

**PRELIMINARY
PRIORITY PUBLIC PROJECT
WATER QUALITY MANAGEMENT PLAN
(WQMP)**

PROJECT: Orange Fire Station No. 1 - Headquarters

WQMP No.: 2020- _____

Prepared by:

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06-22-2020

Date

Reviewed by: _____

Date

Recommended for Approval:

City Engineer

Date

Approved by:

Public Works Director

Date

OWNER'S CERTIFICATION
WATER QUALITY MANAGEMENT PLAN
FOR
Orange Fire Station No. 1 - Headquarters

This Water Quality Management Plan (WQMP) for the City of Orange Fire Station No. 1 – Headquarters at 180 South Jameson Street Project has been prepared for The City of Orange Public Works Department. This WQMP is intended to comply with the requirements of the City of Orange's and the countywide Model Water Quality Management 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 City of Orange Local Implementation Plan (LIP), and the intent of NPDES Permit and Waste Discharge Requirements for the City of Orange, County of Orange, Orange County Flood Control District and the incorporated Cities of Orange County within the Santa Ana Region.

Signature: _____ Date: _____

Name: _____

Title: Fire Chief - City of Orange

Address: _____, Orange, CA

Telephone Number: (714)_____

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I. Discretionary Permit Number(s), Water Quality Condition Number(s) and Conditions of Approval

Tract No. Jameson Tract M.R. L.A. CO 13-44, Block B Lot No. 1-8 per RD-094-022

GPS Coordinates: 33.78748, -117.84100

Water Quality Conditions (WQMP conditions listed below)

A complete copy of the signed Conditions of Approval, will be included in the Final WQMP and included as Appendix A

Conditions of Approval:

Projects that exceed 5,000 square feet of paved surface are considered Priority projects subject to the preparation of a Water Quality Management Plan (WQMP) and BMP design in compliance with the Orange County Technical Guidance Document.

Prior to the issuance of any grading permits the applicant shall submit a Project WQMP for review and approval to the Public Works Department that:

- Prioritizes the use of Low Impact Development principles as follows: preserves natural features; minimizes runoff and reduces impervious surfaces; and utilizes infiltration of runoff as the method of pollutant treatment. Infiltration BMPs to be considered include the use of permeable materials such as concrete and concrete pavers, infiltration trenches, infiltration planters, and other infiltration BMPs as applicable.
- Incorporates the applicable Routine Source and Structural Control BMPs as defined in the Drainage Area Management Plan (DAMP)
- Maintains the hydrologic characteristics of the site by matching time of concentration, runoff, velocity, volume and hydrograph for a 2-year storm event.
- Minimizes the potential increase in downstream erosion and avoids downstream impacts to physical structures, aquatic and riparian habitat.
- Generally describes the long-term operation and maintenance requirements for structural and Treatment Control BMPs
- Identifies the entity or employees that will be responsible for long-term operation, maintenance, repair and or replacement of the structural and Treatment Control BMPs and the training that qualifies them to operate and maintain the BMPs
- Describes the mechanism for funding the long-term operation and maintenance of all structural and Treatment Control BMPs.

- A copy of the forms to be used in conducting maintenance and inspection activities
- Recordkeeping requirements (forms to be kept for 5 years)
- A copy of the form to be submitted annually by the project owner to the Public Works Department that certifies that the project's structural and treatment BMPs are being inspected and maintained in accordance with the project's WQMP.

Prior to the issuance of certificates for use of occupancy, the applicant shall demonstrate the following to the Public Works Department:

- That all structural and treatment control best management practices (BMPs) described in the Project WQMP have been constructed and installed in conformance with the approved plans and specifications,
- That applicant is prepared to implement all non-structural BMPs described in the Project WQMP,
- That an adequate number of copies of the project's approved final Project WQMP are available for the future occupiers.

Prior to the issuance of certificates for use of occupancy or final signoff by the Public Works Department, the applicant shall demonstrate to the satisfaction of Public Works, that the preparer of the WQMP has reviewed the BMP maintenance requirements in Section V of the WQMP with the responsible person and that a copy of the WQMP has been provided to that person. A certification letter from the WQMP preparer may be used to satisfy this condition.

The project applicant shall maintain all structural, treatment and low impact development BMPs at the frequency specified in the approved water quality management plan (WQMP). Upon transfer of ownership or management responsibilities for the project site, the applicant shall notify the City of Orange Public Works Department of the new person(s) or entity responsible for maintenance of the BMPs.

II. Project Description

Planning Area (Location): Office Professional/Residential. To be re-zoned by City.

Project Site Area (ac): 2.00

Project Disturbed Area (ac): 2.00

Percent Change in Impermeable Surfaces: Reduction of 9,927 s.f.

SIC Code: 9224, Fire Protection

Project Description

The existing site was previously developed, but structures have since been demolished. The southwest parcel is currently used for City parking, while the southeast parcel remains vacant and not utilized. The previous existing condition impervious area is estimated as 95% of the site, based on historic aerial photographs.

The City of Orange will be responsible for demolishing and removing the remaining site improvements within the development area. The City is proposing to develop a new Fire Station No. 1 and Headquarters Administration building on the northeast parcel located on Chapman Avenue, and staff parking lot on the southwest parcel located on Water Street. The total proposed impervious surface area of the project including the building, asphalt and concrete paved parking, driving aisles, sidewalks, and flatwork is approximately 74,021 square feet, the proposed landscaping is approximately 13,144 square feet.

Onsite stormwater treatment was designed in accordance with the MWQMP and TGD, to the maximum extent practicable. Infiltration BMPs were used to retain 100% of the LID DCV calculated below.

Total Impervious Surface Areas Impacted

Pre-project impervious area: 1.90 acres

Post-project impervious area: 1.70 acres

Project Purpose and Activities

The purpose of the project is to create a new fire station and headquarters facility. In order to create this use, all existing site features must be demolished and removed for the construction of the new site.

Potential Storm Water Pollutants

The project uses of commercial development and parking lot, will result with the following expected pollutants: Suspended-Solid/ Sediments, Nutrients, Heavy Metals, Pathogens (Bacteria/Virus), Pesticides, Oil and Grease, Toxic Organic Compounds, and Trash and Debris.

Hydrologic Conditions of Concern

Per TGD Susceptibility Analysis Map for Santa Ana River, included in Section VI, the site location is located within an area of potential areas of erosion, habitat, & physical structure susceptibility, therefore Hydromodification controls will be required for this project. Per Section 2.2.3 of Technical Guidance Document, Post Development conditions must meet pre-development conditions, including time of concentration, volume, velocity and matching 2-year hydrographs. Due to the reduction in impervious surface area and implementation on onsite infiltration BMPs at the site, the project will meet these conditions.

Post Development Drainage Characteristics

The site topography slopes from northeast to southwest towards Almond Avenue. The precise grading and drainage for the project is still in the preliminary stage, but all runoff from the site will be collected onsite and conveyed through a new underground storm drain system to the new stormwater treatment system. The fire station and administration building site will be collected and treated separately from the parking lot site on the west side of Water Street. As described further within the site descriptions section below, the site impervious surface area will be reduced from 82,806 in the existing condition to 74,021 in the proposed condition. With the other drainage characteristics remaining relatively consistent in the proposed condition when compared with the existing condition, this will lead to a reduction in peak flowrates from the site in the proposed condition. This reduction in peak runoff will be quantified in the Final Drainage Study submitted with the project construction documents.

Commercial Projects

The fire station site will include a trash enclosure for site refuse, an emergency generator, and a fuel tank used for re-fueling of fire apparatus. Vehicles will be parked onsite on the both sites.

Site Ownership and any Easements

The property owner of the site is the City of Orange. The City will be responsible for on-going operation and maintenance of all proposed Best Management Practices.

III. Site Description

Reference Location Map: XXXX

Site Address: 180 S. Jameson Street, Orange, CA

Zoning: Office Professional/Residential

Predominant Soil type: Well-graded gravel with sand and silt, sand with gravel, and silty sand.

Pre-project percent pervious: 5% (4,359 S.F.)

Post-project percent pervious: 15.1% (13,144 S.F.)

Pre-project percent impervious: 95% (82,806 S.F.)

Post-project percent impervious: 84.9% (74,021 S.F.)

Watershed: Santa Ana River

Downstream Receiving Waters: Santiago Creek E08, Santa Ana River E01.

Water Quality Impairments (if applicable): None (2016 CA 303d list)

Identify Hydromodification susceptibility: The site is located within an area of potential areas of erosion, habitat, & physical structure susceptibility.

Site Characteristics

The existing site was previously developed, but is currently vacant. The project total area of onsite development is 87,165 square feet, or 2.00 acres. Per the project Geotechnical Investigation, the underlying soil conditions are a thin layer of artificial fill. The artificial fill is underlain by Quaternary-age old alluvial fan deposits extending to the maximum exploration depth of 51 feet bgs. The overlying undocumented fill (Afu) encountered within our excavations generally consisted of a loose to dense silty sand and sand with gravel and small mechanically fractured cobbles. The native soils (Qof) were generally composed of slightly moist to moist, dense to very dense, well-graded gravel with sand and silt, sand with gravel, and silty sand with small weathered cobbles derived from the sedimentary formations in the Santa Ana Mountains. The in-situ moisture content within the upper approximately 15 feet generally ranged from 2 to 7 percent. Groundwater was not encountered in our borings excavated to a maximum depth of 51 feet below the existing ground surface (bgs). The historical high groundwater level in the area was estimated to have been on the order of 172 feet bgs. Raw infiltration rates for the well permeameter tests may be assumed to be about 4.5 in/hour within the gravel layer generally encountered at a depth of 15 to 20 feet bgs, but should be considered negligible in the clayey sand layer at a depth of approximately 10 feet in boring LB-4.

Hydrologic Characteristics

All project runoff from the fire station site and the parking lot site, are ultimately tributary to the same point. The entire project area has a Soil Type A (according to the USDA's Web Soil Survey). Within the limits of the fire station site, existing and proposed runoff flows towards the southwest to curb and gutter flow on Water Street that flows to the south. Site runoff if eventually collected within an existing catch basin on Almond Avenue near the intersection with Water Street. For the parking lot site, existing and proposed runoff flows to the southwest towards and existing concrete drainage flume that drains to curb and gutter flow on Almond Avenue. Site runoff if eventually collected within an existing catch basin on Almond Avenue near the intersection with Cambridge Street. Collected runoff is conveyed via a County RCB storm drain south on Cambridge Street and discharges into Santiago Creek before discharging into the Santa Ana River and ultimately the Pacific Ocean

IV. Best Management Practices

The BMPs chosen for this project are designed to reduce and/or eliminate the wide range of pollutants that are common to commercial developments such as this project. Pollutants such as trash & debris, sediment, oil & grease, and many other pollutant types, commonly attached to sediment, will be removed through a combination of Best Management Practices including Site Design, Source Control, and LID BMPs. With consistent stormwater awareness training for all City staff that will be responsible for ongoing maintenance, the City will be able to appropriately address any potential water quality problem that may arise in the project area. Due to the educational efforts within the City and the resulting heightened awareness of residents, the potential to have possible water quality impacts from illegal activities is minimized.

The treatment BMP selected for this project is two separate underground storm water infiltration systems, one for the fire station and administration building site and one for the parking lot site. For the fire station site the system will be placed near the southwest corner of the site, approximately 250 feet south of Chapman Avenue. For the parking lot site the system will be placed near the south limits of the parking lot, approximately 475 feet south of Chapman Avenue. The units will treat runoff from the 24 Hour, 85th Percentile Rainfall depth, determined to be 0.80 inches for the site location. Infiltration systems have been found to provide a high removal efficiency for Total Suspended Solids, total Phosphorus, total Nitrogen, oil & grease, and metals, since they completely retain and infiltrate the design storm event.

As identified on the Preliminary WQMP Site Plan Sheet C20, there are three onsite drainage Areas. The two main areas of development which are treated via infiltration as described above are designated as Drainage Areas A1 and A2. The third smaller drainage area is designated as Drainage Area B, and represents approximately 10% of the total site area that is primarily perimeter landscape planter areas, which drain directly offsite to the public right of way, and due to the project grading are not feasible to capture onsite.

IV.1 Site Design and Drainage Characteristics

Table 1
Site Design BMPs

Technique	Included?		If no, state justification.
	Yes	No	
Minimize Directly Connected Impervious Areas (DCIAs) (C-Factor Reduction)	X		
Create Reduced or "Zero Discharge" Areas (Runoff Volume Reduction) ¹		X	Not feasible due to the ponding depth that would be required within the landscaped areas.
Minimize Impervious Area/Maximize Permeability (C-Factor Reduction) ²	X		
Conserve Natural Areas (C-Factor Reduction)		X	There are no existing natural areas to conserve.

- 1 Detention and retention areas incorporated into landscape design provide areas for retaining and detaining stormwater flows, resulting in lower runoff rates and reductions in volume due to limited infiltration and evaporation. Such Site Design BMPs may reduce the size of Treatment Control BMPs.
- 2 The "C Factor" is a representation of the ability of a surface to produce runoff. Surfaces that produce higher volumes of runoff are represented by higher C Factors. By incorporating more pervious, lower C Factor surfaces into a development, lower volumes of runoff will be produced. Lower volumes and rates of runoff translate directly to lowering treatment requirements.

Minimize Directly Connected Impervious Areas (DCIAs)

The directly connected impervious areas (DCIAs) were eliminated in the design by connecting all impervious areas to the proposed infiltration system.

Minimize Impervious Area/Maximize Permeability

Driving aisles were reduced to the minimum width allowable for truck turning radii, and sidewalk paths were minimized to the minimum width necessary for ADA access. Minimizing the impervious cover reduces the runoff from the site by reducing the project C-Factor.

IV.2 Source Control BMPs

IV.2.1 Routine Non-Structural BMPs

Table 2

Routine Non-Structural BMPs

BMP No.	Name	Check One		If not applicable, state brief reason.
		Included	Not Applicable	
N1	Education for Property Owners, Tenants and Occupants	X		
N2	Activity Restriction	X		
N3	Common Area Landscape Management	X		
N4	BMP Maintenance	X		
N5	Title 22 CCR Compliance		X	No hazardous wastes anticipated.
N6	Local Water Quality Permit Compliance		X	This BMP is not applicable. The City of Orange does not issue water quality permits.
N7	Spill Contingency Plan	X		
N8	Underground Storage Tank Compliance		X	No underground storage tank.
N9	Hazardous Materials Disclosure Compliance	X		
N10	Uniform Fire Code Implementation	X		
N11	Common Area Litter Control	X		
N12	Employee Training	X		
N13	Housekeeping of Loading Docks		X	No loading docks onsite.
N14	Common Area Catch Basin Inspection	X		
N15	Street Sweeping Private Streets and Parking Lots	X		

N1. Education for Property Owners, Tenants and Occupants: Section VII of this document contains BMP fact sheets and education material relevant to the Fire Station project, for use by City employees. The list of the materials provided is shown in the Table of Contents. The City will be responsible for all BMPs for the project. Through BMP implementation and maintenance, pollutants generated by the project will be reduced and/or eliminated. Maintenance will be performed prior to the rainy season, October 1 - April 30, and all BMPs will be inspected prior to and during the rainy season as needed. See Section VII for the education materials included.

N2. Activity Restriction: The City will be required to maintain a list of restricted activities, regarding stormwater and urban runoff. In addition to the requirements provided here, it is required that The City review and add additional requirements as necessary. The following requirements shall be enforced at all times at the site:

- Dumpster lids must always remain closed and trash shall not be placed next to the dumpster at any time.
- Discharges of fertilizer or pesticides to the stormwater drainage system, are prohibited.
- Landscaping maintenance waste must be disposed of properly and no waste shall enter the stormwater drainage system.

N3. Common Area Landscape Management (SC-41): The City will be required to properly maintain the landscaping at the facility. The sprinkler system for the site is a drip irrigation system, which will prevent the chance of overspray or non-stormwater discharge from the site. All federal, state and local laws and regulations will be followed governing the use, storage, and disposal of fertilizers and pesticides. Irrigation schedules shall be offset from pesticide application to prevent non-stormwater discharge.

N4. BMP Maintenance: BMP maintenance, implementation schedules, and responsible parties are included with each specific BMP narrative.

N7. Spill Contingency Plan (SC-11): In the event of a spill, the initial response will be provided by the City's 24-hour emergency response personnel. If the spill is determined to be chemical or otherwise hazardous, the Orange Fire Department will take over response and clean-up of any hazardous materials. Spills will be contained and cleaned up in accordance with those procedures. In addition, the public has been and will continue to be made aware of the phone numbers, (714) 538-1961 or 911, for reporting any condition of concern to the city of Orange.

N9. Hazardous Materials Disclosure Compliance: The City will be required to prepare all disclosure materials required by the Fire Department regarding the storage of diesel fuel on the site, including the "Chemical Inventory and Business Emergency Plan".

N10. Uniform Fire Code Implementation: The City is responsible for maintaining compliance with Article 80 of the Uniform Fire Code, in order to address the proper management and handling of hazardous materials at the fire station (Diesel Fuel).

N11. Common Area Litter Control (SC-34): The City is required to maintain a litter-free common area and is required to provide a sufficient number of litter receptacles for the facility. The City will implement a schedule for the proper removal of the litter receptacles for the purposes of keeping the site free of loose litter or overfilled receptacles.

N12. Employee Training: The City will be required to develop employee-training procedures that correspond to the Best Management Practices provided in this report. Training should focus on the project-specific concepts related to the prevention of stormwater pollution at the site. Any employee that will be working at the site shall perform new-hire training, as well as annual refresher training.

See Section VII for the education materials included to be used for training.

N14. Common Area Catch Basin Inspection: All catch basins will be inspected on an annual basis prior to October 1st and will be cleaned when necessary. This will reduce the potential for sediment, trash & debris, and other pollutants to accumulate within the storm drain system. All Catch Basins will be inspected to determine the legibility of the “No Dumping- Drains to Ocean” stencil, annually.

N15. Street Sweeping Private Streets and Parking Lots: The City shall provide sweeping and cleaning for its parking areas frequently, as needed to prevent accumulated sediment and debris. Hosing down the parking lot and patios is prohibited. No runoff is allowed to drain into the drain box inlets. Use proper procedure with pollution prevention measures to avoid discharges of was water and other materials into the storm drain system.

IV.2.2 Municipal Activities Model Maintenance Procedures

Table 3 - Model Maintenance Procedures

Identifier	Name	Check One		If not applicable, state brief reason
		Included	Not Applicable	
Fixed Facility Model Maintenance Procedures				
FF2	Building Maintenance and Repair	X		
FF3	Equipment Maintenance and Repair	X		
FF4	Fueling	X		
FF5	Landscape Maintenance	X		
FF6	Material Loading and Unloading	X		
FF7	Material Storage, Handling, and Disposal	X		
FF8	Minor Construction		X	Minor construction not a part of project.
FF9	Parking Lot Maintenance	X		
FF10	Spill Prevention and Control	X		
FF11	Vehicle and Equipment Cleaning	X		
FF12	Vehicle and Equipment Storage	X		
FF13	Waste Handling and Disposal	X		
Drainage Facility Model Maintenance Procedure				
DF-1	Drainage Facility Operation and Maintenance	X		
Field Program Model Maintenance Procedures				
FP1	Lake Management		X	No lakes in the area.
FP2	Landscape Maintenance	X		
FP3	Roads, Streets, and Highways Operations and Maintenance		X	Not roadway or highway operations and maintenance
FP4	Sidewalk, Plaza, and Fountain Cleaning		X	No pressure wash cleaning proposed.
FP5	Solid Waste Handling		X	No large-scale solid waste handling/sorting operations.
FP6	Water and Sewer Utility Ops and Maint.		X	Not applicable to this site.
FP7	Fire Department Activities	X		

DF1 - Drainage Facility Operation and Maintenance

All catch basins will be inspected on an annual basis and will be cleaned per permit requirements. This will reduce the potential for sediment, trash & debris, and other pollutants to accumulate within the storm drain system.

IV.2.3 Routine Structural BMPs

Table 4

Routine Structural BMPs

Name	Check One		If not applicable, state brief reason
	Included	Not Applicable	
Provide storm drain system stenciling and signage- "No Dumping – Drains to Ocean"	X		
Design and construct outdoor material storage areas to reduce pollution introduction		X	No outdoor material storage areas.
Design and construct trash and waste storage areas to reduce pollution introduction	X		
Use efficient irrigation systems & landscape design	X		
Protect slopes and channels and provide energy dissipation		X	No slopes/channels.
Incorporate requirements applicable to individual project features			
a. Dock areas		X	No dock areas
b. Maintenance bays		X	No maintenance bays
c. Vehicle or community wash areas	X		
d. Outdoor processing areas		X	No outdoor processing areas
e. Equipment wash areas		X	No equipment wash areas
f. Fueling areas	X		
g. Hillside landscaping		X	No hillside landscaping
h. Wash water control for food preparation areas			No food preparation areas

S1. Provide storm drain system stenciling and signage (BMP No. SD-13): All storm drains and catch basins within the project area will continue to be inspected for legibility, annually. The phrase "No Dumping – Drains to Ocean" will be re-stenciled as needed, as this message serves to reinforce the city of Orange's stormwater program to the public reminding them of the prohibition on pollutants entering into the public right-of-way and storm drain system.

S3. Design and construct trash and waste storage areas to reduce pollution introduction (BMP No. SD-32): The designed trash storage facility is designed to contain pollutants that could occur within the area. The area is enclosed on three sides and the parking lot paving directly adjacent to the trash storage area is sloped away from the trash enclosure in order to prevent run-on to the area. Interior trash bins shall remain closed at all times when not in use. The City shall inspect the trash storage areas for the integrity of the designed trash enclosure a minimum of once per year.

S4. Use efficient irrigation systems & landscape design (BMP No. SD-10): The landscape design for the site has been designed to minimize impervious land coverage. Irrigation is provided using a drip-irrigation system, which will prevent the possibility of non-stormwater discharge due to over-spray. The project will comply with City of Orange Code for water efficient landscaping.

Vehicle Wash Area: BMP No. SD-33 – Vehicle Washing Areas: The vehicle washing area for the Fire Station is located within the building in the apparatus room. The room has been designed to transport waste from vehicle and equipment washing to an oil/sand interceptor, which will then discharge to the sanitary sewer line. The oil/sand interceptor will ensure that the runoff that enters the sanitary sewer has been treated to separate oil and debris before discharge. It is the City's responsibility to make sure that vehicles are being washed properly and all waste from washing enters the proper inlets and no flow enters the storm drain system located outside the apparatus room. The City should achieve this through their employee-training plan BMP No. N12.

BMP No. SD-30 – Fueling Areas: The fuel tank located onsite is enclosed on all sides with a curb to prevent any fuel spill or leak from entering the storm drain system. The surface of the fuel enclosure is concrete, which will prevent seepage of the fuel due to a spill or leak. A spill cleanup sign and post will be installed at the fuel enclosure to provide the information necessary in the event of a fuel spill. The implementation of these BMPs ensures that all fuel leaks or spills will be contained and will always remain separate from stormwater runoff. The fuel tank enclosure shall be inspected within 24 hours of a storm event. Any accumulated liquids within the enclosure area shall be discharged to the sanitary sewer after authorization from the local sewer agency. No accumulated liquids within the fuel tank enclosure shall be permitted to enter the storm drain system.

IV.3 Low Impact Development BMP Selection

IV.3.1 Infiltration BMPs

Table 5 - Infiltration BMPs

Name	Check If Used
Bioretention without underdrains	<input type="checkbox"/>
Rain gardens	<input type="checkbox"/>
Porous landscaping	<input type="checkbox"/>
Infiltration planters	<input type="checkbox"/>
Retention swales	<input type="checkbox"/>
Infiltration trenches	<input type="checkbox"/>
Infiltration basins	<input type="checkbox"/>
Drywells	<input type="checkbox"/>
Subsurface infiltration galleries (INF-7)	<input checked="" type="checkbox"/>
French drains	<input type="checkbox"/>
Permeable asphalt	<input type="checkbox"/>
Permeable concrete	<input type="checkbox"/>
Permeable concrete pavers	<input type="checkbox"/>
Other:	<input type="checkbox"/>
Other:	<input type="checkbox"/>

The LID design storm capture volume is met with two new proposed infiltration systems. For the fire station site the system will be placed near the southwest corner of the site, approximately 250 feet south of Chapman Avenue. For the parking lot site the system will be placed near the south limits of the parking lot, approximately 475 feet south of Chapman Avenue. For the fire station site, the underground infiltration system will consist of 42 linear feet of 8' diameter perforated corrugated steel pipe surrounded by 1 foot of drainage gravel. For the parking lot site, the underground infiltration system will consist of 24 linear feet of 8' diameter perforated corrugated steel pipe surrounded by 1 foot of drainage gravel. Onsite stormwater runoff is collected within new drain box inlets that contain Kristar Fossil Filter inserts for initial pre-treatment and to collect large debris that will occur within the parking lot.

IV.4 Drainage Management Area (DMA)

Describe each DMA used in project, the BMPs in each DMA and the area treated.

DMA Number	BMPs	Area Treated
A1	Underground Infiltration	46,998 s.f.
A2	Underground Infiltration	31,447 s.f.
B	N/A	
Total Area		78,445 s.f.

Total Project Area = 87,165 s.f.

IV.5 Calculations

1. Worksheet B: Simple Design Capture Volume
2. Worksheet H: Factor of Safety and Design Infiltration Rate Worksheet
3. INF-7: Underground Infiltration Fact Sheet and Sizing

Worksheet B: Simple Design Capture Volume Sizing Method

Step 1: Determine the design capture storm depth used for calculating volume				A1	
1	Enter design capture storm depth from Figure III.1, d (inches)	$d =$	0.80	inches	0.80
2	Enter the effect of provided HSCs, d_{HSC} (inches) (Worksheet A)	$d_{HSC} =$		inches	
3	Calculate the remainder of the design capture storm depth, $d_{remainder}$ (inches) (Line 1 - Line 2)	$d_{remainder} =$	0.80	inches	0.80
Step 2: Calculate the DCV					
1	Enter Project area tributary to BMP (s), A (acres)	$A =$	1.08	acres	0.72
2	Enter Project Imperviousness, imp (unitless)	$imp =$	0.969		0.841
3	Calculate runoff coefficient, $C = (0.75 \times imp) + 0.15$	$C =$	0.88		0.78
4	Calculate runoff volume, $V_{design} = (C \times d_{remainder} \times A \times 43560 \times (1/12))$	$V_{design} =$	2,760	cu-ft	1,631
Step 3: Design BMPs to ensure full retention of the DCV					
Step 3a: Determine design infiltration rate					
1	Enter measured infiltration rate, $K_{observed}^1$ (in/hr) (Appendix VII)	$K_{observed} =$	4.5	In/hr	
2	Enter combined safety factor from Worksheet H, S_{total} (unitless)	$S_{total} =$	2.8		
3	Calculate design infiltration rate, $K_{design} = K_{observed} / S_{total}$	$K_{design} =$	1.61	In/hr	
Step 3b: Determine minimum BMP footprint				N/A for INF-7: Underground Infiltration. See drawdown calculations within INF-7 worksheet provided.	
4	Enter drawdown time, T (max 48 hours)	$T =$		Hours	
5	Calculate max retention depth that can be drawn down within the drawdown time (feet), $D_{max} = K_{design} \times T \times (1/12)$	$D_{max} =$		feet	
6	Calculate minimum area required for BMP (sq-ft), $A_{min} = V_{design} / d_{max}$	$A_{min} =$		sq-ft	

¹ $K_{observed}$ is the vertical infiltration measured in the field, before applying a factor of safety. If field testing measures a rate that is different than the vertical infiltration rate (for example, three-dimensional borehole percolation rate), then this rate must be adjusted by an acceptable method (for example, Porchet method) to yield the field estimate of vertical infiltration rate, $K_{observed}$. See Appendix VII.

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

Factor Category		Factor Description	Assigned Weight (w)	Factor Value (v)	Product (p) $p = w \times v$
A	Suitability Assessment	Soil assessment methods	0.25	2	0.50
		Predominant soil texture	0.25	1	0.25
		Site soil variability	0.25	1	0.25
		Depth to groundwater / impervious layer	0.25	1	0.25
		Suitability Assessment Safety Factor, $S_A = \Sigma p$			
B	Design	Tributary area size	0.25	2	0.50
		Level of pretreatment/ expected sediment loads	0.25	3	0.75
		Redundancy	0.25	3	0.50
		Compaction during construction	0.25	2	0.50
		Design Safety Factor, $S_B = \Sigma p$			
Combined Safety Factor, $S_{Total} = S_A \times S_B$				2.8	
Observed Infiltration Rate, inch/hr, $K_{observed}$ (corrected for test-specific bias)				4.5	
Design Infiltration Rate, in/hr, $K_{DESIGN} = K_{Observed} / S_{Total}$				1.61	
Supporting Data					
<p>Briefly describe infiltration test and provide reference to test forms: Infiltration tests were performed in two of the excavated borings during the Geotechnical Investigation. Well permeameter tests were performed. Additional information is provided on Page 13 of the Geotechnical Investigation provided in Appendix E</p>					

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

INF-7: Underground Infiltration

Underground infiltration is a vault or chamber with an open bottom that used to store runoff and percolate into the subsurface. A number of vendors offer proprietary infiltration products that allow for similar or enhanced rates of infiltration and subsurface storage while offering durable prefrabricated structures. There are many varieties of proprietary infiltration BMPs that can be used for roads and parking lots, parks and open spaces, single and multi-family residential, or mixed-use and commercial uses.



Feasibility Screening Considerations

- Infiltration bays shall pass infeasible screening criteria to be considered for use.
- Underground infiltration galleries pose a potential risk of groundwater contamination; pretreatment should be used.

Opportunity Criteria

- Soils are adequate for infiltration or can be amended to provide an adequate infiltration rate.
- Appropriate for sites with limited surface space.
- Can be placed beneath roads, parking lots, parks, and athletic fields.
- Potential for groundwater contamination can be mitigated through isolation of pollutant sources, pretreatment of inflow, and/or demonstration of adequate treatment capacity of underlying soils.
- Infiltration is into native soil, or depth of engineered fill is ≤ 5 feet from the bottom of the facility to native material and infiltration into fill is approved by a geotechnical professional.
- Tributary area land uses include mixed-use and commercial, single-family and multi-family, roads and parking lots, and parks and open spaces. High pollutant land uses should not be tributary to infiltration BMPs.

OC-Specific Design Criteria and Considerations

- Placement of BMPs should observe geotechnical recommendations with respect to geological hazards (e.g. landslides, liquefaction zones, erosion, etc.) and set-backs (e.g., foundations, utilities, roadways, etc.)
- Minimum separation to mounded seasonally high groundwater of 10 feet shall be observed.
- Minimum pretreatment should be provided upstream of the infiltration facility, and water bypassing pretreatment should not be directed to the facility.
- Underground infiltration should not be used for drainage areas with high sediment production potential unless preceded by full treatment control with a BMP effective for sediment removal.
- Design infiltration rate should be determined as described in [Appendix VII](#).
- Inspection ports or similar design features shall be provided to verify continued system performance and identify need for major maintenance.

- For infiltration facilities beneath roads and parking areas, structural requirements should meet H-20 load requirements.

Computing Underground Infiltration Device Size

Underground infiltration devices vary by design and by proprietary designs. The sizing method selected for use must be based on the BMP type it most strongly resembles.

- For underground infiltration devices with open pore volume (e.g., vaults, crates, pipe sections, etc), sizing will be most similar to infiltration basins.
- For underground infiltration devices with pore space (e.g., aggregate reservoirs), sizing will be most similar to permeable pavement.

Additional References for Design Guidance

- Los Angeles Unified School District (LAUSD) Stormwater Technical Manual, Chapter 5: [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](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)

Volume Provided

Area A1

$$Volume\ Pipe = 42' * \pi * \frac{8^2}{4} = 2,111\ cf$$

$$Volume\ Voids = 0.4 * (44' * 10' * 9' - 2,111cf) = 740\ cf$$

$$Total\ Volume = 2,111cf + 740cf = 2,851\ cf$$

Area A2

$$Volume\ Pipe = 24' * \pi * \frac{8^2}{4} = 1,206\ cf$$

$$Volume\ Voids = 0.4 * (26' * 10' * 9' - 1,206cf) = 454\ cf$$

$$Total\ Volume = 1,206cf + 454cf = 1,660\ cf$$

Drawdown

Design Infiltration Rate = 1.61 in/hr

BMP Footprint, Area A1 = 44'*10' = 440s.f.; Area A2 = 26'*10' = 260s.f.

Drawdown Rate, Area A1 = 1.61in/hr*440 sf*1ft/12in=59.0cf/hr

Area A2 = 1.61in/hr*260 sf*1ft/12in=34.9cf/hr

Drawdown Time, Area A1 = 2,851cf/59.0cf/hr = 48.3 hours*

Area A2 = 1,660cf/34.9cf/hr = 47.6 hours*

*Per TGD XI 3.2 for Infiltration BMPs "Surface drawdown shall not exceed 96 hours because of vector issues. Drawdown time of subsurface storage may exceed 96 hours, however consideration should be given to maintenance activities and plant survival, as applicable, in selecting a maximum subsurface drawdown time."

V. Implementation, Maintenance and Inspection Responsibility for BMPs (O&M Plan)

Responsible Party Information (Local Contact Information)

Name: _____ Title: _____

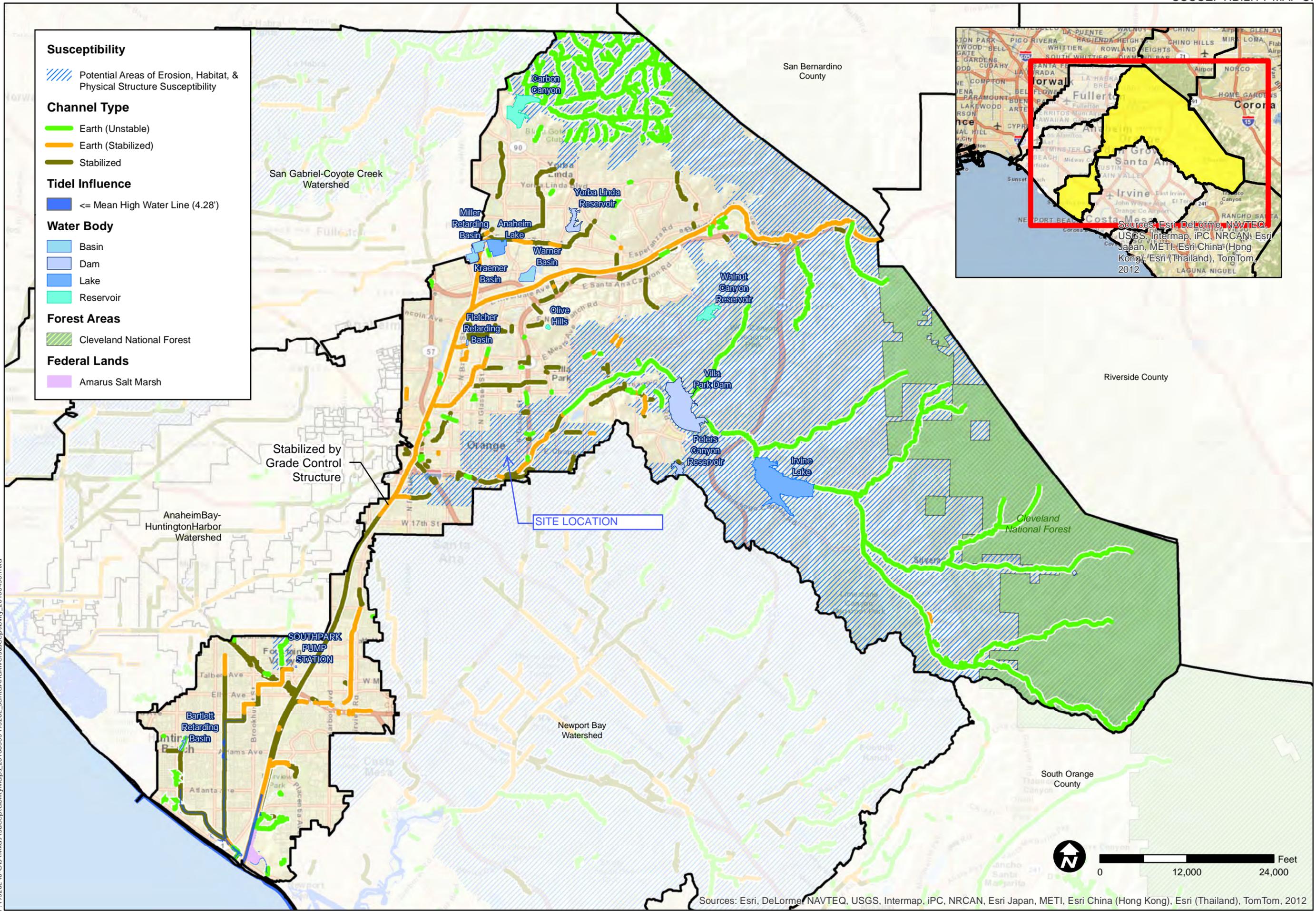
Company: _____ Phone Number: _____

Complete frequency matrix. Expand or increase each cell box to provide the information required.

Table 6 - Frequency Inspection Matrix

BMP	Responsible Party	*Maintenance Activity	*Inspection/ Maintenance Frequency
Source Control BMPs (Structural and Non-structural)			
SD-13 Storm Drain Signage	City of Orange	Stencilling shall be inspected annually and repaired at anytime the stencilling is deemed illegible.	Annually
SD-32 Trash Storage Area	City of Orange	Inspect storage area containment and trench drain annually.	Annually
SD-10 Site Design and Landscape Planning	City of Orange	Inspect vegetation annually.	Annually
Low Impact Development and Treatment BMPs			
MP-52 Drain Inserts	City of Orange	3 annual inspections of the filters and have the filter medium replaced once per year. In addition the filters should be cleaned whenever an inspection shows that the filter is more than 25% clogged.	3 Times per year.
INF-7 Underground Infiltration	City of Orange	Annual inspection of infiltration piping and outlet structure. Vacuum out all sediment and remove any debris from within the pipes. Ensure structure outlet is free of debris and not damaged.	Annually

VI. Location Map, Site Plan, and BMP Details



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

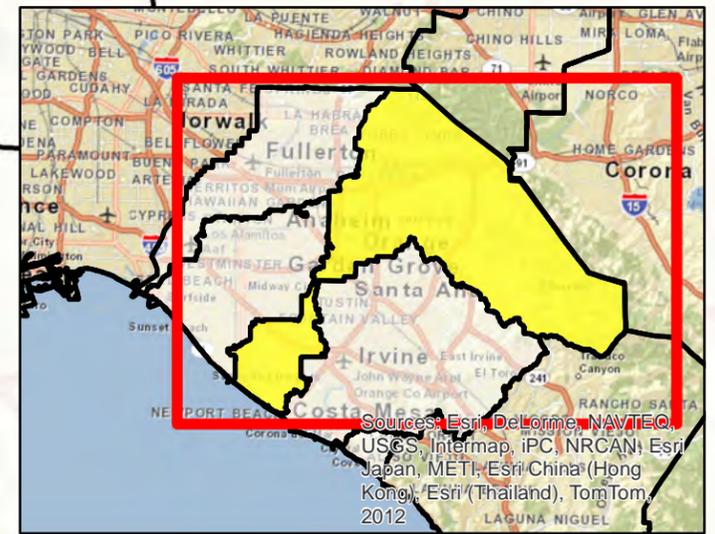
- Basin
- Dam
- Lake
- Reservoir

Forest Areas

- Cleveland National Forest

Federal Lands

- Amarus Salt Marsh



SUSCEPTIBILITY ANALYSIS
 SANTA ANA RIVER

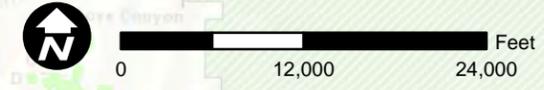
ORANGE COUNTY
 WATERSHED
 MASTER PLANNING

JOB

SCALE	1" = 12000'
DESIGNED	TH
DRAWING	TH
CHECKED	BMP
DATE	04/30/10
JOB NO.	9526 E

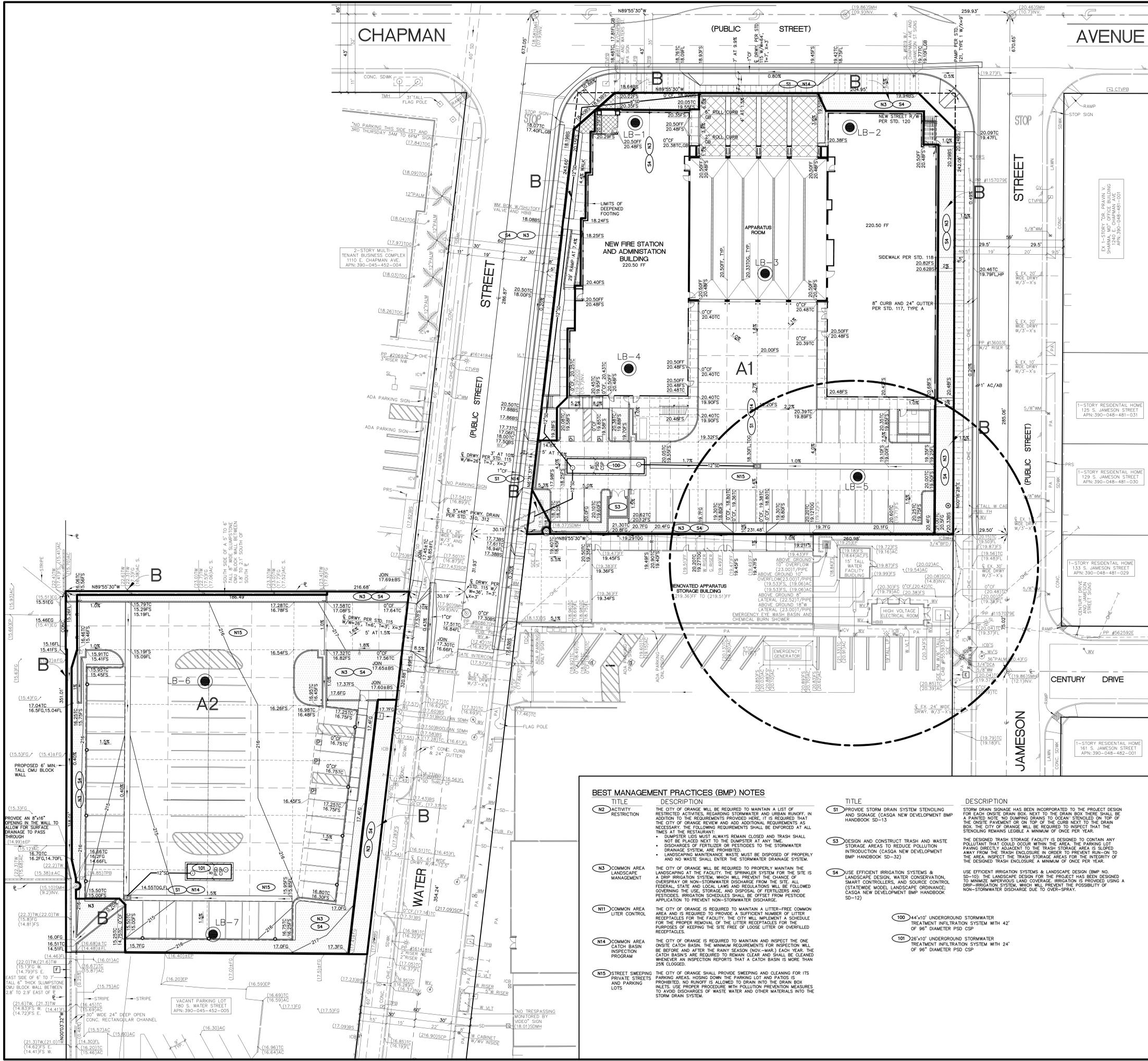


FIGURE



Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012

P:\9526E\6-GIS\MapDocs\Susceptibility\Maps_20100505\9526E_SantaAnaRiverSusceptibility_20100430.mxd



PARTIAL LEGEND

NEW 24"x36" CONCRETE DRAIN BOX INLET WITH A FLOORED PLUS FOSSIL FILTER INSERT FOR THE PRE-TREATMENT OF STORM WATER RUNOFF.

PROPOSED CITY OF ORANGE INSTALLED AND MAINTAINED LANDSCAPED PLANTER AND IRRIGATION SYSTEM ON-SITE

GEOTECHNICAL INVESTIGATION BORING LOCATION

LIMITS OF 100' RADIUS FROM EXISTING WELL FACILITY, NO INFILTRATION TO BE PROVIDED WITHIN LIMITS.

WOMP NOTES

- THIS SITE WILL BE DESIGNED AND CONSTRUCTED IN ACCORDANCE WITH THE CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD SANTA ANA REGION ORDER NO. R8-2009-0030 DISCHARGE REQUIREMENTS (MS4 PERMIT).
- THE BMP'S, SHOWN ON THE APPROVED SITE PLAN ARE ONLY PRELIMINARY AND WILL BE REVISED OR MODIFIED AS NECESSARY UPON COMPLETION OF THE WOMP. PRIOR TO THE ISSUANCE OF THE GRADING PERMIT, THE APPROVED GRADING/UTILITY PLAN SHALL INCORPORATE ALL REQUIRED STRUCTURAL BMP'S.
- ALL BUILDING ROOF DRAINS AND DOWNSPOUTS WILL BE COLLECTED AND ROUTED TO THE PROPOSED INFILTRATION SYSTEM.

DRAINAGE AREAS

ID	AREA (SF)	IMPERVIOUS (SF/%)	PERVIOUS (SF/%)
A1	46,998	45,532/96.9%	1,466/3.1%
A2	31,447	26,439/84.1%	5,008/15.9%
A SUBTOTAL	78,445	71,971/91.7%	6,474/8.3%
B	8,720	2,050/23.5%	6,670/76.5%
TOTAL	87,165	74,021/84.9%	13,144/15.1%

ARCHITECTS

WLC

CLIENT FOCUSED • PASSION DRIVEN

SOUTHERN CALIFORNIA

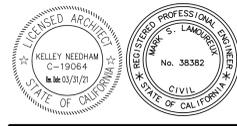
8163 ROCHESTER AVENUE, SUITE 100
RANCHO CUCAMONGA
CALIFORNIA 91730-0729

TEL: 909-987-0909
www.wlcarchitects.com

ORANGE FIRE STATION No. 1 HEADQUARTERS

CITY OF ORANGE FIRE DEPARTMENT

105 SOUTH WATER STREET, ORANGE, CA



CONSULTANT

M.S.L. ENGINEERING, INC.

CIVIL ENGINEERS AND LAND SURVEYORS
SPECIALIZING IN SITE DEVELOPMENT

301 NORTH SAN DIMAS AVENUE
SAN DIMAS, CA 91773
(909) 305-2395 FAX (909) 305-2397

Mark S. Lamoureux 06-22-2020
DATE

NO DATE BY DESCRIPTION REVISIONS

NO	DATE	BY	DESCRIPTION

DRAWN: G.R.H. CHECKED: M.S.L.

DATE: 06/22/2020 SCALE: 1"=20'

PROJECT NUMBER: 19137

PRELIMINARY

WOMP SITE PLAN

DRAWING NUMBER: **C20**

BEST MANAGEMENT PRACTICES (BMP) NOTES

TITLE	DESCRIPTION	TITLE	DESCRIPTION
(N2) ACTIVITY RESTRICTION <p>THE CITY OF ORANGE WILL BE REQUIRED TO MAINTAIN A LIST OF RESTRICTED ACTIVITIES REGARDING STORMWATER AND URBAN RUNOFF. IN ADDITION TO THE REQUIREMENTS PROVIDED HEREIN IT IS REQUIRED THAT THE CITY OF ORANGE REVIEW AND ADD ADDITIONAL REQUIREMENTS AS NECESSARY. THE FOLLOWING REQUIREMENTS SHALL BE ENFORCED AT ALL TIMES AT THE RESTAURANT:</p> <ul style="list-style-type: none"> DUMPSTER LIDS MUST ALWAYS REMAIN CLOSED AND TRASH SHALL NOT BE PLACED NEXT TO THE DUMPSTER AT ANY TIME. DISCHARGES OF FERTILIZER OR PESTICIDES TO THE STORMWATER DRAINAGE SYSTEM, ARE PROHIBITED. LANDSCAPE MAINTENANCE WASTE MUST BE DISPOSED OF PROPERLY AND NO WASTE SHALL ENTER THE STORMWATER DRAINAGE SYSTEM. 	(S1) PROVIDE STORM DRAIN SYSTEM STENCILING AND SIGNAGE (CASQA NEW DEVELOPMENT BMP HANDBOOK SD-13) <p>STORM DRAIN SIGNAGE HAS BEEN INCORPORATED TO THE PROJECT DESIGN FOR EACH ON-SITE DRAIN BOX. NEXT TO THE DRAIN BOX THERE SHALL BE A PAINTED NOTE, NO DUMPING DRAINS TO OCEAN STENCILED ON TOP OF THE ON-SITE PAVEMENT OR ON TOP OF THE CURB NEXT TO THE DRAIN BOX. THE CITY OF ORANGE WILL BE REQUIRED TO INSPECT THAT THE STENCILING REMAINS LEGIBLE A MINIMUM OF ONCE PER YEAR.</p>		
(N3) COMMON AREA LANDSCAPE MANAGEMENT <p>THE CITY OF ORANGE WILL BE REQUIRED TO PROPERLY MAINTAIN THE LANDSCAPING AT THE FACILITY. THE SPRINKLER SYSTEM FOR THE SITE IS A Drip Irrigation System, WHICH WILL PREVENT THE CHANCE OF OVERSPRAY OR NON-STORMWATER DISCHARGE FROM THE SITE. ALL FEDERAL, STATE AND LOCAL LAWS AND REGULATIONS WILL BE FOLLOWED GOVERNING THE USE, STORAGE, AND DISPOSAL OF FERTILIZERS AND PESTICIDES. IRRIGATION SCHEDULES SHALL BE OFFSET FROM PESTICIDE APPLICATION TO PREVENT NON-STORMWATER DISCHARGE.</p>	(S3) DESIGN AND CONSTRUCT TRASH AND WASTE STORAGE AREAS TO REDUCE POLLUTION INTRODUCTION (CASQA NEW DEVELOPMENT BMP HANDBOOK SD-32) <p>THE DESIGNED TRASH STORAGE FACILITY IS DESIGNED TO CONTAIN ANY POLLUTANT THAT COULD OCCUR WITHIN THE AREA. THE PARKING LOT PAVING DIRECTLY ADJACENT TO THE TRASH STORAGE AREA IS SLOPED AWAY FROM THE TRASH ENCLOSURE IN ORDER TO PREVENT RUN-OFF TO THE AREA. INSPECT THE TRASH STORAGE AREAS FOR THE INTEGRITY OF THE DESIGNED TRASH ENCLOSURE A MINIMUM OF ONCE PER YEAR.</p>		
(N11) COMMON AREA LITTER CONTROL <p>THE CITY OF ORANGE IS REQUIRED TO MAINTAIN A LITTER-FREE COMMON AREA AND IS REQUIRED TO PROVIDE A SUFFICIENT NUMBER OF LITTER RECEPTACLES FOR THE FACILITY. THE CITY WILL IMPLEMENT A SCHEDULE FOR THE PROPER REMOVAL OF THE LITTER RECEPTACLES FOR THE PURPOSES OF KEEPING THE SITE FREE OF LOOSE LITTER OR OVERFILLED RECEPTACLES.</p>	(S4) USE EFFICIENT IRRIGATION SYSTEMS & LANDSCAPE DESIGN (BMP NO. 10) - THE LANDSCAPE DESIGN FOR THE PROJECT HAS BEEN DESIGNED TO MINIMIZE IMPERVIOUS LAND COVERAGE. IRRIGATION IS PROVIDED USING A Drip-IRRIGATION SYSTEM, WHICH WILL PREVENT THE POSSIBILITY OF NON-STORMWATER DISCHARGE DUE TO OVER-SPRAY.		
(N14) COMMON AREA CATCH BASIN INSPECTION PROGRAM <p>THE CITY OF ORANGE IS REQUIRED TO MAINTAIN AND INSPECT THE ONE CATCH BASIN. THE MINIMUM REQUIREMENTS FOR INSPECTION WILL BE BEFORE AND AFTER THE RAINY SEASON (NOV-MAR.) EACH YEAR. THE CATCH BASIN IS REQUIRED TO REMAIN CLEAR AND SHALL BE CLEANED WHENEVER AN INSPECTION REPORTS THAT A CATCH BASIN IS MORE THAN 25% CLOGGED.</p>	(100) 44"x10" UNDERGROUND STORMWATER TREATMENT INFILTRATION SYSTEM WITH 42" OF 96" DIAMETER PSD CSP		
(N15) STREET SWEEPING <p>THE CITY OF ORANGE SHALL PROVIDE SWEEPING AND CLEANING FOR ITS PRIVATE STREETS DOWN THE PARKING LOT AND PATIOS IS PROHIBITED. NO RUNOFF IS ALLOWED TO DRAIN INTO THE DRAIN BOX. WEEDS, USE PROPER PROCEDURE WITH WEED LOTTERS TO AVOID DISCHARGES OF WASTE WATER AND OTHER MATERIALS INTO THE STORM DRAIN SYSTEM.</p>	(101) 26"x10" UNDERGROUND STORMWATER TREATMENT INFILTRATION SYSTEM WITH 24" OF 96" DIAMETER PSD CSP		

Underground Service Alert

Call: Toll Free **811**

TWO WORKING DAYS BEFORE YOU DIG

PROJECT NORTH TRUE NORTH

GRAPHIC SCALE 1"=20'

VII. Educational Materials

Refer to the City’s website www.cityoforange.org or the Orange County Stormwater Program (ocwatersheds.com) for a library of materials available. Attach *only* the educational materials specifically applicable to the project.

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	<input type="checkbox"/>	Tips for the Automotive Industry	<input type="checkbox"/>
Tips for Car Wash Fund-raisers	<input type="checkbox"/>	Tips for Using Concrete and Mortar	<input type="checkbox"/>
Tips for the Home Mechanic	<input type="checkbox"/>	Tips for the Food Service Industry	<input checked="" type="checkbox"/>
Homeowners Guide for Sustainable Water Use	<input type="checkbox"/>	Proper Maintenance Practices for Your Business	<input checked="" type="checkbox"/>
Household Tips	<input type="checkbox"/>	Other Material	Check If Attached
Proper Disposal of Household Hazardous Waste	<input type="checkbox"/>		
Recycle at Your Local Used Oil Collection Center (North County)	<input type="checkbox"/>	OCwatersheds.com “Tips for the Food Service Industry”	<input type="checkbox"/>
Recycle at Your Local Used Oil Collection Center (Central County)	<input type="checkbox"/>	OCwatersheds.com “Sewer Spill”	<input checked="" type="checkbox"/>
Recycle at Your Local Used Oil Collection Center (South County)	<input type="checkbox"/>	CASQA BMP SC-41 “Building & Grounds Maintenance”	<input checked="" type="checkbox"/>
Tips for Maintaining a Septic Tank System	<input type="checkbox"/>	CASQA BMP SC-34 “Waste Handling and Disposal”	<input checked="" type="checkbox"/>
Responsible Pest Control	<input type="checkbox"/>	CASQA BMP SD-13 “Storm Drain Signage”	<input checked="" type="checkbox"/>
Sewer Spill Response	<input checked="" type="checkbox"/>	CASQA BMP SD-32 “Trash Storage Areas”	<input checked="" type="checkbox"/>
Tips for the Home Improvement Projects	<input type="checkbox"/>	CASQA BMP SD-10 “Site Design & Landscape Planning”	<input checked="" type="checkbox"/>
Tips for Horse Care	<input type="checkbox"/>	CASQA BMP SD-52 “Drain Inserts”	<input checked="" type="checkbox"/>
Tips for Landscaping and Gardening	<input type="checkbox"/>		<input type="checkbox"/>
Tips for Pet Care	<input type="checkbox"/>		<input type="checkbox"/>
Tips for Pool Maintenance	<input type="checkbox"/>		<input type="checkbox"/>
Tips for Residential Pool, Landscape and Hardscape Drains	<input type="checkbox"/>		<input type="checkbox"/>
Tips for Projects Using Paint	<input type="checkbox"/>		<input type="checkbox"/>

Appendix A:

Conditions of Approval

Resolution Number _____ dated _____

Appendix B:

Educational Material

Sewage Spill Regulatory Requirements

Allowing sewage to discharge to a gutter or storm drain may subject you to penalties and/or out-of-pocket costs to reimburse cities or public agencies for clean-up efforts.

Here are the pertinent codes, fines, and agency contact information that apply.

Orange County Stormwater Program

24 Hour Water Pollution Reporting Hotline

1-877-89-SPILL (1-877-897-7455)

- County and city water quality ordinances prohibit discharges containing pollutants.

Orange County Health Care Agency

Environmental Health

(714) 433-6419

California Health and Safety Code, Sections 5410-5416

- No person shall discharge raw or treated sewage or other waste in a manner that results in contamination, pollution or a nuisance.
- Any person who causes or permits a sewage discharge to any state waters:
 - must immediately notify the local health agency of the discharge.
 - shall reimburse the local health agency for services that protect the public's health and safety (water-contact receiving waters).
 - who fails to provide the required notice to the local health agency is guilty of a misdemeanor and shall be punished by a fine (between \$500-\$1,000) and/or imprisonment for less than one year.

Regional Water Quality Control Board

Santa Ana Region San Diego Region

(951) 782-4130

(858) 467-2952

- Requires the prevention, mitigation, response to and reporting of sewage spills.

California Office of Emergency Services

(800) 852-7550

California Water Code, Article 4, Chapter 4, Sections 13268-13271
California Code of Regulations, Title 23, Division 3, Chapter 9.2, Article 2, Sections 2250-2260

- Any person who causes or permits sewage in excess of 1,000 gallons to be discharged to state waters shall immediately notify the Office of Emergency Services.
- Any person who fails to provide the notice required by this section is guilty of a misdemeanor and shall be punished by a fine (less than \$20,000) and/or imprisonment for not more than one year.

Sewage Spill

Reference Guide

Your Responsibilities as a Private Property Owner

Residences
Businesses
Homeowner/Condominium Associations
Federal and State Complexes
Military Facilities



Orange County
Sanitation District



Health Care Agency
Environmental Health



www.ocwatersheds.com

This brochure was designed courtesy of the Orange County Sanitation District (OCS D).
For additional information, call (714) 962-2411, or visit their website at www.ocsd.com

What is a Sewage Spill?

Sewage spills occur when the wastewater being transported via underground pipes overflows through a manhole, cleanout or broken pipe. Sewage spills can cause health hazards, damage to homes and businesses, and threaten the environment, local waterways and beaches.

Common Causes of Sewage Spills

Grease builds up inside and eventually blocks sewer pipes. Grease gets into the sewer from food establishments, household drains, as well as from poorly maintained commercial grease traps and interceptors.

Structure problems caused by tree roots in the lines, broken/cracked pipes, missing or broken cleanout caps or undersized sewers can cause blockages.

Infiltration and inflow (I/I) impacts pipe capacity and is caused when groundwater or rainwater enters the sewer system through pipe defects and illegal connections.

You Are Responsible for a Sewage Spill Caused by a Blockage or Break in Your Sewer Lines!

Time is of the essence in dealing with sewage spills. You are required to **immediately**:

Control and minimize the spill. Keep spills contained on private property and out of gutters, storm drains and public waterways by shutting off or not using the water.

Use sandbags, dirt and/or plastic sheeting to prevent sewage from entering the storm drain system.

Clear the sewer blockage. Always wear gloves and wash your hands. It is recommended that a plumbing professional be called for clearing blockages and making necessary repairs.

Always notify your city sewer/public works department or public sewer district of sewage spills. If the spill enters the storm drains also notify the Health Care Agency. In addition, if it exceeds 1,000 gallons notify the Office of Emergency Services. Refer to the numbers listed in this brochure.

Overflowing
cleanout pipe
located on
private property



You Could Be Liable

Allowing sewage from your home, business or property to discharge to a gutter or storm drain may subject you to penalties and/or out-of-pocket costs to reimburse cities or public agencies for clean-up and enforcement efforts. See Regulatory Codes & Fines section for pertinent codes and fines that apply.

What to Look For

Sewage spills can be a very noticeable gushing of water from a manhole or a slow water leak that may take time to be noticed. Don't dismiss unaccounted-for wet areas.

Look for:

- Drain backups inside the building.
- Wet ground and water leaking around manhole lids onto your street.
- Leaking water from cleanouts or outside drains.
- Unusual odorous wet areas: sidewalks, external walls or ground/landscape around a building.

Caution

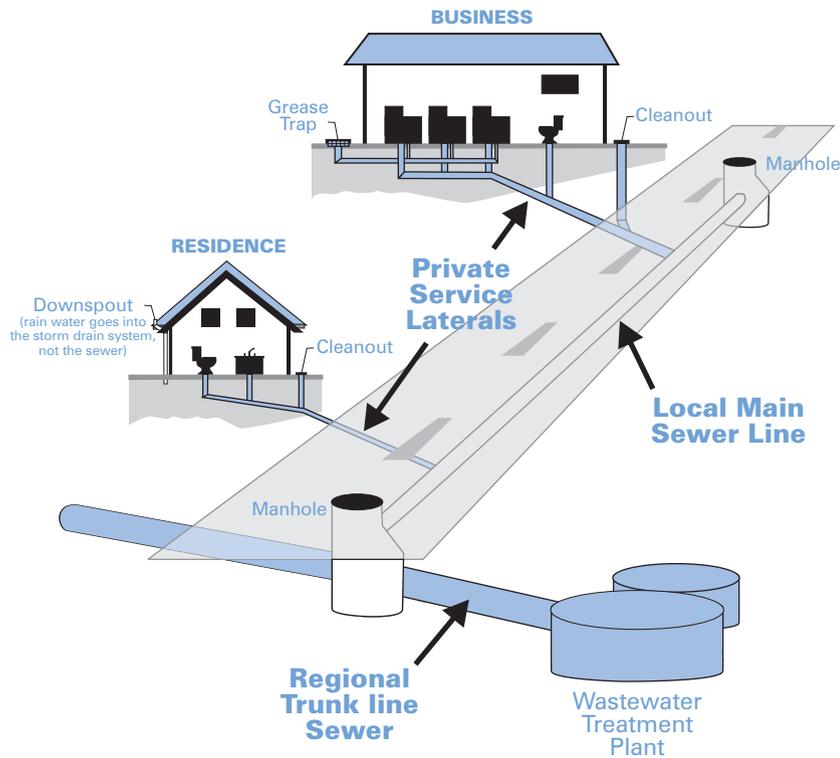
Keep people and pets away from the affected area. Untreated sewage has high levels of disease-causing viruses and bacteria. Call your local health care agency listed on the back for more information.

**If You See a Sewage Spill Occurring,
Notify Your City Sewer/Public Works
Department or Public Sewer District
IMMEDIATELY!**

How a Sewer System Works

A property owner's sewer pipes are called service laterals and are connected to larger local main and regional trunk lines. Service laterals run from the connection at the home to the connection with the public sewer (including the area under the street). These laterals are the responsibility of the property owner and must be maintained by the property owner. Many city agencies have adopted ordinances requiring maintenance of service laterals. Check with your city sewer/local public works department for more information.

Operation and maintenance of **local and regional sewer lines** are the responsibility of the city sewer/public works departments and public sewer districts.



Preventing Grease Blockages

The drain is not a dump! Recycle or dispose of grease properly and never pour grease down the drain.

Homeowners should mix fats, oils and grease with absorbent waste materials such as paper, coffee grounds, or kitty litter and place it in the trash. Wipe food scraps from plates and pans and dump them in the trash.

Restaurants and commercial food service establishments should always use "Kitchen Best Management Practices." These include:

- Collecting all cooking grease and liquid oil from pots, pans and fryers in covered grease containers for recycling.
- Scraping or dry-wiping excess food and grease from dishes, pots, pans and fryers into the trash.
- Installing drain screens on all kitchen drains.
- Having spill kits readily available for cleaning up spills.
- Properly maintaining grease traps or interceptors by having them serviced regularly. Check your local city codes.

How You Can Prevent Sewage Spills

- 1 Never put grease down garbage disposals, drains or toilets.**
- 2 Perform periodic cleaning to eliminate grease, debris and roots in your service laterals.**
- 3 Repair any structural problems in your sewer system and eliminate any rainwater infiltration/inflow leaks into your service laterals.**



Orange County Agency Responsibilities

- **City Sewer/Public Works Departments**— Responsible for protecting city property and streets, the local storm drain system, sewage collection system and other public areas.
- **Public Sewer/Sanitation District**— Responsible for collecting, treating and disposing of wastewater.
- **County of Orange Health Care Agency**— Responsible for protecting public health by closing ocean/bay waters and may close food-service businesses if a spill poses a threat to public health.
- **Regional Water Quality Control Boards**— Responsible for protecting State waters.
- **Orange County Stormwater Program**— Responsible for preventing harmful pollutants from being discharged or washed by stormwater runoff into the municipal storm drain system, creeks, bays and the ocean.

You Could Be Liable for Not Protecting the Environment

Local and state agencies have legal jurisdiction and enforcement authority to ensure that sewage spills are remedied.

They may respond and assist with containment, relieving pipe blockages, and/or clean-up of the sewage spill, especially if the spill is flowing into storm drains or onto public property.

A property owner may be charged for costs incurred by these agencies responding to spills from private properties.



Report Sewage Spills!

City Sewer/Public Works Departments

Aliso Viejo	(949) 425-2500
Anaheim	(714) 765-6860
Brea	(714) 990-7691
Buena Park	(714) 562-3655
Costa Mesa	(949) 645-8400
Cypress	(714) 229-6760
Dana Point	(949) 248-3562
Fountain Valley	(714) 593-4600
Fullerton	(714) 738-6897
Garden Grove	(714) 741-5375
Huntington Beach	(714) 536-5921
Irvine	(949) 453-5300
Laguna Beach	(949) 497-0765
Laguna Hills	(949) 707-2650
Laguna Niguel	(949) 362-4337
Laguna Woods	(949) 639-0500
La Habra	(562) 905-9792
Lake Forest	(949) 461-3480
La Palma	(714) 690-3310
Los Alamitos	(562) 431-3538
Mission Viejo	(949) 831-2500
Newport Beach	(949) 644-3011
Orange	(714) 532-6480
Orange County	(714) 567-6363
Placentia	(714) 993-8245
Rancho Santa Margarita	(949) 635-1800
San Clemente	(949) 366-1553
San Juan Capistrano	(949) 443-6363
Santa Ana	(714) 647-3380
Seal Beach	(562) 431-2527
Stanton	(714) 379-9222
Tustin	(714) 962-2411
Villa Park	(714) 998-1500
Westminster	(714) 893-3553
Yorba Linda	(714) 961-7170

Public Sewer/Water Districts

Costa Mesa Sanitary District	(714) 393-4433/ (949) 645-8400
El Toro Water District	(949) 837-0660
Emerald Bay Service District	(949) 494-8571
Garden Grove Sanitary District	(714) 741-5375
Irvine Ranch Water District	(949) 453-5300
Los Alamitos/Rossmoor Sewer District	(562) 431-2223
Midway City Sanitary District (Westminster)	(714) 893-3553
Moulton Niguel Water District	(949) 831-2500
Orange County Sanitation District	(714) 962-2411
Santa Margarita Water District	(949) 459-6420
South Coast Water District	(949) 499-4555
South Orange County Wastewater Authority	(949) 234-5400
Sunset Beach Sanitary District	(562) 493-9932
Trabuco Canyon Sanitary District	(949) 858-0277
Yorba Linda Water District	(714) 777-3018

Other Agencies

Orange County Health Care Agency	(714) 433-6419
Office of Emergency Services	(800) 852-7550



Preventing water pollution at your commercial/industrial site

Clean beaches and healthy creeks, rivers, bays and ocean are important to Orange County. However, many landscape and building maintenance activities can lead to water pollution if you're not careful. Paint, chemicals, plant clippings and other materials can be blown or washed into storm drains that flow to the ocean. Unlike water in sanitary sewers (from sinks and toilets), water in storm drains is not treated before entering our waterways.

You would never pour soap or fertilizers into the ocean, so why would you let them enter the storm drains? Follow these easy tips to help prevent water pollution.

Some types of industrial facilities are required to obtain coverage under the State General Industrial Permit. For more information visit: www.swrcb.ca.gov/stormwater/industrial.html

For more information, please call the **Orange County Stormwater Program** at **1-877-89-SPILL** (1-877-897-7455) or visit www.ocwatersheds.com

To report a spill, call the **Orange County 24-Hour Water Pollution Problem Reporting Hotline** at **1-877-89-SPILL** (1-877-897-7455).

For emergencies, dial 911.



RECYCLE
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Help Prevent Ocean Pollution:

Proper Maintenance Practices for Your Business



The Ocean Begins at Your Front Door



Proper Maintenance Practices for your Business

Landscape Maintenance

- Compost grass clippings, leaves, sticks and other vegetation, or dispose of it at a permitted landfill or in green waste containers. Do not dispose of these materials in the street, gutter or storm drain.
- Irrigate slowly and inspect the system for leaks, overspraying and runoff. Adjust automatic timers to avoid overwatering.
- Follow label directions for the use and disposal of fertilizers and pesticides.
- Do not apply pesticides or fertilizers if rain is expected within 48 hours or if wind speeds are above 5 mph.
- Do not spray pesticides within 100 feet of waterways.
- Fertilizers should be worked into the soil rather than dumped onto the surface.
- If fertilizer is spilled on the pavement or sidewalk, sweep it up immediately and place it back in the container.

Building Maintenance

- Never allow washwater, sweepings or sediment to enter the storm drain.
- Sweep up dry spills and use cat litter, towels or similar materials to absorb wet spills. Dispose of it in the trash.
- If you wash your building, sidewalk or parking lot, you **must** contain the water. Use a shop vac to collect the water and contact your city or sanitation agency for proper disposal information. Do not let water enter the street, gutter or storm drain.
- Use drop cloths underneath outdoor painting, scraping, and sandblasting work, and properly dispose of materials in the trash.
- Use a ground cloth or oversized tub for mixing paint and cleaning tools.
- Use a damp mop or broom to clean floors.
- Cover dumpsters to keep insects, animals, rainwater and sand from entering. Keep the area around the dumpster clear of trash and debris. Do not overfill the dumpster.

- Call your trash hauler to replace leaking dumpsters.
- Do not dump any toxic substance or liquid waste on the pavement, the ground, or near a storm drain. Even materials that seem harmless such as latex paint or biodegradable cleaners can damage the environment.
- Recycle paints, solvents and other materials. For more information about recycling and collection centers, visit www.oclandfills.com.
- Store materials indoors or under cover and away from storm drains.
- Use a construction and demolition recycling company to recycle lumber, paper, cardboard, metals, masonry, carpet, plastic, pipes, drywall, rocks, dirt, and green waste. For a listing of construction and demolition recycling locations in your area, visit www.ciwmb.ca.gov/recycle.
- Properly label materials. Familiarize employees with Material Safety Data Sheets.

NEVER DISPOSE
OF ANYTHING
IN THE STORM
DRAIN.



Description

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

Approach

Pollution Prevention

- Switch to non-toxic chemicals for maintenance when possible.
- Choose cleaning agents that can be recycled.
- Encourage proper lawn management and landscaping, including use of native vegetation.
- Encourage use of Integrated Pest Management techniques for pest control.
- Encourage proper onsite recycling of yard trimmings.
- Recycle residual paints, solvents, lumber, and other material as much as possible.

Objectives

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

Targeted Constituents

Sediment	<input checked="" type="checkbox"/>
Nutrients	<input checked="" type="checkbox"/>
Trash	<input checked="" type="checkbox"/>
Metals	<input checked="" type="checkbox"/>
Bacteria	<input checked="" type="checkbox"/>
Oil and Grease	<input checked="" type="checkbox"/>
Organics	<input checked="" type="checkbox"/>
Oxygen Demanding	<input checked="" type="checkbox"/>



SC-41 Building & Grounds Maintenance

Suggested Protocols

Pressure Washing of Buildings, Rooftops, and Other Large Objects

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

Landscaping Activities

- Do not apply any chemicals (insecticide, herbicide, or fertilizer) directly to surface waters, unless the application is approved and permitted by the state.
- Dispose of grass clippings, leaves, sticks, or other collected vegetation as garbage, or by composting. Do not dispose of collected vegetation into waterways or storm drainage systems.
- Use mulch or other erosion control measures on exposed soils.
- Check irrigation schedules so pesticides will not be washed away and to minimize non-stormwater discharge.

Building Repair, Remodeling, and Construction

- Do not dump any toxic substance or liquid waste on the pavement, the ground, or toward a storm drain.
- Use ground or drop cloths underneath outdoor painting, scraping, and sandblasting work, and properly dispose of collected material daily.
- Use a ground cloth or oversized tub for activities such as paint mixing and tool cleaning.
- Clean paint brushes and tools covered with water-based paints in sinks connected to sanitary sewers or in portable containers that can be dumped into a sanitary sewer drain. Brushes and tools covered with non-water-based paints, finishes, or other materials must be cleaned in a manner that enables collection of used solvents (e.g., paint thinner, turpentine, etc.) for recycling or proper disposal.

- Use a storm drain cover, filter fabric, or similarly effective runoff control mechanism if dust, grit, wash water, or other pollutants may escape the work area and enter a catch basin. The containment device(s) must be in place at the beginning of the work day, and accumulated dirty runoff and solids must be collected and disposed of before removing the containment device(s) at the end of the work day.
- If you need to de-water an excavation site, you may need to filter the water before discharging to a catch basin or off-site. In which case you should direct the water through hay bales and filter fabric or use other sediment filters or traps.
- Store toxic material under cover with secondary containment during precipitation events and when not in use. A cover would include tarps or other temporary cover material.

Mowing, Trimming, and Planting

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

Fertilizer and Pesticide Management

- Follow all federal, state, and local laws and regulations governing the use, storage, and disposal of fertilizers and pesticides and training of applicators and pest control advisors.
- Follow manufacturers' recommendations and label directions. Pesticides must never be applied if precipitation is occurring or predicted. Do not apply insecticides within 100 feet of surface waters such as lakes, ponds, wetlands, and streams.
- Use less toxic pesticides that will do the job, whenever possible. Avoid use of copper-based pesticides if possible.
- Do not use pesticides if rain is expected.
- Do not mix or prepare pesticides for application near storm drains.
- Use the minimum amount needed for the job.
- Calibrate fertilizer distributors to avoid excessive application.
- Employ techniques to minimize off-target application (e.g. spray drift) of pesticides, including consideration of alternative application techniques.

SC-41 Building & Grounds Maintenance

- Apply pesticides only when wind speeds are low.
- Work fertilizers into the soil rather than dumping or broadcasting them onto the surface.
- Irrigate slowly to prevent runoff and then only as much as is needed.
- Clean pavement and sidewalk if fertilizer is spilled on these surfaces before applying irrigation water.
- Dispose of empty pesticide containers according to the instructions on the container label.
- Use up the pesticides. Rinse containers, and use rinse water as product. Dispose of unused pesticide as hazardous waste.
- Implement storage requirements for pesticide products with guidance from the local fire department and County Agricultural Commissioner. Provide secondary containment for pesticides.

Inspection

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

Training

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

Spill Response and Prevention

- Refer to SC-11, Spill Prevention, Control & Cleanup
- Keep your Spill Prevention Control and countermeasure (SPCC) plan up-to-date, and implement accordingly.
- Have spill cleanup materials readily available and in a known location.
- Cleanup spills immediately and use dry methods if possible.
- Properly dispose of spill cleanup material.

Other Considerations

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

Requirements

Costs

- Overall costs should be low in comparison to other BMPs.

Maintenance

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

Supplemental Information

Further Detail of the BMP

Fire Sprinkler Line Flushing

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

References and Resources

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

King County - <ftp://dnr.metrokc.gov/wlr/dss/spcm/Chapter%203.PDF>

Orange County Stormwater Program

http://www.ocwatersheds.com/StormWater/swp_introduction.asp

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

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

San Diego Stormwater Co-permittees Jurisdictional Urban Runoff Management Program (URMP) -

<http://www.projectcleanwater.org/pdf/Model%20Program%20Municipal%20Facilities.pdf>



Objectives

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

Description

Improper storage and handling of solid wastes can allow toxic compounds, oils and greases, heavy metals, nutrients, suspended solids, and other pollutants to enter stormwater runoff. The discharge of pollutants to stormwater from waste handling and disposal can be prevented and reduced by tracking waste generation, storage, and disposal; reducing waste generation and disposal through source reduction, re-use, and recycling; and preventing runoff and runoff.

Approach

Pollution Prevention

- Reduction in the amount of waste generated can be accomplished using the following source controls such as:
 - Production planning and sequencing
 - Process or equipment modification
 - Raw material substitution or elimination
 - Loss prevention and housekeeping
 - Waste segregation and separation
 - Close loop recycling
- Establish a material tracking system to increase awareness about material usage. This may reduce spills and minimize contamination, thus reducing the amount of waste produced.
- Recycle materials whenever possible.

Targeted Constituents

Sediment	<input checked="" type="checkbox"/>
Nutrients	<input checked="" type="checkbox"/>
Trash	<input checked="" type="checkbox"/>
Metals	<input checked="" type="checkbox"/>
Bacteria	<input checked="" type="checkbox"/>
Oil and Grease	<input checked="" type="checkbox"/>
Organics	<input checked="" type="checkbox"/>
Oxygen Demanding	<input checked="" type="checkbox"/>



Suggested Protocols*General*

- Cover storage containers with leak proof lids or some other means. If waste is not in containers, cover all waste piles (plastic tarps are acceptable coverage) and prevent stormwater runoff and runoff with a berm. The waste containers or piles must be covered except when in use.
- Use drip pans or absorbent materials whenever grease containers are emptied by vacuum trucks or other means. Grease cannot be left on the ground. Collected grease must be properly disposed of as garbage.
- Check storage containers weekly for leaks and to ensure that lids are on tightly. Replace any that are leaking, corroded, or otherwise deteriorating.
- Sweep and clean the storage area regularly. If it is paved, do not hose down the area to a storm drain.
- Dispose of rinse and wash water from cleaning waste containers into a sanitary sewer if allowed by the local sewer authority. Do not discharge wash water to the street or storm drain.
- Transfer waste from damaged containers into safe containers.
- Take special care when loading or unloading wastes to minimize losses. Loading systems can be used to minimize spills and fugitive emission losses such as dust or mist. Vacuum transfer systems can minimize waste loss.

Controlling Litter

- Post “No Littering” signs and enforce anti-litter laws.
- Provide a sufficient number of litter receptacles for the facility.
- Clean out and cover litter receptacles frequently to prevent spillage.

Waste Collection

- Keep waste collection areas clean.
- Inspect solid waste containers for structural damage or leaks regularly. Repair or replace damaged containers as necessary.
- Secure solid waste containers; containers must be closed tightly when not in use.
- Place waste containers under cover if possible.
- Do not fill waste containers with washout water or any other liquid.
- Ensure that only appropriate solid wastes are added to the solid waste container. Certain wastes such as hazardous wastes, appliances, fluorescent lamps, pesticides, etc. may not be

disposed of in solid waste containers (see chemical/ hazardous waste collection section below).

- Do not mix wastes; this can cause chemical reactions, make recycling impossible, and complicate disposal.

Good Housekeeping

- Use all of the product before disposing of the container.
- Keep the waste management area clean at all times by sweeping and cleaning up spills immediately.
- Use dry methods when possible (e.g. sweeping, use of absorbents) when cleaning around restaurant/food handling dumpster areas. If water must be used after sweeping/using absorbents, collect water and discharge through grease interceptor to the sewer.
- Stencil storm drains on the facility's property with prohibitive message regarding waste disposal.

Chemical/Hazardous Wastes

- Select designated hazardous waste collection areas on-site.
- Store hazardous materials and wastes in covered containers protected from vandalism, and in compliance with fire and hazardous waste codes.
- Place hazardous waste containers in secondary containment.
- Make sure that hazardous waste is collected, removed, and disposed of only at authorized disposal areas.

Runon/Runoff Prevention

- Prevent stormwater runon from entering the waste management area by enclosing the area or building a berm around the area.
- Prevent the waste materials from directly contacting rain.
- Cover waste piles with temporary covering material such as reinforced tarpaulin, polyethylene, polyurethane, polypropylene or hypalon.
- Cover the area with a permanent roof if feasible.
- Cover dumpsters to prevent rain from washing waste out of holes or cracks in the bottom of the dumpster.
- Move the activity indoor after ensuring all safety concerns such as fire hazard and ventilation are addressed.

Inspection

- Inspect and replace faulty pumps or hoses regularly to minimize the potential of releases and spills.
- Check waste management areas for leaking containers or spills.
- Repair leaking equipment including valves, lines, seals, or pumps promptly.

Training

- Train staff pollution prevention measures and proper disposal methods.
- Train employees and contractors proper spill containment and cleanup. The employee should have the tools and knowledge to immediately begin cleaning up a spill if one should occur.
- Train employees and subcontractors in proper hazardous waste management.

Spill Response and Prevention

- Refer to SC-11, Spill Prevention, Control & Cleanup.
- Keep your Spill Prevention Control and countermeasure (SPCC) plan up-to-date, and implement accordingly.
- Have spill cleanup materials readily available and in a known location.
- Cleanup spills immediately and use dry methods if possible.
- Properly dispose of spill cleanup material.
- Vehicles transporting waste should have spill prevention equipment that can prevent spills during transport. The spill prevention equipment includes:
 - Vehicles equipped with baffles for liquid waste
 - Trucks with sealed gates and spill guards for solid waste

Other Considerations

- Hazardous waste cannot be re-used or recycled; it must be disposed of by a licensed hazardous waste hauler.

Requirements***Costs***

- Capital and operation and maintenance costs will vary substantially depending on the size of the facility and the types of waste handled. Costs should be low if there is an inventory program in place.

Maintenance

- None except for maintaining equipment for material tracking program.

Supplemental Information

Further Detail of the BMP

Land Treatment System

- Minimize the runoff of polluted stormwater from land application of municipal waste on-site by:
 - Choosing a site where slopes are under 6%, the soil is permeable, there is a low water table, it is located away from wetlands or marshes, there is a closed drainage system.
 - Avoiding application of waste to the site when it is raining or when the ground is saturated with water.
 - Growing vegetation on land disposal areas to stabilize soils and reduce the volume of surface water runoff from the site.
 - Maintaining adequate barriers between the land application site and the receiving waters. Planted strips are particularly good.
 - Using erosion control techniques such as mulching and matting, filter fences, straw bales, diversion terracing, and sediment basins.
 - Performing routine maintenance to ensure the erosion control or site stabilization measures are working.

References and Resources

King County Stormwater Pollution Control Manual - <http://dnr.metrokc.gov/wlr/dss/spcm.htm>

Orange County Stormwater Program

http://www.ocwatersheds.com/StormWater/swp_introduction.asp

Pollution from Surface Cleaning Folder. 1996. Bay Area Stormwater Management Agencies Associations (BASMAA). On-line: <http://www.basmaa.org>



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



– 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.

Description

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

Approach

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

Suitable Applications

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

Design Considerations

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

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

Designing New Installations

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

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

Design Objectives

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

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

Redeveloping Existing Installations

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

Additional Information***Maintenance Considerations***

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

Other Resources

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

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

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

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

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.



SD-10 Site Design & Landscape Planning

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

Site Design & Landscape Planning SD-10

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.

SD-10 Site Design & Landscape Planning

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.

Description

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

California Experience

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

Advantages

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

Limitations

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

Design and Sizing Guidelines

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

Design Considerations

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

Targeted Constituents

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

Removal Effectiveness

See New Development and Redevelopment Handbook-Section 5.



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

Construction/Inspection Considerations

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

Performance

Few products have performance data collected under field conditions.

Siting Criteria

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

Additional Design Guidelines

Follow guidelines provided by individual manufacturers.

Maintenance

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

Cost

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

References and Sources of Additional Information

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

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

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

Manufacturers literature

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

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



Photo Credit: Geoff Brosseau

Design Objectives

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

Description

Vehicle washing, equipment washing, and steam cleaning may contribute high concentrations of metals, oil and grease, solvents, phosphates, and suspended solids to wash waters that drain to stormwater conveyance systems.

Approach

Project plans should include appropriately designed area(s) for washing-steam cleaning of vehicles and equipment. Depending on the size and other parameters of the wastewater facility, wash water may be conveyed to a sewer, an infiltration system, recycling system or other alternative. Pretreatment may be required for conveyance to a sanitary sewer.

Suitable Applications

Appropriate applications include commercial developments, restaurants, retail gasoline outlets, automotive repair shops and others.

Design Considerations

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

Designing New Installations

Areas for washing/steam cleaning should incorporate one of the following features:

- Be self-contained and/or covered with a roof or overhang
- Be equipped with a clarifier or other pretreatment facility
- Have a proper connection to a sanitary sewer



- Include other features which are comparable and equally effective

CAR WASH AREAS - Some jurisdictions' stormwater management plans include vehicle-cleaning area source control design requirements for community car wash racks in complexes with a large number of dwelling units. In these cases, wash water from the areas may be directed to the sanitary sewer, to an engineered infiltration system, or to an equally effective alternative. Pre-treatment may also be required.

Depending on the jurisdiction, developers may be directed to divert surface water runoff away from the exposed area around the wash pad (parking lot, storage areas), and wash pad itself to alternatives other than the sanitary sewer. Roofing may be required for exposed wash pads.

It is generally advisable to cover areas used for regular washing of vehicles, trucks, or equipment, surround them with a perimeter berm, and clearly mark them as a designated washing area. Sumps or drain lines can be installed to collect wash water, which may be treated for reuse or recycling, or for discharge to the sanitary sewer. Jurisdictions may require some form of pretreatment, such as a trap, for these areas.

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.

Additional Information

Maintenance Considerations

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

Other Resources

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

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

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

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



Photo Credit: Geoff Brosseau

Design Objectives

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

Description

Fueling areas have the potential to contribute oil and grease, solvents, car battery acid, coolant and gasoline to the stormwater conveyance system. Spills at vehicle and equipment fueling areas can be a significant source of pollution because fuels contain toxic materials and heavy metals that are not easily removed by stormwater treatment devices.

Approach

Project plans must be developed for cleaning near fuel dispensers, emergency spill cleanup, containment, and leak prevention.

Suitable Applications

Appropriate applications include commercial, industrial, and any other areas planned to have fuel dispensing equipment, including retail gasoline outlets, automotive repair shops, and major non-retail dispensing areas.

Design Considerations

Design requirements for fueling areas are governed by Building and Fire Codes and by current local agency ordinances and zoning requirements. Design requirements described in this fact sheet are meant to enhance and be consistent with these code and ordinance requirements.

Designing New Installations

Covering



Fuel dispensing areas should provide an overhanging roof structure or canopy. The cover's minimum dimensions must be equal to or greater than the area within the grade break. The cover must not drain onto the fuel dispensing area and the downspouts must be routed to prevent drainage across the fueling area. The fueling area should drain to the project's treatment control BMP(s) prior to discharging to the stormwater conveyance system. Note - If fueling large equipment or vehicles that would prohibit the use of covers or roofs, the fueling island should be designed to sufficiently accommodate the larger vehicles and equipment and to prevent stormwater run-on and runoff. Grade to direct stormwater to a dead-end sump.

Surfacing

Fuel dispensing areas should be paved with Portland cement concrete (or equivalent smooth impervious surface). The use of asphalt concrete should be prohibited. Use asphalt sealant to protect asphalt paved areas surrounding the fueling area. This provision may be made to sites that have pre-existing asphalt surfaces.

The concrete fuel dispensing area should be extended a minimum of 6.5 ft from the corner of each fuel dispenser, or the length at which the hose and nozzle assembly may be operated plus 1 ft, whichever is less.

Grading/Contouring

Dispensing areas should have an appropriate slope to prevent ponding, and be separated from the rest of the site by a grade break that prevents run-on of urban runoff. (Slope is required to be 2 to 4% in some jurisdictions' stormwater management and mitigation plans.)

Fueling areas should be graded to drain toward a dead-end sump. Runoff from downspouts/roofs should be directed away from fueling areas. Do not locate storm drains in the immediate vicinity of the fueling area.

Redeveloping Existing Installations

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

Additional Information

- In the case of an emergency, provide storm drain seals, such as isolation valves, drain plugs, or drain covers, to prevent spills or contaminated stormwater from entering the stormwater conveyance system.

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.

Appendix C:

BMP Details

INF-7: Underground Infiltration

Underground infiltration is a vault or chamber with an open bottom that used to store runoff and percolate into the subsurface. A number of vendors offer proprietary infiltration products that allow for similar or enhanced rates of infiltration and subsurface storage while offering durable prefabricated structures. There are many varieties of proprietary infiltration BMPs that can be used for roads and parking lots, parks and open spaces, single and multi-family residential, or mixed-use and commercial uses.

<i>Also known as:</i>
<ul style="list-style-type: none"> ➤ <i>Infiltration vault</i> ➤ <i>Recharge vault</i>

Underground Infiltration
Source: http://www.contech-cpi.com

Feasibility Screening Considerations

- Infiltration bays shall pass infeasible screening criteria to be considered for use.
- Underground infiltration galleries pose a potential risk of groundwater contamination; pretreatment should be used.

Opportunity Criteria

- Soils are adequate for infiltration or can be amended to provide an adequate infiltration rate.
- Appropriate for sites with limited surface space.
- Can be placed beneath roads, parking lots, parks, and athletic fields.
- Potential for groundwater contamination can be mitigated through isolation of pollutant sources, pretreatment of inflow, and/or demonstration of adequate treatment capacity of underlying soils.
- Infiltration is into native soil, or depth of engineered fill is ≤ 5 feet from the bottom of the facility to native material and infiltration into fill is approved by a geotechnical professional.
- Tributary area land uses include mixed-use and commercial, single-family and multi-family, roads and parking lots, and parks and open spaces. High pollutant land uses should not be tributary to infiltration BMPs.

OC-Specific Design Criteria and Considerations

- Placement of BMPs should observe geotechnical recommendations with respect to geological hazards (e.g. landslides, liquefaction zones, erosion, etc.) and set-backs (e.g., foundations, utilities, roadways, etc.)
- Minimum separation to mounded seasonally high groundwater of 10 feet shall be observed.
- Minimum pretreatment should be provided upstream of the infiltration facility, and water bypassing pretreatment should not be directed to the facility.
- Underground infiltration should not be used for drainage areas with high sediment production potential unless preceded by full treatment control with a BMP effective for sediment removal.
- Design infiltration rate should be determined as described in [Appendix VII](#).
- Inspection ports or similar design features shall be provided to verify continued system performance and identify need for major maintenance.

- For infiltration facilities beneath roads and parking areas, structural requirements should meet H-20 load requirements.

Computing Underground Infiltration Device Size

Underground infiltration devices vary by design and by proprietary designs. The sizing method selected for use must be based on the BMP type it most strongly resembles.

- For underground infiltration devices with open pore volume (e.g., vaults, crates, pipe sections, etc), sizing will be most similar to infiltration basins.
- For underground infiltration devices with pore space (e.g., aggregate reservoirs), sizing will be most similar to permeable pavement.

Additional References for Design Guidance

- Los Angeles Unified School District (LAUSD) Stormwater Technical Manual, Chapter 5:
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

Appendix D:

BMP Maintenance Information



FLOGARD+PLUS[®] CATCH BASIN INSERT FILTER

Inspection and Maintenance Guide



SCOPE:

Federal, State and Local Clean Water Act regulations and those of insurance carriers require that stormwater filtration systems be maintained and serviced on a recurring basis. The intent of the regulations is to ensure that the systems, on a continuing basis, efficiently remove pollutants from stormwater runoff thereby preventing pollution of the nation's water resources. These specifications apply to the FloGard+Plus® Catch Basin Insert Filter.

RECOMMENDED FREQUENCY OF SERVICE:

Drainage Protection Systems (DPS) recommends that installed FloGard+Plus Catch Basin Insert Filters be serviced on a recurring basis. Ultimately, the frequency depends on the amount of runoff, pollutant loading and interference from debris (leaves, vegetation, cans, paper, etc.); however, it is recommended that each installation be serviced a minimum of three times per year, with a change of filter medium once per year. DPS technicians are available to do an on-site evaluation, upon request.

RECOMMENDED TIMING OF SERVICE:

DPS guidelines for the timing of service are as follows:

1. For areas with a definite rainy season: Prior to, during and following the rainy season.
2. For areas subject to year-round rainfall: On a recurring basis (at least three times per year).
3. For areas with winter snow and summer rain: Prior to and just after the snow season and during the summer rain season.
4. For installed devices not subject to the elements (wash racks, parking garages, etc.): On a recurring basis (no less than three times per year).

SERVICE PROCEDURES:

1. The catch basin grate shall be removed and set to one side. The catch basin shall be visually inspected for defects and possible illegal dumping. If illegal dumping has occurred, the proper authorities and property owner representative shall be notified as soon as practicable.
2. Using an industrial vacuum, the collected materials shall be removed from the liner. (Note: DPS uses a truck-mounted vacuum for servicing FloGard+Plus catch basin inserts).
3. When all of the collected materials have been removed, the filter medium pouches shall be removed by unsnapping the tether from the D-ring and set to one side. The filter liner, gaskets, stainless steel frame and mounting brackets, etc., shall be inspected for continued serviceability. Minor damage or defects found shall be corrected on-the-spot and a notation made on the Maintenance Record. More extensive deficiencies that affect the efficiency of the filter (torn liner, etc.), if approved by the customer representative, will be corrected and an invoice submitted to the representative along with the Maintenance Record.
4. The filter medium pouches shall be inspected for defects and continued serviceability and replaced as necessary, and the pouch tethers re-attached to the liner's D-ring.
5. The grate shall be replaced.

REPLACEMENT AND DISPOSAL OF EXPOSED FILTER MEDIUM AND COLLECTED DEBRIS

The frequency of filter medium exchange will be in accordance with the existing DPS-Customer Maintenance Contract. DPS recommends that the medium be changed at least once per year. During the appropriate service, or if so determined by the service technician during a non-scheduled service, the filter medium will be replaced with new material. Once the exposed pouches and debris have been removed, DPS has possession and must dispose of it in accordance with local, state and federal agency requirements.

DPS also has the capability of servicing all manner of storm drain filters, catch basin inserts and catch basins without inserts, underground oil/water separators, stormwater interceptors and other such devices. All DPS personnel are highly qualified technicians and are confined-space trained and certified. Call us at (888) 950-8826 for further information and assistance.

FLOGARD+PLUS[®] CATCH BASIN INSERT FILTER

OUR MARKETS



BUILDING
STRUCTURES



COMMUNICATIONS



WATER



ENERGY



TRANSPORTATION

Appendix E:

Geotechnical Information

(Storm water infiltration BMP evaluation)

**GEOTECHNICAL INVESTIGATION
PROPOSED FIRE STATION 1 (SP-4071),
105 SOUTH WATER STREET,
CITY OF ORANGE, CALIFORNIA**

Prepared For:

WLC ARCHITECTS, INC.
8163 Rochester Avenue, Suite 100
Rancho Cucamonga, California 91730

Project No. 12482.001

September 26, 2019



Leighton Consulting, Inc.

A LEIGHTON GROUP COMPANY



Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

September 26, 2019

Project No. 12482.001

To: WLC Architects, Inc.
8163 Rochester Avenue, Suite 100
Rancho Cucamonga, California 91730

Attention: Mr. Kelley Needham

Subject: Geotechnical Investigation, Proposed Fire Station 1 (SP-4071), 105 South Water Street, City of Orange, California

In accordance with our proposal dated March 22, 2019 and your authorization on July 28, 2019, Leighton Consulting, Inc. (Leighton) has conducted a geotechnical investigation for the proposed Fire Station 1 facility (SP-4071), located at 105 South Water Street in the City of Orange, California. The purpose of this study has been to evaluate the subsurface conditions at the site with respect to the proposed fire station development and to provide geotechnical recommendations for design and construction.

Based on this investigation, the proposed development of the fire station is feasible from a geotechnical standpoint. Significant geotechnical issues for this project are those related to the potential for strong seismic shaking and potentially compressible soils. Good planning and design of the project can limit the impact of these constraints. This report presents our findings, conclusions, and geotechnical recommendations for the project.

We appreciate the opportunity to work with you on this project. If you have any questions regarding this report, please call us at your convenience.



Respectfully submitted,

LEIGHTON CONSULTING, INC.

A handwritten signature in blue ink that reads "Jason D. Hertzberg".

Jason D. Hertzberg, GE 2711
Principal Engineer



A handwritten signature in blue ink that reads "Joe Roe".

Joe Roe PG, CEG 2456
Principal Geologist

MM/LP/JDH/JR/rsm

Distribution: (1) Addressee

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- Figure 2 - Geotechnical Exploration Map
- Figure 2A - Geotechnical Cross Sections AA and BB
- Figure 3 - Regional Geology Map
- Figure 4 - Regional Fault and Historical Seismicity Map
- Figure 5 - Seismic Hazard Map
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GBA “Important Information about This Geotechnical Engineering Report”

Appendices

- Appendix A - References
- Appendix B - Exploration Logs
- Appendix C - Geotechnical Laboratory Test Results
- Appendix D - Summary of Seismic Hazard Analysis
- Appendix E - General Earthwork and Grading Specifications

1.0 INTRODUCTION

1.1 Site Location and Description

The site contains two (2) parcels located at the southeast corner of Chapman Avenue and South Water Street and at the northwest corner of Almond Avenue and South Water Street, in Orange, California. The site previously contained several buildings and appears to have been vacant since early 2010. Concrete slabs were observed in the northern and western regions with asphalt paved areas located throughout the northern parcel. The site is surrounded by office buildings and single-family residential homes to the north, east and west. The City of Orange Water Division Department of Public Works is located to the south. The parcel located northwest of South Water Street and Almond Avenue is currently occupied by a car dealership lot.

The site and surroundings are relatively flat, with site elevations ranging from about 214 to 219 feet above mean sea level, with drainage to the south. The site location (latitude 33.7873°, longitude -117.8411°) and immediate vicinity are shown on Figure 1, Site Location Map.

1.2 Proposed Improvements

Based on our review of the proposed site plan *Fire Station 1 Headquarters City of Orange Fire Department 105 South Water Street, Orange, CA*, prepared by WLC Architects dated July 30, 2019, the proposed fire station development includes a headquarters/administration building on the western portion and a separate reserve apparatus building on the southeast portion of the site.

We understand that the site will be designed in stages such that the City has the option to construct an operational Fire Station 1 first and the Fire Headquarters building portion added at a later date. The proposed fire station facility is composed of a two-story, approximate 24,300-square-foot building, of which approximately 5,700 square feet make up the main apparatus building portion.

Additional overflow parking will be constructed on the existing site located northwest of the intersection of Almond Avenue and South Water Street. We assume that remedial cuts and fills of 5 feet or less with localized deeper excavations to remove undocumented fill will be required to attain finish grades for the new structures.

1.3 Purpose of Exploration

The purpose of this study has been to evaluate the general geotechnical conditions at the site with respect to the proposed improvements and to provide geotechnical recommendations for design and construction.

Our geotechnical exploration included hollow-stem auger soil borings, laboratory testing and geotechnical analysis to evaluate existing conditions and develop the recommendations contained in this report. Infiltration testing was conducted to evaluate general infiltration characteristics at the locations and depths tested to support infiltration system design by the civil engineer.

1.4 Scope of Investigation

The scope of our study has included the following tasks:

- Geologic Hazards Review: We reviewed pertinent, readily available geologic and geotechnical literature covering the site. Our review included regional geologic maps and reports available from our in-house library. Key documents reviewed are referenced in Appendix A, *References*.
- Utility Coordination: We contacted Underground Service Alert (USA) prior to our subsurface exploration to have underground utilities located and marked.
- Field Exploration: Our field investigation included drilling, logging, and sampling of five (5) hollow-stem auger borings (LB-1 through LB-5) at representative locations in the areas of the proposed building to depths ranging from approximately 6 feet to 51.5 feet below the existing ground surface (bgs). Additionally, two hollow-stem auger borings (LB-6 and LB-7) were drilled, logged, and sampled in the area of the proposed overflow parking lot to depths of approximately 9 feet bgs. Encountered earth materials were logged in the field by our representative and described in accordance with the Unified Soil Classification System (ASTM D 2488). Relatively undisturbed soil samples were obtained at selected intervals within these borings using a California Ring Sampler. Standard Penetration Tests (SPT) were conducted at selected depths and samples were obtained from the SPT split-spoon sampler. Representative bulk samples were also collected at shallow depths from the borings.

Two infiltration tests were conducted within borings LB-4 and LB-5 to evaluate general infiltration rates of the subsurface soils with bottom depths of 14 feet bgs and 20.5 feet bgs.

All excavations were backfilled with the soil cuttings. An asphalt concrete patch was placed at the top of LB-6 and LB-7 to match the existing ground surface. Logs of the geotechnical borings are presented in Appendix B, *Exploration Logs*. Approximate boring locations are shown on Figure 2, *Exploration Location Map*.

- Geotechnical Laboratory Testing: Geotechnical laboratory tests were conducted on selected relatively undisturbed and bulk soil samples obtained during our field investigation. This testing program was designed to evaluate engineering characteristics of the onsite soils. Laboratory tests conducted during this investigation include:
 - In situ moisture content and dry density
 - Proctor Compaction Test
 - Sieve analysis
 - Atterberg Limits
 - Expansion Index
 - Water-soluble sulfate concentration in the soil
 - Resistivity, chloride content and pH

The in situ moisture content and dry density test results are shown on the boring logs in Appendix B. The other laboratory test results are presented in Appendix C, *Geotechnical Laboratory Test Results*.

- Engineering Analysis: Data obtained from our background review, field exploration and geotechnical laboratory testing was evaluated and analyzed to develop geotechnical conclusions and provide recommendations presented in this report.
- Report Preparation: Results of our geotechnical investigation have been summarized in this report, presenting our findings, conclusions and geotechnical recommendations for design and construction of the proposed Fire Station development as currently planned.

2.0 FINDINGS

2.1 Geologic Hazards Review

We have reviewed pertinent, readily available geologic and geotechnical literature covering the site. Our review included regional geologic maps and reports available from our library. Documents reviewed are listed in Appendix A, *References*. Potential geologic hazards are discussed in the following sections. Our review has considered California Geological Survey's Note 48, *Checklist of the Review of Engineering Geology and Seismology Reports for California Public Schools, Hospitals, and Essential Services Buildings*.

2.1.1 Site History

Our review of site history included analysis of historical topographic maps between the dates of 1896 and 2015 and historical aerial photographs between the dates of 1946 and 2016. The purpose of this evaluation was to help understand the origin of the current site profile, former site use, as well as past grading activities.

In its original undeveloped state, up until early 1930, the properties consisted of gently southerly sloping terrain, with the Santiago Creek drainage channel situated approximately 0.20 mile to the east. Between approximately 1940 and 1963, both properties were utilized for agricultural purposes with the western area of proposed parking overflow as orchard and the proposed fire station site as buildings likely associated with the agriculture activities.

While the overall use of the buildings and foundation elements are unknown, structures onsite were not observed in 2010 aerial imagery. It is unknown if all foundation elements were removed and should be anticipated in the subsurface during grading of the site.

2.2 Regional Geologic Conditions

The project site is located in the western part of the Tustin Plain within the Peninsular Ranges geomorphic province west of Santiago Creek drainage. The Peninsular Ranges geomorphic province extends 900 miles southward from the Los Angeles Basin to the tip of Baja California (Yerkes et al., 1965) and is

characterized by elongate northwest-trending mountain ranges separated by sediment-floored valleys. The most dominant structural features of the province are the northwest-trending fault zones, most of which die out, merge with, or are terminated by the steep reverse faults at the southern margin of the Transverse Ranges geomorphic province.

East of the site are the northwest-trending Santa Ana Mountains, a large range which has been uplifted on its eastern side along the Whittier-Elsinore Fault Zone, producing a tilted, irregular highland that slopes westward toward the sea. Sediments eroded from the Santa Ana Mountains have been transported by Santiago Creek and the lower reach of the Santa Ana River to build a large, broad alluvial fan known as the Tustin Plain. The Tustin Plain is comprised of relatively flat-lying, unconsolidated to semi-consolidated clastic sediments that are approximately 1,000 to 1,100 feet thick (Singer, 1973; Sprotte et al., 1980a and 1980b). Beneath the site, the near surface, unconsolidated, relatively fine-grained sediments are Holocene age (less than 11,000 years old) and consist of predominately youthful alluvial fan deposits (Sprotte et al., 1980a and 1980b). These sediments in turn are underlain at depth by sedimentary bedrock of Tertiary age.

The surficial geologic units mapped in the vicinity of the site are shown on Figure 3, *Regional Geology Map*.

2.3 Subsurface Soil Conditions

Based upon our review of pertinent geotechnical literature and our subsurface exploration, the site is underlain by undocumented fill (Map Symbol: Afu) in the upper five to seven feet, localized deeper fill to seven feet below grade was interpreted in boring LB-5 due to the presence of fresh, mechanically fractured black slaty gravels and cobble size rock fragments. Review of historic aerial imagery indicates former structures were onsite until circa 2010. Foundation elements should be anticipated in the subsurface during grading of the site. Refusal at shallow depth in boring LB-2 was encountered which is within the footprint of a historical structure formerly located onsite (NETR, 2019). The artificial fill is underlain by Quaternary-age old alluvial fan deposits (Map Symbol: Qof) extending to the maximum exploration depth of 51 feet bgs. The overlying undocumented fill (Afu) encountered within our excavations generally consisted of a loose to dense silty sand and sand with gravel and small mechanically fractured cobbles. The native soils (Qof) were generally composed of slightly

moist to moist, dense to very dense, well-graded gravel with sand and silt, sand with gravel, and silty sand with small weathered cobbles derived from the sedimentary formations in the Santa Ana Mountains. The in-situ moisture content within the upper approximately 15 feet generally ranged from 2 to 7 percent. More detailed descriptions of the subsurface soil are presented on the boring logs in Appendix B.

2.3.1 Compressible and Collapsible Soil

Soil compressibility refers to a soil's potential for settlement when subjected to increased loads as from a fill surcharge or a new structure. Based on our observations and the laboratory test results, the native soil encountered is generally considered slightly compressible. Removal and recompaction of this material under shallow foundations is recommended to reduce the potential for adverse total and differential settlement of the proposed improvements.

Collapse potential (moisture sensitivity, sometimes referred to as 'hydrocollapse') refers to the potential settlement of a soil under existing stresses upon being wetted. Based upon the dense nature of encountered sands and gravel, the hydrocollapse potential of the onsite soil is expected to be very low.

2.3.2 Expansive Soils

Expansive soils contain significant amounts of clay particles that swell considerably when wetted and shrink when dried. Foundations constructed on these soils are subjected to large uplifting forces caused by the swelling. Without proper measures taken, heaving and cracking of building foundations and slabs-on-grade could result.

A near-surface soil sample from the proposed fire station building area was tested for expansion index. The results of the tests indicated soil with very low expansion potential. Based on these test results, the near surface soil is expected to have a very low expansion potential. The results of the expansion testing are included in Appendix C of this report

2.3.3 Sulfate Content

Water-soluble sulfates in soil can react adversely with concrete. However, concrete in contact with soil containing sulfate concentrations of less than 0.1 percent by weight is considered to have negligible sulfate exposure based on the American Concrete Institute (ACI) provisions, adopted by the 2016 CBC (CBC, 2016, Chapter 19; and ACI, 2008).

A near-surface soil sample was tested for soluble sulfate content. The result of this test indicated a sulfate content of less than 0.02 percent by weight, indicating negligible sulfate exposure. As such, the soils exposed at pad grade are not expected to pose a significant potential for sulfate reaction with concrete. The results of the chemical analyses are included in Appendix C of this report

2.3.4 Resistivity, Chloride and pH

Soil corrosivity to ferrous metals can be estimated by the soil's electrical resistivity, chloride content and pH. In general, soil having a minimum resistivity between 1,000 and 2,000 ohm-cm is considered corrosive, and soil having a minimum resistivity less than 1,000 ohm-cm is considered severely corrosive. Soil with a chloride content of 500 parts-per-million (ppm) or more is considered corrosive to ferrous metals.

As a screening for potentially corrosive soil, a soil sample was tested during this investigation to determine its minimum resistivity, chloride content, and pH. These tests indicated a minimum resistivity of 1,570 ohm-cm, chloride content of 187 ppm, and pH of 7.1. Based on these results, the onsite soil is considered corrosive to ferrous metals. The results of the chemical analyses are included in Appendix C of this report.

2.4 Groundwater

Groundwater was not encountered in our borings excavated to a maximum depth of 51 feet below the existing ground surface (bgs). The historical high groundwater level in the area was estimated to have been on the order of 172 feet bgs in State Well 04S09W33M001S, located 0.6 miles southeast of the site (CDWR, 2019). The California Geological Survey (1997) Seismic Hazard Zone Report for this region shows the site area as not having historically shallow

groundwater levels (greater than 40 feet bgs). Based on this, groundwater has historically been deep, and shallow groundwater is not expected at the site.

Fluctuations of the groundwater level and localized zones of perched water should be anticipated below grade during and following the rainy season. Irrigation of landscaped areas and infiltration of groundwater can also cause a fluctuation of local groundwater levels and may create temporary zones of perched water.

2.5 Faulting and Seismicity

In general, the primary seismic hazards for sites in the region include surface rupture along active faults and strong ground shaking. The potential for fault rupture and seismic shaking are discussed below.

2.5.1 Surface Faulting

One of the primary seismic hazards for this region is surface fault rupture. Our assessment of the possible presence of active faulting through the proposed improvement project site included a review of available literature, maps, and aerial photographs.

Our review of available in-house literature indicates that there are no known active faults traversing the site and the site is not located within a currently designated Alquist-Priolo Earthquake Fault Zone. Therefore, the potential risk for surface fault rupture through the site is considered low.

The closest known active or potentially active faults are the Elysian Park Blind Thrust and the Puente Hills Blind Thrust fault systems located approximately 9 miles northwest of the project site. The known regional active and potentially active faults that could produce the most significant ground shaking at the site include the Whittier-Elsinore, San Andreas, Sierra Madre, San Jacinto, Newport-Inglewood, Raymond, Puente Hills, Verdugo-Eagle Rock, Elysian Park and Norwalk faults. Active faults within a 60-mile radius from the site are listed in Appendix D.

2.5.2 Seismic Design Parameters

The principal seismic hazard to the site is ground shaking resulting from an earthquake occurring along any of several major active and potentially active faults in southern California, see Figure 4, *Regional Fault and Historical Seismicity Map*. The intensity of ground shaking at a given location depends primarily upon the earthquake magnitude, the distance from the source, and the site response characteristics. Accordingly, design of the project should be performed in accordance with all applicable current codes and standards utilizing the appropriate seismic design parameters to reduce seismic risk as defined by California Geological Survey (CGS) Chapter 2 of Special Publication 117A (CGS, 2008). The 2016 edition of the California Building Code (CBC) is the current edition of the code. Through compliance with these regulatory requirements and the utilization of appropriate seismic design parameters selected by the design professionals, potential effects relating to seismic shaking can be reduced. A summary of the analysis is provided in Appendix D, *Seismic Analysis*.

The following code-based seismic parameters should be considered for design under the 2016 CBC:

Table 1 - 2016 CBC Seismic Design Parameters

Description (2016 CBC reference)	Parameter	Design Value
Site Latitude, degrees		33.7873
Site Longitude, degrees		-117.8411
Site Class Definition (1613A.3.2)		D
Mapped MCE Spect Resp Accel at 0.2s for (Fig 1613.3.1(1)), using USGS	S_s	1.5
Mapped MCE Spect Resp Accel at 1.0s for (Fig 1613.3.1(2)) using USGS	S_1	0.549
Short Period Site Coefficient (Table 1613A.3.3(1))	F_a	1.0
Long Period Site Coefficient (Table 1613A.3.3(2))	F_v	1.5
Adjusted MCE Spectral Response Acceleration at 0.2s Period [$=F_a S_s$] (Eq. 16-37)	S_{MS}	1.5
Adjusted MCE Spectral Response Acceleration at 1s Period [$=F_v S_1$] (Eq. 16-38)	S_{M1}	0.823
Design Spectral Response Acceleration at 0.2s Period, 5% damped [$=2/3 S_{MS}$] (Eq. 16-39)	S_{DS}	1.0
Design Spectral Response Acceleration at 1s Period, 5% damped [$=2/3 S_{M1}$] (Eq 16-40)	S_{D1}	0.549
Is S_1 greater than or equal to 0.75?		No
Seismic Design Category [$=$ "D" if $S_1 < 0.75$] (1613A.2.5)		D

2.5.3 Seismic Parameters for Geotechnical Evaluation

Based on ASCE 7-10 Equation 11.8-1, the F_{PGA} is 1.0, the PGA is 0.515g, and the PGA_M is 0.51g. This is the value used for seismic analysis of the onsite soils. As an added check, PGA and hazard deaggregation were also estimated using the United States Geological Survey's (USGS) 2008 Interactive Deaggregations utility. The results of this analysis indicate that the predominant modal earthquake has a PGA of 0.58g with magnitude of approximately 6.9 (M_W) at a distance on the order of 12.8 kilometers for the Maximum Considered Earthquake (2% probability of exceedance in 50 years); 2/3 of this value is 0.39g. Results are included in Appendix D. This is not an exhaustive site-specific analysis, yet is useful in evaluating the general seismic potential at the site as an added check.

2.5.4 Historical Seismicity

Figure 4, *Regional Fault and Historical Seismicity Map* shows recorded historical regional seismic events (those that have been recorded since the mid 1700s) with respect to the site. Based on this map, it appears that the site has been exposed to relatively significant seismic events; however, this site does not appear to have experienced more severe seismicity than compared to much of southern California in general. We are unaware of documentation indicating that past earthquake damage in the site vicinity has been significantly worse than for the majority of southern California. In addition, we are unaware of damage in the site vicinity as the result of liquefaction, lateral spreading, or other related phenomenon.

We also performed an evaluation of site historical seismicity with respect to significant past earthquakes (those recorded from the 1800s with magnitudes 5 or greater) using the EQSEARCH computer program (Blake, 2011; see Appendix D). This is a relatively simple analysis, based on epicenters, and does not include more complex characteristics of earthquakes, such as rupture length and direction; however, it gives an idea of past seismicity at the site. This analysis suggests that the largest ground acceleration at the site generated from the magnitude 6.3Mw 1933 Long Beach Earthquake along the Newport Inglewood Fault is estimated to have been roughly 0.16g.

2.6 Secondary Seismic Hazards

In general, secondary seismic hazards for sites in the region could include soil liquefaction, earthquake-induced settlement, lateral displacement, landsliding, and earthquake-induced flooding. The potential for secondary seismic hazards at the site is discussed below.

2.6.1 Liquefaction Potential

Liquefaction is the loss of soil shear strength due to a buildup of pore-water pressure during severe and sustained ground shaking. Liquefaction is associated primarily with loose (low density), saturated, fine-to-medium grained, cohesionless soils. As the shaking action of an earthquake progresses, the soil grains are rearranged and the soil densifies within a short period of time. Rapid densification of the soil results in a buildup of pore-water pressure. When the pore-water pressure approaches the total overburden pressure, the soil shear strength reduces greatly and this soil temporarily behaves similarly to a fluid. Effects of liquefaction can include sand boils, settlement, and bearing capacity failures below structural foundations.

As shown on the Seismic Hazard Zones map for the Orange Quadrangle (CGS, 1998), the project site is **not** located within an area that has been identified by the State of California as being potentially susceptible to liquefaction (Figure 5, *Seismic Hazard Map*).

We have evaluated liquefaction potential of the soil encountered in our borings assuming a historic high groundwater depth deeper than 50 feet. Our analysis was based on the modified Seed Simplified Procedure as detailed by Youd et al. (2001) and Martin and Lew (1999), which compares the seismic demand on a soil layer (Cyclic Stress Ratio, or CSR) to the capacity of the soil to resist liquefaction (Cyclic Resistance Ratio, or CRR), (Youd et al, 2001). A minimum required factor of safety of 1.3 was used in our analysis, with factor of safety defined as CRR/CSR. As required, our analysis assumes that the design earthquake would occur while the groundwater is at its estimated historically highest level. In the SPT method, soil resistance to liquefaction is estimated based on several factors, including SPT sampling blow counts normalized and corrected for several factors including fines content, and overburden

pressure. Soil plasticity and moisture content are also considered in an evaluation of liquefaction. Parameters utilized in our analysis include Standard Penetration Test (SPT) results from the borings, visual descriptions of soil samples retrieved, and geotechnical laboratory test results.

Based on our analysis, the nature of the onsite soils, and the historically deep groundwater level, the potential for liquefaction at the site is considered very low.

2.6.2 Seismically Induced Settlement

During a strong seismic event, seismically induced settlement can occur within loose to moderately dense, dry or saturated granular soil. Settlement caused by ground shaking is often nonuniformly distributed, which can result in differential settlement.

We have performed analyses to estimate the potential for seismically induced settlement using the method of Tokimatsu and Seed (1987), and based on Martin and Lew (1999), considering the maximum considered earthquake (MCE) peak ground acceleration (PGA_M). The results of our analyses suggest that the onsite soils are susceptible to less than an 1-inch of seismic settlement based on the MCE. Differential settlement due to seismic loading is assumed to be less than $\frac{1}{2}$ inch over a horizontal distance of 40 feet based on the MCE. A summary of seismic settlement analysis is included in Appendix D.

2.6.3 Seiches and Tsunamis

Seiches are large waves generated in enclosed bodies of water in response to ground shaking. Tsunamis are waves generated in large bodies of water by fault displacement or major ground movement. Based on the location of the site and distance from contained water facilities, seiches and tsunamis are not a hazard to the site.

2.7 Slope Stability and Landslides

The potential for seismically induced landsliding to occur at the site is considered low due to the absence of slopes at the site. In addition, based on review of the

Seismic Hazard Zones Map for the Orange Quadrangle (CGS, 1998), the site is **not** located within an area that has been identified by the State of California as being potentially susceptible to seismically induced landslides (Figure 5, *Seismic Hazard Map*). Proposed slopes, while not anticipated, should be engineered and constructed at a gradient of 2:1 (horizontal:vertical) or flatter.

2.8 Flooding and Dam Inundation Potential

The site is not located within the 100-year or 500-year flood plain based on the Federal Emergency Management Agency (FEMA) flood maps (see Figure 7, *Flood Hazard Zone Map*).

Flooding can also result from the failure of dams. Based on our review of dam inundation data by the California Office of Emergency Services (OES), the site is not located near dams or in an area shown as susceptible to dam inundation, see Figure 6, *Dam Inundation Map*.

2.9 Infiltration Testing

Infiltration tests was conducted in two of the excavated borings (LB-4 and LB-5) to estimate the infiltration rate of the onsite soils at the depths tested. The infiltration test was conducted at bottom depths of approximately 14 and 20.5 feet below the existing ground surface.

Well permeameter tests are useful for field measurements of soil infiltration rates, and are suited for testing when the design depth of the basin or chamber is deeper than current existing grades. It should be noted that this is a clean-water, small-scale test, and that correction factors need to be applied. The test consists of excavating a boring to the depth of the test (or deeper if it is partially backfilled with soil and a bentonite plug with a thin soil covering is placed just below the design test elevation). A layer of clean sand or gravel is placed in the boring bottom to support temporary perforated well casing pipe and a float valve. In addition, coarse sand is poured around the outside of the well casing within the test zone to prevent the boring from caving/collapsing or eroding when water is added. The float valve, lowered into the boring inside the casing, adds water stored in barrels at the top of the hole to the boring as water infiltrates into the soil, while maintaining a relatively constant water head in the boring. The incremental infiltration rate as measured during intervals of the test is defined as the incremental flow rate of water infiltrated, divided by the surface area of the

infiltration interface. The test was conducted based on the USBR 7300-89 test method.

Raw infiltration rates for the well permeameter tests may be assumed to be about 4.5 in/hour within the gravel layer generally encountered at a depth of 15 to 20 feet bgs, but should be considered negligible in the clayey sand layer at a depth of approximately 10 feet in boring LB-4. These are raw values and do not include a factor of safety or correction. Results of infiltration testing are provided in Appendix B. Further discussion on infiltration testing and recommendations are included in Section 3.9.

2.10 Other Potential Hazards Listed on CGS Note 48

The following naturally occurring hazards are not believed to exist at the site nor in the region: methane gas, hydrogen-sulfide gas, tar seeps, volcanic eruption, radon-22 gas, and naturally occurring asbestos in geologic formations associated with serpentine.

We are unaware of significant subsidence or damage from subsidence near the site due to groundwater withdrawal.

3.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the results of this study, the proposed fire station is feasible from a geotechnical standpoint. No severe geologic or soils related issues were identified that would preclude development of the site for the proposed improvements. The most significant geotechnical issues at the site are those related to the potential for strong seismic shaking, undocumented fill soils and potentially compressible soils. Good planning and design of the project can limit the impact of these constraints. Remedial recommendations for these and other geotechnical issues are provided in the following sections.

3.1 General Earthwork and Grading

All grading should be performed in accordance with the General Earthwork and Grading Specifications presented in Appendix E, General Earthwork Recommendations, unless specifically revised or amended below or by future recommendations based on final development plans.

3.1.1 Site Preparation

Prior to construction, the site should be cleared of vegetation, trash and debris, which should be disposed of offsite. Any underground obstructions should be removed, as should trees and their root systems. Resulting cavities should be properly backfilled and compacted. Efforts should be made to locate existing utility lines. Those lines should be removed or rerouted if they interfere with the proposed construction, and the resulting cavities should be properly backfilled and compacted.

Although not encountered during this investigation, abandoned septic tanks, seepage pits, or other buried structures, or items related to past site uses may be present. If such items are encountered during grading, they will require further evaluation and special consideration.

3.1.2 Overexcavation and Recompanction

To reduce the potential for adverse differential settlement of the proposed improvements, the underlying subgrade soil should be prepared in such a manner that a uniform response to the applied loads is achieved. For the proposed fire station building and apparatus building constructed with

shallow foundations, we recommend that onsite soils be overexcavated and recompacted to a minimum depth of 2 feet below the bottom of the proposed footings or 5 feet below existing grade, whichever is deeper. In addition, existing undocumented artificial fill in structural areas should be removed to undisturbed native alluvial soil. Where feasible, overexcavation and recompaction should extend a minimum horizontal distance of 5 feet from perimeter edges of the proposed footings, or a distance equal to the depth of overexcavation, whichever is greater.

Local conditions, such as those interpreted in boring LB-5 may require that deeper overexcavation be performed; such areas should be evaluated by Leighton during grading.

Areas outside these overexcavation limits planned for asphalt or concrete pavement, flatwork, and areas to receive fill should be overexcavated to a minimum depth of 18 inches below the existing ground surface or 12 inches below the proposed subgrade, whichever is deeper. Overexcavation for site walls should extend a minimum 2 feet below the bottom of the wall footings.

All excavation or removal bottoms should be observed by a representative of the geotechnical engineer prior to placement of fill or other improvements to determine that geotechnically suitable soil is exposed. The overexcavation in the building area may also require observation by the City Grading Inspector prior to fill placement. Excavation bottoms observed to be suitable for fill placement or other improvements should be scarified to a depth of at least 8 inches, moisture-conditioned as necessary to achieve a moisture content approximately 2 to 3 percentage points above the optimum moisture content, and then compacted to a minimum of 90 percent of the laboratory derived maximum density as determined by ASTM Test Method D 1557 (Modified Proctor).

Once final development plans are completed and building loads have been calculated this information should be provided to Leighton for geotechnical review to ensure our recommendations have been properly interpreted and remain appropriate for the project as currently proposed.

3.1.3 Fill Placement and Compaction

The onsite soil is geotechnically suitable for use as compacted structural fill, provided it is free of debris and oversized material (cobbles) (greater than 6 inches in largest dimension). Any soil to be placed as fill, whether onsite or imported material, should be reviewed and possibly tested by Leighton.

Based upon the anticipated conceptual plan, site grading is not expected to require significant cut or fill; however, excavations as deep as 5 to 6 feet with localized deeper excavation should be expected for the removal and reworking of all undocumented fill and overexcavation of building foundations. All fill soil should be placed in thin, loose lifts, moisture-conditioned as necessary to achieve a moisture content approximately 2 to 3 percentage points above the optimum moisture content, and then compacted to a minimum of 90 percent of the laboratory derived maximum density as determined by ASTM Test Method D 1557 (Modified Proctor). Aggregate base for pavement should be compacted to a minimum of 95 percent relative compaction.

3.1.4 Import Fill Soil

If import soil is to be placed as fill, it should be geotechnically accepted by Leighton. Preferably at least 3 working days prior to proposed import to the site, the contractor should provide Leighton pertinent information of the proposed import soil, such as location of the soil, whether stockpiled or native in place, and pertinent geotechnical reports if available. We recommend that a Leighton representative visit the proposed import site to observe the soil conditions and obtain representative soil samples. Potential issues may include soil that is more expansive than onsite soil, soil that is too wet, soil that is too rocky or too dissimilar to onsite soils, oversize material, organics, debris, environmental unsuitability etc.

3.1.5 Shrinkage and Subsidence

The change in volume of excavated and recompacted soil varies according to soil type and location. This volume change is represented as a percentage increase (bulking) or decrease (shrinkage) in volume of fill after removal and recompaction. Subsidence occurs as in-place soil (e.g., natural ground) is moisture-conditioned and densified to receive fill, such

as in processing an overexcavation bottom. Subsidence is in addition to shrinkage due to recompaction of fill soil. Field and laboratory data used in our calculations included laboratory-measured maximum dry densities for soil types encountered at the subject site, the measured in-place densities of soils encountered, sampling blow counts, and our experience. We preliminarily estimate the following earth volume changes will occur during grading:

Shrinkage and Subsidence	
Shrinkage	Approximately 10 +/- 3 percent
Subsidence (overexcavation bottom processing)	Approximately 0.1 foot

The level of fill compaction, variations in the dry density of the existing soils and other factors influence the amount of volume change. Some adjustments to earthwork volume should be anticipated during grading of the site.

3.2 Foundation Recommendations

The following recommendations are based on soils with a very low expansion potential. The structural engineer should design the footing reinforcement in accordance with current California Building Code (CBC) requirements. Local agencies, the structural engineer or the CBC may have requirements that are more stringent.

Overexcavation and recompaction of the footing subgrade soil should be performed as detailed in Section 3.1.2.

3.2.1 Minimum Embedment and Width

Based on our preliminary investigation, footings should have a minimum embedment depth and width per the 2016 CBC. These minimums include a depth and width of 12 inches.

3.2.2 Allowable Bearing

An allowable bearing pressure of 2,000 pounds-per-square-foot (psf) may be used, based on the minimum embedment depth and width above. This allowable bearing value may be increased by 200 psf per foot increase in depth or width to a maximum allowable bearing pressure of 4,000 psf. These allowable bearing pressures are for total dead load and sustained live loads. Footing reinforcement should be designed by the structural engineer.

3.2.3 Lateral Load Resistance

Soil resistance available to withstand lateral loads on a shallow foundation is a function of the frictional resistance along the base of the footing and the passive resistance that may develop as the face of the structure tends to move into the soil. The frictional resistance between the base of the foundation and the subgrade soil may be computed using a coefficient of friction of 0.40. The passive resistance may be computed using an allowable equivalent fluid pressure of 240 pounds per cubic foot (pcf), assuming there is constant contact between the footing and undisturbed soil. The maximum passive resistance should not exceed 3,500 psf. The coefficient of friction and passive resistance may be combined without further reduction.

3.2.4 Increase in Bearing and Friction - Short Duration Loads

The allowable bearing pressure and coefficient of friction values may be increased by one-third when considering loads of short duration, such as those imposed by wind and seismic forces.

3.2.5 Settlement Estimates

The recommended allowable bearing capacity is generally based on a total allowable, post construction settlement of 1 inch. Differential settlement due to static loading is estimated at ½ inch over a horizontal distance of 30 feet. Since settlement is a function of footing sustained load, size and contact bearing pressure, differential settlement can be expected between adjacent columns or walls where a large differential loading condition exists.

3.3 Recommendations for Slabs-On-Grade

Concrete slabs-on-grade should be designed by the structural engineer in accordance with the current CBC for a soil with a very low expansion potential. Laboratory testing should be conducted at finish grade to evaluate the Expansion Index (EI) of near-surface subgrade soils. Where conventional light floor loading conditions exist, the following minimum recommendations should be used. More stringent requirements may be required by local agencies, the structural engineer, the architect, or the CBC. Slabs-on-grade should have the following minimum recommended components:

- Subgrade Moisture Conditioning: The subgrade soil should be moisture conditioned to at least 3 percentage points above optimum moisture content to a minimum depth of 18 inches prior to placing steel or concrete.
- Concrete Thickness: Thickness of slabs-on-grade should be designed by the structural engineer, but should be at least 4 inches thick (this is referring to the actual minimum thickness, not the nominal thickness). Reinforcing steel should be designed by the structural engineer, but as a minimum (for conventionally reinforced slabs) should be No. 4 rebar placed at 18 inches on center, each direction, mid-depth in the slab. Crack control joints should be placed at 13 feet on center or less, forming approximately square panels.

For the apparatus bay, the slab should be a minimum of 8 inches thick and underlain by 6 inches of aggregate base. Reinforcing steel should be designed by the structural engineer, but as a minimum should be No. 4 rebar placed at 18 inches on center, each direction, mid-depth in the slab. Construction joints should be designed by the structural engineer, but should be spaced no more than 13 feet on center, forming square sections.

- Moisture Vapor Retarder: We recommend a minimum of a 15-mil vapor retarder should be placed below slabs where moisture-sensitive floor coverings or equipment is planned. Since moisture will otherwise be transmitted up from the soil through the concrete, it is important that an intact vapor retarder be installed. We recommend that the vapor retarder intended for the specific conditions present be used and meet the requirements of ASTM E1745 and installed per ASTM E1643. The structural engineer should specify pertinent concrete design parameters and moisture migration prevention measures, such as whether or not a sand blotter layer should be

placed over the vapor retarder. If sand is placed on top of the vapor retarder, the contractor should not allow the sand to become wet prior to concrete placement (e.g., sand should not be placed if rain is expected). Sharp objects, such as gravel or other protruding objects that could puncture the moisture retarder should be removed from the subgrade prior to placing the vapor retarder, or a stronger vapor retarder intended for the specific conditions present can be used. *Mechanically fractured gravel and small cobbles observed during drilling and sampling resulted in angular sharp fragments that could puncture the barrier.*

Minor cracking of the concrete as it cures, due to drying and shrinkage is normal and should be expected. However, cracking is often aggravated by a high water/cement ratio, high concrete temperature at the time of placement, small nominal aggregate size, aggregate that is not sufficiently clean, and rapid moisture loss due to hot, dry, and/or windy weather conditions during placement and curing. Cracking due to temperature and moisture fluctuations can also be expected. Low slump concrete can reduce the potential for shrinkage cracking. Additionally, our experience indicates that reinforcement in slabs and foundations can generally reduce the potential for concrete cracking. The structural engineer should consider these components in slab design and specifications.

Moisture retarders can reduce, but not eliminate moisture vapor rise from the underlying soils up through the slab. Moisture retarders should be designed and constructed in accordance with the applicable American Concrete Institute, Portland Cement Association, Post-Tensioning Institute, ASTM International, and California Building Code requirements and guidelines.

Leighton does not practice in the field of moisture vapor transmission recommend that a qualified person, such as the flooring subcontractor and/or structural engineer, be consulted with to evaluate the general and specific moisture vapor transmission paths and any impact on the proposed construction. That person (or persons) should provide recommendations for mitigation of potential adverse impact of moisture vapor transmission on various components of the structures as deemed appropriate. In addition, the recommendations in this report and our services in general are not intended to address mold prevention, since we, along with geotechnical consultants in general, do not practice in the area of mold prevention. If specific

recommendations are desired, a professional mold prevention consultant should be contacted.

3.4 Seismic Design Parameters

Seismic parameters presented in this report should be considered during project design. In order to reduce the effects of ground shaking produced by regional seismic events, seismic design should be performed in accordance with the most recent edition of the California Building Code (CBC). The seismic design parameters listed in Table 1 of Section 0 of this report should be considered for the seismic analysis of the subject site.

3.5 Lateral Earth Pressures

The following retaining wall recommendations are included for design consideration of walls with a height less than 6 feet. We recommend that retaining walls be backfilled with very low expansive soil and constructed with a backdrain in accordance with the recommendations provided on Figure 8, *Retaining Wall Backfill and Subdrain Detail*. Using expansive soil as retaining wall backfill will result in higher lateral earth pressures exerted on the wall and are, therefore, not recommended. Retaining wall locations and configurations are unknown at the time of this report.

Table 2 - Retaining Wall Design Parameters

Static Equivalent Fluid Pressure (pcf)	
Condition	Level Backfill
Active	40
At-Rest (drained, compacted-fill backfill)	60
Passive (ultimate)	360 (Max. 5,000 psf)

The above values do not contain an appreciable factor of safety, so the structural engineer should apply the applicable factors of safety and/or load factors during design.

Cantilever walls that are designed to yield at least $0.001H$, where H is equal to the wall height, may be designed using the active condition. Rigid walls and walls braced at the top should be designed using the at-rest condition.

Passive pressure is used to compute soil resistance to lateral structural movement. In addition, for sliding resistance, a frictional resistance coefficient of 0.40 may be used at the concrete and soil interface. The lateral passive resistance should be taken into account only if it is ensured that the soil providing passive resistance, embedded against the foundation elements, will remain intact with time. A soil unit weight of 120 pcf may be assumed for calculating the actual weight of the soil over the wall footing.

In addition to the above lateral forces due to retained earth, surcharge due to improvements, such as an adjacent structure or traffic loading, should be considered in the design of the retaining wall. Loads applied within a 1:1 projection from the surcharging structure on the stem of the wall should be considered in the design. A third of uniform vertical surcharge-loads should be applied at the surface as a horizontal pressure on cantilever (active) retaining walls, while half of uniform vertical surcharge-loads should be applied as a horizontal pressure on braced (at-rest) retaining walls. To account for automobile parking surcharge, we suggest that a uniform horizontal pressure of 100 psf (for restrained walls) or 70 psf (for cantilever walls) be added for design, where autos are parked within a horizontal distance behind the retaining wall less than the height of the retaining wall stem.

We recommend that the wall designs for walls 6 feet tall or taller be checked seismically using an *additive seismic* Equivalent Fluid Pressure (EFP) of 28 pcf, which is added to the EFP. The *additive seismic* EFP should be applied at the retained midpoint.

Conventional retaining wall footings should have a minimum width of 24 inches and a minimum embedment of 12 inches below the lowest adjacent grade. An allowable bearing pressure of 2,000 psf may be used for retaining wall footing design, based on the minimum footing width and depth. This bearing value may be increased by 200 psf per foot increase in width or depth to a maximum allowable bearing pressure of 4,000 psf.

3.6 Cement Type and Corrosion Protection

Based on the results of laboratory testing (Appendix C), concrete structures in contact with the onsite soil will have negligible exposure to water-soluble sulfates in the soil. Therefore, common Type II cement may be used for concrete

construction. Concrete should be designed in accordance with ACI 318-14, Section 4.2 (ACI, 2014), adopted by the 2016 CBC (Section 1904A.2).

Based on our laboratory testing, the onsite soil is considered corrosive to ferrous metals. Metallic utilities should be avoided, or typical corrosion protection of underground metallic utilities should be considered. Corrosion information presented in this report should be provided to your underground utility contractors.

3.7 Pavement Design

Based on the design procedures outlined in the current Caltrans Highway Design Manual, and using an assumed design R-value of 40 for compacted silty sand subgrade soils, preliminary flexible pavement sections may consist of the following for the Traffic Indices (TI) indicated.

Table 3 – Hot Mix Asphalt (HMA) Pavement Sections

Traffic Index	Asphaltic Concrete (AC) Thickness (inches)	Class 2 Aggregate Base (AB) Thickness (inches)
5 or less (auto access)	3.0	4.0
7 (truck access)	4.0	4.0

For fire truck (60,000-pound “apparatus”) lanes, asphalt pavements designed for a TI=7 are recommended. However, note that undisturbed apparatus outrigger loads could cause local asphalt pavement punching damage. When possible, outrigger loads should be distributed over asphalt pavements with planks and plywood. Otherwise, areas where outrigger loads are anticipated could be paved with 8-inch-thick concrete as described below.

Portland cement concrete pavement sections were calculated in accordance with procedures developed by the Portland Cement Association. Concrete paving sections for three Traffic Indices (TIs) are presented below.

Table 4 – Portland Cement Concrete Pavement Sections

Traffic Index	Asphaltic Concrete (AC) Thickness (inches)	Class 2 Aggregate Base (AB) Thickness (inches)
5 or less (auto access)	6.0	4.0
7 (truck access)	8.0	6.0

We have assumed that this Portland cement concrete will have a compressive strength of at least 4,000 psi. Reinforcement should be specified by the structural engineer, but should be a minimum of #3 rebar at 18 inches on center each way. The PCC pavement sections should be provided with crack-control joints spaced no more than 13 feet on center each way. If sawcuts are used, they should have a minimum depth of $\frac{1}{4}$ of the slab thickness and made within 24 hours of concrete placement. We recommend that sections be as nearly square as possible.

PCC sidewalks should be at least 4 inches thick over prepared subgrade soil, with construction joints no more than 8 feet on center each way, with sections as nearly square as possible. Use of reinforcing will help reduce severity of cracking.

All pavement construction should be performed in accordance with the Standard Specifications for Public Works Construction. Field observations and periodic testing, as needed during placement of the base course materials, should be undertaken to ensure that the requirements of the standard specifications are fulfilled. Prior to placement of aggregate base, the subgrade soil should be processed to a minimum depth of 8 inches, moisture-conditioned, as necessary, and recompact to a minimum of 90 percent relative compaction. Aggregate base should be moisture conditioned, as necessary, and compacted to a minimum of 95 percent relative compaction.

3.8 Infiltration Recommendations

Infiltration Rate: We recommend an unfactored (small-scale) infiltration rate of 4.5 inches per hour be used for preliminary design for an infiltration system designed at a depth of 15 to 20 feet below the existing grade within the natural gravel layer. The infiltration chamber may be deepened by excavating trenches in the bottom of the infiltration chamber excavation for the length of the excavation, and backfilling

these trenches with ASTM C33 Fine Aggregate (washed concrete sand). Leighton should observe the soil in the excavation to confirm these recommendations.

We recommend that a correction factor/safety factor be applied to the infiltration rate in conformance with the Orange County guidelines, since monitoring of actual facility performance has shown that actual infiltration rates are lower than for small-scale tests. The small-scale infiltration rate should be divided by a correction factor of at least 2 for buried chambers, and at least 3 for open basins or for conditions where retained water will be exposed to the open atmosphere, but the correction/safety factor may be higher based on project-specific aspects.

The infiltration rates described herein are for a clean, unsilted infiltration surface in native, sandy alluvial soil. These values may be reduced over time as silting of the infiltration facility occurs. Furthermore, if the basin or chamber bottom is allowed to be compacted by heavy equipment, this value is expected to be significantly reduced. Infiltration of water through soil is highly dependent on such factors as grain size distribution of the soil particles, particle shape, fines content, clay content, and density. Small changes in soil conditions, including density, can cause large differences in observed infiltration rates. Infiltration is not suitable in compacted fill.

It should be noted that during periods of prolonged precipitation, the underlying soils tend to become saturated to greater and greater depths/extents. Therefore, infiltration rates tend to decrease with prolonged rainfall. It is difficult to extrapolate longer-term, full-scale infiltration rates from small-scale tests, and as such, this is a significant source of uncertainty in infiltration rates.

Additional Review and Evaluation: Infiltration rates are anticipated to vary significantly based on the location and depth. Infiltration concepts should be discussed with Leighton as infiltration plans are being developed. Leighton should review all infiltration plans, including specific locations and invert depths of proposed facilities. Further testing may be needed based on the design of infiltration facilities, particularly considering their type, depth and location.

General Design Considerations: The periodic flow of water carrying sediments into the infiltration facility, plus the introduction of wind-blown sediments and sediments from erosion of basin side walls, can eventually cause the bottom of the facility to accumulate a layer of silt, which has the potential of significantly reducing the overall infiltration rate. Therefore, we recommend that significant

amounts of silt/sediment not be allowed to flow into the facility within stormwater, especially during construction of the project and prior to achieving mature landscape on site. We recommend that an easily maintained, robust silt/sediment removal system be installed to pretreat storm water before it enters the infiltration facility.

As infiltrating water can seep within the soil strata nearly horizontally for long distances, it is important to consider the impact that infiltration facilities can have on nearby subterranean structures, such as basement walls or open excavations, whether onsite or offsite, and whether existing or planned. Any such nearby features should be identified and evaluated as to whether infiltrating water can impact these. Such features should be brought to Leighton's attention as they are identified.

Infiltration facilities should not be constructed adjacent to or under buildings. Setbacks should be discussed with Leighton during the planning process.

Infiltration facilities should be constructed with spillways or other appropriate means that would cause overflowing to not be a concern to the facility or nearby improvements.

For buried chambers, control/access manhole covers should not contain holes or should be screened to prevent mosquitos from entering the chambers.

Construction Considerations: We recommend that Leighton evaluate the infiltration facility excavations, to confirm that granular, undisturbed alluvium is exposed in the bottoms and sides. Additional excavation or evaluation may be required if silty or clayey soils are exposed.

It is critical to infiltration that the basin or chamber bottom not be allowed to be compacted during construction or maintenance; rubber-tired equipment and vehicles should not be allowed to operate on the bottom. We recommend that at least the bottom 3 feet of the basins or chambers be excavated with an excavator or similar.

If fill material is needed to be placed in the basin, such as due to removal of uncontrolled artificial fill, the fill material should be select and free-draining sand, and should be observed and evaluated by Leighton.

Maintenance Considerations: The infiltration facilities should be routinely monitored, especially before and during the rainy season, and corrective measures should be implemented as/when needed. Things to check for include proper upkeep, proper infiltration, absence of accumulated silt, and that de-silting filters/features are clean and functioning. Pretreatment desilting features should be cleaned and maintained per manufacturers' recommendations. Even with measures to prevent silt from flowing into the infiltration facility, accumulated silt may need to be removed occasionally as part of maintenance.

3.9 Temporary Excavations

All temporary excavations, including utility trenches, retaining wall excavations and other excavations should be performed in accordance with project plans, specifications and all OSHA requirements. Contractors should be advised that sand and gravelly fill soils should be considered Type C soils as defined in the California Construction Safety Orders.

No surcharge loads should be permitted within a horizontal distance equal to the height of cut or 5 feet, whichever is greater from the top of the slope, unless the cut is shored appropriately. Excavations that extend below an imaginary plane inclined at 45 degrees below the edge of any adjacent existing site foundation should be properly shored to maintain support of the adjacent structures.

Cantilever shoring should be designed based on an active equivalent fluid pressure of 35 pcf. If excavations are braced at the top and at specific design intervals, the active pressure may then be approximated by a rectangular soil pressure distribution with the pressure per foot of width equal to $25H$, where H is equal to the depth of the excavation being shored.

During construction, the soil conditions should be regularly evaluated to verify that conditions are as anticipated. The contractor should be responsible for providing the "competent person" required by OSHA, standards to evaluate soil conditions. Close coordination between the competent person and the geotechnical engineer should be maintained to facilitate construction while providing safe excavations.

3.10 Trench Backfill

Utility trenches should be backfilled with compacted fill in accordance with Sections 306-1.2 and 306-1.3 of the *Standard Specifications for Public Works Construction*, (SSPWC, "Greenbook"), 2018 Edition. Utility trenches may be backfilled with onsite material free of rubble, debris, organic and oversized material up to 3 inches in largest dimension. Prior to backfilling trenches, pipes should be bedded in and covered with either:

- (1) **Granular Bedding:** a uniform sand material with a Sand Equivalent (SE) greater-than-or-equal-to (\geq) 30, passing the No. 4 U.S. Standard Sieve (or as specified by the pipe manufacturer).
- (2) **CLSM:** Controlled Low Strength Material (CLSM) conforming to Section 201-6 of the SPWC. CLSM bedding should be placed to 1-foot (0.3 m) over the top of the conduit, and vibrated.

Pipe bedding should extend at least 4 inches below the pipeline invert and at least 12 inches over the top of the pipeline. The bedding and shading sand is recommended to be densified in place by vibratory, lightweight compaction equipment.

Trench backfill over the pipe bedding zone may consist of native and clean fill soils. All backfill should be placed in thin lifts (appropriate for the type of compaction equipment), moisture conditioned to slightly above optimum, and mechanically compacted to at least 90 percent of the laboratory derived maximum density as determined by ASTM Test Method D 1557.

3.11 Surface Drainage

Inadequate control of runoff water and/or poorly controlled irrigation can cause the onsite soils to expand and/or shrink, producing heaving and/or settlement of foundations, flatwork, walls, and other improvements. Maintaining adequate surface drainage, proper disposal of runoff water, and control of irrigation should help reduce the potential for future soil moisture problems. Positive surface drainage should be designed to be directed away from foundations and toward approved drainage devices, such as gutters, paved drainage swales, or watertight area drains and collector pipes.

Surface drainage should be provided to prevent ponding of water adjacent to the structures. In general, the area around the buildings should slope away from the building. We recommend that unpaved landscaped areas adjacent to the buildings be avoided. Roof runoff should be carried to suitable drainage outlets by watertight drain pipes or over paved areas.

3.12 Additional Geotechnical Services

The geotechnical recommendations presented in this report are based on subsurface conditions as interpreted from limited subsurface explorations and limited laboratory testing. Geotechnical recommendations provided in this report are based on information available at the time the report was prepared and may change as plans are developed. Additional geotechnical investigation and analysis may be required based on final improvement plans. Leighton should review the site and grading plans when available and comment further on the geotechnical aspects of the project. Geotechnical observation and testing should be conducted during excavation and all phases of grading operations. Our conclusions and preliminary recommendations should be reviewed and verified by Leighton during construction and revised accordingly if geotechnical conditions encountered vary from our preliminary findings and interpretations.

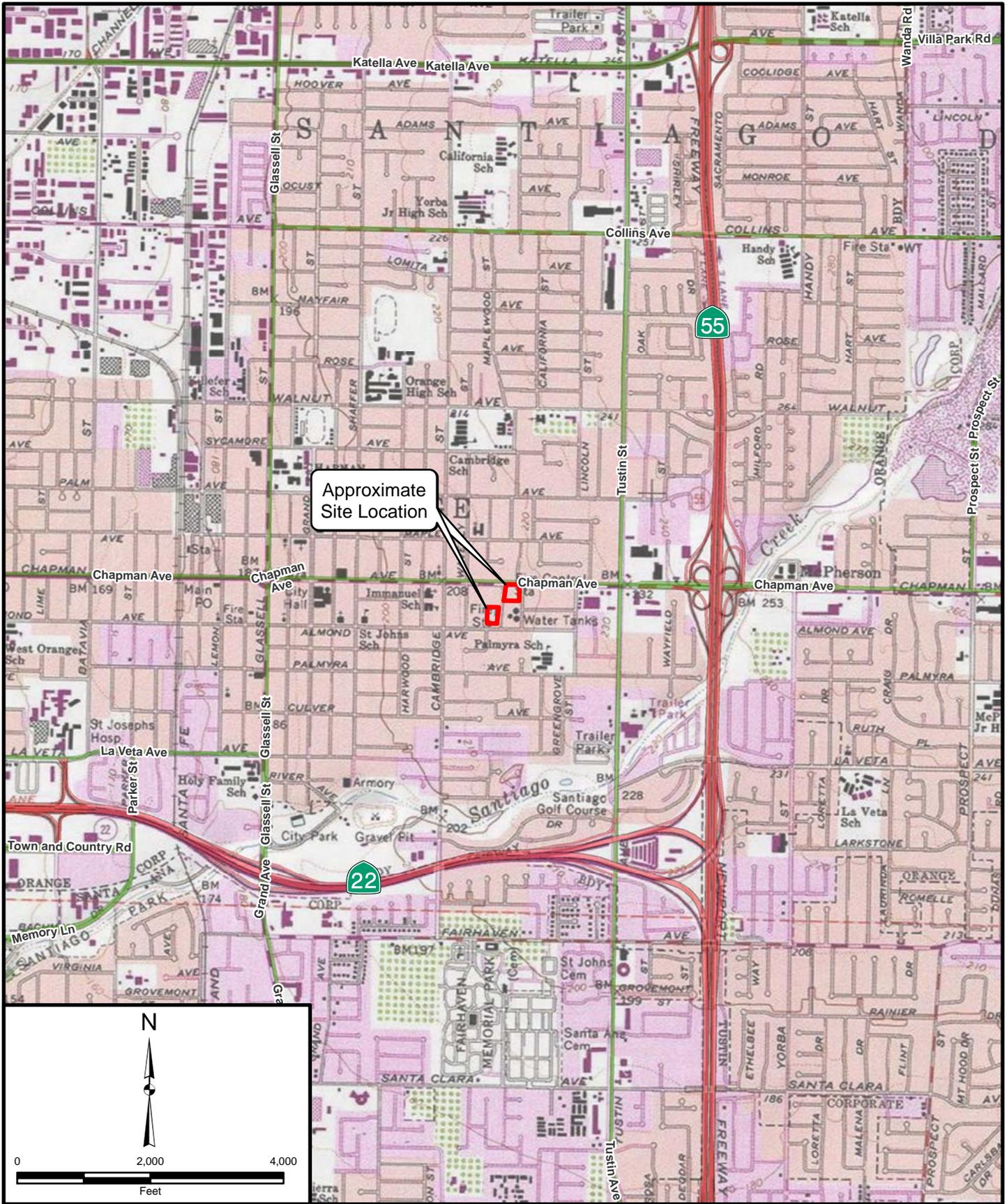
Geotechnical observation and testing should be provided:

- After completion of site clearing.
- During overexcavation of compressible soil.
- During compaction of all fill materials.
- After excavation of all footings and prior to placement of concrete.
- During utility trench backfilling and compaction.
- During pavement subgrade and base preparation.
- When any unusual conditions are encountered.

4.0 LIMITATIONS

This report was based in part on data obtained from a limited number of observations, site visits, soil excavations, samples, and tests. Such information is, by necessity, incomplete. The nature of many sites is such that differing soil or geologic conditions can be present within small distances and under varying climatic conditions. Changes in subsurface conditions can and do occur over time. Therefore, our findings, conclusions, and recommendations presented in this report are based on the assumption that Leighton Consulting, Inc. will provide geotechnical observation and testing during construction. Please refer to the GBA "Important Information about This Geotechnical Engineering Report" presented on at the end of this report.

This report was prepared for the sole use of WLC Architects, Inc. for application to the design of the proposed City of Orange Fire Station 1 in accordance with generally accepted geotechnical engineering practices at this time in California.

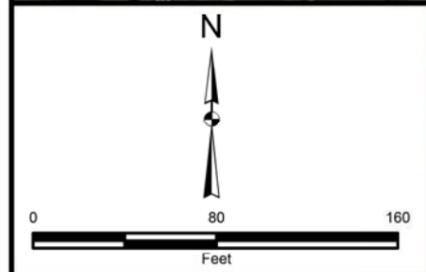


Project: 12482.001	Eng/Geol: JDH/PB
Scale: 1" = 2,000'	Date: September 2019
Base Map: ESRI ArcGIS Online 2019	
Thematic Information: Leighton	
Author: (kmanchikanti)	

SITE LOCATION MAP
Proposed Fire Station 1
105 South Water Street
City of Orange, California

Figure 1

Leighton



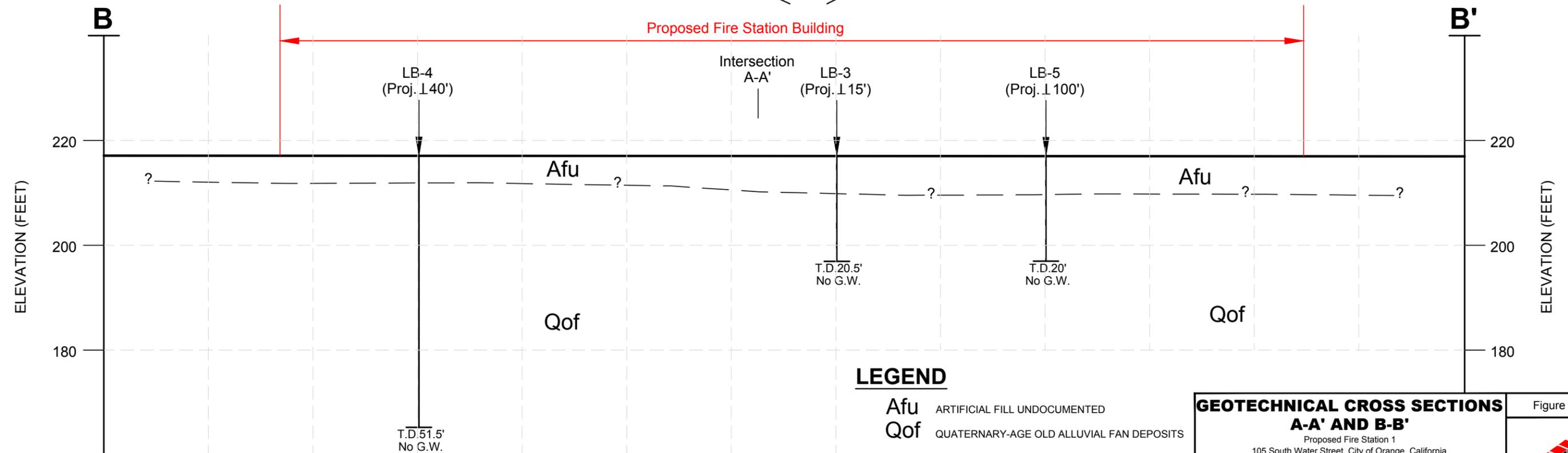
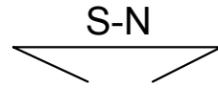
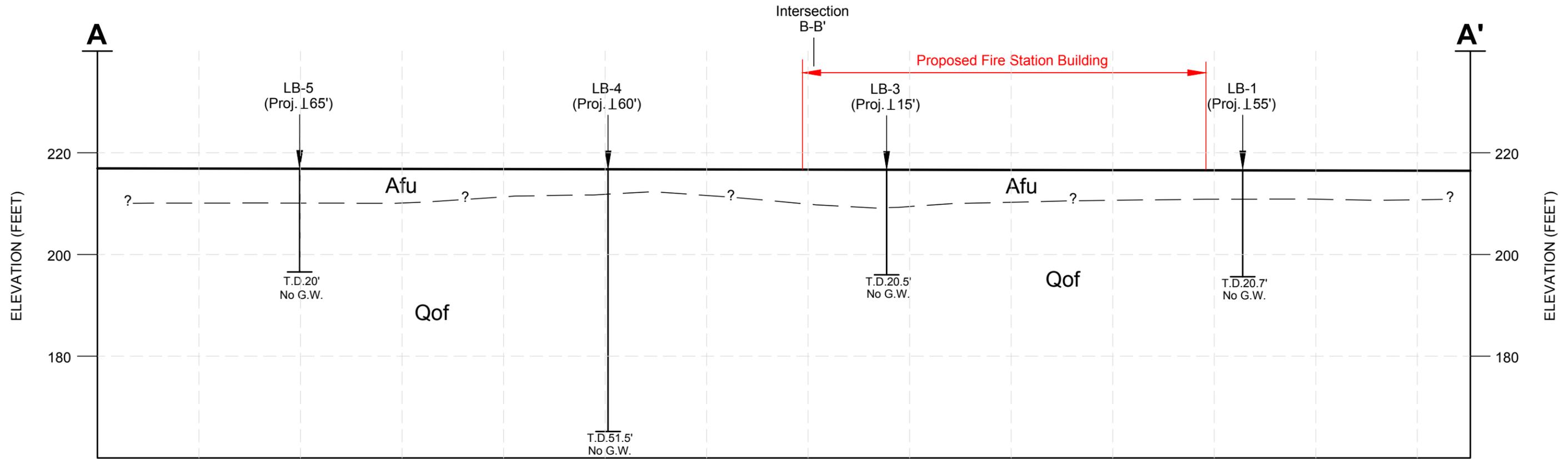
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 Scale: 1" = 80' Date: September 2019
 Base Map: ESRI ArcGIS Online 2019
 Thematic Information: Leighton
 Author: (kmanc)

EXPLORATION LOCATION MAP

Proposed Fire Station 1
 105 South Water Street
 City of Orange, California

Figure 2





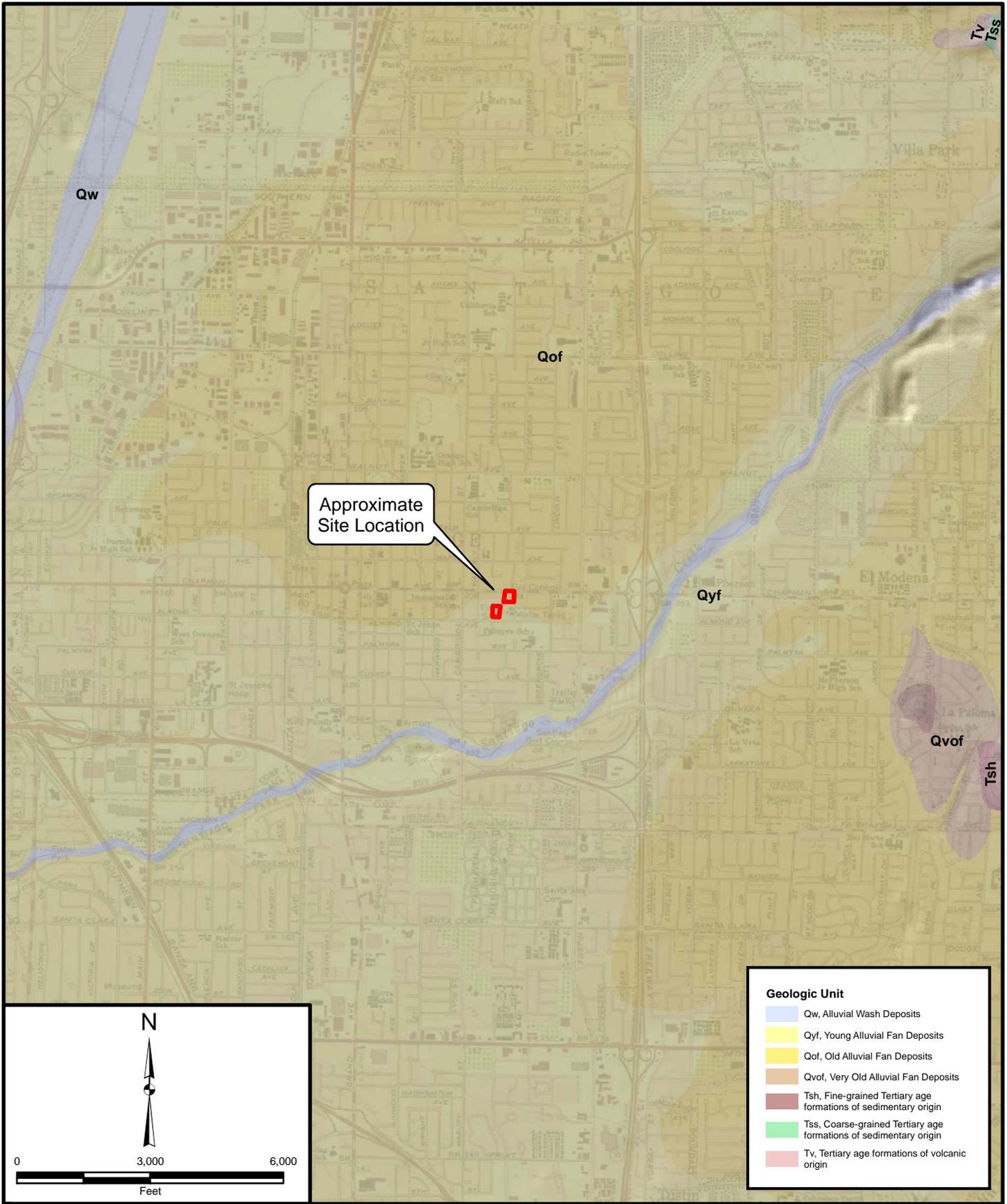
LEGEND
 Afu ARTIFICIAL FILL UNDOCUMENTED
 Qof QUATERNARY-AGE OLD ALLUVIAL FAN DEPOSITS

GEOTECHNICAL CROSS SECTIONS	
A-A' AND B-B'	
Proposed Fire Station 1 105 South Water Street, City of Orange, California	
Proj: 12482.001	Eng/Geol: JEH/PB
Scale: 1"=20'	Date: September 2019
<small>Drafted By: BOT Checked By: BOT V:\DRAFTING\12482001\CAD\2019-09-25\12482-001_FJA_CS_2019-09-25.DWG (09-25-19 11:50:54AM) Plotted by: sbran</small>	

Figure 2A



Leighton



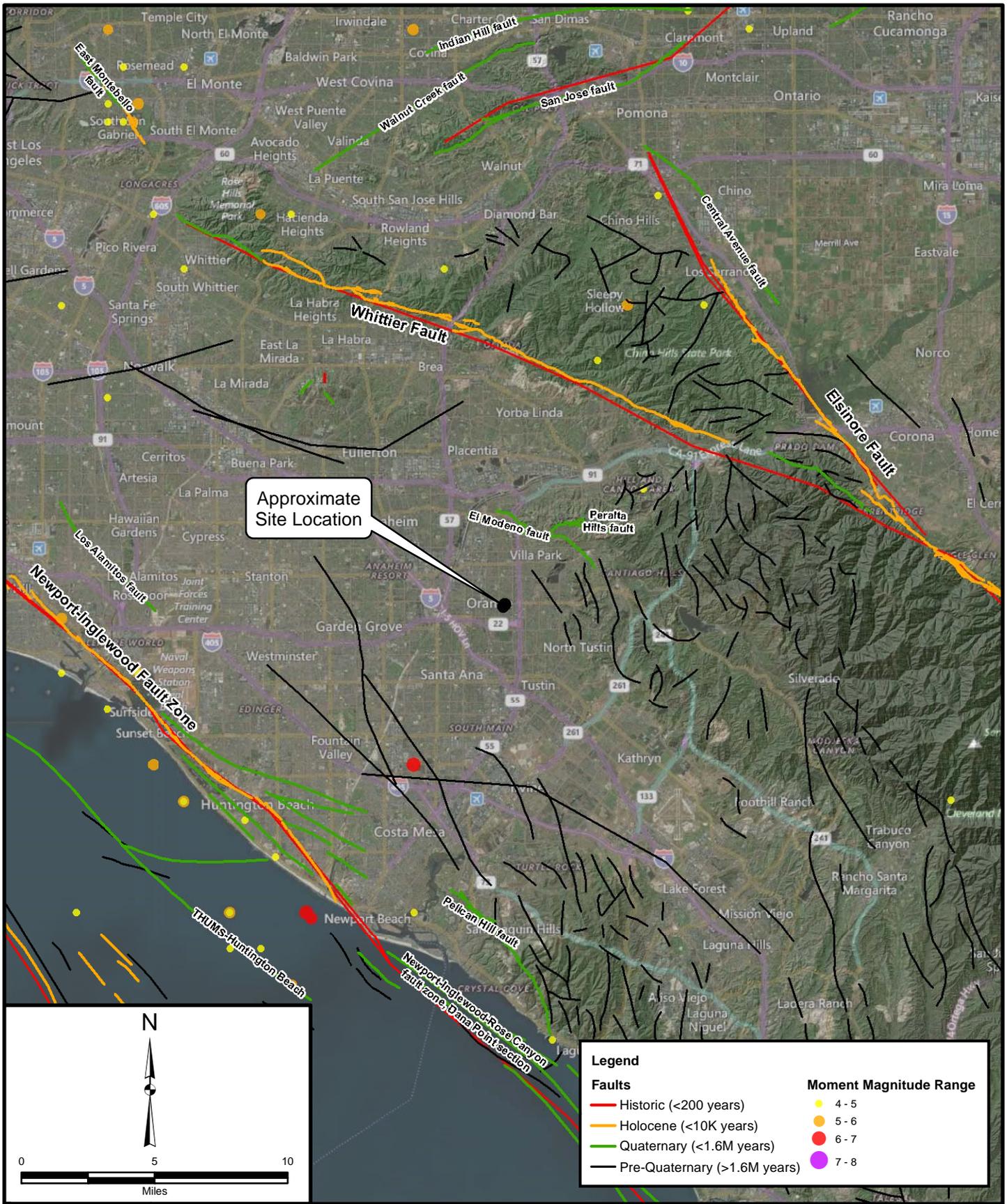
Project: 12482.001	Eng/Geol: JDH/PB
Scale: 1" = 3,000'	Date: September 2019
Base Map: ESRI ArcGIS Online 2019 Thematic Information: Leighton, USGS Author: (kmanchikanti)	

REGIONAL GEOLOGY MAP

Proposed Fire Station 1 105 South Water Street City of Orange, California

Figure 3

Leighton



Project: 12375.001 Eng/Geol: JDH/PB
 Scale: 1" = 5 miles Date: September 2019
 Base Map: ESRI ArcGIS Online 2019
 Thematic Information: Leighton
 Author: Leighton Geomatics (kmanchikanti)

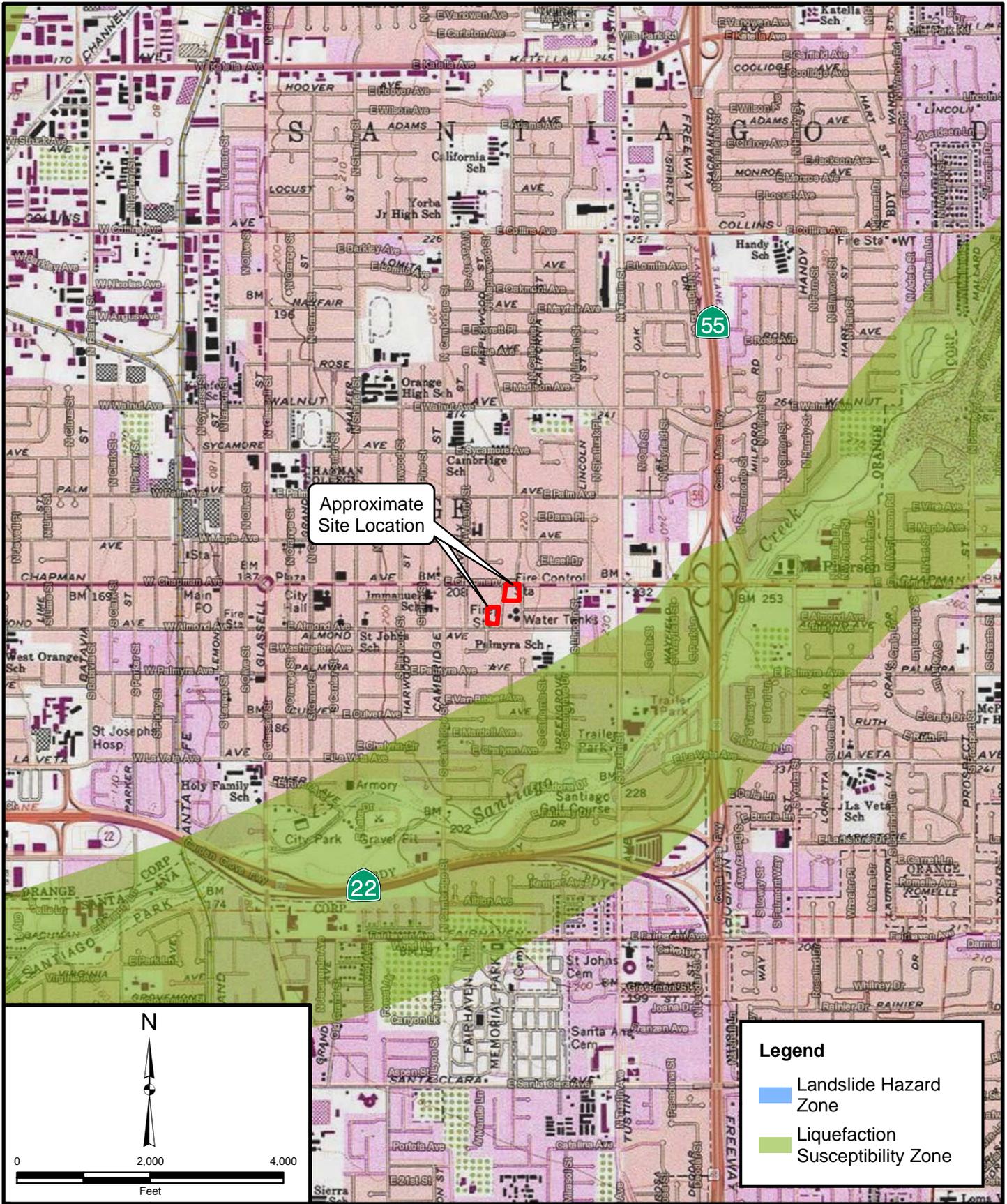
REGIONAL FAULT AND HISTORIC SEISMICITY MAP

Proposed Fire Station 1

105 South Water Street, City of Orange, California

Figure 4

Leighton



Project: 12482.001 Eng/Geol: JDH/PB

Scale: 1" = 2,000' Date: September 2019

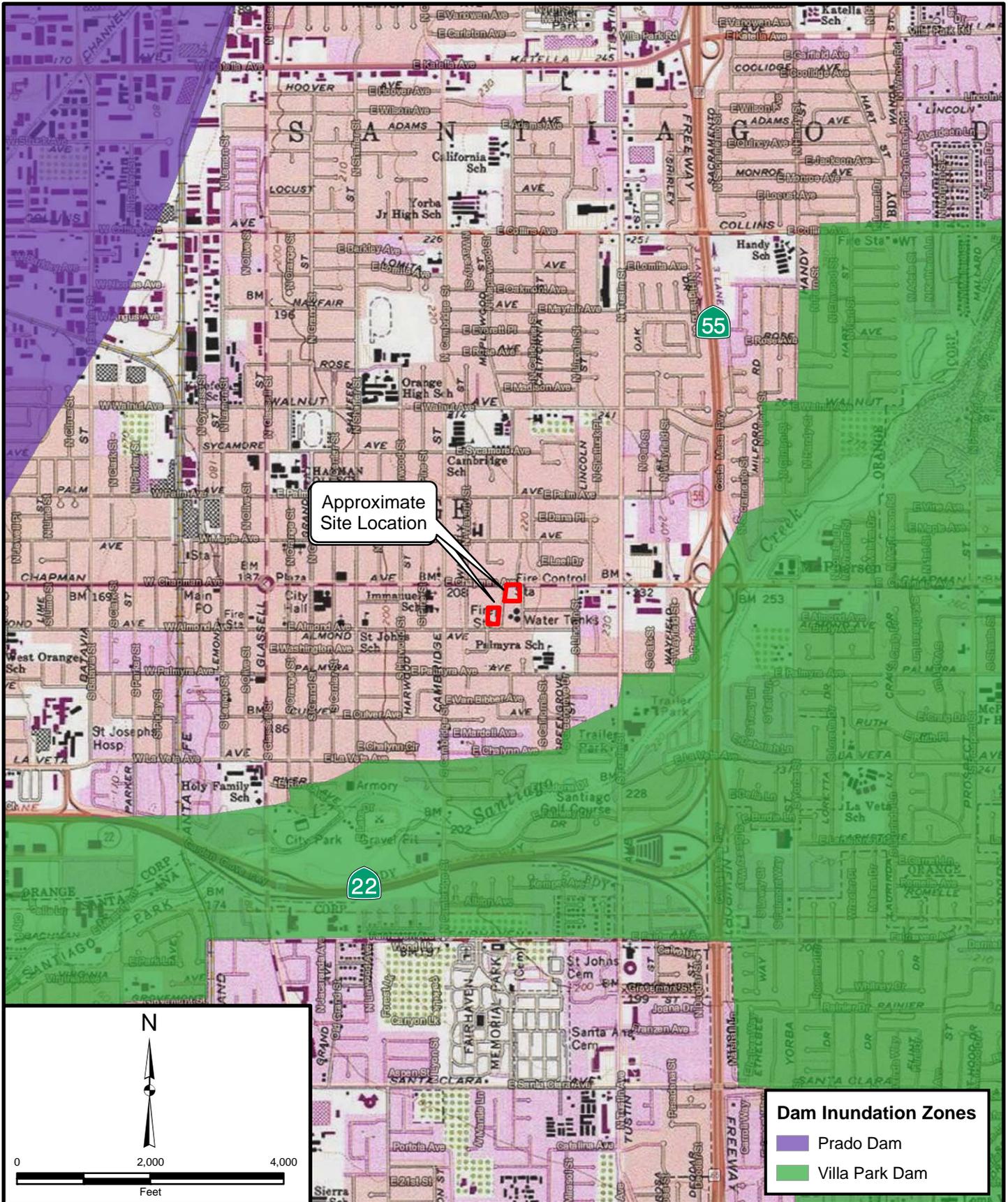
Base Map: ESRI ArcGIS Online 2019
 Thematic Information: Leighton
 Author: Leighton Geomatics (kmanchikanti)

SEISMIC HAZARD MAP

Proposed Fire Station 1 105 South Water Street City of Orange, California

Figure 5

Leighton



Approximate Site Location

Dam Inundation Zones

- Prado Dam
- Villa Park Dam

Project: 12482.001	Eng/Geol: JDH/PB
Scale: 1" = 2,000'	Date: September 2019
Base Map: ESRI ArcGIS Online 2019 Thematic Information: Leighton, CA DWR, FEMA Author: Leighton Geomatics (kmanchikanti)	

DAM INUNDATION MAP

Proposed Fire Station 1 105 South Water Street City of Orange, California

Figure 6

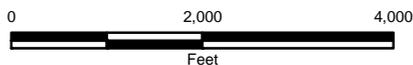
Leighton

FEMA Flood Zone

- 500 Year Flood Plain
- 100 Year Flood Plain

Approximate Site Location

N



Project: 12482.001 Eng/Geol: JDH/PB
Scale: 1" = 2,000' Date: September 2019

Base Map: ESRI ArcGIS Online 2019
Thematic Information: Leighton; FEMA
Author: Leighton Geomatics (kmanchikanti)

FLOOD HAZARD ZONE MAP

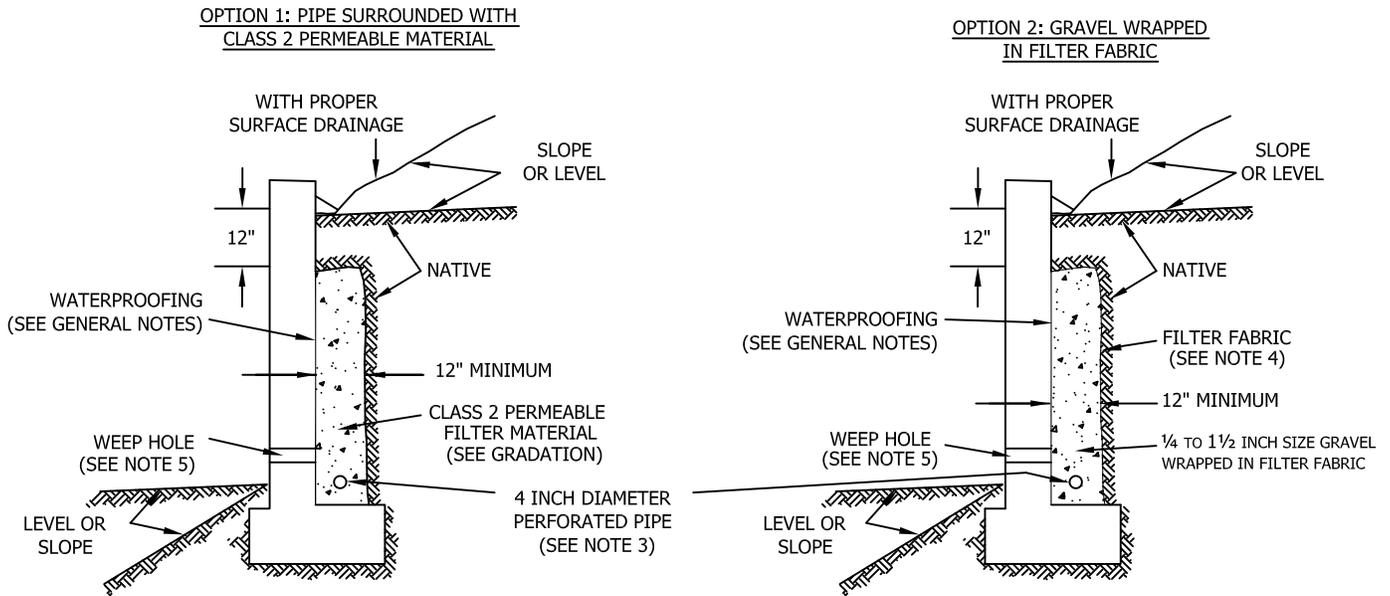
Proposed Fire Station 1 105 South Water Street City of Orange, California

Figure 7



Leighton

SUBDRAIN OPTIONS AND BACKFILL WHEN NATIVE MATERIAL HAS EXPANSION INDEX OF ≤ 50



Class 2 Filter Permeable Material Gradation
Per Caltrans Specifications

Sieve Size	Percent Passing
1"	100
3/4"	90-100
3/8"	40-100
No. 4	25-40
No. 8	18-33
No. 30	5-15
No. 50	0-7
No. 200	0-3

GENERAL NOTES:

- * Waterproofing should be provided where moisture nuisance problem through the wall is undesirable.
- * Water proofing of the walls is not under purview of the geotechnical engineer
- * All drains should have a gradient of 1 percent minimum
- * Outlet portion of the subdrain should have a 4-inch diameter solid pipe discharged into a suitable disposal area designed by the project engineer. The subdrain pipe should be accessible for maintenance (rodding)
- * Other subdrain backfill options are subject to the review by the geotechnical engineer and modification of design parameters.

Notes:

- 1) Sand should have a sand equivalent of 30 or greater and may be densified by water jetting.
- 2) 1 Cu. ft. per ft. of 1/4- to 1 1/2-inch size gravel wrapped in filter fabric
- 3) Pipe type should be ASTM D1527 Acrylonitrile Butadiene Styrene (ABS) SDR35 or ASTM D1785 Polyvinyl Chloride plastic (PVC), Schedule 40, Armco A2000 PVC, or approved equivalent. Pipe should be installed with perforations down. Perforations should be 3/8 inch in diameter placed at the ends of a 120-degree arc in two rows at 3-inch on center (staggered)
- 4) Filter fabric should be Mirafi 140NC or approved equivalent.
- 5) Weepholes should be 3-inch minimum diameter and provided at 10-foot maximum intervals. If exposure is permitted, weepholes should be located 12 inches above finished grade. If exposure is not permitted such as for a wall adjacent to a sidewalk/curb, a pipe under the sidewalk to be discharged through the curb face or equivalent should be provided. For a basement-type wall, a proper subdrain outlet system should be provided.
- 6) Retaining wall plans should be reviewed and approved by the geotechnical engineer.
- 7) Walls over six feet in height are subject to a special review by the geotechnical engineer and modifications to the above requirements.

RETAINING WALL BACKFILL AND SUBDRAIN DETAIL FOR WALLS 6 FEET OR LESS IN HEIGHT

WHEN NATIVE MATERIAL HAS EXPANSION INDEX OF ≤ 50



Figure 8

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, clients can benefit from a lowered exposure to the subsurface problems that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed below, contact your GBA-member geotechnical engineer. Active involvement in the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Geotechnical-Engineering Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. *Those who rely on a geotechnical-engineering report prepared for a different client can be seriously misled.* No one except authorized client representatives should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. *And no one – not even you – should apply this report for any purpose or project except the one originally contemplated.*

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read it *in its entirety*. Do not rely on an executive summary. Do not read selected elements only. *Read this report in full.*

You Need to Inform Your Geotechnical Engineer about Change

Your geotechnical engineer considered unique, project-specific factors when designing the study behind this report and developing the confirmation-dependent recommendations the report conveys. A few typical factors include:

- the client's goals, objectives, budget, schedule, and risk-management preferences;
- the general nature of the structure involved, its size, configuration, and performance criteria;
- the structure's location and orientation on the site; and
- other planned or existing site improvements, such as retaining walls, access roads, parking lots, and underground utilities.

Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse;
- the elevation, configuration, location, orientation, or weight of the proposed structure;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

This Report May Not Be Reliable

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, that it could be unwise to rely on a geotechnical-engineering report whose reliability may have been affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If your geotechnical engineer has not indicated an "apply-by" date on the report, ask what it should be, and, in general, if you are the least bit uncertain about the continued reliability of this report, contact your geotechnical engineer before applying it.* A minor amount of additional testing or analysis – if any is required at all – could prevent major problems.

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface through various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing were performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgment to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team from project start to project finish, so the individual can provide informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, *they are not final*, because the geotechnical engineer who developed them relied heavily on judgment and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* revealed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a full-time member of the design team, to:

- confer with other design-team members,
- help develop specifications,
- review pertinent elements of other design professionals' plans and specifications, and
- be on hand quickly whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction observation.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for informational purposes only*. To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report, but they may rely on the factual data relative to the specific times, locations, and depths/elevations referenced. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may

perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely*. Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures*. If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. As a general rule, *do not rely on an environmental report prepared for a different client, site, or project, or that is more than six months old*.

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, none of the engineer's services were designed, conducted, or intended to prevent uncontrolled migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, *proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infiltration*. Confront the risk of moisture infiltration by including building-envelope or mold specialists on the design team. *Geotechnical engineers are not building-envelope or mold specialists*.



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APPENDIX A
REFERENCES



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APPENDIX A

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APPENDIX B
GEOTECHNICAL BORING AND INFILTRATION LOGS



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GEOTECHNICAL BORING LOG LB-1

Project No. 12482.001
Project Proposed Fire Station 1
Drilling Co. 2R Drilling, Inc.
Drilling Method Hollow Stem Auger - 140lb - Autohammer - 30" Drop
Location See Figure 2 Exploration Location Map

Date Drilled 8-8-19
Logged By MM
Hole Diameter 8"
Ground Elevation 217'
Sampled By MM

Elevation Feet	Depth Feet	Graphic Log	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.										
0	0	N S		B-1					@Surface: gravel, sand Artificial Fill, undocumented (Afu)	EI
215				R-1	8 14 17	111	3	SM	@2.5' SILTY SAND (SM), medium dense, orange brown, moist, fine sand, 30% fines (field estimate), 10% gravel (field estimate) subround, subangular, fine gravel, mechanically fractured	
5				R-2	11 23 20			SM	Quaternary Old Alluvial Fan (Qof) @5' SILTY SAND with gravel (SM), medium dense, orange brown, moist, fine sand, fine to medium gravel, angular due to mechanical fracturing (soil cuttings)	
210				R-3	50/5"	122	1	GW-GM	@10' GRAVEL with silt and sand (GW-GM), dense, orange brown, moist, fine sand, fine to coarse gravel and cobbles, no recovery	
205				R-4	41 50/5"	121	7	SP-SM	@15' SAND with silt to silty sand with gravel (SP-SM), dense, orange brown, moist, fine to medium sand, oxidized throughout, fine angular gravel, due to mechanical fracturing	
200				S-1	18 50/2.5"			SP-SM	@20' SAND with silt to silty sand with gravel (SP-SM), very dense, orange brown, moist, fine to medium sand, oxidized throughout, fine angular gravel, angular due to mechanical fracturing, low recovery	
195									Total Depth: 21 feet No groundwater encountered Backfilled with soil cuttings and tamped upon completion of drilling	
25										
190										
30										

SAMPLE TYPES:

- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:

- 200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL

- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE

- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH



GEOTECHNICAL BORING LOG LB-2

Project No. 12482.001
Project Proposed Fire Station 1
Drilling Co. 2R Drilling, Inc.
Drilling Method Hollow Stem Auger - 140lb - Autohammer - 30" Drop
Location See Figure 2 Exploration Location Map

Date Drilled 8-8-19
Logged By MM
Hole Diameter 8"
Ground Elevation 217'
Sampled By MM

Elevation Feet	Depth Feet	Graphic Log	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
		N S							This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	
215	0			B-1					@Surface: 2 inches Asphalt Concrete Artificial Fill, undocumented (Afu)	
	2.5			R-1	23 23 25	97	3	SM	@2.5' SILTY SAND with gravel (SM), medium dense, orange brown, moist, fine sand, fine to medium gravel, subangular to subround, majority of gravel in cuttings, no recovery	
	5			R-2	25 50/3"			GP	Quaternary Old Alluvial Fan (Qof) @5' GRAVEL with sand (GP), dense, grayish brown, slightly moist, fine sand, fine to medium gravel, subangular to subround, mechanically fractured gravel, low recovery	
210	6								Drilling refusal at 6 feet No groundwater encountered Backfilled with soil cuttings and tamped upon completion of drilling	
205	10									
200	15									
195	20									
190	25									
30	30									

SAMPLE TYPES:

- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:

- 200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL

- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE

- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH



GEOTECHNICAL BORING LOG LB-3

Project No. 12482.001
Project Proposed Fire Station 1
Drilling Co. 2R Drilling, Inc.
Drilling Method Hollow Stem Auger - 140lb - Autohammer - 30" Drop
Location See Figure 2 Exploration Location Map

Date Drilled 8-8-19
Logged By MM
Hole Diameter 8"
Ground Elevation 217'
Sampled By MM

Elevation Feet	Depth Feet	Graphic Log	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION		Type of Tests
									<i>This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.</i>		
0		N S		B-1					@Surface: Gravel and sand Artificial Fill, undocumented (Afu)	MD, CR	
215				R-1	8 6 6	112	7	SM	@2.5' SILTY SAND (SM), loose, brown, moist, fine sand, gravel, fine gravel, angular to subangular gravel, 28% fines	-200	
5				R-2	7 11 15	124	2	SM	@5' SILTY SAND (SM), medium dense, brown, moist, fine sand, no recovery, cuttings same as @2.5'		
210									Quaternary Old Alluvial Fan (Qof)		
				R-3	10 15 18			SP	@8' SAND with gravel (SP), medium dense, light brown to grayish brown, slightly moist, fine sand, angular to subangular fine gravel		
10				R-4	10 18 32			SP	@10' SAND with gravel (SP), dense, light brown to grayish brown, slightly moist, fine to medium sand, fine to medium subangular gravel due to mechanical fracturing, clay with gravel in shoe		
205											
15				R-5	50/3"			GW-GM	@15' GRAVEL with silt and sand (GW-GM), very dense, no recovery, sand with gravel in cuttings		
200											
20				S-1	50/5"			GW-GM	@20' GRAVEL with silt and sand (GW-GM), very dense, no recovery, sand with gravel in cuttings		
195									Total Depth: 20.5 feet No groundwater encountered Backfilled with soil cuttings and tamped upon completion of drilling		
25											
190											
30											

SAMPLE TYPES:

- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:

- 200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL

- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE

- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH



GEOTECHNICAL BORING LOG LB-4

Project No. 12482.001
Project Proposed Fire Station 1
Drilling Co. 2R Drilling, Inc.
Drilling Method Hollow Stem Auger - 140lb - Autohammer - 30" Drop
Location See Figure 2 Exploration Location Map

Date Drilled 8-8-19
Logged By MM
Hole Diameter 8"
Ground Elevation 217'
Sampled By MM

Elevation Feet	Depth Feet	Graphic Log	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION		Type of Tests
									<i>This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.</i>		
0		N S		B-1					@Surface: sand, gravel Artificial Fill, undocumented (Afu)		
215				R-1	19 12 9			SM	@2.5' SILTY SAND with gravel (SM), medium dense, brown		
5				R-2	13 20 27	136	3	GP	Quaternary Old Alluvial Fan (Qof) @5' SANDY GRAVEL (GP), medium dense, grayish brown, slightly moist, fine sand, rounded gravels, with few mechanically fractured during sampling, cobble-sized slaty bedrock fragments @8' gravel, hard drilling		
210				R-3	32 32 18	122	7	SC	CLAYEY SAND with gravel (SC), medium dense, reddish brown, moist, low to medium plasticity, 31% fines	-200	
205				R-4	30 47 50/5"	108	4	GW-GM	@15' GRAVEL with silt and sand (GW-GM), very dense, reddish brown, moist, fine, subangular, well graded	SA	
200				R-5	50/5"	115	4	GW-GM	@20' GRAVEL with silt and sand (GW-GM), very dense, reddish brown, moist, fine, subangular, well graded		
195				S-1	32 49 50/4"			SP	@25' SAND (SP), very dense, reddish brown, moist, fine to medium, subangular, trace silt		
190											
30											

SAMPLE TYPES:

- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:

- 200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL

- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE

- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH



GEOTECHNICAL BORING LOG LB-4

Project No. 12482.001
Project Proposed Fire Station 1
Drilling Co. 2R Drilling, Inc.
Drilling Method Hollow Stem Auger - 140lb - Autohammer - 30" Drop
Location See Figure 2 Exploration Location Map

Date Drilled 8-8-19
Logged By MM
Hole Diameter 8"
Ground Elevation 217'
Sampled By MM

Elevation Feet	Depth Feet	Graphic Log	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.										
30		N S		R-6	50/2"			GW-GM	@30' GRAVEL with silt and sand (GW-GM), very dense, brown, no recovery	
185										
35				S-2	11 18 10			CL	@35' CLAY (CL), very stiff, orange brown, moist, low to medium plasticity	
180										
40				R-7	5 10 14	105	21	CL	@40' CLAY (CL), stiff, orange brown, moist, low to medium plasticity, with some gravel, 81% fines	-200, AL
175										
45				S-3	11 14 50/5"			SP	@45' SAND (SP), very dense, light brown, moist, fine grained	
170										
50				R-8	20 24 23	119	11	CL	@50' CLAY (CL), very stiff, orange brown, moist, low plasticity	
165									Total Depth: 51.5 feet No groundwater encountered Caved at 30' Backfilled with soil cuttings and tamped upon completion of drilling	
55										
160										
60										

SAMPLE TYPES:

- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:

- 200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL

- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE

- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH



GEOTECHNICAL BORING LOG LB-5

Project No. 12482.001
Project Proposed Fire Station 1
Drilling Co. 2R Drilling, Inc.
Drilling Method Hollow Stem Auger - 140lb - Autohammer - 30" Drop
Location See Figure 2 Exploration Location Map

Date Drilled 8-8-19
Logged By MM
Hole Diameter 8"
Ground Elevation 217'
Sampled By MM

Elevation Feet	Depth Feet	Graphic Log	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	0	N S							<i>This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.</i>	
	215			B-1					@Surface: 3.5 inches Asphalt Concrete Artificial Fill, undocumented (Afu)	
				R-1	11 29 30	127	3	SP	@2.5' SAND with gravel (SP), dense, light orange brown, moist, fine to medium, subangular, 4% fines	-200
	5			R-2	26 36 44	119	1	GP	@5' SANDY GRAVEL (GP), dense, grayish orange brown, moist, fine to medium, subangular slaty rock fragments @6' gravel, hard drilling, abundant mechanically fractured gravel, small cobble-sized slaty rock fragments	
	210								Quaternary Old Alluvial Fan (Qof)	
	10			R-3	21 50/4"	121	3	GP	@10' SANDY GRAVEL with cobbles (GP), dense, orange brown, moist, abundant mechanically fractured rock fragments	
	205			R-4	50/3"			GW-GM	@15' GRAVEL with silt and sand (GW-GM), very dense, reddish brown, moist, fine to medium, subangular, no recovery	
	200			S-1	50/1"			GW-GM	@20' GRAVEL with silt and sand (GW-GM), very dense, reddish brown, moist, fine to medium, subangular, no recovery	
	195								Total Depth: 20 feet No groundwater encountered Backfilled with soil cuttings and tamped upon completion of drilling	
	25									
	190									
	30									

SAMPLE TYPES:

- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:

- 200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL

- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE

- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH



GEOTECHNICAL BORING LOG LB-6

Project No. 12482.001
Project Proposed Fire Station 1
Drilling Co. 2R Drilling, Inc.
Drilling Method Hollow Stem Auger - 140lb - Autohammer - 30" Drop
Location See Figure 2 Exploration Location Map

Date Drilled 8-8-19
Logged By MM
Hole Diameter 8"
Ground Elevation 216'
Sampled By MM

Elevation Feet	Depth Feet	Graphic Log	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION		Type of Tests
									<i>This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.</i>		
215	0	N S		B-1				SC	@Surface: 6 inches Asphalt Concrete Artificial Fill, undocumented (Afu)		
		N S		R-1	3 4 11	117	12	SC	@2.5 CLAYEY SAND (SC), stiff, brown, moist, fine, low plasticity, 43% fines	-200, AL	
210	5	N S		R-2	50/5"			SP	Quaternary Old Alluvial Fan (Qof) @ 5' No Recovery		
		N S		R-3	17 24 29			SP	@ 6.5' SAND with gravel (SP), dense, light brown, slightly moist, fine, subangular		
205	10								Total Depth: 8' No groundwater encountered Backfilled with soil cuttings and tamped upon completion of drilling		
200	15										
195	20										
190	25										
	30										

SAMPLE TYPES:

- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:

- 200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL

- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE

- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH



GEOTECHNICAL BORING LOG LB-7

Project No. 12482.001
Project Proposed Fire Station 1
Drilling Co. 2R Drilling, Inc.
Drilling Method Hollow Stem Auger - 140lb - Autohammer - 30" Drop
Location See Figure 2 Exploration Location Map

Date Drilled 8-8-19
Logged By MM
Hole Diameter 8"
Ground Elevation 216'
Sampled By MM

Elevation Feet	Depth Feet	Graphic Log	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
		N S			Bulk Driven				<i>This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.</i>	
215	0			B-1					@Surface: 3 inches Asphalt Concrete Artificial Fill, undocumented (Afu)	
				R-1				SM	@2.5' SILTY SAND with gravel (SM), light brown, moist, fine, subangular	
210	5			R-2	27 35 42	100	10	SM	Quaternary Old Alluvial Fan (Qof) @6' SAND with gravel (SP), dense, light brown, fine, subangular	
				R-3	18 24 38			SP	@7.5' SAND with gravel (SP), dense, light brown, fine to medium, subangular	
205	10								Total Depth: 9' No groundwater encountered Backfilled with soil cuttings and tamped upon completion of drilling	
200	15									
195	20									
190	25									
	30									

SAMPLE TYPES:

- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:

- 200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL

- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE

- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH



Results of Well Permeameter, from USBR 7300-89 Method.



Project:

Exploration #/Location:	12482
Depth Boring drilled to (ft):	LB-4
Tested by:	JK
USCS Soil Type in test zone:	
Weather (start to finish):	Cloudy
Liquid Used/pH:	H2O
Measured boring diameter:	9 in.
Approx Depth to GW below GS:	60 ft
Well Prep:	Caved to 30', Backfilled to 15', Added Bentonite, Gravel to 14'

Initial estimated Depth to Water Surface (in.):	127
Average depth of water in well, "h" (in.):	41
approx. h/r:	9.1
Tu (Fig. 8) (ft):	49.4
Tu>3h?:	yes, OK

4.5 in. Well Radius

Cross-sectional area for vol calcs (in.^2): 63.6

Depth to Bot of well (or top of soil over Bentonite)

ft	in.	Total (in.)
14. ft	0. in.	168
0. ft	10. in.	10

Pilot Tube stickup (+ is above ground)

Depth to top of sand outside of casing from top of pilot tube

Depth to top of float assembly from top of pilot tube

9. ft	4. in.	112	102 Depth below GS (in.)
-------	--------	-----	--------------------------

Float Assembly ID

DHVA

Float assembly Extension length (in.)

34

Flow Meter:

Meter ID	SN18003236
Meter Color	Black
Meter Unit	Gallons
DL ID	1
	0.05 gallons/pulse

Field Data

Calculations

Date	Time	Data from Flow Meter		Depth to WL in Boring (measured from top of pilot tube)		Water Temp (deg F)	Comments	Δt (min)	Total Elapsed Time (min.)	Depth to WL in well (in.)	h, Height of Water in Well (in.)	Δh (in.)	Avg. h	Vol Change (in.^3)			Flow (in.^3/ min)	q, Flow (in.^3/ hr)	V (Fig 9)	K20, Coef. Of Permeability at 20 deg C (in./hr)	Infiltration Rate [flow/surf area] (in./hr) (FS=1)	
		Reading (cu-ft or gal)	Interval Pulse Count	ft	in.									from supply	from Δh	Total						
8/8/19	10:30	593.5		10	8.5				6.3E+07	118.5	49.5											
8/8/19	10:55	595.2		10	7.4			25	6.3E+07	117.4	50.6	1.1	50	393	-70	323	13	775	0.9	0.10	0.48	
8/8/19	11:26	595.4		10	9.9			31	6.3E+07	119.9	48.1	-2.5	49	46	159	205	7	397	0.9	0.05	0.25	
8/8/19	11:53	595.4		10	11.8			27	6.3E+07	121.8	46.2	-1.9	47	0	121	121	4	268	0.921	0.04	0.18	
8/8/19	12:24	595.4		11	2.1			31	6.3E+07	124.1	43.9	-2.3	45	0	146	146	5	283	0.9	0.05	0.20	
8/8/19	12:50	595.45		11	3.2			26	6.3E+07	125.2	42.8	-1.1	43	12	70	81	3	188	0.9	0.03	0.13	
8/8/19	13:15	595.45		11	4.3			25	6.3E+07	126.3	41.7	-1.1	42	0	70	70	3	168	0.9	0.03	0.12	
8/8/19	13:45	595.45		11	5.9			30	6.3E+07	127.9	40.1	-1.6	41	0	102	102	3	203	0.9	0.04	0.15	
8/8/19	14:15	595.54		11	6.2			30	6.3E+07	128.2	39.8	-0.3	40	21	19	40	1	80	0.9	0.01	0.06	
8/8/19	14:30	595.7		11	6.1			15	6.3E+07	128.1	39.9	0.1	40	37	-6	31	2	122	0.9	0.02	0.09	

Results of Well Permeameter, from USBR 7300-89 Method.



Project: 12482
 Exploration #/Location: LB-5
 Depth Boring drilled to (ft): 30
 Tested by: JK
 USCS Soil Type in test zone:
 Weather (start to finish): Sunny
 Liquid Used/pH:
Measured boring diameter: 10 in.
 Approx Depth to GW below GS: 60 ft

Initial estimated Depth to Water Surface (in.): 212
 Average depth of water in well, "h" (in.): 34
 approx. h/r: 6.9
 Tu (Fig. 8) (ft): 42.4
 Tu>3h?: yes, OK

5 in. Well Radius
 Cross-sectional area for vol calcs (in.^2): 78.5
 Well Prep: Drilled to 30', Caved to 25', Backfilled to 21', Added Bentonite, Gravel to 20.5'

	ft	in.	Total (in.)
Depth to Bot of well (or top of soil over Bentonite)	20. ft	6. in.	246
Pilot Tube stickup (+ is above ground)	0. ft	4. in.	4
Depth to top of sand outside of casing from top of pilot tube			
Depth to top of float assembly from top of pilot tube	15. ft	8. in.	188
Float Assembly ID		E	
Float assembly Extension length (in.)		34	

184 Depth below GS (in.)

Flow Meter:

Meter ID: SN18003242
 Meter Color: Black
 Meter Unit: Gallons
 DL ID: 2
 0.05 gallons/pulse

Field Data

Calculations

Date	Time	Data from Flow Meter		Depth to WL in Boring (measured from top of pilot tube)		Water Temp (deg F)	Comments	Δt (min)	Total Elapsed Time (min.)	Depth to WL in well (in.)	h. Height of Water in Well (in.)	Δh (in.)	Avg. h	Vol Change (in.^3)			Flow (in^3/ min)	q. Flow (in^3/ hr)	V (Fig 9)	K20, Coef. Of Permeability at 20 deg C (in./hr)	Infiltration Rate [flow/surf area] (in./hr) (FS=1)		
		Reading (cu-ft or gal)	Interval Pulse Count	ft	in.									from supply	from Δh	Total							
8/8/19	12:03	350.4		18	0.6				6.3E+07	212.6	33.4												
8/8/19	12:26	364.2		17	11.2			23	6.3E+07	211.2	34.8	1.4	34	3188	-110	3078	134	8029	0.9	1.71	6.44		
8/8/19	12:51	375.8		17	11.6			25	6.3E+07	211.6	34.4	-0.4	35	2680	31	2711	108	6506	0.9	1.43	5.15		
8/8/19	13:16	385.4		18	1.3			25	6.3E+07	213.3	32.7	-1.7	34	2218	133	2351	94	5643	0.921	1.35	4.59		
8/8/19	13:46	398.5		18	1.4			30	6.3E+07	213.4	32.6	-0.1	33	3026	8	3034	101	6068	0.9	1.44	5.07		
8/8/19	14:16	416.8		18	1.2			30	6.3E+07	213.2	32.8	0.2	33	4227	-16	4212	140	8423	0.9	1.97	7.02		
8/8/19	14:45	437.2		17	11.5			29	6.3E+07	211.5	34.5	1.7	34	4712	-133	4579	158	9474	0.9	2.04	7.69		
8/8/19	15:00	448.6		17	10.8			15	6.3E+07	210.8	35.2	0.7	35	2633	-55	2578	172	10314	0.9	2.17	8.10		
8/8/19	15:15	459.3		17	10.7			15	6.3E+07	210.7	35.3	0.1	35	2472	-8	2464	164	9855	0.9	2.07	7.66		
8/8/19	15:30	468.9		17	11.4			15	6.3E+07	211.4	34.6	-0.7	35	2218	55	2273	152	9090	0.9	1.98	7.12		

APPENDIX C
LABORATORY TEST RESULTS



Leighton

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Classification	Water Content (%)	Dry Density (pcf)	Saturation (%)	Void Ratio
LB-1	2.5							3.2	110.5		
LB-1	10.0							0.6	121.7		
LB-1	15.0							6.5	120.8		
LB-2	2.5							3.0	96.9		
LB-3	2.5							7.0	112.4		
LB-3	5.0							1.8	123.5		
LB-4	5.0							2.6	136.5		
LB-4	10.0							7.4	121.6		
LB-4	15.0							3.5	107.9		
LB-4	20.0							3.5	114.9		
LB-4	40.0							21.1	105.4		
LB-4	50.0							11.5	118.7		
LB-5	2.5							3.0	126.6		
LB-5	5.0							0.9	118.5		
LB-5	10.0							3.3	120.5		
LB-6	2.5							11.7	116.9		
LB-7	6.0							10.5	99.7		

US LAB SUMMARY 12482.01 BORING LOGS DRAFT.GPJ ROCKLOG2012.GDT 9/6/19



Summary of Laboratory Results

Project Name: WLC Orange FS1

Project Number: 12482.001

Date: 9/6/2019 2:38:21 PM

Figure No. 1



MODIFIED PROCTOR COMPACTION TEST

ASTM D 1557

Project Name: WLC/Orange FS 1 Tested By: O. Figueroa Date: 09/05/19
 Project No.: 12482.001 Input By: G. Bathala Date: 09/06/19
 Boring No.: LB-3 Depth (ft.): 0-5
 Sample No.: B-1
 Soil Identification: Olive brown silty, clayey sand with gravel (SC-SM)g

Note: Corrected dry density calculation assumes specific gravity of 2.70 and moisture content of 1.0% for oversize particles

Preparation Method:	<input checked="" type="checkbox"/>	Moist	Scalp Fraction (%)			
		Dry				
Compaction Method:	<input checked="" type="checkbox"/>	Mechanical Ram	#3/4		Rammer Weight (lb.) =	10.0
		Manual Ram	#3/8	16.5	Height of Drop (in.) =	18.0
			#4		Mold Volume (ft ³)	0.03320

TEST NO.	1	2	3	4	5	6
Wt. Compacted Soil + Mold (g)	3852	3945	3995	3901		
Weight of Mold (g)	1817	1817	1817	1817		
Net Weight of Soil (g)	2035	2128	2178	2084		
Wet Weight of Soil + Cont. (g)	395.3	442.6	435.5	459.9		
Dry Weight of Soil + Cont. (g)	385.1	420.8	405.4	419.4		
Weight of Container (g)	62.3	39.2	39.4	39.8		
Moisture Content (%)	3.16	5.71	8.22	10.67		
Wet Density (pcf)	135.1	141.3	144.6	138.4		
Dry Density (pcf)	131.0	133.7	133.6	125.0		

Maximum Dry Density (pcf) 134.4
Corrected Dry Density (pcf) 139.0

Optimum Moisture Content (%) 7.1
Corrected Moisture Content (%) 6.1

Procedure A
 Soil Passing No. 4 (4.75 mm) Sieve
 Mold : 4 in. (101.6 mm) diameter
 Layers : 5 (Five)
 Blows per layer : 25 (twenty-five)
 May be used if + #4 is 20% or less

Procedure B
 Soil Passing 3/8 in. (9.5 mm) Sieve
 Mold : 4 in. (101.6 mm) diameter
 Layers : 5 (Five)
 Blows per layer : 25 (twenty-five)
 Use if + #4 is >20% and +3/8 in. is 20% or less

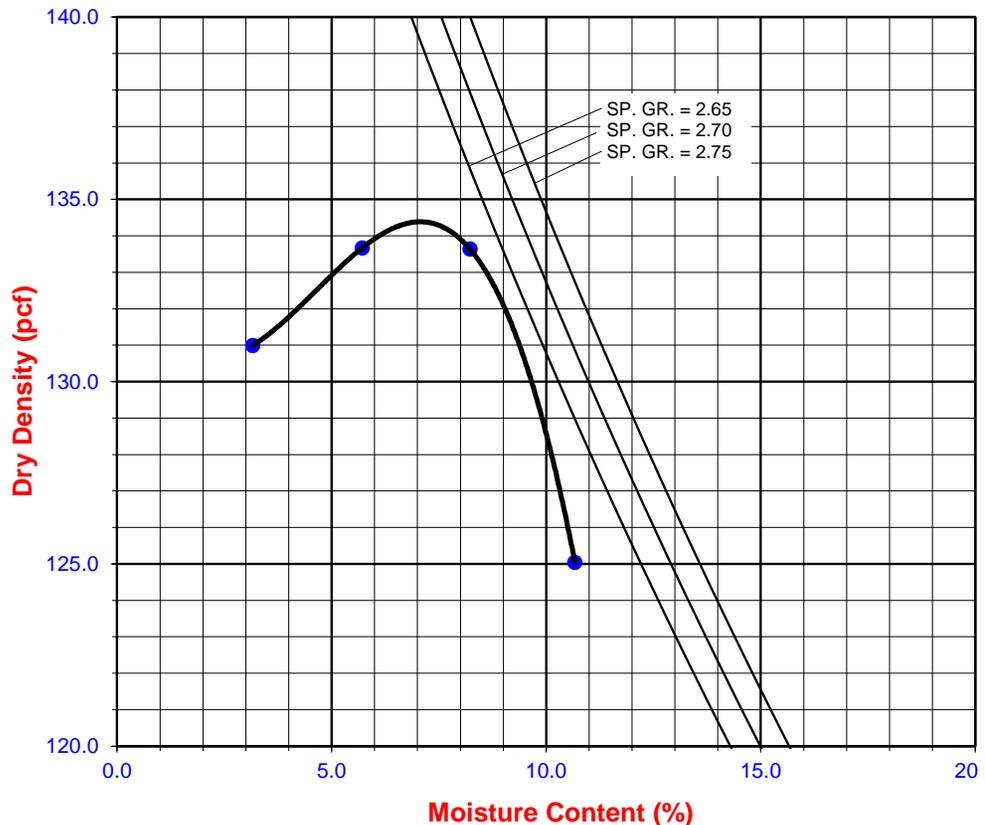
Procedure C
 Soil Passing 3/4 in. (19.0 mm) Sieve
 Mold : 6 in. (152.4 mm) diameter
 Layers : 5 (Five)
 Blows per layer : 56 (fifty-six)
 Use if +3/8 in. is >20% and +3/4 in. is <30%

Particle-Size Distribution:

GR:SA:FI

Atterberg Limits:

LL,PL,PI



Boring No.	LB-3	LB-4	LB-4	LB-5	LB-6			
Sample No.	R-1	R-3	R-7	R-1	R-1			
Depth (ft.)	2.5	10.0	40.0	2.5	2.5			
Sample Type	Ring	Ring	Ring	Ring	Ring			
Soil Identification	Brown silty sand with gravel (SM)g	Brown clayey sand with gravel (SC)g	Brown lean clay with sand (CL)s	Brown poorly-graded sand with gravel (SP)g	Brown clayey sand (SC)			
Moisture Correction								
Wet Weight of Soil + Container (g)	0.00	0.00	0.00	0.00	0.00			
Dry Weight of Soil + Container (g)	0.00	0.00	0.00	0.00	0.00			
Weight of Container (g)	1.00	1.00	1.00	1.00	1.00			
Moisture Content (%)	0.00	0.00	0.00	0.00	0.00			
Sample Dry Weight Determination								
Weight of Sample + Container (g)	769.70	1024.80	627.10	867.90	699.50			
Weight of Container (g)	108.70	99.80	108.40	107.80	108.80			
Weight of Dry Sample (g)	661.00	925.00	518.70	760.10	590.70			
Container No.:								
After Wash								
Method (A or B)	A	A	A	A	A			
Dry Weight of Sample + Cont. (g)	584.00	740.30	205.10	834.20	442.40			
Weight of Container (g)	108.70	99.80	108.40	107.80	108.80			
Dry Weight of Sample (g)	475.30	640.50	96.70	726.40	333.60			
% Passing No. 200 Sieve	28.1	30.8	81.4	4.4	43.5			
% Retained No. 200 Sieve	71.9	69.2	18.6	95.6	56.5			
 Leighton	PERCENT PASSING No. 200 SIEVE ASTM D 1140				Project Name: <u>WLC/Orange FS 1</u>			
					Project No.: <u>12482.001</u>			
					Client Name: _____			
					Tested By: <u>S. Felter</u>		Date: <u>08/19/19</u>	



**PARTICLE-SIZE DISTRIBUTION (GRADATION)
of SOILS USING SIEVE ANALYSIS
ASTM D 6913**

Project Name: WLC/Orange FS 1

Tested By: S. Felter Date: 08/19/19

Project No.: 12482.001

Checked By: G. Bathala Date: 09/06/19

Boring No.: LB-4

Depth (feet): 15.0

Sample No.: R-4

Soil Identification: Brown well-graded gravel with silt and sand (GW-GM)s

		Moisture Content of Total Air - Dry Soil	
Container No.:	A-15	Wt. of Air-Dry Soil + Cont. (g)	0.0
Wt. of Air-Dried Soil + Cont.(g)	893.6	Wt. of Dry Soil + Cont. (g)	0.0
Wt. of Container (g)	107.2	Wt. of Container No._____ (g)	1.0
Dry Wt. of Soil (g)	786.4	Moisture Content (%)	0.0

After Wet Sieve	Container No.	A-15
	Wt. of Dry Soil + Container (g)	842.9
	Wt. of Container (g)	107.2
	Dry Wt. of Soil Retained on # 200 Sieve (g)	735.7

U. S. Sieve Size		Cumulative Weight Dry Soil Retained (g)	Percent Passing (%)
(in.)	(mm.)		
1 1/2"	37.5	0.0	100.0
1"	25.0	59.8	92.4
3/4"	19.0	112.3	85.7
1/2"	12.5	250.7	68.1
3/8"	9.5	324.1	58.8
#4	4.75	453.6	42.3
#8	2.36	548.3	30.3
#16	1.18	612.3	22.1
#30	0.600	665.1	15.4
#50	0.300	704.4	10.4
#100	0.150	723.1	8.0
#200	0.075	735.1	6.5
PAN			

GRAVEL: **58 %**

SAND: **35 %**

FINES: **7 %**

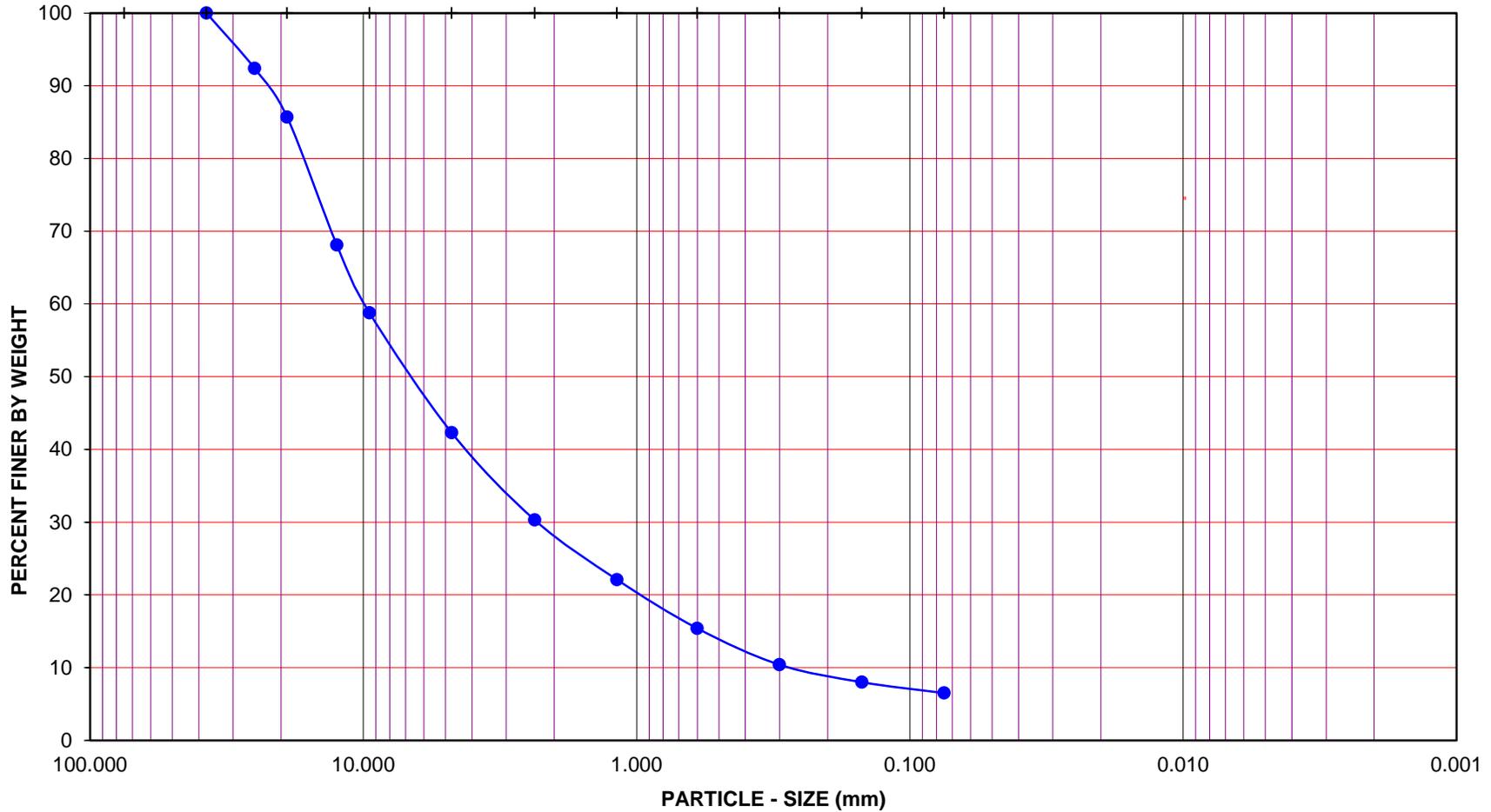
GROUP SYMBOL: **(GW-GM)s**

Cu = D60/D10 = 35.71

Cc = (D30)²/(D60*D10) = 2.06

Remarks: _____

GRAVEL				SAND						FINES		
COARSE		FINE		COARSE	MEDIUM	FINE		SILT		CLAY		
U.S. STANDARD SIEVE OPENING				U.S. STANDARD SIEVE NUMBER						HYDROMETER		
3.0"	1 1/2"	3/4"	3/8"	#4	#8	#16	#30	#50	#100	#200		



Project Name: WLC/Orange FS 1

Project No.: 12482.001

Boring No.: LB-4

Sample No.: R-4

Depth (feet): 15.0

Soil Type : (GW-GM)s

Soil Identification: Brown well-graded gravel with silt and sand (GW-GM)s

GR:SA:FI : (%) **58 : 35 : 7**

sep-19



Leighton

**PARTICLE - SIZE
DISTRIBUTION
ASTM D 6913**



ATTERBERG LIMITS

ASTM D 4318

Project Name: WLC/Orange FS 1 Tested By: S. Felter Date: 08/20/19
 Project No. : 12482.001 Input By: G. Bathala Date: 09/06/19
 Boring No.: LB-4 Checked By: G. Bathala
 Sample No.: R-7 Depth (ft.) 40.0
 Soil Identification: Brown lean clay with sand (CL)s

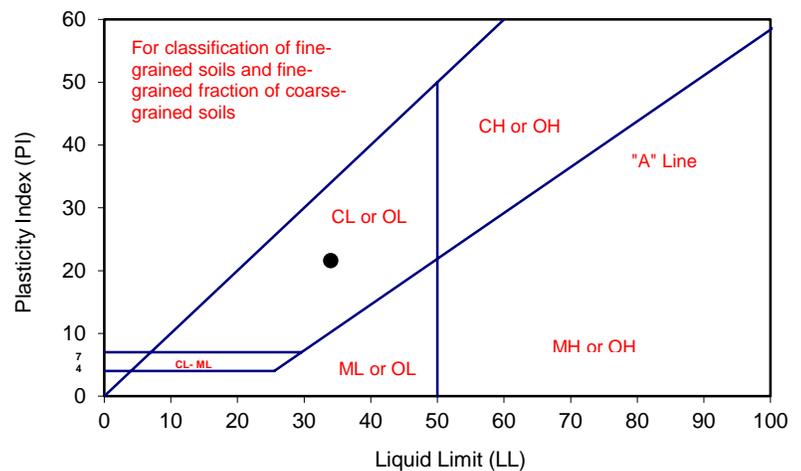
TEST NO.	PLASTIC LIMIT		LIQUID LIMIT			
	1	2	1	2	3	4
Number of Blows [N]			34	27	18	
Wet Wt. of Soil + Cont. (g)	10.19	10.14	20.91	20.14	21.78	
Dry Wt. of Soil + Cont. (g)	9.17	9.16	16.08	15.40	16.37	
Wt. of Container (g)	1.09	1.10	1.03	1.10	1.12	
Moisture Content (%) [Wn]	12.62	12.16	32.09	33.15	35.48	

Liquid Limit	34
Plastic Limit	12
Plasticity Index	22
Classification	CL

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

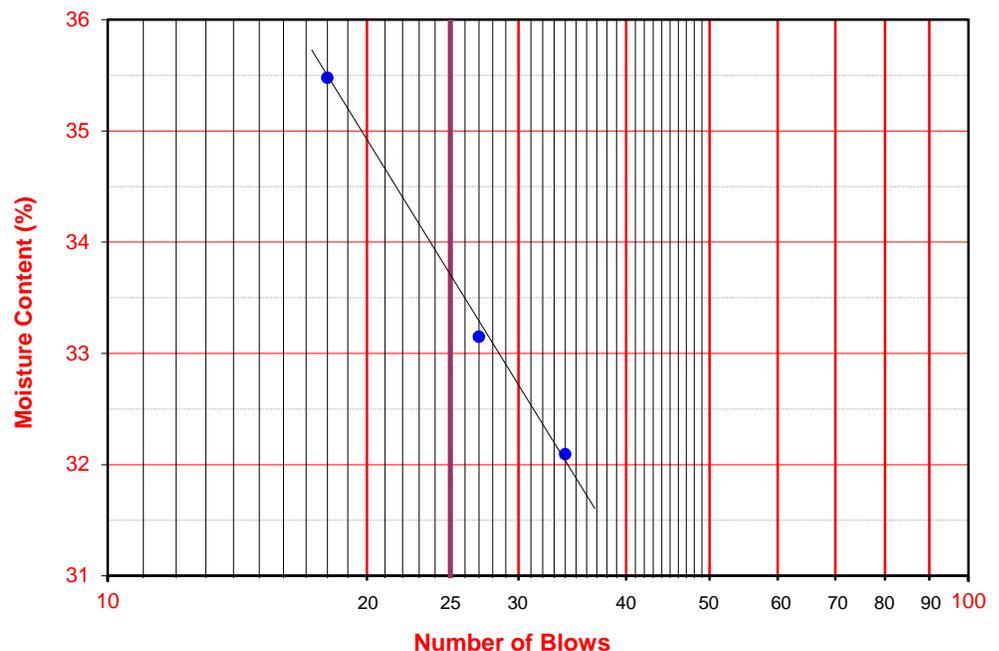
One - Point Liquid Limit Calculation

$$LL = Wn(N/25)^{0.12}$$



PROCEDURES USED

- Wet Preparation Multipoint - Wet
- Dry Preparation Multipoint - Dry
- Procedure A Multipoint Test
- Procedure B One-point Test





ATTERBERG LIMITS

ASTM D 4318

Project Name: WLC/Orange FS 1 Tested By: S. Felter Date: 08/20/19
 Project No. : 12482.001 Input By: G. Bathala Date: 09/06/19
 Boring No.: LB-6 Checked By: G. Bathala
 Sample No.: R-1 Depth (ft.) 2.5
 Soil Identification: Brown clayey sand (SC)

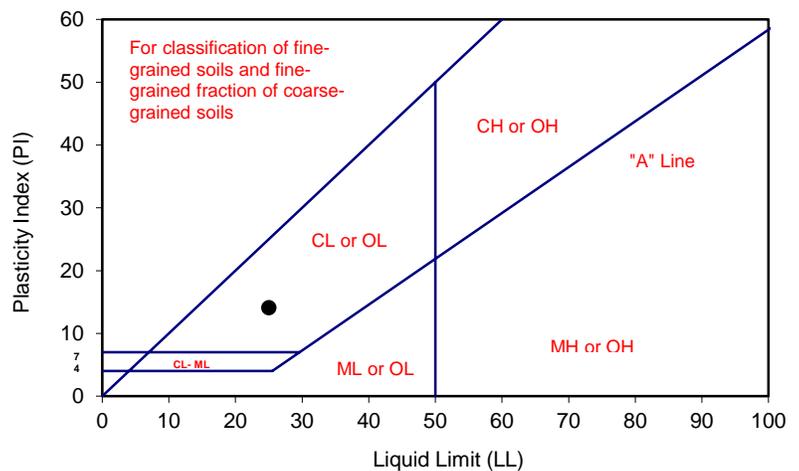
TEST NO.	PLASTIC LIMIT		LIQUID LIMIT			
	1	2	1	2	3	4
Number of Blows [N]			30	22	17	
Wet Wt. of Soil + Cont. (g)	10.14	10.15	22.28	22.14	21.95	
Dry Wt. of Soil + Cont. (g)	9.26	9.25	18.19	17.92	17.65	
Wt. of Container (g)	1.11	1.11	1.12	1.14	1.10	
Moisture Content (%) [Wn]	10.80	11.06	23.96	25.15	25.98	

Liquid Limit	25
Plastic Limit	11
Plasticity Index	14
Classification	CL

PI at "A" - Line = $0.73(LL-20)$ 3.65

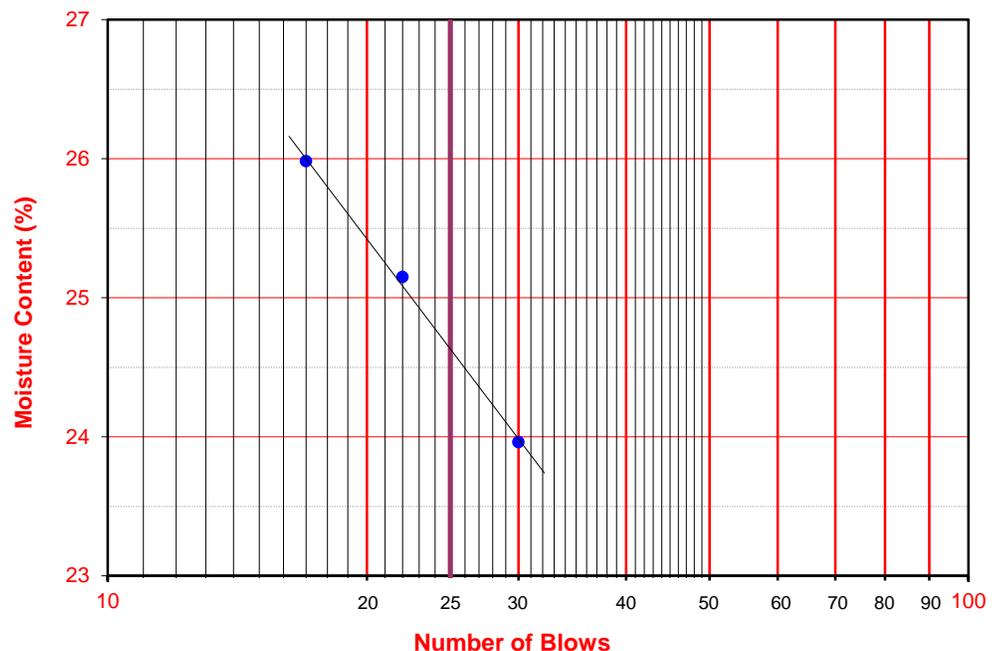
One - Point Liquid Limit Calculation

$$LL = Wn(N/25)^{0.12}$$



PROCEDURES USED

- Wet Preparation Multipoint - Wet
- Dry Preparation Multipoint - Dry
- Procedure A Multipoint Test
- Procedure B One-point Test





EXPANSION INDEX of SOILS
ASTM D 4829

Project Name: WLC/Orange FS 1 Tested By: S. Felter Date: 09/05/19
 Project No.: 12482.001 Checked By: G. Bathala Date: 09/06/19
 Boring No.: LB-1 Depth (ft.): 0-5
 Sample No.: B-1
 Soil Identification: Brown poorly-graded sand with silt (SP-SM)

Dry Wt. of Soil + Cont.	(g)	1000.00
Wt. of Container No.	(g)	0.00
Dry Wt. of Soil	(g)	1000.00
Weight Soil Retained on #4 Sieve		0.00
Percent Passing # 4		100.00

MOLDED SPECIMEN	Before Test	After Test
Specimen Diameter (in.)	4.01	4.01
Specimen Height (in.)	1.0000	1.0010
Wt. Comp. Soil + Mold (g)	610.00	436.98
Wt. of Mold (g)	191.60	0.00
Specific Gravity (Assumed)	2.70	2.70
Container No.	0	0
Wet Wt. of Soil + Cont. (g)	842.70	628.58
Dry Wt. of Soil + Cont. (g)	780.30	579.04
Wt. of Container (g)	0.00	191.60
Moisture Content (%)	8.00	12.79
Wet Density (pcf)	126.2	131.7
Dry Density (pcf)	116.9	116.8
Void Ratio	0.443	0.444
Total Porosity	0.307	0.307
Pore Volume (cc)	63.5	63.7
Degree of Saturation (%) [S _{meas}]	48.8	77.8

SPECIMEN INUNDATION in distilled water for the period of 24 h or expansion rate < 0.0002 in./h

Date	Time	Pressure (psi)	Elapsed Time (min.)	Dial Readings (in.)
09/05/19	7:57	1.0	0	0.4670
09/05/19	8:07	1.0	10	0.4670
Add Distilled Water to the Specimen				
09/05/19	14:02	1.0	355	0.4680
09/06/19	6:28	1.0	1341	0.4680
09/06/19	7:44	1.0	1417	0.4680

Expansion Index (EI _{meas}) = ((Final Rdg - Initial Rdg) / Initial Thick.) x 1000	1
---	----------



**TESTS for SULFATE CONTENT
CHLORIDE CONTENT and pH of SOILS**

Project Name: WLC/Orange FS 1 Tested By : GEB/GB Date: 09/04/19
 Project No. : 12482.001 Input By: G. Bathala Date: 09/06/19

Boring No.	LB-3			
Sample No.	B-1			
Sample Depth (ft)	0-5			
Soil Identification: Olive brown (SC-SM)g				
Wet Weight of Soil + Container (g)	130.22			
Dry Weight of Soil + Container (g)	126.87			
Weight of Container (g)	39.58			
Moisture Content (%)	3.84			
Weight of Soaked Soil (g)	100.10			

SULFATE CONTENT, DOT California Test 417, Part II

Beaker No.	304			
Crucible No.	12			
Furnace Temperature (°C)	860			
Time In / Time Out	10:50/11:35			
Duration of Combustion (min)	45			
Wt. of Crucible + Residue (g)	20.7428			
Wt. of Crucible (g)	20.7384			
Wt. of Residue (g) (A)	0.0044			
PPM of Sulfate (A) x 41150	181.06			
PPM of Sulfate, Dry Weight Basis	188			

CHLORIDE CONTENT, DOT California Test 422

ml of Extract For Titration (B)	30			
ml of AgNO3 Soln. Used in Titration (C)	2.0			
PPM of Chloride (C -0.2) * 100 * 30 / B	180			
PPM of Chloride, Dry Wt. Basis	187			

pH TEST, DOT California Test 643

pH Value	7.15			
Temperature °C	20.1			



SOIL RESISTIVITY TEST

DOT CA TEST 643

Project Name: WLC/Orange FS 1

Tested By : O. Figueroa Date: 09/06/19

Project No. : 12482.001

Input By: G. Bathala Date: 09/06/19

Boring No.: LB-3

Depth (ft.) : 0-5

Sample No. : B-1

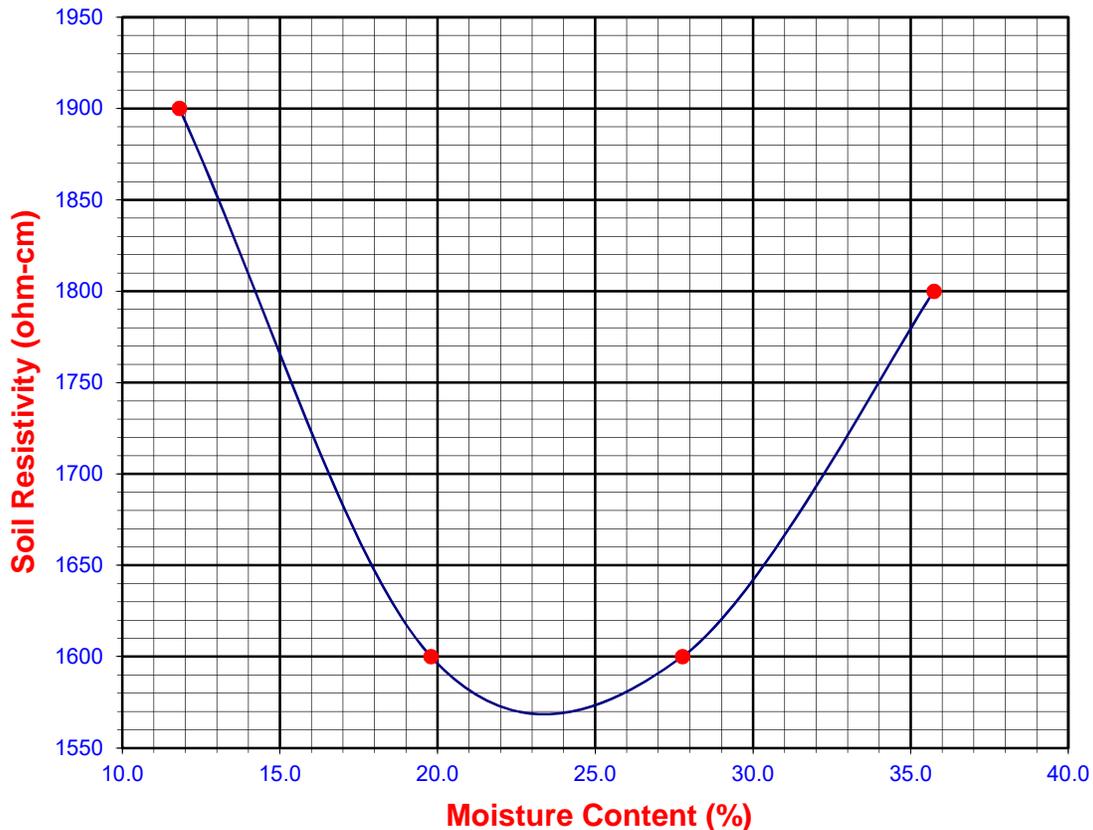
Soil Identification:* Olive brown (SC-SM)g

*California Test 643 requires soil specimens to consist only of portions of samples passing through the No. 8 US Standard Sieve before resistivity testing. Therefore, this test method may not be representative for coarser materials.

Specimen No.	Water Added (ml) (Wa)	Adjusted Moisture Content (MC)	Resistance Reading (ohm)	Soil Resistivity (ohm-cm)
1	10	11.81	1900	1900
2	20	19.79	1600	1600
3	30	27.76	1600	1600
4	40	35.74	1800	1800
5				

Moisture Content (%) (Mci)	3.84
Wet Wt. of Soil + Cont. (g)	130.22
Dry Wt. of Soil + Cont. (g)	126.87
Wt. of Container (g)	39.58
Container No.	
Initial Soil Wt. (g) (Wt)	130.20
Box Constant	1.000
$MC = (((1 + Mci/100) \times (Wa/Wt + 1)) - 1) \times 100$	

Min. Resistivity (ohm-cm)	Moisture Content (%)	Sulfate Content (ppm)	Chloride Content (ppm)	Soil pH	
				pH	Temp. (°C)
DOT CA Test 643		DOT CA Test 417 Part II		DOT CA Test 643	
1570	23.4	188	187	7.15	20.1



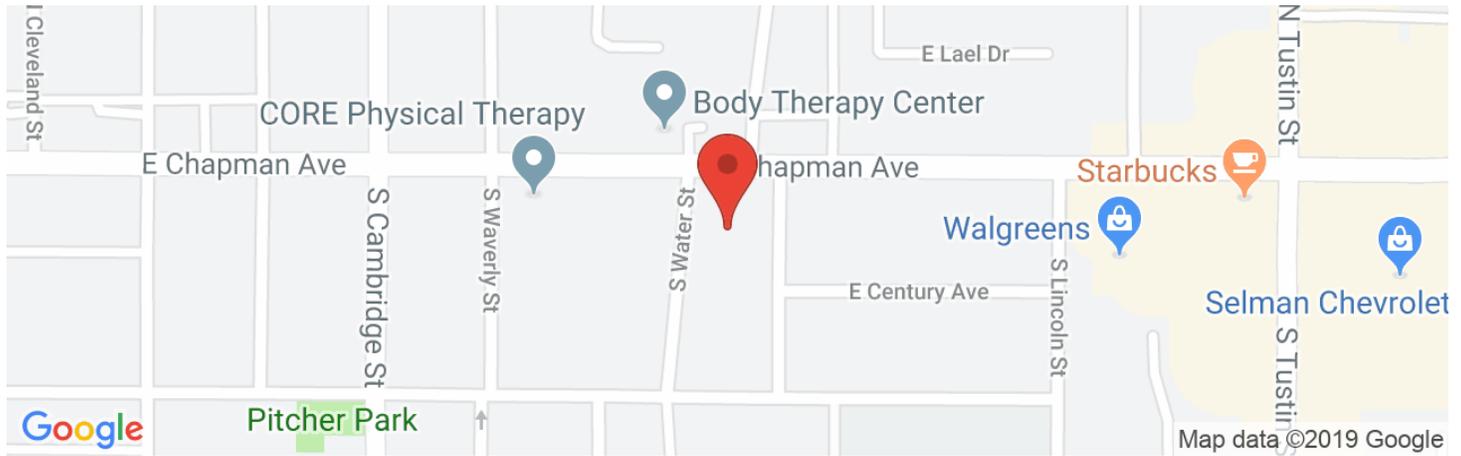
APPENDIX D
SUMMARY OF SEISMIC HAZARD ANALYSIS



Leighton



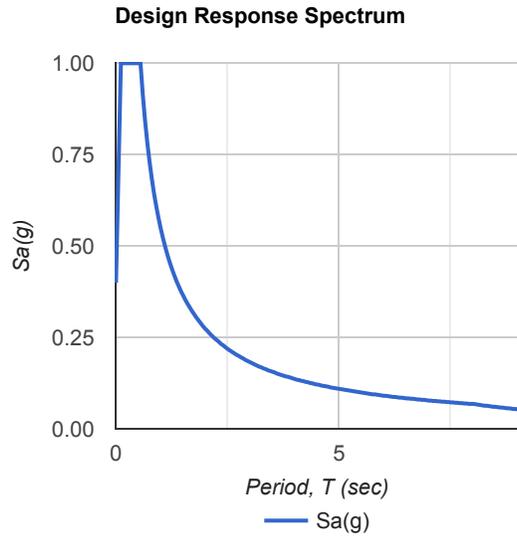
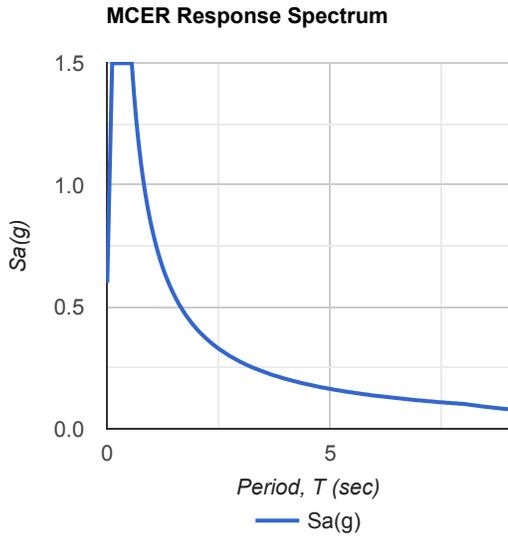
Latitude, Longitude: 33.7873345, -117.84107526



Date	8/20/2019, 11:05:16 AM
Design Code Reference Document	ASCE7-10
Risk Category	II
Site Class	D - Stiff Soil

Type	Value	Description
S_S	1.5	MCE_R ground motion. (for 0.2 second period)
S_1	0.549	MCE_R ground motion. (for 1.0s period)
S_{MS}	1.5	Site-modified spectral acceleration value
S_{M1}	0.823	Site-modified spectral acceleration value
S_{DS}	1	Numeric seismic design value at 0.2 second SA
S_{D1}	0.549	Numeric seismic design value at 1.0 second SA

Type	Value	Description
SDC	D	Seismic design category
F_a	1	Site amplification factor at 0.2 second
F_v	1.5	Site amplification factor at 1.0 second
PGA	0.515	MCE_G peak ground acceleration
F_{PGA}	1	Site amplification factor at PGA
PGA_M	0.515	Site modified peak ground acceleration
T_L	8	Long-period transition period in seconds
SsRT	1.504	Probabilistic risk-targeted ground motion. (0.2 second)
SsUH	1.443	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration
SsD	1.5	Factored deterministic acceleration value. (0.2 second)
S1RT	0.549	Probabilistic risk-targeted ground motion. (1.0 second)
S1UH	0.511	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration.
S1D	0.6	Factored deterministic acceleration value. (1.0 second)
PGAd	0.515	Factored deterministic acceleration value. (Peak Ground Acceleration)
C_{RS}	1.042	Mapped value of the risk coefficient at short periods
C_{R1}	1.073	Mapped value of the risk coefficient at a period of 1 s



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Unified Hazard Tool



Please do not use this tool to obtain ground motion parameter values for the design code reference documents covered by the [U.S. Seismic Design Maps web tools](#) (e.g., the International Building Code and the ASCE 7 or 41 Standard). The values returned by the two applications are not identical.

^ Input

Edition

Spectral Period

Latitude

Decimal degrees

Time Horizon

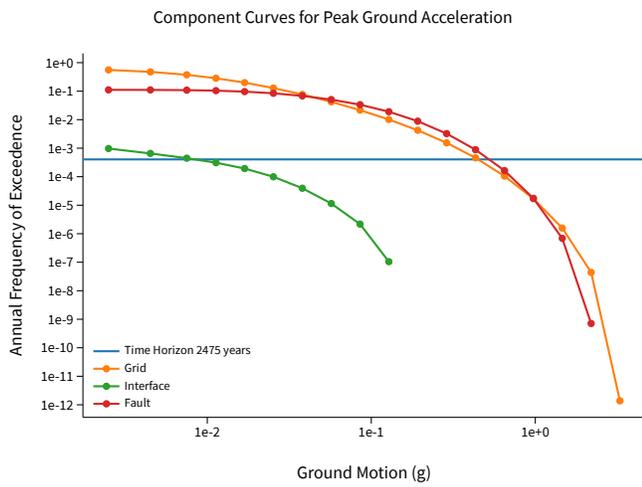
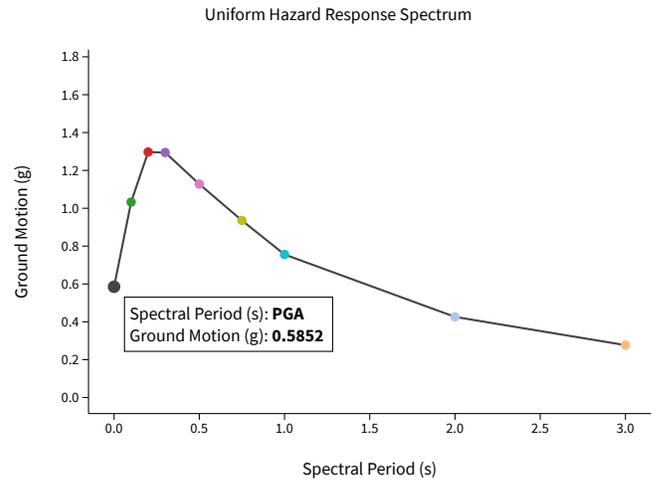
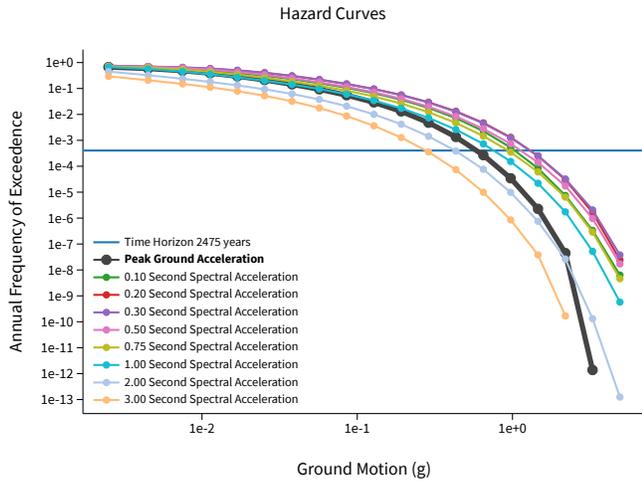
Return period in years

Longitude

Decimal degrees, negative values for western longitudes

Site Class

^ Hazard Curve

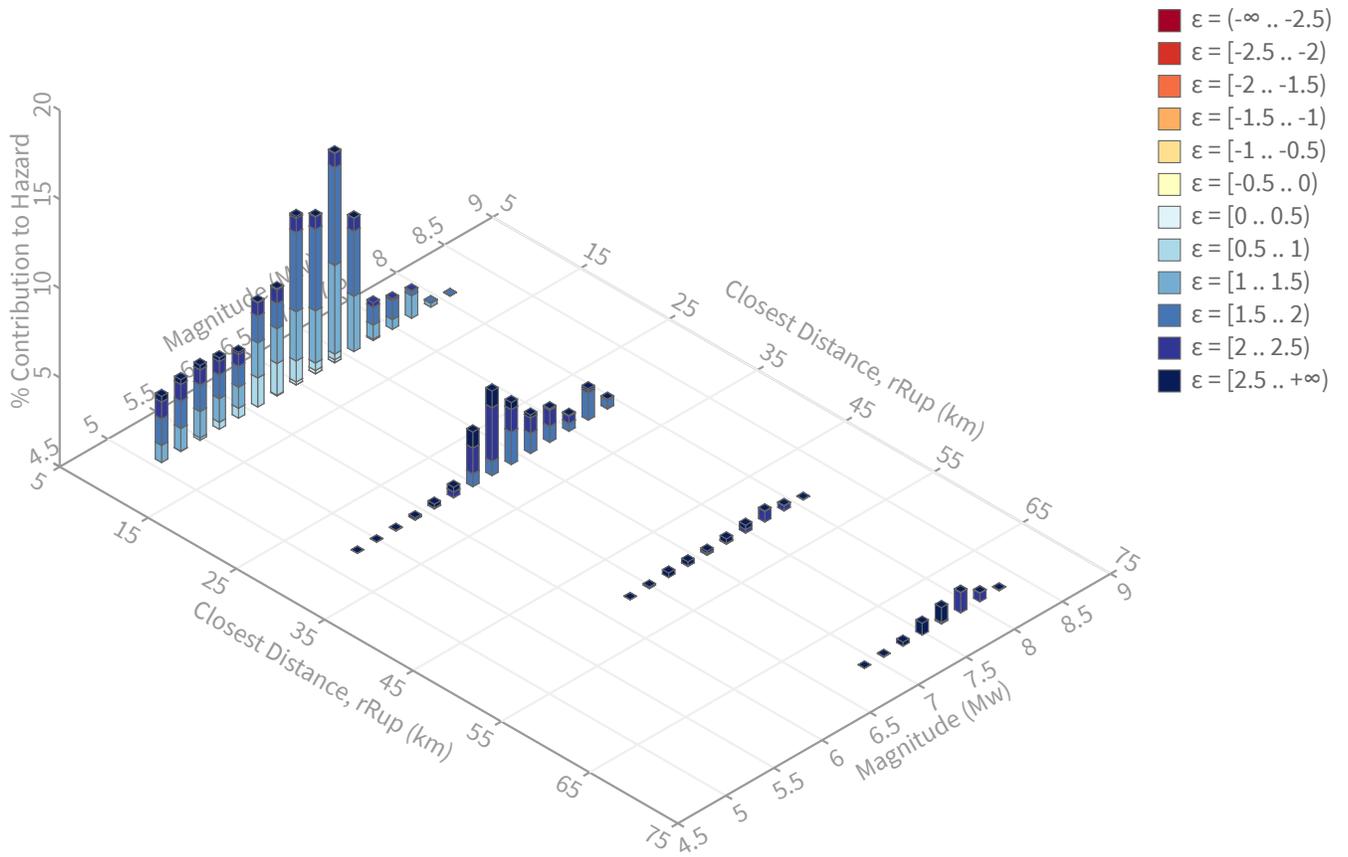


[View Raw Data](#)

^ Deaggregation

Component

Total



Summary statistics for, Deaggregation: Total

Deaggregation targets

Return period: 2475 yrs

Exceedance rate: 0.0004040404 yr⁻¹

PGA ground motion: 0.58520247 g

Recovered targets

Return period: 3014.5434 yrs

Exceedance rate: 0.0003317252 yr⁻¹

Totals

Binned: 100 %

Residual: 0 %

Trace: 0.05 %

Mean (over all sources)

m: 6.59

r: 17.19 km

ε₀: 1.72 σ

Mode (largest m-r bin)

m: 6.9

r: 12.83 km

ε₀: 1.53 σ

Contribution: 11.76 %

Mode (largest m-r-ε₀ bin)

m: 6.91

r: 14.52 km

ε₀: 1.68 σ

Contribution: 5.48 %

Discretization

r: min = 0.0, max = 1000.0, Δ = 20.0 km

m: min = 4.4, max = 9.4, Δ = 0.2

ε: min = -3.0, max = 3.0, Δ = 0.5 σ

Epsilon keys

ε₀: [-∞ .. -2.5)

ε₁: [-2.5 .. -2.0)

ε₂: [-2.0 .. -1.5)

ε₃: [-1.5 .. -1.0)

ε₄: [-1.0 .. -0.5)

ε₅: [-0.5 .. 0.0)

ε₆: [0.0 .. 0.5)

ε₇: [0.5 .. 1.0)

ε₈: [1.0 .. 1.5)

ε₉: [1.5 .. 2.0)

ε₁₀: [2.0 .. 2.5)

ε₁₁: [2.5 .. +∞]

Deaggregation Contributors

Source Set ↘ Source	Type	r	m	ϵ_0	lon	lat	az	%
bFault.ch	Fault							20.70
San Joaquin Hills		11.07	6.98	1.32	117.823°W	33.688°N	171.39	4.92
Puente Hills (Coyote Hills)		12.13	6.71	1.50	117.921°W	33.871°N	321.86	3.90
Puente Hills		16.48	7.06	1.56	117.867°W	33.927°N	351.14	1.89
Chino - alt 1		17.21	6.54	2.03	117.648°W	33.907°N	53.14	1.67
Chino - alt 2		20.12	6.70	1.97	117.629°W	33.886°N	60.81	1.43
bFault.gr	Fault							14.58
San Joaquin Hills		11.19	6.74	1.43	117.823°W	33.688°N	171.39	4.58
Puente Hills (Coyote Hills)		12.13	6.61	1.55	117.921°W	33.871°N	321.86	2.68
Puente Hills		18.62	6.81	1.84	117.867°W	33.927°N	351.14	1.11
Chino - alt 1		17.21	6.49	2.04	117.648°W	33.907°N	53.14	1.01
CAmap.21.ch.in (opt)	Grid							13.08
PointSourceFinite: -117.841, 33.828		6.75	5.76	1.28	117.841°W	33.828°N	0.00	1.08
PointSourceFinite: -117.841, 33.819		6.21	5.73	1.21	117.841°W	33.819°N	0.00	1.04
PointSourceFinite: -117.841, 33.837		7.32	5.79	1.35	117.841°W	33.837°N	0.00	1.03
CAmap.24.ch.in (opt)	Grid							13.04
PointSourceFinite: -117.841, 33.828		6.75	5.76	1.28	117.841°W	33.828°N	0.00	1.08
PointSourceFinite: -117.841, 33.819		6.21	5.73	1.21	117.841°W	33.819°N	0.00	1.04
PointSourceFinite: -117.841, 33.837		7.32	5.79	1.35	117.841°W	33.837°N	0.00	1.03
aFault_aPriori_D2.1	Fault							12.03
Elsinore : W		13.90	6.96	1.73	117.792°W	33.907°N	18.74	3.63
Elsinore : GI		23.65	6.82	2.13	117.590°W	33.829°N	78.66	2.62
Elsinore : GI+T		23.65	7.26	1.96	117.590°W	33.829°N	78.66	1.85
Elsinore : GI+T+J+CM		23.65	7.74	1.74	117.590°W	33.829°N	78.66	1.02
aFault_MoBal	Fault							11.61
Elsinore : W		13.90	6.94	1.74	117.792°W	33.907°N	18.74	5.31
Elsinore : GI		23.65	6.79	2.14	117.590°W	33.829°N	78.66	1.53
CAmap.21.gr.in (opt)	Grid							6.38
CAmap.24.gr.in (opt)	Grid							6.27
aFault_unseg	Fault							2.28
Elsinore		15.43	7.48	1.54	117.792°W	33.907°N	18.74	2.14

Determination of Site Class and Estimation of Shear Wave Velocity

Project: 12482.001

Depth (ft)	di, Layer Thick (ft)	Field Blow Counts, Ni Corrected for Cs and sampler type Blows per foot (bpf)	Average Ni (bpf)	Ni Hammer Corr:	di / Ni
		LB-4		1.3	
3	4	14	14	18	0.22
5	3.5	30	30	39	0.09
10	5	32	32	42	0.12
15	5	52	52	68	0.07
20	5	52	52	68	0.07
25	5	90	90	100	0.05
30	5	52	52	68	0.07
35	5	33	33	43	0.12
40	5	15	15	20	0.26
45	5	90	90	100	0.05
50	7.5	30	30	39	0.19
60	10	40 Assumed	40	52	0.19
70	10	40	40	52	0.19
80	15	40	40	52	0.29
100	10	40	40	52	0.19
Summation	100				2.18
Navg = Sum(di) / Sum(di / Ni) =					46

Extract of ASCE 7-10 Table 20.3-1 Site Classification (2016 CBC 1613A.3.2):

Site Class	Soil Profile Name	Avg. N upper 100'		Vs30 (ft/sec)		Vs30 (m/s)		Site Avg N	Interpolated vs30 (ft/s)
		from	to	from	to	from	to		
A	Hard Rock	-	-	5000	10000	1524	3048	46	1128
B	Rock	-	-	2500	5000	762	1524		
C	VD soil & soft rock	50.001	100	1200	2500	366	762		
D	Stiff Soil	15	50	600	1200	183	366		
E	Soft Soil	0	14.999	0	600	0	183		
F		-	-			0	0		

Site class, Table 20.3-1: **D**

Liquefaction Susceptibility Analysis: SPT Method

Based on Youd and Idriss (2001), Martin and Lew (1999).

Project: 12482
 Project No.: Proposed Fire Station 1

Leighton

General Boring Information:

Boring No.	Existing GW Depth (ft)	Design GW Depth (ft)	Design Fill Height (ft)	Ground Surface Elev (ft)
LB-1	100	100	0	211
LB-3	100	100	0	211
LB-4	100	100	0	211
LB-5	100	100	0	211

General Parameters:	
$a_{max} = 0.51g$	MCE
$M_w = 6.9$	(Idriss, 2001)
MSF eq: 1	
MSF = 1.24	
Hammer Efficiency = 83	%
$C_E = 1.38$	
$C_B = 1$	
$C_{S(SPT)} = 1.2$	
$C_{S(ring)} = 1$	
Rod Stickup (feet) = 3	
Ring sample correction = 0.65	

Summary of Liquefaction Susceptibility Analysis: SPT Method

Liquefaction Method: Youd and Idriss (2001). Seismic Settlement Method: Tokimatsu and Seed (1987) and Martin and Lew (1999).

Project: 12482

Project No.: Proposed Fire Station 1

Leighton

Boring No.	Approx. Layer Depth (ft)	SPT Depth (ft)	Approx Layer Thickness (ft)	Plasticity ("n"=non susc. to liq.)	Estimated Fines Cont (%)	γ_t (pcf)	N_m or B (blows/ft)	Sampler Type (enter 2 if mod CA Ring)	C_s	N_m (corrected for C_s and ring->SPT) (blows/ft)	Exist σ_{vo}' (psf)	$(N_1)_{60}$	$(N_1)_{60CS}$	$CRR_{7.5}$	Design σ_{vo}' (psf)	$CSR_{7.5}$	CSR_M	Liquefaction Factor of Safety	$(N_1)_{60CS}$ (for Settlement) (blows/ft)	Dry Sand Strain (%) (Tok/ Seed 87)	Sat Sand Strain (%) (Tok/ Seed 87)	Seismic Sett. of Layer (in.)	Cummulative Seismic Settlement (in.)
LB-1	0 to 4	3	4		30	115	31	2	1	20.2	345	35.5	45.7	>Range	345	0.33	0.27	NonLiq	45.7	0.01		0.00	0.0
LB-1	4 to 8	5	4		30	125	43	2	1	28.0	585	49.3	61.6	>Range	585	0.33	0.26	NonLiq	61.6	0.01		0.00	0.0
LB-1	8 to 13	10	5		10	125	80	2	1	52.0	1210	80.3	82.9	>Range	1210	0.32	0.26	NonLiq	82.9	0.01		0.00	0.0
LB-1	13 to 18	15	5		10	125	80	2	1	52.0	1835	65.2	67.5	>Range	1835	0.32	0.26	NonLiq	67.5	0.01		0.01	0.0
LB-1	18 to 22	20	5		10	125	80	1	1.2	96.0	2460	116.2	119.6	>Range	2460	0.32	0.26	NonLiq	119.6	0.01		0.00	0.0
LB-3	0 to 4	3	4		28	115	12	2	1	7.8	345	13.8	20.2	0.218	345	0.33	0.27	NonLiq	20.2	0.05		0.02	0.1
LB-3	4 to 7	5	3		28	125	26	2	1	16.9	585	29.8	38.5	>Range	585	0.33	0.26	NonLiq	38.5	0.03		0.01	0.0
LB-3	7 to 9	8	3		5	125	33	2	1	21.5	960	35.0	35.0	>Range	960	0.33	0.26	NonLiq	35.0	0.04		0.01	0.0
LB-3	9 to 13	10	4		5	125	50	2	1	32.5	1210	50.2	50.2	>Range	1210	0.32	0.26	NonLiq	50.2	0.01		0.00	0.0
LB-3	13 to 18	15	5		10	120	80	2	1	52.0	1823	65.4	67.7	>Range	1822.5	0.32	0.26	NonLiq	67.7	0.01		0.01	0.0
LB-3	18 to 22	20	5		10	120	80	1	1.2	96.0	2423	117.1	120.5	>Range	2422.5	0.32	0.26	NonLiq	120.5	0.01		0.00	0.0
LB-4	0 to 4	3	4		30	120	21	2	1	13.7	360	24.1	32.5	>Range	360	0.33	0.27	NonLiq	32.5	0.02		0.01	0.2
LB-4	4 to 8	5	4		10	130	47	2	1	30.6	610	53.9	55.9	>Range	610	0.33	0.26	NonLiq	55.9	0.01		0.00	0.2
LB-4	8 to 13	10	5		31	125	50	2	1	32.5	1248	49.4	62.2	>Range	1247.5	0.32	0.26	NonLiq	62.2	0.01		0.01	0.2
LB-4	13 to 18	15	5		7	115	80	2	1	52.0	1848	65.0	65.7	>Range	1847.5	0.32	0.26	NonLiq	65.7	0.01		0.01	0.2
LB-4	18 to 23	20	5		7	115	80	2	1	52.0	2423	63.4	64.1	>Range	2422.5	0.32	0.26	NonLiq	64.1	0.01		0.01	0.2
LB-4	23 to 28	25	5		7	120	80	1	1.2	96.0	3010	105.1	106.1	>Range	3010	0.31	0.25	NonLiq	106.1	0.01		0.01	0.2
LB-4	28 to 33	30	5		7	120	80	2	1	52.0	3610	54.7	55.3	>Range	3610	0.31	0.25	NonLiq	55.3	0.01		0.01	0.1
LB-4	33 to 38	35	5		80	125	28	1	1.2	33.6	4223	32.7	44.2	>Range	4222.5	0.29	0.24	NonLiq	44.2	0.02		0.01	0.1
LB-4	38 to 43	40	5		80	125	24	2	1	15.6	4848	14.2	22.0	0.242	4847.5	0.28	0.23	NonLiq	22.0	0.15		0.09	0.1
LB-4	43 to 48	45	5		10	125	80	1	1.2	96.0	5473	82.0	84.7	>Range	5472.5	0.27	0.22	NonLiq	84.7	0.01		0.01	0.0
LB-4	48 to 52	50	5		80	130	47	2	1	30.6	6110	24.7	34.6	>Range	6110	0.25	0.21	NonLiq	34.6	0.06		0.03	0.0
LB-5	0 to 4	3	4		5	125	59	2	1	38.4	375	67.6	67.6	>Range	375	0.33	0.27	NonLiq	67.6	0.00		0.00	0.0
LB-5	4 to 8	5	4		5	120	80	2	1	52.0	620	91.7	91.7	>Range	620	0.33	0.26	NonLiq	91.7	0.00		0.00	0.0
LB-5	8 to 13	10	5		5	120	80	2	1	52.0	1220	80.0	80.0	>Range	1220	0.32	0.26	NonLiq	80.0	0.01		0.01	0.0
LB-5	13 to 18	15	5		8	125	80	2	1	52.0	1833	65.3	66.4	>Range	1832.5	0.32	0.26	NonLiq	66.4	0.01		0.01	0.0
LB-5	18 to 22	20	5		8	125	80	1	1.2	96.0	2458	116.3	118.1	>Range	2457.5	0.32	0.26	NonLiq	118.1	0.01		0.00	0.0

EQ Search WLC Orange FS1

```
*****  
*                               *  
*   E Q S E A R C H           *  
*                               *  
*   Versi on 3.00             *  
*                               *  
*****
```

ESTIMATION OF
PEAK ACCELERATION FROM
CALIFORNIA EARTHQUAKE CATALOGS

JOB NUMBER: 12482.001

DATE: 08-21-2019

JOB NAME: WLC Orange FS1

EARTHQUAKE-CATALOG-FILE NAME: ALLQUAKE.DAT

MAGNITUDE RANGE:

MINIMUM MAGNITUDE: 5.00
MAXIMUM MAGNITUDE: 9.00

SITE COORDINATES:

SITE LATITUDE: 33.7873
SITE LONGITUDE: 117.8411

SEARCH DATES:

START DATE: 1800
END DATE: 1999

SEARCH RADIUS:

60.0 mi
96.6 km

ATTENUATION RELATION: 20) Sadigh et al. (1997) Horiz. - Soil

UNCERTAINTY (M=Median, S=Sigma): M Number of Sigmas: 0.0

ASSUMED SOURCE TYPE: DS [SS=Strike-slip, DS=Reverse-slip, BT=Blind-thrust]

SCOND: 0 Depth Source: A

Basement Depth: 5.00 km Campbell SSR: Campbell SHR:

COMPUTE PEAK HORIZONTAL ACCELERATION

MINIMUM DEPTH VALUE (km): 0.0

EQ Search WLC Orange FS1

EARTHQUAKE SEARCH RESULTS

Page 1

FILE CODE	LAT. NORTH	LONG. WEST	DATE	TIME (UTC)	DEPTH (km)	QUAKE MAG.	SITE ACC. g	SITE MM INT.	APPROX. DI STANCE	
				H M Sec					mi	[km]
DMG	33. 6170	117. 9670	03/11/1933	154 7. 8	0. 0	6. 30	0. 160	V I I	13. 8	(22. 2)
MGI	33. 8000	117. 6000	04/22/1918	2115 0. 0	0. 0	5. 00	0. 057	V I	13. 9	(22. 3)
DMG	33. 6830	118. 0500	03/11/1933	658 3. 0	0. 0	5. 50	0. 084	V I I	14. 0	(22. 5)
DMG	33. 7500	118. 0830	03/11/1933	323 0. 0	0. 0	5. 00	0. 055	V I	14. 1	(22. 7)
DMG	33. 7500	118. 0830	03/11/1933	230 0. 0	0. 0	5. 10	0. 060	V I	14. 1	(22. 7)
DMG	33. 7500	118. 0830	03/11/1933	910 0. 0	0. 0	5. 10	0. 060	V I	14. 1	(22. 7)
DMG	33. 7500	118. 0830	03/13/1933	131828. 0	0. 0	5. 30	0. 071	V I	14. 1	(22. 7)
DMG	33. 7500	118. 0830	03/11/1933	2 9 0. 0	0. 0	5. 00	0. 055	V I	14. 1	(22. 7)
DMG	33. 7000	118. 0670	03/11/1933	85457. 0	0. 0	5. 10	0. 059	V I	14. 3	(23. 0)
DMG	33. 7000	118. 0670	03/11/1933	51022. 0	0. 0	5. 10	0. 059	V I	14. 3	(23. 0)
DMG	33. 6170	118. 0170	03/14/1933	19 150. 0	0. 0	5. 10	0. 054	V I	15. 5	(24. 9)
DMG	33. 7830	118. 1330	10/02/1933	91017. 6	0. 0	5. 40	0. 063	V I	16. 7	(27. 0)
DMG	33. 5750	117. 9830	03/11/1933	518 4. 0	0. 0	5. 20	0. 054	V I	16. 8	(27. 0)
MGI	34. 0000	118. 0000	12/25/1903	1745 0. 0	0. 0	5. 00	0. 044	V I	17. 3	(27. 8)
DMG	33. 6990	117. 5110	05/31/1938	83455. 4	10. 0	5. 50	0. 056	V I	19. 9	(32. 0)
PAS	34. 0610	118. 0790	10/01/1987	144220. 0	9. 5	5. 90	0. 065	V I	23. 3	(37. 5)
DMG	33. 7830	118. 2500	11/14/1941	84136. 3	0. 0	5. 40	0. 042	V I	23. 5	(37. 8)
MGI	34. 0000	117. 5000	12/16/1858	10 0 0. 0	0. 0	7. 00	0. 141	V I I I	24. 4	(39. 3)
PAS	34. 0730	118. 0980	10/04/1987	105938. 2	8. 2	5. 30	0. 036	V	24. 6	(39. 6)
DMG	33. 8500	118. 2670	03/11/1933	1425 0. 0	0. 0	5. 00	0. 027	V	24. 8	(39. 9)
GSP	34. 1400	117. 7000	02/28/1990	234336. 6	5. 0	5. 20	0. 031	V	25. 7	(41. 3)
DMG	33. 7000	117. 4000	05/13/1910	620 0. 0	0. 0	5. 00	0. 026	V	26. 0	(41. 9)
DMG	33. 7000	117. 4000	05/15/1910	1547 0. 0	0. 0	6. 00	0. 062	V I	26. 0	(41. 9)
DMG	33. 7000	117. 4000	04/11/1910	757 0. 0	0. 0	5. 00	0. 026	V	26. 0	(41. 9)
MGI	34. 1000	118. 1000	07/11/1855	415 0. 0	0. 0	6. 30	0. 079	V I I	26. 2	(42. 1)
T-A	34. 0000	118. 2500	01/10/1856	0 0 0. 0	0. 0	5. 00	0. 024	I V	27. 7	(44. 5)
T-A	34. 0000	118. 2500	03/26/1860	0 0 0. 0	0. 0	5. 00	0. 024	I V	27. 7	(44. 5)
T-A	34. 0000	118. 2500	09/23/1827	0 0 0. 0	0. 0	5. 00	0. 024	I V	27. 7	(44. 5)
DMG	34. 2000	117. 9000	08/28/1889	215 0. 0	0. 0	5. 50	0. 035	V	28. 7	(46. 2)
MGI	34. 0000	118. 3000	09/03/1905	540 0. 0	0. 0	5. 30	0. 028	V	30. 1	(48. 5)
MGI	34. 0800	118. 2600	07/16/1920	18 8 0. 0	0. 0	5. 00	0. 020	I V	31. 4	(50. 5)
GSP	34. 2620	118. 0020	06/28/1991	144354. 5	11. 0	5. 40	0. 025	V	34. 0	(54. 8)
DMG	34. 0000	117. 2500	07/23/1923	73026. 0	0. 0	6. 25	0. 049	V I	36. 9	(59. 4)
DMG	34. 2700	117. 5400	09/12/1970	143053. 0	8. 0	5. 40	0. 022	I V	37. 5	(60. 4)
DMG	33. 9000	117. 2000	12/19/1880	0 0 0. 0	0. 0	6. 00	0. 038	V	37. 6	(60. 5)
MGI	34. 1000	117. 3000	07/15/1905	2041 0. 0	0. 0	5. 30	0. 020	I V	37. 8	(60. 8)
DMG	34. 3000	117. 6000	07/30/1894	512 0. 0	0. 0	6. 00	0. 038	V	38. 0	(61. 1)
DMG	34. 2000	117. 4000	07/22/1899	046 0. 0	0. 0	5. 50	0. 024	I V	38. 1	(61. 3)
DMG	34. 3000	117. 5000	07/22/1899	2032 0. 0	0. 0	6. 50	0. 054	V I	40. 4	(65. 0)
MGI	34. 0000	118. 5000	11/19/1918	2018 0. 0	0. 0	5. 00	0. 014	I V	40. 5	(65. 2)
DMG	34. 0000	118. 5000	08/04/1927	1224 0. 0	0. 0	5. 00	0. 014	I V	40. 5	(65. 2)
DMG	34. 3700	117. 6500	12/08/1812	15 0 0. 0	0. 0	7. 00	0. 076	V I I	41. 7	(67. 1)
PAS	33. 9190	118. 6270	01/19/1989	65328. 8	11. 9	5. 00	0. 011	I I I	46. 0	(74. 0)

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EQ Search WLC Orange FS1

DMG	33. 9500	118. 6320	08/31/1930	04036. 0	0. 0	5. 20	0. 013	III	46. 7(75. 2)
GSP	34. 2310	118. 4750	03/20/1994	212012. 3	13. 0	5. 30	0. 014	IV	47. 5(76. 4)
DMG	33. 8000	117. 0000	12/25/1899	1225 0. 0	0. 0	6. 40	0. 039	V	48. 3(77. 7)
DMG	33. 7500	117. 0000	04/21/1918	223225. 0	0. 0	6. 80	0. 054	VI	48. 3(77. 8)
DMG	33. 7500	117. 0000	06/06/1918	2232 0. 0	0. 0	5. 00	0. 011	III	48. 3(77. 8)
PAS	33. 9440	118. 6810	01/01/1979	231438. 9	11. 3	5. 00	0. 010	III	49. 3(79. 4)
GSP	34. 2130	118. 5370	01/17/1994	123055. 4	18. 0	6. 70	0. 048	VI	49. 5(79. 7)
DMG	34. 3080	118. 4540	02/09/1971	144346. 7	6. 2	5. 20	0. 012	III	50. 2(80. 8)
DMG	34. 2000	117. 1000	09/20/1907	154 0. 0	0. 0	6. 00	0. 025	V	51. 1(82. 2)
DMG	33. 7100	116. 9250	09/23/1963	144152. 6	16. 5	5. 00	0. 009	III	52. 9(85. 1)

EARTHQUAKE SEARCH RESULTS

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FILE CODE	LAT. NORTH	LONG. WEST	DATE	TIME (UTC) H M Sec	DEPTH (km)	QUAKE MAG.	SITE ACC. g	SITE MM INT.	APPROX. DI STANCE mi [km]
DMG	34. 4110	118. 4010	02/09/1971	141028. 0	8. 0	5. 30	0. 012	III	53. 7(86. 3)
DMG	34. 4110	118. 4010	02/09/1971	14 244. 0	8. 0	5. 80	0. 019	IV	53. 7(86. 3)
DMG	34. 4110	118. 4010	02/09/1971	14 1 8. 0	8. 0	5. 80	0. 019	IV	53. 7(86. 3)
DMG	34. 4110	118. 4010	02/09/1971	14 041. 8	8. 4	6. 40	0. 033	V	53. 7(86. 3)
DMG	34. 5190	118. 1980	08/23/1952	10 9 7. 1	13. 1	5. 00	0. 009	III	54. 5(87. 7)
GSB	34. 3010	118. 5650	01/17/1994	204602. 4	9. 0	5. 20	0. 011	III	54. 5(87. 7)
GSP	34. 3050	118. 5790	01/29/1994	112036. 0	1. 0	5. 10	0. 010	III	55. 3(89. 0)
DMG	34. 3000	118. 6000	04/04/1893	1940 0. 0	0. 0	6. 00	0. 022	IV	56. 0(90. 1)
PAS	32. 9710	117. 8700	07/13/1986	1347 8. 2	6. 0	5. 30	0. 011	III	56. 4(90. 7)
DMG	33. 9500	116. 8500	09/28/1946	719 9. 0	0. 0	5. 00	0. 008	III	57. 9(93. 2)
DMG	34. 1800	116. 9200	01/16/1930	034 3. 6	0. 0	5. 10	0. 009	III	59. 3(95. 4)
DMG	34. 1800	116. 9200	01/16/1930	02433. 9	0. 0	5. 20	0. 009	III	59. 3(95. 4)
DMG	34. 2670	116. 9670	08/29/1943	34513. 0	0. 0	5. 50	0. 012	III	60. 0(96. 5)

-END OF SEARCH- 66 EARTHQUAKES FOUND WITHIN THE SPECIFIED SEARCH AREA.

TIME PERIOD OF SEARCH: 1800 TO 1999

LENGTH OF SEARCH TIME: 200 years

THE EARTHQUAKE CLOSEST TO THE SITE IS ABOUT 13.8 MILES (22.2 km) AWAY.

LARGEST EARTHQUAKE MAGNITUDE FOUND IN THE SEARCH RADIUS: 7.0

LARGEST EARTHQUAKE SITE ACCELERATION FROM THIS SEARCH: 0.160 g

COEFFICIENTS FOR GUTENBERG & RICHTER RECURRENCE RELATION:

a-value= 1.043
b-value= 0.349
beta-value= 0.803

TABLE OF MAGNITUDES AND EXCEEDANCES:

Earthquake Magnitude	Number of Times Exceeded	Cumulative No. / Year
----------------------	--------------------------	-----------------------

EQ Search WLC Orange FS1

4.0	66	0.33166
4.5	66	0.33166
5.0	66	0.33166
5.5	23	0.11558
6.0	15	0.07538
6.5	5	0.02513
7.0	2	0.01005

EQ Fault

```
*****  
*                               *  
*   E Q F A U L T             *  
*                               *  
*   Versi on 3.00             *  
*                               *  
*****
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DETERMINISTIC ESTIMATION OF
PEAK ACCELERATION FROM DIGITIZED FAULTS

JOB NUMBER: 12482.001

DATE: 08-20-2019

JOB NAME: WLC Orange FS1

CALCULATION NAME: Test Run Analysis

FAULT-DATA-FILE NAME: CDMGFLTE.DAT

SITE COORDINATES:

SITE LATITUDE: 33.7873
SITE LONGITUDE: 117.8411

SEARCH RADIUS: 60 mi

ATTENUATION RELATION: 20) Sadi gh et al. (1997) Horiz. - Soil
UNCERTAINTY (M=Median, S=Sigma): M Number of Sigmas: 0.0
DISTANCE MEASURE: cl odis
SCOND: 0
Basement Depth: 5.00 km Campbell SSR: Campbell SHR:
COMPUTE PEAK HORIZONTAL ACCELERATION

FAULT-DATA FILE USED: CDMGFLTE.DAT

MINIMUM DEPTH VALUE (km): 0.0

EQFAULT SUMMARY

DETERMINISTIC SITE PARAMETERS

ABBREVIATED FAULT NAME	APPROXIMATE DISTANCE mi (km)	ESTIMATED MAX. EARTHQUAKE EVENT		
		MAXIMUM EARTHQUAKE MAG. (Mw)	PEAK SITE ACCEL. g	EST. SITE INTENSITY MOD. MERC.
ELYSIAN PARK THRUST	8.6(13.9)	6.7	0.303	IX
WHITTIER	8.8(14.1)	6.8	0.243	IX
COMPTON THRUST	9.9(15.9)	6.8	0.287	IX
NEWPORT-INGLEWOOD (L. A. Basin)	12.2(19.6)	6.9	0.199	VIII
ELSI NORE-GLEN IVY	12.6(20.3)	6.8	0.184	VIII
CHINO-CENTRAL AVE. (Elsinore)	13.0(20.9)	6.7	0.220	IX
NEWPORT-INGLEWOOD (Offshore)	14.2(22.9)	6.9	0.175	VIII
SAN JOSE	17.5(28.2)	6.5	0.147	VIII
PALOS VERDES	22.2(35.8)	7.1	0.129	VIII
SIERRA MADRE	23.9(38.4)	7.0	0.145	VIII
CUCAMONGA	24.2(39.0)	7.0	0.142	VIII
RAYMOND	27.7(44.5)	6.5	0.088	VII
CLAMSHELL-SAWPIT	28.5(45.8)	6.5	0.084	VII
VERDUGO	29.8(47.9)	6.7	0.092	VII
ELSI NORE-TEMECULA	30.0(48.3)	6.8	0.076	VII
HOLLYWOOD	32.0(51.5)	6.4	0.067	VI
SAN JACINTO-SAN BERNARDINO	35.6(57.3)	6.7	0.058	VI
CORONADO BANK	36.2(58.2)	7.4	0.093	VII
SAN JACINTO-SAN JACINTO VALLEY	38.2(61.4)	6.9	0.061	VI
SANTA MONICA	38.4(61.8)	6.6	0.062	VI
SAN ANDREAS - San Bernardino	40.1(64.5)	7.3	0.077	VII
SAN ANDREAS - Southern	40.1(64.5)	7.4	0.082	VII
SAN ANDREAS - 1857 Rupture	40.3(64.9)	7.8	0.106	VII
SAN ANDREAS - Mojave	40.3(64.9)	7.1	0.066	VI
CLEGHORN	42.2(67.9)	6.5	0.040	V
SIERRA MADRE (San Fernando)	42.8(68.8)	6.7	0.058	VI
MALIBU COAST	43.1(69.4)	6.7	0.058	VI
SAN GABRIEL	44.5(71.6)	7.0	0.054	VI
NORTH RIDGE (E. Oak Ridge)	46.2(74.4)	6.9	0.061	VI
NORTH FRONTAL FAULT ZONE (West)	48.2(77.6)	7.0	0.063	VI
ANACAPA-DUME	50.9(81.9)	7.3	0.074	VII
ROSE CANYON	51.3(82.6)	6.9	0.042	VI
SANTA SUSANA	52.8(84.9)	6.6	0.040	V
SAN JACINTO-ANZA	53.2(85.6)	7.2	0.050	VI
ELSI NORE-JULIAN	55.4(89.1)	7.1	0.044	VI
HOLSER	58.6(94.3)	6.5	0.032	V

EQ Fault

-END OF SEARCH- 36 FAULTS FOUND WITHIN THE SPECIFIED SEARCH RADIUS.

THE ELYSIAN PARK THRUST FAULT IS CLOSEST TO THE SITE.
IT IS ABOUT 8.6 MILES (13.9 km) AWAY.

LARGEST MAXIMUM-EARTHQUAKE SITE ACCELERATION: 0.3030 g

APPENDIX E
GENERAL EARTHWORK AND GRADING SPECIFICATIONS



Leighton

GENERAL EARTHWORK AND GRADING SPECIFICATIONS FOR ROUGH GRADING

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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 the Geotechnical Consultant of Record (Geotechnical Consultant). The Geotechnical Consultants 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. Subsurface areas to be geotechnically observed, mapped, elevations recorded, and/or tested include natural ground after it has been cleared for receiving fill but before fill is placed, bottoms of all "remedial removal" areas, all key bottoms, and benches made on sloping ground to receive fill.

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

LEIGHTON CONSULTING, INC.
General Earthwork and Grading Specifications

- 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 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 "spreads" 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 observations and tests can be planned and accomplished. 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.

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). No fill lift shall contain more than 5 percent of organic matter. 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.

- 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 overexcavated as specified in the following section. Scarification shall continue until soils are broken down and free of large clay lumps or clods and the working surface is reasonably uniform, flat, and free of uneven features that would inhibit uniform compaction.
- 2.3 Overexcavation: In addition to removals and overexcavations 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 overexcavated 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 overexcavated 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 Section 3.1. 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 D1557-91).

- 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 D1557-91). 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 sheepfoot 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 D1557-91.
- 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 Safety: The Contractor shall follow all OSHA and Cal/OSHA requirements for safety of trench excavations.

7.2 Bedding and Backfill: 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.

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.

7.3 Lift Thickness: 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.

7.4 Observation and Testing: The jetting of the bedding around the conduits shall be observed by the Geotechnical Consultant.