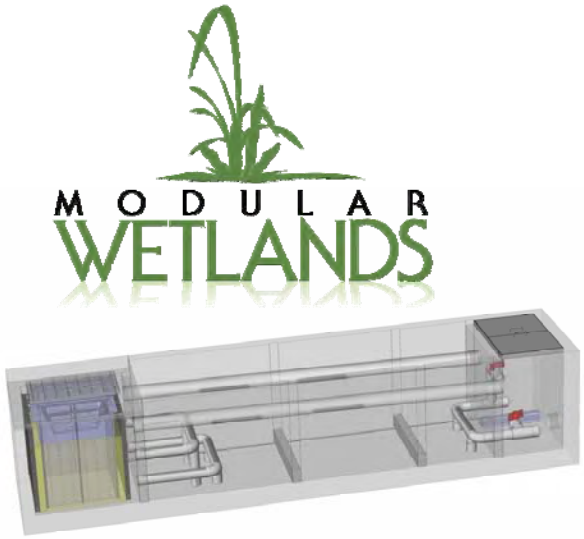
Hybrid Stormwater Filtration System

Modular Wetland Systems, Inc.
P.O. Box 869
Oceanside, CA 92049

www.modularwetlands.com
P 760-433-7640
F 760-433-3179

MWS – Linear

Hybrid Stormwater Filtration System



Save valuable space with small footprint for urban sites.

Improve BMP aesthetics with attractive native and tropical landscape plants.

Reduce lifetime costs with safer and less expensive maintenance

"The MWS – Linear hybrid stormwater treatment system is described as a self contained treatment train. This system utilizes an innovative combination of l treatment processes. Stormwater runoff flows into the system via pipe or curb/grate type catch basin opening. Polluted runoff first encounters a screening device to remove larger pollutants and then enters a hydrodynamic separation chamber which settles out the sediments and larger suspended solids. Next the runoff is treated by a revolutionary filter media, BioMediaGREEN that removes fines and associated pollutants, including bacteria. From there runoff enters of bioretention filter in the form of a subsurface flow vegetated gravel wetland. Within the wetland physical, chemical, and biological mechanisms remove the remaining particulate and dissolved pollutants. The purified runoff leaves the system via the discharge chamber. In the discharge chamber the rate of discharge is controlled by valves set to a desired rate".

Tested Pollutant Removal Efficiencies:

TSS Removal	Dissolved Lead Removal	Dissolved Copper Removal	TPH	E. coli Removal	Turbidity Removal
98%	81%	92%	99%	60.2%	92%

"Nature and Harmony Working Together in Perfect Harmony"

SPECIFICATIONS – MWS- LINEAR

Track Record: The MWS- Linear Hybrid Stormwater Treatment System is manufactured by a company whom is regularly engaged in the engineering design and production of treatment systems for stormwater.

Coverage: The MWS- Linear is designed to treat the water quality volume or water quality flow. For flow based design, high flow bypass is internal, for volume based design, high flow bypass is external and prior to pre-detention system. For offline volume based designs the MWS - Linear has the ability to treat the entire water quality volume when used with pre-storage and properly sized.

Non-Corrosive Materials: The MWS – Linear is designed with non-corrosive materials. All internal piping is SD35 PVC. Catch basin filter components, including mounting hardware, fasteners, support brackets, filtration material, and support frame are constructed of non-corrosive materials (316 stainless steel, and UV protected/marine grade fiberglass). Fasteners are stainless steel. Primary filter mesh is 316 stainless steel welded screens. Filtration basket screens for coarse, medium and fine filtration is ¾" x 1 ¾"expanded, 10 x 10 mesh, and 35 x 35 mesh, respectively. No polypropylene, monofilament netting or fabrics shall be used in this system. Media Protective Panels are constructed of UV protected/marine grade fiberglass. Mounts are constructed of stainless steel. BioMediaGREEN is an inert rock substrate and is non-corrosive. Perimeter filter structure is constructed of lightweight injection molded plastic. Mounting brackets are constructed of SD40 PVC and are mounted with 3/8" diameter stainless steel redheads. Drain down filter cover is constructed of UV protected/marine grade fiberglass and stainless steel hinge and mount.

Weight: Each complete unit weighs approximately 29,000 to 40,000 pounds and requires a boom crane to install. Details of this are provided in the installation section of the MWS-Linear Design Kit.

Transportation: The Modular Wetland System – Linear is designed to be transported on a standard flat bed truck. The unit easily fits on a flat bed truck without the need of special permitting.

Alternative Technology Configurations: The Modular Wetland System – Linear is modular is design. Each module will be up to 22 feet long and 5 feet wide. The system can be made in lengths varying from 13 to 100s of feet long. For lengths longer than 22 feet the system will shipped in modules and assembled on site. The Modular Wetland System – Linear has many alternative configurations. This allows the system to be adapted to many site conditions. Runoff can enter the system through a pipe, and/or a built in curb or grate type opening.

Energy Requirements: The Modular Wetland System – Linear is completely passive and requires no external energy sources.

Buoyancy Issues: Buoyancy is only a an issue when ground water levels rise above the bottom of the Modular Wetland System – Linear's concrete structure. With 8.5 cubic yards of wetland media there is no concern of floatation. As a precaution a footing can also be built into the systems concrete structure.

Durability: The structure of the box will be precast concrete. The concrete will be 28 day compressive strength fc = 5,000 psi. Steel reinforcing will be ASTM A – C857. Structure will support an H20 loading as indicted by AASHTO. The joint between the concrete sections will ship lap and joint sealed with ram-nek. Filter (excluding oil absorbent media) and support structures are of proven durability. The filter and mounting structures are of sufficient strength to support water, sediment, and debris loads when the filter is full, with no slippage, breaking, or tearing. All filters are warranted for a minimum of five (5) years.

Oil Absorbent Media: The MWS – Linear utilizes both physical and biological mechanisms to capture and filter oil and grease. A skimmer and boom system will be positioned on the internal perimeter of the catch basin insert. The primary filtration media, BioMediaGreen, utilized in the perimeter and drain down filters, has excellent hydrocarbon removal abilities. Within the wetland filter biological processes capture and

break down oil and grease. Much of the breakdown and transformation of oil and grease is performed by natural occurring bacteria.

Overflow Protection: The grate and curb type MWS – Linear are designed with an internal bypass consisting of two SD PVC pipes which direct high flows around the perimeter and wetland filter, directly into the discharge chamber. For the volume based vault type configuration, bypass should be located prior to the pre-detention system. For peak flows that exceed internal bypass capacity, external bypass is use.

Filter Bypass: Runoff will bypass filtration (BioMediaGREEN and wetland filter) components of the MWS - Linear. The system will still provide screening and settling during higher flow rates for internally bypassed flows. External bypass will bypass of treatment processes.

Pollutant Removal Efficiency: The MWS - Linear is capable of removing over 90% of the net annual total suspended solids (TSS) load based on a 20-micron particle size. Annual TSS removal efficiency models are based on documented removal efficiency performance from full-scale laboratory tests on BioMediaGreen and quarter-scale laboratory tests on the MWS – Linear flow based system.

POLLUTANT	REMOVAL EFFICIENCY
Trash & Litter	99%
TPH (mg/L)	99%
TSS (mg/L)	98%
E. Coli (MPN/100ml)	60%
Turbidity (NTU)	92%
Dissolved Metals (mg/L)	76%

Sil-Co-Sil 106. Mean particle diameter = 19 microns

Non-Scouring: During heavy storm events the runoff bypasses perimeter and wetland filter components. The system will not re-suspend solids at design flows.

Uniqueness: The Modular Wetland System – Linear is a complete self contained treatment train that incorporates capture, screening, sedimentation, filtration, bioretention, high flow bypass, and flow control into a single modular structure. This system provides four stages of treatment making it the only 4 stage treatment train stormwater filtration system, therefore making it unique to the industry. Other systems do not incorporate all the necessary attributes to make it a complete stormwater management device as with the Modular Wetland System – Linear. Therefore, no equal exists for this system.

Pretreatment & Preconditioning: Since the Modular Wetland System – Linear is a complete capture and treatment train stormwater management system no external pretreatment of preconditioning is necessary.

SPECIFICATIONS – BioMediaGREEN

BioMediaGREEN is a proprietary engineered filter media. Made of a unique combination of the inert naturally occurring material this product is non-combustible and do not pose a fire hazard, stable and non-reactive, and is also biodegradable. It is stable with no known adverse environmental effects.

This product has been tested in long-term carcinogenicity studies [inhalation and intraperitoneal injection (i.p.)] with no significant increase in lung tumors or abdominal tumors. Short-term biopersistent (inhalation and intra-tracheal injection) studies have shown that the products disappear very rapidly from the lung.

In October 2001, IARC classified this product as Group 3, "not classifiable as to its carcinogenicity to humans". The 2001 decision was based on the latest epidemiological studies and animal inhalation studies that show no relation between inhalation exposure and the development of tumors.

The product can typically be disposed of in an ordinary landfill (local regulations may apply). If you are unsure of the regulations, contact your local Public Health Department or the local office of the Environmental Protection Agency (EPA).

Coverage: When properly installed BioMediaGREEN Filter Blocks provide sufficient contact time, at rated flows, of passing contaminate water. The BioMediaGREEN material will capture and retain most pollutants that pass through it. The BioMediaGREEN material is made of a proprietary blend of inert substances. The BioMediaGREEN Filter Blocks can be used in different treatment devices, including but not limited to flume filters, trench drain filters, downspout filters, catch basin inserts, water polishing units, and hydrodynamic separators.

Non-Corrosive Materials: The BioMediaGreen material is made of non-corrosive materials.

Durability: The BioMediaGREEN material has been chosen for its proven durability, with an expected life of 2 plus years. The BioMediaGREEN material is of sufficient strength to support water, sediment, and debris loads when the media is at maximum flow; with no slippage, breaking, or tearing. The BioMediaGREEN material has been tested through rigorous flow and loading conditions.

Oil Absorbent Media: The BioMediaGREEN material has been proven to capture and retain hydrocarbons.

Pollutant Removal Efficiency: The BioMediaGREEN Filter Blocks are designed to capture high levels of Hydrocarbons including but not limited to oils & grease, gasoline, diesel, and PAHs. BioMediaGREEN Filter Blocks have the physical ability to block and filter trash and litter, grass and foliage, sediments, TSS, particulate and dissolved metals, nutrients, and bacteria.

BioMediaGREEN technology is based on a proprietary blend of synthetic inert natural substances aimed at removal of various stormwater pollutants. BioMediaGREEN was created to have a very porous structure capable of selectively removing pollutants while

allowing high flow through rates for water. As pollutants are captured by its structure, BioMediaGREEN captures most pollutants and maintains porosity and filtering capabilities.

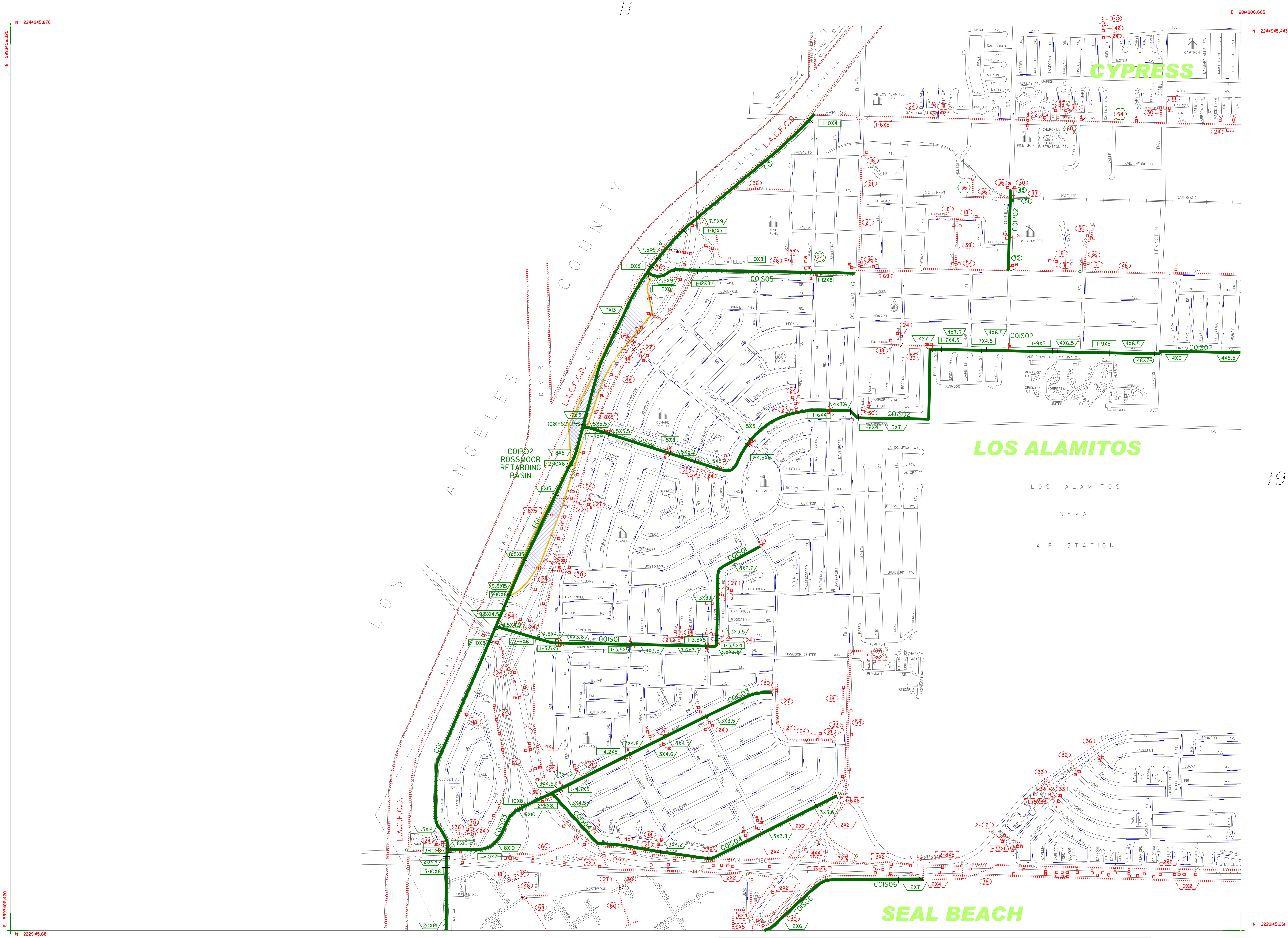
Field and laboratory tests have confirmed the BioMediaGREEN capability to capture large percentage of TSS, hydrocarbons, nutrients, and heavy metals. Microbial reduction efficiency will vary depending on colony size, flow rates and site specific conditions.

POLLUTANT	REMOVAL EFFICIENCY
Oil & Grease (mg/L)	90%
TPH (mg/L)	99%
TSS (mg/L)	85%
Turbidity (NTU)	99%
Total Phosphorus (mg/L)	69.6%
Dissolved Metals (mg/L)	75.6%

Sil-Co-Sil 106. Mean particle diameter = 19 microns

Replacement: Removal and replacement of the blocks is simple. Remove blocks from filtration system. Replace with new block of equal size.

Attachment D
Reference Materials



NOTICE

The drainage information has been prepared for information purposes only. The location, ownership, facility information and limits have been determined from available information provided by public agencies, but may not be exact, accurate, or up–to–date. The user of this information is responsible for verifying exact location, ownership, accuracy, and the regional versus local character of drainage facilities.

Additional information may be obtained from public plans and recorded deeds. Facility designations included with this information are for convenience only and are not controlling or intended to imply ownership by the County or the Orange County Flood Control District (OCFCD). The information is being provided as a courtesy and neither the County of Orange nor OCFCD assume any liabilities for inaccuracy of the information.

To notify OC Public Works Flood Control Section of additions or corrections, please contact Sal Gutierrez at (714) 834–5396 or by email at sal.gutierrez@ocpw.ocgov.com

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FEET

ORANGE COUNTY FLOOD CONTROL DISTRICT

BASE MAP OF DRAINAGE FACILITIES IN ORANGE COUNTY

REVISION	DATE	SHEET NO.	DWG. NO.
S. GUTIERREZ	JUN 9, 2008	18	MAPS–113–3

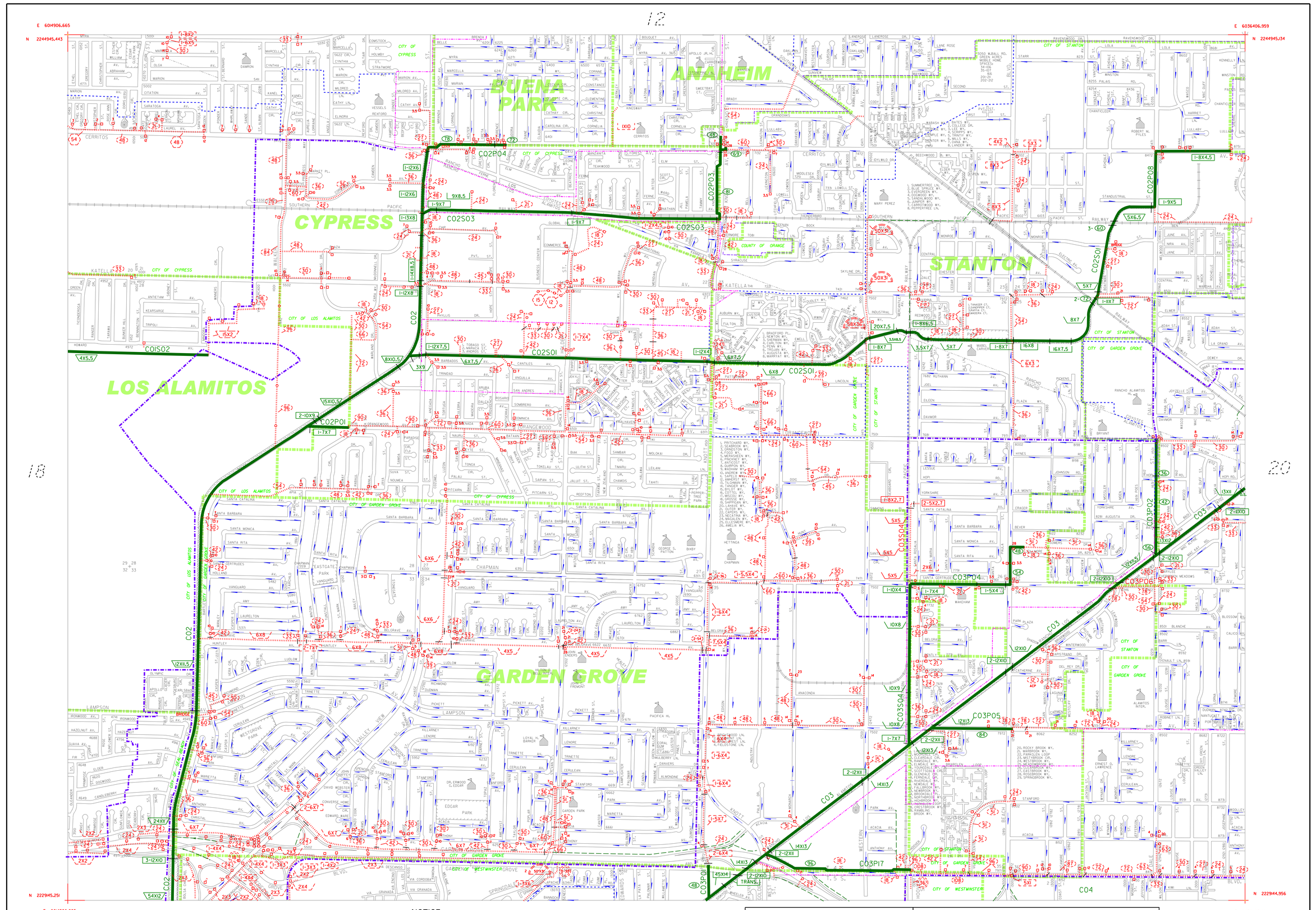
- Channel Drainage Area Boundary
- Major Sub–Area Drainage Boundary
- Minor Sub–Area Drainage Boundary
- Existing O.C.F.C.D. Facility
- Existing Local Facility
- Existing Retarding Basin or Reservoir
- Natural Watercourse
- City Limits
- G G Greenbelt
- P.S. P.S. Pump Station
- Catch Basin (length in feet)
- Drop Inlet or Other Entry
- OCFCD Basins or Reservoirs

Ownership (If other than City or County): Private = P State = S Federal = F

EXISTING FACILITIES

O.C.F.C.D. LOCAL

- Earth Trapezoidal Channel (base width by height in feet)
- Reinforced Concrete Trapezoidal Channel (base width by height in feet)
- Reinforced Concrete Rectangular Channel (base width by height in feet)
- Reinforced Concrete Box (RCB) (number of barrels–span by height in feet)
- Reinforced Concrete Pipe (RCP) (diameter in inches)
- Metal Sheet Channel (MSC) (Base width by pile height in feet/Sheet pile total length)
- Corrugated Metal Pipe (CMP) (diameter in inches)
- Concrete Pipe (diameter in inches)
- Concrete Oval Pipe (width by height in inches)
- Steel Pipe (diameter in inches)
- Reinforced Concrete Arch (base span by height in inches)
- Corrugated Metal Arch (base span by height in inches)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N 2244945.443
E 6036406.959
N 2244945.434
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18
20
19
19
CYPRESS
LOS ALAMITOS
ANAHEIM
BUENA PARK
STANTON
GARDEN GROVE
CITY OF CYPRESS
CITY OF LOS ALAMITOS
CITY OF GARDEN GROVE
CITY OF STANTON
COUNTY OF ORANGE
C02P04
C02P03
C02P08
C02S03
C02S01
C02P01
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C03
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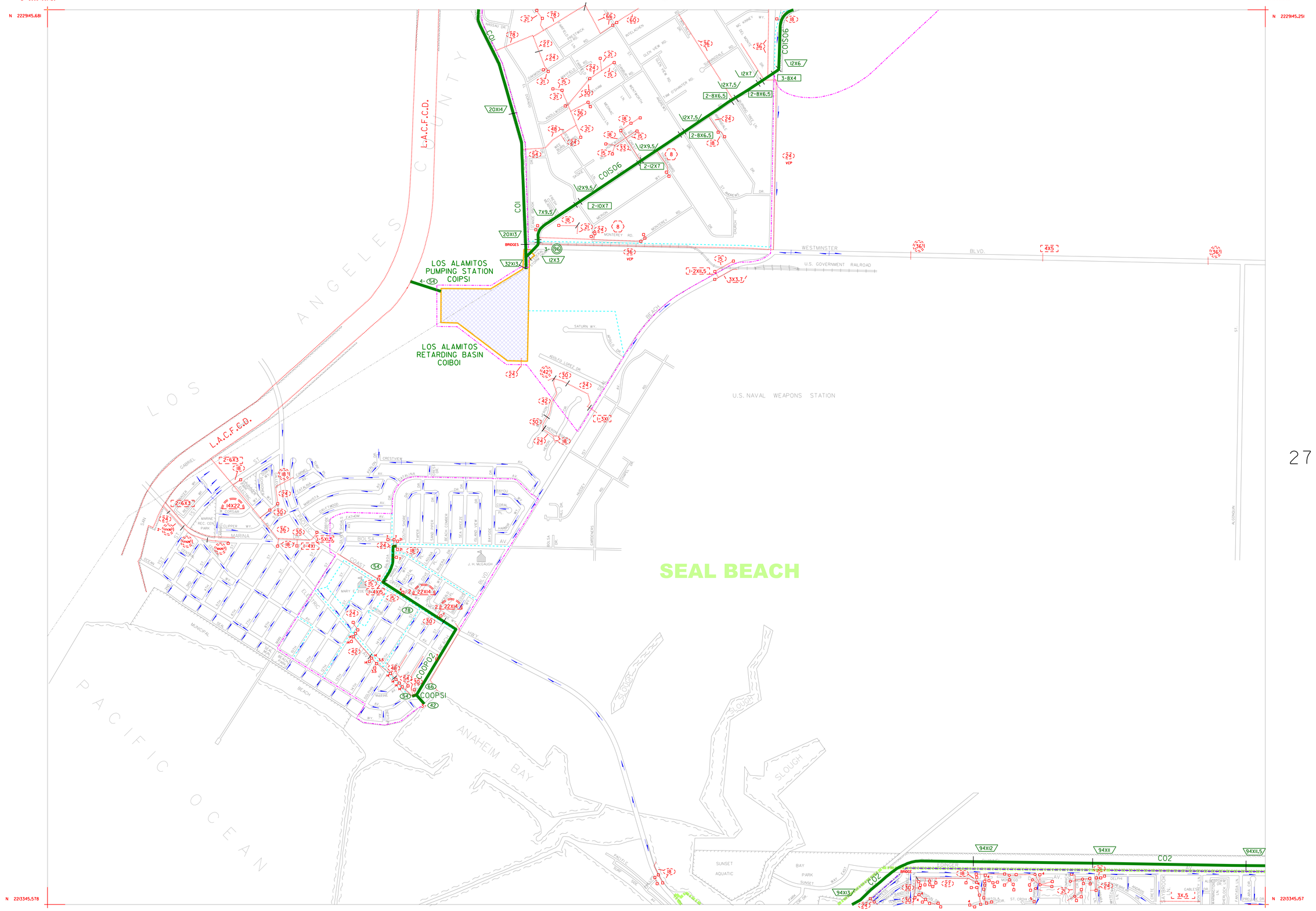
C03P04
C03P06
C03S04
C03P05
C03P01
C03P17
C04
E 6014906.805
N 2229145.251
E 6036407.116
N 2229144.956
NOTICE
The drainage information has been prepared for information purposes only. The location, ownership, facility information and limits have been determined from available information provided by public agencies, but may not be exact, accurate, or up-to-date. The user of this information is responsible for verifying exact location, ownership, accuracy, and the regional versus local character of drainage facilities.
Additional information may be obtained from public plans and recorded deeds. Facility designations included with this information are for convenience only and are not controlling or intended to imply ownership by the County or the Orange County Flood Control District (OCFCD). The information is being provided as a courtesy and neither the County of Orange nor OCFCD assume any liabilities for inaccuracy of the information.
To notify OC Public Works Flood Control Section of additions or corrections, please contact Sal Gutierrez at (714) 647-3992 or by email at sal.gutierrez@ocpw.ocgov.com
N
0 200 400 600 800
FEET
27
ORANGE COUNTY FLOOD CONTROL DISTRICT
BASE MAP
OF DRAINAGE FACILITIES
IN ORANGE COUNTY
REVISION
S. GUTIERREZ
DATE
JAN 23,2012
SHEET NO.
19
DWG. NO.
MAPS-113-3
Channel Drainage Area Boundary
Major Sub-Area Drainage Boundary
Minor Sub-Area Drainage Boundary
Existing O.C.F.C.D. Facility
Existing Local Facility
Existing Retarding Basin or Reservoir
Natural Watercourse
City Limits
Greenbelt
Pump Station
Catch Basin (length in feet)
Drop Inlet or Other Entry
OCFCD Basins or Reservoirs
Ownership (If other than City or County): Private = P State = S Federal = F
EXISTING FACILITIES
O.C.F.C.D.
LOCAL
Earth Trapezoidal Channel (base width by height in feet)
Reinforced Concrete Trapezoidal Channel (base width by height in feet)
Reinforced Concrete Rectangular Channel (base width by height in feet)
Reinforced Concrete Box (RCB) (number of barrels-span by height in feet)
Reinforced Concrete Pipe (RCP) (diameter in inches)
Metal Sheet Channel (MSC) (Base width by pile height in feet.Sheet pile total length)
Corrugated Metal Pipe (CMP) (diameter in inches)
Concrete Pipe (diameter in inches)
Concrete Oval Pipe (width by height in inches)
Steel Pipe (diameter in inches)
Reinforced Concrete Arch (base span by height in inches)
Corrugated Metal Arch (base span by height in inches)

E 5993406.420
N 2229145.681

E 6014906.805
N 2229145.251



N

0 200 400 600 800
FEET

NOTICE

The drainage information has been prepared for information purposes only. The location, ownership, facility information and limits have been determined from available information provided by public agencies, but may not be exact, accurate, or up-to-date. The user of this information is responsible for verifying exact location, ownership, accuracy, and the regional versus local character of drainage facilities.

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To notify the Resources & Development Management Department (RDMD) of additions or corrections, please contact Sal Gutierrez at (714) 834-5396 or by email at sal.gutierrez@rdmd.ocgov.com

ORANGE COUNTY FLOOD CONTROL DISTRICT

BASE MAP OF DRAINAGE FACILITIES IN ORANGE COUNTY

REVISION	DATE	SHEET NO.	DWG. NO.
S. GUTIERREZ	MAR. 7, 2007	26	MAPS-113-3

- Channel Drainage Area Boundary
- Major Sub-Area Drainage Boundary
- Minor Sub-Area Drainage Boundary
- Existing O.C.F.C.D. Facility
- Existing Local Facility
- Existing Retarding Basin or Reservoir
- Natural Watercourse
- City Limits
- G G Greenbelt
- P.S. P.S. Pump Station
- Catch Basin (length in feet)
- Drop Inlet or Other Entry
- OCFCD Basins or Reservoirs

Ownership (If other than City or County): Private = P State = S Federal = F

EXISTING FACILITIES

O.C.F.C.D.	LOCAL	
		Earth Trapezoidal Channel (base width by height in feet)
		Reinforced Concrete Trapezoidal Channel (base width by height in feet)
		Reinforced Concrete Rectangular Channel (base width by height in feet)
		Reinforced Concrete Box (RCB) (number of barrels-span by height in feet)
		Reinforced Concrete Pipe (RCP) (diameter in inches)
		Metal Sheet Channel (MSC) (Base width by pile height in feet /Sheet pile total length)
		Corrugated Metal Pipe (CMP) (diameter in inches)
		Concrete Pipe (diameter in inches)
		Concrete Oval Pipe (width by height in inches)
		Steel Pipe (diameter in inches)
		Reinforced Concrete Arch (base span by height in inches)
		Corrugated Metal Arch (base span by height in inches)

26

Attachment E

Operations and Maintenance Plan

(to be completed during final engineering)

Bio Clean

A Forterra Company

Bio Clean ARS

A Stormwater Trash Capture Solution

OPERATION & MAINTENANCE MANUAL

5796 Armada Drive Suite 250 | Carlsbad, CA 92008 | 855.566.3938

stormwater@forterrabp.com | biocleanenvironmental.com

MAINTENANCE

The Bio Clean ARS requires minimal preventative maintenance. Regular street sweeping will prevent debris from building up in front of the unit thereby obstructing storm water from entering the catch basin curb opening. The Bio Clean ARS is specially designed with flow control blades that will open during larger rain events to prevent flooding regardless of trash build up in front of the unit.

Pressure-washing the unit may be necessary if street sweeping is unavailable.

Yearly Maintenance Schedule:

Inspections consist of visually inspecting the unit from street level and performing an opening-closing function check.

Visual Inspection:

1. Built-up debris and foreign object debris can hinder the unit's operation. Remove any visible debris that may be on, in front of, and nearby the unit.

2. Look for any visible signs of vandalism or damage that may compromise the unit's ability to properly function. Attempted vandalism and slight damage should be inspected closely to ensure no future damage may result.

Opening-Closing Function Check:

1. Manually push on the blades at the bottom from the front of the catch basin. Perform this at the center and at each end of the device Please ensure all appropriate traffic control has been set up and all appropriate safety procedures are followed based on local and state regulations, if required.

2. Observe if the tension is appropriate on the blades and that the return to the close position. Note if any or all of the blades to not return to the close position.

3. Observe if the blades which are interconnecting work together. The blade being pushed on should open the most and the adjacent blades should open slight less in an outward pattern as shown below. Please note if any blades are moving or not moving outside of this pattern.

5. Check to see if the tensioner and cable/spring is properly connected behind each blade. Note any issues related to the cable/spring not being connected.

Blades Maintenance/Adjustment/Replacement:

1. Verify which Blade is damaged and plan which faceplate is easiest and most efficient to remove.
2. Remove Faceplate from brackets and remove tension spring from back of unit.
3. Slide each blade off until damaged blade has been reached. Replace damaged blade or blades.
4. Feed tensioner spring through all the back clips and attach faceplate to top bar.
5. Secure tensioner spring on back of unit and secure faceplate to mounted bracket

LA-ARS Locking Screen: Torsion Spring and Adjustment Knob System Maintenance

1. Verify unit does not have damage blades and working properly
2. Check the status of the locking system making sure the system can tighten by first releasing the unit by pressing on the releases on each side of the unit. If unit releases, proceed to next step
3. Check the status of the tension knob by clicking it tighter to make sure the unit tightens with each click of the tightening knob. If unit tightens, maintenance is complete.
4. If unit does not tighten or release, remove faceplates from bracket and remove torsion spring system. Both Torsion Spring and Adjustment knob units will need to be replaced.
5. Screw new torsion spring and adjustment knob system into place and place metal wire into plastic holding system on back of each blade.
6. Test unit by tightening and releasing the locking system. If unit is working properly, reinstall unit.

Replacement Schedule:

All components on the on the Bio Clean ARS are made from 304 or 316 stainless steel parts with the exception of the flow control blades which are made of structural polymer. Replacement of individual blades is quick and easy. If during maintenance inspection it is observed the unit is damaged or vandalized to the point at which the opening-closing function is not operating correctly, the unit should be repaired. Bio Clean Environmental should be notified if a replacement parts or repair work is needed.

For Maintenance Services
Please Contact Us At:
760-433-7640
stormwater@forterrabpm.com

BioMediaGREEN

Modular Wetland System (MWS) – LINEAR

Maintenance Cost (per acre)

MWS - LINEAR	Cleaning Required	Yearly Maintenance Cost
Year 1	1) Clean Inlet Filter (6 Month Intervals) 2) Vacuum Catch Basin (12 Month Intervals) 3) Replace BioMedia Green Filter Media	$80 / each (x2) $350 / year $500 / year
Year 2	1) Clean Inlet Filter (6 Month Intervals) 2) Vacuum Catch Basin (12 Month Intervals) 3) Replace BioMedia Green Filter Media	$80 / each (x2) $350 / year $500 / year
Year 3	1) Clean Inlet Filter (6 Month Intervals) 2) Vacuum Catch Basin (12 Month Intervals) 3) Replace BioMedia Green Filter Media	$80 / each (x2) $350 / year $500 / year
Year 4	1) Clean Inlet Filter (6 Month Intervals) 2) Vacuum Catch Basin (12 Month Intervals) 3) Replace BioMedia Green Filter Media	$80 / each (x2) $350 / year $500 / year
Year 5	1) Clean Inlet Filter (6 Month Intervals) 2) Vacuum Catch Basin (12 Month Intervals) 3) Replace BioMedia Green Filter Media	$80 / each (x2) $350 / year $500 / year
Year 6	1) Clean Inlet Filter (6 Month Intervals) 2) Vacuum Catch Basin (12 Month Intervals) 3) Replace BioMedia Green Filter Media	$80 / each (x2) $350 / year $500 / year
Year 7	1) Clean Inlet Filter (6 Month Intervals) 2) Vacuum Catch Basin (12 Month Intervals) 3) Replace BioMedia Green Filter Media	$80 / each (x2) $350 / year $500 / year
Year 8	1) Clean Inlet Filter (6 Month Intervals) 2) Vacuum Catch Basin (12 Month Intervals) 3) Replace BioMedia Green Filter Media	$80 / each (x2) $350 / year $500 / year
Year 9	1) Clean Inlet Filter (6 Month Intervals) 2) Vacuum Catch Basin (12 Month Intervals) 3) Replace BioMedia Green Filter Media	$80 / each (x2) $350 / year $500 / year
Year 10	1) Clean Inlet Filter (6 Month Intervals) 2) Vacuum Catch Basin (12 Month Intervals) 3) Replace BioMedia Green Filter Media 4) Remove & Replace Wetland Plants & Media	$80 / each (x2) $350/ year $500 / year $2,500
Total 1 - 10	**Total Maintenance Cost Over 10 Years**	**$11,800**
Average Yearly Cost	**Assumes 10 Year Replacement of Wetland Media.**	**$1,180 / Year**

WWW.MODULARWETLANDS.COM

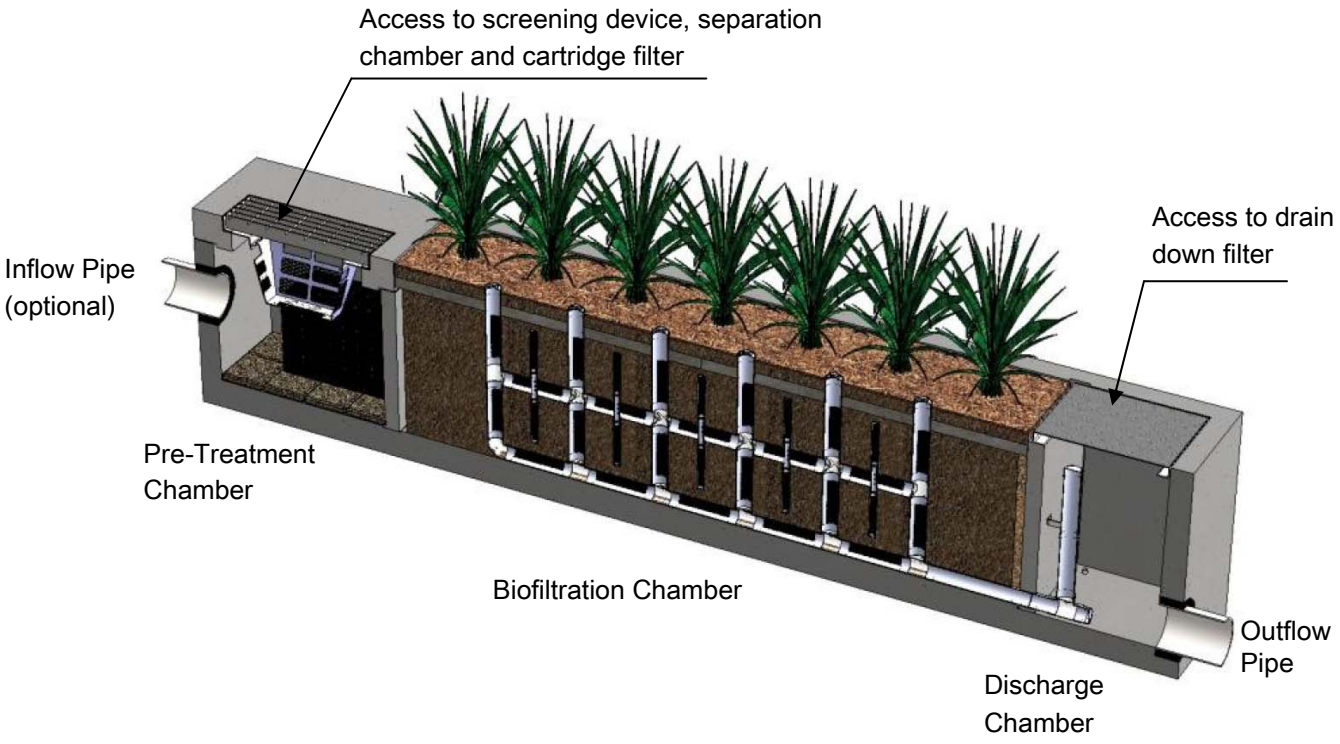
P: 760-433-7640

Maintenance Guidelines for Modular Wetland System - Linear

Maintenance Summary

- Remove Trash from Screening Device – average maintenance interval is 6 to 12 months.
  - (*5 minute average service time*).
- Remove Sediment from Separation Chamber – average maintenance interval is 12 to 24 months.
  - (*10 minute average service time*).
- Replace Cartridge Filter Media – average maintenance interval 12 to 24 months.
  - (*10-15 minute per cartridge average service time*).
- Replace Drain Down Filter Media – average maintenance interval is 12 to 24 months.
  - (*5 minute average service time*).
- Trim Vegetation – average maintenance interval is 6 to 12 months.
  - (*Service time varies*).

System Diagram



Maintenance Procedures

Screening Device

1. Remove grate or manhole cover to gain access to the screening device in the Pre-Treatment Chamber. Vault type units do not have screening device. Maintenance can be performed without entry.
2. Remove all pollutants collected by the screening device. Removal can be done manually or with the use of a vacuum truck. The hose of the vacuum truck will not damage the screening device.
3. Screening device can easily be removed from the Pre-Treatment Chamber to gain access to separation chamber and media filters below. Replace grate or manhole cover when completed.

Separation Chamber

1. Perform maintenance procedures of screening device listed above before maintaining the separation chamber.
2. With a pressure washer spray down pollutants accumulated on walls and cartridge filters.
3. Vacuum out Separation Chamber and remove all accumulated pollutants. Replace screening device, grate or manhole cover when completed.

Cartridge Filters

1. Perform maintenance procedures on screening device and separation chamber before maintaining cartridge filters.
2. Enter separation chamber.
3. Unscrew the two bolts holding the lid on each cartridge filter and remove lid.
4. Remove each of 4 to 8 media cages holding the media in place.
5. Spray down the cartridge filter to remove any accumulated pollutants.
6. Vacuum out old media and accumulated pollutants.
7. Reinstall media cages and fill with new media from manufacturer or outside supplier. Manufacturer will provide specification of media and sources to purchase.
8. Replace the lid and tighten down bolts. Replace screening device, grate or manhole cover when completed.

Drain Down Filter

1. Remove hatch or manhole cover over discharge chamber and enter chamber.
2. Unlock and lift drain down filter housing and remove old media block. Replace with new media block. Lower drain down filter housing and lock into place.
3. Exit chamber and replace hatch or manhole cover.

Maintenance Notes

1. Following maintenance and/or inspection, it is recommended the maintenance operator prepare a maintenance/inspection record. The record should include any maintenance activities performed, amount and description of debris collected, and condition of the system and its various filter mechanisms.

2. The owner should keep maintenance/inspection record(s) for a minimum of five years from the date of maintenance. These records should be made available to the governing municipality for inspection upon request at any time.

3. Transport all debris, trash, organics and sediments to approved facility for disposal in accordance with local and state requirements.

4. Entry into chambers may require confined space training based on state and local regulations.

5. No fertilizer shall be used in the Biofiltration Chamber.

6. Irrigation should be provided as recommended by manufacturer and/or landscape architect. Amount of irrigation required is dependent on plant species. Some plants may require irrigation.

Maintenance Procedure Illustration

Screening Device

The screening device is located directly under the manhole or grate over the Pre-Treatment Chamber. It's mounted directly underneath for easy access and cleaning. Device can be cleaned by hand or with a vacuum truck.

Separation Chamber

The separation chamber is located directly beneath the screening device. It can be quickly cleaned using a vacuum truck or by hand. A pressure washer is useful to assist in the cleaning process.

Cartridge Filters

The cartridge filters are located in the Pre-Treatment chamber connected to the wall adjacent to the biofiltration chamber. The cartridges have removable tops to access the individual media filters. Once the cartridge is open media can be easily removed and replaced by hand or a vacuum truck.

Drain Down Filter

The drain down filter is located in the Discharge Chamber. The drain filter unlocks from the wall mount and hinges up. Remove filter block and replace with new block.

Trim Vegetation

Vegetation should be maintained in the same manner as surrounding vegetation and trimmed as needed. No fertilizer shall be used on the plants. Irrigation per the recommendation of the manufacturer and or landscape architect. Different types of vegetation requires different amounts of irrigation.

Inspection Form

Modular Wetland System, Inc.
P. 760.433-7640
F. 760-433-3176
E. Info@modularwetlands.com

www.modularwetlands.com

Inspection Report
Modular Wetlands System

Project Name _____

Project Address _____
(city) (Zip Code)

Owner / Management Company _____

Contact _____ Phone ( ) –

Inspector Name _____ Date ____/____/____ Time _____ AM / PM

For Office Use Only
(Reviewed By)
(Date)
Office personnel to complete section to the left.

Type of Inspection ☐ Routine ☐ Follow Up ☐ Complaint ☐ Storm Storm Event in Last 72-hours? ☐ No ☐ Yes

Weather Condition _____ Additional Notes _____

Inspection Checklist

Modular Wetland System Type (Curb, Grate or UG Vault): _____ Size (22', 14' or etc.): _____

Structural Integrity:	**Yes**	**No**	**Comments**
Damage to pre-treatment access cover (manhole cover/grate) or cannot be opened using normal lifting pressure?			
Damage to discharge chamber access cover (manhole cover/grate) or cannot be opened using normal lifting pressure?			
Does the MWS unit show signs of structural deterioration (cracks in the wall, damage to frame)?			
Is the inlet/outlet pipe or drain down pipe damaged or otherwise not functioning properly?			
Working Condition:			
Is there evidence of illicit discharge or excessive oil, grease, or other automobile fluids entering and clogging the unit?			
Is there standing water in inappropriate areas after a dry period?			
Is the filter insert (if applicable) at capacity and/or is there an accumulation of debris/trash on the shelf system?			
Does the depth of sediment/trash/debris suggest a blockage of the inflow pipe, bypass or cartridge filter? If yes, specify which one in the comments section. Note depth of accumulation in in pre-treatment chamber.			Depth:
Does the cartridge filter media need replacement in pre-treatment chamber and/or discharge chamber?			Chamber:
Any signs of improper functioning in the discharge chamber? Note issues in comments section.			
Other Inspection Items:			
Is there an accumulation of sediment/trash/debris in the wetland media (if applicable)?			
Is it evident that the plants are alive and healthy (if applicable)? Please note Plant Information below.			
Is there a septic or foul odor coming from inside the system?			

Waste:	**Yes**	**No**
Sediment / Silt / Clay		
Trash / Bags / Bottles		
Green Waste / Leaves / Foliage		

Recommended Maintenance	
No Cleaning Needed	
Schedule Maintenance as Planned	
Needs Immediate Maintenance	

Plant Information	
Damage to Plants	
Plant Replacement	
Plant Trimming	

Additional Notes:

2972 San Luis Rey Road, Oceanside, CA 92058 P (760) 433-7640 F (760) 433-3176

Maintenance Report

Modular Wetland System, Inc.
P. 760.433-7640
F. 760-433-3176
E. Info@modularwetlands.com

www.modularwetlands.com

Cleaning and Maintenance Report
Modular Wetlands System

Project Name _____

Project Address _____
(city) (Zip Code)

Owner / Management Company _____

Contact _____ Phone ( ) –

Inspector Name _____ Date ____/____/____ Time _____ AM / PM

Type of Inspection ☐ Routine ☐ Follow Up ☐ Complaint ☐ Storm Storm Event in Last 72-hours? ☐ No ☐ Yes

Weather Condition _____ Additional Notes _____

For Office Use Only
(Reviewed By)
(Date)
Office personnel to complete section to the left.

Site Map #	GPS Coordinates of Insert	Manufacturer / Description / Sizing	Trash Accumulation	Foliage Accumulation	Sediment Accumulation	Total Debris Accumulation	Condition of Media 25/50/75/100 (will be changed @ 75%)	Operational Per Manufactures' Specifications (If not, why?)
	Lat: Long:	MWS Catch Basins						
		MWS Sedimentation Basin						
		Media Filter Condition						
		Plant Condition						
		Drain Down Media Condition						
		Discharge Chamber Condition						
		Drain Down Pipe Condition						
		Inlet and Outlet Pipe Condition						

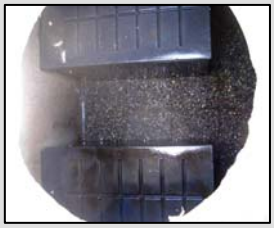
Comments:

2972 San Luis Rey Road, Oceanside, CA 92058 P. 760.433.7640 F. 760.433.3176

Modular Wetland System - Linear (MWS-Linear)

Maintenance Schedule

MWS - LINEAR	Cleaning Required	Est. Cleaning Time
Year 1	1) Clean Inlet Filter (6 Month Intervals) (does not apply to vault type) 2) Vacuum Catch Basin (12 Month Intervals) 3) Replace BioMedia Green Filter Media (12 month Intervals)	10 Minutes 25 Minutes 45 Minutes
Year 2	1) Clean Inlet Filter (6 Month Intervals) (does not apply to vault type) 2) Vacuum Catch Basin (12 Month Intervals) 3) Replace BioMedia Green Filter Media (12 month Intervals)	10 Minutes 25 Minutes 45 Minutes
Year 3	1) Clean Inlet Filter (6 Month Intervals) (does not apply to vault type) 2) Vacuum Catch Basin (12 Month Intervals) 3) Replace BioMedia Green Filter Media (12 month Intervals)	10 Minutes 25 Minutes 45 Minutes
Year 4	1) Clean Inlet Filter (6 Month Intervals) (does not apply to vault type) 2) Vacuum Catch Basin (12 Month Intervals) 3) Replace BioMedia Green Filter Media (12 month Intervals)	10 Minutes 25 Minutes 45 Minutes
Year 5	1) Clean Inlet Filter (6 Month Intervals) (does not apply to vault type) 2) Vacuum Catch Basin (12 Month Intervals) 3) Replace BioMedia Green Filter Media (12 month Intervals)	10 Minutes 25 Minutes 45 Minutes
Year 6	1) Clean Inlet Filter (6 Month Intervals) (does not apply to vault type) 2) Vacuum Catch Basin (12 Month Intervals) 3) Replace BioMedia Green Filter Media (12 month Intervals)	10 Minutes 25 Minutes 45 Minutes
Year 7	1) Clean Inlet Filter (6 Month Intervals) (does not apply to vault type) 2) Vacuum Catch Basin (12 Month Intervals) 3) Replace BioMedia Green Filter Media (12 month Intervals)	10 Minutes 25 Minutes 45 Minutes
Year 8	1) Clean Inlet Filter (6 Month Intervals) (does not apply to vault type) 2) Vacuum Catch Basin (12 Month Intervals) 3) Replace BioMedia Green Filter Media (12 month Intervals)	10 Minutes 25 Minutes 45 Minutes
Year 9…	1) Clean Inlet Filter (6 Month Intervals) (does not apply to vault type) 2) Vacuum Catch Basin (12 Month Intervals) 3) Replace BioMedia Green Filter Media (12 month Intervals)	10 Minutes 25 Minutes 45 Minutes
Year 15	1) Clean Inlet Filter (6 Month Intervals) (does not apply to vault type) 2) Vacuum Catch Basin (12 Month Intervals) 3) Replace BioMedia Green Filter Media (12 month Intervals) 4) Remove & Replace Wetland Plants & Media (every 10-20 years)	10 Minutes 25 Minutes 45 Minutes 6 to 8 Hours
Procedure 1 **Clean Inlet Filter** (does not apply to vault type) 	Modular Wetland Systems, Inc. recommends the catch basin filter be inspected and cleaned a minimum of once every six months and replacement of hydrocarbon booms once a year. The procedure is easily done with the use of any standard vacuum truck. Before doing maintenance please use proper safety and traffic control. 1) Remove grate or manhole, remove the deflector shield (grate type only). Note: entry into an underground stormwater vault such as an inlet vault requires certification in confined space training. 2) Remove all trash, debris, organics, and sediments collected by the inlet filter insert either manually or with the use of a vactor truck. 3) Evaluate hydrocarbon boom. If the boom is filled with hydrocarbons and oils it should be replaced. Attach new boom to basket with plastic ties through pre-drilled holes in basket. Place the deflector shield (grate type only) back into the filter. Hydrocarbon boom should be replaced annually. (The hydrocarbon boom may be classified as hazardous material and will have to be picked up and disposed of as hazardous waste).	**10 Minutes**

Procedure 2 **Vacuum Catch Basin** 	Modular Wetland Systems, Inc. recommends the separation chamber be inspected and cleaned a minimum of once a year. The procedure is easily done with the use of any standard vacuum truck. Before doing maintenance please use proper safety and traffic control. 1) Remove grate or manhole. 2) Remove catch basin filter. 3) Spray down pollutants accumulated on cartridge filters and catch basin walls. 4) Vacuum out sediments and debris accumulated on catch basin floor. 5) Replace catch basin filter, and replace grate or manhole cover.	**25 Minutes**
Procedure 3 **Replace BioMedia Green Media Filter**   	Modular Wetland Systems, Inc. recommends the BioMediaGREEN Cartridge Filters be inspected and cleaned a minimum of once a year. The procedure will require prior maintenance of catch basin. Before doing maintenance please use proper safety and traffic control. 1) Remove grate, remove catch basin filter. 2) Perform maintenance activities on catch basin. 3) Enter separation chamber, unscrew the two bolts holding the lid on the cartridge filter. This will expose the 14 pieces of BioMediaGREEN in each cartridge. 4) Evaluate media condition, replace if necessary. If the spaces between the media are filled with sediment and the surface of the media is dark brown or black the media should be replaced. The old media can be removed by hand by pulling the media pieces up out of the cartridge and taking them out of the catch basin. 5) Once all old media is removed, spray down the interior of the cartridge and vacuum out accumulated debris. 6) Use new pieces of BioMediaGREEN and slide down over the perforated PVC risers. The media will only go in one way for easy installation. Replace media over all risers. 5) Replace cartridge filter lid, replace catch basin filter, and replace grate or manhole cover. Modular Wetland Systems, Inc. recommends the drain down filter be inspected and maintained a minimum of once a year. 1) Open hatch of discharge chamber, enter chamber. 2) Unlatch fiberglass cover, remove media block, replace with new block, replace and latch cover. 3) Exit chamber, close and lock down the hatch. BioMediaGREEN	**45 Minutes**
Procedure 4 **Replace Wetland Media** 	Modular Wetland Systems, Inc. recommends the wetland media be evaluated every 3 to 5 years to test flow rate. The media life is approximately 15 to 20 years. The wetland media is an expanded shale that can be ordered from the manufacturer or independent supplier. If the flow through the wetland filter is decreasing the internal inflow and outflow pipes leading to and from the wetland chamber can be jetted. If the flow through the wetland is still minimal then the media may need to be replaced. To replace the media the following steps are required. Before doing maintenance please use proper safety and traffic control. 1) Remove plants and dispose. Have new plants standing ready to plant. 2) Use a larger vacuum truck to remove the media from the wetland chamber. 3) Spray down the chamber walls and remove all sediment and water. 4) Replace with new wetland media and plant plants.	**6 to 8 Hours**

Attachment F
Geotechnical Report

December 21, 2021 Project No. 21198-01

Mr. Matthew J. Waken
MW Investment Group, LLC
27702 Crown Valley Parkway, Suite D-4-197
Ladera Ranch, CA 92694

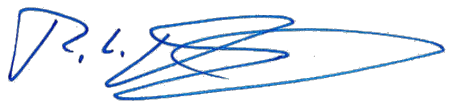
Subject: ***Preliminary Geotechnical Evaluation and Design Recommendations for Proposed Single-Family and Multi-Family Residential Development, 4665 Lampson Avenue, Los Alamitos, California***

In accordance with your request and authorization, LGC Geotechnical, Inc. has performed a preliminary geotechnical evaluation for the proposed single-family and multi-family residential development located at 4665 Lampson Avenue in the City of Los Alamitos, California. The purpose of our study was to evaluate the existing onsite geotechnical conditions and to provide preliminary geotechnical recommendations relative to the proposed residential development.

Should you have any questions regarding this report, please do not hesitate to contact our office. We appreciate this opportunity to be of service.

Respectfully Submitted,

LGC Geotechnical, Inc.



Ryan Douglas, PE, GE 3147
Project Engineer

RLD/BPP/amm

Distribution: (1) Addressee (electronic copy)

TABLE OF CONTENTS

Section ***Page***

LIST OF ILLUSTRATIONS, TABLES, AND APPENDICES

Figures

Tables

Appendices

1.0 INTRODUCTION

1.1 Purpose and Scope of Services

This report presents the results of our preliminary geotechnical evaluation for the proposed single-family and multi-family residential development located at 4665 Lampson Avenue in the City of Los Alamitos, California. Refer to the Site Location Map (Figure 1).

The purpose of our study was to provide a preliminary geotechnical evaluation relative to the proposed residential development. As part of our scope of work, we have: 1) reviewed available geotechnical background information including in-house regional geologic maps and published geotechnical literature pertinent to the site (Appendix A); 2) performed a limited subsurface geotechnical evaluation of the site consisting of the excavation of seven small-diameter borings ranging in depth from approximately 5 to 46.5 feet below existing ground surface; 3) performed two field infiltration tests; 4) performed laboratory testing of select soil samples obtained during our subsurface evaluation; and 5) prepared this preliminary geotechnical summary report presenting our findings, preliminary conclusions and recommendations for the development of the proposed residential project.

It should be noted that our evaluation and this report only address geotechnical issues associated with the site and do not address any environmental issues.

1.2 Project Description

Based on the preliminary site plan (KTGY, 2021), the proposed development includes the construction of 102 single-family residential lots and 90 affordable multi-family units. Proposed site improvements include a park and a series of internal streets. Design cuts and fills (not including required remedial grading) are anticipated to be on the order of 1 to 3 feet. The proposed building structures are anticipated to be relatively light-weight at-grade structures with maximum column and wall loads of approximately 30 kips and 2 kips per linear foot, respectively. Please note no grading plans or structural loads were provided to us at the time of this report.

The recommendations given in this report are based upon the estimated structural loading, grading and layout information above. We understand that the project plans are currently being developed at this time; LGC Geotechnical should be provided with updated project plans and any changes to structural loads when they become available, in order to either confirm or modify the recommendations provided herein. Additional field work and/or laboratory testing may be necessary.

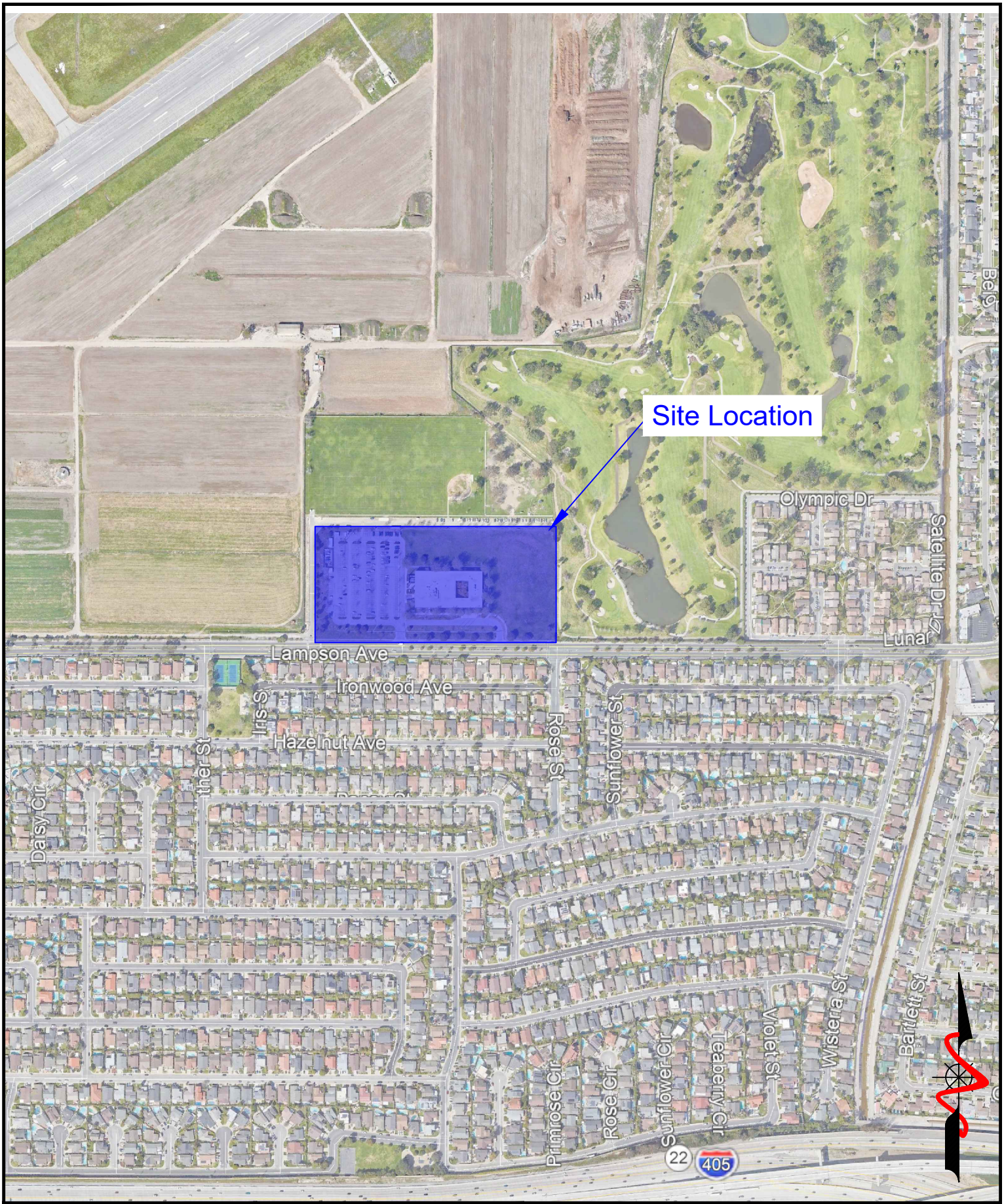
1.3 Existing Conditions

The site is approximately 12 acres and is bound to the south by Lampson Avenue, to the east by a golf course, to the north by a park and to the west by vacant land. The site is currently occupied by the California Department of Fish and Wildlife with an associated parking lot and open space.

The site has minor relief, with the highest being the northern side of the site and gently slopes gently from north to south.

1.4 Background

Review of historical aerials indicates that the building and associated improvements were constructed after 1963, but prior to 1972 and remained relatively unchanged since (Historic Aerials, 2021). Aerial photos from 1952 and 1963 indicate the site was previously raw land.



LGC Geotechnical, Inc.

FIGURE 1
Site Location Map

PROJECT NAME	MWIG - Los Alamitos
PROJECT NO.	21198-01
ENG. / GEOL.	RLD
SCALE	Not to Scale
DATE	December 2021

1.5 Subsurface Geotechnical Evaluation

LGC Geotechnical performed a subsurface geotechnical evaluation of the site consisting of the excavation of five hollow-stem auger borings and two hand-auger borings to evaluate onsite geotechnical conditions.

Five hollow-stem borings (HS-1 through HS-3, I-1, and I-2) were drilled to depths ranging from approximately 5 to 46.5 feet below existing grade. An LGC Geotechnical staff engineer observed the drilling operations, logged the borings, and collected soil samples for laboratory testing. The borings were excavated by Cal Pac Drilling, Inc. under subcontract to LGC Geotechnical using a truck-mounted drill rig equipped with 6 and 8-inch-diameter hollow-stem augers. Driven soil samples were collected by means of the Standard Penetration Test (SPT) and Modified California Drive (MCD) sampler generally obtained at 2.5 to 5-foot vertical increments. The MCD is a split-barrel sampler with a tapered cutting tip and lined with a series of 1-inch-tall brass rings. The SPT sampler (1.4-inch ID) and MCD sampler (2.4-inch ID, 3.0-inch OD) were driven using a 140-pound automatic hammer falling 30 inches to advance the sampler a total depth of 18 inches. The raw blow counts for each 6-inch increment of penetration were recorded on the boring logs. Bulk samples of the near-surface soils were also collected and logged at select borings for laboratory testing. At the completion of drilling, the borings were backfilled with the native soil cuttings and tamped. Some settlement of the backfill soils may occur over time.

Two hand auger borings (HA-1 and HA-2) were excavated to approximately 5 feet below the existing surface, sampled, logged, and backfilled. The approximate locations of our hand auger borings are presented on our Boring Location Map (Figure 2). The boring logs are presented in Appendix B.

Infiltration testing was performed within two of the borings (I-1 and I-2) to depths of approximately 5 feet below existing grade. An LGC Geotechnical geologist installed standpipes, backfilled the borings with crushed rock and pre-soaked the infiltration holes prior to testing. Infiltration testing was performed per the County of Orange testing guidelines. Standpipes were removed and the locations were subsequently backfilled with native soils at the completion of testing. Some settlement of the backfill soils may occur over time.

The approximate locations of our subsurface explorations are provided on the Boring Location Map (Figure 2). The boring logs are provided in Appendix B.

1.6 Laboratory Testing

Representative bulk and driven (relatively undisturbed) samples were obtained for laboratory testing during our field evaluation. Laboratory testing included in-situ moisture content and in-situ dry density, fines content, Atterberg Limits, expansion index, consolidation, direct shear, laboratory compaction and corrosion (sulfate, chloride, pH and minimum resistivity).

The following is a summary of the laboratory test results:

- Dry density of the samples collected ranged from approximately 87 pounds per cubic foot (pcf) to 111 pcf, with an average of 99 pcf. Field moisture contents ranged from approximately 9 to 35 percent, with an average of 25 percent.

- Two fines content tests were performed and indicated a fines content (passing No. 200 sieve) of approximately 15 and 16.5 percent. Based on the Unified Soils Classification System (USCS), the tested samples would be classified as "coarse-grained."
- Four Atterberg Limit (liquid limit and plastic limit) tests were performed. Results indicated a Plasticity Index (PI) value ranging from 12 to 24.
- Two consolidation tests were performed. The load versus deformation plots are provided in Appendix C.
- One remolded direct shear test was performed. The plot is provided in Appendix C.
- One laboratory compaction test of a near surface sample indicated a maximum dry density of 116.0 pcf with an optimum moisture content of 13.0 percent.
- Two Expansion potential tests were performed and indicated an expansion index value of 30 and 32, corresponding to "Low" expansion potential.
- Corrosion testing indicated soluble sulfate contents ranging from approximately 0.032 to 0.254 percent, a chloride content ranging from 140 to 600 parts per million (ppm), pH of 8.92, and a minimum resistivity of 210 ohm-centimeters.

A summary of the laboratory test results is presented in Appendix C. The moisture and dry density results are presented on the boring logs in Appendix B.

2.0 GEOTECHNICAL CONDITIONS

2.1 Geologic Conditions

The subject site is located within the Orange County coastal plain, more generally located on the broad southern margin of the Los Angeles Basin. The site is located more specifically within the Santa Ana River drainage basin, and it is underlain at depth by poorly consolidated alluvial sediments mapped as Quaternary Young Alluvial Fan deposits "Unit 2" (Qya_2) (USGS, 2016).

2.2 Site-Specific Geology

Based on the results of our subsurface investigation, the site is underlain by a thin veneer of topsoil and older artificial fill over young alluvial deposits of Holocene age, per regional geologic mapping (USGS, 2016). The materials are described on the boring logs presented in Appendix B.

The young alluvial sediments encountered during our subsurface exploration generally consist of interbedded layers of gray and brown, silty clay, clay, silty sand, and clayey sand. The materials were observed to be very moist to wet with depth, soft to very stiff and medium dense to dense.

2.3 Groundwater

Groundwater was encountered in three of our borings (HS-1 through HS-3) at depths of approximately 11 to 13 feet below existing grade. Additionally, historic high groundwater is estimated to be about 10 feet below existing grade (CDMG, 1998). The location and approximate depth of groundwater is summarized in Table 1 below.

TABLE 1

Groundwater Summary

Boring Number	Total Drilled Depth of Boring (ft)	Groundwater Depth Below Existing Grade (ft)
HS-1	21.5	13
HS-2	46.5	11.5
HS-3	21.5	11

Seasonal fluctuations of groundwater elevations should be expected over time. In general, groundwater levels fluctuate with the seasons and local zones of perched groundwater may be present due to local seepage caused by irrigation and/or recent precipitation. Local perched groundwater conditions or surface seepage may develop once site development is completed.

2.4 Field Infiltration Testing

Two field percolation tests were performed in locations and depths per the direction of the project civil engineer, the location is depicted on Figure 2 – Boring Location Map. Test well installation consisted of placing a 3-inch diameter perforated PVC pipe in the excavated 8-inch diameter borehole and backfilling the annulus with crushed rock including the placement of approximately 2 inches of crushed rock at the bottom of the borehole. The infiltration test wells were presoaked the day of installation and testing took place within 24 hours of presoaking. During the pre-test, the water level was observed to drop less than 6 inches in 25 minutes for two consecutive readings. Therefore, the test procedure for fine-grained soils or "slow test" was followed. Test well installation and the estimation of infiltration rates were accomplished in general accordance with the guidelines set forth by the County of Orange (2013). In general, three-dimensional flow out of the test well (*percolation*), as observed in the field, is mathematically reduced to one-dimensional flow out of the bottom of the test well (*infiltration*). Infiltration tests are performed using relatively clean water, free of particulates, silt, etc. The results of our recent field infiltration testing are presented in Appendix D and summarized below.

TABLE 2

Summary of Field Infiltration Testing

Infiltration Test Identification	Approx. Depth Below Existing Grade (ft)	Observed Infiltration Rate* (in./hr.)
I-1	5	0.03
I-2	5	0.04

*Observed Infiltration Rates Do Not Include Factor of Safety.

The tested infiltration rates provided in this report are considered a general representation of the infiltration rates at the location of the proposed infiltration boring. Please note, the testing of infiltration rates is highly dependent upon the materials encountered at the point of testing (i.e., location and depth of testing). Varying subsurface conditions may exist outside of the test location which could alter the calculated infiltration rate. Please refer to Section 4.7 for subsurface water infiltration recommendations.

2.5 Seismic Design Criteria

The site seismic characteristics were evaluated per the guidelines set forth in Chapter 16, Section 1613 of the 2019 California Building Code (CBC). Since the site contains soils that are susceptible to liquefaction (refer to below Section "Liquefaction and Dynamic Settlement"), ASCE 7-16 which has been adopted by the CBC requires that site soils be assigned Site Class "F" and a site-specific response spectrum be performed. However, in accordance with Section 20.3.1 of ASCE 7-16, if the fundamental periods of vibration of the planned structure are equal to or less than 0.5 second, a site-specific response spectrum is not required and ASCE 7-16/2019 CBC site class and seismic parameters may be used in lieu of a site-specific response

spectrum. It should be noted that the seismic parameters provided herein are not applicable for any structure having a fundamental period of vibration greater than 0.5 second. **Please note that the following seismic parameters are only applicable for code-based acceleration response spectra and are not applicable for where site-specific ground motion procedures are required by ASCE 7-16.** Representative site coordinates of latitude 33.7815 degrees north and longitude -118.0510 degrees west were utilized in our analyses. The maximum considered earthquake (MCE) spectral response accelerations (S_{MS} and S_{M1}) and adjusted design spectral response acceleration parameters (S_{DS} and S_{D1}) for Site Class D are provided in Table 3 below. The structural designer should contact the geotechnical consultant if structural conditions (e.g., number of stories, seismically isolated structures, etc.) require site-specific ground motions.

TABLE 3

Seismic Design Parameters

Selected Parameters from 2019 CBC, Section 1613 - Earthquake Loads	**Seismic Design Values**	**Notes/Exceptions**
Distance to applicable faults classifies the site as a "Near-Fault" site.		Section 11.4.1 of ASCE 7
Site Class	D*	Chapter 20 of ASCE 7
Ss (Risk-Targeted Spectral Acceleration for Short Periods)	1.467g	From SEAOC, 2021
S_1 (Risk-Targeted Spectral Accelerations for 1-Second Periods)	0.524g	From SEAOC, 2021
F_a (per Table 1613.2.3(1))	1.000	For Simplified Design Procedure of Section 12.14 of ASCE 7, F_a shall be taken as 1.4 (Section 12.14.8.1)
F_v (per Table 1613.2.3(2))	1.776	Value is only applicable per requirements/exceptions per Section 11.4.8 of ASCE 7
S_{MS} for Site Class D [Note: $S_{MS} = F_aS_S$]	1.467g	-
S_{M1} for Site Class D [Note: $S_{M1} = F_vS_1$]	0.931g	Value is only applicable per requirements/exceptions per Section 11.4.8 of ASCE 7
S_{DS} for Site Class D [Note: $S_{DS} = (^2/_3)S_{MS}$]	0.978g	-
S_{D1} for Site Class D [Note: $S_{D1} = (^2/_3)S_{M1}$]	0.620g	Value is only applicable per requirements/exceptions per Section 11.4.8 of ASCE 7
C_{RS} (Mapped Risk Coefficient at 0.2 sec)	0.908	ASCE 7 Chapter 22
C_{R1} (Mapped Risk Coefficient at 1 sec)	0.913	ASCE 7 Chapter 22
*Since site soils are Site Class D and S_1 is greater than or equal to 0.2, the seismic response coefficient Cs is determined by Eq. 12.8-2 for values of $T \leq 1.5T_s$ and taken equal to 1.5 times the value calculated in accordance with either Eq. 12.8-3 for $T_L \geq T > T_s$, or Eq. 12.8-4 for $T > T_L$. Refer to ASCE 7-16.		

Section 1803.5.12 of the 2019 CBC (per Section 11.8.3 of ASCE 7) states that the maximum considered earthquake geometric mean (MCE_G) Peak Ground Acceleration (PGA) should be used for liquefaction potential. The PGA_M for the site is equal to 0.696g (SEAOC, 2021).

A deaggregation of the PGA based on a 2,475-year average return period indicates that an earthquake magnitude of 6.8 at a distance of approximately 10.6 km from the site would contribute the most to this ground motion (USGS, 2014).

2.6 Faulting

Prompted by damaging earthquakes in Northern and Southern California, State legislation and policies concerning the classification and land-use criteria associated with faults have been developed. Their purpose was to prevent the construction of urban developments across the trace of active faults, resulting in the Alquist-Priolo Earthquake Fault Zoning Act. Earthquake Fault Zones have been delineated along the traces of active faults within California. Where developments for human occupation are proposed within these zones, the state requires detailed fault evaluations be performed so that engineering geologists can mitigate the hazards associated with active faulting by identifying the location of active faults and allowing for a setback from the zone of previous ground rupture.

The subject site is not located within a State of California Earthquake Fault Zone (Alquist-Priolo) and no faults were identified on the site during our site evaluation (CGS, 2018). The possibility of damage due to ground rupture is considered low since no active faults are known to cross the site. The closest known active faults to the subject site are the Newport-Inglewood, Puente Hills, Palos Verdes and Elsinore Fault Zones (USGS 2016).

Secondary effects of seismic shaking resulting from large earthquakes on the major faults in the Southern California region, which may affect the site, include ground lurching and shallow ground rupture, soil liquefaction, and dynamic settlement. These secondary effects of seismic shaking are a possibility throughout the Southern California region and are dependent on the distance between the site and causative fault and the onsite geology. A discussion of these secondary effects is provided in the following sections.

2.6.1 Liquefaction and Dynamic Settlement

Liquefaction is a seismic phenomenon in which loose, saturated, granular soils behave similarly to a fluid when subject to high-intensity ground shaking. Liquefaction occurs when three general conditions coexist: 1) shallow groundwater; 2) low density non-cohesive (granular) soils; and 3) high-intensity ground motion. Studies indicate that saturated, loose near-surface cohesionless soils exhibit the highest liquefaction potential, while dry, dense, cohesionless soils and cohesive soils exhibit low to negligible liquefaction potential. In general, cohesive soils are not considered susceptible to liquefaction, depending on their plasticity and moisture content (Bray & Sancio, 2006). Effects of liquefaction on level ground include settlement, sand boils, and bearing capacity failures below structures. Dynamic settlement of dry loose sands can occur as the sand particles tend to settle and densify as a result of a seismic event.

Based on our review of the State of California Seismic Hazard Zone for liquefaction potential (CDMG, 1999), the site is located within a liquefaction hazard zone. Subsurface field data indicates that the site contains isolated sandy layers susceptible to liquefaction interfingered with fine-grained non-liquefiable soils and dense sands. The recent explored groundwater elevation of 11 feet below existing grade and historic high groundwater elevation of 10 feet below existing grade were both used in the liquefaction analysis. Liquefaction potential was evaluated using the procedures outlined by Special Publication 117A (SCEC, 1999 & CGS, 2008) and the applicable seismic criteria (e.g., 2019 CBC). Liquefaction induced settlement was estimated using the PGA_M per the 2019 CBC and a moment magnitude of 6.80 (USGS, 2014).

Results indicate total seismic settlement on the order of 2 inches. Differential seismic settlement can be estimated as half of the total estimated seismic settlement over a horizontal span of about 40 feet. This can be mitigated using a post-tensioned slab and interconnecting isolated pad footings with grade beams.

2.6.2 Liquefaction Surface Effects

Liquefaction induced surface effects, such as sand boils, can occur when shallow liquefiable soil layers trigger during a seismic event and are not contained deep enough below a non-liquefiable cap (i.e., non-liquefiable soils such as artificial fill or fine-grained soil). Based on analysis of the subsurface data, surface effects due to liquefaction are not anticipated to significantly affect the proposed surface improvements.

2.6.3 Lateral Spreading

Lateral spreading is a type of liquefaction-induced ground failure associated with the lateral displacement of surficial blocks of sediment resulting from liquefaction in a subsurface layer. Once liquefaction transforms the subsurface layer into a fluid mass, gravity plus the earthquake inertial forces may cause the mass to move downslope towards a free face (such as a river channel or an embankment). Lateral spreading may cause large horizontal displacements and such movement typically damages pipelines, utilities, bridges, and structures.

Due to the lack of a nearby "free face" condition and non-continuous nature of the subsurface layers, the potential for lateral spreading is considered very low.

2.7 Static Settlement

Although no grading plans were available during the preparation of this report, the subject site is sensitive to static settlement and grade changes. Static settlement would be induced by raising the planned grades and subjecting the new grades to building loads. Moderate increases in grades up to approximately 2 to 3 feet are estimated at this time.

The underlying soils were found to be generally stiff to very stiff silts and clays. Based on laboratory test data consisting of in-situ moisture content, consolidation tests, and blow counts,

fine-grained soils are considered generally normally consolidated. Based upon in-situ testing, visual examination, lab data, geotechnical evaluation and the proposed corrective grading and fill placement recommendations, static settlement induced by raising grades 1 to 3 feet is estimated to be on the order of 1-inch. LGC Geotechnical should be provided with the grading plans to for review to confirm or modify the recommendations for static settlement.

2.8 Expansion Potential

Based on the results of our laboratory testing, site soils are anticipated to have a "Low" expansion potential. Final expansion potential of site soils should be determined at the completion of grading. Results of expansion testing at finish grades will be utilized to confirm final foundation design.

3.0 CONCLUSIONS

Based on the results of our geotechnical evaluation, it is our opinion that the proposed development is feasible from a geotechnical standpoint, provided the following conclusions and recommendations are implemented.

The following is a summary of the primary geotechnical factors that may affect future development of the site:

- In general, our borings indicate the site is underlain by young alluvial fan deposits to the maximum explored depth of approximately 46.5 feet below existing grade. The material consists of clay, clayey sand, silty clay, and silty sand. The material was observed to be very moist to wet with depth and soft to stiff and medium dense to dense.
- Groundwater was encountered during our subsurface evaluation at depths of approximately 11 to 13 feet below existing grade. Historic high groundwater is estimated to be about 10 feet below existing grade (CDMG, 1998).
- The subject site is not located within a State of California Earthquake Fault Zone (Alquist-Priolo). The main seismic hazard that may affect the site is ground shaking from one of the active regional faults. The subject site will likely experience strong seismic ground shaking during its design life.
- Site soils are considered susceptible to liquefaction. The site is located in a State of California Seismic Hazard Zone for liquefaction (CDMG, 1999). Total seismic settlement is estimated to be on the order of 2.0 inches. Differential seismic settlement can be estimated at half of the total seismic settlement over a horizontal span of 40 feet for design of foundations.
- Based on the results of preliminary laboratory testing, site soils are anticipated to have "Low" expansion potential. Mitigation measures are required for foundations and site improvements like concrete flatwork to minimize the impacts of expansive site soils. Final design expansion potential must be determined at the completion of grading.
- Pre-soaking of the subgrade for building slabs will be required due to site expansive soils. The duration of this process varies greatly based on the chosen method and is also dependent on factors such as soil type and weather conditions. Time duration for presoaking from completion of rough grading to trenching of foundations should be accounted for in the construction schedule (typically 1 to 2 weeks).
- From a geotechnical perspective, the existing onsite soils are suitable material for use as general fill (not retaining wall backfill), provided that they are relatively free from rocks (larger than 8 inches in maximum dimension), construction debris, and significant organic material.
- The site contains soils that are not suitable for retaining wall backfill due to their fines content and expansion potential, therefore import of sandy soils will be required by the contractor for obtaining suitable backfill soil for planned site retaining walls.
- Excavations into the existing site soils should be feasible with heavy construction equipment in good working order.
- Due to the relatively shallow site groundwater (about 11 feet below existing ground surface) and soils above the groundwater table with high moisture contents, dewatering or stabilization of subgrade for removal bottoms or deep utility trenches may be locally required, prior to subsequent fill placement.

4.0 PRELIMINARY RECOMMENDATIONS

The following recommendations are to be considered preliminary and should be confirmed upon completion of grading and earthwork operations. In addition, they should be considered minimal from a geotechnical viewpoint, as there may be more restrictive requirements from the architect, structural engineer, building codes, governing agencies, or the owner.

It should be noted that the following geotechnical recommendations are intended to provide sufficient information to develop the site in general accordance with the 2019 CBC requirements. With regard to the potential occurrence of potentially catastrophic geotechnical hazards such as fault rupture, earthquake-induced landslides, liquefaction, etc. the following geotechnical recommendations should provide adequate protection for the proposed development to the extent required to reduce seismic risk to an "acceptable level." The "acceptable level" of risk is defined by the California Code of Regulations as "that level that provides reasonable protection of the public safety, though it does not necessarily ensure continued structural integrity and functionality of the project" [Section 3721(a)]. Therefore, repair and remedial work of the proposed improvements may be required after a significant seismic event. With regards to the potential for less significant geologic hazards to the proposed development, the recommendations contained herein are intended as a reasonable protection against the potential damaging effects of geotechnical phenomena such as expansive soils, fill settlement, groundwater seepage, etc. It should be understood, however, that although our recommendations are intended to maintain the structural integrity of the proposed development and structures given the site geotechnical conditions, they cannot preclude the potential for some cosmetic distress or nuisance issues to develop as a result of the site geotechnical conditions.

The geotechnical recommendations contained herein must be confirmed to be suitable or modified based on the actual as-graded conditions.

4.1 Site Earthwork

We anticipate that earthwork at the site will consist of demolition of the existing site improvements, required earthwork removals, subgrade preparation, precise grading and construction of the proposed new improvements, including the residential structures, neighborhood amenities, subsurface utilities, interior streets, etc.

We recommend that earthwork onsite be performed in accordance with the following recommendations, future grading plan review report(s), the 2019 CBC/City of Los Alamitos grading requirements, and the General Earthwork and Grading Specifications included in Appendix E. In case of conflict, the following recommendations shall supersede those included in Appendix E. The following recommendations should be considered preliminary and may be revised based upon future evaluation and review of the project plans and/or based on the actual conditions encountered during site grading/construction.

4.1.1 Site Preparation

Prior to grading of areas to receive structural fill or engineered improvements, the areas should be cleared of existing building structures, asphalt, surface obstructions, and

demolition debris. Vegetation and debris should be removed and properly disposed of off-site. Holes resulting from the removal of buried obstructions, which extend below proposed finish grades, should be replaced with suitable compacted fill material. Any abandoned sewer or storm drain lines should be completely removed and replaced with properly placed compacted fill. Deeper demolition may be required in order to remove existing foundations. We recommend the trenches associated with demolition which extend below the remedial grading depth of 5 feet be backfilled and properly compacted prior to the demolition contractor leaving the site.

If cesspools or septic systems are encountered, they should be removed in their entirety. The resulting excavation should be backfilled with properly compacted fill soils. As an alternative, cesspools can be backfilled with lean sand-cement slurry. Any encountered wells should be properly abandoned in accordance with regulatory requirements. At the conclusion of the clearing operations, a representative of LGC Geotechnical should observe and accept the site prior to further grading.

4.1.2 Removal and Recompaction Depths and Limits

In order to provide a relatively uniform bearing condition for the planned residential building pads and improvements, we recommend the site soils be removed and recompacted according to the criteria outlined below.

Building Pads: We recommend that soils within building pads be removed and recompacted to a minimum depth of 5 feet below existing grade or 3 feet below the base of the foundations, whichever is deeper. Where space is available, the envelope for removal and recompaction should extend laterally a minimum distance equal to the depth of removal and recompaction below finish grade or 5 feet beyond the edges of the proposed building improvements, whichever is larger.

Minor Site Structures: For minor site structures such as free-standing walls, retaining walls, etc., removal and recompaction should extend at least 3 feet below existing grade or 2 feet below the base of foundations, whichever is deeper. Where space is available, the envelope for removal and recompaction should extend laterally a minimum distance of 3 feet beyond the edges of the proposed minor site structure improvements.

Pavement and Hardscape: Within pavement and hardscape areas, removal and recompaction should extend to a depth of at least 2 feet below the existing grade or 1-foot below finished subgrade (i.e., below planned aggregate base/asphalt concrete), whichever is deeper. In general, the envelope for removal and recompaction should extend laterally a minimum distance of 2 feet beyond the edges of the proposed pavement and hardscape improvements.

Based on our findings, the recommended removal and recompaction depths may extend to a depth in the proximity of the anticipated groundwater table and through clayey soils with high moisture contents. Care should be taken in order to avoid creating an unstable removal bottom during grading. Recommendations for subgrade stabilization are included in Section 4.1.4.

Local conditions may be encountered during excavation that could require additional over-excavation beyond the above noted minimum in order to obtain an acceptable subgrade. The actual depths and lateral extents of grading will be determined by the geotechnical consultant, based on subsurface conditions encountered during grading. Removal areas and areas to be over-excavated should be accurately staked in the field by the Project Surveyor.

4.1.3 Temporary Excavations

Temporary excavations should be performed in accordance with project plans, specifications, and all Occupational Safety and Health Administration (OSHA) requirements. Excavations should be laid back or shored in accordance with OSHA requirements before personnel or equipment are allowed to enter. Based on our field investigation, the majority of site soils are anticipated to be OSHA Type "B" soils (refer to the attached boring logs). Minor amounts of sandy soils are present and should be considered susceptible to caving. Soil conditions should be regularly evaluated during construction to verify conditions are as anticipated. The contractor shall be responsible for providing the "competent person" required by OSHA standards to evaluate soil conditions. Close coordination with the geotechnical consultant should be maintained to facilitate construction while providing safe excavations. Excavation safety is the sole responsibility of the contractor.

Vehicular traffic, stockpiles, and equipment storage should be set back from the perimeter of excavations a minimum distance equivalent to a 1:1 projection from the bottom of the excavation or 5 feet, whichever is greater, unless the cut is shored and designed for applicable surcharge load. Once an excavation has been initiated, it should be backfilled as soon as practical. Prolonged exposure of temporary excavations may result in some localized instability. Excavations should be planned so that they are not initiated without sufficient time to shore/fill them prior to weekends, holidays, or forecasted rain.

It should be noted that any excavation that extends below a 1:1 (horizontal to vertical) projection of an existing foundation will remove existing support of the structure foundation. If requested, temporary shoring parameters will be provided.

4.1.4 Removal Bottoms and Subgrade Preparation

In general, removal bottoms, over-excavation bottoms and areas to receive compacted fill should be scarified to a minimum depth of 6 inches, brought to a near-optimum moisture condition (generally within optimum and 2 percent above optimum moisture content), and re-compacted per project recommendations.

Based on the presence of shallow groundwater, shallow soils with very high moisture contents, and the potential to encounter very moist/wet alluvial materials near/at the estimated removal bottoms and deep utility trenches, some of the removal bottoms are anticipated to be wet and unstable. Pumping subgrade is possible. We recommend all wet/unstable removal bottoms and pumping subgrade be stabilized by the placement

and "working in" of 1 to 3-inch nominal diameter crushed aggregate or an approved alternate stabilization method. Based on our experience with similar projects, we anticipate the thickness of crushed rock (stabilization aggregate) needed to stabilize the removal bottoms will be on the order to 6 to 18 inches thick. The actual thickness of aggregate required to stabilize the excavation bottom shall be determined in the field based on the actual conditions and equipment used. It should be anticipated that the first lift of crushed aggregate will be worked into the pumping subgrade. Subsequent lifts should be properly compacted and will help bridge the pumping conditions. Thickness of required aggregate stabilization may be reduced by placing a layer of biaxial geogrid reinforcement (e.g., Tensar TX140 or acceptable equivalent) directly on the subgrade prior to aggregate base placement. The contractor may have to minimize construction traffic on the removal bottom to reduce disturbance. Soft and yielding subgrade should be evaluated on a case-by-case basis during earthwork operations.

Removal bottoms, over-excavation bottoms and areas to receive fill should be observed and accepted by the geotechnical consultant prior to subsequent fill placement. Soil subgrade for planned footings and improvements (e.g., slabs, etc.) should be firm and competent.

4.1.5 Material for Fill

From a geotechnical perspective, the onsite soils are generally considered suitable for use as general compacted fill, provided they are screened of organic materials, construction debris and oversized material (8 inches in greatest dimension).

From a geotechnical viewpoint, any required import soils for general fill (i.e., non-retaining wall backfill) should consist of soils of "Very Low" to "Low" expansion potential (expansion index 50 or less based on American Society for Testing and Materials [ASTM] D 4829), and free of organic materials, construction debris and any material greater than 3 inches in maximum dimension. Import for any required retaining wall backfill should meet the criteria outlined in the following paragraph. Source samples should be provided to the geotechnical consultant for laboratory testing a minimum of four working days prior to any planned importation.

The onsite soils are not suitable for retaining wall backfill due to their fines content and expansion index; therefore, import of soils will be required by the contractor for obtaining suitable retaining wall backfill soil. These preliminary findings will be confirmed during grading. Retaining wall backfill should consist of imported sandy soils with a maximum of 35 percent fines (passing the No. 200 sieve) per ASTM Test Method D1140 (or ASTM D6913/D422) and a "Very Low" expansion potential (EI of 20 or less per ASTM D4829). Soils should also be screened of organic materials, construction debris, and any material greater than 3 inches in maximum dimension.

Aggregate base (crushed aggregate base or crushed miscellaneous base) should conform to the requirements of Section 200-2 of the most recent version of the Standard Specifications for Public Works Construction ("Greenbook") for untreated base materials (except processed miscellaneous base) and/or City of Los Alamitos requirements.

The placement of demolition materials in compacted fill is acceptable from a geotechnical viewpoint provided the demolition material is broken up into pieces not larger than typically used for aggregate base (approximately 1-inch in maximum dimension) and well blended into fill soils with essentially no resulting voids. Demolition material placed in fills must be free of construction debris (wood, organics, etc.) and reinforcing steel. If asphalt concrete fragments will be incorporated into the demolition materials, approval from an environmental viewpoint may be required and is not the purview of the geotechnical consultant. From our previous experience, we recommend that asphalt concrete fragments be limited to fill areas within planned street areas (i.e., not within building pad areas).

4.1.6 Placement and Compaction of Fills

Material to be placed as fill should be brought to near-optimum moisture content (generally within optimum and 2 percent above optimum moisture content) and recompacted to at least 90 percent relative compaction (per ASTM D1557). Moisture conditioning of site soils will be required in order to achieve adequate compaction. Significant drying and or mixing of very moist soils will be required prior to reusing the materials in compacted fills.

The optimum lift thickness to produce a uniformly compacted fill will depend on the type and size of compaction equipment used. In general, fill should be placed in uniform lifts not exceeding 8 inches in compacted thickness. Each lift should be thoroughly compacted and accepted prior to subsequent lifts. Generally, placement and compaction of fill should be performed in accordance with local grading ordinances and with observation and testing performed by the geotechnical consultant. Oversized material as previously defined should be removed from site fills.

During backfill of excavations, the fill should be properly benched into firm and competent soils of temporary backcut slopes as it is placed in lifts.

Aggregate base material should be compacted to at least 95 percent relative compaction at or slightly above optimum moisture content per ASTM D1557. Subgrade below aggregate base should be compacted to at least 90 percent relative compaction per ASTM D1557 at near-optimum moisture content (generally within optimum and 2 percent above optimum moisture content).
If gap-graded ¾-inch rock is used for backfill (around storm drain storage chambers, retaining wall backfill, etc.) it will require compaction. Rock shall be placed in thin lifts (typically not exceeding 6 inches) and mechanically compacted with observation by geotechnical consultant. Backfill rock shall meet the requirements of ASTM D2321. Gap-graded rock is required to be wrapped in filter fabric (Mirafi 140N or approved alternative) to prevent the migration of fines into the rock backfill.

4.1.7 Trench and Retaining Wall Backfill and Compaction

The onsite soils may generally be suitable as trench backfill, provided the soils are screened of rocks and other material greater than 6 inches in diameter and organic

matter. If trenches are shallow or the use of conventional equipment may result in damage to the utilities, sand having a sand equivalent (SE) of 30 or greater (per California Test Method [CTM] 217) may be used to bed and shade the pipes. Based on our field evaluation, onsite soils will not meet this sand equivalent requirement. Sand backfill within the pipe bedding zone may be densified by jetting or flooding and then tamping to ensure adequate compaction. Subsequent trench backfill should be compacted in uniform thin lifts by mechanical means to at least the recommended minimum relative compaction (per ASTM D1557).

Retaining wall backfill should consist of sandy soils as outlined in preceding Section 4.1.5. The limits of select sandy backfill should extend at minimum ½ the height of the retaining wall or the width of the heel (if applicable), whichever is greater (Figure 3). Retaining wall backfill soils should be compacted in relatively uniform thin lifts to at least 90 percent relative compaction (per ASTM D1557). Jetting or flooding of retaining wall backfill materials should not be permitted.

In backfill areas where mechanical compaction of soil backfill is impractical due to space constraints, typically sand-cement slurry may be substituted for compacted backfill. The slurry should contain about one sack of cement per cubic yard. When set, such a mix typically has the consistency of compacted soil. Sand cement slurry placed near the surface within landscape areas should be evaluated for potential impacts on planned improvements.

A representative from LGC Geotechnical should observe, probe, and test the backfill to verify compliance with the project recommendations.

4.1.8 Shrinkage and Subsidence

Allowance in the earthwork volumes budget should be made for an estimated 5 to 15 percent reduction in volume of near-surface (upper approximate 5 feet) soils. It should be stressed that these values are only estimates and that an actual shrinkage factor would be extremely difficult to predetermine. Subsidence, due to earthwork operations, is expected to be on the order of 0.1 feet. These values are estimates only and exclude losses due to removal of any vegetation or debris. The effective shrinkage of onsite soils will depend primarily on the type of compaction equipment and method of compaction used onsite by the contractor and accuracy of the topographic survey.

4.2 Preliminary Foundation Recommendations

Provided that the remedial grading recommendations provided herein are implemented, the site may be considered suitable for the support of the residential structures using a post-tensioned foundation system designed to resist the impacts of expansive soils and liquefaction induced differential settlement. Due to seismic settlement potential, we recommend isolated pad footings be interconnected with grade beams. The foundations designer should verify the foundation can accommodate the estimated settlement and differential settlement.

Site soils are anticipated to be "Low" expansion potential (EI of 50 or less per ASTM D4829) and special design considerations from a geotechnical perspective are required. Please note that the following foundation recommendations are preliminary and must be confirmed by LGC Geotechnical at the completion of grading. Recommended soil bearing and estimated settlement due to structural loads are provided in Section 4.3.

4.2.1 Provisional Post-Tensioned Foundation Design Parameters

The geotechnical parameters provided herein may be used for post-tensioned slab foundations. These parameters have been determined in general accordance with the Post-Tensioning Institute (PTI, 2012) Standard Requirements (PTI DC 10.5), referenced in Chapter 18 of the 2019 CBC. In utilizing these parameters, the foundation engineer should design the foundation system in accordance with the allowable deflection criteria of applicable codes and the requirements of the structural designer/architect. Other types of stiff slabs may be used in place of the CBC post-tensioned slab design provided that, in the opinion of the foundation structural designer, the alternative type of slab is at least as stiff and strong as that designed by the CBC/PTI method to resist expansive soils.

Our design parameters are based on our experience with similar residential projects and the anticipated nature of the soil (with respect to expansion potential). Please note that implementation of our recommendations will not eliminate foundation movement (and related distress) should the moisture content of the subgrade soils fluctuate. It is the intent of these recommendations to help maintain the integrity of the proposed structures and reduce (not eliminate) movement, based upon the anticipated site soil conditions. Should future owners not properly maintain the areas surrounding the foundation, for example by overwatering, then we anticipate for highly expansive soils the maximum differential movement of the perimeter of the foundation to the center of the foundation to be on the order of a couple of inches. Soils of lower expansion potential are anticipated to show less movement.

TABLE 4

Provisional Geotechnical Parameters for Post-Tensioned Foundation Slab Design

Parameter	PT Slab with Perimeter Footing	PT Mat with Thickened Edge
Expansion Index	Low[1]	Low[1]
Thornthwaite Moisture Index	-20	-20
Constant Soil Suction	PF 3.9	PF 3.9
Center Lift Edge moisture variation distance, e_m Center lift, y_m	 9.0 feet 0.35 inch	 9.0 feet 0.45 inch
Edge Lift Edge moisture variation distance, e_m Edge lift, y_m	 5.0 feet 0.75 inch	 5.0 feet 0.85 inch
Modulus of Subgrade Reaction, k (assuming presoaking as indicated below)	200 pci	200 pci
Minimum perimeter footing/thickened edge embedment below finish grade	12 inches	6 inches
Perimeter foundation reinforcement	N/A[2]	N/A[2]
Presoak (moisture conditioning)	100% optimum to depth of 12 inches	100% optimum to depth of 12 inches

1. Assumed for preliminary design purposes. Further evaluation is needed at the completion of grading. PT slab parameters are based on expansive soil conditions as well as seismic settlement findings.
2. Recommendations for foundation reinforcement and slab thickness are ultimately the purview of the foundation engineer/structural engineer based upon geotechnical criteria and structural engineering considerations.
3. Recommendations for sand below slabs have traditionally been included with geotechnical foundation recommendations, although they are not the purview of the geotechnical consultant. The sand layer requirements are the purview of the foundation engineer/structural engineer and should be provided in accordance with ACI Publication 302 "Guide for Concrete Floor and Slab Construction".
4. Recommendations for vapor retarders below slabs are also the purview of the foundation engineer/structural engineer and should be provided in accordance with applicable code requirements.

4.2.2 Post-Tensioned Foundation Subgrade Preparation and Maintenance

Moisture conditioning (presoaking) of the subgrade soils is recommended prior to trenching the foundation. The duration of this process varies greatly based on the chosen method and is also dependent on factors such as soil type and weather conditions. Time duration for presoaking from completion of rough grading to trenching of foundations should be accounted for in the construction schedule (typically 1 to 2 weeks). The recommendations specific to the anticipated site soil conditions, including recommended presoak, are presented in Table 4. The subgrade moisture

condition of the building pad soils should be maintained at near-optimum moisture content up to the time of concrete placement. This moisture content should be maintained around the immediate perimeter of the slab during construction and up to occupancy of the homes.

The geotechnical parameters provided herein assume that if the areas adjacent to the foundation are planted and irrigated, these areas will be designed with proper drainage and adequately maintained so that ponding, which causes significant moisture changes below the foundation, does not occur. Our recommendations do not account for excessive irrigation and/or incorrect landscape design. Plants should only be provided with sufficient irrigation for life and not overwatered to saturate subgrade soils. Sunken planters placed adjacent to the foundation, should either be designed with an efficient drainage system or liners to prevent moisture infiltration below the foundation. Some lifting of the perimeter foundation beam should be expected even with properly constructed planters.

In addition to the factors mentioned above, future homeowners should be made aware of the potential negative influences of trees and/or other large vegetation. Roots that extend near the vicinity of foundations can cause distress to foundations. Future homeowners (and the owner's landscape architect) should not plant trees/large shrubs closer to the foundations than a distance equal to half the mature height of the tree or 20 feet, whichever is more conservative unless specifically provided with root barriers to prevent root growth below the house foundation.

It is the homeowner's responsibility to perform periodic maintenance during hot and dry periods to ensure that adequate watering has been provided to keep soils from separating or pulling back from the foundation. Future homeowners should be informed and educated regarding the importance of maintaining a constant level of soil-moisture. The homeowners should be made aware of the potential negative consequences of both excessive watering, as well as allowing potentially expansive soils to become too dry. Expansive soils can undergo shrinkage during drying and swelling during the rainy winter season or when irrigation is resumed. This can result in distress to building structures and hardscape improvements. The builder should provide these recommendations to future homeowners.

4.2.3 Slab Underlayment Guidelines

The following is for informational purposes only since slab underlayment (e.g., moisture retarder, sand or gravel layers for concrete curing and/or capillary break) is unrelated to the geotechnical performance of the foundation and thereby not the purview of the geotechnical consultant. Post-construction moisture migration should be expected below the foundation. The foundation engineer/architect should determine whether the use of a capillary break (sand or gravel layer), in conjunction with the vapor retarder, is necessary or required by code. Sand layer thickness and location (above and/or below vapor retarder) should also be determined by the foundation engineer/architect.

4.3 Soil Bearing and Lateral Resistance

Provided our earthwork recommendations are implemented, an allowable soil bearing pressure of 1,500 pounds per square foot (psf) may be used for the design of footings having a minimum width of 12 inches and minimum embedment of 12 inches below lowest adjacent ground surface. This value may be increased by 300 psf for each additional foot of embedment and 150 psf for each additional foot of foundation width to a maximum value of 2,500 psf. A post-tensioned mat foundation a minimum of 6 inches below lowest adjacent grade may be designed for an allowable soil bearing pressure of 1,200 psf. These allowable bearing pressures are applicable for level (ground slope equal to or flatter than 5H:1V) conditions only. Bearing values indicated are for total dead loads and frequently applied live loads and may be increased by ⅓ for short duration loading (i.e., wind or seismic loads).

In utilizing the above-mentioned allowable bearing capacity and provided our earthwork recommendations are implemented, foundation settlement due to consolidation and structural loads is anticipated to be less than 2 inches. Differential static settlement may be taken as half of the total settlement (i.e., 1-inch over a horizontal span of 40 feet due to structural loads). Seismically induced settlement is discussed in Section 2.6.1.

Resistance to lateral loads can be provided by friction acting at the base of foundations and by passive earth pressure. For concrete/soil frictional resistance, an allowable coefficient of friction of 0.25 may be assumed with dead-load forces. For slabs constructed over a moisture retarder, the allowable friction coefficient should be provided by the manufacturer. An allowable passive lateral earth pressure of 200 psf per foot of depth (or pcf) to a maximum of 2,000 psf may be used for the sides of footings poured against properly compacted fill. Allowable passive pressure may be increased to 270 pcf (maximum of 2,700 psf) for short duration seismic loading. This passive pressure is applicable for level (ground slope equal to or flatter than 5H:1V) conditions. Frictional resistance and passive pressure may be used in combination without reduction. We recommend that the upper foot of passive resistance be neglected if finished grade will not be covered with concrete or asphalt. The provided allowable passive pressures are based on a factor of safety of 1.5 and 1.1 for static and seismic loading conditions, respectively.

4.4 Lateral Earth Pressures for Retaining Walls

The following may be used for design of site retaining walls. Lateral earth pressures are provided as equivalent fluid unit weights, in psf per foot of depth (or pcf). These values do not contain an appreciable factor of safety, so the retaining wall designer should apply the applicable factors of safety and/or load factors during design. A soil unit weight of 120 pcf may be assumed for calculating the actual weight of soil over the wall footing.

The following lateral earth pressures are presented in Table 5 for approved imported granular soils with a maximum of 35 percent fines (passing the No. 200 sieve per ASTM D-421/422) and a "Very Low" expansion potential (EI of 20 or less per ASTM D4829). The onsite soils are not suitable for retaining wall backfill due to their fines content and expansion potential. Therefore, import of sandy soils meeting the criteria outlined above will be required by the contractor for obtaining suitable retaining wall backfill soil.

The wall designer should clearly indicate on the retaining wall plans the required select sandy soil backfill criteria. These preliminary findings should be confirmed during grading.

TABLE 5

Lateral Earth Pressures – Imported Sandy Soils

Conditions	Equivalent Fluid Unit Weight (pcf)	Equivalent Fluid Unit Weight (pcf)
	Level Backfill	2:1 Sloped Backfill
	Approved Sandy Soils (Import)	Approved Sandy Soils (Import)
Active	35	55
At-Rest	55	70

If the wall can yield enough to mobilize the full shear strength of the soil, it can be designed for "active" pressure. If the wall cannot yield under the applied load, the earth pressure will be higher. This would include 90-degree corners of retaining walls. Such walls should be designed for "at-rest." The equivalent fluid pressure values assume free-draining conditions. If conditions other than those assumed above are anticipated, the equivalent fluid pressure values should be provided on an individual-case basis by the geotechnical engineer.

Retaining wall structures should be provided with appropriate drainage and appropriately waterproofed. To reduce, but not eliminate, saturation of near-surface (upper approximate 1-foot) soils in front of the retaining walls, the perforated subdrain pipe should be located as low as possible behind the retaining wall. The outlet pipe should be sloped to drain to a suitable outlet. In general, we do not recommend retaining wall outlet pipes be connected to area drains. If subdrains are connected to area drains, special care and information should be provided to homeowners to maintain these drains. Typical retaining wall drainage is illustrated in Figure 3. It should be noted that the recommended subdrain does not provide protection against seepage through the face of the wall and/or efflorescence. Efflorescence is generally a white crystalline powder (discoloration) that results when water containing soluble salts migrates over a period of time through the face of a retaining wall and evaporates. If such seepage or efflorescence is undesirable, retaining walls should be waterproofed to reduce this potential. Waterproofing and outlet systems are not the purview of the geotechnical consultant.

Surcharge loading effects from any adjacent structures should be evaluated by the retaining wall designer. In general, structural loads within a 1:1 (horizontal: vertical) upward projection from the bottom of the proposed retaining wall footing will surcharge the proposed retaining wall. In addition to the recommended earth pressure, retaining walls adjacent to streets should be designed to resist a uniform lateral pressure of 85 pounds per square foot (psf) due to normal street vehicle traffic, if applicable. Uniform lateral surcharges may be estimated using the applicable coefficient of lateral earth pressure using a rectangular distribution. A factor of 0.45 and 0.3 may be used for at-rest and active conditions, respectively. The retaining wall designer should contact the geotechnical consultant for any required geotechnical input in

estimating surcharge loads.

If a retaining wall greater than 6 feet in height is proposed, the retaining wall designer should contact the geotechnical engineer for specific seismic lateral earth pressure increments based on the configuration of the planned retaining wall structures.

Soil bearing and lateral resistance (friction coefficient and passive resistance) are provided in Section 4.3. Earthwork considerations (temporary backcuts, backfill, compaction, etc.) for retaining walls are provided in Section 4.1 (Site Earthwork) and the subsequent earthwork related sub-sections.

4.5 Soil Corrosivity

Although not corrosion engineers (LGC Geotechnical is not a corrosion consultant), several governing agencies in Southern California require the geotechnical consultant to determine the corrosion potential of soils to buried concrete and metal facilities. We therefore present the results of our testing with regard to corrosion for the use of the client and other consultants, as they determine necessary.

Corrosion testing of a near-surface bulk sample indicated a soluble sulfate content ranging from approximately 0.032 to 0.254 percent, a chloride content ranging from 140 to 600 parts per million (ppm), pH of 8.92, and a minimum resistivity of 210 ohm-centimeters. Based on Caltrans Corrosion Guidelines (Caltrans, 2021), soils are considered corrosive to structural elements if the pH is 5.5 or less, or the chloride concentration is 500 ppm or greater, or the sulfate concentration is 2,000 ppm (0.2 percent) or greater. Based on the preliminary test results, soils are considered corrosive using Caltrans criteria.

Based on preliminary laboratory sulfate test results, the near surface soils are designated to a class "S2" per ACI 318, Table 19.3.1.1 with respect to sulfates. Concrete in direct contact with the onsite soils can be designed according to ACI 318, Table 19.3.2.1 using the "S2" sulfate classification.

Laboratory testing may need to be performed at the completion of grading by the project corrosion engineer to further evaluate the as-graded soil corrosivity characteristics. Accordingly, revision of the corrosion potential may be needed, should future test results differ substantially from the conditions reported herein. The client and/or other members of the development team should consider this during the design and planning phase of the project and formulate an appropriate course of action.

4.6 Control of Surface Water and Drainage Control

From a geotechnical perspective, we recommend that compacted finished grade soils adjacent to proposed residences be sloped away from the proposed residence and towards an approved drainage device or unobstructed swale. Drainage swales, wherever feasible, should not be constructed within 5 feet of buildings. Where lot and building geometry necessitates that the side yard drainage swales be routed closer than 5 feet to structural foundations, we recommend the use of area drains together with drainage swales. Drainage swales used in

conjunction with area drains should be designed by the project civil engineer so that a properly constructed and maintained system will prevent ponding within 5 feet of the foundation. Code compliance of grades is not the purview of the geotechnical consultant.

Planters with open bottoms adjacent to buildings should be avoided. Planters should not be designed adjacent to buildings unless provisions for drainage, such as catch basins, liners, and/or area drains, are made. Overwatering must be avoided.

4.7 Subsurface Water Infiltration

Recent regulatory changes in some jurisdictions have recommended that low flow runoff be infiltrated rather than discharged via conventional storm drainage systems. Typically, a combination of methods is implemented to reduce surface water runoff and increase infiltration including; permeable pavements/pavers for roadways and walkways and directing surface water runoff to grass-lined swales, retention areas, and/or drywells. It should be noted that intentionally infiltrating storm water conflicts with the geotechnical engineering objective of directing surface water away from structures and improvements. The geotechnical stability and integrity of the project site is reliant upon appropriately handling all surface water. In general, the vast majority of geotechnical distress issues are directly related to improper drainage. In general, distress in the form of movement of improvements could occur as a result of soil saturation and loss of soil support, expansion, internal soil erosion, collapse and/or settlement. Infiltrated water may enter underground utility pipe zones and migrate along the pipe backfill, potentially impacting other improvements located far away from the point of infiltration.

Geotechnical stability and integrity of the project site is reliant upon appropriate handling of surface water. Due to the extremely low measured infiltration rate, low permeability fine-grained soils at depth, shallow groundwater and site liquefaction potential, we strongly recommend against the intentional infiltration of storm water into subsurface soils.

4.8 Preliminary Asphalt Concrete Pavement Sections

The following provisional minimum asphalt concrete (AC) street sections are provided in Table 6 for Traffic Indices (TI) of 5.0, 5.5 and 6.0. These sections are based on an assumed R-value of 10. These recommendations must be confirmed with R-value testing of representative near-surface soils at the completion of grading and after underground utilities have been installed and backfilled. Final pavement sections should be confirmed by the project civil engineer based upon the final design Traffic Index. If requested, LGC Geotechnical will provide sections for alternate TI values. Should the City of Los Alamitos have more stringent requirements, updated pavement recommendation can be provided.

TABLE 6

Preliminary Pavement Section Options

Assumed Traffic Index	5.0	5.5	6.0
R -Value Subgrade	10	10	10
AC Thickness	4.0 inches	4.0 inches	5.0 inches
Aggregate Base Thickness	7.0 inches	9.0 inches	9.0 inches

The pavement section thicknesses provided above are considered minimum thicknesses. Increasing the thickness of any or all of the above layers will reduce the likelihood of the pavement experiencing distress during its service life. The above recommendations are based on the assumption that proper maintenance and irrigation of the areas adjacent to the roadway will occur throughout the design life of the pavement. Failure to maintain a proper maintenance and/or irrigation program may jeopardize the integrity of the pavement.

Earthwork recommendations regarding aggregate base and subgrade are provided in the previous Section 4.1 (Site Earthwork) and the related sub-sections of this report.

4.9 Nonstructural Concrete Flatwork

Nonstructural concrete flatwork (such as walkways, private drives, patio slabs, etc.) has a potential for cracking due to changes in soil volume related to soil-moisture fluctuations. To reduce the potential for excessive cracking and lifting, concrete may be designed in accordance with the minimum guidelines outlined in Table 7 on the following page. These guidelines will reduce the potential for irregular cracking and promote cracking along construction joints but will not eliminate all cracking or lifting. Thickening the concrete and/or adding additional reinforcement will further reduce cosmetic distress.

TABLE 7

Nonstructural Concrete Flatwork for Low Expansion Potential

	Homeowner Sidewalks	Private Drives	Patios/ Entryways	City Sidewalk Curb and Gutters
Minimum Thickness (in.)	4 (nominal)	4 (full)	4 (full)	City/Agency Standard
Presoaking	Wet down prior to placing	Wet down prior to placing	Wet down prior to placing	City/Agency Standard
Reinforcement	—	No. 3 at 24 inches on centers	No. 3 at 24 inches on centers	City/Agency Standard
Thickened Edge (in.)	—	8 x 8	—	City/Agency Standard
Crack Control Joints	Saw cut or deep open tool joint to a minimum of $^1/_3$ the concrete thickness	Saw cut or deep open tool joint to a minimum of $^1/_3$ the concrete thickness	Saw cut or deep open tool joint to a minimum of $^1/_3$ the concrete thickness	City/Agency Standard
Maximum Joint Spacing	5 feet	10 feet or quarter cut whichever is closer	6 feet	City/Agency Standard
Aggregate Base Thickness (in.)	—	—	—	City/Agency Standard

To reduce the potential for driveways to separate from the garage slab, the builder may elect to install dowels to tie these two elements together. Similarly, future homeowners should consider the use of dowels to connect flatwork to the foundation.

4.10 Geotechnical Plan Review

When available, grading, retaining wall and foundation plans should be reviewed by LGC Geotechnical in order to verify our geotechnical recommendations are implemented. Updated recommendations and/or additional field work may be necessary.

4.11 Geotechnical Observation and Testing During Construction

The recommendations provided in this report are based on limited subsurface observations and geotechnical analysis. The interpolated subsurface conditions should be checked in the field during construction by a representative of LGC Geotechnical. Geotechnical observation and testing is required per Section 1705 of the 2019 California Building Code (CBC).

Geotechnical observation and/or testing should be performed by LGC Geotechnical at the following stages:

- During grading (removal bottoms, fill placement, etc);
- During retaining wall backfill and compaction;
- During utility trench backfill and compaction;
- After presoaking building pads and other concrete-flatwork subgrades, and prior to placement of aggregate base or concrete;
- Preparation of pavement subgrade and placement of aggregate base;
- After building and wall footing excavation and prior to placing steel reinforcement and/or concrete; and
- When any unusual soil conditions are encountered during any construction operation subsequent to issuance of this report.

5.0 LIMITATIONS

Our services were performed using the degree of care and skill ordinarily exercised, under similar circumstances, by reputable soils engineers and geologists practicing in this or similar localities. No other warranty, expressed or implied, is made as to the conclusions and professional advice included in this report.

This report is based on data obtained from limited observations of the site, which have been extrapolated to characterize the site. While the scope of services performed is considered suitable to adequately characterize the site geotechnical conditions relative to the proposed development, no practical evaluation can completely eliminate uncertainty regarding the anticipated geotechnical conditions in connection with a subject site. Variations may exist and conditions not observed or described in this report may be encountered during grading and construction.

This report is issued with the understanding that it is the responsibility of the owner, or of his/her representative, to ensure that the information and recommendations contained herein are brought to the attention of the other consultants (at a minimum the civil engineer, structural engineer, landscape architect) and incorporated into their plans. The contractor should properly implement the recommendations during construction and notify the owner if they consider any of the recommendations presented herein to be unsafe, or unsuitable.

The findings of this report are valid as of the present date. However, changes in the conditions of a site can and do occur with the passage of time, whether they be due to natural processes or the works of man on this or adjacent properties. The findings, conclusions, and recommendations presented in this report can be relied upon only if LGC Geotechnical has the opportunity to observe the subsurface conditions during grading and construction of the project, in order to confirm that our preliminary findings are representative for the site. This report is intended exclusively for use by the client, any use of or reliance on this report by a third party shall be at such party's sole risk.

In addition, changes in applicable or appropriate standards may occur, whether they result from legislation or the broadening of knowledge. Accordingly, the findings of this report may be invalidated wholly or partially by changes outside our control. Therefore, this report is subject to review and modification.

Approximate Site Limits

HS-3
T.D. = 21.5'

HS-2
T.D. = 46.5'

AFFORDABLE
APARTMENT SITE
HA-2 30 DU/AC
±3 ACRES
T.D. = 5'

Pocket
Park
±5000sf

I-2
T.D. = 5'

HS-1
T.D. = 21.5'

HA-1
T.D. = 5'

I-1
T.D. = 5'

Lampson Ave

Lampson Ave

Lampson Ave

Ironwood Ave

SCALE: 1"=100'
100' 0 100' 200'

LEGEND

HS-3
T.D. = 21.5'
Approximate Location of Hollow Stem Auger Boring by LGC Geotechnical, With Total Depth in Feet

I-2
T.D. = 5'
Approximate Location of Hollow Stem Auger Infiltration Boring by LGC Geotechnical, With Total Depth in Feet

HA-2
T.D. = 5'
Approximate Location of Hand Auger Boring by LGC Geotechnical, With Total Depth in Feet

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San Clemente, CA 92672
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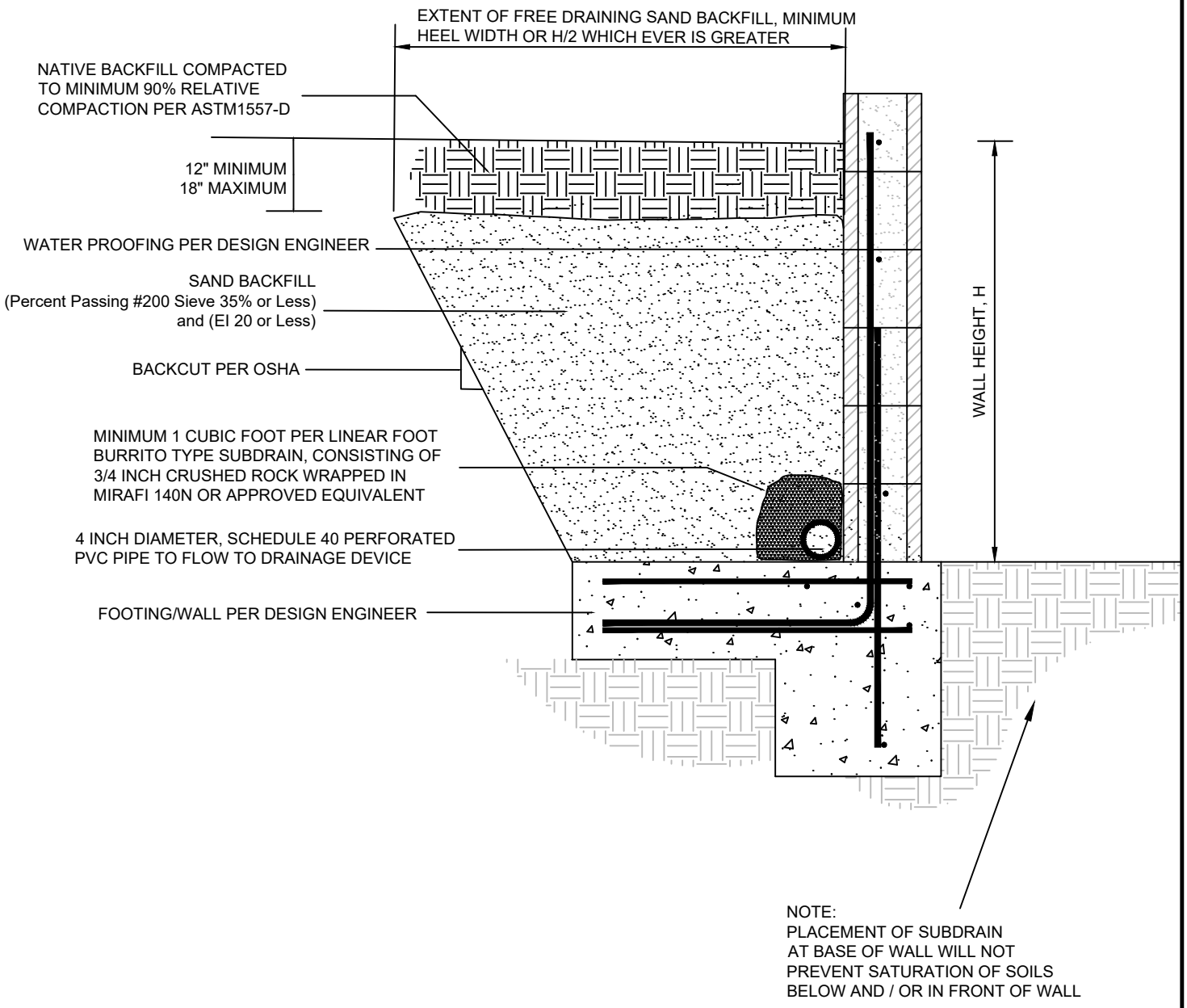
FIGURE 2
Boring Location Map

PROJECT NAME	MWIG - Los Alamitos
PROJECT NO.	21198-01
ENG. / GEOL.	RLD
SCALE	1" = 100'
DATE	December 2021



LGC Geotechnical, Inc.

FIGURE 3
Retaining Wall Backfill Detail

PROJECT NAME	*MWIG - Los Alamitos*
PROJECT NO.	*21198-01*
ENG. / GEOL.	*RLD*
SCALE	*Not to Scale*
DATE	*December 2021*

Appendix A
References

APPENDIX A

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Appendix B
Boring Logs

Geotechnical Boring Log Borehole HS-1

Date: 11/11/2021 | **Drilling Company:** Cal Pac Drilling

Project Name: MWIG - Los Alamitos | **Type of Rig:** Track Mounted

Project Number: 21198-01 | **Drop:** 30" | **Hole Diameter:** 6"

Elevation of Top of Hole: ~24' MSL | **Drive Weight:** 140 pounds

Hole Location: See Geotechnical Map

Logged By BPP
Sampled By BPP
Checked By RLD

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
	0	B-1						**@0' to T.D. - <u>Quaternary Young Alluvium (Qya):</u>**	
								@0'- 1' of Topsoil; Sandy SILT: brown/gray, slightly moist	
20			R-1	10 7 9	92.9	8.6	CL-ML	@2.5'- Silty CLAY with Sand: grayish brown, slightly moist, stiff	
	5		R-2	4 6 8	94.5	24.6		@5'- Silty CLAY: olive brown, very moist, stiff	
			R-3	3 3 4	94.0	27.9	SM/CL	@7.5'- Top: Silty SAND: brown, wet, loose; Bottom: CLAY: brown, wet, medium stiff	
15									
	10		R-4	3 4 5	99.0	26.3	CL-ML	@10'- Silty CLAY: olive brown, wet, medium stiff	
10									
	15		SPT-1	2 3 4		27.8		@15'- Silty CLAY: olive brown, wet, stiff	
5									
	20		R-5	7 9 12	106.1	20.9	SM	@20'- Silty SAND: grayish brown, wet, medium dense	
0								Total Depth = 21.5' Groundwater Encountered at Approximately 13' Backfilled with Cuttings on 11/11/2021	
	25								
-5									
	30								

LGC Geotechnical, Inc.

THIS SUMMARY APPLIES ONLY AT THE LOCATION OF THIS BORING AND AT THE TIME OF DRILLING. SUBSURFACE CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH THE PASSAGE OF TIME. THE DATA PRESENTED IS A SIMPLIFICATION OF THE ACTUAL CONDITIONS ENCOUNTERED. THE DESCRIPTIONS PROVIDED ARE QUALITATIVE FIELD DESCRIPTIONS AND ARE NOT BASED ON QUANTITATIVE ENGINEERING ANALYSIS.

SAMPLE TYPES:

B	BULK SAMPLE
R	RING SAMPLE (CA Modified Sampler)
G	GRAB SAMPLE
SPT	STANDARD PENETRATION TEST SAMPLE
▽	GROUNDWATER TABLE

TEST TYPES:

DS	DIRECT SHEAR
MD	MAXIMUM DENSITY
SA	SIEVE ANALYSIS
S&H	SIEVE AND HYDROMETER
EI	EXPANSION INDEX
CN	CONSOLIDATION
CR	CORROSION
AL	ATTERBERG LIMITS
CO	COLLAPSE/SWELL
RV	R-VALUE
-#200	% PASSING # 200 SIEVE

Last Edited: 12/16/2021

Geotechnical Boring Log Borehole HS-2

Date: 11/11/2021 | **Drilling Company:** Cal Pac Drilling

Project Name: MWIG - Los Alamitos | **Type of Rig:** Track Mounted

Project Number: 21198-01 | **Drop:** 30" | **Hole Diameter:** 6"

Elevation of Top of Hole: ~25' MSL | **Drive Weight:** 140 pounds

Hole Location: See Geotechnical Map

Logged By BPP
Sampled By BPP
Checked By RLD

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
	0							**@0 to T.D. - Quaternary Young Alluvium (Qya):** @0'- 1' of Topsoil; Sandy SILT: gray/brown, slightly moist	
			R-1	13 7 11	94.9	25.1	CL-ML	@2.5'- Silty CLAY: olive brown, wet, stiff	
20	5		R-2	3 6 9	96.3	28.1		@5'- Silty CLAY: olive brown, wet, stiff	
			R-3	5 5 4	89.3	33.2	CL	@7.5'- CLAY: olive brown, wet, medium stiff	AL CN
15	10	▽	R-4	2 3 4	97.8	27.8		@10'- CLAY: brown, wet, medium stiff	
10	15		R-5	5 5 8	101.2	26.2		@15'- CLAY: brown, wet, stiff	AL
5	20		SPT-1	4 6 8		22.9	ML	@20'- Sandy SILT: grayish brown, wet, medium dense	
0	25		R-6	6 6 5	99.1	30.4	CL	@25'- CLAY: dark gray, wet, stiff	
	30								

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RV	R-VALUE
-#200	% PASSING # 200 SIEVE

Last Edited: 12/16/2021

Geotechnical Boring Log Borehole HS-2

Date: 11/11/2021 | **Drilling Company:** Cal Pac Drilling

Project Name: MWIG - Los Alamitos | **Type of Rig:** Track Mounted

Project Number: 21198-01 | **Drop:** 30" | **Hole Diameter:** 6"

Elevation of Top of Hole: ~25' MSL | **Drive Weight:** 140 pounds

Hole Location: See Geotechnical Map

Logged By BPP
Sampled By BPP
Checked By RLD

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
	30		SPT-2	3 5 7		32.3	CL	@30'- CLAY: olive gray, wet, very stiff	AL
-5	35		R-7	6 21 33	110.9	17.4	SM	@35'- Silty SAND: gray, wet, dense	
-10	40		SPT-3	5 7 15		28.1		@40'- Silty SAND: dark gray, wet, medium dense	-#200
-15	45		R-8	7 9 11	99.2	26.6		@45'- Silty SAND: dark gray, wet, medium dense	-#200
-20	50							Total Depth = 46.5' Groundwater Encountered at Approximately 11.5' Backfilled with Cuttings on 11/11/2021	
-25	55								
	60								

LGC Geotechnical, Inc.

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TEST TYPES:

DS	DIRECT SHEAR
MD	MAXIMUM DENSITY
SA	SIEVE ANALYSIS
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EI	EXPANSION INDEX
CN	CONSOLIDATION
CR	CORROSION
AL	ATTERBERG LIMITS
CO	COLLAPSE/SWELL
RV	R-VALUE
-#200	% PASSING # 200 SIEVE

Geotechnical Boring Log Borehole HS-3

Date: 11/11/2021 | **Drilling Company:** Cal Pac Drilling

Project Name: MWIG - Los Alamitos | **Type of Rig:** Track Mounted

Project Number: 21198-01 | **Drop:** 30" | **Hole Diameter:** 6"

Elevation of Top of Hole: ~24' MSL | **Drive Weight:** 140 pounds

Hole Location: See Geotechnical Map

Logged By BPP
Sampled By BPP
Checked By RLD

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
	0	B-1						**@0' to T.D. - <u>Quaternary Young Alluvium (Qya):</u>**	MD
								@0'- Topsoil; Sandy SILT: brown/gray, slightly moist	DS
20			R-1	5 7 14	110.5	15.2	CL-ML	@2.5'- Silty CLAY: olive brown, moist, very stiff	EI CR
	5		R-2	7 8 13	101.6	22.0	CL	@5'- CLAY: olive brown, very moist, very stiff	
15			R-3	5 2 3	87.4	35.4		@7.5'- CLAY: olive brown, wet, soft	AL CN
	10	▽	R-4	1 3 4	98.7	26.9		@10'- CLAY: olive brown, wet, medium stiff	
10									
	15		SPT-1	2 3 3		24.7		@15'- CLAY: olive brown, wet, medium stiff	
5									
	20		R-5	3 5 6	107.9	20.7		@20'- CLAY: olive brown, wet, stiff	
0								Total Depth = 21.5' Groundwater Encountered at Approximately 11' Backfilled with Cuttings on 11/11/2021	
	25								
-5									
	30								

LGC Geotechnical, Inc.

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EI	EXPANSION INDEX
CN	CONSOLIDATION
CR	CORROSION
AL	ATTERBERG LIMITS
CO	COLLAPSE/SWELL
RV	R-VALUE
-#200	% PASSING # 200 SIEVE

Last Edited: 12/16/2021

Geotechnical Boring Log Borehole I-1

Date: 11/11/2021	**Drilling Company:** Cal Pac Drilling
Project Name: MWIG - Los Alamitos	**Type of Rig:** Track Mounted
Project Number: 21198-01	**Drop:** 30" **Hole Diameter:** 8"
Elevation of Top of Hole: ~23' MSL	**Drive Weight:** 140 pounds
Hole Location: See Geotechnical Map	Page 1 of 1

Logged By BPP
Sampled By BPP
Checked By RLD

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
20	0	B-1				22.0	SC	**@0' to 2.5' - Older Artificial Fill (afo):** @0'- 3" of Asphalt over 5" of Base @1'- Clayey SAND: gray/brown, very moist **@2.5' to T.D. - Quaternary Young Alluvium (Qya):** @2.5'- Clayey SAND: gray/brown, very moist	
15	5							Total Depth = 5' Groundwater Not Encountered 3" Perforated Pipe With Filter Sock Installed, Surrounded by Gravel, and Presoaked on 11/11/2021 Pipe Removed and Boring Backfilled With Cuttings on 11/12/2021	
10	10								
5	15								
0	20								
-5	25								
	30								

LGC Geotechnical, Inc.

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CO	COLLAPSE/SWELL
RV	R-VALUE
-#200	% PASSING # 200 SIEVE

Last Edited: 12/16/2021

Geotechnical Boring Log Borehole I-2

Date: 11/11/2021	**Drilling Company:** Cal Pac Drilling
Project Name: MWIG - Los Alamitos	**Type of Rig:** Track Mounted
Project Number: 21198-01	**Drop:** 30" **Hole Diameter:** 8"
Elevation of Top of Hole: ~23' MSL	**Drive Weight:** 140 pounds
Hole Location: See Geotechnical Map	Page 1 of 1

Logged By BPP
Sampled By BPP
Checked By RLD

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
20	0	B-1				16.9	SM	**@0' to 2.5'- <u>Older Artificial Fill (afo):</u>** @0'- 3" of Asphalt over 5" of Base @1'- Silty SAND: dark gray, very moist **@2.5' to T.D. - <u>Quaternary Young Alluvium (Qya):</u>** @2.5'- Silty SAND: dark gray, very moist	
15	5							Total Depth = 5' Groundwater Not Encountered 3" Perforated Pipe With Filter Sock Installed, Surrounded by Gravel, and Presoaked on 7/23/2021 Pipe Removed and Boring Backfilled With Cuttings on 11/12/2021	
10	10								
5	15								
0	20								
-5	25								
	30								

LGC Geotechnical, Inc.

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CR	CORROSION
AL	ATTERBERG LIMITS
CO	COLLAPSE/SWELL
RV	R-VALUE
-#200	% PASSING # 200 SIEVE

Last Edited: 12/16/2021

Geotechnical Boring Log Borehole HA-1

Date: 11/11/2021	**Drilling Company:** Cal Pac Drilling
Project Name: MWIG - Los Alamitos	**Type of Rig:** Track Mounted
Project Number: 21198-01	**Drop:** 30" **Hole Diameter:** 3"
Elevation of Top of Hole: ~24' MSL	**Drive Weight:** 140 pounds
Hole Location: See Geotechnical Map	Page 1 of 1

Logged By BPP
Sampled By BPP
Checked By RLD

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
20	0	B-1				12.8	ML	**@0' to T.D. - <u>Quaternary Young Alluvium (Qya):</u>** @0'- 1' of Topsoil @1'- Sandy SILT: brown, slightly moist	
						12.8	CL	@3'- Silty CLAY: brown, moist	
15	5							Total Depth = 5' Groundwater Not Encountered Backfilled with Cuttings on 11/11/2021	
10	10								
5	15								
0	20								
-5	25								
	30								

LGC Geotechnical, Inc.

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SPT	STANDARD PENETRATION TEST SAMPLE
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S&H	SIEVE AND HYDROMETER
EI	EXPANSION INDEX
CN	CONSOLIDATION
CR	CORROSION
AL	ATTERBERG LIMITS
CO	COLLAPSE/SWELL
RV	R-VALUE
-#200	% PASSING # 200 SIEVE

Last Edited: 12/16/2021

Geotechnical Boring Log Borehole HA-2

Date: 11/12/2021	**Drilling Company:** Cal Pac Drilling
Project Name: MWIG - Los Alamitos	**Type of Rig:** Track Mounted
Project Number: 21198-01	**Drop:** 30" **Hole Diameter:** 3"
Elevation of Top of Hole: ~24' MSL	**Drive Weight:** 140 pounds
Hole Location: See Geotechnical Map	Page 1 of 1

Logged By BPP
Sampled By BPP
Checked By RLD

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
20	0	B-1					SM SC	**@0' to 2.5'- Undocumented Artificial Fill (afu):** @0'- Silty SAND: grayish brown, dry **@2.5' to T.D. - Quaternary Young Alluvium (Qya):** @2.5'- Clayey SAND: grayish brown, very moist	EI CR
15	5							Total Depth = 5' Groundwater Not Encountered Backfilled with Cuttings on 11/12/2021	
10	10								
5	15								
0	20								
-5	25								
	30								

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CO	COLLAPSE/SWELL
RV	R-VALUE
-#200	% PASSING # 200 SIEVE

Last Edited: 12/16/2021

Appendix C
Laboratory Test Results

APPENDIX C

Laboratory Testing Procedures and Test Results

The laboratory testing program was formulated towards providing data relating to the relevant engineering properties of the soils with respect to residential construction. Samples considered representative of site conditions were tested in general accordance with American Society for Testing and Materials (ASTM) procedure and/or California Test Methods (CTM), where applicable. The following summary is a brief outline of the test type and a table summarizing the test results.

Moisture and Density Determination Tests: Moisture content (ASTM D2216) and dry density determinations (ASTM D2937) were performed on relatively undisturbed samples obtained from the test borings and/or trenches. The results of these tests are presented in the boring logs. Where applicable, only moisture content was determined from undisturbed or disturbed samples.

Expansion Index: The expansion potential of selected samples was evaluated by the Expansion Index Test, Standard ASTM D4829. Specimens are molded under a given compactive energy to approximately the optimum moisture content and approximately 50 percent saturation or approximately 90 percent relative compaction. The prepared 1-inch-thick by 4-inch-diameter specimens are loaded to an equivalent 144 psf surcharge and are inundated with tap water until volumetric equilibrium is reached. The results of these tests are presented in the table below.

Sample Location	Expansion Index	Expansion Potential*
HS-3 @ 1-5 feet	32	Low
HA-2 @ 1-5 feet	30	Low

* ASTM D4829

Grain Size Distibution/Fines Content: Representative samples were dried, weighed and soaked in water until individual soil particles were separated (per ASTM D421) and then washed on a No. 200 sieve (ASTM D1140). Where applicable, the portion retained on the No. 200 sieve and dried and then sieved on a U.S. Standard brass sieve set in accordance with ASTM D6913 (sieve).

Sample Location	Description	% Passing # 200 Sieve
HS-2 @ 40 feet	Silty Sand	16.5
HS-2 @ 45 feet	Silty Sand	15

Laboratory Testing Procedures and Test Results

Atterberg Limits: The liquid and plastic limits ("Atterberg Limits") were determined per ASTM D4318 for engineering classification of fine-grained material and presented in the table below. The USCS soil classification indicated in the table below is based on the portion of sample passing the No. 40 sieve and may not necessarily be representative of the entire sample. The plot is provided in this Appendix.

Sample Location	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	USCS Soil Classification
HS-2 @ 7.5 feet	31	19	12	CL
HS-2 @ 15 feet	34	17	17	CL
HS-2 @ 30 feet	35	16	19	CL
HS-3 @ 7.5 feet	48	24	24	CL

Consolidation: Two consolidation tests were performed per ASTM D2435. A sample (2.4 inches in diameter and 1 inch in height) was placed in a consolidometer and increasing loads were applied. The sample was allowed to consolidate under "double drainage" and total deformation for each loading step was recorded. The percent consolidation for each load step was recorded as the ratio of the amount of vertical compression to the original sample height. The consolidation pressure curve is provided in this Appendix.

Direct Shear: One direct shear test was performed on remolded samples, which was soaked for a minimum of 24 hours prior to testing. The samples were tested under various normal loads using a motor-driven, strain-controlled, direct-shear testing apparatus (ASTM D3080). The plot is provided in this Appendix.

Maximum Density Tests: The maximum dry density and optimum moisture content of typical materials were determined in accordance with ASTM D1557. The results of these tests are presented in the table below:

Sample Location	Sample Description	Maximum Dry Density (pcf)	Optimum Moisture Content (%)
HS-3 @ 1-5 feet	Dark Olive Brown Clayey Sand	116.0	13.0

Laboratory Testing Procedures and Test Results

Chloride Content: Chloride content was tested in accordance with Caltrans Test Method (CTM) 422. The results are presented below.

Sample Location	Chloride Content, ppm
HS-3 @ 1-5 feet	600
HA-2 @ 1-5 feet	140

Soluble Sulfates: The soluble sulfate contents of selected samples were determined by standard geochemical methods (CTM 417). The soluble sulfate content is used to determine the appropriate cement type and maximum water-cement ratios. The test results are presented in the table below.

Sample Location	Sulfate Content (ppm)	Sulfate Exposure Class *
HS-3 @ 1-5 feet	2535	S2
HA-2 @ 1-5 feet	317	S0

*Based on ACI 318R-14, Table 19.3.1.1

Minimum Resistivity and pH Tests: Minimum resistivity and pH tests were performed in general accordance with CTM 643 and standard geochemical methods. The results are presented in the table below.

Sample Location	pH	Minimum Resistivity (ohms-cm)
HS-3 @ 1-5 feet	8.92	210

ATTERBERG LIMITS

ASTM D 4318

Project Name:	Los Alamitos	Tested By:	S. Felter	Date:	12/03/21
Project No. :	21198-01	Input By:	J. Ward	Date:	12/14/21
Boring No.:	HS-2	Checked By:	J. Ward		
Sample No.:	R-3	Depth (ft.)	7.5		
Soil Identification:	Light olive brown lean clay (CL)				

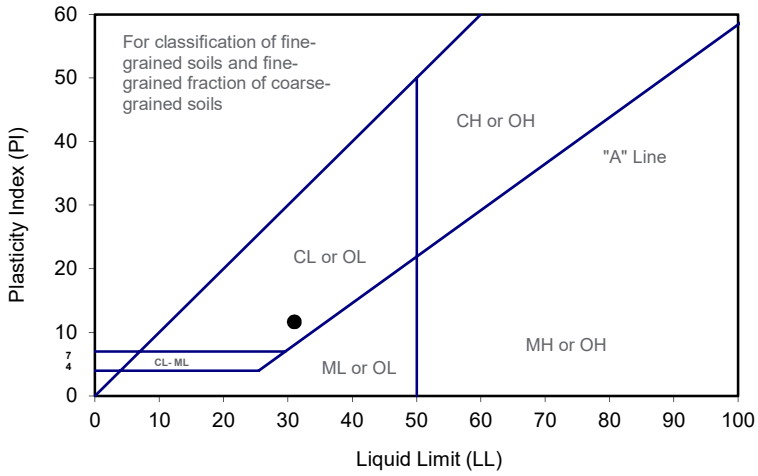
TEST	PLASTIC LIMIT		LIQUID LIMIT			
NO.	1	2	1	2	3	4
Number of Blows [N]			34	27	17	
Wet Wt. of Soil + Cont. (g)	10.70	10.61	21.36	20.43	20.11	
Dry Wt. of Soil + Cont. (g)	9.13	9.08	16.65	15.91	15.53	
Wt. of Container (g)	1.08	1.12	1.11	1.06	1.04	
Moisture Content (%) [Wn]	19.50	19.22	30.31	30.44	31.61	

Liquid Limit	**31**
Plastic Limit	**19**
Plasticity Index	**12**
Classification	**CL**

PI at "A" - Line = 0.73(LL-20) 8.03

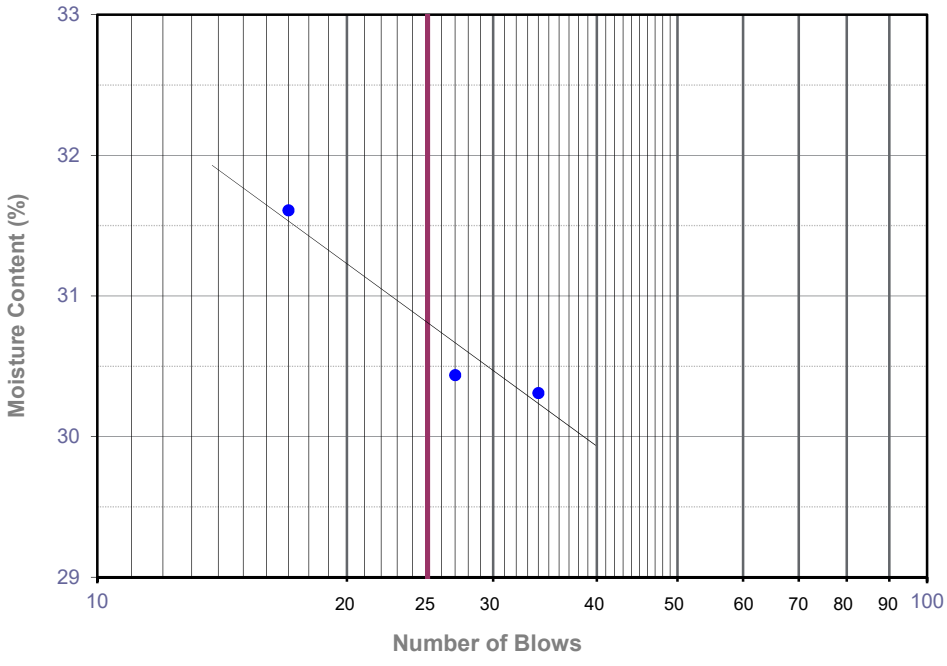
One - Point Liquid Limit Calculation

$LL = Wn(N/25)^{0.121}$



PROCEDURES USED

- [ ] Wet Preparation
  Multipoint - Wet
- [X] Dry Preparation
  Multipoint - Dry
- [X] Procedure A
  Multipoint Test
- [ ] Procedure B
  One-point Test



ATTERBERG LIMITS

ASTM D 4318

Project Name:	Los Alamitos	Tested By:	S. Felter	Date:	12/03/21
Project No. :	21198-01	Input By:	J. Ward	Date:	12/14/21
Boring No.:	HS-2	Checked By:	J. Ward		
Sample No.:	R-5	Depth (ft.)	15.0		
Soil Identification:	Brown lean clay (CL)				

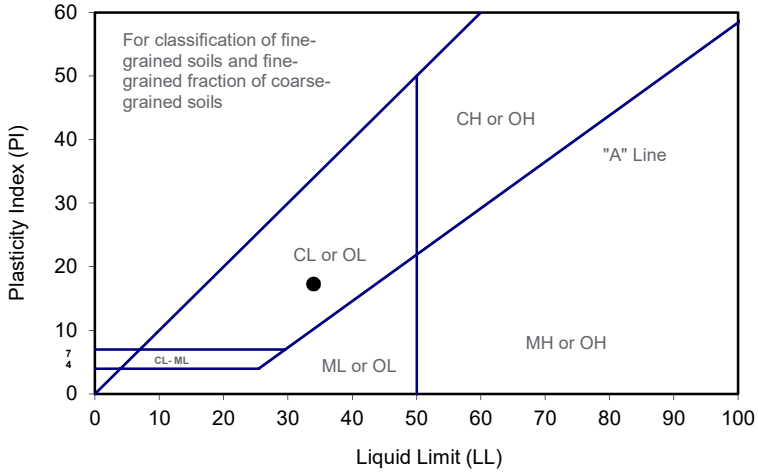
TEST	PLASTIC LIMIT		LIQUID LIMIT			
NO.	1	2	1	2	3	4
Number of Blows [N]			34	25	15	
Wet Wt. of Soil + Cont. (g)	10.21	10.20	20.36	20.23	21.00	
Dry Wt. of Soil + Cont. (g)	8.90	8.89	15.65	15.33	15.77	
Wt. of Container (g)	1.08	1.06	1.10	1.09	1.12	
Moisture Content (%) [Wn]	16.75	16.73	32.37	34.41	35.70	

Liquid Limit	**34**
Plastic Limit	**17**
Plasticity Index	**17**
Classification	**CL**

PI at "A" - Line = 0.73(LL-20) 10.22

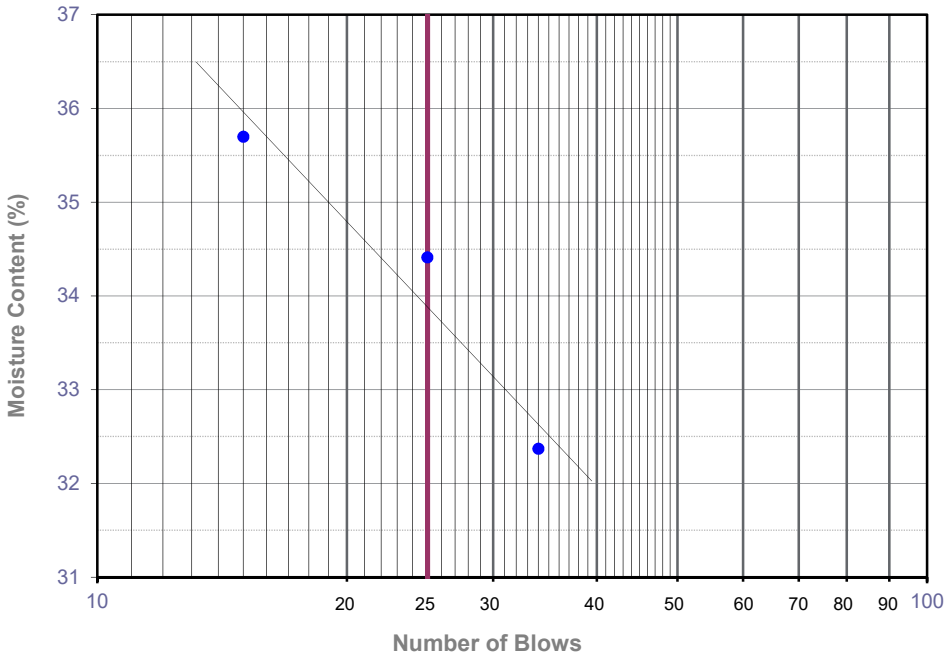
One - Point Liquid Limit Calculation

$LL = Wn(N/25)^{0.121}$



PROCEDURES USED

- [ ] Wet Preparation
  Multipoint - Wet
- [X] Dry Preparation
  Multipoint - Dry
- [X] Procedure A
  Multipoint Test
- [ ] Procedure B
  One-point Test



ATTERBERG LIMITS

ASTM D 4318

Project Name:	Los Alamitos	Tested By:	S. Felter	Date:	12/03/21
Project No. :	21198-01	Input By:	J. Ward	Date:	12/14/21
Boring No.:	HS-2	Checked By:	J. Ward		
Sample No.:	SPT-2	Depth (ft.)	30.0		
Soil Identification:	Olive gray lean clay (CL)				

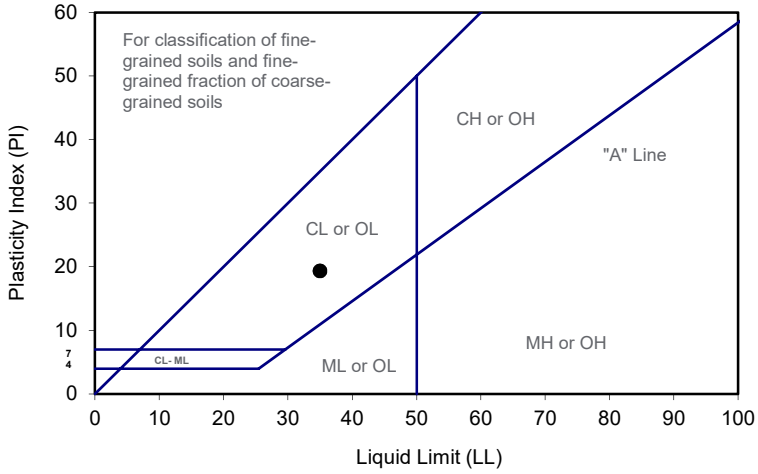
TEST	PLASTIC LIMIT		LIQUID LIMIT			
NO.	1	2	1	2	3	4
Number of Blows [N]			35	25	18	
Wet Wt. of Soil + Cont. (g)	10.49	10.83	20.53	20.10	21.13	
Dry Wt. of Soil + Cont. (g)	9.24	9.48	15.72	15.13	15.74	
Wt. of Container (g)	1.08	1.06	1.12	1.07	1.08	
Moisture Content (%) [Wn]	15.32	16.03	32.95	35.35	36.77	

Liquid Limit	**35**
Plastic Limit	**16**
Plasticity Index	**19**
Classification	**CL**

PI at "A" - Line = 0.73(LL-20) 10.95

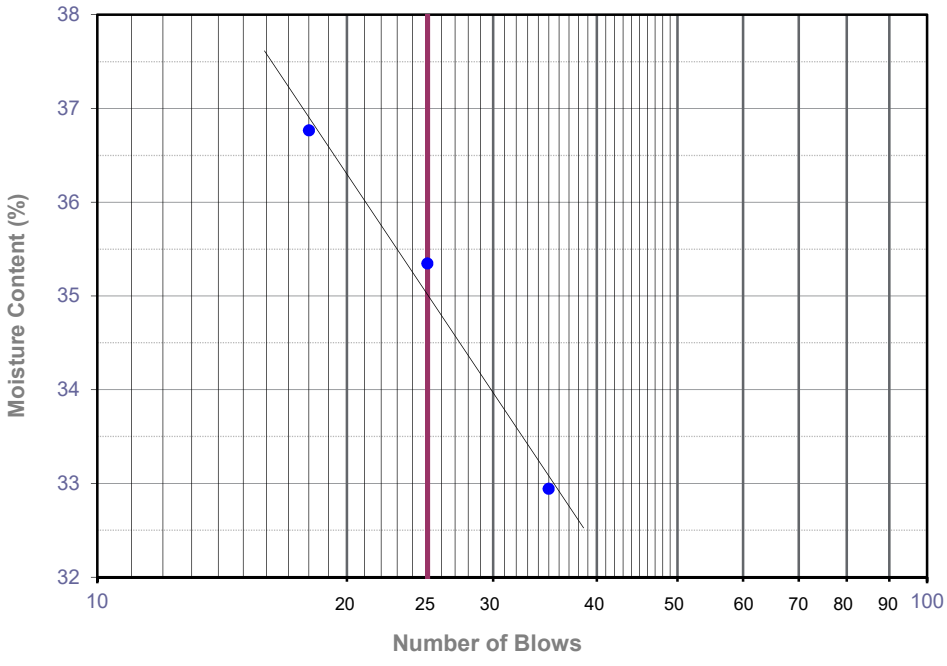
One - Point Liquid Limit Calculation

$LL = Wn(N/25)^{0.121}$



PROCEDURES USED

- [ ] Wet Preparation
  Multipoint - Wet
- [X] Dry Preparation
  Multipoint - Dry
- [X] Procedure A
  Multipoint Test
- [ ] Procedure B
  One-point Test



ATTERBERG LIMITS

ASTM D 4318

Project Name:	Los Alamitos	Tested By:	S. Felter	Date:	12/03/21
Project No. :	21198-01	Input By:	J. Ward	Date:	12/14/21
Boring No.:	HS-3	Checked By:	J. Ward		
Sample No.:	R-3	Depth (ft.)	7.5		
Soil Identification:	Olive brown lean clay (CL)				

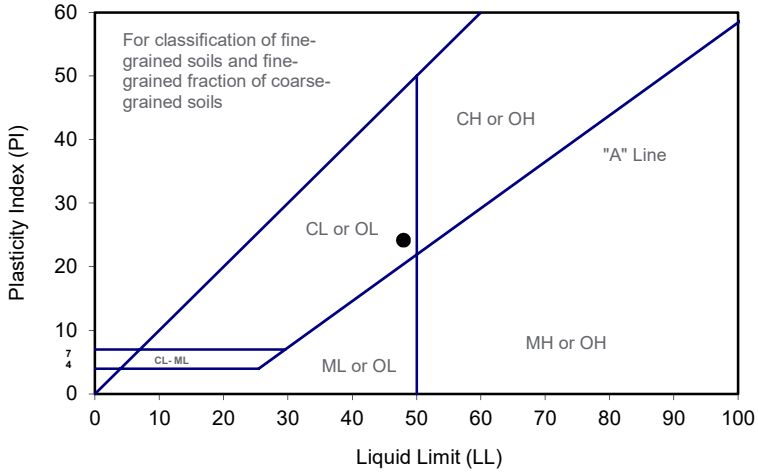
TEST	PLASTIC LIMIT		LIQUID LIMIT			
NO.	1	2	1	2	3	4
Number of Blows [N]			34	28	21	
Wet Wt. of Soil + Cont. (g)	10.09	10.02	20.94	20.13	20.15	
Dry Wt. of Soil + Cont. (g)	8.36	8.30	14.72	14.05	13.85	
Wt. of Container (g)	1.04	1.14	1.05	1.03	1.01	
Moisture Content (%) [Wn]	23.63	24.02	45.50	46.70	49.07	

Liquid Limit	**48**
Plastic Limit	**24**
Plasticity Index	**24**
Classification	**CL**

PI at "A" - Line = 0.73(LL-20) 20.44

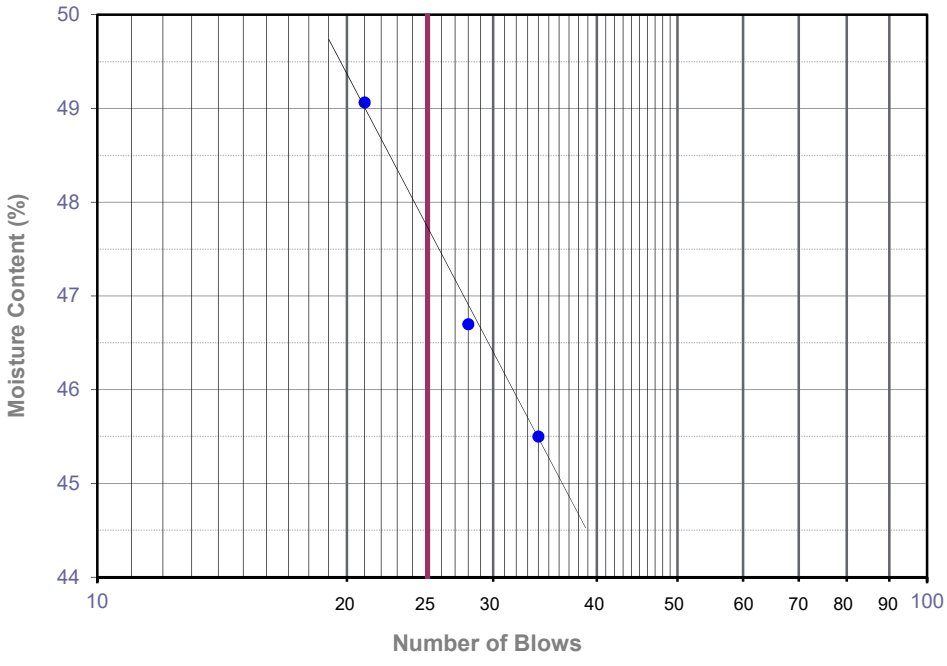
One - Point Liquid Limit Calculation

$LL = Wn(N/25)^{0.121}$



PROCEDURES USED

- [ ] Wet Preparation
  Multipoint - Wet
- [X] Dry Preparation
  Multipoint - Dry
- [X] Procedure A
  Multipoint Test
- [ ] Procedure B
  One-point Test



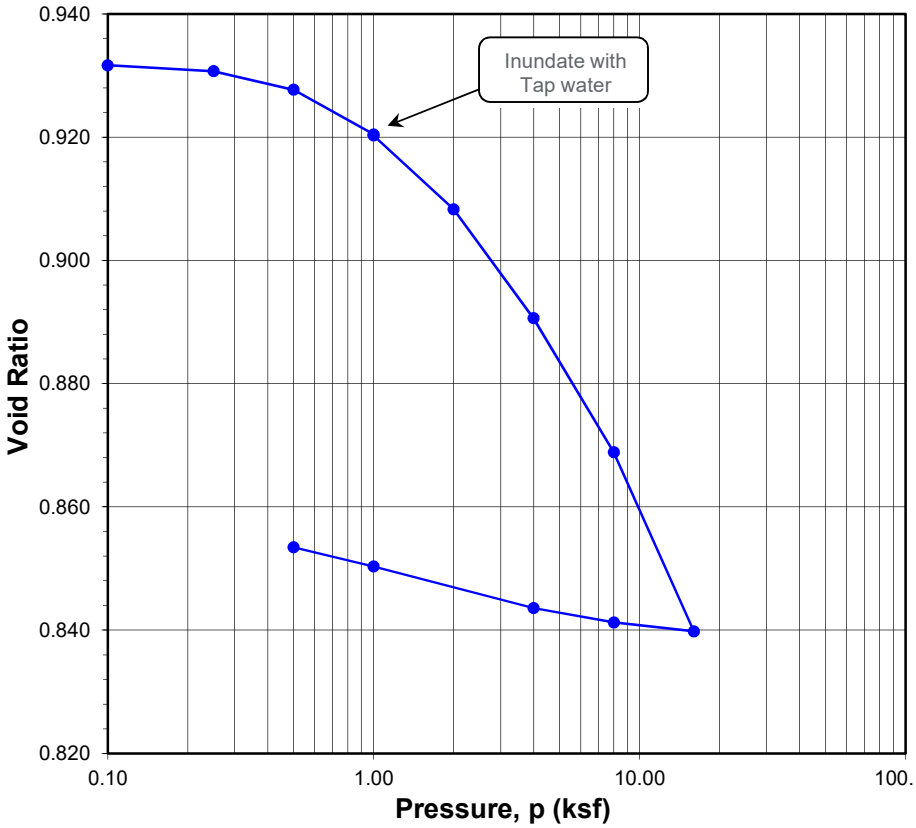
ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS

ASTM D 2435

Project Name: Los Alamitos
Project No.: 21198-01
Boring No.: HS-2
Sample No.: R-3
Soil Identification: Light olive brown lean clay (CL)

Tested By: G. Bathala Date: 11/30/21
Checked By: J. Ward Date: 12/16/21
Depth (ft.): 7.5
Sample Type: Ring

Sample Diameter (in.)	2.415
Sample Thickness (in.)	1.000
Wt. of Sample + Ring (g)	191.82
Weight of Ring (g)	45.88
Height after consol. (in.)	0.9595
Before Test	
Wt.Wet Sample+Cont. (g)	270.84
Wt.of Dry Sample+Cont. (g)	216.12
Weight of Container (g)	51.16
Initial Moisture Content (%)	33.2
Initial Dry Density (pcf)	91.1
Initial Saturation (%)	100
Initial Vertical Reading (in.)	0.3176
After Test	
Wt.of Wet Sample+Cont. (g)	246.12
Wt. of Dry Sample+Cont. (g)	216.12
Weight of Container (g)	59.16
Final Moisture Content (%)	27.01
Final Dry Density (pcf)	96.3
Final Saturation (%)	92
Final Vertical Reading (in.)	0.2743
Specific Gravity (assumed)	2.82
Water Density (pcf)	62.43

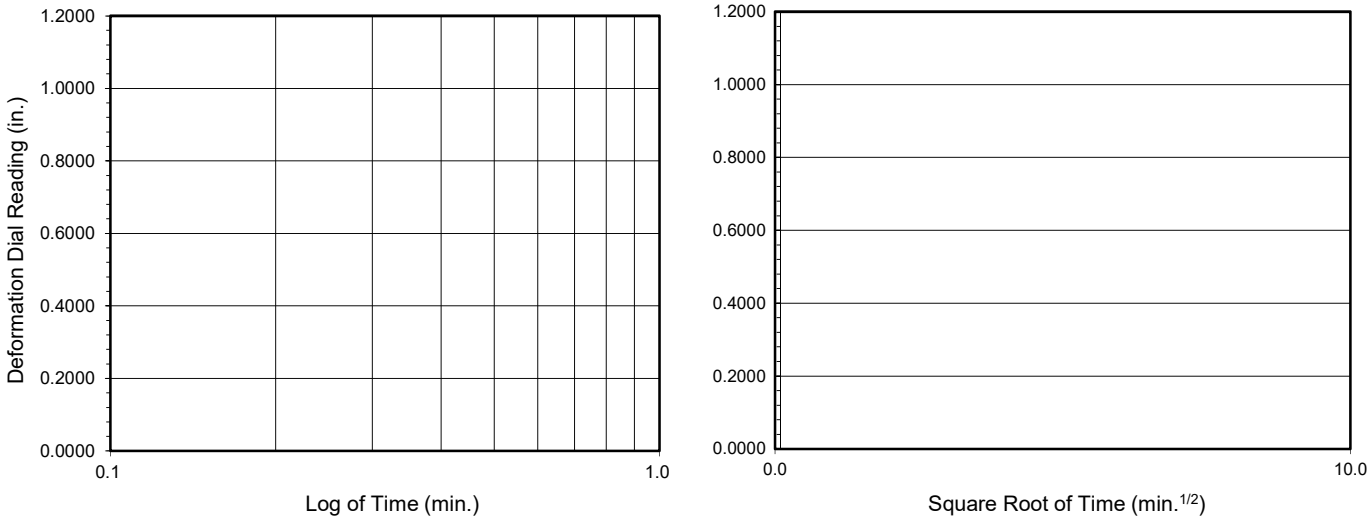


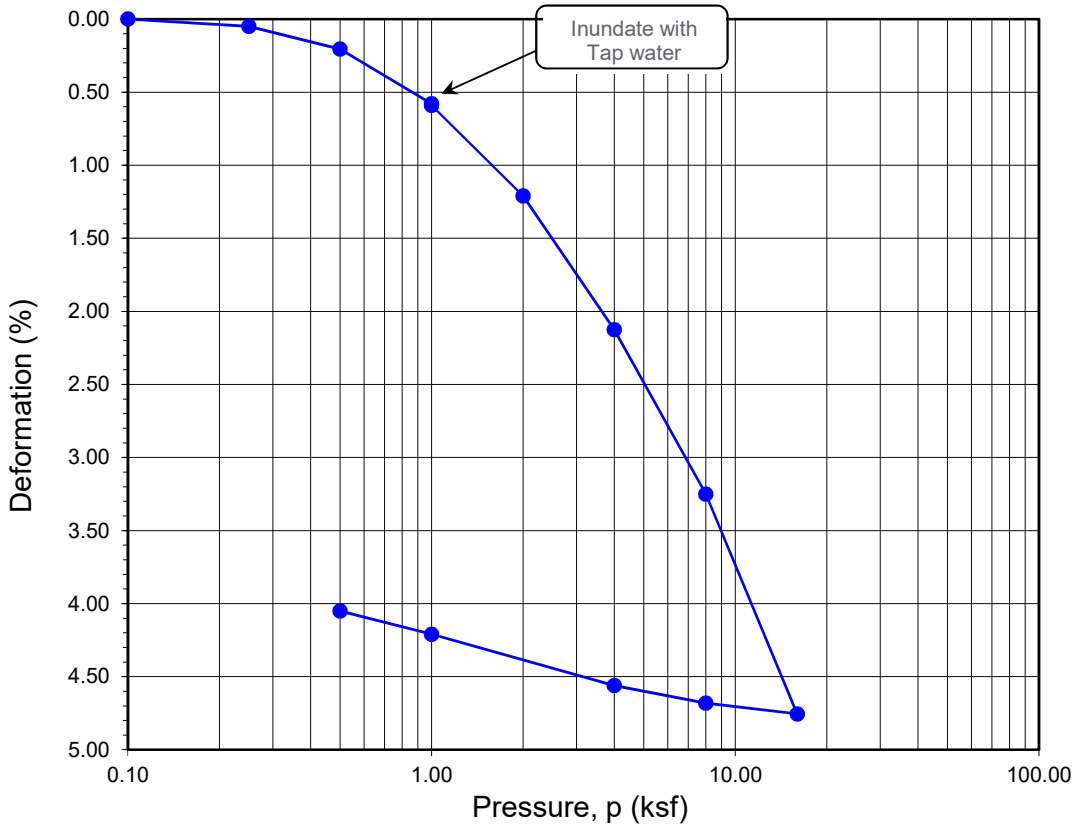
Pressure (p) (ksf)	Final Reading (in.)	Apparent Thickness (in.)	Load Compliance (%)	Deformation % of Sample Thickness	Void Ratio	Corrected Deformation (%)
0.10	0.3176	1.0000	0.00	0.00	0.932	0.00
0.25	0.3166	0.9990	0.05	0.10	0.931	0.05
0.50	0.3146	0.9970	0.10	0.31	0.928	0.21
1.00	0.3100	0.9924	0.18	0.76	0.920	0.58
1.00	0.3099	0.9923	0.18	0.77	0.920	0.59
2.00	0.3028	0.9852	0.27	1.48	0.908	1.21
4.00	0.2924	0.9748	0.40	2.53	0.891	2.13
8.00	0.2795	0.9619	0.56	3.81	0.869	3.25
16.00	0.2624	0.9448	0.77	5.53	0.840	4.76
8.00	0.2643	0.9467	0.65	5.33	0.841	4.68
4.00	0.2666	0.9490	0.54	5.10	0.844	4.56
1.00	0.2719	0.9543	0.36	4.57	0.850	4.21
0.50	0.2743	0.9567	0.28	4.33	0.853	4.05

Time Readings

Date	Time	Elapsed Time (min)	Square Root of Time	Dial Rdgs. (in.)

Time Readings





Boring No.	Sample No.	Depth (ft.)	Moisture Content (%)		Dry Density (pcf)		Void Ratio		Degree of Saturation (%)	
			Initial	Final	Initial	Final	Initial	Final	Initial	Final
HS-2	**R-3**	**7.5**	**33.2**	**27.0**	**91.1**	**96.3**	**0.932**	**0.853**	**100**	**92**

Soil Identification: Light olive brown lean clay (CL)

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS
ASTM D 2435

Project No.: 21198-01

Los Alamitos

12-21

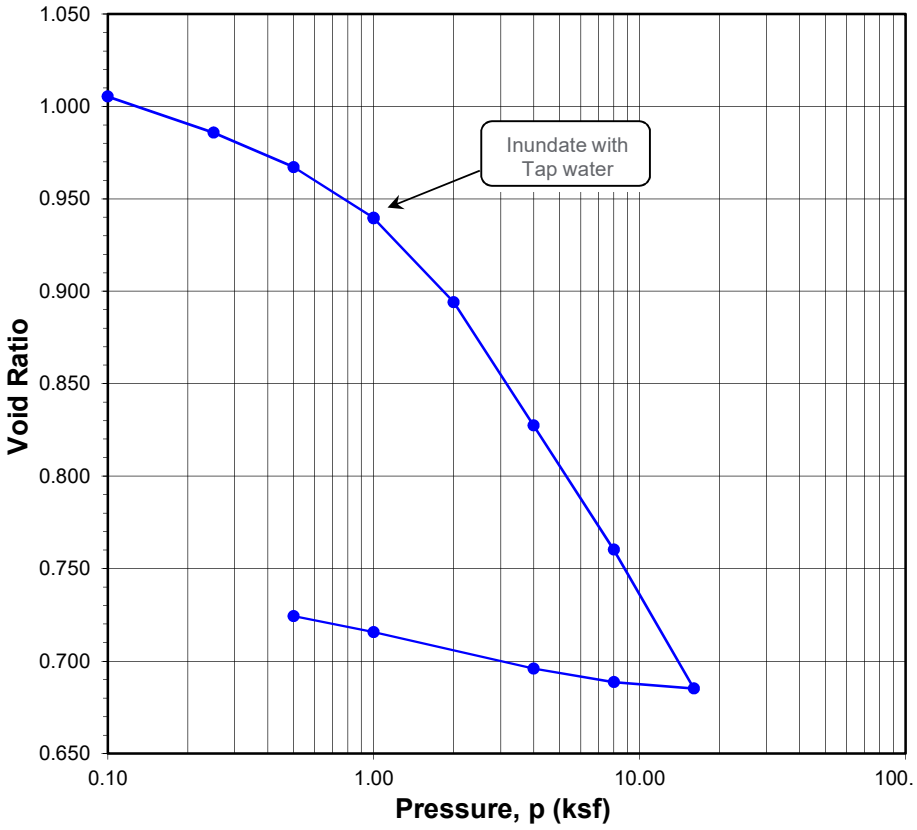
ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS

ASTM D 2435

Project Name: Los Alamitos
Project No.: 21198-01
Boring No.: HS-3
Sample No.: R-3
Soil Identification: Olive brown lean clay (CL)

Tested By: G. Bathala Date: 11/30/21
Checked By: J. Ward Date: 12/16/21
Depth (ft.): 7.5
Sample Type: Ring

Sample Diameter (in.)	2.415
Sample Thickness (in.)	1.000
Wt. of Sample + Ring (g)	190.90
Weight of Ring (g)	45.41
Height after consol. (in.)	0.8542
Before Test	
Wt.Wet Sample+Cont. (g)	264.56
Wt.of Dry Sample+Cont. (g)	210.43
Weight of Container (g)	57.44
Initial Moisture Content (%)	35.4
Initial Dry Density (pcf)	89.4
Initial Saturation (%)	100
Initial Vertical Reading (in.)	0.3339
After Test	
Wt.of Wet Sample+Cont. (g)	234.04
Wt. of Dry Sample+Cont. (g)	209.24
Weight of Container (g)	53.68
Final Moisture Content (%)	22.51
Final Dry Density (pcf)	107.2
Final Saturation (%)	95
Final Vertical Reading (in.)	0.1866
Specific Gravity (assumed)	2.89
Water Density (pcf)	62.43

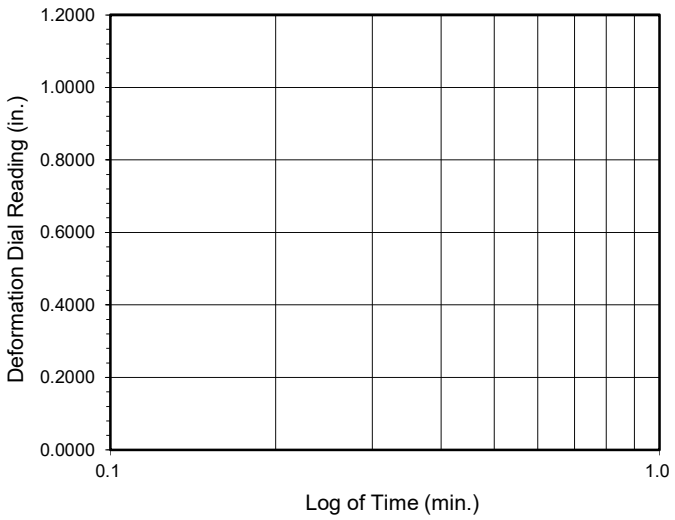


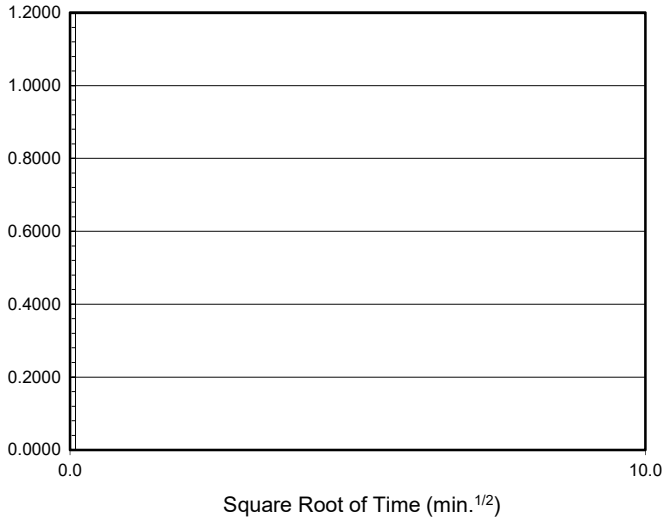
Pressure (p) (ksf)	Final Reading (in.)	Apparent Thickness (in.)	Load Compliance (%)	Deformation % of Sample Thickness	Void Ratio	Corrected Deformation (%)
0.10	0.3273	0.9934	0.00	0.66	1.005	0.66
0.25	0.3174	0.9835	0.02	1.65	0.986	1.63
0.50	0.3080	0.9741	0.04	2.59	0.967	2.55
1.00	0.2941	0.9602	0.07	3.98	0.940	3.91
1.00	0.2940	0.9601	0.07	3.99	0.939	3.92
2.00	0.2711	0.9372	0.11	6.28	0.894	6.17
4.00	0.2374	0.9035	0.18	9.65	0.827	9.47
8.00	0.2031	0.8692	0.28	13.08	0.760	12.80
16.00	0.1646	0.8307	0.41	16.93	0.685	16.52
8.00	0.1668	0.8329	0.36	16.71	0.689	16.35
4.00	0.1710	0.8371	0.30	16.29	0.696	15.99
1.00	0.1819	0.8480	0.19	15.20	0.716	15.01
0.50	0.1866	0.8527	0.15	14.73	0.724	14.58

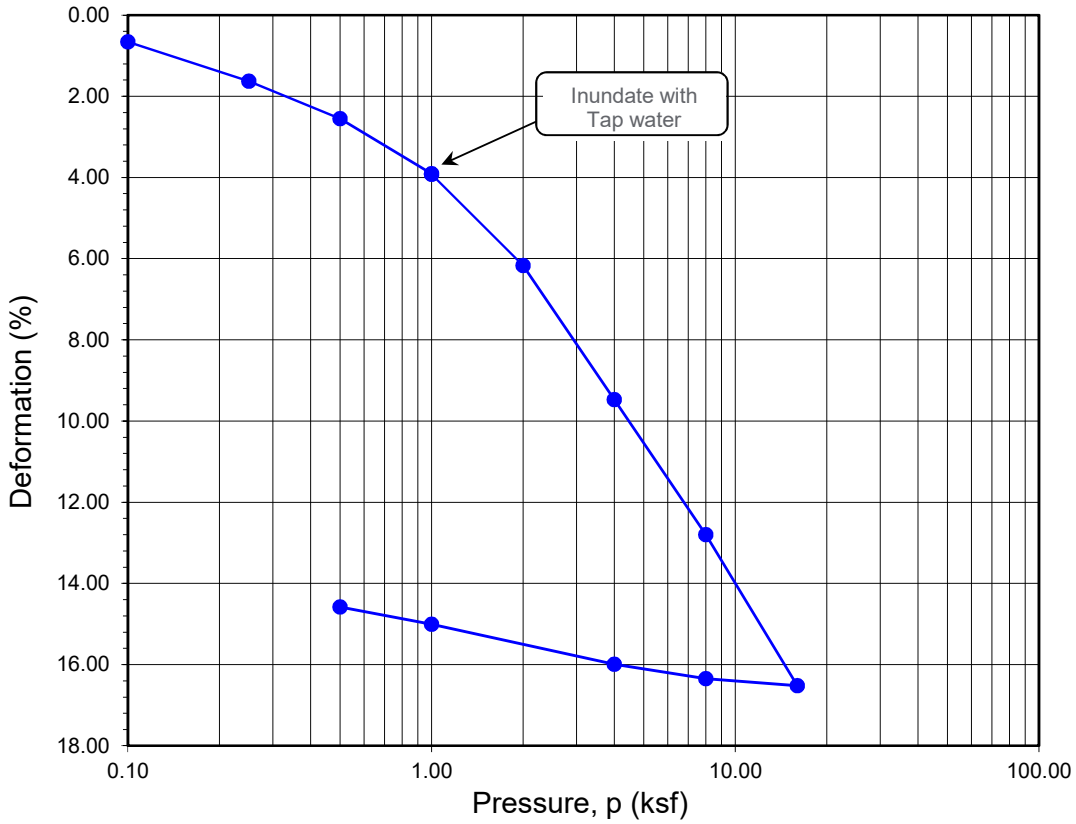
Time Readings

Date	Time	Elapsed Time (min)	Square Root of Time	Dial Rdgs. (in.)

Time Readings







Boring No.	Sample No.	Depth (ft.)	Moisture Content (%)		Dry Density (pcf)		Void Ratio		Degree of Saturation (%)	
			Initial	Final	Initial	Final	Initial	Final	Initial	Final
HS-3	**R-3**	**7.5**	**35.4**	**22.5**	**89.4**	**107.2**	**1.019**	**0.724**	**100**	**95**

Soil Identification: Olive brown lean clay (CL)

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS
ASTM D 2435

Project No.: 21198-01

Los Alamitos

12-21

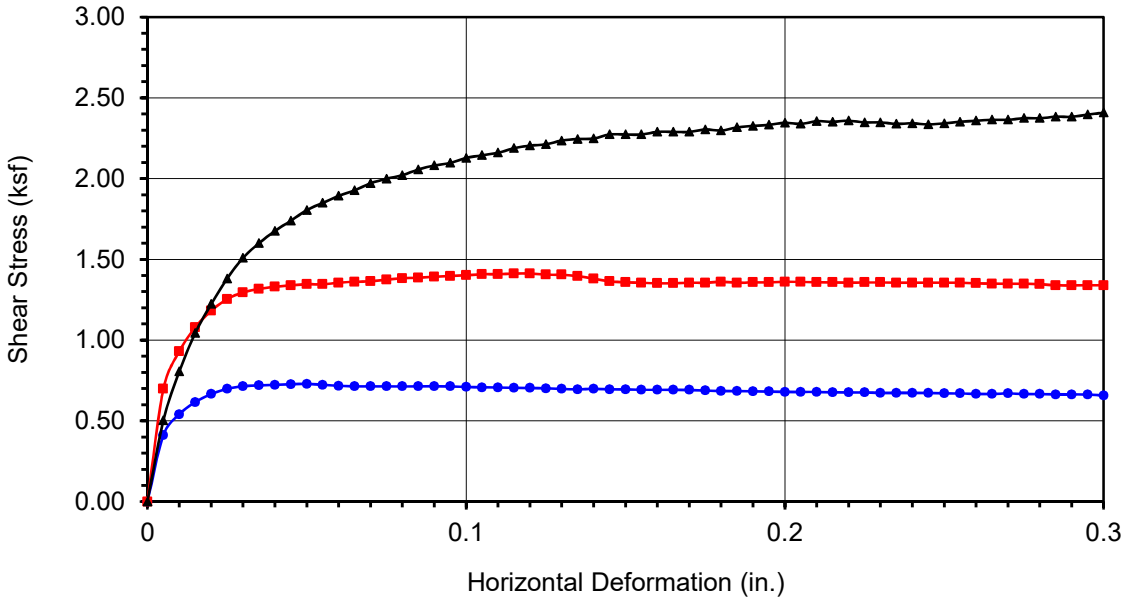
DIRECT SHEAR TEST

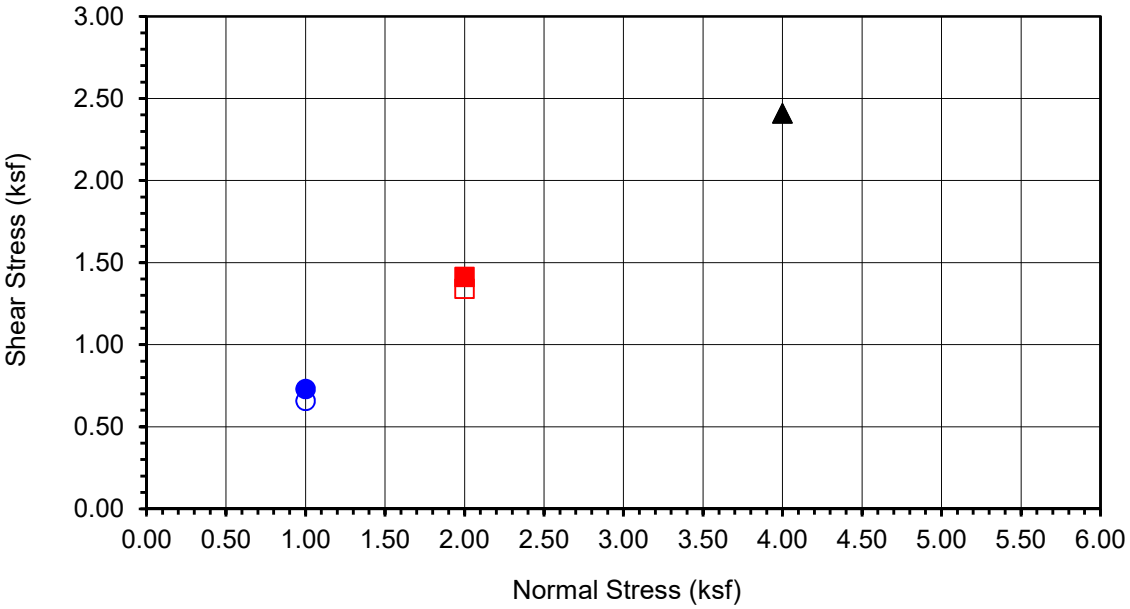
Consolidated Drained - ASTM D 3080

Project Name:	Los Alamitos	Tested By:	G. Bathala	Date:	12/07/21
Project No.:	21198-01	Checked By:	J. Ward	Date:	12/14/21
Boring No.:	HS-3	Sample Type:	Ring		
Sample No.:	B-1	Depth (ft.):	1-5		

Soil Identification: Dark olive brown clayey sand (SC)

Sample Diameter(in):	2.415	2.415	2.415
Sample Thickness(in.):	1.000	1.000	1.000
Weight of Sample + ring(gm):	187.01	186.85	187.84
Weight of Ring(gm):	45.35	44.87	45.57
Before Shearing			
Weight of Wet Sample+Cont.(gm):	163.89	163.89	163.89
Weight of Dry Sample+Cont.(gm):	151.63	151.63	151.63
Weight of Container(gm):	57.48	57.48	57.48
Vertical Rdg.(in): Initial	0.2546	0.2461	0.0000
Vertical Rdg.(in): Final	0.2615	0.2585	-0.0239
After Shearing			
Weight of Wet Sample+Cont.(gm):	213.85	185.81	215.32
Weight of Dry Sample+Cont.(gm):	188.00	160.70	191.32
Weight of Container(gm):	64.02	36.53	68.15
Specific Gravity (Assumed):	2.70	2.70	2.70
Water Density(pcf):	62.43	62.43	62.43





Boring No.	**HS-3**
Sample No.	**B-1**
Depth (ft)	**1-5**
Sample Type:	
Ring	
Soil Identification:	
Dark olive brown clayey sand (SC)	

Normal Stress (kip/ft²)	1.000	2.000	4.000
Peak Shear Stress (kip/ft²)	● 0.729	■ 1.412	▲ 2.408
Shear Stress @ End of Test (ksf)	○ 0.657	□ 1.339	△ 2.408
Deformation Rate (in./min.)	0.0017	0.0017	0.0017
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	13.02	13.02	13.02
Dry Density (pcf)	104.2	104.5	104.7
Saturation (%)	57.0	57.3	57.6
Soil Height Before Shearing (in.)	0.9931	0.9876	0.9761
Final Moisture Content (%)	20.9	20.2	19.5

DIRECT SHEAR TEST RESULTS

Consolidated Drained - ASTM D 3080

Project No.: 21198-01

Los Alamitos

12-21

Appendix D
Infiltration Test Data

Infiltration Test Data Sheet

LGC Geotechnical, Inc

131 Calle Iglesia Suite 200, San Clemente, CA 92672 tel. (949) 369-6141

Project Name: MWIG - Los Alamitos
Project Number: 21198-01
Date: 11/12/2021
Boring Number: I-1

Test hole dimensions (if circular)	
Boring Depth (feet)*:	5
Boring Diameter (inches):	8
Pipe Diameter (inches):	3

Test pit dimensions (if rectangular)	
Pit Depth (feet):	
Pit Length (feet):	
Pit Breadth (feet):	

*Pre-Test (Sandy Soil Criteria)**

Trial No.	Start Time (24:HR)	Stop Time (24:HR)	Time Interval (min)	Initial Depth to Water (feet)	Final Depth to Water (feet)	Total Change in Water Level (feet)	Greater Than or Equal to 0.5 feet (yes/no)
1	8:47	9:12	25.0	2.52	2.54	0.02	No
2	9:12	9:37	25.0	2.54	2.56	0.02	No

*If two consecutive measurements show that six inches of water seeps away in less than 25 minutes, the test shall be run for an additional hour with measurements taken every 10 minutes. Otherwise, pre-soak (fill) overnight, and then obtain at least twelve measurements per hole over at least six hours (approximately 30 minute intervals) with a precision of at least 0.25 inches

Main Test Data

Trial No.	Start Time (24:HR)	Stop Time (24:HR)	Time Interval, Δt (min)	Initial Depth to Water, D_o (feet)	Final Depth to Water, D_f (feet)	Change in Water Level, ΔD (feet)	Calculated Infiltration Rate(in/hr)
1	9:37	10:07	30.0	2.56	2.57	0.01	0.02
2	10:07	10:37	30.0	2.57	2.58	0.01	0.02
3	10:37	11:07	30.0	2.58	2.59	0.01	0.02
4	11:07	11:37	30.0	2.59	2.60	0.01	0.02
5	11:37	12:07	30.0	2.60	2.61	0.01	0.02
6	12:07	12:37	30.0	2.61	2.62	0.01	0.02
7	12:37	13:07	30.0	2.62	2.63	0.01	0.02
8	13:07	13:37	30.0	2.63	2.64	0.01	0.02
9	13:37	14:07	30.0	2.64	2.66	0.02	0.03
10	14:07	14:37	30.0	2.66	2.67	0.01	0.02
11	14:37	15:07	30.0	2.67	2.68	0.01	0.02
12	15:07	15:37	30.0	2.68	2.70	0.02	0.03
						Calculated Infiltration Rate (No factors of safety)	**0.03**
						Factor of Safety	
						Calculated Infiltration Rate (With Factor of Safety)	

Sketch:

Notes:

Based on Guidelines from: Orange County 12/20/2013

Spreadsheet Revised on: 10/26/2016

LGC Geotechnical, Inc.

Infiltration Test Data Sheet

LGC Geotechnical, Inc

131 Calle Iglesia Suite 200, San Clemente, CA 92672 tel. (949) 369-6141

Project Name: MWIG - Los Alamitos
Project Number: 21198-01
Date: 11/12/2021
Boring Number: I-2

Test hole dimensions (if circular)	
Boring Depth (feet)*:	5
Boring Diameter (inches):	8
Pipe Diameter (inches):	3

Test pit dimensions (if rectangular)	
Pit Depth (feet):	
Pit Length (feet):	
Pit Breadth (feet):	

*Pre-Test (Sandy Soil Criteria)**

Trial No.	Start Time (24:HR)	Stop Time (24:HR)	Time Interval (min)	Initial Depth to Water (feet)	Final Depth to Water (feet)	Total Change in Water Level (feet)	Greater Than or Equal to 0.5 feet (yes/no)
1	8:54	9:19	25.0	2.72	2.74	0.02	No
2	9:19	9:44	25.0	2.74	2.75	0.01	No

*If two consecutive measurements show that six inches of water seeps away in less than 25 minutes, the test shall be run for an additional hour with measurements taken every 10 minutes. Otherwise, pre-soak (fill) overnight, and then obtain at least twelve measurements per hole over at least six hours (approximately 30 minute intervals) with a precision of at least 0.25 inches

Main Test Data

Trial No.	Start Time (24:HR)	Stop Time (24:HR)	Time Interval, Δt (min)	Initial Depth to Water, D_o (feet)	Final Depth to Water, D_f (feet)	Change in Water Level, ΔD (feet)	Calculated Infiltration Rate(in/hr)
1	9:44	10:14	30.0	2.75	2.76	0.01	0.02
2	10:14	10:44	30.0	2.76	2.77	0.01	0.02
3	10:44	11:14	30.0	2.77	2.78	0.01	0.02
4	11:14	11:44	30.0	2.78	2.80	0.02	0.03
5	11:44	12:14	30.0	2.80	2.81	0.01	0.02
6	12:14	12:44	30.0	2.81	2.82	0.01	0.02
7	12:44	13:14	30.0	2.82	2.83	0.01	0.02
8	13:14	13:44	30.0	2.83	2.85	0.02	0.03
9	13:44	14:14	30.0	2.85	2.87	0.02	0.03
10	14:14	14:44	30.0	2.87	2.88	0.01	0.02
11	14:44	15:14	30.0	2.88	2.89	0.01	0.02
12	15:14	15:44	30.0	2.89	2.91	0.02	0.04
						Calculated Infiltration Rate (No factors of safety)	**0.04**
						Factor of Safety	
						Calculated Infiltration Rate (With Factor of Safety)	

Sketch:

Notes:

Based on Guidelines from: Orange County 12/20/2013

Spreadsheet Revised on: 10/26/2016

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Appendix E
General Earthwork and Grading Specifications for Rough Grading

General Earthwork and Grading Specifications for Rough Grading

1.0 General

1.1 Intent

These General Earthwork and Grading Specifications are for the grading and earthwork shown on the approved grading plan(s) and/or indicated in the geotechnical report(s). These Specifications are a part of the recommendations contained in the geotechnical report(s). In case of conflict, the specific recommendations in the geotechnical report shall supersede these more general Specifications. Observations of the earthwork by the project Geotechnical Consultant during the course of grading may result in new or revised recommendations that could supersede these specifications or the recommendations in the geotechnical report(s).

1.2 The Geotechnical Consultant of Record

Prior to commencement of work, the owner shall employ a qualified Geotechnical Consultant of Record (Geotechnical Consultant). The Geotechnical Consultant shall be responsible for reviewing the approved geotechnical report(s) and accepting the adequacy of the preliminary geotechnical findings, conclusions, and recommendations prior to the commencement of the grading.

Prior to commencement of grading, the Geotechnical Consultant shall review the "work plan" prepared by the Earthwork Contractor (Contractor) and schedule sufficient personnel to perform the appropriate level of observation, mapping, and compaction testing.

During the grading and earthwork operations, the Geotechnical Consultant shall observe, map, and document the subsurface exposures to verify the geotechnical design assumptions. If the observed conditions are found to be significantly different than the interpreted assumptions during the design phase, the Geotechnical Consultant shall inform the owner, recommend appropriate changes in design to accommodate the observed conditions, and notify the review agency where required.

The Geotechnical Consultant shall observe the moisture-conditioning and processing of the subgrade and fill materials and perform relative compaction testing of fill to confirm that the attained level of compaction is being accomplished as specified. The Geotechnical Consultant shall provide the test results to the owner and the Contractor on a routine and frequent basis.

1.3 The Earthwork Contractor

The Earthwork Contractor (Contractor) shall be qualified, experienced, and knowledgeable in earthwork logistics, preparation and processing of ground to receive fill, moisture-conditioning and processing of fill, and compacting fill. The Contractor shall review and accept the plans, geotechnical report(s), and these Specifications prior to commencement of grading. The Contractor shall be solely responsible for performing the grading in accordance with the project plans and specifications. The Contractor shall prepare and submit to the owner and the Geotechnical Consultant a work plan that indicates the sequence of earthwork grading, the number of “equipment” of work and the estimated quantities of daily earthwork

contemplated for the site prior to commencement of grading. The Contractor shall inform the owner and the
Geotechnical Consultant of changes in work schedules and updates to the work plan at least 24 hours in advance of such changes so that appropriate personnel will be available for observation and testing. The Contractor shall not assume that the Geotechnical Consultant is aware of all grading operations.

The Contractor shall have the sole responsibility to provide adequate equipment and methods to accomplish the earthwork in accordance with the applicable grading codes and agency ordinances, these Specifications, and the recommendations in the approved geotechnical report(s) and grading plan(s). If, in the opinion of the Geotechnical Consultant, unsatisfactory conditions, such as unsuitable soil, improper moisture condition, inadequate compaction, insufficient buttress key size, adverse weather, etc., are resulting in a quality of work less than required in these specifications, the Geotechnical Consultant shall reject the work and may recommend to the owner that construction be stopped until the conditions are rectified. It is the contractor's sole responsibility to provide proper fill compaction.

2.0 Preparation of Areas to be Filled

2.1 Clearing and Grubbing

Vegetation, such as brush, grass, roots, and other deleterious material shall be sufficiently removed and properly disposed of in a method acceptable to the owner, governing agencies, and the Geotechnical Consultant.

The Geotechnical Consultant shall evaluate the extent of these removals depending on specific site conditions. Earth fill material shall not contain more than 1 percent of organic materials (by volume). Nesting of the organic materials shall not be allowed.

If potentially hazardous materials are encountered, the Contractor shall stop work in the affected area, and a hazardous material specialist shall be informed immediately for proper evaluation and handling of these materials prior to continuing to work in that area.

As presently defined by the State of California, most refined petroleum products (gasoline, diesel fuel, motor oil, grease, coolant, etc.) have chemical constituents that are considered to be hazardous waste. As such, the indiscriminate dumping or spillage of these fluids onto the ground may constitute a misdemeanor, punishable by fines and/or imprisonment, and shall not be allowed. The contractor is responsible for all hazardous waste relating to his work. The Geotechnical Consultant does not have expertise in this area. If hazardous waste is a concern, then the Client should acquire the services of a qualified environmental assessor.

2.2 Processing

Existing ground that has been declared satisfactory for support of fill by the Geotechnical Consultant shall be scarified to a minimum depth of 6 inches. Existing ground that is not satisfactory shall be over-excavated as specified in the following section. Scarification shall continue until soils are broken down and free of oversize material and the working surface is reasonably uniform, flat, and free of uneven features that would inhibit uniform compaction.

2.3 Over-excavation

In addition to removals and over-excavations recommended in the approved geotechnical report(s) and the grading plan, soft, loose, dry, saturated, spongy, organic-rich, highly fractured or otherwise unsuitable ground shall be over-excavated to competent ground as evaluated by the Geotechnical Consultant during grading.

2.4 Benching

Where fills are to be placed on ground with slopes steeper than 5:1 (horizontal to vertical units), the ground shall be stepped or benched. Please see the Standard Details for a graphic illustration. The lowest bench or key shall be a minimum of 15 feet wide and at least 2 feet deep, into competent material as evaluated by the Geotechnical Consultant. Other benches shall be excavated a minimum height of 4 feet into competent material or as otherwise recommended by the Geotechnical Consultant. Fill placed on ground sloping flatter than 5:1 shall also be benched or otherwise over-excavated to provide a flat subgrade for the fill.

2.5 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 the survey control for determining elevations of processed areas, keys, and benches.

3.0 Fill Material

3.1 General

Material to be used as fill shall be essentially free of organic matter and other deleterious substances evaluated and accepted by the Geotechnical Consultant prior to placement. 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.

3.2 Oversize

Oversize material defined as rock, or other irreducible material with a maximum dimension greater than 8 inches, shall not be buried or placed in fill unless location, materials, and placement methods are specifically accepted by the Geotechnical Consultant. Placement operations shall be such that nesting of oversized material does not occur and such that oversize material is completely surrounded by compacted or densified fill. Oversize material shall not be placed within 10 vertical feet of finish grade or within 2 feet of future utilities or underground construction.

3.3 Import

If importing of fill material is required for grading, proposed import material shall meet the requirements of the geotechnical consultant. The potential import source shall be given to the Geotechnical Consultant at least 48 hours (2 working days) before importing begins so that its suitability can be determined and appropriate tests performed.

4.0 Fill Placement and Compaction

4.1 Fill Layers

Approved fill material shall be placed in areas prepared to receive fill (per Section 3.0) in near-horizontal layers not exceeding 8 inches in loose thickness. The Geotechnical Consultant may accept thicker layers if testing indicates the grading procedures can adequately compact the thicker layers. Each layer shall be spread evenly and mixed thoroughly to attain relative uniformity of material and moisture throughout.

4.2 Fill 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 over optimum. Maximum density and optimum soil moisture content tests shall be performed in accordance with the American Society of Testing and Materials (ASTM Test Method D1557).

4.3 Compaction of Fill

After each layer has been moisture-conditioned, mixed, and evenly spread, it shall be uniformly compacted to not less than 90 percent of maximum dry density (ASTM Test Method D1557). Compaction equipment shall be adequately sized and be either specifically designed for soil compaction or of proven reliability to efficiently achieve the specified level of compaction with uniformity.

4.4 Compaction of Fill Slopes

In addition to normal compaction procedures specified above, compaction of slopes shall be accomplished by backrolling of slopes with sheepsfoot rollers at increments of 3 to 4 feet in fill elevation, or by other methods producing satisfactory results acceptable to the Geotechnical Consultant. Upon completion of grading, relative compaction of the fill, out to the slope face, shall be at least 90 percent of maximum density per ASTM Test Method D1557.

4.5 Compaction Testing

Field tests for moisture content and relative compaction of the fill soils shall be performed by the Geotechnical Consultant. Location and frequency of tests shall be at the Consultant's discretion based on field conditions encountered. Compaction test locations will not necessarily be selected on a random basis. Test locations shall be selected to verify adequacy of compaction levels in areas that are judged to be prone to inadequate compaction (such as close to slope faces and at the fill/bedrock benches).

4.6 Frequency of Compaction Testing

Tests shall be taken at intervals not exceeding 2 feet in vertical rise and/or 1,000 cubic yards of compacted fill soils embankment. In addition, as a guideline, at least one test shall be taken on slope faces for each 5,000 square feet of slope face and/or each 10 feet of vertical height of slope. The Contractor shall assure that fill construction is such that the testing schedule can be accomplished by the Geotechnical Consultant. The Contractor shall stop or slow down the earthwork construction if these minimum standards are not met.

4.7 Compaction Test Locations

The Geotechnical Consultant shall document the approximate elevation and horizontal coordinates of each test location. The Contractor shall coordinate with the project surveyor to assure that sufficient grade stakes are established so that the Geotechnical Consultant can determine the test locations with sufficient accuracy. At a minimum, two grade stakes within a horizontal distance of 100 feet and vertically less than
5 feet apart from potential test locations shall be provided.

5.0 Subdrain Installation

Subdrain systems shall be installed in accordance with the approved geotechnical report(s), the grading plan, and the Standard Details. The Geotechnical Consultant may recommend additional subdrains and/or changes in subdrain extent, location, grade, or material depending on conditions encountered during grading. All subdrains shall be surveyed by a land surveyor/civil engineer for line and grade after installation and prior to burial. Sufficient time should be allowed by the Contractor for these surveys.

6.0 Excavation

Excavations, as well as over-excavation for remedial purposes, shall be evaluated by the Geotechnical Consultant during grading. Remedial removal depths shown on geotechnical plans are estimates only. The actual extent of removal shall be determined by the Geotechnical Consultant based on the field evaluation of exposed conditions during grading. Where fill-over-cut slopes are to be graded, the cut portion of the slope shall be made, evaluated, and accepted by the Geotechnical Consultant prior to placement of materials for construction of the fill portion of the slope, unless otherwise recommended by the Geotechnical Consultant.

7.0 Trench Backfills

7.1 The Contractor shall follow all OHSA and Cal/OSHA requirements for safety of trench excavations.

7.2 All bedding and backfill of utility trenches shall be done in accordance with the applicable provisions of Standard Specifications of Public Works Construction. Bedding material shall have a Sand Equivalent greater than 30 (SE>30). The bedding shall be placed to 1 foot over

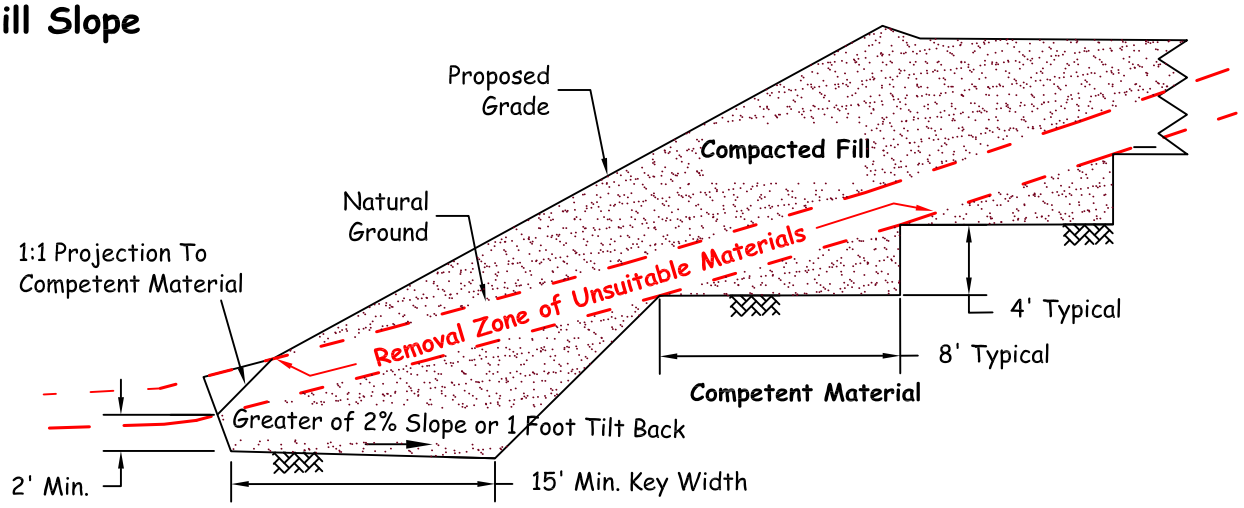
the top of the conduit and densified by jetting. Backfill shall be placed and densified to a minimum of 90 percent of maximum from 1 foot above the top of the conduit to the surface.

7.3 The jetting of the bedding around the conduits shall be observed by the Geotechnical Consultant.

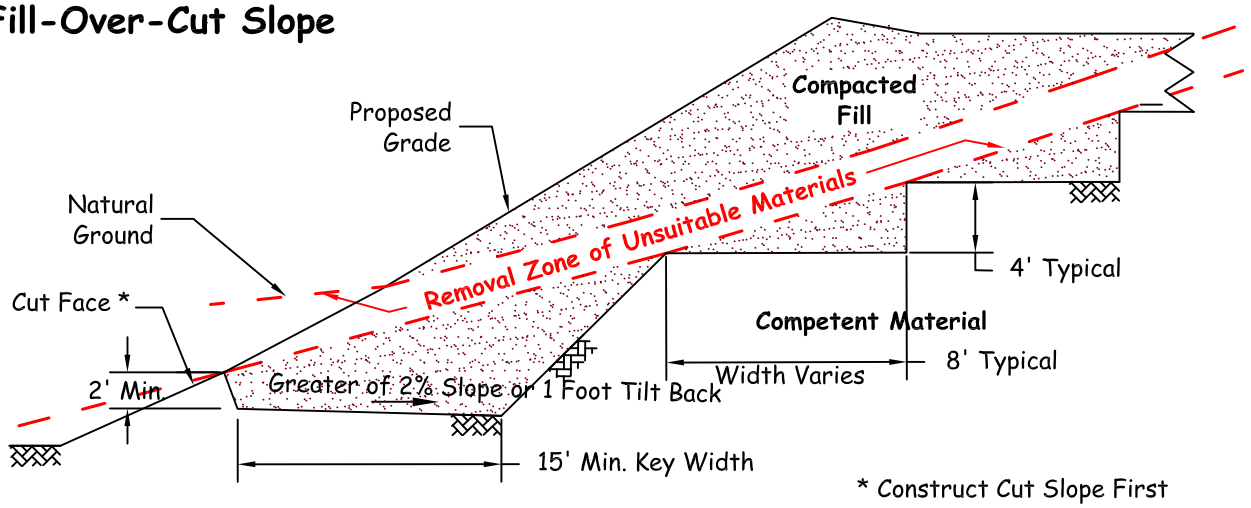
7.4 The Geotechnical Consultant shall test the trench backfill for relative compaction. At least one test should be made for every 300 feet of trench and 2 feet of fill.

7.5 Lift thickness of trench backfill shall not exceed those allowed in the Standard Specifications of Public Works Construction unless the Contractor can demonstrate to the Geotechnical Consultant that the fill lift can be compacted to the minimum relative compaction by his alternative equipment and method.

Fill Slope

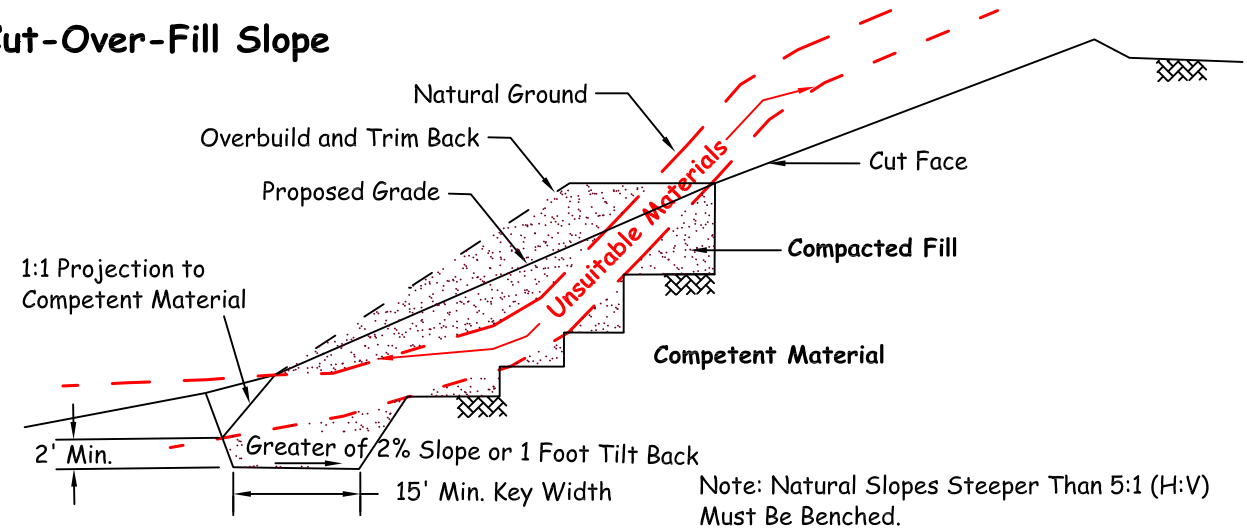


Fill-Over-Cut Slope



* Construct Cut Slope First

Cut-Over-Fill Slope



Note: Natural Slopes Steeper Than 5:1 (H:V) Must Be Benched.

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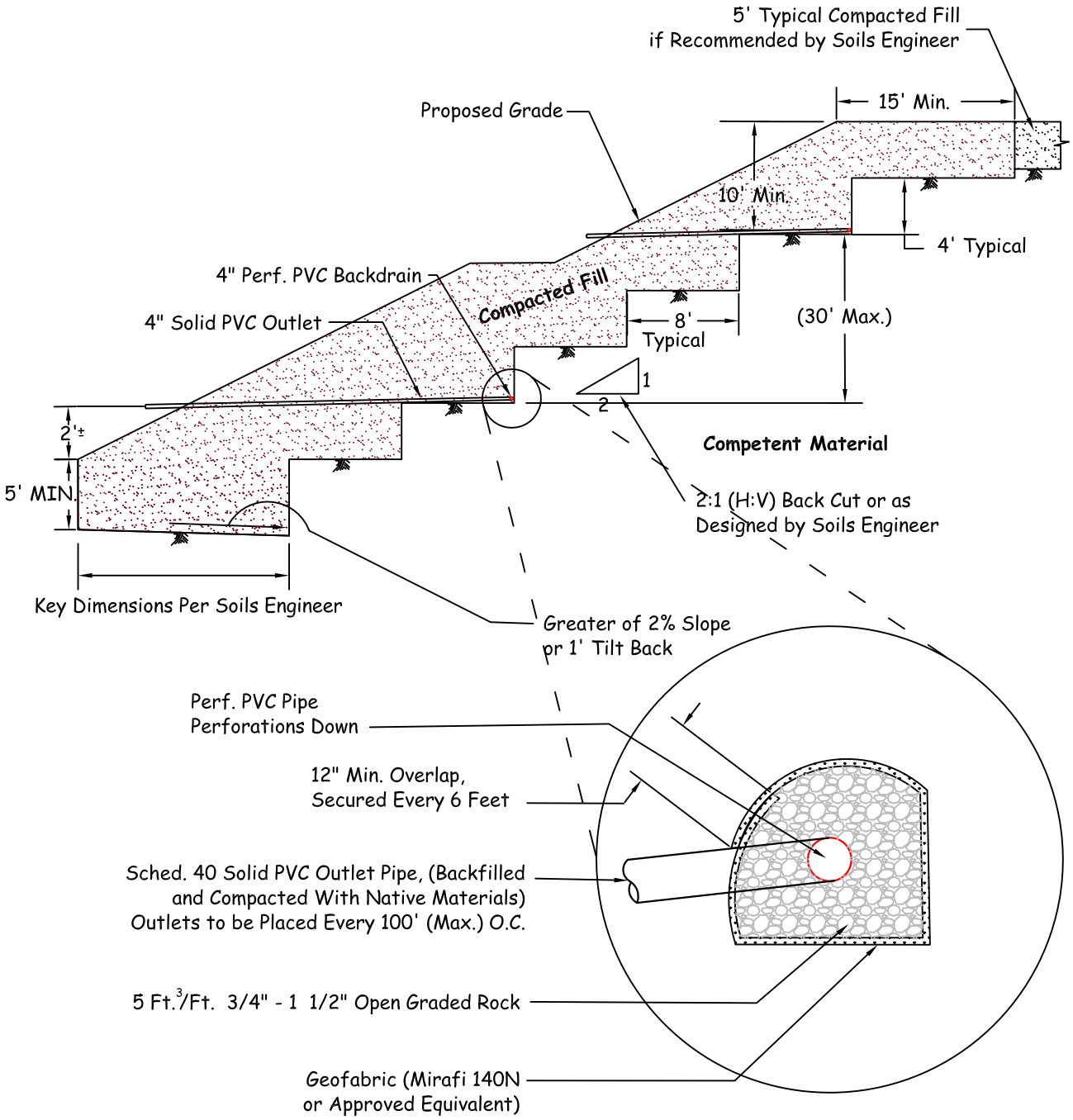
KEYING AND BENCHING



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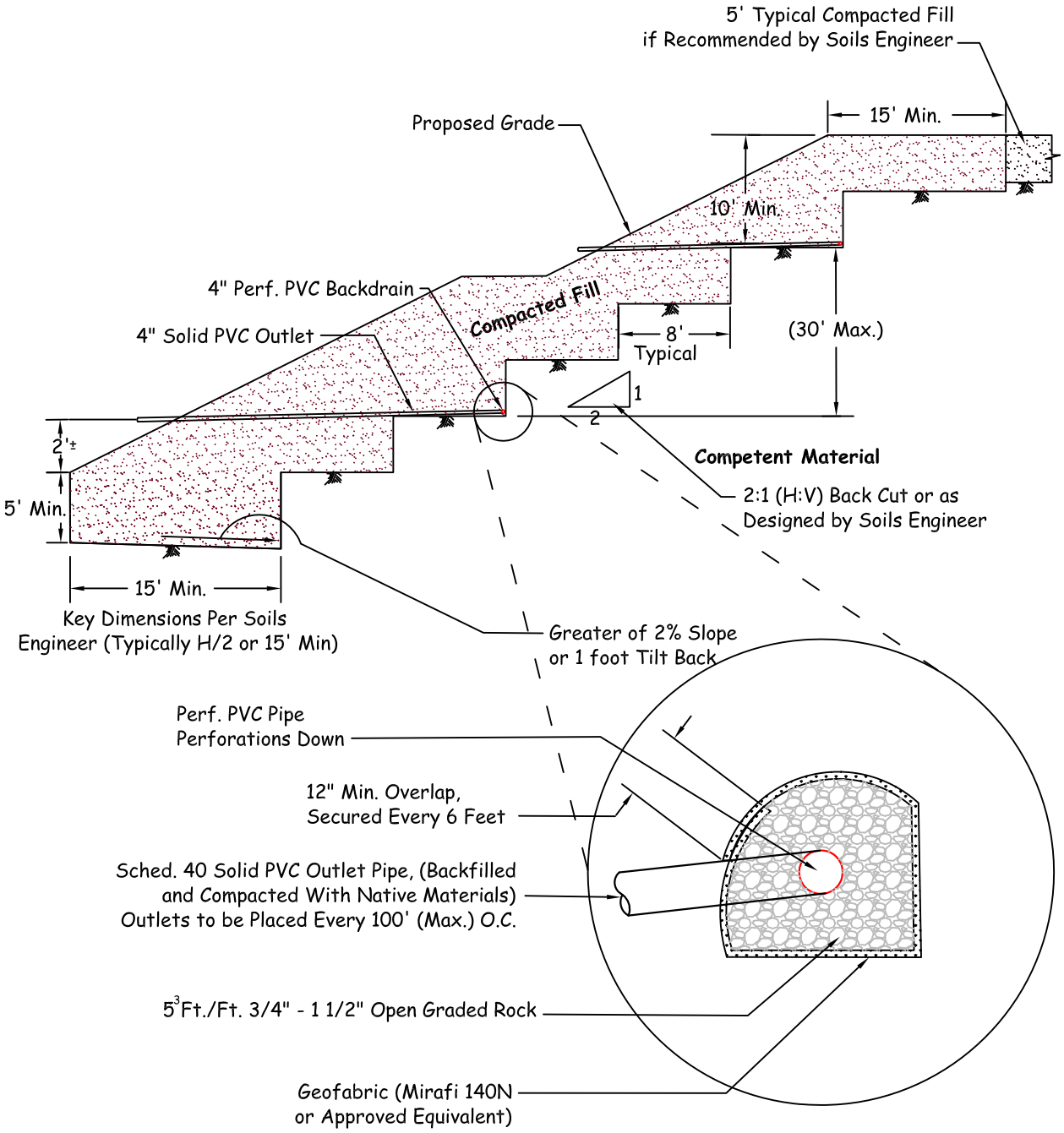
TYPICAL BUTTRESS DETAIL



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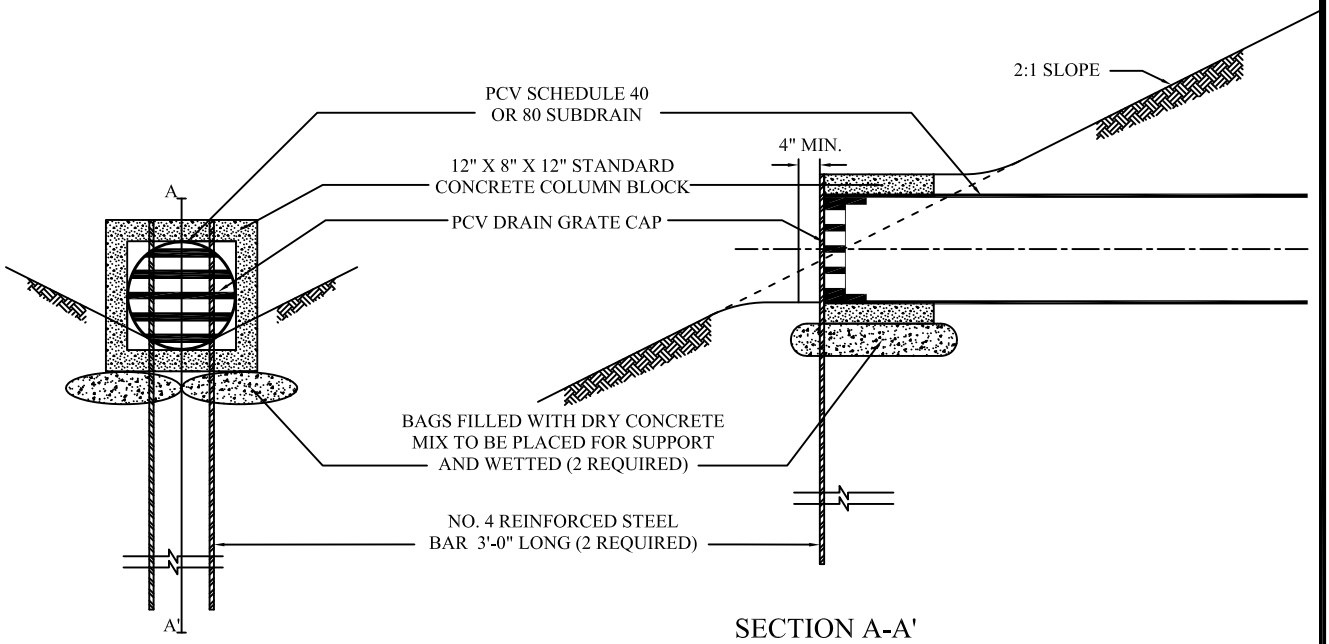
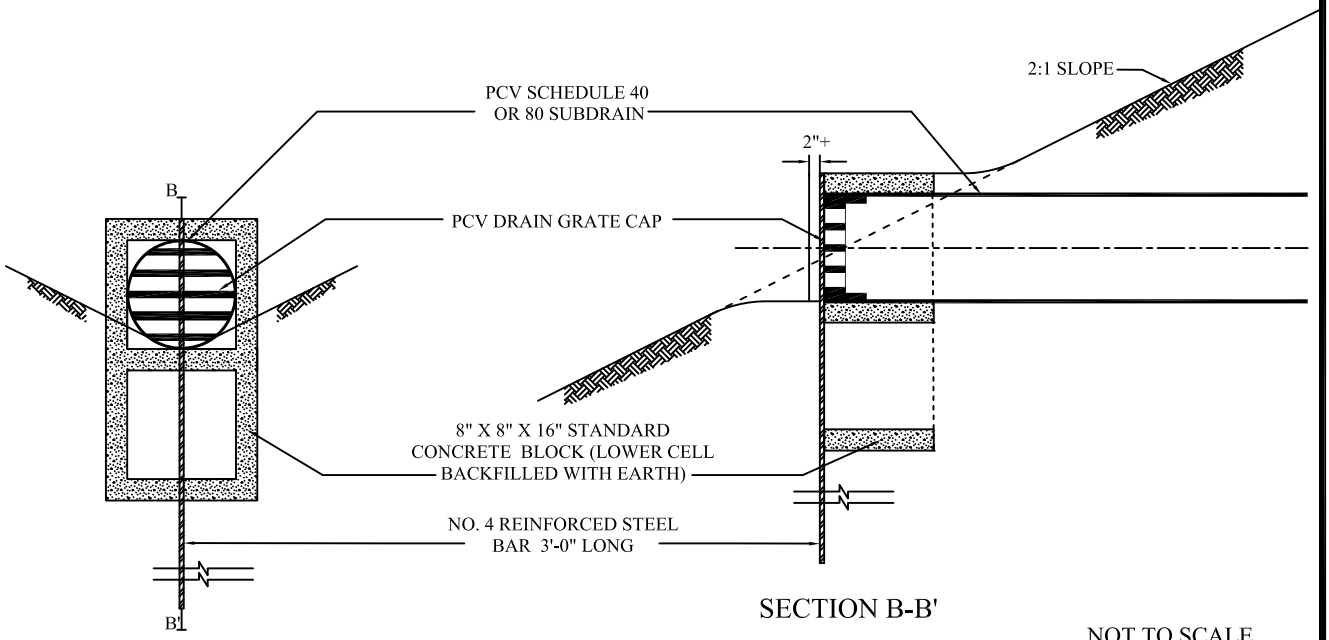
TYPICAL STABILIZATION FILL DETAIL

SUBDRAIN OUTLET MARKER -6" & 8" PIPE



SECTION A-A'

SUBDRAIN OUTLET MARKER -4" PIPE



SECTION B-B'

NOT TO SCALE

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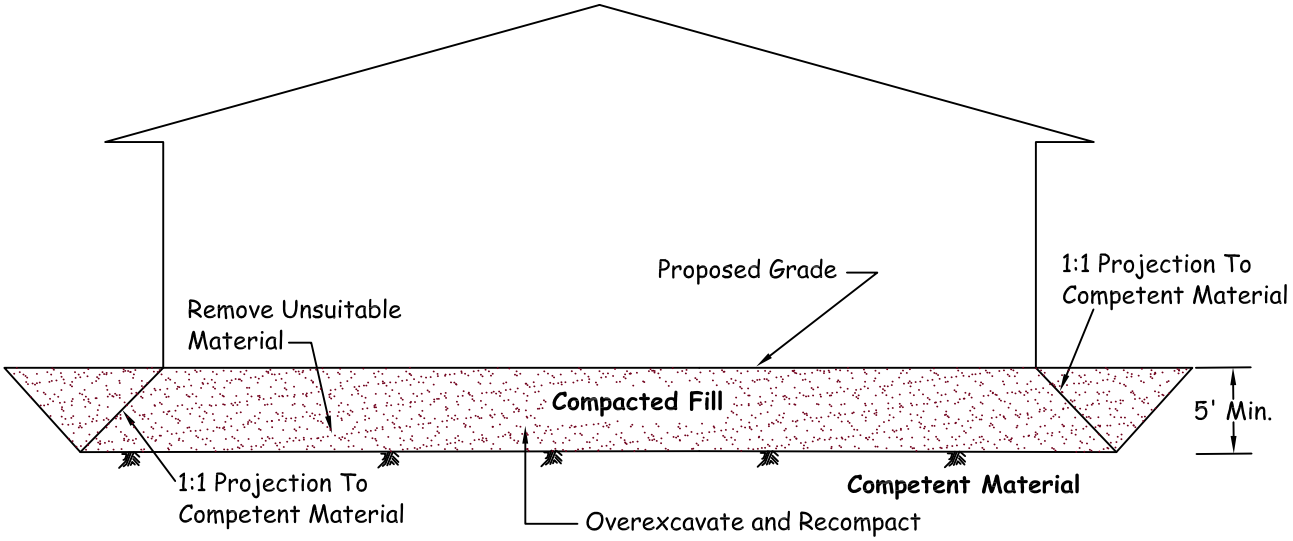
SUBDRAIN OUTLET MARKER DETAIL

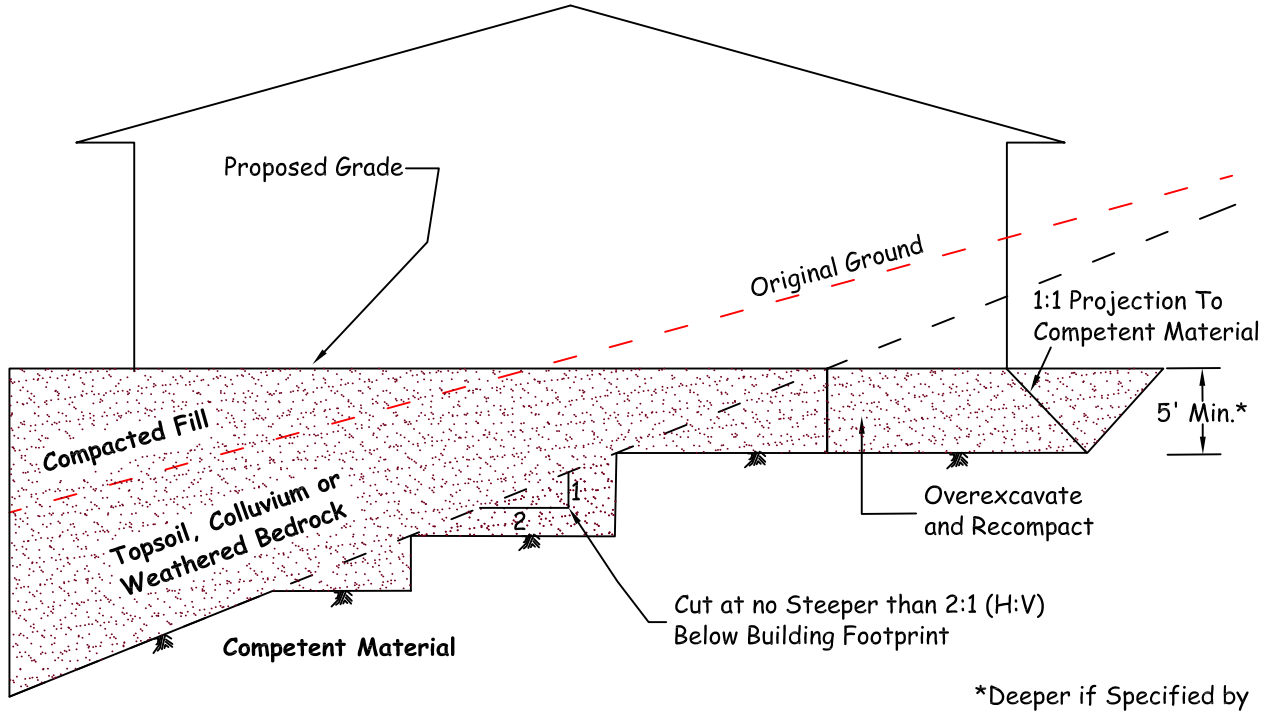
Cut Lot
(Exposing Unsuitable Soils at Design Grade)



Note 1: Removal Bottom Should be Graded With Minimum 2% Fall Towards Street or Other Suitable Area (as Determined by Soils Engineer) to Avoid Ponding Below Building

Note 2: Where Design Cut Lots are Excavated Entirely Into Competent Material, Overexcavation May Still be Required for Hard-Rock Conditions or for Materials With Variable Expansion Characteristics.

Cut/Fill Transition Lot



*Deeper if Specified by Soils Engineer

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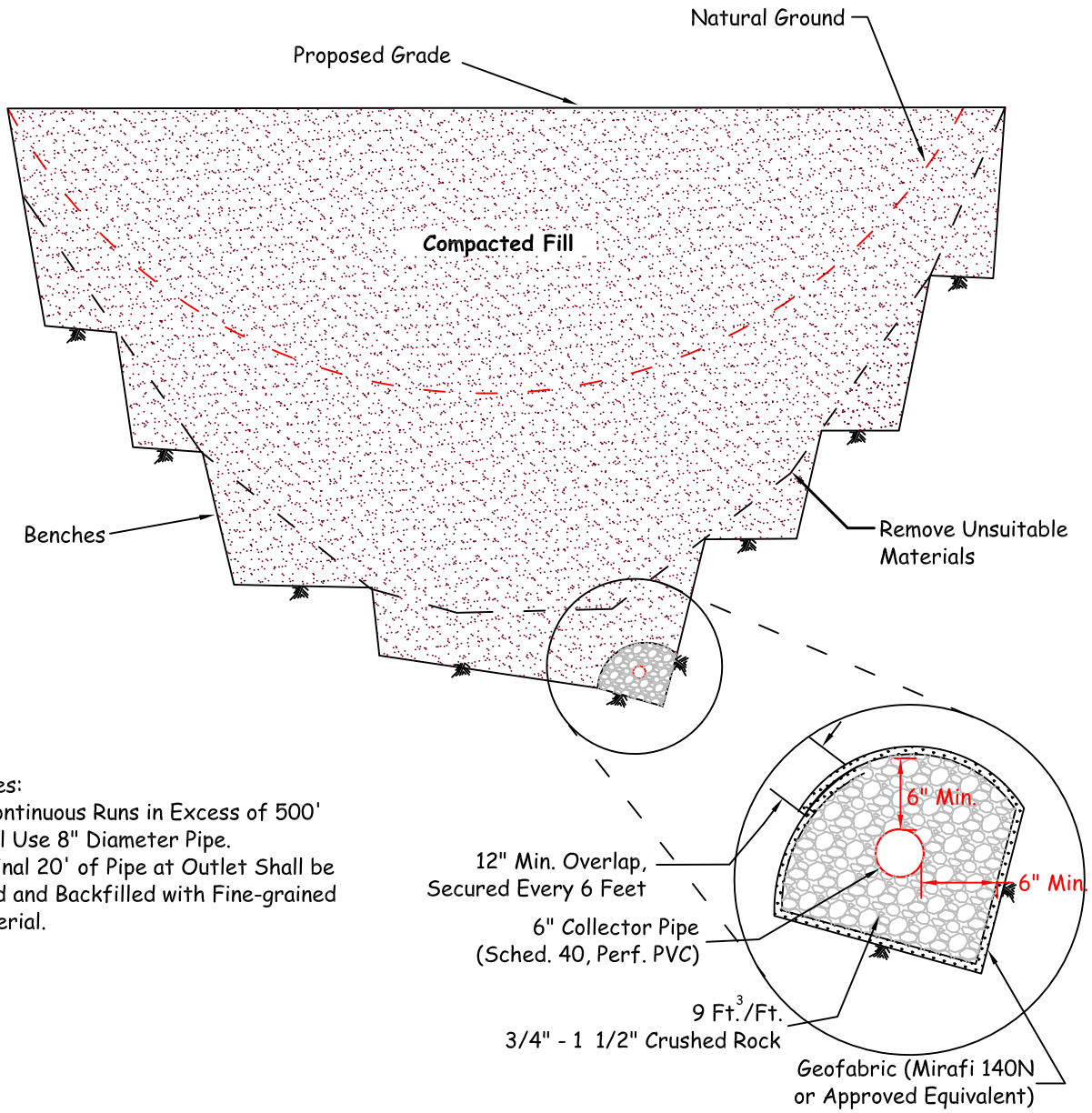
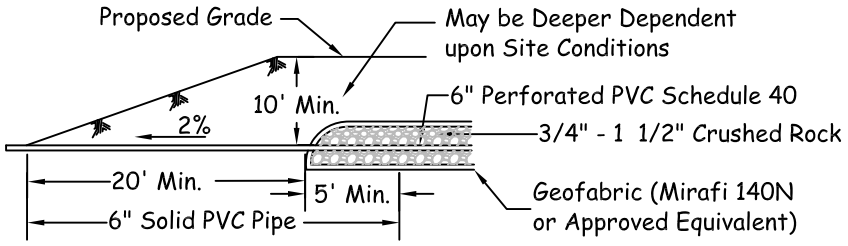
CUT AND TRANSITION LOT OVEREXCAVATION DETAIL



Notes:
1) Continuous Runs in Excess of 500' Shall Use 8" Diameter Pipe.
2) Final 20' of Pipe at Outlet Shall be Solid and Backfilled with Fine-grained Material.

Proposed Outlet Detail



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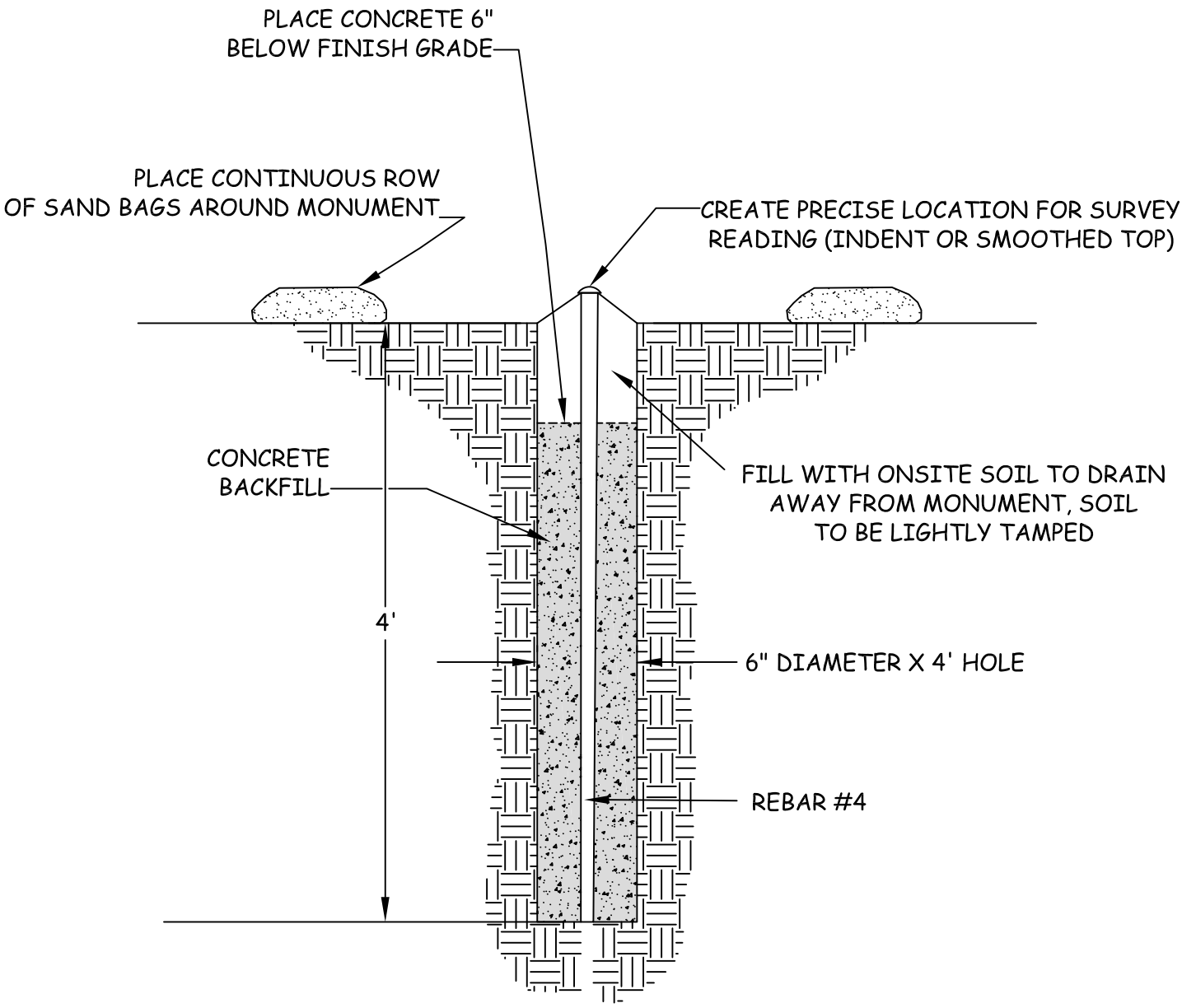
CANYON SUBDRAINS



NO CONSTRUCTION EQUIPMENT WITHIN 25 FEET
OF ANY INSTALLED SETTLEMENT MONUMENTS

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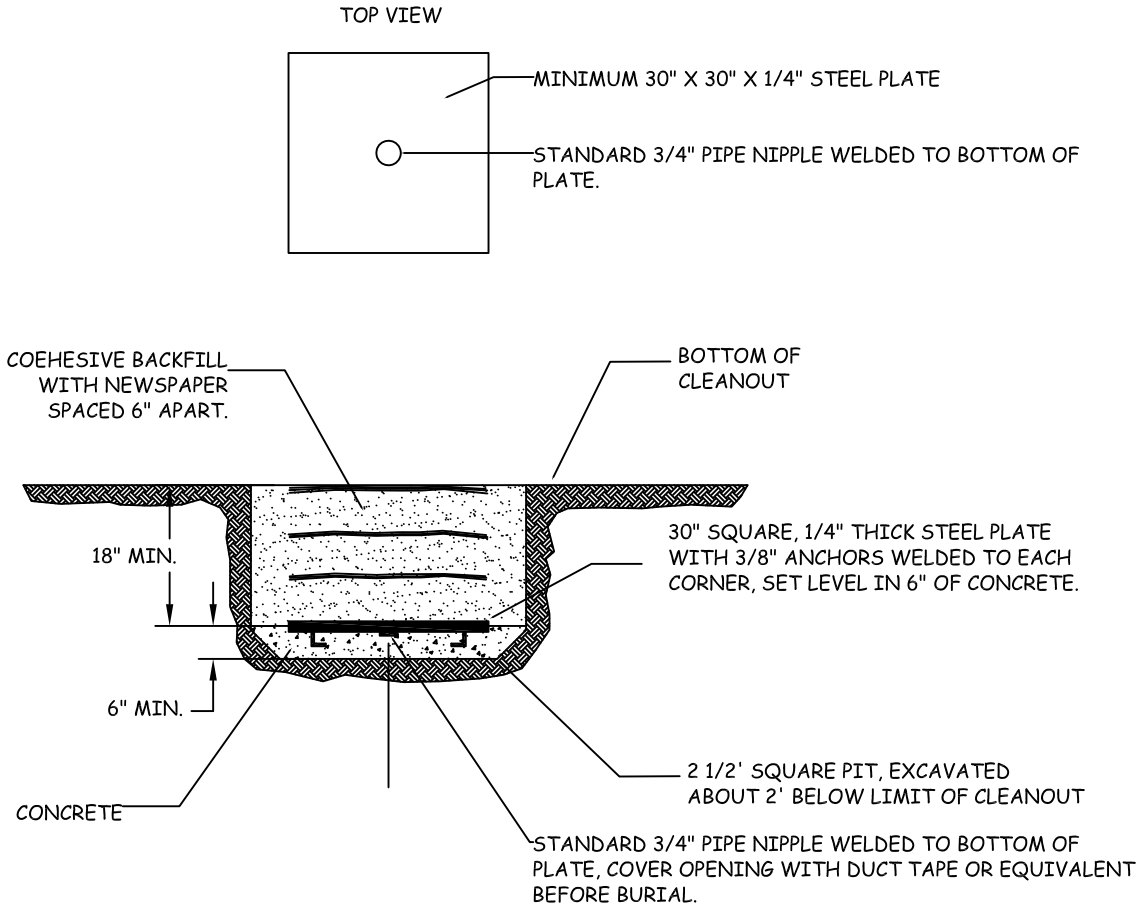
TYPICAL SURFACE SETTLEMENT MONUMENT



1. SURVEY FOR HORIZONTAL AND VERTICAL LOCATION TO NEAREST .01 INCH PRIOR TO BACKFILL USING KNOW LOCATIONS THAT WILL REMAIN INTACT DURING THE DURATION OF THE MONITORING PROGRAM. KNOW POINTS EXPLICITELY NOT ALLOWED ARE THOSE LOCATED ON FILL OR THAT WILL BE DESTROYED DURING GRADING.
2. IN THE EVENT OF DAMAGE TO SETTLEMENT PLATE DURING GRADING, CONTRACTOR SHALL IMMEDIATELY NOTIFY THE GEOTECHNICAL ENGINEER AND SHALL BE RESPONSIBLE FOR RESTORING THE SETTLEMENT PLATES TO WORKING ORDER.
3. DRILL TO RECOVER AND ATTACH RISER PIPE.

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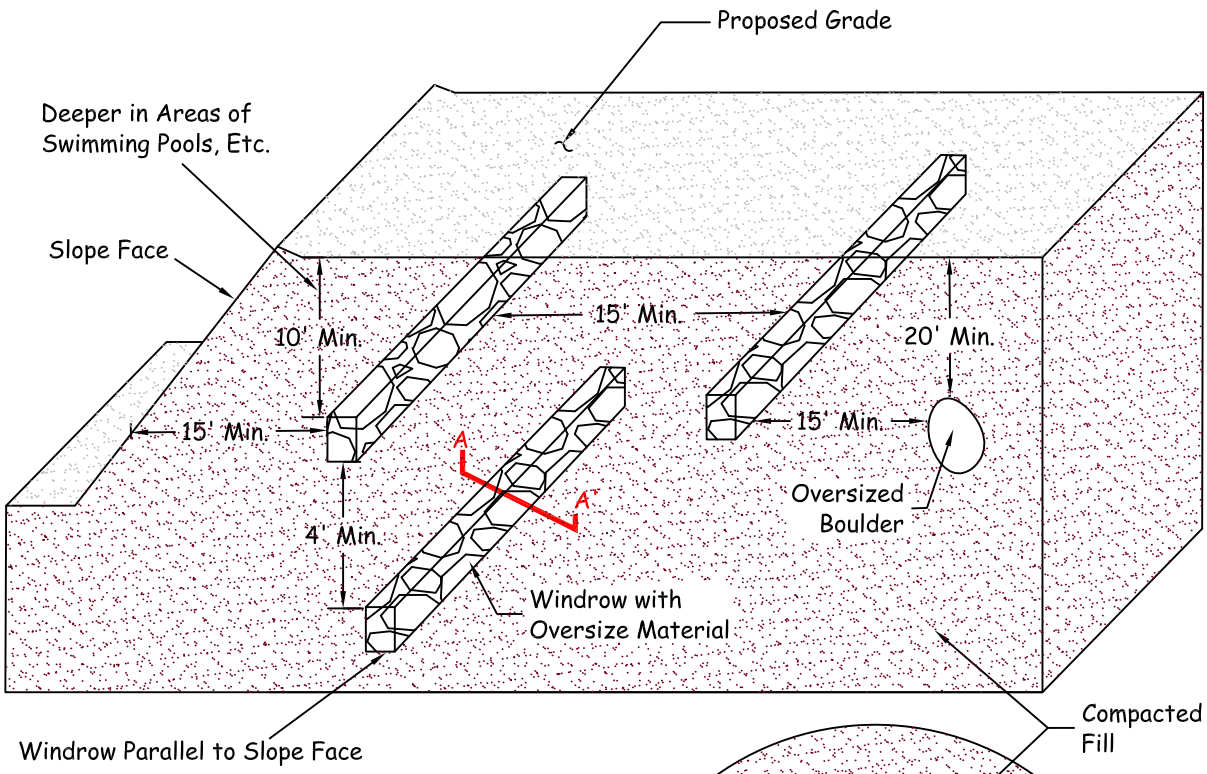
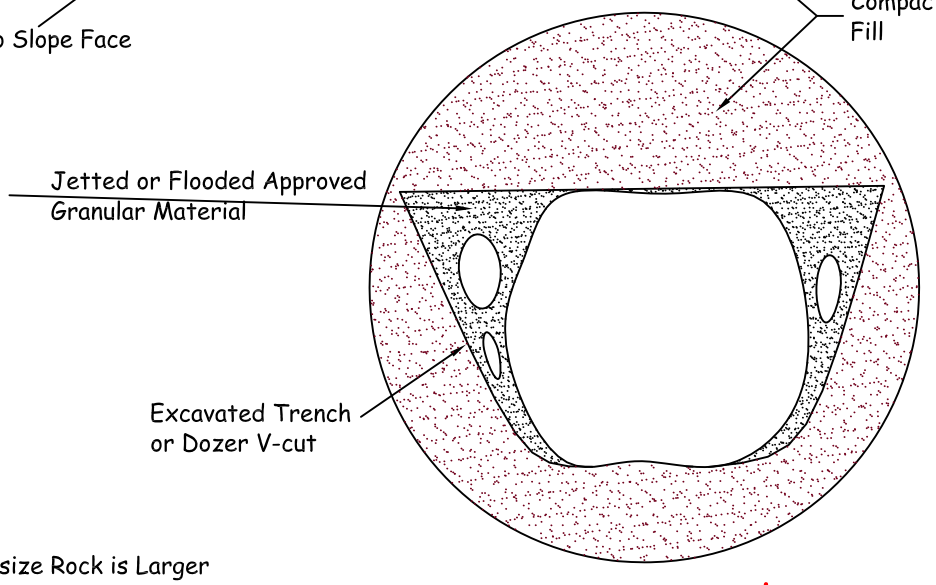
TYPICAL SETTLEMENT PLATE AND RISER





Note: Oversize Rock is Larger
than 8" in Maximum Dimension.

Section A-A'

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OVERSIZE ROCK DISPOSAL DETAIL