APPENDIX H

PRELIMINARY WQMP VESSELS CIRCLE OFF-SITE IMPROVEMENTS

This page intentionally left blank

FUSCOE ENGINEERING

WATER QUALITY MANAGEMENT PLAN (WQMP)

VESSELS CIRCLE OFFSITE IMPROVEMENTS

December 9, 2020

FUSCOE ENGINEERING

WATER QUALITY MANAGEMENT PLAN (WQMP)

VESSELS CIRCLE OFFSITE IMPROVEMENTS

December 9, 2020

FUSCOE ENGINEERING

WATER QUALITY MANAGEMENT PLAN (WQMP)

VESSELS CIRCLE OFFSITE IMPROVEMENTS

December 9, 2020

FUSCOE ENGINEERING

PRELIMINARY WATER QUALITY MANAGEMENT PLAN (PWQMP)

VESSELS CIRCLE OFFSITE IMPROVEMENTS

CYPRESS, CA

PREPARED FOR
MELIA HOMES
8951 Research Drive, Suite 100
Irvine, CA 92618
949.759.4367

FUSCOE ENGINEERING, INC.
16795 Von Karman, Suite 100
Irvine, California 92606
949.474.1960
www.fuscoe.com

PROJECT MANAGER
Shelby Shirlock

DATE PREPARED: December 9, 2020

PROJECT NUMBER: 1703-002-01

full circle thinking®

PRELIMINARY
WATER QUALITY MANAGEMENT PLAN (WQMP)

VESSELS CIRCLE
CYPRESS TOWN CENTER OFFSITE IMPROVEMENTS

West of Vessel Circle and Walker Street, County of Orange

PARCEL 2 OF LL 2019-01
APN: 241-091-40 and 241-091-36

Prepared for:

MELIA HOMES
8951 Research Drive, Suite 100
Irvine, CA 92618
949.474.1960

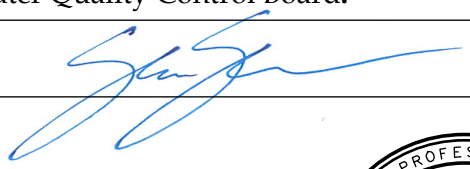
Prepared by:

FUSCOE ENGINEERING, INC.
16795 Von Karman, Suite 100
Irvine, CA 92618
949.474.1960
Shelby Shirlock, PE

Date Prepared: December 9, 2020

ENGINEER'S CERTIFICATION

WATER QUALITY MANAGEMENT PLAN

Preparer (Engineer) Certification			
Preparer (Engineer): Shelby Shirlock			
Title	Project Manager	PE Registration #	75912
Company	Fuscoe Engineering, Inc.		
Address	16795 Von Karman Ave. Irvine, CA 92606		
Email	sshirlock@fuscoe.com		
Telephone #	949.474.1960		
I hereby certify that this Water Quality Management Plan is in compliance with, and meets the requirements set forth in, Order No. R8-2009-0030/NPDES No. CAS618030, of the Santa Ana Regional Water Quality Control Board.			
Preparer Signature		Date	12/08/2020
Place Stamp Here			

PROJECT OWNER'S CERTIFICATION			
Permit/Application No.:	Pending	**Grading Permit No.:**	Pending
Tract/Parcel Map and Lot(s)No.:	Parcel 2 of LL 2019-01	**Building Permit No.:**	Pending
Address of Project Site and APN:	West of Vessel Circle and Walker Street, Cypress, CA APN: 241-091-40 and 241-091-36		

This Water Quality Management Plan (WQMP) has been prepared for MELIA HOMES by FUSCOE ENGINEERING, INC. The WQMP is intended to comply with the requirements of the County of Orange NPDES Stormwater Program requiring the preparation of the plan.

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

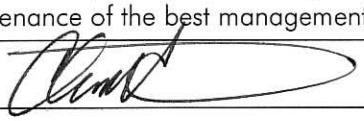
OWNER:			
Name:	Chad Brown		
Title:	Vice President of Planning and Development		
Company:	Melia Homes		
Address:	8951 Research Drive, Suite 100, Irvine, CA 92618		
Email:	chad@melia-homes.com		
Telephone #:	949.468.9430		
I understand my responsibility to implement the provisions of this WQMP including the ongoing operation and maintenance of the best management practices (BMPs) described herein.			
Owner Signature:		**Date:**	12/8/2020

TABLE OF CONTENTS

APPENDICES

EXHIBITS & BMP DETAILS (INCLUDED IN SECTION VI)

- Vicinity Map
- WQMP Exhibit
- Connector Pipe Screen Standard Detail
- Vegetated Swale (BIO-2)
- Planting / Storage Media (MISC-1)
- Proprietary Biotreatment (BIO-7)

EDUCATIONAL MATERIALS (INCLUDED IN APPENDIX C)

- Tips for Protecting Your Watershed
- DF-1 Drainage System Operation & Maintenance
- R-3 Automobile Parking
- SD-10 Site Design & Landscape Planning
- SD-12 Efficient Irrigation
- SD-13 Storm Drain Signage

SECTION I DISCRETIONARY PERMITS AND WATER QUALITY CONDITIONS

PROJECT INFORMATION			
Permit/Application No.:	Pending	**Grading or Building Permit No.:**	Pending
Address of Project Site (or Tract Map and Lot Number if no address) and APN:	West of Vessel Circle and Walker Street, Cypress, CA APN: 241-091-40 and 241-091-36		
WATER QUALITY CONDITIONS OF APPROVAL OR ISSUANCE			
Discretionary Permit(s):	Pending Issuance		
Water Quality Conditions of Approval or Issuance applied to this project: **(Please list verbatim.)**	<u>Standard Conditions of Approval – Provided in Appendix E</u> 1. Prior to the submittal of any grading plan the applicant shall submit a Preliminary Project WQMP for review and approval to the Public Works Department that: • Utilizes Low Impact Development principles as follows: preserves natural features, minimizes runoff and reduces impervious surfaces; and utilizes infiltration of runoff as the preferred method of pollutant treatment. Infiltration Best Management Practices (BMPs) to be considered include the use of permeable materials such as pervious concrete and concrete pavers, infiltration trenches and 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. • Reduces the potential in downstream erosion and avoids downstream impacts to physical structures, aquatic and riparian habitat. • Thoroughly 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. • A certified copy of the Covenant and Agreement Regarding the O & M Plan to Fund and Maintain Water Quality BMPs, Consent to Inspect, and Indemnification form 2. Prior to the issuance of certificates of occupancy, the applicant shall demonstrate the following to the Public Works Department: • That all structural and treatment control 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.
CONCEPTUAL WQMP	
Was a Conceptual Water Quality Management Plan previously approved for this project?	This report serves as the Preliminary Water Quality Management Plan (WQMP).
WATERSHED-BASED PLAN CONDITIONS	
Applicable conditions from watershed - based plans including WIHMPs and TMDLs:	The project is located within the San Gabriel – Coyote Creek Watershed and is tributary to the Los Alamitos Channel. Currently, there is no approved WIHMP for the Coyote Creek Watershed. The project's receiving waters are considered impaired under the Section 303(d) of the Clean Water Act and the following TMDL's have been established for these waterbodies: Coyote Creek – Copper (2007), Indicator Bacteria (2016), Iron (2005), Malathion (2005), pH (2005), Toxicity (2005) San Gabriel River Estuary – Copper (2007) , Dioxin (2005), Indicator Bacteria (2016), Nickel (2005), and Dissolved Oxygen (2005) San Pedro Bay – Chlordane (2012), PCB (2012), DDT (2012), Toxicity (2012)

SECTION II PROJECT DESCRIPTION

II.1 PROJECT DESCRIPTION

The proposed Vessels Circle Offsite Improvements project site encompasses approximately 0.95 acres in the City of Cypress. The project site is bounded by Cerritos Ave (with the Los Alamitos racecourse directly to the north), Walker St to the east, an adjacent parking lot area to the west, and Winner's Circle (along the existing Costco property) meeting with Katella Ave to the south. A Vicinity Map is included in Section VI.

Under existing conditions, the project site is an asphalt parking lot used by the racecourse. Adjacent land uses include commercial to the north, east and south and the Los Alamitos Racecourse to the west.

The table below summarizes the proposed project.

DESCRIPTION OF PROPOSED PROJECT	
Development Category (Model WQMP, Table 7.11-2; or 7.11-3):	6. Parking lots 5,000 square feet or more including associated drive aisle, and potentially exposed to urban stormwater runoff. A parking lot is defined as a land area or facility for the temporary parking or storage of motor vehicles used personally, for business, or for commerce. 8. All significant redevelopment projects, where significant redevelopment is defined as the addition or replacement of 5,000 or more square feet of impervious surface on an already developed site. Redevelopment does not include routine maintenance activities that are conducted to maintain original line and grade, hydraulic capacity, original purpose of the facility, or emergency redevelopment activity required to protect public health and safety.
Project Area (ft^2):	41,382 ft^2 (0.95 acres)
# of Dwelling Units:	N/A
SIC Code:	N/A
Narrative Project Description:	The project site is located north of the Cypress Town Center project. Right-of-Way improvements along Vessel's Circle will consist of adding additional asphalt and expanding the existing street to run along the north edge of the Cypress Town Center property. A Modular Wetland System (MWS) has been proposed to treat a portion of the improvements. Low flows will be intercepted before co-mingling with offsite drainage from the existing Vessel's Circle. The MWS unit has been upsized to the 1-year 1-hour storm event to provide the City with compliance with the CA Trash Provisions. The remainder of the street improvements will drain and be treated by one of three swales. One proposed swale will be located offsite on Los Alamitos Racecourse (LARC) property. A cross lot drainage agreement, LARC Vessel's Drainage – Bioswale Acceptance, is provided in Appendix E.

DESCRIPTION OF PROPOSED PROJECT				
Project Area:	**Pervious Area**	**Pervious Area Percentage**	**Impervious Area**	**Impervious Area Percentage**
Pre-Project Conditions:	0.0 ac	0%	0.95 ac	100%
Post-Project Conditions:	0.37 ac	31.2%	0.58 ac	61.8%
Drainage Patterns/ Connections:	Under existing conditions, runoff flows in a southwesterly direction. Stormwater continues to drain southwesterly across the adjacent property where it is gathered in ribbon gutters and conveyed toward Katella Avenue without any restriction. From there, flows travel west on Katella Ave to the Orange County Flood Control District (OCFCD) Los Alamitos Channel, then to the San Gabriel River Estuary, out to the San Pedro Bay and ultimately to the Pacific Ocean. Under proposed conditions, flows will split and travel in either a westerly or easterly direction. About three quarters of the site's runoff will flow to one of three swales for water quality treatment. Roughly a quarter of the site's runoff will flow southeast to a proposed Modular Wetland System (MWS) for water quality treatment. A small portion of runoff at the far east side of the street improvements is unable to be captured. The MWS has been upsized to offset the untreated runoff. Treated flows will enter a storm drain system that either connects to Walker Street or the adjacent Los Alamitos Racecourse (LARC) property. A cross lot drainage agreement, LARC Vessel's Drainage – Bioswale Acceptance, is provided in Appendix E. From there, flows travel west on Katella Ave to the Orange County Flood Control District (OCFCD) Los Alamitos Channel, then to Coyote Creek and the San Gabriel River Estuary, out to the San Pedro Bay and ultimately to the Pacific Ocean.			

PROJECT FEATURES	
Amenities:	The project site will include common landscaping.
Landscaped Areas:	Common area landscaping adjacent to the street improvements will comprise of approximately 31.2% of the entire site.
Parking Facilities:	N/A
Other Project Features:	The site will not have any outdoor trash enclosures, loading docks, wash areas, outdoor storage areas, vehicle/community car wash racks, vehicle/equipment wash areas, or commercial kitchens/food preparation areas.
Outdoor Activities:	Outdoor areas will be used for street improvements, walkways, common areas and landscaping.
Materials Stored:	No outdoor storage of materials is anticipated (materials will be stored indoors). No hazardous waste will be stored on-site.

PROJECT FEATURES	
Wastes Generated:	The project is not anticipated to generate any wastes other than landscaping clippings and trash & debris generated from tenants and residents on the adjacent Cypress Town Center property. All trash generated in townhomes will be individually managed by owners and picked up on a weekly schedule. Any waste generated from maintenance activities will be disposed of properly off-site. Wash water and other waste from maintenance activities are not to be discharged or disposed of into the storm drain system. Clippings from landscape maintenance (i.e. prunings) will be collected and disposed of properly off-site, and will not be washed into the streets, local area drains/conveyances, or catch basin inlets.

II.2 POTENTIAL STORM WATER POLLUTANTS

The table below, derived from Table 2 of the Countywide Model WQMP Technical Guidance Document (December 2013), summarizes the categories of land use or project features of concern and the general pollutant categories associated with them.

ANTICIPATED & POTENTIAL POLLUTANTS GENERATED BY LAND USE TYPE								
Priority Project Categories and/or Project Features	General Pollutant Categories							
	Suspended Solid/ Sediments	Nutrients	Heavy Metals	Pathogens (Bacteria/ Virus)	Pesticides	Oil & Grease	Toxic Organic Compounds	Trash & Debris
Detached Residential Development	E	E	N	E	E	E	N	E
Attached Residential Development	E	E	N	E	E	E(2)	N	E
Commercial/Industrial Development	E(1)	E(1)	E(5)	E(3)	E(1)	E	E	E
Automotive Repair Shops	N	N	E	N	N	E	E	E
Restaurants	E(1)(2)	E(1)	E(2)	E	E(1)	E	N	E
Hillside Development >5,000 ft²	E	E	N	E	E	E	N	E
Parking Lots	E	E(1)	E	E(4)	E(1)	E	E	E
Streets, Highways, & Freeways	E	E(1)	E	E(4)	E(1)	E	E	E
Retail Gasoline Outlets	N	N	E	N	N	E	E	E

ANTICIPATED & POTENTIAL POLLUTANTS GENERATED BY LAND USE TYPE								
Priority Project Categories and/or Project Features	General Pollutant Categories							
	Suspended Solid/ Sediments	Nutrients	Heavy Metals	Pathogens (Bacteria/ Virus)	Pesticides	Oil & Grease	Toxic Organic Compounds	Trash & Debris

Notes:
E = expected to be of concern N = not expected to be of concern
(1) Expected pollutant if landscaping exists on-site, otherwise not expected.
(2) Expected pollutant if the project includes uncovered parking areas, otherwise not expected.
(3) Expected pollutant if land use involves food or animal waste products, otherwise not expected.
(4) Bacterial indicators are routinely detected in pavement runoff.
(5) Expected if outdoor storage or metal roofs, otherwise not expected.
Source: County of Orange. (2013, December 20). Technical Guidance Document for the Preparation of Conceptual/ Preliminary and/or Project Water Quality Management Plans (WQMPs). Table 2.1.

Priority Project Categories and/or Features: Streets

POLLUTANTS OF CONCERN		
Pollutant	E = Expected to be of concern N =Not Expected to be of concern	Additional Information and Comments
Suspended Solid/ Sediment	E	
Nutrients	E	TMDL established 2012
Heavy Metals	E	TMDL established 2005 (Nickel), 2007 (Copper)
Pathogens (Bacteria/Virus)	E	TMDL established 2016
Pesticides	E	TMDL established 2012
Oil & Grease	E	
Toxic Organic Compounds	E	TMDL established 2012
Trash & Debris	E	TMDL established 2017

II.3 HYDROLOGIC CONDITIONS OF CONCERN

The purpose of this section is to identify any hydrologic conditions of concern (HCOC) with respect to downstream flooding, erosion potential of natural channels downstream, impacts of increased flows on natural habitat, etc. As specified in Section 2.3.3 of the 2011 Model WQMP, projects must identify and mitigate any HCOCs. A HCOC is a combination of upland hydrologic conditions and stream biological and physical conditions that presents a condition of concern for physical and/or biological degradation of streams.

In the North Orange County permit area, HCOCs are considered to exist if any streams located downstream from the project are determined to be potentially susceptible to hydromodification impacts and either of the following conditions exists:

- Post-development runoff volume for the 2-yr, 24-hr storm exceeds the pre-development runoff volume for the 2-yr, 24-hr storm by more than 5 percent

or

- Time of concentration (Tc) of post-development runoff for the 2-yr, 24-hr storm event exceeds the time of concentration of the pre-development condition for the 2-yr, 24-hr storm event by more than 5 percent.

If these conditions do not exist or streams are not potentially susceptible to hydromodification impacts, an HCOC does not exist and hydromodification does not need to be considered further. In the North Orange County permit area, downstream channels are considered not susceptible to hydromodification, and therefore do not have the potential for a HCOC, if all downstream conveyance channels that will receive runoff from the project are engineered, hardened, and regularly maintained to ensure design flow capacity, and no sensitive habitat areas will be affected.

Is the proposed project potentially susceptible to hydromodification impacts?

☐ **Yes** ☒ **No (show map)**

The site is not subject to hydromodification as seen on Figure XVI-3a in Appendix A. The site will have a detention system in the center courtyard to mitigate the 100 year storm for flood control purposes. Treated flows from the MWS units and high flows will be temporarily detained in the underground detention system. A pump will release the flows at a maximum rate of 2.1 cfs before exiting to the OCFCD Los Alamitos Channel downstream.

II.4 POST DEVELOPMENT DRAINAGE CHARACTERISTICS

Under proposed conditions, flows will split and travel in either a westerly or easterly direction. About three quarters of the site's runoff will flow to one of three swales for water quality treatment. Roughly a quarter of the site's runoff will flow southeast to a proposed Modular Wetland System (MWS) for water quality treatment. A small portion of runoff at the far east side of the street improvements is unable to be captured. The MWS has been upsized to offset the untreated runoff. Treated flows will enter a storm drain system that either connects to Walker Street or the adjacent Los Alamitos Racecourse (LARC) property. A cross lot drainage agreement, LARC Vessel's Drainage – Bioswale

Acceptance, is provided in Appendix E. From there, flows travel west on Katella Ave to the Orange County Flood Control District (OCFCD) Los Alamitos Channel, then to Coyote Creek and the San Gabriel River Estuary, out to the San Pedro Bay and ultimately to the Pacific Ocean.

II.5 PROPERTY OWNERSHIP/MANAGEMENT

PROPERTY OWNERSHIP/MANAGEMENT	
Public Streets:	City of Cypress
Private Streets:	Melia Homes / Future HOA / Future City of Cypress
Landscaped Areas:	Melia Homes / Future HOA / Future City of Cypress
Open Space:	Melia Homes / Future HOA / Future City of Cypress
Structural BMPs:	Melia Homes / Future HOA / Future City of Cypress

A Home Owners Association (HOA) will be formed upon project completion for the neighboring Cypress Town Center project. The HOA will be responsible for inspecting and maintaining all BMPs prescribed for Cypress Town Center as well as Vessels Circle. Until a HOA is formally established, Melia Homes shall assume all BMP maintenance and inspection responsibilities for the proposed project. In a future date and time, the City of Cypress will inherit Vessels Circle and assume all BMP maintenance and inspection responsibilities. Inspection and maintenance responsibilities are outlined in Section V of this report.

SECTION III SITE DESCRIPTION

III.1 PHYSICAL SETTING

Planning Area/ Community Name:	Town Center District
Address:	West of Vessel Circle and Walker Street, Cypress, CA
Project Area Description:	The project site is located west of the existing Vessels Circle and west of Walker Street in the City of Cypress, Orange County, California.
Land Use:	Race Track (Privately -Owned)
Zoning:	Public and Semi-Public Zone
Acreage:	0.95 acres
Predominant Soil Type:	Type B (according to Figure XVI-2a of the TGD)
Impervious Conditions:	Existing Impervious: 100% (0% Pervious) Proposed Impervious: 61.8% (38.2% Pervious)

III.2 SITE CHARACTERISTICS

Precipitation Zone:	0.85 (according to Figure XVI-1 of the TGD)
Topography:	The existing site is generally flat, as storm drainage surface flows southwesterly from a high area at an average elevation of 36 ± feet in northeast portion of the site toward the southwest corner of the site at an average elevation of 34± feet.
Existing Drainage Patterns/ Connections:	Under existing conditions, runoff flows in a southwesterly direction. Stormwater continues to drain southwesterly across the adjacent property where it is gathered in ribbon gutters and conveyed toward Katella Avenue without any restriction. From there, flows travel west on Katella Ave to the Orange County Flood Control District (OCFCD) Los Alamitos Channel, then to the San Gabriel River Estuary, out to the San Pedro Bay and ultimately to the Pacific Ocean.
Proposed Drainage Patterns/ Connections:	Under proposed conditions, flows will split and travel in either a westerly or easterly direction. About three quarters of the site's runoff will flow to one of three swales for water quality treatment. Roughly a quarter of the site's runoff will flow southeast to a proposed Modular Wetland System (MWS) for water quality treatment. A small portion of runoff at the far east side of the street improvements is unable to be captured. The MWS has been upsized to offset the untreated runoff. Treated flows will enter a storm drain system that either connects to Walker Street or the adjacent Los Alamitos Racecourse (LARC) property. A cross lot drainage agreement, LARC Vessel's Drainage – Bioswale Acceptance, is provided in Appendix E. From there, flows

	travel west on Katella Ave to the Orange County Flood Control District (OCFCD) Los Alamitos Channel, then to Coyote Creek and the San Gabriel River Estuary, out to the San Pedro Bay and ultimately to the Pacific Ocean.
Soil Type, Geology, and Infiltration Properties:	According to a study done by Geotek, Inc. in August 2019, undocumented fill was encountered to depths of three to four feet below ground surface (bgs). The fill consisted of interbedded layers of silty sand, clayey sand, sandy silt, and sandy clay. Under the fill, alluvium was encountered to depths of about 51.5 feet bgs. The alluvium encountered consisted of layers of silty sand, poorly graded sand, sandy silt, and clay. The alluvium was brown to gray in color and moist to saturated.
Hydrogeologic (Groundwater) Conditions:	The project site is located in an area with shallow (or high) groundwater levels, approximately 10 feet below bgs as illustrated in the TGD Figure XVI-2e (see Appendix F). During the August 2019 exploration, Geoteck Inc. installed a monitoring well which indicated groundwater is about five to six feet deep around the project site.
Geotechnical Conditions (relevant to infiltration):	While the OC TGD Figure XVI-2a shows Type B soils for infiltration, several site constraints inhibit the use of infiltration for water quality treatment. The main constraint being the presence of shallow groundwater. Due to shallow groundwater, there is a potential for liquefaction on the site. The analyses indicated the presence of some layers of loose sands and silty sands that would be prone to liquefaction and settlement during the design level earthquake. Due to shallow groundwater and liquefaction potential, infiltration has been deemed infeasible for the project site.
Off-Site Drainage:	The project does not receive offsite run-on from adjacent properties.
Utility and Infrastructure Information:	Wet and dry utilities are proposed for the project and will connect to existing facilities located in Winners Circle.

III.3 WATERSHED DESCRIPTION

Receiving Waters:	Los Alamitos Channel, Coyote Creek, San Gabriel River Estuary, San Pedro Bay and the Pacific Ocean.
303(d) Listed Impairments:	Los Alamitos Channel – none Coyote Creek – Copper, Indicator Bacteria, Iron, Malathion, pH, Toxicity San Gabriel River Estuary – Copper, Dioxin, Indicator Bacteria, Nickel, and Dissolved Oxygen San Pedro Bay – Chlordane, PCB, DDT, Toxicity

Applicable TMDLs:	Los Alamitos Channel – none Coyote Creek – Copper (2007), Indicator Bacteria (2016), Iron (2005), Malathion (2005), pH (2005), Toxicity (2005) San Gabriel River Estuary – Copper (2007) , Dioxin (2005), Indicator Bacteria (2016), Nickel (2005), and Dissolved Oxygen (2005) San Pedro Bay – Chlordane (2012), PCB (2012), DDT (2012), Toxicity (2012)
Pollutants of Concern for the Project:	Pollutants of Concern: Suspended Solids/Sediment, Nutrients, Heavy Metals, Pathogens, Pesticides, Oil and Grease, Toxic Organic Compounds, Trash and Debris. Primary Pollutants of Concern: Nutrients, Heavy Metals, Pathogens, Pesticides, Toxic Organic Compounds.
Hydrologic Conditions of Concern (HCOCs):	There are no HCOC. See Section II.3.
Environmentally Sensitive and Special Biological Significant Areas:	There are no Environmentally Sensitive Areas (ESAs) or Areas of Special Biological Significance (ASBS) within the project site or within the project's vicinity.

SECTION IV BEST MANAGEMENT PRACTICES (BMPs)

IV.1 PROJECT PERFORMANCE CRITERIA

Is there an approved WIHMP or equivalent for the project area that includes more stringent LID feasibility criteria or if there are opportunities identified for implementing LID on regional or sub-regional basis?

☐ Yes ☒ No

PROJECT PERFORMANCE CRITERIA	
Hydromodification Control Performance Criteria: (Model WQMP Section 7.II-2.4.2.2)	If a hydrologic condition of concern (HCOC) exists, priority projects shall implement onsite or regional hydromodification controls such that: ▪ Post-development runoff volume for the two-year frequency storm does not exceed that of the predevelopment condition by more than five percent, and ▪ Time of concentration of post-development runoff for the two-year storm event is not less than that for the predevelopment condition by more than five percent. Where the Project WQMP documents that excess runoff volume from the two-year runoff event cannot feasibly be retained and where in-stream controls cannot be used to otherwise mitigate HCOCs, the project shall implement on-site or regional hydromodification controls to: ▪ Retain the excess volume from the two-year runoff event to the MEP, and ▪ Implement on-site or regional hydromodification controls such that the post-development runoff two-year peak flow rate is no greater than 110 percent of the predevelopment runoff two-year peak flow rate.
LID Performance Criteria: (Model WQMP Section 7.II-2.4.3)	Infiltrate, harvest and use, evapotranspire, or biotreat/biofilter, the 85th percentile, 24-hour storm event (Design Capture Volume). LID BMPs must be designed to retain, on-site, (infiltrate, harvest and use, or evapotranspire) storm water runoff up to 80 percent average annual capture efficiency.
Treatment Control BMP Performance Criteria: (Model WQMP Section 7.II-3.2.2)	If it is not feasible to meet LID performance criteria through retention and/or biotreatment provided on-site or at a sub-regional/regional scale, then treatment control BMPs shall be provided on-site or offsite prior to discharge to waters of the US. Sizing of treatment control BMP(s) shall be based on either the unmet volume after claiming applicable water quality credits, if appropriate.

PROJECT PERFORMANCE CRITERIA	
LID Design Storm Capture Volume:	DCV = C × d × A × 43560 sf/ac × 1/12 in/ft Where: DCV = design storm capture volume, cu-ft C = runoff coefficient = (0.75 × imp + 0.15) Imp = impervious fraction of drainage area (ranges from 0 to 1) d = storm depth (inches) A = tributary area (acres) Imp = 61.8 d = 0.85 inches A = 0.95 acres *DCV* = *(0.75 x* 0.618 *+0.15) x* 0.85 *inches x 0.95 ac x 43560 sf/ac x 1/12 in/ft* = *1,800* cu-ft *Refer to Section IV.2.2 for specific Drainage Manage Area (DMA) breakdown and Appendix A for detailed calculations (Worksheet B).*

IV.2 SITE DESIGN AND DRAINAGE PLAN

The following section describes the site design BMPs used in this project and the methods used to incorporate them. Careful consideration of site design is a critical first step in storm water pollution prevention from new developments and redevelopments.

IV.2.1 Site Design BMPs

Minimize Impervious Area

Impervious surfaces have been minimized by incorporating landscaped areas adjacent to the street improvements.

Maximize Natural Infiltration Capacity

Infiltration of the entire site is not recommended for the project site due to shallow groundwater and liquefaction potential. Refer to Section III.2 and IV.3.2 for details.

Preserve Existing Drainage Patterns and Time of Concentration

Runoff from the site will continue to flow similar to existing conditions. Low-flows and first-flush runoff will drain to either one of three swales or one Modular Wetland Systems for water quality treatment via biotreatment.

Disconnect Impervious Areas

Landscaping will be provided adjacent to sidewalks/street. Low-flows and first-flush runoff will drain to either one of three swales or one Modular Wetland Systems for water quality treatment via bio-filtration. Refer to Section IV.3.4 for further details.

Protect Existing Vegetation and Sensitive Areas, and Revegetate Disturbed Areas

There are no existing vegetated or sensitive areas to preserve on the project site. All disturbed areas will either be paved or landscaped.

Xeriscape Landscaping

Xeriscape landscaping is not proposed for the project. However, native and/or tolerant landscaping will be incorporated into the site design consistent with City guidelines.

IV.2.2 Drainage Management Areas

In accordance with the MS4 permit and the 2011 Model WQMP, the project site has been divided into Drainage Management Areas (DMAs) to be utilized for defining drainage areas and sizing LID and other treatment control BMPs. DMAs have been delineated based on the proposed site grading patterns, drainage patterns, storm drain and catch basin locations.

The design capture volumes (DCV) and treatment flow rates (Q_{Design}) for each DMA are summarized in the table below. These have been derived utilizing the "Simple Method" in accordance with the TGD Section III.1.1. Actual BMP sizing requirements, including 80 percent capture design volumes, flow rates, depths, and other design details for the specific BMPs proposed are provided in Section IV.3.4 below. Locations of DMAs and associated LID and treatment BMPs are identified on the exhibits in Section VI. Additional calculations and TGD Worksheets are provided in Appendix A.

DRAINAGE MANAGEMENT AREAS (DMAs)								
DMA/ Drainage Area ID[1]	Tributary Drainage Area (ft^2)	Tributary Drainage Area (ac)	% Imp.	Design Storm Depth[2] (in)	Estimated Tc (min)	Rainfall Intensity[3] (in/hr)	Simple Method DCV[4] (ft^3)	Q_{Design} [5] (cfs)
DMA C1	8,712	0.20	85.2	0.85	5	0.403*	486.9	0.064
DMA C2	9,148	0.21	35.5	0.85	5	0.403*	269.5	0.035
DMA D1	8,712	0.20	32.2	0.85	5	0.403*	241.9	0.032
DMA D2	10,019	0.23	81.1	0.85	5	0.403*	537.9	0.070
DMA E	4,792	0.11	82.8	0.85	5	0.403*	261.7	0.034

Notes:
1. Refer to exhibits in Section VI for locations of each DMA.
2. Per Figure XVI-1 of the Technical Guidance Document, dated December 20, 2013. See also Appendix A.
3. Per Figure III.4 of the Technical Guidance Document, dated December 20, 2013. See also Appendix A. *Per 1-year, 1-hour storm event in compliance with the Statewide CA Trash Amendments.
4. Per Section III.1.1 of the Technical Guidance Document.
5. Per Section III.3.3 and Worksheet D of the Technical Guidance Document.

IV.3 LID BMP SELECTION AND PROJECT CONFORMANCE ANALYSIS

Low Impact Development (LID) BMPs are required in addition to site design measures and source controls to reduce pollutants in storm water discharges. LID BMPs are engineered facilities that are designed to retain or biotreat runoff on the project site. The 4th Term MS4 Storm Water Permit (Order R8-2009-0030) requires the evaluation and use of LID features using the following hierarchy of treatment: infiltration, evapotranspiration, harvest/reuse, and biotreatment. The following sections summarize the LID BMPs proposed for the project in accordance with the permit hierarchy and performance criteria outlined in Section IV.1.

IV.3.1 Hydrologic Source Controls (HSCs)

Hydrologic source controls (HSCs) can be considered to be a hybrid between site design practices and LID BMPs. HSCs are distinguished from site design BMPs in that they do not reduce the tributary area or reduce the imperviousness of a drainage area; rather they reduce the runoff volume that would result from a drainage area with a given imperviousness compared to what would result if HSCs were not used.

HYDROLOGIC SOURCE CONTROLS		
ID	**Name**	**Included?**
HSC-1	Localized on-lot infiltration	☐
HSC-2	Impervious area dispersion (e.g. roof top disconnection)	☐
HSC-3	Street trees (canopy interception)	☐
HSC-4	Residential rain barrels (not actively managed)	☐
HSC-5	Green roofs/Brown roofs	☐
HSC-6	Blue roofs	☐
HSC-7	Impervious area reduction (e.g. permeable pavers, site design)	☐

HSCs were not incorporated into the project's design at this stage in the project's development. Any HSC's will be accounted for during final design and the cumulative volume of the HSC's will be subtracted from the required treatment volume in the Final WQMP.

IV.3.2 Infiltration BMPs

Infiltration BMPs are LID BMPs that capture, store and infiltrate storm water runoff. These BMPs are engineered to store a specified volume of water and have no design surface discharge (underdrain or outlet structure) until this volume is exceeded. Examples of infiltration BMPs include infiltration trenches, bioretention without underdrains, drywells, permeable pavement, and underground infiltration galleries.

INFILTRATION		
ID	**Name**	**Included?**
INF-3 INF-4	Bioretention Without Underdrains	☐
	Rain Gardens	☐
	Porous Landscaping	☐
	Infiltration Planters	☐
	Retention Swales	☐
INF-2	Infiltration Trenches	☐
INF-1	Infiltration Basins	☐
INF-5	Drywells	☐
INF-7	Subsurface Infiltration Galleries	☐
--	French Drains	☐
INF-6	Permeable Asphalt	☐
	Permeable Concrete	☐
	Permeable Concrete Pavers	☐
	Other:	☐

No infiltration BMPs are proposed within the redevelopment project. As discussed in Section III.2, due to shallow groundwater and liquefaction potential, infiltration has been deemed infeasible for the project site.

IV.3.3 Evapotranspiration & Rainwater Harvesting BMPs

Evapotranspiration (ET) BMPs are a class of retention BMPs that discharges stored volume predominately to ET, though some infiltration may occur. ET includes both evaporation and transpiration, and ET BMPs may incorporate one or more of these processes. BMPs must be designed to achieve the maximum feasible ET, where required to demonstrate that the maximum amount of water has been retained on-site. Since ET is not the sole process in these BMPs, specific design and sizing criteria have not been developed for ET-based BMPs.

EVAPOTRANSPIRATION		
ID	**Name**	**Included?**
--	HSCs, *see Section IV.3.1*	☐
--	Surface-based infiltration BMPs	☐

EVAPOTRANSPIRATION		
ID	**Name**	**Included?**
--	Biotreatment BMPs, see *Section VI.3.4*	☐
	Other:	☐

Harvest and use (aka. Rainwater Harvesting) BMPs are LID BMPs that capture and store storm water runoff for later use. These BMPs are engineered to store a specified volume of water and have no design surface discharge until this volume is exceeded. Harvest and use BMPs include both above-ground and below-ground cisterns. Examples of uses for harvested water include irrigation, toilet and urinal flushing, vehicle washing, evaporative cooling, industrial processes and other non-potable uses.

HARVEST & REUSE / RAINWATER HARVESTING		
ID	**Name**	**Included?**
HU-1	Above-ground cisterns and basins	☐
HU-2	Underground detention	☐
--	Other:	☐

In order to quantify harvested water demand for the common areas of the project, the Modified Estimated Applied Water Use (EAWU) method was used, consistent with Appendix X of the Model WQMP's Technical Guidance Document (TGD), dated December 20, 2013.

The Modified EAWU method is modified from the OC Irrigation Code (County Ordinance No. 09-010) to account for the wet season demand and storm events (assuming that no irrigation would be applied for approximately 30% of the days in the wet season).

The equation used to calculate the Modified EAWU is:

$$Modified\ EAWU = \frac{(ETo\text{wet} \times K\text{L} \times LA \times 0.015)}{IE}$$

Where:

$Modified\ EAWU$ = estimated daily average water use during wet season
ETo_{wet} = average reference ET from November through April (inches per month) per Table X.2 of the TGD
K_L = landscape coefficient (Table X.4 of the TGD)
LA = landscape area irrigated with harvested water (square feet)
IE = irrigation efficiency (assumed at 90%)

Note: In the equation, the coefficient (0.015) accounts for unit conversions and shut down of irrigation during and for three days following a significant precipitation event.

For a system to be considered "feasible", the system must be designed with a storage volume equal to the DCV from the tributary area and achieve more than 40% capture. The system must also be able to drawdown in 30 days to meet the 40% capture value. In addition, Table X.6 of the Technical Guidance Document sets forth the demand thresholds for minimum partial capture.

TABLE X.6: HARVESTED WATER DEMAND THRESHOLDS FOR MINIMUM PARTIAL CAPTURE	
Design Capture Storm Depth, inches	Wet Season Demand Required for Minimum Partial Capture, gpd per impervious acre
0.60	490
0.65	530
0.70	570
0.75	610
0.80	650
0.85	690
0.90	730
0.95	770
1.00	810

The following table summarizes the estimated applied water use for the common area landscaping of the project.

ESTIMATED APPLIED WATER USE (EAWU) FOR COMMON AREA LANDSCAPING									
Landscape Type	Total Area (ac)	% Impervious	Impervious Tributary (ac)	Irrigated LS Area (ac)	ETo_{Wet} [1] (in/mo)	K_L [2]	Modified EAWU (gpd)	Modified EAWU per impervious acre (gpd/ac)	Minimum Capture Threshold [3] (gpd/ac)
Blend	0.95	62	0.59	0.36	2.93	0.55	425	723	690
Design Capture Volume (gal)				13,462	Drawdown (days)				32

Notes:

1 Per Table X.2 for Santa Ana Region (similar climate type), Model WQMP Technical Guidance Document, dated December 20, 2013.
2 Per Table X.4 of the Model WQMP Technical Guidance Document, dated December 20, 2013.
3 Per Table X.6 of Model WQMP Technical Guidance Document, dated December 20, 2013.

As shown above, the project site does not have sufficient water demand during the wet season to support harvest and reuse. The project does not meet the minimum capture threshold of 690 gallons per day/acre with its Modified EAWU or estimated daily average water usage during the wet season. Therefore the DCV will not be fully utilized and emptied for the next storm event. Drawdown of the

DCV is anticipated to take approximately 32 days by the landscape's water demand usage, which is greater than the maximum drawdown time of 30 days.

IV.3.4 Biotreatment BMPs

Biotreatment BMPs are a broad class of LID BMPs that reduce storm water volume to the maximum extent practicable, treat storm water using a suite of treatment mechanisms characteristic of biologically active systems, and discharge water to the downstream storm drain system or directly to receiving waters. Treatment mechanisms include media filtration (though biologically-active media), vegetative filtration (straining, sedimentation, interception, and stabilization of particles resulting from shallow flow through vegetation), general sorption processes (i.e., absorption, adsorption, ion-exchange, precipitation, surface complexation), biologically-mediated transformations, and other processes to address both suspended and dissolved constituents. Examples of biotreatment BMPs include bioretention with underdrains, vegetated swales, constructed wetlands, and proprietary biotreatment systems.

BIOTREATMENT		
ID	**Name**	**Included?**
BIO-1	Bioretention with underdrains	☐
	Storm Water planter boxes with underdrains	☐
	Rain gardens with underdrains	☐
BIO-5	Constructed wetlands	☐
BIO-2	Vegetated swales	☒
BIO-3	Vegetated filter strips	☐
BIO-7	Proprietary vegetated biotreatment systems	☒
BIO-4	Wet extended detention basin	☐
BIO-6	Dry extended detention basins	☐
--	Other:	☐

Since infiltration and harvest and reuse are infeasible, biotreatment BMPs will be utilized on-site for water quality treatment. The project will implement two proprietary biotreatment systems for water quality treatment to treat all pollutants of concern to a medium to high level of effectiveness. The systems will include the Modular Wetlands Systems developed by Bio Clean Environmental Services, Inc. There are several advantages of the Modular Wetland System over traditional bioretention planters including the following reasons:

- Modular Wetlands are the only proprietary biotreatment device approved through the Washington State University TAPE (Technology Assessment Protocol – Ecology) program for basic storm water treatment and enhanced treatment including sediment, nutrients and heavy metals (all proposed pollutants of concern for the Upper Newport Bay). TAPE approval is

based on a series of independent field studies using strict sampling criteria to validate vendor's claims. TAPE approval is considered one of the most stringent and most reliable in the country.

- Modular Wetlands have a pre-treatment chamber that is specifically designed to capture fine sediments and particulates through a series of BioMediaGREEN sponges which prohibit the fines and particulates from entering the bioretention chamber and accelerating potential clogging of the bioretention soil.
- Modular Wetland Systems are specifically designed for higher flow through treatment rates which reduce the potential for nutrient and copper leaching under more stagnant conditions (a common occurrence with planters that are left unmaintained).

Modular Wetlands by Modular Wetlands Systems, Inc. are proprietary biotreatment systems that utilize multi-stage treatment processes including screening media filtration, settling, and biofiltration. The pre-treatment chamber contains the first three stages of treatment, and includes a catch basin inlet filter to capture trash, debris, gross solids and sediments, a settling chamber for separating out larger solids, and a media filter cartridge for capturing fine TSS, metals, nutrients, and bacteria. Runoff then flows through the wetland chamber where treatment is achieved through a variety of physical, chemical, and biological processes. As storm water passes down through the planting soil, pollutants are filtered, adsorbed, biodegraded and sequestered by the soil and plants, functioning similar to bioretention systems. The discharge chamber at the end of the unit collects treated flows and discharges back into the storm drain system.

This system was selected based on its ability to treat the project's pollutants of concerns to a medium or high effectiveness, in accordance with the Model WQMP and TGD requirements. The table below summarizes the overall treatment effectiveness for Modular Wetlands, derived from Table 4.2 of the Technical Guidance Document and testing data provided by the manufacturer.

POLLUTANTS OF CONCERN AND PERFORMANCE RATINGS		
Pollutant of Concern	**Treatment Effectiveness**	
	Bioretention System [1]	**Modular Wetlands Proprietary Bioretention Units** [2]
Oil & Grease	High	High
Trash & Debris	High	High
Oxygen Demanding Substances	N/A	N/A
Toxic Organic Compounds	Medium	N/A[4]
Primary Pollutant of Concern (303d listed impairments & TMDLs)		
Suspended Solids/Sediments	High	High
Nutrients	Low	Medium-High
Metals	High	High
Pathogens/Bacteria	Medium	Medium-High
Pesticides	N/A	N/A

POLLUTANTS OF CONCERN AND PERFORMANCE RATINGS		
Pollutant of Concern	Treatment Effectiveness	
	Bioretention System (1)	Modular Wetlands Proprietary Bioretention Units (2)

Notes:
1 Per Table 4.2 of the Model WQMP's companion Technical Guidance Document dated December 20, 2013.
2 Based on Washington State University Technology Assessment Protocol – Ecology (TAPE) third-party independent field tests for a high-flow biotreatment system with raised under drain (Modular Wetland System-Linear). Refer to manufacturer documentation (attached) for specific removal efficiencies and source references.
3 Field and Lab Testing demonstrates 75-83% removal rates of Chemical Oxygen Demand (COD), a measure of the amount of organic pollutants commonly found in surface water. COD removals of this range would fall within the Medium-High effectiveness category.

In accordance with the Model WQMP and TGD, the bioretention/biotreatment BMPs will be sized to treat runoff from the Design Capture Storm (85th percentile, 24-hour). Since Modular Wetlands are sized based on flow rate, they were sized utilizing the methodology for flow based BMPs (TGD Section III.1.2 and Worksheet D).

MODULAR WETLAND DESIGN SUMMARY					
DMA(1)	Total Drainage Area (ac)	% Imp.	Q_{Design} (cfs)	Sizes / Models	Total Treatment Capacity(2) (cfs)
DMA D2 + E	0.34	81.6%	0.104	MWS-L-4-15-SM	0.113

Notes:
(1) Refer to WQMP Exhibit attached for locations of each drainage area and BMP.
(2) Treatment capacities of each unit are based on wetland media design loading rate (controlled by downstream orifice) and perimeter surface area of wetland media provided. Individual unit sizing calculations provided by the manufacturer are included on each cut sheet/detail included in Appendix A.

One Modular Wetland System (MWS) unit is proposed for DMA D2 street improvements to treat water quality volumes. A small portion of runoff in DMA E is unable to be captured and routed to a BMP due to grading and shallow storm drain elevation challenges. To offset this runoff, the MWS unit in DMA D2 has been upsized to account for the untreated flows. Runoff from DMA D2 will be treated with one MWS-L-4-15-SM unit. This shallow model unit will have a depth of 2.2' and a total treatment capacity of 0.113 cfs (see MWS location in the WQMP exhibit in Section VI).

Vegetated Swale

This BMP functions as a soil and plant-based filtration device that removes pollutants through a variety of physical, biological, and chemical treatment processes. Pollutants removed by adsorption include metals, phosphorus, and hydrocarbons. Filtration occurs as runoff passes through the bioswale. Plant cover and planting soil aid in dropping out particulates, sediment and pollutants adsorbed onto sediment (including, for example certain pesticides and pathogens). Nitrogen is removed by nitrifying and denitrifying bacteria, while aerobic bacteria are responsible for the decomposition of the organic matter.

An offsite swale along with two onsite swales are proposed to treat the remaining street improvements. The offsite swale that treats DMA C1 will be located on Los Alamitos Racecourse property. A cross lot drainage agreement, LARC Vessel's Drainage – Bioswale Acceptance, is provided in Appendix E. As

displayed in the design summary below, the swales have a residence time greater than 10 minutes and length longer than 100 ft consistent with the standards required in the Technical Guidance Document for removal of pollutants prior to discharge. Calculations can be found in Appendix A. A detail can be found on the WQMP exhibit in Section VI.

SWALE DESIGN SUMMARY						
DMA / BMP ID[1]	Total Drainage Area (ac)	% Imp.	Q_{Design}[2] (cfs)	Side Slopes (ft/ft) Bottom Width (ft)	Residence Time (min)	Swale Length Provided (ft)
DMA C1	0.20	85.2%	0.064	Side – 2, Bottom – 2	37	200
DMA C2	0.21	35.5%	0.035	Side – 2, Bottom – 2	39	213
DMA D1	0.20	32.2%	0.032	Side – 2, Bottom – 2	46	250

Notes:
(3) Refer to WQMP Exhibit in Section VI for locations of each drainage area and BMP.
(4) Detailed calculations and worksheets are included in Attachment 1.

Full Trash Capture (FCS)

Biotreatment BMPs, such as Modular Wetlands and Swales, are certified by the State Water Board as a Full Trash Capture device. BMPs in DMAs C1, C2, D1, and D2 were sized to the 1-year 1-hour storm event in compliance with the CA State Trash Provisions. Per request of the City, untreated flows in DMA E will enter one of two catch basins which will install a Connector Pipe Screen (CPS or similar) to capture trash for larger storm events in compliance with the CA Trash Provisions. See Section VI for a standard detail.

IV.3.5 Hydromodification Control BMPs

Not applicable. Refer to Section II.3 for further information.

IV.3.6 Regional/Sub-Regional LID BMPs

Not applicable. LID BMPs (biotreatment) will be utilized for water quality treatment on-site in accordance with the MS4 Permit hierarchy identified at the beginning of this Section.

IV.3.7 Treatment Control BMPs

Treatment control BMPs can only be considered if the project conformance analysis indicates that it is not feasible to retain the full design capture volume with LID BMPs.

TREATMENT CONTROL BMPs		
ID	Name	Included?
TRT-1	Sand Filters	☐
TRT-2	Cartridge Media Filter	☐
PRE-1	Hydrodynamic Separation Device	☐
PRE-2	Catch Basin Insert	☐
	Other:	☐

Not applicable. LID BMPs (biotreatment) will be utilized for water quality treatment on-site in accordance with the MS4 Permit hierarchy identified at the beginning of this Section.

IV.3.8 Non-Structural Source Control BMPs

The table below indicates all BMPs to be incorporated in the project. For those designated as not applicable (N/A), a brief explanation why is provided.

NON-STRUCTURAL SOURCE CONTROL BMPs				
ID	Name	Included?	Not Applicable?	If Not Applicable, Provide Brief Reason
N1	Education for Property Owners, Tenants and Occupants	☒	☐	
N2	Activity Restrictions	☒	☐	
N3	Common Area Landscape Management	☒	☐	
N4	BMP Maintenance	☒	☐	
N5	Title 22 CCR Compliance (How development will comply)	☐	☒	Not applicable – no hazardous materials.
N6	Local Water Quality Permit Compliance	☐	☒	The City of Cypress does not issue water quality permits.
N7	Spill Contingency Plan	☐	☒	Not applicable – no hazardous materials.
N8	Underground Storage Tank Compliance	☐	☒	No underground storage tanks are proposed.
N9	Hazardous Materials Disclosure Compliance	☐	☒	Hazardous materials will not be stored on-site.
N10	Uniform Fire Code Implementation	☐	☒	Not applicable – no hazardous materials.

NON-STRUCTURAL SOURCE CONTROL BMPs				
ID	Name	Included?	Not Applicable?	If Not Applicable, Provide Brief Reason
N11	Common Area Litter Control	☒	☐	
N12	Employee Training	☒	☐	
N13	Housekeeping of Loading Docks	☐	☒	No loading docks are proposed.
N14	Common Area Catch Basin Inspection	☒	☐	
N15	Street Sweeping Private Streets and Parking Lots	☒	☐	
N16	Retail Gasoline Outlets	☐	☒	No retail gasoline outlets are proposed.

N1, Education for Property Owners, Tenants and Occupants

Educational materials will be provided to tenants, including brochures and restrictions to reduce pollutants from reaching the storm drain system. Examples include tips for pet care, household tips, and proper household hazardous waste disposal. Tenants will be provided with these materials by the property management prior to occupancy, and periodically thereafter. Refer to Section VII for a list of materials available and attached to this WQMP. Additional materials are available through the County of Orange Stormwater Program website (http://ocwatersheds.com/PublicEd/) and the California Stormwater Quality Association's (CASQA) BMP Handbooks (http://www.cabmphandbooks.com/).

N2, Activity Restrictions

The Owner shall develop ongoing activity restrictions that include those that have the potential to create adverse impacts on water quality. Activities include, but are not limited to: handling and disposal of contaminants, fertilizer and pesticide application restrictions, litter control and pick-up, and vehicle or equipment repair and maintenance in non-designated areas, as well as any other activities that may potentially contribute to water pollution.

N3, Common Area Landscape Management

Management programs will be designed and implemented by the Owner to maintain all the common areas within the project site. These programs will cover how to reduce the potential pollutant sources of fertilizer and pesticide uses, utilization of water-efficient landscaping practices and proper disposal of landscape wastes by the owner/developer and/or contractors.

N4, BMP Maintenance

The Owner will be responsible for the implementation and maintenance of each applicable non-structural BMP, as well as scheduling inspections and maintenance of all applicable structural BMP facilities through its staff, landscape contractor, and/or any other necessary maintenance contractors.

Details on BMP maintenance are provided in Section V of this WQMP, and the O&M Plan is included in Appendix D.

N11, Common Area Litter Control

The Owner will be responsible for performing trash pickup and sweeping of littered common areas on a weekly basis or whenever necessary. Responsibilities will also include noting improper disposal materials by the public and reporting such violations for investigation.

N12, Employee Training

All employees of the Owner and any contractors will require training to ensure that employees are aware of maintenance activities that may result in pollutants reaching the storm drain. Training will include, but not be limited to, spill cleanup procedures, proper waste disposal, housekeeping practices, etc.

N14, Common Area Catch Basin Inspection

All on-site catch basin inlets and drainage facilities shall be inspected and maintained by the Owner at least once a year, prior to the rainy season, no later than October 1st of each year.

N15, Street Sweeping Private Streets and Parking Lots

The Owner shall be responsible for sweeping all on-site streets, drive aisles, and uncovered parking areas within the project on a monthly basis.

IV.3.9 Structural Source Control BMPs

The table below indicates all BMPs to be incorporated in the project. For those designated as not applicable (N/A), a brief explanation why is provided.

STRUCTURAL SOURCE CONTROL BMPs				
ID	Name	Included?	Not Applicable?	If Not Applicable, Provide Brief Reason
S1 SD-13	Provide storm drain system stenciling and signage	☒	☐	
S2 SD-34	Design and construct outdoor material storage areas to reduce pollution introduction	☐	☒	No outdoor storage areas are proposed.
S3 SD-32	Design and construct trash and waste storage areas to reduce pollution introduction	☐	☒	No outdoor trash enclosures are proposed.
S4 SD-12	Use efficient irrigation systems & landscape design, water conservation, smart controllers, and source control	☒	☐	

STRUCTURAL SOURCE CONTROL BMPs				
ID	Name	Included?	Not Applicable?	If Not Applicable, Provide Brief Reason
S5	Protect slopes and channels and provide energy dissipation	☐	☒	There are no slopes or channels on the project site.
S6 SD-31	Properly Design: Dock areas	☐	☒	No below-grade loading docks are proposed.
S7 SD-31	Properly Design: Maintenance bays	☐	☒	No maintenance bays are proposed.
S8 SD-33	Properly Design: Vehicle wash areas	☐	☒	No vehicle wash areas are proposed.
S9 SD-36	Properly Design: Outdoor processing areas	☐	☒	No outdoor processing areas are proposed.
S10	Properly Design: Equipment wash areas	☐	☒	No equipment wash areas are proposed.
S11 SD-30	Properly Design: Fueling areas	☐	☒	No fueling areas are proposed.
S12 SD-10	Properly Design: Hillside landscaping	☐	☒	Project is not located in a hillside area.
S13	Properly Design: Wash water control for food preparation areas	☐	☒	No food preparation areas or commercial kitchens are proposed.
S14	Properly Design: Community car wash racks	☐	☒	No community car wash racks are proposed.

S1/SD-13, Provide storm drain system stenciling and signage

The phrase "NO DUMPING! DRAINS TO OCEAN", or an equally effective phrase approved by the City, will be stenciled on all major storm drain inlets within the project site to alert the public to the destination of pollutants discharged into storm water. Stencils shall be in place prior to release of certificate of occupancy. Stencils shall be inspected for legibility on an annual basis and re-stenciled as necessary.

S4/SD-12, Use efficient irrigation systems & landscape design, water conservation, smart controllers, and source control

The Owner will be responsible for the installation and maintenance of all common landscape areas utilizing similar planting materials with similar water requirements to reduce excess irrigation runoff. The Owner will be responsible for implementing all efficient irrigation systems for common area landscaping including, but not limited to, provisions for water sensors and programmable irrigation cycles. This includes smart timers, rain sensors, and moisture shut-off valves. The irrigation systems shall be in conformance with water efficiency guidelines. Systems shall be tested twice per year, and water used during testing/flushing shall not be discharged to the storm drain system.

IV.4 ALTERNATIVE COMPLIANCE PLAN

IV.4.1 Water Quality Credits

Local jurisdictions may develop a water quality credit program that applies to certain types of development projects after they first evaluate the feasibility of meeting LID requirements on-site. If it is not feasible to meet the requirements for on-site LID, project proponents for specific project types can apply credits that would reduce project obligations for selecting and sizing other treatment BMPs or participating in other alternative programs.

WATER QUALITY CREDITS	
Credit	**Applicable?**
Redevelopment projects that reduce the overall impervious footprint of the project site.	☐
Brownfield redevelopment, meaning redevelopment, expansion, or reuse of real property which may be complicated by the presence or potential presence of hazardous substances, pollutants or contaminants, and which have the potential to contribute to adverse ground or surface water quality if not redeveloped.	☐
Higher density development projects which include two distinct categories (credits can only be taken for one category): those with more than seven units per acre of development (lower credit allowance); vertical density developments, for example, those with a Floor to Area Ratio (FAR) of 2 or those having more than 18 units per acre (greater credit allowance)	☐
Mixed use development, such as a combination of residential, commercial, industrial, office, institutional, or other land uses which incorporate design principles that can demonstrate environmental benefits that would not be realized through single use projects (e.g. reduced vehicle trip traffic with the potential to reduce sources of water or air pollution).	☐
Transit-oriented developments, such as a mixed use residential or commercial area designed to maximize access to public transportation; similar to above criterion, but where the development center is within one half mile of a mass transit center (e.g. bus, rail, light rail or commuter train station). Such projects would not be able to take credit for both categories, but may have greater credit assigned	☐
Redevelopment projects in an established historic district, historic preservation area, or similar significant city area including core City Center areas (to be defined through mapping).	☐
Developments with dedication of undeveloped portions to parks, preservation areas and other pervious uses.	☐
Developments in a city center area.	☐
Developments in historic districts or historic preservation areas.	☐
Live-work developments, a variety of developments designed to support residential and vocational needs together – similar to criteria to mixed use development; would not be able to take credit for both categories.	☐

WATER QUALITY CREDITS	
Credit	**Applicable?**
In-fill projects, the conversion of empty lots and other underused spaces into more beneficially used spaces, such as residential or commercial areas.	☐

Not applicable. Water quality credits will not be applied for the project. LID BMPs will be utilized for water quality treatment on-site in accordance with the MS4 Permit hierarchy identified at the beginning of this Section.

IV.4.2 Alternative Compliance Plan Information

Not applicable. LID BMPs (biotreatment) will be utilized for water quality treatment on-site in accordance with the MS4 Permit hierarchy identified at the beginning of this Section.

SECTION V INSPECTION/MAINTENANCE RESPONSIBILITY FOR BMPs

It has been determined that Melia Homes shall assume all BMP inspection and maintenance responsibilities for the Vessels Circle project.

Contact Name:	Chad Brown
Title:	Vice President of Planning and Development
Company:	Melia Homes
Address:	8951 Research Drive, Suite 100, Irvine, CA 92618
Phone:	949.468.9430
Email:	chad@melia-homes.com

Should the maintenance responsibility be transferred at any time during the operational life of Vessels Circle, such as when an HOA or POA is formed for a project, a formal notice of transfer shall be submitted to the City of Cypress at the time responsibility of the property subject to this WQMP is transferred. The transfer of responsibility shall be incorporated into this WQMP as an amendment.

The Owner shall verify BMP implementation and ongoing maintenance through inspection, self-certification, survey, or other equally effective measure. The certification shall verify that, at a minimum, the inspection and maintenance of all structural BMPs including inspection and performance of any required maintenance in the late summer / early fall, prior to the start of the rainy season. A form that may be used to record implementation, maintenance, and inspection of BMPs is included in Appendix D.

The City of Cypress may conduct verifications to assure that implementation and appropriate maintenance of structural and non-structural BMPs prescribed within this WQMP is taking place at the project site. The Owner shall retain operations, inspections and maintenance records of these BMPs and they will be made available to the City or County upon request. All records must be maintained for at least five (5) years after the recorded inspection date for the lifetime of the project.

Long-term funding for BMP maintenance will be provided by Melia Homes. Once established, the HOA will be responsible to inform residents of established CC&Rs in compliance with the O&M of the project's WQMP as well as maintain and upkeep structural BMPs outlined in the O&M. Through vendor communication, it has been estimated that the annual budget for maintaining the proposed BMPs will cost around $1,300 per year.

The Operations and Maintenance (O&M) Plan can be found in Appendix D.

BMP INSPECTION & MAINTENANCE RESPONSIBILITY MATRIX				
	BMP	Inspection/Maintenance Activities	Minimum Frequency	Responsible Party
BIOTREATMENT BMPs				
BIO-7	Proprietary Biotreatment: Modular Wetland Systems (MWS)	The Modular Wetland unit shall be maintained in accordance with manufacturer's specifications. The system shall be inspected at a minimum of once every six months, prior to the start of the rainy season (October 1) each year, and after major storm events. Typical maintenance includes removing trash & debris from the catch basin screening filter (by hand), removal of sediment and solids in the settlement chamber (vacuum truck), replacement of the BioMediaGREEN™ filter cartridge, and replacement of the BioMediaGREEN™ drain down filter (if equipped). In addition, plants within the wetland chamber will require trimming as needed in conjunction with routine landscape maintenance activities. No fertilizer shall be used in this chamber. Wetland chamber should be inspected during rain events to verify flow through the system. If little to no flow is observed from the lower valve or orifice plate, the wetland media may require replacement. If prior treatment stages are properly maintained, the life of the wetland media can be up to 20 years.	2x per year	Melia Homes until future City of Cypress dedication

BMP INSPECTION & MAINTENANCE RESPONSIBILITY MATRIX				
	BMP	**Inspection/Maintenance Activities**	**Minimum Frequency**	**Responsible Party**
BIO-2	Vegetated Swale	Maintenance activities should include periodic mowing (with grass never cut shorter than the design flow depth), weed control, watering during drought conditions, reseeding of bare areas, and clearing of debris and blockages. Cuttings should be removed from the channel and disposed in a local composting facility. Accumulated sediment should also be removed manually to avoid concentrated flows in the swale. The application of fertilizers and pesticides should be minimal. If the channel develops ruts or holes, it should be repaired utilizing a suitable soil that is properly tamped and seeded. The grass cover should be thick; if it is not, reseed as necessary. Any standing water removed during the maintenance operation must be disposed to a sanitary sewer at an approved discharge location. Residuals (e.g., silt, grass cuttings) must be disposed in accordance with local or State requirements.	2x per year	Melia Homes until future City of Cypress dedication
PRE-2	Full Capture Trash System Bio Clean (or similar) Connector Pipe Screen	During the rainy season (October 1 – April 30), the catch basins with connector pipe screens should be inspected monthly and cleaned out at least once per year at a minimum. Manufacturer recommends cleaning the insert four times per year.	Monthly Inspections Cleanout Annually and before major storm events (min.)	Melia Homes until future City of Cypress dedication
NON-STRUCTURAL SOURCE CONTROL BMPs				

BMP INSPECTION & MAINTENANCE RESPONSIBILITY MATRIX				
	BMP	**Inspection/Maintenance Activities**	**Minimum Frequency**	**Responsible Party**
N1	Education for Property Owners, Tenants and Occupants	Educational materials will be provided to tenants annually. Materials to be distributed are found in Appendix C of this WQMP. Tenants will be provided these materials by the Property Management prior to occupancy and annually thereafter.	Annually	Melia Homes until future City of Cypress dedication
N2	Activity Restrictions	The Owner will prescribe activity restrictions to protect surface water quality, through lease terms or other equally effective measure, for the property. Restrictions include, but are not limited to, prohibiting vehicle maintenance or vehicle washing.	Ongoing	Melia Homes until future City of Cypress dedication
N3	Common Area Landscape Management	Maintenance shall be consistent with City requirements. Fertilizer and/or pesticide usage shall be consistent with County Management Guidelines for Use of Fertilizers (OC DAMP Section 5.5). Maintenance includes mowing, weeding, and debris removal on a weekly basis. Trimming, replanting, and replacement of mulch shall be performed on an as-needed basis to prevent exposure of erodible surfaces. Trimmings, clippings, and other landscape wastes shall be properly disposed of in accordance with local regulations. Materials temporarily stockpiled during maintenance activities shall be placed away from water courses and storm drains inlets.	Monthly	Melia Homes until future City of Cypress dedication
N4	BMP Maintenance	Maintenance of structural BMPs implemented at the project site shall be performed at the frequency prescribed in this WQMP. Records of inspections and BMP maintenance shall be kept by the Owner and shall be available for review upon request.	Ongoing	Melia Homes until future City of Cypress dedication

BMP INSPECTION & MAINTENANCE RESPONSIBILITY MATRIX				
	BMP	**Inspection/Maintenance Activities**	**Minimum Frequency**	**Responsible Party**
N11	Common Area Litter Control	Litter patrol, violations investigations, reporting and other litter control activities shall be performed on a weekly basis and in conjunction with routine maintenance activities.	Weekly	Melia Homes until future City of Cypress dedication
N12	Employee Training	The Owner shall educate all new employees/ managers on storm water pollution prevention, particularly good housekeeping practices, prior to the start of the rainy season (October 1). Refresher courses shall be conducted on an as needed basis. Materials that may be utilized on BMP maintenance are included in Appendix D.	Annually	Melia Homes until future City of Cypress dedication
N14	Common Area Catch Basin Inspection	Catch basin inlets and other drainage facilities shall be inspected monthly. Inlets and other facilities shall be cleaned when the sump is 40% full and annually at a minimum.	Annually	Melia Homes until future City of Cypress dedication
N15	Street Sweeping Private Streets and Parking Lots	On-site parking lots and drive aisles will be swept on a monthly basis, at minimum.	Monthly	Melia Homes until future City of Cypress dedication
STRUCTURAL SOURCE CONTROL BMPs				
S1 SD-13	Provide storm drain system stenciling and signage	Stenciling shall be inspected for legibility no later than the beginning of the rainy season on October 1st of each year. Stenciling must be re-stenciled to maintain legibility as necessary and when deemed necessary by the local inspecting agency.	Annually	Melia Homes until future City of Cypress dedication

BMP INSPECTION & MAINTENANCE RESPONSIBILITY MATRIX				
	BMP	Inspection/Maintenance Activities	Minimum Frequency	Responsible Party
S4 SD-12	Use efficient irrigation systems & landscape design, water conservation, smart controllers, and source control	In conjunction with routine maintenance, verify that landscape design continues to function properly by adjusting systems to eliminate overspray to hardscape areas and to verify that irrigation timing and cycle lengths are adjusted in accordance to water demands, given the time of year, weather, and day or nighttime temperatures. System testing shall occur twice per year. Water from testing/flushing shall be collected and properly disposed to the sewer system and shall not discharge to the storm drain system.	2x per year	Melia Homes until future City of Cypress dedication

Any waste generated from maintenance activities will be disposed of properly. Wash water and other waste from maintenance activities is not to be discharged or disposed of into the storm drain system. Clippings from landscape maintenance (i.e. prunings) will be collected and disposed of properly off-site, and will not be washed into the streets, local area drains/conveyances, or catch basin inlets.

SECTION VI SITE PLAN AND DRAINAGE PLAN

The exhibits provided in this section are to illustrate the post construction BMPs prescribed within this WQMP. Drainage flow information of the proposed project, such as general surface flow lines, concrete or other surface drainage conveyances, and storm drain facilities are also depicted. All structural source control and treatment control BMPs are shown as well.

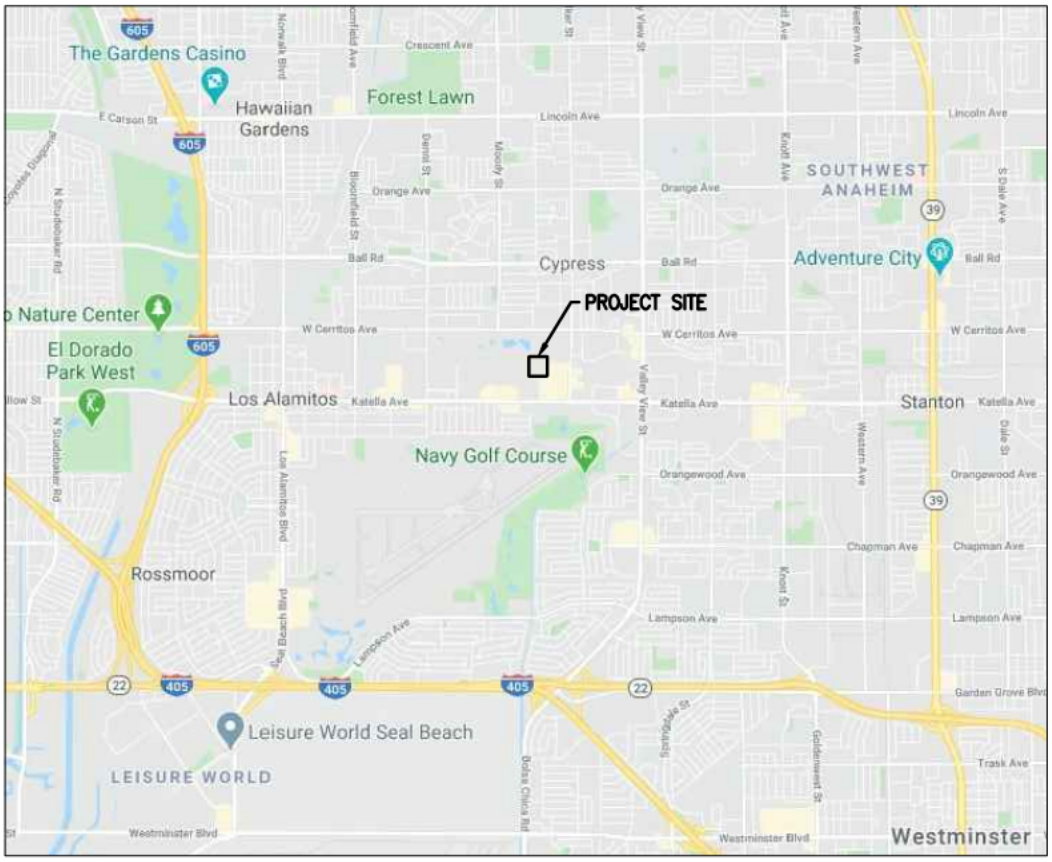
EXHIBITS

- Vicinity Map
- WQMP Exhibit

BMP DETAILS & FACT SHEETS

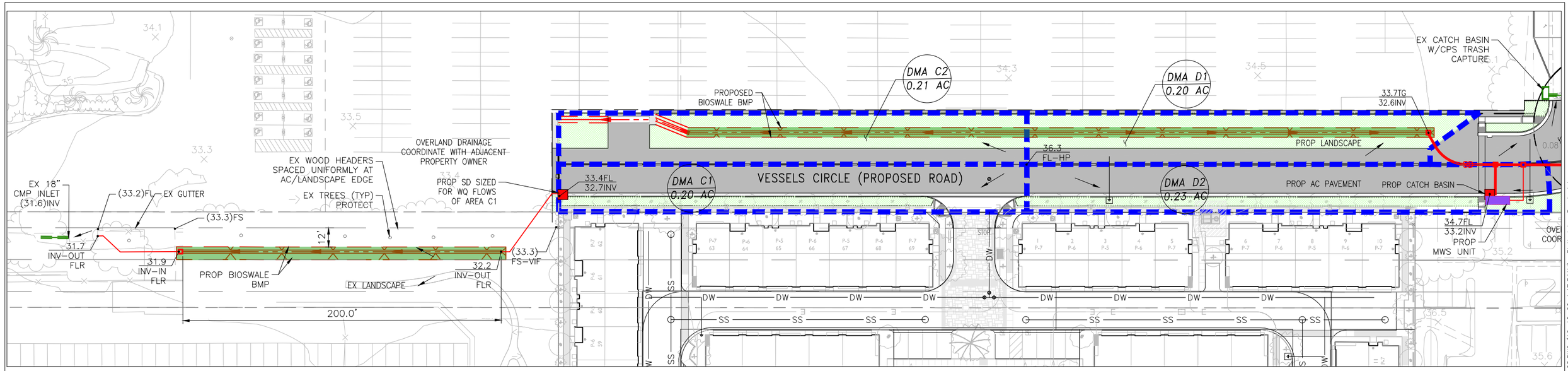
- Connector Pipe Screen Standard Detail
- Vegetated Swale (BIO-2)
- Planting / Storage Media (MISC-1)
- Proprietary Bioretention (BIO-7)

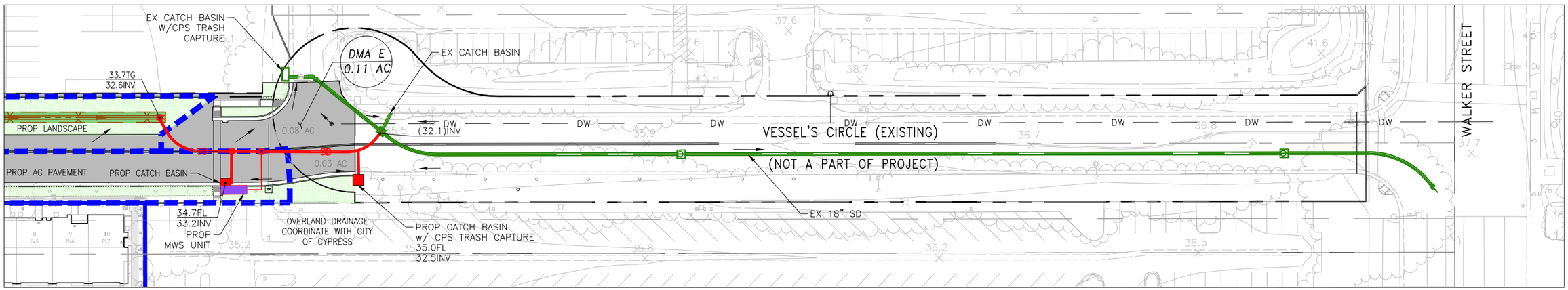
VICINITY MAP



VICINITY MAP

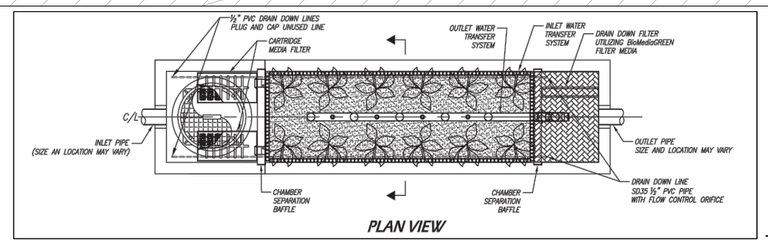
NTS

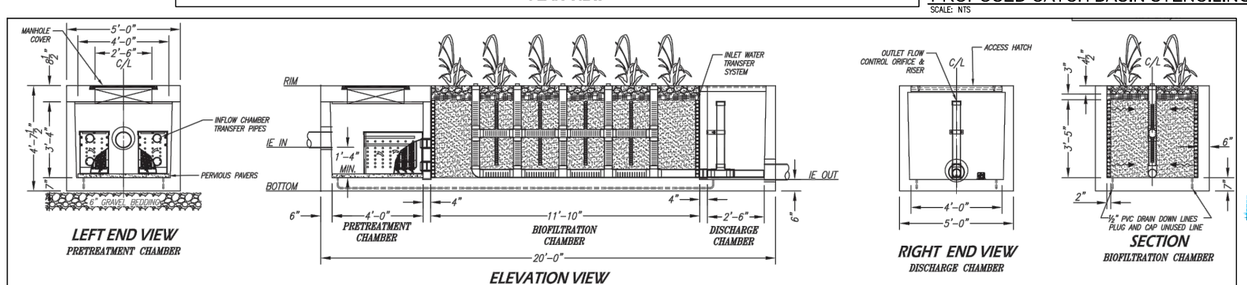




LEGEND

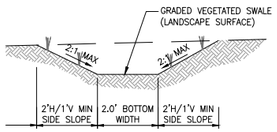
- PROPERTY LINE
- EXISTING STORM DRAIN
- PROPOSED STORM DRAIN
- BMP DRAINAGE AREA BOUNDARY
- RIGHT OF WAY LANDSCAPING
- PUBLIC STREET IMPROVEMENTS
- CATCH BASIN STENCILING & MAINTENANCE (1 / -)
- PROPOSED MODULAR WETLAND SYSTEM (MWS) (2 / -) *HAS BEEN UPSIZED TO OFFSET DMA E
- PROPOSED BIOSWALE BMP (3 / -)
- DRAINAGE MANAGEMENT AREA AND ACREAGE (DMA1 / X.XX AC)





PROPRIETARY BIOFILTRATION UNIT (MODULAR WETLANDS SYSTEM) (2 / -)
SCALE: NTS

PROPOSED CATCH BASIN STENCILING (1 / -)
SCALE: NTS



PROPOSED BIOSWALE BMP (3 / -)
SCALE: NTS
PER OC TECHNICAL GUIDANCE BIO-2

N

60' 0' 30' 60'

SCALE: 1" = 60'

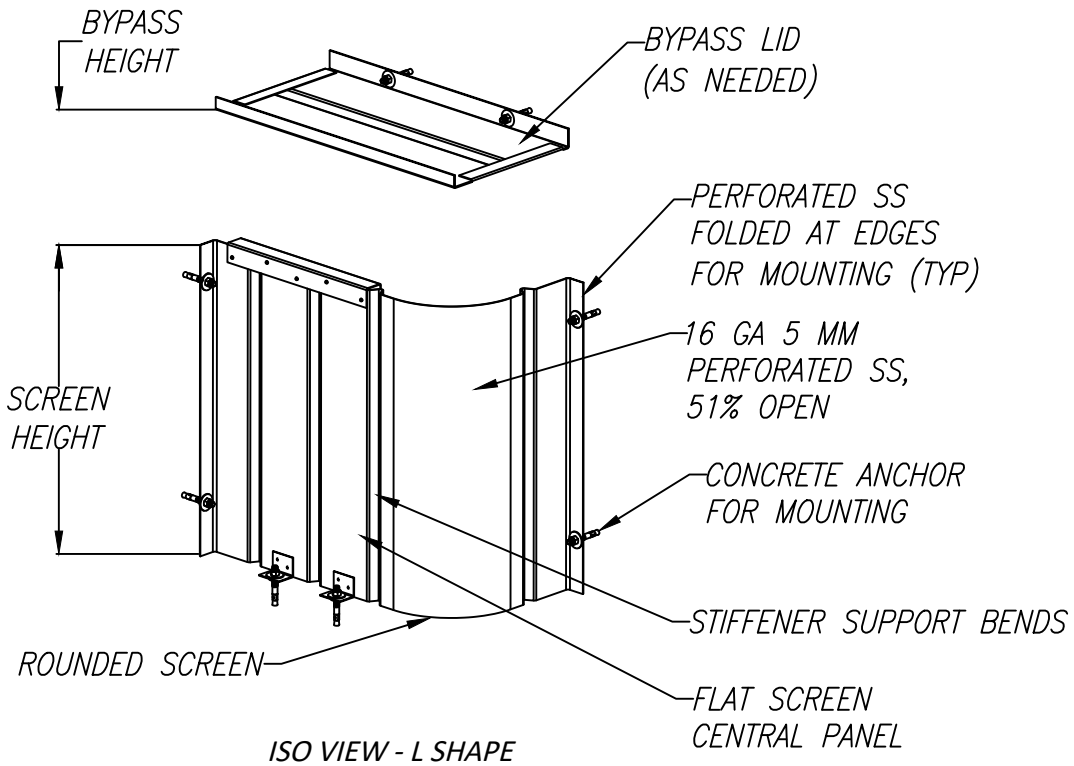
FUSCOE ENGINEERING
16795 Von Karman, Suite 100
Irvine, California 92606
tel 949.474.1960 • fax 949.474.5315
www.fuscoe.com

PRELIMINARY WATER QUALITY MANAGEMENT PLAN

VESSEL'S CIRCLE IMPROVEMENTS

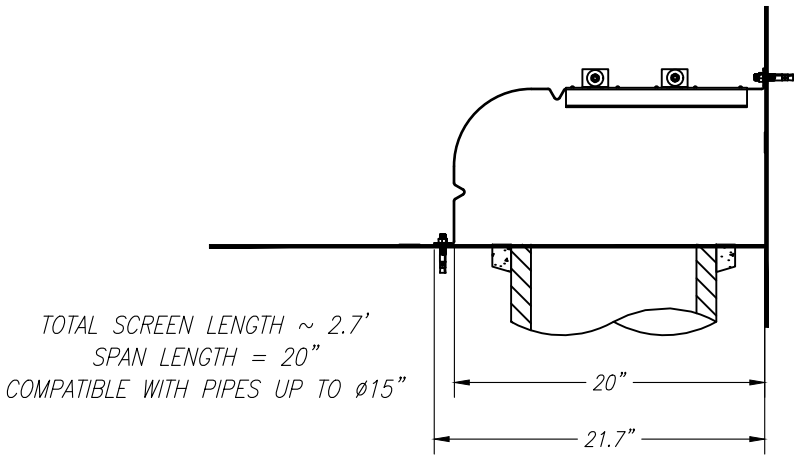
CYPRESS, CA

CONNECTOR PIPE SCREEN (CPS)
L 2.7



ISO VIEW - L SHAPE

CPS L WITH 2.7 FT SCREEN LENGTH	
CPS HEIGHT (IN)	SCREEN FLOW (CFS)
12	3.84
18	7.06
24	10.88
30	15.20
36	19.99
NOTE: BYPASS FLOW RATES VARY WITH VAULT DEPTH AND BYPASS HEIGHT. CONTACT BIO CLEAN FOR ADDITIONAL INFORMATION.	



TOP SECTION VIEW - L SHAPE

GENERAL NOTES

1. BIO CLEAN TO PROVIDE ALL MATERIALS UNLESS OTHERWISE NOTED.
2. ALL DIMENSIONS, ELEVATIONS, SPECIFICATIONS, AND CAPACITIES ARE SUBJECT TO CHANGE.
3. THIS CPS UNIT IS DESIGNED FOR TREATMENT FLOWS THROUGH THE SCREEN. FLOWS GREATER THAN THE TREATMENT FLOW RATE WILL BYPASS OVER THE SCREEN.
4. A BYPASS LID IS REQUIRED WHEN THE OUTLET PIPE IS DIRECTLY BELOW THE CURB OPENING.
5. CPS IS COMPRISED OF 304 STAINLESS STEEL. THICKNESS IS 16 GAUGE. SCREEN PERFORATIONS ARE 5 MILLIMETERS IN DIAMETER. THE SCREEN AREA IS 51% OPEN SPACE.

INSTALLATION NOTES

1. CONTRACTOR TO PROVIDE ALL LABOR, EQUIPMENT, MATERIALS, AND INCIDENTALS REQUIRED TO INSTALL THE CPS UNIT AND APPURTENANCES IN ACCORDANCE WITH THIS DRAWING AND THE MANUFACTURER'S SPECIFICATIONS, UNLESS OTHERWISE STATED IN MANUFACTURER'S CONTRACT.
2. POSITION THE CPS SO IT IS EVENLY SPACED AROUND THE CONNECTOR PIPE, ENSURING A MIN. OF 4" SPACING AWAY FROM ANY CORNERS. SCREEN BOTTOM SHALL BE FLUSH WITH THE CATCH BASIN FLOOR, OR WITH GAPS NO GREATER THAN 5 MM.
3. IF A BYPASS LID IS REQUIRED, VERIFY THE BYPASS HEIGHT NEEDED AND MARK THAT LOCATION ON THE WALL DIRECTLY ABOVE THE BASE UPRIGHTS. LIFT THE LID IN PLACE AND MARK THE HOLE LOCATIONS FOR THE LID MOUNTING BRACKETS. SECURE THE LID WITH STAINLESS STEEL NUTS.

WARRANTY: 3 YEAR MANUFACTURER'S		MEETS FULL CAPTURE REQUIREMENTS	
BIO CLEAN ENVIRONMENTAL SERVICES, INC. 398 VIA EL CENTRO, OCEANSIDE CA 92058 PHONE: 760-433-7640		REVISIONS:	DATE:
		REVISIONS:	DATE:
DATE: 1/17/2020	SCALE: NTS	REVISIONS:	DATE:
DRAFTER: G.M.S.	UNITS = INCHES	REVISIONS:	DATE:

Bio Clean
A Forterra Company

BIO-2: Vegetated Swale

Also known as:

- *Bioswale*
- *Biofiltration swale*
- *Grass swale*

Vegetated Swale
Source: Geosyntec Consultants

Vegetated swale filters (vegetated swales) are open, shallow channels with low-lying vegetation covering the side slopes and bottom that collect and slowly convey runoff flow to downstream discharge points. Vegetated swales provide pollutant removal through settling and filtration in the vegetation (usually grasses) lining the channels. In addition, they provide the opportunity for volume reduction through infiltration and ET, and reduce the flow velocity in addition to conveying storm water runoff. Where soil conditions allow, volume reduction in vegetated swales can be enhanced by adding a gravel drainage layer underneath the swale allowing additional flows to be retained and infiltrated. Where slopes are shallow and soil conditions limit or prohibit infiltration, an underdrain system or low flow channel for dry weather flows may be required to minimize ponding and convey treated and/or dry weather flows to an acceptable discharge point. An effective vegetated swale achieves uniform sheet flow through a densely vegetated area for a period of several minutes. The vegetation in the swale can vary depending on its location within the project area and is generally the choice of the designer, subject to the design criteria outlined in this section.

Feasibility Screening Considerations

- Swales may cause incidental infiltration; however, infiltration is not a mandatory mechanism for pollutant removal for swales and it may create hazards in some circumstances. Therefore, conditions should be evaluated to determine whether circumstances require an impermeable liner to avoid infiltration into the subsurface.

Opportunity Criteria

- Open areas are needed for vegetated swales, including, but not limited to, road shoulders, road medians, parks and athletic fields and can be constructed in residential or commercial areas.
- Site slope is less than 10 percent.
- Drainage area is ≤ 5 acres.
- Vegetated swales must not interfere with flood control functions of existing conveyance and detention structures.

OC-Specific Design Criteria and Considerations

☐ Swales should have a minimum bottom width of 2 feet and a maximum bottom width of 10 feet. Swale dividers should be used if the bottom width must exceed 10 feet to promote even distribution of flow across the swale. Local juridictions may require larger minimum widths based on maintenance requirements.

☐ The channel side slope should not exceed 2:1 (H:V) for a total swale depth of 1 foot or less. For deeper swales or mowed grass swales, the maximum channel side slope should be 3:1. Where space is constrained, swales may have vertical concrete or block walls provided that slope

stability, maintenance access and public safety considerations are met.

- ☐ The minimum swale length for biotreatment applications is 100 feet. The minimum residence time for flows in the swale is 10 minutes.
- ☐ If slope is less than 1.5%, underdrains should be provided for the length of the swale
- ☐ A gravel blanket or bedding is required around the underdrain pipe(s). At least 0.5 feet of washed aggregate must be placed below, to the top, and to the sides of the underdrain pipe(s).
- ☐ If an underdrain is included, an amended soil layer of 1 foot minimum thickness must be provided above the underdrain meeting the specifications of MISC-1: Planting/Storage Media.
- ☐ The maximum bed slope in flow direction should not exceed 6% (unles check dams are provided).
- ☐ The maximum flow velocity should not exceed 1.0 ft/sec for water quality treatment swales.
- ☐ For infrequently mowed swales, a maximum flow depth of 4 inches should be implemented. For frequently mowed turf swales, the maximum flow depth is 2 inches.
- ☐ The vegetation height should be maintained between 4 to 6 inches.
- ☐ Gradual meandering bends in the swale are desirable for aesthetic purposes and to promote slower flow and particulate settling.
- ☐ Blockages in the swale that result in uneven flow distribution and points of concentrated flow should be avoided. Blockages that should be avoided include trees, bushes, light pole piers, and utility vaults or pads.

Sizing Method for Vegetated Swales

The Design Capture Method for Flow-based BMPs should be used to determine the design flowrate for a vegetated swale. The user then selects the design flow depth and longitudinal slope and uses the sizing steps below to determine the length and width of the swale. The sizing steps are as follows:

Step 1: Determine Design Flowrate (Q)

Calculate the Design Flowrate (Q) using the Capture Efficiency Method for Flow-based BMPs (See **Appendix III.3.3**). Inputs include the time of concentration of the catchment (T_c) and the capture efficiency achieved upstream by HSCs or other BMPs.

Step 2: Estimate the Swale Bottom Width

For shallow flow depths, channel side slopes can be ignored and the bottom width can be calculated using a simplified form of Manning's formula:

$$b = (Q \times n_{WQ}) / (1.49 \times y^{1.67} \times s^{0.5})$$

Where:

b = estimated swale bottom width, ft

Q = design flowrate, cfs

n_{WQ} = Manning's roughness coefficient for shallow flow conditions, use 0.2 unless other information is available

y = design flow depth, ft (not to exceed 4 inches or 0.33 ft)

s = longitudinal slope in flow direction, ft/ft (not to exceed 0.06)

If b is between 2 and 10 feet, proceed to step 3.

If b is less than 2 feet, increase b to 2 feet and recalculate design flow depth using the following:

$$y = ((Q \times n_{WQ}) / (1.49 \times b \times s^{0.5}))^{0.6}$$

If b is greater than 10 feet, one of the following steps is necessary:

- Increase longitudinal slope to a maximum of 6% or 0.06, and recalculate b
- Increase design flow depth to a maximum of 4 inches or 0.33 ft, and recalculate b
- Install a divider lengthwise along swale bottom at least three-quarters of the swale length, beginning at the inlet. The swale width can be increased to 16 feet if a divider is provided.

Step 3: Determine Design Flow Velocity

Calculate the design flow velocity using the following equation:

$$V_{WQ} = Q / A_{WQ}$$

Where:

V_{WQ} = design flow velocity, fps

Q = design flowrate, cfs

$A_{WQ} = by + Zy^2$, cross sectional area of flow at design depth

Z = side slope length per unit height

If the design flow velocity exceeds 1 foot per second, design parameters in Step 2 should be adjusted (slope, bottom width, or design flow depth) until V_{WQ} is equal or less than 1 fps.

Step 4: Calculate Swale Length

Calculate the swale length needed to achieve a minimum hydraulic residence time of 10 minutes using the following equation:

$$L = 60 \times t_{HR} \times V_{WQ}$$

Where:

L = swale length, ft

t_{HR} = hydraulic residence time, min (minimum 10 minutes)

V_{WQ} = design flow velocity, fps

Step 5: If Needed, Adjust Swale Length to Site Constraints

Note that oftentimes swale length can be accomodated by providing a meandering swale. However, if swale length is too large for the site, the length can be adjusted as follows:

- Calculate the swale treatment top area (A_{top}), based on the swale length calculated in Step 4:

$$A_{TOP} = (b_i + b_{SLOPE}) \times L_i$$

Where:

A_{TOP} = top area (ft^2) at the design treatment depth

b_i = bottom width (ft), calculated in Step 2

b_{SLOPE} = the additional top width (ft) above the side slope for the design water depth (for 3:1 side slopes and a 4-inch water depth, b_{slope} = 2 feet)

L_i = initial length (ft) calculated in Step 4

- Use the swale top area and a reduced swale length (L_f) to increase the bottom width, using the following equation:

$$L_F = A_{TOP} / (b_F + b_{SLOPE})$$

Where:

L_F = reduced swale length (ft)

b_F = increased bottom width (ft)

- Recalculate V_{WQ} according to Step 3 using the revised cross-sectional area A_{WQ} based on the increased bottom width (b_F). Revise the design as necessary if the design flow velocity exceeds 1 foot per second.
- Recalculate to ensure that the 10 minute retention time is retained.

Configuration for Use in a Treatment Train

- Vegetated swales can be incorporated in a treatment train to provide enhanced water quality treatment and reductions in runoff volume and rate. For example, if a vegetated swale is placed upgradient of a dry extended detention (ED) basin, the rate and volume of water flowing to the dry ED basin can be reduced and the water quality enhanced. As another example, dry ED basins may be placed upstream a vegetated swale to reduce the size of the vegetated swale.
- Vegetated swales can be used as pretreatment for infiltration BMPs.
- If designed with an infiltration sump, vegetated "bioinfiltration" swales can provide retention and biotreatment capacity.

Additional References for Design Guidance

Los Angeles Unified School District (LAUSD) Stormwater Technical Manual, Chapter 4:
http://www.laschools.org/employee/design/fs-studies-and-reports/download/white_paper_report_material/Storm_Water_Technical_Manual_2009-opt-red.pdf?version_id=76975850

Santa Barbara BMP Guidance Manual, Chapter 6:
http://www.santabarbaraca.gov/NR/rdonlyres/91D1FA75-C185-491E-A882-49EE17789DF8/0/Manual_071008_Final.pdf

- County of San Diego Drainage Design Manual for design criteria, Section 5.5:
http://www.co.san-diego.ca.us/dpw/floodcontrol/floodcontrolpdf/drainage-designmanual05.pdf

  County of Los Angeles Low Impact Development Standards Manual, Chapter 5:
http://dpw.lacounty.gov/wmd/LA_County_LID_Manual.pdf
- Los Angeles County Stormwater BMP Design and Maintenance Manual:
http://dpw.lacounty.gov/DES/design_manuals/StormwaterBMPDesignandMaintenance.pdf

XIV.2. Miscellaneous BMP Design Element Fact Sheets (MISC)

MISC-1: Planting/Storage Media

Planting and storage media is a critical design element for several common BMP types, including bioretention, bioinfiltration, swales, filter strips, and greenroofs. This fact sheet is intended to be used as referenced from these fact sheets.

Also known as:

- *Bioretention soil media (BSM)*

Street-end biofiltration with planting/storage media
Source: City of Portland

General Design Criteria

- Planting/storage media should be designed to achieve the long term hydraulic design requirements associated with the design of the facility (i.e., design K_{sat}).
- The planting media shall be designed to address pollutants of concern at the design hydraulic capacity.
- Bioretention soil shall also support vigorous plant growth.
- Planting media should consist of 60 to 80% fine sand and 20 to 40% compost.
- Planting media for projects draining to nutrient sensitive receiving water should adhere to recommendations for nutrient sensitive planting media provided below.

Sand

- Sand should be free of wood, waste, coating such as clay, stone dust, carbonate, etc., or any other deleterious material. All aggregate passing the No. 200 sieve size should be non-plastic. Sand for bioretention should be analyzed by an accredited lab using #200, #100, #40, #30, #16, #8, #4, and 3/8 sieves (ASTM D 422 or as approved by the local permitting authority) and meet the following gradation (Note: all sands complying with ASTM C33 for fine aggregate comply with the gradation requirements below):

Sieve Size (ASTM D422)	% Passing (by weight)	
	Minimum	Maximum
3/8 inch	100	100
#4	90	100
#8	70	100
#16	40	95
#30	15	70
#40	5	55
#100	0	15
#200	0	5

- Note: the gradation of the sand component of the media is believed to be a major factor in the hydraulic conductivity of the media mix. If the desired hydraulic conductivity of the media cannot be achieved within the specified proportions of sand and compost (#2), then it may be necessary to utilize sand at the coarser end of the range specified in the table above ("minimum" column).

Compost

Compost should be a well decomposed, stable, weed free organic matter source derived from waste materials including yard debris, wood wastes, or other organic materials not including manure or biosolids meeting standards developed by the US Composting Council (USCC). The product shall be certified through the USCC Seal of Testing Assurance (STA) Program (a compost testing and information disclosure program). Compost quality should be verified via a lab analysis to be:

- Feedstock materials shall be specified and include one or more of the following: landscape/yard trimmings, grass clippings, food scraps, and agricultural crop residues.
- Organic matter: 35-75% dry weight basis.
- Carbon and Nitrogen Ratio: 15:1 < C:N < 25:1
- Maturity/Stability: shall have dark brown color and a soil-like odor. Compost exhibiting a sour or putrid smell, containing recognizable grass or leaves, or is hot (120 F) upon delivery or rewetting is not acceptable.
- Toxicity: any one of the following measures is sufficient to indicate non-toxicity:
    - NH4:NH3 < 3
    - Ammonium < 500 ppm, dry weight basis
    - Seed Germination > 80% of control
    - Plant trials > 80% of control
- Solvita® > 5 index value
- Nutrient content:
    - Total Nitrogen content 0.9% or above preferred
    - Total Boron should be <80 ppm, soluble boron < 2.5 ppm
- Salinity: < 6.0 mmhos/cm
- pH between 6.5 and 8 (may vary with plant palette)
- Compost for bioretention should be analyzed by an accredited lab using #200, ¼ inch, ½ inch, and 1 inch sieves (ASTM D 422 or as approved by the local permitting authority) and meet the following gradation:

Sieve Size (ASTM D422)	% Passing (by weight)	
	Minimum	Maximum
1 inch	99	100
½ inch	90	100
¼ inch	40	90
#200	2	10

- Tests should be sufficiently recent to represent the actual material that is anticipated to be delivered to the site. If processes or sources used by the supplier have changed significantly since the most recent testing, new tests should be requested.
- Note: the gradation of compost used in bioretention media is believed to play an important role in the saturated hydraulic conductivity of the media. To achieve a higher saturated hydraulic conductivity, it may be necessary to utilize compost at the coarser end of this range ("minimum" column). The percent passing the #200 sieve (fines) is believed to be the most important factor in hydraulic conductivity. In addition, a coarser compost mix provides more heterogeneity of the bioretention media, which is believed to be advantageous for more rapid development of soil structure needed to support health biological processes. This may be an advantage for plant establishment with lower nutrient and water input.

Mulch

- Planting area should generally be covered with 2 to 4 inches (average 3 inches) of mulch at the start and an additional placement of 1 to 2 inches of mulch should be added annually. *The intention is that to help sustain the nutrient levels, suppress weeds, retain moisture, and maintain infiltration capacity*.
- For nutrient-sensitive planting/storage media design, inorganic mulch such as gravel, may be used.

Planting/Storage Media Design for Nutrient Sensitive Receiving Waters

Where the BMP discharges to receiving waters with nutrient impairments or nutrient TMDLs, the planting media placed should be designed with the specific goal of minimizing the potential for initial and long term leaching of nutrients from the media.

- In general, the potential for leaching of nutrients can be minimized by:
  - Utilizing stable, aged compost (as required of media mixes under all conditions).
  - Utilizing other sources of organic matter, as appropriate, that are safe, non-toxic, and have lower potential for nutrient leaching than compost.
  - Reducing the content of compost or other organic material in the media mix to the minimum amount necessary to support vigorous plant growth and healthy biological processes.
- A landscape architect should be consulted to assist in the design of planting/storage media to balance the interests of plant establishment, water retention capacity (irrigation demand), and the potential for nutrient leaching. The following practices should be considered in developing the media mix design:
  - The actual nutrient content and organic content of the selected compost source should be considered when specifying the proportions of compost and sand. The compost specification allows a range of organic content over approximately a factor of 2 and nutrient content may vary more widely. Therefore determining the actual organic content and nutrient content of the compost expected to be supplied is important in determining the proportion to be used for amendment.
  - A commitment to periodic soil testing for nutrient content and a commitment to adaptive management of nutrient levels can help reduce the amount of organic amendment that must be provided initially. Generally, nutrients can be added planting areas through the addition of organic mulch, but cannot be removed.
  - Plant palettes and the associated planting mix should be designed with native plants where possible. Native plants generally have a broader tolerance for nutrient content, and can be longer lived in leaner/lower nutrient soils. An additional benefit of lower nutrient levels is that native plants will generally have less competition from weeds.

- Nutrients are better retained in soils with higher cation exchange capacity (CEC). CEC can be increased through selection of organic material with naturally high CEC, such as peat, and/or selection of inorganic material with high CEC such as some sands or engineered minerals (e.g., low P-index sands, zeolites, rhyolites, etc). Including higher CEC materials would tend to reduce the net leaching of nutrients.
- Soil structure can be more important than nutrient content in plant survival and biologic health of the system. If a good soil structure can be created with very low amounts of compost, plants survivability should still be provided. Soil structure is loosely defined as the ability of the soil to conduct and store water and nutrients as well as the degree of aeration of the soil. While soil structure generally develops with time, planting/storage media can be designed to promote earlier development of soil structure. Soil structure is enhanced by the use of amendments with high hummus content (as found in well-aged organic material). In addition, soil structure can be enhanced through the use of compost/organic material with a distribution of particle sizes (i.e., a more heterogeneous mix). Finally, inorganic amendments such as polymer beads may be useful for promoting aeration and moisture retention associated with a good soil structure. An example of engineered soil to promote soil structure can be found here:

  http://www.hort.cornell.edu/uhi/outreach/pdfs/custructuralsoilwebpdf.pdf
- Younger plants are generally more tolerant of lower nutrient levels and tend to help develop soil structure as they grow. Starting plants from smaller transplants can help reduce the need for organic amendments and improve soil structure. The project should be able to accept a plant mortality rate that is somewhat higher than starting from larger plants and providing high organic content.

- With these considerations, it is anticipated that less than 10 percent compost amendment could be used, while still balancing plant survivability and water retention.

We wish to express our gratitude to following individuals for their feedback on the design of planting/storage media for nutrient sensitive receiving waters in Southern California.

Deborah Deets, City of Los Angeles Bureau of Sanitation

Drew Ready, LA and San Gabriel Rivers Watershed Council

Rick Fisher, ASLA, City of Los Angeles Bureau of Engineering

Dr. Garn Wallace, Wallace Laboratories

Glen Dake, GDML

Jason Schmidt, Tree People

The guidance provided herein does not reflect the individual opinions of any individual listed above and should not be cited or otherwise attributed to those listed.

Selecting Plants for Planting/Storage Media

- Plant materials should be tolerant of summer drought, ponding fluctuations, and saturated soil conditions for 48 to 96 hours.
- It is recommended that a minimum of three types of tree, shrubs, and/or herbaceous groundcover species be incorporated to protect against facility failure due to disease and insect infestations of a single species.
- Native plant species and/or hardy cultivars that are not invasive and do not require chemical inputs should be used to the maximum extent feasible.

BIO-7: Proprietary Biotreatment

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

Also known as:

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

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

Feasibility Screening Considerations

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

Opportunity Criteria

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

OC-Specific Design Criteria and Considerations

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

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

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

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

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

Computing Sizing Criteria for Proprietary Biotreatment Device

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

Additional References for Design Guidance

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

SECTION VII EDUCATIONAL MATERIALS

The educational materials included in this WQMP are provided to inform people involved in future uses, activities, or ownership of the site about the potential pitfalls associated with careless storm water management. "The Ocean Begins at Your Front Door" provides users with information about storm water that is/will be generated on site, what happens when water enters a storm drain, and its ultimate fate, discharging into the ocean. Also included are activities guidelines to educate anyone who is or will be associated with activities that have a potential to impact storm water runoff quality, and provide a menu of BMPs to effectively reduce the generation of storm water runoff pollutants from a variety of activities. The educational materials that may be used for the proposed project are included in Appendix C of this WQMP and are listed below.

EDUCATION MATERIALS			
Residential Materials (http://www.ocwatersheds.com)	**Check If Attached**	**Business Materials (http://www.ocwatersheds.com)**	**Check If Attached**
The Ocean Begins at Your Front Door	☐	Tips for the Automotive Industry	☐
Tips for Car Wash Fund-raisers	☐	Tips for Using Concrete and Mortar	☐
Tips for the Home Mechanic	☐	Tips for the Food Service Industry	☐
Homeowners Guide for Sustainable Water Use	☐	Proper Maintenance Practices for Your Business	☐
Household Tips	☐	**Other Materials (http://www.ocwatersheds.com) (https://www.casqa.org/resources/bmp-handbooks)**	**Check If Attached**
Proper Disposal of Household Hazardous Waste	☐		
Recycle at Your Local Used Oil Collection Center (North County)	☐	DF-1 Drainage System Operation & Maintenance	☒
Recycle at Your Local Used Oil Collection Center (Central County)	☐	R-1 Automobile Repair & Maintenance	☐
Recycle at Your Local Used Oil Collection Center (South County)	☐	R-2 Automobile Washing	☐
Tips for Maintaining Septic Tank Systems	☐	R-3 Automobile Parking	☒
Responsible Pest Control	☐	R-4 Home & Garden Care Activities	☐
Sewer Spill	☐	R-5 Disposal of Pet Waste	☐
Tips for the Home Improvement Projects	☐	R-6 Disposal of Green Waste	☐
Tips for Horse Care	☐	R-7 Household Hazardous Waste	☐
Tips for Landscaping and Gardening	☐	R-8 Water Conservation	☐
Tips for Pet Care	☐	SD-10 Site Design & Landscape Planning	☒
Tips for Pool Maintenance	☐	SD-11 Roof Runoff Controls	☐
Tips for Residential Pool, Landscape and Hardscape Drains	☐	SD-12 Efficient Irrigation	☒
Tips for Projects Using Paint	☐	SD-13 Storm Drain Signage	☒
Tips for Protecting Your Watershed	☒	SD-31 Maintenance Bays & Docs	☐
Other: Children's Brochure	☐	SD-32 Trash Storage Areas	☐

APPENDICES

APPENDIX A

SUPPORTING CALCULATIONS

SUBJECT TO FURTHER REVISION

Project Site

0.9
0.9
0.95
0.7
0.75
0.7
0.65
0.8
0.75
0.85
0.9
0.95
1.05
1
0.6
0.5

LOS ANGELES COUNTY
ORANGE COUNTY
SAN BERNARDINO COUNTY
RIVERSIDE COUNTY
San Diego County

LEGEND

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

Rainfall Zones

Design Capture Storm Depth (inches)

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

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

0 3 6 12 Kilometers
0 1.8 3.6 7.2 Miles

Pacific Ocean
San Pedro Channel
San Pedro Bay
Long Beach Harbor

TITLE
RAINFALL ZONES

JOB
ORANGE COUNTY
TECHNICAL GUIDANCE
DOCUMENT
ORANGE CO. CA

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

PACE
Advanced Water Engineering

FIGURE
XVI-1

P:\9526E\6-GIS\Mxds\Reports\InfiltrationFeasability_20110215\9526E_FigureXVI-1_RainfallZones_20110215.mxd

SUBJECT TO FURTHER REVISION

Project Site

LOS ANGELES COUNTY
ORANGE COUNTY

SAN BERNARDINO COUNTY
ORANGE COUNTY

RIVERSIDE COUNTY
ORANGE COUNTY

LOS ANGELES COUNTY
ORANGE COUNTY

LEGEND

City Boundaries

Hydrologic Soil Groups

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

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

0 2.5 5 10 Kilometers

0 1.8 3.6 7.2 Miles

P:\ 9526E\ 6-GIS\ Mxds\ Reports\ InfiltrationFeasability_20110215\ 9526E_FigureXVI-2a_HydroSoils_20110215.mxd

TITLE
NRCS HYDROLOGIC SOILS GROUPS

JOB
ORANGE COUNTY INFILTRATION STUDY
CA
ORANGE CO.

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

PACE
Advanced Water Engineering

FIGURE
XVI-2a

SUBJECT TO FURTHER REVISION

Project Site

LOS ANGELES COUNTY
ORANGE COUNTY

SAN BERNARDINO COUNTY
ORANGE COUNTY

RIVERSIDE COUNTY
ORANGE COUNTY

LEGEND

City Boundaries

OCWD Groundwater Basin Protection Boundary

Depth To Groundwater

<= 5'

5-10'

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

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

0 2 4 8 Kilometers

0 1.25 2.5 5 Miles

TITLE

NORTH ORANGE COUNTY
MAPPED SHALLOW GROUNDWATER

ORANGE COUNTY
INFILTRATION STUDY

CA

JOB

ORANGE CO.

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

PACE
Advanced Water Engineering

FIGURE

XVI-2e

P:\9526E\16-GIS\Mxds\Reports\Infiltration\Feasability_20110215\9526E_FigureXVI-2e_DepthToGroundwaterLt5ft_20110215.mxd

Susceptibility

Potential Areas of Erosion, Habitat, & Physical Structure Susceptibility

Channel Type

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

Tidel Influence

- <= Mean High Water Line (4.28')

Water Body

- Basin
- Lake
- Reservoir

Other Lands

- Airport/Military

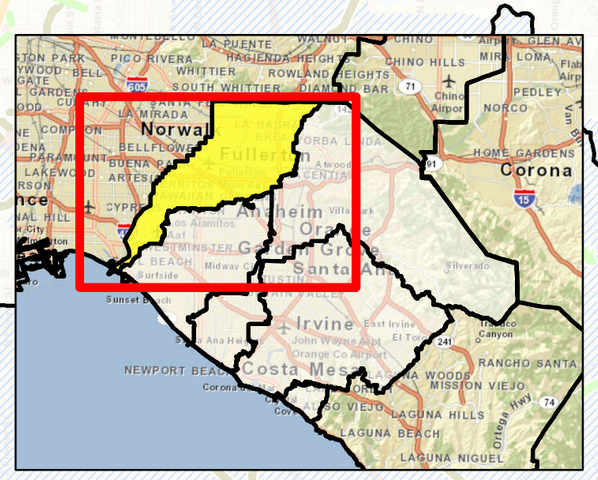
Project Site

Channel in Retarding Basin

Humble Reservoir
Orange County
Valencia Reservoir
Fullerton Reservoir
Loftus Diversion Channel
Desilting Basin
Brea Creek Reservoir
Fullerton Reservoir
Fullerton Reservoir
Hillcrest Park Reservoir
Fullerton Airport
Miller Retarding Basin
La Jolla Recharge Basin
Placentia Retarding Basin
Kraemer Basin
Raymond Retarding Basin
Gilbert Retarding Basin
Crescent Retarding Basin
Cypress Retarding Basin
Rossmoor Retarding Basin
Los Alamitos Retarding Basin
Los Alamitos Naval Air Station
Seal Beach Naval Weapons Station

Los Angeles County
Santa River Watershed
Anaheim Bay-Huntington Harbor Watershed
Newport Bay-Newport Coastal Streams Watershed

0 8,000 16,000 Feet



TITLE: SUSCEPTIBILITY ANALYIS
SAN GABRIEL-COYOTE CREEK

CA

ORANGE COUNTY
WATERSHED
MASTER PLANNING

JOB: ORANGE CO.

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

PACE
Advanced Water Engineering

1

P:\9526E\6-GIS\Mxds\SuceptabilityMaps_20100505\9526E_SanGabrielCoyoteCreekSusceptibility_20100430.mxd

Table 2.7: Infiltration BMP Feasibility Worksheet

	Infeasibility Criteria	*Yes*	*No*
1	**Would Infiltration BMPs pose significant risk for groundwater related concerns?** Refer to Appendix VII (Worksheet I) for guidance on groundwater-related infiltration feasibility criteria.	X	
Provide basis: *During the August 2019 exploration, Geoteck Inc. installed a monitoring well which indicated groundwater is about five to six feet deep around the project site. Due to shallow groundwater, there is a potential for liquefaction on the site. The analyses indicated the presence of some layers of loose sands and silty sands that would be prone to liquefaction and settlement during the design level earthquake. Due to shallow groundwater and liquefaction potential, infiltration has been deemed infeasible for the project site.* Summarize findings of studies provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability.			
2	Would Infiltration BMPs **pose significant risk of increasing risk of geotechnical hazards that cannot be mitigated to an acceptable level**? (Yes if the answer to any of the following questions is yes, as established by a geotechnical expert): The BMP can only be located less than 50 feet away from slopes steeper than 15 percent The BMP can only be located less than eight feet from building foundations or an alternative setback. A study prepared by a geotechnical professional or an available watershed study substantiates that stormwater infiltration would potentially result in significantly increased risks of geotechnical hazards that cannot be mitigated to an acceptable level.		X
Provide basis: Summarize findings of studies provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability.			
3	Would infiltration of the DCV from drainage area **violate downstream water rights**?		X
Provide basis: Summarize findings of studies provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability.			

Table 2.7: Infiltration BMP Feasibility Worksheet (continued)

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

Infiltration Screening Results (check box corresponding to result):		
8	Is there substantial evidence that infiltration from the project would result in a significant increase in I&I to the sanitary sewer that cannot be sufficiently mitigated? (See Appendix XVII) Provide narrative discussion and supporting evidence: Summarize findings of studies provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability.	
9	If any answer from row 1-3 is yes: infiltration of any volume is **not feasible** within the DMA or equivalent. Provide basis: *Due to shallow groundwater and liquefaction potential, infiltration has been deemed infeasible for the project site.* Summarize findings of infeasibility screening	X
10	If any answer from row 4-7 is yes, infiltration is **permissible but is not presumed to be feasible for the entire DCV.** Criteria for designing biotreatment BMPs to achieve the maximum feasible infiltration and ET shall apply. Provide basis: Summarize findings of infeasibility screening	
11	If all answers to rows 1 through 11 are no, infiltration of the full DCV is potentially feasible, BMPs must be designed to infiltrate the full DCV to the maximum extent practicable.	X

Harvest & Reuse Irrigation Demand Calculations

12/10/2020

Storm Water Design Caputre Volume (SQDV)

Drainage Area / Land Use Type	Impervious Area (ac)	Irrigated Area (ac)	% impervious	Runoff Coefficient	Design Storm Depth (in)	Drainage Area (acres)	DCV (ft^3)	DCV (gal)
Total Site	0.59	0.36	62%	0.614	0.85	0.950	**1,799.8**	**13,462**
				#REF!			**#REF!**	**#REF!**
				#REF!			**#REF!**	**#REF!**
				#REF!			**#REF!**	**#REF!**
				0.789			**0.0**	**0**
				0.416			**0.0**	**0**

	Eto
Irvine	3.00
Laguna Beach	2.75
Santa Ana	2.93

Modified

$$EAWU = \frac{(Eto \times KL \times LA \times 0.015)}{IE}$$

$$EIATA = \frac{LA \times KL}{(IE \times \text{Tributary Imp. Area})}$$

Blend of High-Use and Low-Use Landscaping

Drainage Area / Land Use Type	Total Area (ac)	Total Area (sf)	% Impervious	Impervious (sf)	Pervious / LA (sf)	Eto	KL	Modified EAWU	EAWU/ Impervious Acre	Minimum EAWU/ Impervious Acre (Table X.6)	Feasible?	EIATA	Minimum EIATA (interpo-lated)	Drawdown (days)	Drawdown (hours)	% Capture (Fig. III.2)
Total Site	0.950	41,382	62%	25,574	15,808	2.93	0.55	424.57	723.17	690	No	0.38	0.00	31.7	761	<40%
0	0.000	0	0%	0	0		0.55	0.00	#DIV/0!			#DIV/0!	0.00	#REF!	#REF!	

TABLE X.6: HARVESTED WATER DEMAND THRESHOLDS FOR MINIMUM PARTIAL CAPTURE

Design Capture Storm Depth, inches	Wet Season Demand Required for Minimum Partial Capture, gpd per impervious acre
0.60	490
0.65	530
0.70	570
0.75	610
0.80	650
0.85	690
0.90	730
0.95	770
1.00	810

TABLE X.8: MINIMUM IRRIGATED AREA FOR POTENTIAL PARTIAL CAPTURE FEASIBILITY

General Landscape Type	Conservation Design: KL = 0.35			Active Turf Areas: KL = 0.7		
Closest ET Station	Irvine	Santa Ana	Laguna	Irvine	Santa Ana	Laguna
Design Capture Storm Depth, inches	Minimum Required Irrigated Area per Tributary Impervious Acre for Potential Partial Capture, ac/ac					
0.60	0.66	0.68	0.72	0.33	0.34	0.36
0.65	0.72	0.73	0.78	0.36	0.37	0.39
0.70	0.77	0.79	0.84	0.39	0.39	0.42
0.75	0.83	0.84	0.9	0.41	0.42	0.45
0.80	0.88	0.9	0.96	0.44	0.45	0.48
0.85	0.93	0.95	1.02	0.47	0.48	0.51
0.90	0.99	1.01	1.08	0.49	0.51	0.54
0.95	1.04	1.07	1.14	0.52	0.53	0.57
1.00	1.1	1.12	1.2	0.55	0.56	0.6

Source: Technical Guidance Document for the Preparation of Conceptual/Preliminary and/or Project Water Quality Management Plans (WQMPs). March 22, 2011. Appendix X.

Worksheet B: Simple Design Capture Volume Sizing Method

Project: Vessels Circle

Date: December 9, 2020

		DMA =	C1	C2	D1	D2	E	
Step 1: Determine the design capture storm depth used for calculating volume								
1	Enter design capture storm depth from Figure III.1, *d* (inches)	d=	0.85	0.85	0.85	0.85	0.85	inches
2	Enter the effect of provided HSCs, d_{HSC} (inches) (Worksheet A)	d_{HSC}=	0	0	0	0	0	inches
3	Calculate the remainder of the design capture storm depth, $d_{remainder}$ (inches) (Line 1 – Line 2)	$d_{remainder}$=	0.85	0.85	0.85	0.85	0.85	inches
Step 2: Calculate the DCV								
1	Enter Project area tributary to BMP(s), *A* (acres)	A=	0.200	0.210	0.200	0.230	0.110	acres
2	Enter Project Imperviousness, *imp* (unitless)	imp=	85.2%	35.5%	32.2%	81.1%	82.8%	%
3	Calculate runoff coefficient, $C= (0.75 \times imp) + 0.15$	C=	0.789	0.416	0.392	0.758	0.771	
4	Calculate runoff volume, $V_{design} = (C \times d_{remainder} \times A \times 43560 \times (1/12))$	V_{design}=	486.9	269.5	241.9	537.9	261.7	cu-ft
Step 3: Design BMPs to ensure full retention of the DCV								
Step 3a: Determine design infiltration rate								
1	Enter measured infiltration rate, $K_{measured}$ (in/hr) (Appendix VII)	$K_{measured}$=	N/A	N/A	N/A	N/A	N/A	in/hr
2	Enter combined safety factor from Worksheet H, S_{final} (unitless)	S_{final}=	N/A	N/A	N/A	N/A	N/A	
3	Calculate design infiltration rate, $K_{design} = K_{measured} / S_{final}$	K_{design}=	N/A	N/A	N/A	N/A	N/A	in/hr
Step 3b: Determine minimum BMP footprint								
4	Enter drawdown time, *T* (max 48 hours)	T=	See Worksheet D					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

Worksheet D: Capture Efficiency Method for Flow-Based BMPs

Project: Vessels Circle

Date: December 9, 2020

			C1	C2	D1	D2	E	
Step 1: Determine the design capture storm depth used for calculating volume								
1	Enter the time of concentration, T_c (min) (See Appendix IV.2)	T_c=	5.0	5.0	5.0	5.0	5.0	min
2	Using Figure III.4, determine the design intensity at which the estimated time of concentration (T_c) achieves 80% capture efficiency, I_1	I_1=	0.403	0.403	0.403	0.403	0.403	in/hr
3	Enter the effect depth of provided HSCs upstream, d_{HSC} (inches) (Worksheet A)	d_{HSC}=	0	0	0	0	0	inches
4	Enter capture efficiency corresponding to d_{HSC}, Y_2 (Worksheet A)	Y_2=	0%	0%	0%	0%	0%	%
5	Using Figure III.4, determine the design intensity at which the time of concentration (T_c) achieves the upstream capture efficiency (Y_2), I_2	I_2=	0	0	0	0	0	in/hr
6	Determine the design intensity that must be provided by BMP, $I_{design} = I_1 - I_2$	I_{design}=	0.403	0.403	0.403	0.403	0.403	in/hr
Step 2: Calculate the design flowrate								
1	Enter Project area tributary to BMP(s), *A* (acres)	A=	0.200	0.210	0.200	0.230	0.110	acres
2	Enter Project Imperviousness, *imp* (unitless)	imp=	85.2%	35.5%	32.2%	81.1%	82.8%	%
3	Calculate runoff coefficient, $C = (0.75 \times imp) + 0.15$	C=	0.789	0.416	0.392	0.758	0.771	
4	Calculate design flowrate, $Q_{design} = (C \times i_{design} \times A)$	Q_{design}=	0.064	0.035	0.032	0.070	0.034	cfs

Supporting Calculations

Describe System:

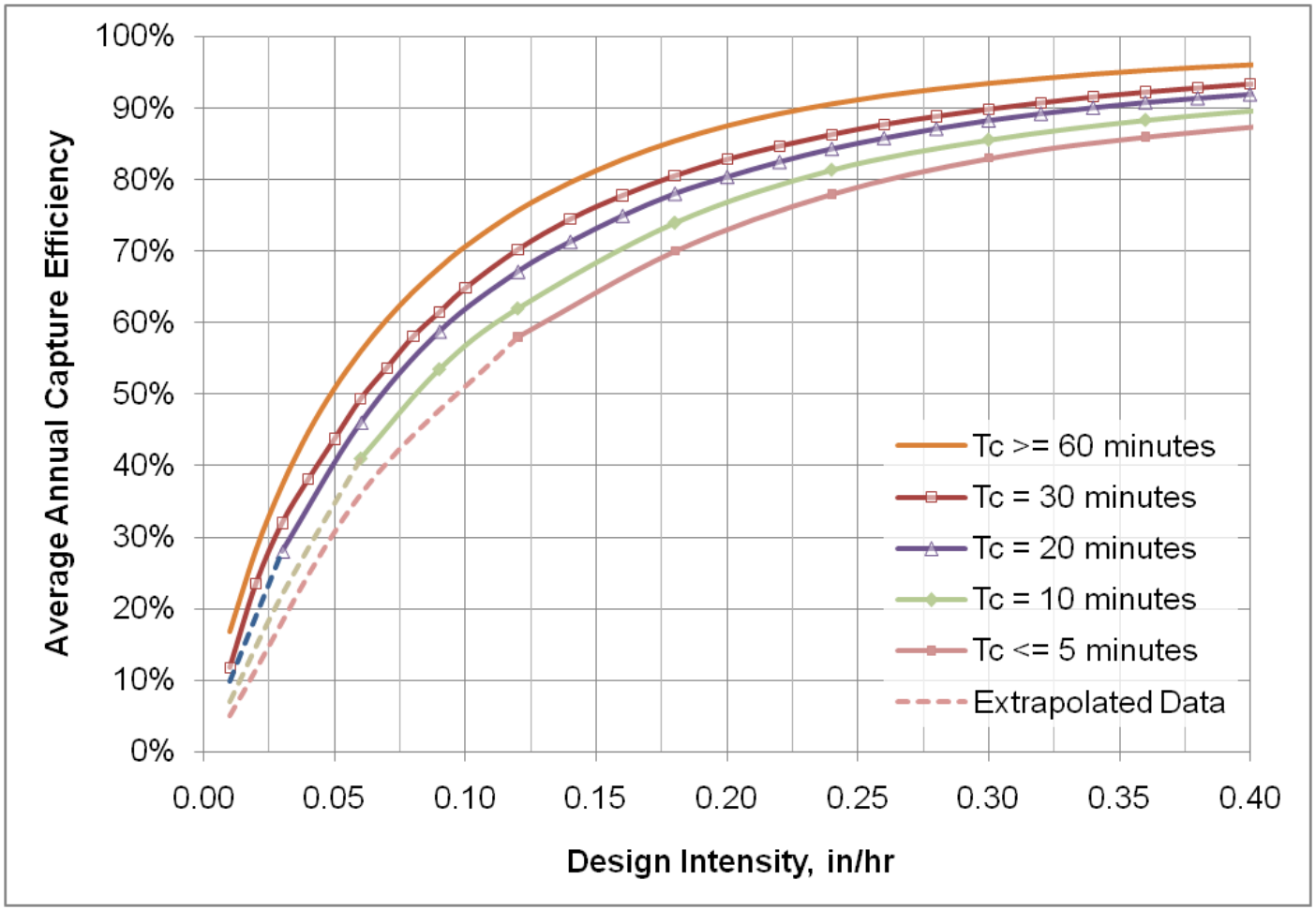
Proprietary BioTreatment (BIO-7):

Unit Size / Model =	*See Swale Sizing*	*MWS-L-4-15 at 2.2' depth*	
Unit Size / Model Treatment Capacity =		*0.113*	cfs
Number of Units Needed =		*1*	
Total Bio-treatment Provided =		*0.113*	cfs

Provide time of concentration assumptions:

Assumed a conservative time of concentration of *5.0* min

Figure III.4. Capture Efficiency Nomograph for Off-line Flow-based Systems in Orange County



Swale Sizing for Vessels Circle Using Manning Formula

DMA C1

Step 1

$Q_{design} = C \times i_{design} \times A)$

$Q_{design} = 0.789 \times 0.403 \times 0.2$

$Q_{design} = 0.064$ cfs

Step 2

$b = (Q \times n_{WQ}) / (1.49 \times y^{1.67} \times s^{0.5})$

$b = (0.064 \times 0.25) / (1.49 \times 0.33^{1.67} \times 0.002^{0.5})$

$b = 0.016 / (1.49 \times 0.157 \times 0.0447)$

$b = 0.016 / 0.01046$

$b = 1.52$ ft

If b is less than 2 feet, increase b to 2 feet and recalculate design flow depth using the following:

$y = ((Q \times n_{WQ}) / (1.49 \times b \times s^{0.5}))^{0.6}$

$y = ((0.064 \times 0.25) / (1.49 \times 2 \times 0.0447))^{0.6}$

$y = (0.016 / 0.133206)^{0.6}$

$y = 0.28$ ft

Step 3

$V_{WQ} = Q/A_{WQ}$

$A_{WQ} = by + Zy^2$

$A_{WQ} = (2 \times 0.28) + (2 \times 0.28^2)$

$A_{WQ} = 0.7168$

$V_{WQ} = 0.064 / 0.7168$

$V_{WQ} = 0.09$ fps

Step 4

Swale Length Needed

$L = 60 \times t_{HR} \times V_{WQ}$

$L = 60 \times 10 \times 0.09$

$L = 53.57$ ft

Swale Length Provided

L = 200 ft with a 37 min residence time

DMA C2

Step 1

$Q_{design} = C \times i_{design} \times A)$

$Q_{design} = 0.416 \times 0.403 \times 0.21$

$Q_{design} = 0.035$ cfs

Step 2

$b = (Q \times n_{WQ}) / (1.49 \times y^{1.67} \times s^{0.5})$

$b = (0.035 \times 0.25) / (1.49 \times 0.33^{1.67} \times 0.003^{0.5})$

$b = 0.00875 / (1.49 \times 0.157 \times 0.05477)$

$b = 0.00875 / 0.01281$

$b = 0.683$ ft

If b is less than 2 feet, increase b to 2 feet and recalculate design flow depth using the following:

$y = ((Q \times n_{WQ}) / (1.49 \times b \times s^{0.5}))^{0.6}$

$y = ((0.035 \times 0.25) / (1.49 \times 2 \times 0.05477))^{0.6}$

$y = (0.00875 / 0.1632146)^{0.6}$

$y = 0.17$ ft

Step 3

$V_{WQ} = Q/A_{WQ}$

$A_{WQ} = by + Zy^2$

$A_{WQ} = (2 \times 0.17) + (2 \times 0.17^2)$

$A_{WQ} = 0.3978$

$V_{WQ} = 0.035 / 0.3978$

$V_{WQ} = 0.09$ fps

Step 4

Swale Length Needed

$L = 60 \times t_{HR} \times V_{WQ}$

$L = 60 \times 10 \times 0.09$

$L = 53.57$ ft

Swale Length Provided

L = 213 ft with a 39 min residence time

DMA D1

Step 1

$Q_{design} = C \times i_{design} \times A)$

$Q_{design} = 0.392 \times 0.403 \times 0.2$

$Q_{design} = 0.032$ cfs

Step 2

$b = (Q \times n_{WQ}) / (1.49 \times y^{1.67} \times s^{0.5})$

$b = (0.032 \times 0.25) / (1.49 \times 0.33^{1.67} \times 0.004^{0.5})$

$b = 0.008 / (1.49 \times 0.157 \times 0.0632456)$

$b = 0.008 / 0.014795$

$b = 0.541$ ft

If b is less than 2 feet, increase b to 2 feet and recalculate design flow depth using the following:

$y = ((Q \times n_{WQ}) / (1.49 \times b \times s^{0.5}))^{0.6}$

$y = ((0.032 \times 0.25) / (1.49 \times 2 \times 0.0632456))^{0.6}$

$y = (0.008 / 0.18847)^{0.6}$

$y = 0.15$ ft

Step 3

$V_{WQ} = Q/A_{WQ}$

$A_{WQ} = by + Zy^2$

$A_{WQ} = (2 \times 0.15) + (2 \times 0.15^2)$

$A_{WQ} = 0.345$

$V_{WQ} = 0.032 / 0.345$

$V_{WQ} = 0.09$ fps

Step 4

Swale Length Needed

$L = 60 \times t_{HR} \times V_{WQ}$

$L = 60 \times 10 \times 0.09$

$L = 53.57$ ft

Swale Length Provided

L = 250 ft with a 46 min residence time

Appendix B

Notice of Transfer of Responsibility

NOTICE OF TRANSFER OF RESPONSIBILITY

WATER QUALITY MANAGEMENT PLAN

Vessels Circle (Cypress Town Center Offsite Improvements)
APN: 241-091-40 and 241-091-36

Submission of this Notice Of Transfer of Responsibility constitutes notice to the City of Cypress that responsibility for the Water Quality Management Plan ("WQMP") for the subject property identified below, and implementation of that plan, is being transferred from the Previous Owner (and his/her agent) of the site (or a portion thereof) to the New Owner, as further described below.

I. Previous Owner/ Previous Responsible Party Information

Company/ Individual Name:		Contact Person:	
Street Address:		Title:	
City:	State:	ZIP:	Phone:

II. Information about Site Transferred

Name of Project (if applicable):	
Title of WQMP Applicable to site:	
Street Address of Site (if applicable):	
Planning Area (PA) and/ or Tract Number(s) for Site:	Lot Numbers (if Site is a portion of a tract):
Date WQMP Prepared (and revised if applicable):	

III. New Owner/ New Responsible Party Information

Company/ Individual Name:		Contact Person:	
Street Address:		Title:	
City:	State:	ZIP:	Phone:

IV. Ownership Transfer Information

General Description of Site Transferred to New Owner:	General Description of Portion of Project/ Parcel Subject to WQMP Retained by Owner (if any):

Lot/ Tract Numbers of Site Transferred to New Owner:
Remaining Lot/ Tract Numbers Subject to WQMP Still Held by Owner (if any):
Date of Ownership Transfer:

Note: When the Previous Owner is transferring a Site that is a portion of a larger project/ parcel addressed by the WQMP, as opposed to the entire project/parcel addressed by the WQMP, the General Description of the Site transferred and the remainder of the project/ parcel no transferred shall be set forth as maps attached to this notice. These maps shall show those portions of a project/ parcel addressed by the WQMP that are transferred to the New Owner (the Transferred Site), those portions retained by the Previous Owner, and those portions previously transferred by Previous Owner. Those portions retained by Previous Owner shall be labeled as "Previously Transferred".

V. Purpose of Notice of Transfer

The purposes of this Notice of Transfer of Responsibility are: 1) to track transfer of responsibility for implementation and amendment of the WQMP when property to which the WQMP is transferred from the Previous Owner to the New Owner, and 2) to facilitate notification to a transferee of property subject to a WQMP that such New Order is now the Responsible Party of record for the WQMP for those portions of the site that it owns.

VI. Certifications

A. Previous Owner

I certify under penalty of law that I am no longer the owner of the Transferred Site as described in Section II above. I have provided the New Owner with a copy of the WQMP applicable to the Transferred Site that the New Owner is acquiring from the Previous Owner.

Printed Name of Previous Owner Representative:	Title:
Signature of Previous Owner Representative:	Date:

B. New Owner

I certify under penalty of law that I am the owner of the Transferred Site, as described in Section II above, that I have been provided a copy of the WQMP, and that I have informed myself and understand the New Owner's responsibilities related to the WQMP, its implementation, and Best Management Practices associated with it. I understand that by signing this notice, the New Owner is accepting all ongoing responsibilities for implementation and amendment of the WQMP for the Transferred Site, which the New Owner has acquired from the Previous Owner.

Printed Name of New Owner Representative:	Title:
Signature:	Date:

APPENDIX C

EDUCATIONAL MATERIALS

Clean beaches and healthy creeks, rivers, bays and ocean are important to Orange County. However, if we are not careful, our daily activities can lead directly to water pollution problems. Water that drains through your watershed can pick up pollutants which are then transported to our waterways and beautiful ocean.

You can prevent water pollution by taking personal action and by working with members of your watershed community to prevent urban runoff from entering your waterway.

For more information, please call the **Orange County Stormwater Program** at **1.877.89.SPILL** 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**.

For emergencies, dial 911.

The tips contained in this brochure provide useful information to help protect your watershed. If you have other suggestions, please contact your city's stormwater representatives or call the Orange County Stormwater Program.

Printed on Recycled Paper

Help Prevent Ocean Pollution: Tips For Protecting Your Watershed

The Ocean Begins at Your Front Door

PROJECT Pollution PREVENTION

Tips for Protecting Your Watershed

My Watershed. Our Ocean.

Water + shed, *noun: A region of land within which water flows down into a specified water body, such as a river, lake, sea, or ocean; a drainage basin or catchment basin.*

Orange County is comprised of 11 major watersheds into which most of our water flows, connecting all of Orange County to the Pacific Ocean.

As water from rain (stormwater) or sprinklers and hoses (urban runoff) runs down your driveway and into your neighborhood streets, sidewalks and gutters, it flows into storm drains that lead to waterways within your watershed. The waterways from other cities merge as they make their way through our watersheds until all the runoff water in Orange County meets at the Pacific Ocean. The water that reaches our ocean is not pure. As it flows through the watershed, it picks up pollutants such as litter, cigarette butts, fertilizer, pesticides, pet waste, motor oil and lawn clippings. Unlike water that enters the sewer (from sinks and toilets), water that enters the storm drain is not treated before it flows, ultimately, to the ocean.

Water quality can be improved by "Adopting Your Watershed." Through this effort, we are challenging citizens and organizations to join the Orange County Stormwater Program and others who are working to protect and restore our creeks, rivers, bays and ocean.

There are many opportunities to get involved:

- Appreciate your watershed - explore the creeks, trails and ocean and make observations about its conditions. If you see anything abnormal (such as dead fish, oil spills, leaking barrels, and other pollution) contact the Orange County 24-hour water pollution problem reporting hotline at 1.877.89.SPILL to report the problem.
- Research your watershed. Learn about what watershed you live in by visiting www.ocwatersheds.com.
- Find a watershed organization in your community and volunteer to help. If there are no active groups, consider starting your own.
- Visit EPA's Adopt Your Watershed's Catalog of Watershed Groups at www.epa.gov/adopt to locate groups in your community.
- Organize or join in a creek, river, bay or ocean cleanup event such as Coastal & Inner Coastal Cleanup Day that takes place the 3rd Saturday of every September. For more information visit www.coast4u.org.

Follow these simple tips to protect the water quality of your watershed:

- **Sweep up debris and dispose of it in the trash. Do not hose down driveways or sidewalks into the street or gutter.**
- **Use dry cleanup methods such as cat litter to absorb spills and sweep up residue.**
- **Set your irrigation systems to reflect seasonal water needs or use weather-based controllers. Inspect for runoff regularly.**
- **Cover trashcans securely.**
- **Take hazardous waste to a household hazardous waste collection center. (For example, paint, batteries and petroleum products)**
- **Pick up after your pet.**
- **Follow application and disposal directions for pesticides and fertilizers.**
- **If you wash your car at home, wash it on your lawn or divert the runoff onto a landscaped area. Consider taking your car to a commercial car wash, where the water is reclaimed or recycled.**
- **Keep your car well maintained.**
- **Never pour oil or antifreeze in the street, gutter or storm drain.**

DF-1
DRAINAGE FACILITY OPERATION AND MAINTENANCE

As a consequence of its function, the stormwater conveyance system collects and transports urban runoff and storm water that may contain certain pollutants. Consequently these pollutants may accumulate in the system and must be removed periodically. In addition, the systems must also be maintained to function properly hydraulically to avoid flooding. Maintaining the system may involve the following activities:

1. Inspection and Cleaning of Stormwater Conveyance Structures
2. Controlling Illicit Connections and Discharges
3. Controlling Illegal Dumping

This list of Model Maintenance Procedures can be utilized as an inspection checklist to determine where better compliance with Designated Minimum Best Management Practices (notated with checkmarks and capital letters) is needed, and to recommend Additional Best Management Practices (notated with bullet points and lower case letters) that may be applicable under certain circumstances, especially where there are certain Pollutant Constituents of Concern. BMPs applicable to certain constituents are notated as:

Bacteria (BACT) *Sediment (SED)* *Nutrients (NUT)* *Oil and Grease (O&G)* *Pesticides (PEST)*
OtherToxic Compounds (TOX) *Trash (TRASH)* *Hydrological Impacts (HYD)* *Any/All or General (ANY)*

Program/Facility Being Inspected: _____

Date: _____ Inspector Name: _____

When completed, the checklist should be attached to the General Inspection Form Cover Sheet and copies should be provided to the Supervisor of the Facility/Program being inspected.

MAINTENANCE PROCEDURES:

1. Inspection and Cleaning of Drainage Facilities

Unsatisfactory	OK	General Guidelines
☐ _____	☐	T 1A. Annually inspect and clean drainage structures as needed.
☐ _____	☐	T 1B. Maintain appropriate records of cleaning and inspections.
☐ _____	☐	T 1C. Properly dispose of removed materials at a landfill or recycling facility.
☐ _____	☐	T 1D. Conduct intermittent supplemental visual inspections during the wet season to determine if there are problem inlets where sediment/trash or other pollutants accumulate, and provide for additional cleanouts as appropriate.
☐ _____	☐	T 1E. Prevent or clean up any discharges that may occur during the course of maintenance and cleaning procedures.
☐ _____	☐	T 1F. Verify that appropriate employees or subcontractors are trained in proper conductance of maintenance activities, including record keeping and disposal.
☐ _____	☐	T 1G. Annually inspect and clean v-ditches as needed, prior to the wet season. On shrub-covered slopes, vegetative debris may be placed on the downhill side of the ditch. Trash should be bagged and disposed at a landfill.

Unsatisfactory	OK
☐	☐
☐	☐
☐	☐
☐	☐
☐	☐
☐	☐
☐	☐
☐	☐
☐	☐
☐	☐
☐	☐
☐	☐

General Guidelines (cont.)

- 1a. Remove trash or debris as needed from open channels. It should be noted that major vegetative debris removal may require other regulatory permits prior to completing the work. (TRASH)
- 1b. Consider retrofitting energy dissipaters (e.g. riprap) below culvert outfalls to minimize potential for erosion. (SED)
- 1c. Repair any v-ditches that have cracked or displaced in a manner that accelerates erosion. (SED)
- 1d. If suspicious conditions appear to exist, test selected samples of the removed wastes for compliance with hazardous waste regulations prior to disposal. (TOX)
- 1e. Consider more frequent regular cleaning of selected drainage structures to help address ongoing specific impairments. (SED, BACT, NUT, TRASH)
- 1f. Consider structural retrofits to the MS4 to help address ongoing specific impairments (SED, BACT, NUT, TRASH, O&G)
- 1g. Consider cleaning out pipes at gradient breaks or other in-pipe debris accumulation points as identified/needed. (ANY, BACT, NUT, TRASH)

Storm Drain Flushing

- 1h. Flushing of storm drains or storm drain inlets should only be done when critically necessary and no other solution is practical. (SED, BACT, TRASH).
- 1i. If flushed, to the extent practical the material should be collected (vacuumed), treated with an appropriate filtering device to remove sand and debris and disposed of properly. (SED)

Waste Management

T 1H. Store wastes collected from cleaning activities of the drainage facilities in appropriate containers or temporary storage sites in a manner that prevents discharge to the storm drain.

- 1j. Dewater the wastes if necessary with outflow into the sanitary sewer if permitted. Water should be treated with an appropriate filtering device to remove the sand and debris prior to discharge to the sanitary sewer. If discharge to the sanitary sewer is not permitted, water should be pumped or vacuumed to a tank and properly disposed of. Do not dewater near a storm drain or stream. (SED, TRASH)
- 1k. Provide for laboratory analysis of at least one randomly collected sediment (less the debris) sample per year from the storm drain inlet leaning program to ensure that it does not meet the EPA criteria for hazardous waste. If the sample is determined to be hazardous, the sediment must be disposed of as hazardous waste and the source should be investigated. (TOX).

2. Controlling Illicit Connections and Discharges

Unsatisfactory	OK	General Guidelines
☐	☐	T 2A. Report prohibited discharges such as dumping, paint spills, abandoned oil containers, etc. observed during the course of normal daily activities so they can be investigated, contained, and cleaned up.
☐	☐	T 2B. Where field observations and/or monitoring data indicate significant problems, conduct field investigations to detect and eliminate existing illicit connections and improper disposal of pollutants into the storm drain (i.e. identify problem areas where discharges or illegal connections may occur and follow up stream to determine the source(s)). (Refer to Appendices A-10 and A-11.)
☐	☐	T 2C. Report all observed illicit connections and discharges to the 24-hour water pollution problem reporting hotline (714) 567-6363.
☐	☐	T 2D. Encourage public reporting of improper waste disposal by distributing public education materials and advertising the 24-hour water pollution problem reporting hotline.
		Storm Drain Stenciling ("No Dumping—Drains to Ocean")
☐	☐	T 2E. Implement and maintain a storm drain stenciling program.
☐	☐	• 2a. Consider adding the hotline number to the storm drain stencils (BACT, TOX, TRASH).

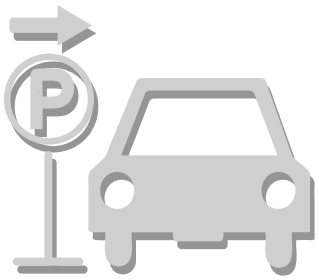
3. Controlling Illegal Dumping

		Field Investigation
☐	☐	T 3A. Report prohibited discharges such as dumpings observed during the course of normal daily activities so they can be investigated, contained and cleaned up.
☐	☐	T 3B. Conduct field investigations to detect and eliminate improper disposal of pollutants into the storm drain (i.e. identify problem areas where discharges or illegal connections may occur and follow up stream to determine the source(s)).
☐	☐	T 3C. Report all observed illegal dumping to the 24-hour water pollution problem reporting hotline (714) 567-6363.
☐	☐	T 3D. Encourage public reporting of improper waste disposal by distributing public education materials and advertising the 24-hour water pollution problem reporting hotline.
☐	☐	T 3E. If perpetrator can be identified, take appropriate enforcement action.
☐	☐	• 3a. Consider posting "No Dumping" signs in problem areas with a phone number for reporting dumping and disposal. Signs could also indicate fines and penalties for illegal dumping. (ANY)

Unsatisfactory	OK	Training/Education/Outreach
☐ _____	☐	T 3F. Verify that appropriate employees and subcontractors are trained to recognize and report illegal dumping.
☐ _____	☐	T 3G. Encourage public reporting of illegal dumping by advertising the 24-hour water pollution problem reporting hotline (714) 567-6363.
☐ _____	☐	• 3b. Take extra steps to educate the public in neighborhoods where illegal dumping has occurred to inform them why illegal dumping is a problem, and that illegal dumping carries a significant financial penalty. (ANY)

LIMITATIONS:

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



R-3
AUTOMOBILE PARKING

The activities outlined in this fact sheet target the following pollutants:	
Sediment	x
Nutrients	
Bacteria	
Foaming Agents	
Metals	X
Hydrocarbons	X
Hazardous Materials	x
Pesticides and Herbicides	
Other	

Parked automobiles may contribute pollutants to the storm drain because poorly maintained vehicles may leak fluids containing hydrocarbons, metals, and other pollutants. In addition, heavily soiled automobiles may drop clods of dirt onto the parking surface, contributing to the sediment load when runoff is present. During rain events, or wash-down activities, the pollutants may be carried into the storm drain system. The pollution prevention activities outlined in this fact sheets are used to prevent the discharge of pollutants to the storm drain system.

Think before parking your car. Remember - The ocean starts at your front door.

Required Activities

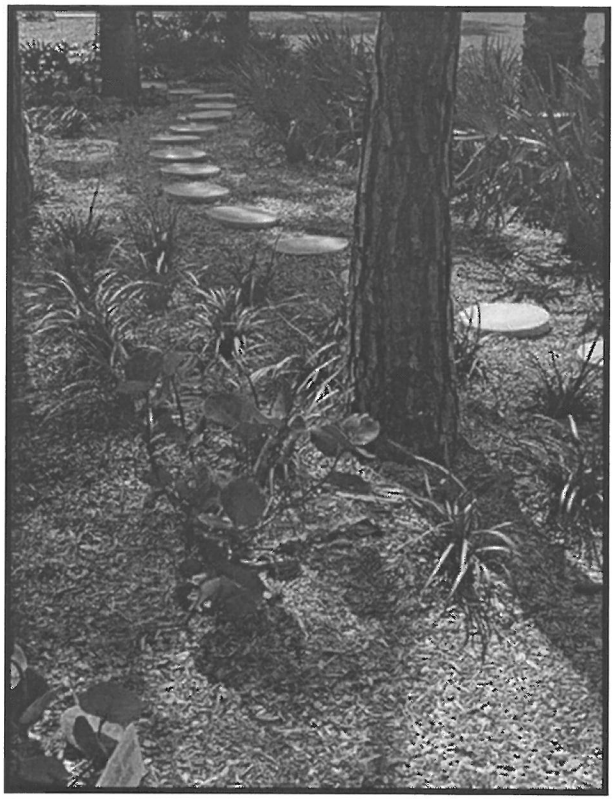
- If required, vehicles have to be removed from the street during designated street sweeping/cleaning times.
- If the automobile is leaking, place a pan or similar collection device under the automobile, until such time as the leak may be repaired.
- Use dry cleaning methods to remove any materials deposited by vehicles (e.g. adsorbents for fluid leaks, sweeping for soil clod deposits).

Recommended Activities

- Park automobiles over permeable surfaces (e.g. gravel, or porous cement).
- Limit vehicle parking to covered areas.
- Perform routine maintenance to minimize fluid leaks, and maximize fuel efficiency.

For additional information contact:
County of Orange, OC Watershed
Main: (714) 955-0600/ 24hr Water Pollution Discharge Hotline 1-877-89-SPILL
or visit our website at: www.ocwatersheds.com

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.

CASQA
CALIFORNIA STORMWATER QUALITY ASSOCIATION

Designing New Installations

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

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

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

Conserve Natural Areas during Landscape Planning

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

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

Maximize Natural Water Storage and Infiltration Opportunities Within the Landscape Unit

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

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

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

Protection of Slopes and Channels during Landscape Design

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

Redeveloping Existing Installations

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

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

Other Resources

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

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

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

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

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

Efficient Irrigation SD-12

Design Objectives

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

Description

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

Approach

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

Suitable Applications

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

Design Considerations

Designing New Installations

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

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

CASQA
CALIFORNIA STORMWATER QUALITY ASSOCIATION

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

Redeveloping Existing Installations

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

Other Resources

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

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

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

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

Storm Drain Signage SD-13

Design Objectives

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

Description

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

Approach

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

Suitable Applications

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

Design Considerations

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

Designing New Installations

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

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

CASQA
CALIFORNIA STORMWATER QUALITY ASSOCIATION

– 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.

APPENDIX D

BMP MAINTENANCE SUPPLEMENT / O&M PLAN

OPERATIONS AND MAINTENANCE (O&M) PLAN

Water Quality Management Plan

For

VESSELS CIRCLE
(CYPRESS TOWN CENTER OFFSITE IMPROVEMENTS)

APN: 241-091-40 and 241-091-36

West of Vessel Circle and Walker Street
Cypress, CA

This page intentionally left blank

BMP INSPECTION & MAINTENANCE RESPONSIBILITY MATRIX			
BMP Applicable? Yes/No	**BMP Name and BMP Implementation, Maintenance and Inspection Procedures**	**Implementation, Maintenance, and Inspection Frequency and Schedule**	**Person or Entity with Operation & Maintenance Responsibility**
NON-STRUCTURAL SOURCE CONTROL BMPs			
Yes	**N1. Education for Property Owners, Tenants and Occupants** Educational materials will be provided to tenants, including brochures and restrictions to reduce pollutants from reaching the storm drain system. Examples include tips for pet care, household tips, and proper household hazardous waste disposal.	Educational materials will be provided to tenants annually. Materials to be distributed are found in Appendix C of this WQMP. Tenants will be provided these materials by the Property Management prior to occupancy and annually thereafter. Frequency: Annually	Melia Homes until future City of Cypress dedication
Yes	**N2. Activity Restrictions** The owner shall develop ongoing activity restrictions that include those that have the potential to create adverse impacts on water quality. Activities include, but are not limited to: handling and disposal of contaminants, fertilizer and pesticide application restrictions, litter control and pick-up, and vehicle or equipment repair and maintenance in non-designated areas, as well as any other activities that may potentially contribute to water pollution.	The Owner will prescribe activity restrictions to protect surface water quality, through lease terms or other equally effective measure, for the property. Restrictions include, but are not limited to, prohibiting vehicle maintenance or vehicle washing. Frequency: Ongoing	Melia Homes until future City of Cypress dedication

BMP INSPECTION & MAINTENANCE RESPONSIBILITY MATRIX			
BMP Applicable? Yes/No	**BMP Name and BMP Implementation, Maintenance and Inspection Procedures**	**Implementation, Maintenance, and Inspection Frequency and Schedule**	**Person or Entity with Operation & Maintenance Responsibility**
Yes	**N3. Common Area Landscape Management** The Owner shall be responsible for ongoing maintenance and management of landscaped areas on the project site, consistent with OC DAMP Section 5.5, Management Guidelines for Use of Fertilizers as well as City standards. Program includes how to reduce the potential pollutant sources of fertilizer and pesticide uses, utilization of water-efficient landscaping practices, ongoing trimming and other landscape maintenance activities and proper disposal of landscape wastes by the owner and/or contractors.	Maintenance shall be consistent with City requirements. Fertilizer and/or pesticide usage shall be consistent with County Management Guidelines for Use of Fertilizers (OC DAMP Section 5.5). Maintenance includes mowing, weeding, and debris removal on a weekly basis. Trimming, replanting, and replacement of mulch shall be performed on an as-needed basis to prevent exposure of erodible surfaces. Trimmings, clippings, and other landscape wastes shall be properly disposed of in accordance with local regulations. Materials temporarily stockpiled during maintenance activities shall be placed away from water courses and storm drains inlets. Frequency: Monthly	Melia Homes until future City of Cypress dedication
Yes	**N4. BMP Maintenance** The Owner will be responsible for the implementation and maintenance of each applicable LID and structural BMP prescribed for the project. Inspection and maintenance will be carried out by property management staff and/or contractors.	Maintenance of structural BMPs implemented at the project site shall be performed at the frequency prescribed in this WQMP. Records of inspections and BMP maintenance shall be kept by the Owner and shall be available for review upon request. Frequency: Ongoing	Melia Homes until future City of Cypress dedication

BMP INSPECTION & MAINTENANCE RESPONSIBILITY MATRIX			
BMP Applicable? Yes/No	**BMP Name and BMP Implementation, Maintenance and Inspection Procedures**	**Implementation, Maintenance, and Inspection Frequency and Schedule**	**Person or Entity with Operation & Maintenance Responsibility**
Yes	N11. Common Area Litter Control The property management will be responsible for performing trash pickup and sweeping of littered common areas as needed, and weekly at a minimum. Any trash/debris waste collected shall be properly disposed of in accordance with local regulations. Responsibilities will also include noting improper disposal of materials and reporting such violations for further investigation.	Litter patrol, violations investigations, reporting and other litter control activities shall be performed on a weekly basis and in conjunction with routine maintenance activities. Frequency: Weekly	Melia Homes until future City of Cypress dedication
Yes	N12. Employee Training All employees of the property owner/management and any contractors will require training to ensure that employees are aware of maintenance activities that may result in pollutants reaching the storm drain. Training will include, but not be limited to, spill cleanup procedures, proper waste disposal, and housekeeping practices.	The Owner shall educate all new employees/managers on storm water pollution prevention, particularly good housekeeping practices, prior to the start of the rainy season (October 1). Refresher courses shall be conducted on an as needed basis. Materials that may be utilized on BMP maintenance are included in Appendix D. Frequency: Annually	Melia Homes until future City of Cypress dedication

BMP INSPECTION & MAINTENANCE RESPONSIBILITY MATRIX			
BMP Applicable? Yes/No	**BMP Name and BMP Implementation, Maintenance and Inspection Procedures**	**Implementation, Maintenance, and Inspection Frequency and Schedule**	**Person or Entity with Operation & Maintenance Responsibility**
Yes	N11. Common Area Litter Control The property management will be responsible for performing trash pickup and sweeping of littered common areas as needed, and weekly at a minimum. Any trash/debris waste collected shall be properly disposed of in accordance with local regulations. Responsibilities will also include noting improper disposal of materials and reporting such violations for further investigation.	Litter patrol, violations investigations, reporting and other litter control activities shall be performed on a weekly basis and in conjunction with routine maintenance activities. Frequency: Weekly	Melia Homes until future City of Cypress dedication
Yes	N12. Employee Training All employees of the property owner/management and any contractors will require training to ensure that employees are aware of maintenance activities that may result in pollutants reaching the storm drain. Training will include, but not be limited to, spill cleanup procedures, proper waste disposal, and housekeeping practices.	The Owner shall educate all new employees/managers on storm water pollution prevention, particularly good housekeeping practices, prior to the start of the rainy season (October 1). Refresher courses shall be conducted on an as needed basis. Materials that may be utilized on BMP maintenance are included in Appendix D. Frequency: Annually	Melia Homes until future City of Cypress dedication
Yes	N14. Common Area Catch Basin Inspection All on-site storm drain inlets shall be inspected by the Owner, and cleaned when the sump is 40% full and annually at a minimum.	Catch basin inlets and other drainage facilities shall be inspected annually. Inlets and other facilities shall be cleaned when the sump is 40% full and annually at a minimum. Frequency: Monthly (inspections), Annually (cleanout)	Melia Homes until future City of Cypress dedication

BMP INSPECTION & MAINTENANCE RESPONSIBILITY MATRIX			
BMP Applicable? Yes/No	**BMP Name and BMP Implementation, Maintenance and Inspection Procedures**	**Implementation, Maintenance, and Inspection Frequency and Schedule**	**Person or Entity with Operation & Maintenance Responsibility**
Yes	**N15. Street Sweeping Private Streets and Parking Lots** The Owner shall be responsible for sweeping all roadways (i.e. fire access road) and uncovered parking areas within the project on a monthly basis.	Parking areas and drive aisles within the project shall be swept at a minimum frequency monthly as well as once per year prior to the storm season, no later than October 1st each year. Frequency: Monthly	Me Melia Homes until future City of Cypress dedication lia Homes / Future HOA
STRUCTURAL SOURCE CONTROL BMPs			
Yes	**S1. Provide storm drain system stenciling and signage** The phrase "NO DUMPING! DRAINS TO OCEAN", or an equally effective phrase approved by the City, will be stenciled on all major storm drain inlets within the project site to alert the public to the destination of pollutants discharged into storm water. Stencils shall be in place prior to release of certificate of occupancy.	Stenciling shall be inspected for legibility no later than the beginning of the rainy season on October 1st of each year. Stenciling must be re-stenciled to maintain legibility as necessary and when deemed necessary by the local inspecting agency. Frequency: Annually	Melia Homes until future City of Cypress dedication

BMP INSPECTION & MAINTENANCE RESPONSIBILITY MATRIX			
BMP Applicable? Yes/No	**BMP Name and BMP Implementation, Maintenance and Inspection Procedures**	**Implementation, Maintenance, and Inspection Frequency and Schedule**	**Person or Entity with Operation & Maintenance Responsibility**
Yes	**S4. Use efficient irrigation systems & landscape design, water conservation, smart controllers, and source control** The Owner will be responsible for the installation and maintenance of all common landscape areas utilizing similar planting materials with similar water requirements to reduce excess irrigation runoff. Includes implementation of efficient irrigation systems for common area landscaping including, but not limited to, provisions for water sensors and programmable irrigation cycles. This includes smart timers, rain sensors, and moisture shut-off valves.	In conjunction with routine maintenance, verify that landscape design continues to function properly by adjusting systems to eliminate overspray to hardscape areas and to verify that irrigation timing and cycle lengths are adjusted in accordance to water demands, given the time of year, weather, and day or nighttime temperatures. System testing shall occur twice per year. Water from testing/flushing shall be collected and properly disposed to the sewer system and shall not discharge to the storm drain system. Frequency: Monthly	Melia Homes until future City of Cypress dedication

BMP INSPECTION & MAINTENANCE RESPONSIBILITY MATRIX		
BMP Name and BMP Implementation, Maintenance and Inspection Procedures	**Implementation, Maintenance, and Inspection Frequency and Schedule**	**Person or Entity with Operation & Maintenance Responsibility**
LOW IMPACT DEVELOPMENT BMPs		
Biotreatment BMP: Modular Wetland Systems (MWS) Modular Wetlands by Modular Wetlands Systems, Inc. are proprietary biotreatment systems that utilize multi-stage treatment processes. The pre-treatment chamber contains the first three stages of treatment, and includes a catch basin inlet filter to capture trash, debris, gross solids and sediments, a settling chamber for separating out larger solids, and a media filter cartridge for capturing fine TSS, metals, nutrients, and bacteria. Runoff then flows through the wetland chamber where treatment is achieved through a variety of physical, chemical, and biological processes. As storm water passes down through the planting soil, pollutants are filtered, adsorbed, biodegraded and sequestered by the soil and plants, functioning similar to bioretention systems. The discharge chamber at the end of the unit collects treated flows and discharges back into the storm drain system.	Inspect system at a minimum of once every six months, prior to the start of the rainy season (October 1), and after major storm events. Typical maintenance includes removing trash & debris from the catch basin screening filter (by hand), removal of sediment and solids in the settlement chamber (vacuum truck), replacement of the BioMediaGREENTM filter cartridge, and replacement of the BioMediaGREENTM drain down filter (if equipped). In addition, plants within the wetland chamber will require trimming in conjunction with landscape maintenance activities. See attached manufacturer's specifications for additional requirements. Frequency: 2x per year	Melia Homes until future City of Cypress dedication

BMP INSPECTION & MAINTENANCE RESPONSIBILITY MATRIX		
BMP Name and BMP Implementation, Maintenance and Inspection Procedures	**Implementation, Maintenance, and Inspection Frequency and Schedule**	**Person or Entity with Operation & Maintenance Responsibility**
Biotreatment BMP: Swale BIO-2 Vegetated Swale	Maintenance activities should include periodic mowing (with grass never cut shorter than the design flow depth), weed control, watering during drought conditions, reseeding of bare areas, and clearing of debris and blockages. Cuttings should be removed from the channel and disposed in a local composting facility. Accumulated sediment should also be removed manually to avoid concentrated flows in the swale. The application of fertilizers and pesticides should be minimal. If the channel develops ruts or holes, it should be repaired utilizing a suitable soil that is properly tamped and seeded. The grass cover should be thick; if it is not, reseed as necessary. Any standing water removed during the maintenance operation must be disposed to a sanitary sewer at an approved discharge location. Residuals (e.g., silt, grass cuttings) must be disposed in accordance with local or State requirements. Frequency: 2x per year	Melia Homes until future City of Cypress dedication
Treatment BMP: Full Capture Trash System (Bio Clean CPS or similar)	During the rainy season (October 1 – April 30), the catch basins with connector pipe screens should be inspected monthly and cleaned out at least once per year at a minimum. Manufacturer recommends cleaning the insert four times per year. Frequency: Monthly (inspections), Annual and before major storm events (cleanout)	Melia Homes until future City of Cypress dedication

Required Permits

Permits are not required for the implementation, operation, and maintenance of the BMPs.

Forms to Record BMP Implementation, Maintenance, and Inspection

The form that will be used to record implementation, maintenance, and inspection of BMPs is attached.

Recordkeeping

All records must be maintained for at least five (5) years and must be made available for review upon request.

Waste Management

Any waste generated from maintenance activities will be disposed of properly. Wash water and other waste from maintenance activities is not to be discharged or disposed of into the storm drain system. Clippings from landscape maintenance (i.e. prunings) will be collected and disposed of properly off-site, and will not be washed into the streets, local area drains/conveyances, or catch basin inlets.

RECORD OF BMP IMPLEMENTATION, MAINTENANCE, AND INSPECTION

Today's Date: _____

Name of Person Performing Activity (Printed): _____

Signature: _____

BMP Name (As Shown in O&M Plan)	Brief Description of Implementation, Maintenance, and Inspection Activity Performed

RECORD OF BMP IMPLEMENTATION, MAINTENANCE, AND INSPECTION

Today's Date: _____

Name of Person Performing Activity (Printed): _____

Signature: _____

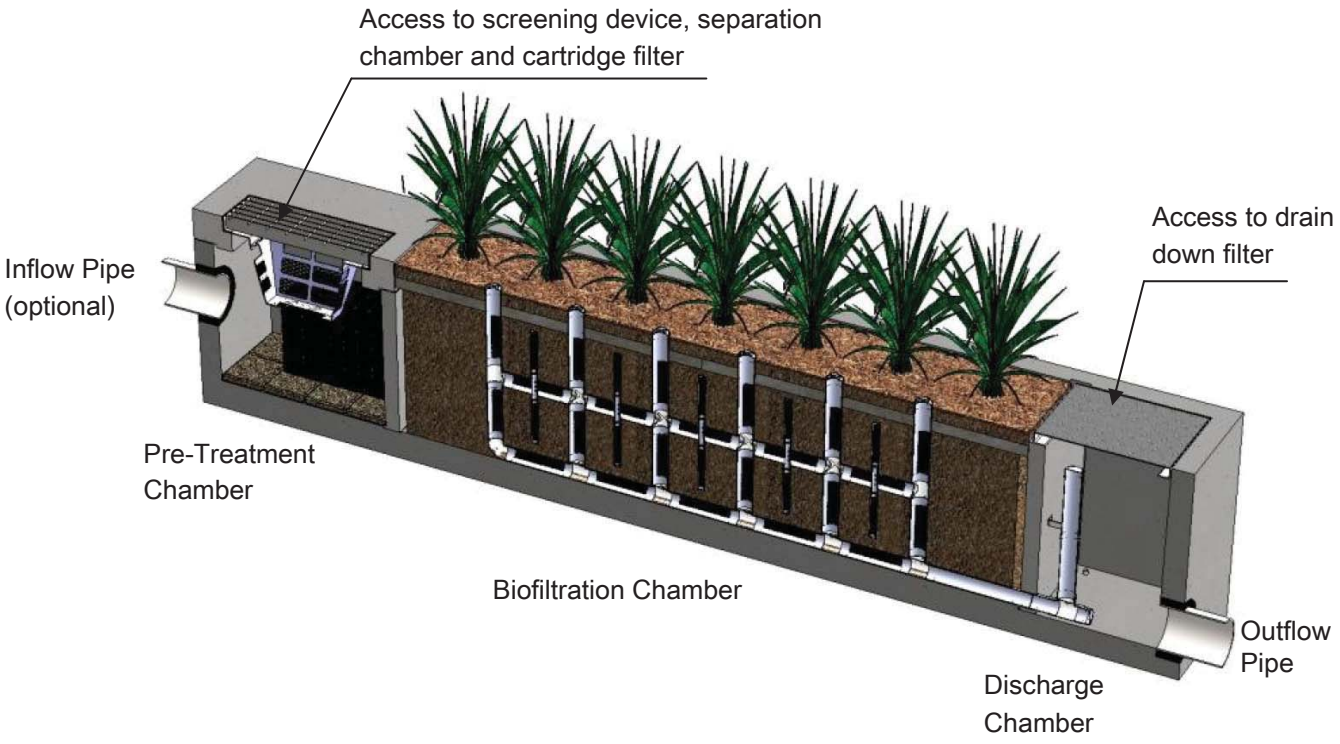
BMP Name (As Shown in O&M Plan)	Brief Description of Implementation, Maintenance, and Inspection Activity Performed

Maintenance Guidelines for Modular Wetland System - Linear

Maintenance Summary

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

System Diagram



Maintenance Procedures

Screening Device

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

Separation Chamber

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

Cartridge Filters

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

Drain Down Filter

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

Maintenance Notes

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

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

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

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

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

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

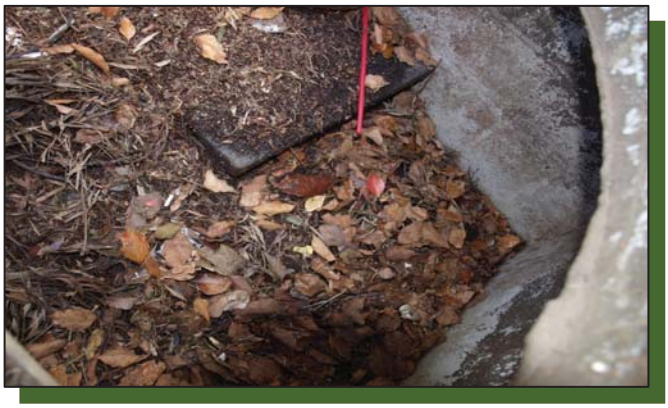
Maintenance Procedure Illustration

Screening Device

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

Separation Chamber

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



Cartridge Filters

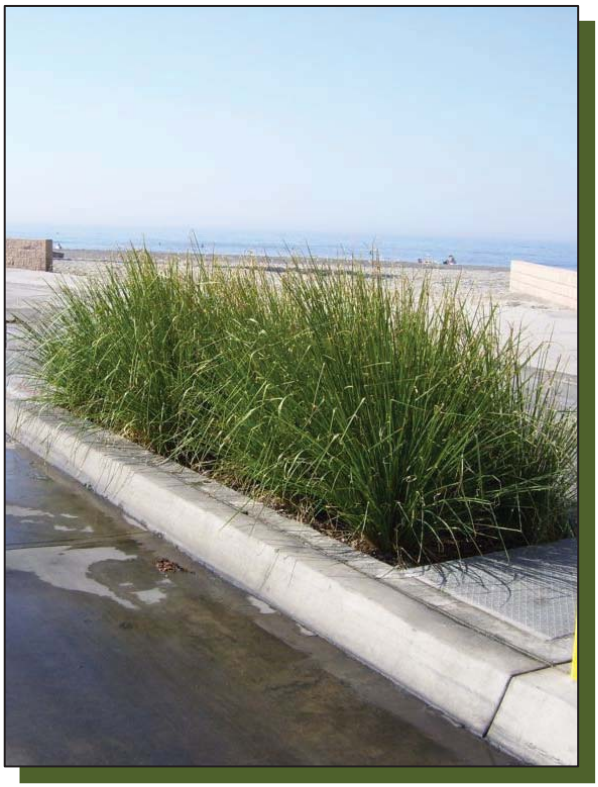
The cartridge filters are located in the Pre-Treatment chamber connected to the wall adjacent to the biofiltration chamber. The cartridges have removable tops to access the individual media filters. Once the cartridge is open media can be easily removed and replaced by hand or a vacuum truck.

Drain Down Filter

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

Trim Vegetation

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



Inspection Form

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

www.modularwetlands.com

Inspection Report
Modular Wetlands System

Project Name _____

Project Address _____
(city) (Zip Code)

Owner / Management Company _____

Contact _____ Phone ( ) –

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

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

Weather Condition _____ Additional Notes _____

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

Inspection Checklist

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

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

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

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

Plant Information	
Damage to Plants	
Plant Replacement	
Plant Trimming	

Additional Notes: _____

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

Maintenance Report

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

www.modularwetlands.com

Cleaning and Maintenance Report
Modular Wetlands System

Project Name _____

Project Address _____
(city) (Zip Code)

Owner / Management Company _____

Contact _____ Phone ( ) –

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

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

Weather Condition _____ Additional Notes _____

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

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

Comments:

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

APPENDIX E

CONDITIONS OF APPROVAL

LOS ALAMITOS
RACE COURSE

CYPRESS TOWN CENTER / MELIA PROJECT

Date: June 29, 2020

City of Cypress
5275 Orange Ave.
Cypress, CA 90630

RE: Proposed Vessel's Circle Drainage

The Melia Homes project is located on 7 acres that was formally Los Alamitos Race Course (LARC) property. The project, as part of its Hydrology Study, has proposed the installation of an offsite Bioswale. The Bioswale is designed to filter storm water runoff from a new section of Vessel's Circle street extension before it enters the existing LARC flood control system. To accomplish this the Bioswale must be located on LARC property in the existing landscape parkway.

This proposed Bioswale location is illustrated on the Fuscoe Engineering's Vessel's Circle offsite improvement plan.

Los Alamitos Race Course, hereby grants Melia Homes permission to construct the proposed Bioswale on Los Alamitos Race Course property, as illustrated in the Fuscoe Plan. Additionally, Los Alamitos Race Course will grant Melia Homes Temporary Construction Access for the purposes of constructing and installing the proposed Bioswale.

LARC recognizes this Bioswale may be an interim drainage condition as the anticipated future development of Cypress Town Center property may render the Bioswale obsolete. Since the drainage area of Vessel's Circle is already allocated for and within the same LARC flood control system, LARC will continue to accept the proposed drainage within this system. The development of the balance of Cypress Town Center property and the drainage studies associated with the development may require that this bioswale be re-engineered, removed or replaced.

Los Alamitos Race Course acknowledges this potential and approves the construction and installation of the Bioswale.

Respectfully,

Frank Sherren
Los Alamitos Race Course

4961 Katella Ave • Cypress, CA 90720 • ph 714-820-2800 • fax 714-820-2820

Standard Conditions of Approval for WQMPs

1. Prior to the submittal of any grading plan the applicant shall submit a Preliminary Project WQMP for review and approval to the Public Works Department that:
    - 1.1 Utilizes Low Impact Development principles as follows: preserves natural features, minimizes runoff and reduces impervious surfaces; and utilizes infiltration of runoff as the preferred method of pollutant treatment. Infiltration Best Management Practices (BMPs) to be considered include the use of permeable materials such as pervious concrete and concrete pavers, infiltration trenches and planters and other infiltration BMPs as applicable.
    - 1.2 Incorporates the applicable Routine Source and Structural Control BMPs as defined in the Drainage Area Management Plan (DAMP)
    - 1.3 Maintains the hydrologic characteristics of the site by matching time of concentration, runoff, velocity, volume, and hydrograph for a 2-year storm event.
    - 1.4 Reduces the potential in downstream erosion and avoids downstream impacts to physical structures, aquatic and riparian habitat.
    - 1.5 Thoroughly describes the long-term operation and maintenance requirements for Structural and Treatment Control BMPs.
    - 1.6 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.
    - 1.7 Describes the mechanism for funding the long-term operation and maintenance of all Structural and Treatment Control BMPs.
    - 1.8 A copy of the forms to be used in conducting maintenance and inspection activities.
    - 1.9 Recordkeeping requirements (forms to be kept for 5 years).
    - 1.10 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.
    - 1.11 A certified copy of the Covenant and Agreement Regarding the O & M Plan to Fund and Maintain Water Quality BMPs, Consent to Inspect, and Indemnification form

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

    2.1 That all structural and treatment control BMPs described in the Project WQMP have been constructed and installed in conformance with the approved plans and specifications.

    2.2 That applicant is prepared to implement all non-structural BMPs described in the Project WQMP.

    2.3 That an adequate number of copies of the project's approved final Project WQMP are available for the future occupiers.

3. Prior to the issuance of certificates of occupancy or final signoff by the Public Works Department, the applicant shall demonstrate to the satisfaction of Public Works Director/City Engineer or his/her designee, that the preparer of the WQMP has reviewed the BMP maintenance requirements in Section 4.0 of the Model WQMP with the legally 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.

4. SWPPP (for projects that will result in soil disturbance of one or more acres of land that will require coverage under the State's General Construction Permit)

    4.1 Prior to the issuance of a grading permit (include grubbing, clearing, surface mining or paving permits as appropriate) the applicant shall demonstrate that coverage has been obtained under California's General Permit for Stormwater Discharges Associated with Construction Activity (General Permit) by providing a copy of the Notice of Intent (NOI) submitted to the State Water Resources Control Board and a copy of the subsequent notification of the issuance of a Waste Discharge Identification (WDID) Number or other proof of filing. A copy of the current Storm Water Pollution Prevention Plan (SWPPP) required by the General Permit shall be kept at the project site at all times and be submitted for review by City.

5. Industrial Permit (for projects subject to coverage by the State's General Industrial Permit as defined by the business' Standard Industrial Classification (SIC) code)

    5.1 Prior to the issuance of certificates of occupancy, the applicant shall demonstrate that coverage under the State's General Permit for Stormwater Discharges Associated with Industrial Activity has been obtained by providing a copy of the Notice of Intent (NOI) submitted to the State Water Resources Control Board and a copy of the notification of the issuance of a Waste Discharge Identification (WDID) number or other proof of filing.

6. Special Condition

6.1 Prior to issuance of certificates of occupancy or building permits for individual tenant improvements or construction permits for a tank or pipeline, uses shall be identified and, for specified uses, the applicant shall propose plans and measures for chemical management (including, but not limited to, storage, emergency response, employee training, spill contingencies and disposal). The chemical management measures shall be incorporated as an element of a Project WQMP and shall be subject to the approval of the Public Works Department and other specified agencies such as the Orange County Fire Authority, the Orange County Health Care Agency and sewering agencies (as appropriate) to ensure implementation of each agency's respective requirements. Certificates or permits may be withheld if features needed to properly manage chemicals cannot be incorporated into a previously completed building, center or complex.

7. Conditions for Condominiums, Apartments and other projects with CC&Rs

7.1 Prior to recordation of the final map, a copy of the project's Covenants, Conditions and Restrictions shall be provided to the Public Works Department for review and approval that includes requirements for maintenance and funding of the project's structural and treatment water quality best management practices as approved by the City in the project's WQMP.

8. Conditions for Coordination of Water Quality BMPs

8.1 Landscape Plans

8.1.1 Prior to submittal of landscape plans for City approval, the applicant shall review the approved Water Quality Management Plan and ensure the proposed landscape plans are consistent with the project grading plans and show applicable Best Management Practices such as grass swales, detention basins, grass or vegetated buffers, filters, permeable pavers, etc.

8.2 Building Permits

8.2.1 Prior to submittal of building plans, the applicant shall review the approved Water Quality Management Plan (WQMP) and grading plan to ensure the structure's downspouts or drainage outlet locations are consistent with those documents. Copies of the building or architectural plans showing the downspouts and drainage outlets shall be submitted to the Public Works Departments for review and approval.

9. I have fully read and understood the Standard Conditions of Approval for WQMPs and how it pertains to the proposed project as required by the Santa Ana Region Water Quality Control Board Permit Order No. R8-2009-0030, the Orange County Drainage Area Management Plan (DAMP), the City of Cypress Local Implementation Plan (LIP), and the City of Cypress Water Quality Ordinance in their entirety (and revisions thereto)

Developer Signature **Date**

Developer

Development Address

APPENDIX F

GEOTECHNICAL REPORT

GEOTECHNICAL EVALUATION
FOR
PROPOSED MULTI-FAMILY RESIDENTIAL DEVELOPMENT
SOUTH OF VESSELS CIRCLE AND WEST OF WALKER STREET
CITY OF CYPRESS, ORANGE COUNTY, CALIFORNIA

PREPARED FOR

MELIA HOMES
8951 RESEARCH DRIVE
IRVINE, CALIFORNIA 92618

PREPARED BY

GEOTEK, INC.
1548 NORTH MAPLE STREET
CORONA, CALIFORNIA 92880

PROJECT NO. 2155-CR **AUGUST 12, 2019**

GEOTEK

GeoTek, Inc.
1548 North Maple Street, Corona, California 92880
(951) 710-1160 Office (951) 710-1167 Fax www.geotekusa.com

August 12, 2019
Project No. 2155-CR

Melia Homes
8951 Research Drive
Irvine, California 92618

Attention: Mr. Chad Brown

Subject: Geotechnical Evaluation
Proposed Multi-Family Residential Development
South of Vessels Circle and West of Walker Street
City of Cypress, Orange County, California

Dear Mr. Brown:

We are pleased to provide herein the results of our geotechnical evaluation for the subject site located in the city of Cypress, Orange County, California. This report presents a discussion of our evaluation and provides preliminary geotechnical recommendations for earthwork, foundation design, and construction. In our opinion, site development appears feasible from a geotechnical viewpoint provided that the recommendations included herein are incorporated into the design and construction phases of site development.

The opportunity to be of service is sincerely appreciated. If you should have any questions, please do not hesitate to call our office.

Respectfully submitted,
GeoTek, Inc.

REGISTERED GEOLOGIST
EDWARD H. LaMONT
No. 1892
Exp.
Certified Engineering Geologist
STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER
GABY M. BOGDANOFF
C 66619
EXP. 06/30/20
CIVIL
STATE OF CALIFORNIA

Edward H. LaMont
CEG 1892, Exp. 07/31/20
Principal Geologist

Gaby M. Bogdanoff
C 66619, Exp. 06/30/20
Project Engineer

Distribution: (5) Addressee

G:\Projects\2151 to 2200\2155CR Melia Homes 7-Acre Site Cypress Town Center Cypress\Geotechnical Report\2155-CR Geotechnical Evaluation Cypress Town Center Cypress.docx

TABLE OF CONTENTS

TABLE OF CONTENTS

ENCLOSURES

1. PURPOSE AND SCOPE OF SERVICES

The purpose of this study was to complete a geotechnical evaluation of the existing geotechnical conditions of the project site with respect to currently anticipated site development. Services provided for this study included the following:

- Research and review of available geologic and geotechnical data, and general information pertinent to the site,
- Site reconnaissance,
- Site exploration consisting of the excavation, logging, and sampling of five exploratory hollow-stem auger borings; recording of penetration data of four Cone Penetration Test (CPT) soundings; and installation of one groundwater monitoring well within the property,
- Collection of relatively undisturbed and bulk soil samples of the onsite materials,
- Laboratory testing of the soil samples obtained from the site,
- Review and evaluation of site seismicity,
- Engineering analyses, and
- Compilation of this geotechnical report which presents our findings, conclusions, and recommendations for site development.

The intent of this report is to aid in the assessment of the site for future proposed development from a geotechnical perspective. The professional opinions and geotechnical information contained in this report may need to be updated based upon our review of the final site development plans. These plans should be provided to GeoTek, Inc. (GeoTek) for review when available.

2. SITE DESCRIPTION AND PROPOSED DEVELOPMENT

2.1 SITE DESCRIPTION

The subject site consists of a seven-acre property located south of Vessels Circle and west of Walker Street in the city of Cypress, Orange County, California. The site comprises the southeastern-most portion of the parking lot of Los Alamitos Horse Racetrack facility. The property is part of the Town Center District of the city of Cypress.

The project area mostly includes asphalt concrete-paved drive and parking areas with minimal landscaped zones. The site has a generally flat topography with a gentle fall of about two to four feet to the south-southwest. Surface drainage is to the south-southwest.

The site is surrounded by additional parking areas of the referenced racetrack and parking lots of nearby commercial buildings.

The general location of the site is shown in Figure 1. The current conditions of the site are displayed on a Google Earth aerial image shown as Figure 2, Exploration Location Map.

2.2 PROPOSED DEVELOPMENT

According to the Conceptual Site Plan, prepared by Bassenian Lagoni Architecture, dated April 18, 2019, the site will be developed with townhomes and condominiums, a pool area, parking/drive zones, underground utilities, and hardscape as well as landscape improvements. The structures are anticipated to be two to three stories, of wood-framed construction, and will utilize either concrete slab-on-grade floors and conventional shallow foundations or post-tensioned slabs. Cuts and fills are estimated to be less than five feet.

If site development differs from the assumptions made herein, the recommendations included in this report should be subject to further review and evaluation. Site development plans should be reviewed by GeoTek when they become available. Additional geotechnical field exploration, analyses and recommendations may be necessary upon review of site development plans.

3. FIELD EXPLORATION AND LABORATORY TESTING

3.1 FIELD EXPLORATION

The soils underlying the site were explored on July 12 and 29, 2019 by means of excavating four CPT soundings to maximum depths of 50 feet below the ground surface and five exploratory borings to depths between 21.0 and 51.5 feet. In addition, one temporary monitoring well to a depth of about 30 feet was installed within the northwestern region of the site in order to assess groundwater conditions that may affect the future site development. The CPT soundings were excavated with a 30-ton CPT rig and the borings and monitoring well were drilled with a truck-mounted hollow-stem auger drill rig. An engineer from this firm kept detailed logs of the borings and obtained disturbed as well as undisturbed soil samples for laboratory testing.
The approximate locations of the site explorations are shown on the Exploration Location Map, Figure 2. Logs of the borings and CPT soundings are provided in Appendices A and B, respectively.

3.2 LABORATORY TESTING

Laboratory testing was performed on selected relatively undisturbed and bulk soil samples collected during the field exploration. The purpose of the laboratory testing was to confirm the field classification of the soil materials encountered and to evaluate the soils physical properties for use in the engineering design and analysis. Results of the laboratory testing program along with a brief description and relevant information regarding testing procedures are included in Appendix C.

4. GEOLOGIC AND SOILS CONDITIONS

4.1 REGIONAL SETTING

The subject property is situated in the Peninsular Ranges geomorphic province. The Peninsular Ranges province is one of the largest geomorphic units in western North America. Basically, it extends roughly 975 miles from the north and extends from the Transverse Ranges geomorphic province to the tip of Baja California, from north to south. This province varies in width from about 30 to 100 miles. It is bounded on the west by the Pacific Ocean, on the south by the Gulf of California and on the east by the Colorado Desert Province.

The Peninsular Ranges are essentially a series of northwest-southeast oriented fault blocks. Several major fault zones are found in this province. The Elsinore Fault zone and the San Jacinto

Fault zone trend northwest-southeast and are found in the near the middle of the province. The San Andreas Fault zone borders the northeasterly margin of the province.

More specific to the subject property, Roffers, P.D. and Bedrossian, T.L., (2010) map the site to be underlain by Holocene to Late Pleistocene age younger alluvial fan deposits. Additionally, the nearest known active fault to the site is the Los Alamitos fault located approximately 2.3 miles to the southwest.

4.2 GENERAL SOIL/GEOLOGIC CONDITIONS

A brief description of the earth materials encountered in our explorations is presented in the following sections.

4.2.1 Undocumented Fill

Undocumented fill was encountered in all exploratory borings below the existing asphalt concrete pavement to depths of about three to four feet. The fill consisted of interbedded layers of silty sand, clayey sand, sandy silt, and sandy clay which were brown in color, moist to very moist, and soft/loose to medium stiff/dense.

4.2.2 Alluvium

Alluvial deposits were encountered in our borings below the fill and extended to the maximum depth explored of about 51.5 feet. The alluvium encountered generally consisted of alternating layers of silty sand, poorly graded sand, sandy silt, and clay. The alluvium was brown to gray in color, moist to saturated, and loose/soft to medium dense/stiff to the total depth explored, based on our field observations, blow counts, and in-place density determinations. Similar soil conditions were noted in the CPT soundings.

The near surface site soils tested were found to have "very low" to "low" expansion potential when tested and classified in accordance with ASTM D 4829.

Detailed descriptions of the subsurface soil conditions are provided in the boring logs presented in Appendix A.

4.3 SURFACE AND GROUNDWATER

4.3.1 Surface Water

If encountered during the earthwork construction, surface water on this site is the result of precipitation or surface run-off from surrounding sites. Overall drainage in the area is variable,

and most commonly directed toward the south-southwest. Provisions for surface drainage will need to be accounted for by the project civil engineer.

4.3.2 Groundwater

Pore pressure dissipation tests conducted at selected levels in three of the CPT soundings indicate that the depth to groundwater at the property is about six to seven feet. This agrees with the measurements conducted in the monitoring well installed within the northwestern edge of the site which indicate that groundwater is about five to six feet deep.

It should be noted that open hole groundwater measurements were done immediately at the completion of the exploratory borings and CPT soundings, with groundwater levels on the order of 12 to 18 feet. These levels were somewhat deeper than the levels observed in the monitoring well and pressure dissipation test probably because of the lack of additional time for the groundwater to reach the hydrostatic level in the holes.

Our review of the *Historically Highest Groundwater Map* published within the *Seismic Hazard Zone Report for the Los Alamitos 7.5-Minute Quadrangle* (California Department of Conservation, 1998) reveal past high groundwater levels on the order of 10 to 20 feet in the general area of the site.

The GeoTracker database shows records for a property located about one-third of a mile southwest of the site, with depth to groundwater ranging from five to eight feet. This information concurs with the groundwater levels recorded during our field investigation.

Perched groundwater or localized seepage can occur due to variations in rainfall, irrigation practices, and other factors not evident at the time of this investigation.

4.4 FAULTING AND SEISMICITY

The geologic structure of the entire southern California area is dominated mainly by northwest-trending faults associated with the San Andreas system. The site is in a seismically active region. No active or potentially active fault is known to exist at this site nor is the site situated within an *"Alquist-Priolo"* Earthquake Fault Zone (Bryant and Hart, 2007; CGS, 1986). The subject property is located within a State of California Seismic Hazard Zone for earthquake induced liquefaction (CGS, 1998). The subject property is not located within a State of California Seismic Hazard Zone for earthquake induced landsliding. The nearest known active fault to the site is the Los Alamitos fault located approximately 2.3 miles to the southwest.

4.4.1 Seismic Design Parameters

The site is located at approximately 33.8059 Latitude and -118.0404 Longitude. Site spectral accelerations (S_a and S_1), for 0.2 and 1.0 second periods for a Class "D" site, was determined from the SEAOC/OSHPD web interface that utilizes the USGS web services and retrieves the seismic design data and presents that information in a report format. The results are presented in the following table.

SITE SEISMIC PARAMETERS	
Mapped 0.2 sec Period Spectral Acceleration, S_s	1.502g
Mapped 1.0 sec Period Spectral Acceleration, S_1	0.547g
Site Coefficient for Site Class "D", F_a	1.0
Site Coefficient for Site Class "D", F_v	1.5
Maximum Considered Earthquake Spectral Response Acceleration for 0.2 Second, S_{MS}	1.502g
Maximum Considered Earthquake Spectral Response Acceleration for 1.0 Second, S_{M1}	0.821g
5% Damped Design Spectral Response Acceleration Parameter at 0.2 Second, S_{DS}	1.001g
5% Damped Design Spectral Response Acceleration Parameter at 1 second, S_{D1}	0.547g
Peak Ground Acceleration Adjusted for Site Class Effects, PGA_M	0.550g

4.5 LIQUEFACTION AND SEISMICALLY INDUCED SETTLEMENT

Liquefaction describes a phenomenon in which cyclic stresses, produced by earthquake-induced ground motion, create excess pore pressures in relatively cohesionless and low plastic soils. These soils may thereby acquire a high degree of mobility, which can lead to lateral movement, sliding, consolidation and settlement of loose sediments, sand boils and other damaging deformations. This phenomenon occurs only below the water table, but, after liquefaction has developed, the effects can propagate upward into overlying non-saturated soil as excess pore water dissipates.

The factors known to influence liquefaction potential include soil type and grain size, relative density, groundwater level, confining pressures, and both intensity and duration of ground shaking. In general, materials that are susceptible to liquefaction are loose, saturated granular soils having low fines content under low confining pressures and some low plastic silts and clays.

Based on the review of available groundwater data, a highest groundwater depth of about five feet was used in our liquefaction analysis. The analysis was performed with the aid of the computer program Cliq version 2.2.0.32 (Geologismiki, 2006) in conjunction with the soil profiles identified within all CPT soundings performed at the property. A mean magnitude weighted (Mw)

seismic event of 6.71 obtained with the USGS deaggregation web application (based on a 2 percent exceedance in 50 years) and a PGA_M value of 0.55g were used in the assessment.

The results of the analyses indicated the presence of some layers of loose sands and silty sands that would be prone to liquefaction and settlement during the design-level earthquake. The following table summarizes the amount of settlement estimated at each CPT location:

ESTIMATED SEISMICALLY INDUCED TOTAL SETTLEMENT (PGAM = 0.55g, MW=6.71)	
CPT Sounding	Total Settlement (in)
1	2.0
2	1.5
3	2.0
4	1.4

As noted above, the seismically induced total settlements of the sandy soils at the property could be up to two inches total and one-inch differential over a 40-foot span.

Due to the flat topography of the site, the potential for lateral spread is considered nil.

Based on relationships developed by Ishihara (1985) with respect to the thickness of potentially liquefiable soils relative to the thickness of the non-liquefiable soils, it is our opinion that there is potential for surface manifestations (sand boils and/or loss of bearing support) to occur during the design level earthquake. Recommendations presented in subsequent sections of this report have been prepared to reduce the potential impacts due to surface manifestations and seismically induced settlement.

The results of the liquefaction analysis are presented within Appendix D.

4.6 OTHER SEISMIC HAZARDS

Evidence of ancient landslides or slope instabilities at this site was not observed during our investigation. Thus, the potential for landslides is considered negligible.

The potential for secondary seismic hazards such as a seiche or tsunami is considered negligible due to site elevation and distance to an open body of water.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 GENERAL

Development of the site appears feasible from a geotechnical viewpoint. The following recommendations should be incorporated into the design and construction phases of development.

5.2 EARTHWORK CONSIDERATIONS

Earthwork and grading should be performed in accordance with the applicable grading ordinances of the City of Cypress, the *2016 California Building Code* (CBC), and recommendations contained in this report. Site grading plans should be reviewed by this office when they become available. Additional recommendations will likely be offered subsequent to review of these plans.

5.2.1 Site Clearing and Preparation

Site preparation should start with demolition/razing of existing site improvements and removal of deleterious materials and vegetation. Demolition should include removal of all pavements, slabs, underground utilities, and any other below-grade construction. These materials should be properly disposed of off-site. Voids resulting from site clearing (such as removals of underground utilities, etc.) should be backfilled with engineered fill materials.

5.2.2 Removals

As a minimum, the upper four feet of soil should be completely removed within the structural grading limits. The depth of removals should be extended, where needed, to eliminate any undocumented fill. Additional removals may be recommended if unsuitable materials are exposed. As a minimum, removals should extend down and away from foundation elements at a 1:1 (h:v) projection to the recommended removal depth, or a minimum of five feet laterally.

A minimum 24 inches of engineered fill should be provided below the bottom of the proposed foundations. A representative of this firm should observe the bottom of all excavations.

A minimum of 12 inches of engineered fill should be provided below asphaltic concrete pavement and Portland cement concrete hardscape areas. The horizontal extent of removals should extend at least two feet beyond the edge.

Development plans should be reviewed by this firm when available. Depending on actual field conditions encountered during grading, locally deeper areas of removal may be recommended.

The bottom of all removals should be scarified to a minimum depth of six inches, brought to slightly above the optimum moisture content, and then recompacted to at least 90 percent of the soil's maximum dry density (ASTM D 1557). The bottoms of removals should be observed by a GeoTek representative prior to scarification.

The bottom of removals may encounter very moist/soft soils that may require stabilization. If necessary, removal bottoms may be stabilized with a layer of gravel or geogrid supplemented with gravel, prior to placing engineered compacted fill. A 12-inch thick layer of gravel has been successfully used on similar project sites that GeoTek has provided services in the past. Specific stabilization recommendations should be provided by GeoTek based on the soil conditions encountered at the time of site grading.

5.2.3 Engineered Fill

The onsite soils are considered suitable for reuse as engineered fill provided they are free from vegetation, roots, and rock or hard lumps greater than six inches in maximum dimension.

At the time of our field investigation, most of the on-site soils were very moist (six to ten percent above optimum water content). To be suitable for placement as engineered fill, these materials should be dried to approximately optimum moisture content.

The undercut areas should be brought to final pad elevations with fill materials that are placed and compacted in general accordance with minimum project standards. Fill materials should be placed at or above optimum moisture content and should be compacted to a minimum relative compaction of 90 percent as determined by ASTM Test Method D 1557. Additional recommendations pertaining to fill placement are presented in Appendix E.

5.2.4 Excavation Characteristics

Excavation in the onsite soil materials is expected to be easy using heavy-duty grading equipment in good operating conditions.

All temporary excavations for grading purposes and installation of underground utilities should be constructed in accordance with local and Cal-OSHA guidelines. Temporary excavations within the onsite materials should be stable at 1:1 (h:v) inclinations for cuts less than five feet in height.

5.2.5 Shrinkage and Subsidence

Several factors will impact earthwork balancing on the site, including shrinkage, bulking, subsidence, trench spoil from utilities and footing excavations, as well as the accuracy of topography.

Shrinkage, bulking, and subsidence are primarily dependent upon the degree of compactive effort achieved during construction. For planning purposes, a shrinkage factor of 10 to 15 percent for both the existing fills and upper alluvium may be considered. Site balance areas should be available in order to adjust project grades, depending on actual field conditions at the conclusion of site earthwork construction. Bulking is not considered to be a significant factor with the underlying materials within the vicinity of the anticipated construction. Subsidence on the order of 0.1-foot could occur.

5.2.6 Trench Excavations and Backfill

Temporary excavations within the onsite materials should be stable at 1:1 (h:v) inclinations for short durations during construction, and where cuts do not exceed five feet in height. Temporary cuts to a maximum height of four feet can be excavated vertically, but local sloughing and/or failure could occur due to the granular nature of some of the site soils. Increased caution should be applied when working near or within any excavations at this site.

Trench excavations should conform to Cal-OSHA regulations. The contractor should have a competent person, per OSHA requirements, on site during construction to observe conditions and to make the appropriate recommendations.

Utility trench backfill should be compacted to at least 90 percent relative compaction (as determined per ASTM D 1557). Under-slab trenches should also be compacted to project specifications. Where applicable, based on jurisdictional requirements, the top 12 inches of backfill below subgrade for road pavements should be compacted to at least 95 percent relative compaction. Much of the surficial onsite materials may not be suitable for use as bedding material but should be suitable as backfill provided particles larger than 6± inches are removed.

Compaction should be achieved with a mechanical compaction device. Ponding or jetting of trench backfill is not recommended. If backfill soils have dried out, they should be thoroughly moisture conditioned prior to placement in trenches.

5.2.7 Slopes

Slopes at the site constructed at gradients of 2:1 (h:v) or flatter, in accordance with industry standards, are anticipated to be grossly stable. Fill placed on sloping ground should be properly benched into competent soils.

5.3 DESIGN RECOMMENDATIONS

5.3.1 Foundation Design Criteria

Post-tensioned slabs are recommended for the site to help mitigate the potential effects of surface manifestations of liquefaction and seismically induced settlements. We recommend that the post-tensioned slabs be designed to span a potential five-foot horizontal distance where loss of support could occur, resulting from surface manifestations caused by soil liquefaction. In addition, foundations should be designed for the estimated seismically induced settlement of about two-inches total and one-inch differential in a 40-foot span.

Based on the results of our recent testing, the on-site soils near subgrade may be classified as having a "very low" ($0 \leq EI \leq 20$) to "low" ($21 \leq EI \leq 50$) potential for expansion in accordance with ASTM D 4829. However, additional expansion index testing should be performed upon completion of the site rough grading in order to verify the expansiveness of the materials near the finish pad elevations.

Presented below are post-tensioned foundation design parameters for the proposed residential structures at the site. These parameters are in general conformance with *Design of Post-Tensioned Slabs-on-Ground*, Third Edition *with 2008 Supplement* (PTI, 2008). These are minimal recommendations and are not intended to supersede the design by the project structural engineer. The parameters presented below were developed for foundation areas with "low" expansive soils. Areas with "very low" expansive soils could be safely designed using the "low" expansive criteria.

DESIGN PARAMETERS FOR POST-TENSIONED SLABS	
Foundation Design Parameter	Design Value
	"Low" Expansion Potential (LL≤29; PI≤11; Passing #200 Sieve ≈ 58%; Clay fines ≈ 20%)
Edge Moisture Variation Distance, e_m - Edge Lift (swelling) - Center Lift (shrinkage)	 4.9 ft 9.0 ft
Soil Differential Movement, y_m - Edge Lift (swelling) - Center Lift (shrinkage)	 ≈0.40 in ≈0.17 in
Ext. Perimeter Beam Embedment	One- and Two-Story – 12 inches* Three-Story – 18 inches*
Presaturation of Subgrade Soil (Percent of Optimum)	Minimum 110% to a depth of 12 inches

*Required depth of perimeter beam/stiffening rib per structural calculations may govern.
The following assumptions were used to generate e_m and y_m values: Thornthwaite Moisture Index = -20; constant suction value = 3.9pF; post-equilibrium case assumed with wet (swelling) cycle going from 3.9pF to 3.0pF and drying (shrinking) cycle going from 3.9pF to 4.5pF.

Post-tensioned slabs should be designed in accordance with the *2016 CBC* and PTI design methodology.

The bottom of the perimeter edge beam/deepened footing should be designed to resist tension forces using either cable or conventional reinforcement, per the structural engineer.

In general, an allowable bearing capacity of 2,000 pounds per square foot (psf) may be used for design of post-tensioned slab foundations.

The passive earth pressure may be computed as an equivalent fluid having a density of 220 psf per foot of depth, to a maximum earth pressure of 2,500 psf for footings founded on engineered fill. A coefficient of friction between soil and concrete of 0.35 may be used with dead load forces. The upper one foot of soil below the adjacent grade should not be used in calculating passive pressure.

The above values may be increased as allowed by Code to resist short-term transient loads (e.g. seismic and wind loads).

For foundations designed in accordance with the recommendations presented in this report, we would anticipate a maximum static settlement of less than one-inch and a maximum differential static settlement of less than ½-inch in a 40-foot span. Seismically induced settlement is expected to be about two-inches total and one-inch differential in a 40-foot span.

It should be noted that the above recommendations are based on soil support characteristics only. The structural engineer should design the slab and beam reinforcement based on actual loading conditions.

A moisture and vapor retarding system should be placed below slabs-on-grade where moisture migration through the slab is undesirable. Guidelines for these systems are provided in the 2016 *California Green Building Standards Code (CALGreen)* Section 4.505.2 and the 2016 *CBC* Section 1910.1.

It should be realized that the effectiveness of the vapor retarding membrane can be adversely impacted as the result of construction related punctures (e.g. stake penetrations, tears, punctures from walking on the aggregate layer, etc.). These occurrences should be limited as much as possible during construction. Thicker membranes are generally more resistant to accidental puncture than thinner ones. Products specifically designed for use as moisture/vapor retarders may also be more puncture resistant. It is GeoTek's opinion that a minimum ten mil thick membrane with joints properly overlapped and sealed should be considered, unless otherwise specified by the slab design professional. Moisture and vapor retarding systems are intended to provide a certain level of resistance to vapor and moisture transmission through the concrete, but do not eliminate it. The acceptable level of moisture transmission through the slab is to a large extent based on the type of flooring used and atmospheric conditions.

Ultimately, the vapor retarding system should be comprised of suitable elements to limit migration of water and reduce transmission of water vapor through the slab to acceptable levels. The selected elements should have suitable properties (i.e. thickness, composition, strength, and permeance) to achieve the desired performance level. Consideration should be given to consulting with an individual possessing specific expertise in this area for additional evaluation.

5.3.2 Miscellaneous Foundation Recommendations

- To minimize moisture penetration beneath the slab on grade areas, utility trenches should be backfilled with engineered fill, lean concrete or concrete slurry where they intercept the perimeter footing or thickened slab edge.
- Soils from the footing excavations should not be placed in the slab-on-grade areas unless properly compacted and tested. The excavations should be free of loose/sloughed materials and be neatly trimmed at the time of concrete placement.
- Under-slab utility trenches should be compacted to project specifications. Compaction should be achieved with a mechanical compaction device. If backfill soils have dried out, they should be thoroughly moisture conditioned prior to placement in trenches.

5.3.3 Foundation Setbacks

Foundations should comply with the following setbacks. Improvements not conforming to these setbacks are subject to the increased likelihood of excessive lateral movements and/or differential settlements. If large enough, these movements can compromise the integrity of the improvements. The following recommendations are presented:

- The outside bottom edge of all footings should be set back a minimum of H/2 (where H is the slope height) from the face of any ascending slope. The setback should be at least five feet and need not to exceed 15 feet. Where a retaining wall is constructed at the toe of the slope, the height of the slope should be measured from top of the wall to the top of the slope.
- The outside bottom edge of all footings should be set back a minimum of H/3 from the face of any descending slope. The setback should be at least seven feet and need not exceed 40 feet.
- The bottom of all footings for structures near retaining walls should be deepened so as to extend below a 1:1 (h:v) projection upward from the bottom inside edge of the wall foundation.
- The bottom of any existing foundations for structures should be deepened so as to extend below a 1:1 (h:v) projection upward from the bottom of the nearest excavation.

5.3.4 Retaining Wall Design and Construction

5.3.4.1 General Design Criteria

Recommendations presented in this report apply to typical masonry or concrete retaining walls to a maximum height of up to six feet. Additional review and recommendations should be requested for higher walls. These are typical design criteria and are not intended to supersede the design by the structural engineer.

Retaining wall foundations should be embedded a minimum of 12 inches into engineered fill. Retaining wall foundations should be designed in accordance with Section 5.3.1 of this report. Structural needs may govern and should be evaluated by the project structural engineer.

All earth retention structure plans, as applicable, should be reviewed by this office prior to finalization. The seismic design parameters as discussed in this report remain applicable to all proposed earth retention structures at this site and should be properly incorporated into the design and construction of the structures.

Earthwork considerations, site clearing and remedial earthwork for all earth retention structures should meet the requirements of this report, unless specifically provided otherwise, or more stringent requirements or recommendations are made by the designer. The backfill material placement for all earth retention structures should meet the requirement of *Section 5.3.4.4* in this report.

In general, cantilever earth retention structures, which are designed to yield at least 0.001H, where H is equal to the height of the earth retention structure to the base of its footing, may be designed using the active condition. Rigid earth retention structures (including but not limited to rigid walls, and walls braced at top, such as typical basement walls) should be designed using the at-rest condition.

In addition to the design lateral forces due to retained earth, surcharges due to improvements, such as an adjacent building or traffic loading, should be considered in the design of the earth retention structures. Loads applied within a 1:1 (h:v) projection from the surcharge on the stem and footing of the earth retention structure should be considered in the design.

Final selection of the appropriate design parameters should be made by the designer of the earth retention structures.

5.3.4.2 Cantilevered Walls

The recommendations presented below are for cantilevered retaining walls up to six feet high. Active earth pressure may be used for retaining wall design, provided the top of the wall is not restrained from minor deflections. An equivalent fluid pressure approach may be used to compute the horizontal pressure against the wall. Appropriate fluid unit weights are given below for specific slope gradients of the retained material. These do not include other superimposed loading conditions such as traffic, structures, or adverse geologic conditions.

ACTIVE EARTH PRESSURES	
Surface Slope of Retained Materials (h:v)	Equivalent Fluid Pressure (pcf) Native Backfill*
Level	44
2:1	78

*The design pressures assume the native backfill material has an expansion index less than or equal to 50. Backfill zone includes area between the back of the wall and footing to a plane (1:1 h:v) up from the bottom of the wall foundation to the ground surface.

5.3.4.3 Restrained Retaining Walls

Retaining walls that will be restrained prior to placing and compacting backfill material or that have reentrant or male corners should be designed for an at-rest equivalent fluid pressure of 64 pcf, plus any applicable surcharge loading, for drained native backfill and level back slope condition. For areas of male or reentrant corners, the restrained wall design should extend a minimum distance of twice the height of the wall laterally from the corner, or a distance otherwise determined by the project structural engineer.

5.3.4.4 Retaining Wall Backfill and Drainage

Retaining wall backfill should be free of deleterious and/or oversized materials and should have expansion index less than 50. Retaining walls should be provided with an adequate pipe and gravel back drain system to help prevent buildup of hydrostatic pressures. Backdrains should consist of a four-inch diameter perforated collector pipe (Schedule 40, SDR 35, or approved equivalent) embedded in a minimum of one-cubic foot per linear foot of ¾- to 1-inch clean crushed rock or an approved equivalent, wrapped in filter fabric (Mirafi 140N or an approved equivalent). The drain system should be connected to a suitable outlet. Waterproofing of site walls should be performed where moisture migration through the wall is undesirable.

Retaining wall backfill should be placed in lifts no greater than eight inches in thickness and compacted to a minimum of 90 percent relative compaction in accordance with ASTM Test Method D 1557. The wall backfill should also include a minimum one-foot wide section of ¾- to 1-inch clean crushed rock (or an approved equivalent). The rock should be placed immediately adjacent to the back of the wall and extend up from a back drain to within approximately 24 inches of the finish grade. The rock should be separated from the earth with filter fabric. The upper 24 inches should consist of compacted on-site soil.

As an alternative to the drain rock and fabric, Miradrain 2000, or approved equivalent, may be used behind the retaining wall. The Miradrain 2000 should extend from the base of the wall to within two feet of the ground surface. The subdrain should be placed at the base of the wall in direct contact with the Miradrain 2000.

The presence of other materials might necessitate revision to the parameters provided and modification of the wall designs. Proper surface drainage needs to be provided and maintained.

5.3.4.5 Other Design Considerations

- Wall design should consider the additional surcharge loads from superjacent slopes and/or footings, where appropriate.

- No backfill should be placed against concrete until minimum design strengths are evident by compression tests of cylinders.
- The retaining wall footing excavations, backcuts, and backfill materials should be approved the project geotechnical engineer or their authorized representative.

5.3.5 Pool Construction

Because of the presence of shallow groundwater, dewatering systems will likely be required to facilitate the excavation of the pool area. We recommend that the water table be lowered to a least two feet below the deepest excavation and maintained at that depth until the pool is constructed and filled.

The proposed swimming pool should derive support entirely from engineered fill. A minimum 12 inches of engineered fill should be provided below the pool shell.

The pool walls should be designed for at-rest soil conditions using an equivalent fluid density of 64 pcf for at-rest conditions. Pool walls surcharged by adjacent structures should be designed for additional pressures. Alternatively, the pool walls may be designed as freestanding walls using the active soil state conditions provided that some lateral movement of the pool walls would be acceptable. If the active state is to be used, an equivalent fluid density of 44 pcf is considered suitable. These pressures are recommended for sections of the pool walls above the groundwater table and are based on drained conditions. Below the groundwater level (about five to six feet), the pool walls should then be designed for an equivalent fluid density of 86 pcf for the active condition and 98 pcf for the at-rest condition. These values include the hydrostatic pressure.

Due to the high groundwater table under the site, positive drainage below the pool will likely not be feasible. We recommend that the pool walls be designed to include the hydrostatic pressure as indicated above. Also, buoyancy of the pool should be evaluated by the pool designer using a groundwater level of about five feet below the existing ground surface. The pool designer should consider hydrostatic relief valves or equivalent in order to prevent the effects of hydrostatic pressure on an empty pool shell.

Pool decking supported on grade should be separated from the pool bond beam by a full-depth, mastic construction joint. If it is desired to extend the pool deck over the bond beam, consideration should be given to designing the deck as a structural slab supported by the pool shell. This will reduce the possibility of deck cracking occurring along the outer edge of the bond beam. We also recommend that the area of the pool decking be pre-saturated prior to concrete placement. The subgrade soils should be moisture conditioned to at least 110 percent of the soil's optimum moisture content to a depth of 12 inches, prior to concrete placement. Testing

by the geotechnical engineer is recommended to confirm that the soils have been adequately moisture treated.

Pool decking may consist of five-inch thick concrete and the use of reinforcement is suggested. Control joints should be placed in two directions and located a distance apart approximately equal to 24 to 36 times the slab thickness. The project structural engineer should provide final design recommendations.

5.3.6 Pavement Design Considerations

Pavement design for proposed street improvements was conducted per Caltrans *Highway Design Manual* guidelines for flexible pavements. Based on an assumed design R-value of 20 and for Traffic Indices (TIs) of 5.0 and 6.0 generally linked to roads with light vehicular traffic with occasional heavy truck traffic, the following preliminary sections were calculated:

PRELIMINARY MINIMUM PAVEMENT SECTION		
Traffic Index	Thickness of Asphalt Concrete (inches)	Thickness of Aggregate Base (inches)
5.0	3	8
6.0	4	9

Traffic Indices (TIs) used in our pavement design are considered reasonable values for the proposed residential street areas and should provide a pavement life of approximately 20 years with a normal amount of flexible pavement maintenance. Irrigation adjacent to pavements, without a deep curb or other cutoff to separate landscaping from the paving may result in premature pavement failure. Traffic parameters used for design were selected based upon engineering judgment and not upon information furnished to us such as an equivalent wheel load analysis or a traffic study.

The recommended pavement sections provided are intended as a minimum guideline and final selection of pavement cross section parameters should be made by the project civil engineer, based upon the local laws and ordinates, expected subgrade and pavement response, and desired level of conservatism. If thinner or highly variable pavement sections are constructed, increased maintenance and repair could be expected. Final pavement design should be checked by testing of soils exposed at subgrade (the upper five feet) after final grading has been completed.

Asphalt concrete and aggregate base should conform to current Caltrans Standard Specifications Section 39 and 26-1.02, respectively. As an alternative, asphalt concrete can conform to Section 203-6 of the current Standard Specifications for Public Work (Green Book). Crushed aggregate base or crushed miscellaneous base can conform to Section 200-2.2 and 200-2.4 of the Green

Book, respectively. Pavement base should be compacted to at least 95 percent of the ASTM D1557 laboratory maximum dry density (modified proctor).

All pavement installation, including preparation and compaction of subgrade, compaction of base material, placement and rolling of asphaltic concrete should be done in accordance with the City of Cypress specifications, and under the observation and testing of GeoTek and a City Inspector where required. Jurisdictional minimum compaction requirements in excess of the aforementioned minimums may govern.

Deleterious material, excessive wet or dry pockets, oversized rock fragments, and other unsuitable yielding materials encountered during grading should be removed. Once existing compacted fill are brought to the proposed pavement subgrade elevations, the subgrade should be proof-rolled in order to check for a uniform and unyielding surface. The upper 12 inches of pavement subgrade soils should be scarified, moisture conditioned at or near optimum moisture content, and recompacted to at least 95 percent of the laboratory maximum dry density (ASTM D1557). If loose or yielding materials are encountered during construction, additional evaluation of these areas should be carried out by GeoTek. All pavement section changes should be properly transitioned.

5.3.7 Soil Corrosivity

The soil resistivity was tested in the laboratory on two samples collected during our field exploration. The results of the testing (2,010 ohm-cm) indicate that the soil samples are "highly corrosive" to buried ferrous metals, based on the guidelines provided in *Corrosion Basics: An Introduction* (Roberge, 2005). Chloride content of the samples (0.0027 and 0.0035 percent) was found to be negligible. Consideration should be given to consulting with a corrosion engineer.

5.3.8 Soil Sulfate Content

The sulfate content was determined in the laboratory for two soil samples obtained during our field investigation. The results (0.0071 and 0.0192 percent) indicate that the water-soluble sulfate range is less than 0.1 percent by weight which is considered "not applicable" (i.e. negligible) as per Table 4.2.1 of ACI 318. Based upon the test results, no special concrete mix design is required by Code for sulfate attack resistance. Additional testing of soils collected near finish grade should be performed subsequent to site grading.

5.3.9 Import Soils

Import soils should have an expansion index similar to the on-site soils. GeoTek also recommends that, as a minimum, proposed import soils be tested for soluble sulfate content.

GeoTek should be notified a minimum of 72 hours of potential import sources so that appropriate sampling and laboratory testing can be performed.

5.3.10 Concrete Flatwork

5.3.10.1 Exterior Concrete Slabs, Sidewalks, and Driveways

Exterior concrete slabs, sidewalks, and driveways should be designed using a four-inch minimum thickness. No specific reinforcement is required due to the non-structural nature. However, the use of some reinforcement should be considered. Some shrinkage and cracking of the concrete should be anticipated as a result of typical mix designs and curing practices commonly utilized in residential construction.

Sidewalks and driveways may be under the jurisdiction of the governing agency. If so, jurisdictional design and construction criteria would apply, if more restrictive than the recommendations presented herein.

Subgrade soils below exterior concrete flatwork should be pre-moistened prior to placing concrete. The subgrade soils with "very low" expansion potential should be pre-saturated to a minimum of 100 percent of optimum moisture content to a depth of 12 inches. Subgrade soils with "low" expansion potential should be presaturated to a minimum of 110 percent of optimum moisture content to a depth of approximately 12 inches.

All concrete installation, including preparation and compaction of subgrade, should be done in accordance with the City of Cypress specifications, and under the observation and testing of GeoTek and a City Inspector, if necessary.

5.3.10.2 Concrete Performance

Concrete cracks should be expected. These cracks can vary from sizes that are essentially unnoticeable to more than 1/8 inch in width. Most cracks in concrete, while unsightly, do not significantly impact long-term performance. While it is possible to take measures (proper concrete mix, placement, curing, control joints, etc.) to reduce the extent and size of cracks that occur, some cracking will occur despite the best efforts to minimize it. Concrete can also undergo chemical processes that are dependent on a wide range of variables, which are difficult, at best, to control. Concrete, while seemingly a stable material, is also subject to internal expansion and contraction due to external changes over time.

One of the simplest means to control cracking is to provide weakened control joints for cracking to occur along. These do not prevent cracks from developing; they simply provide a relief point

for the stresses that develop. These joints are a widely accepted means to control cracks but are not always effective. Control joints are more effective the more closely spaced they are. GeoTek suggests that control joints be placed in two directions and located a distance apart roughly equal to 24 to 36 times the slab thickness.

Exterior concrete flatwork (patios, walkways, driveways, etc.) is often some of the most visible aspects of site development. They are typically given the least level of quality control, being considered "non-structural" components. We suggest that the same standards of care be applied to these features as to the structure itself.

5.4 POST CONSTRUCTION CONSIDERATIONS

5.4.1 Landscape Maintenance and Planting

Water has been shown to weaken the inherent strength of soil, and slope stability is significantly reduced by overly wet conditions. Positive surface drainage away from graded slopes should be maintained and only the amount of irrigation necessary to sustain plant life should be provided for planted slopes. Controlling surface drainage and runoff, and maintaining a suitable vegetation cover can minimize erosion. Plants selected for landscaping should be lightweight, deep-rooted types that require little water and are capable of surviving the prevailing climate.

Overwatering should be avoided. The soils should be maintained in a solid to semi-solid state as defined by the materials Atterberg Limits. Care should be taken when adding soil amendments to avoid excessive watering. Leaching as a method of soil preparation prior to planting is not recommended. An abatement program to control ground-burrowing rodents should be implemented and maintained. This is critical as burrowing rodents can decreased the long-term performance of slopes.

It is common for planting to be placed adjacent to structures in planter or lawn areas. This will result in the introduction of water into the ground adjacent to the foundation. This type of landscaping should be avoided. If used, then extreme care should be exercised with regard to the irrigation and drainage in these areas.

5.4.2 Drainage

The need to maintain proper surface drainage and subsurface systems cannot be overly emphasized. Positive site drainage should be maintained at all times. Drainage should not flow uncontrolled down any descending slope. Water should be directed away from foundations and not allowed to pond or seep into the ground. Pad drainage should be directed toward approved area(s) and not be blocked by other improvements.

It is the owner's responsibility to maintain and clean drainage devices on or contiguous to their lot. In order to be effective, maintenance should be conducted on a regular and routine schedule and necessary corrections made prior to each rainy season.

5.5 PLAN REVIEW AND CONSTRUCTION OBSERVATIONS

We recommend that site grading plans, pool plans, retaining wall plans, foundation plans, and relevant project specifications be reviewed by this office prior to construction to check for conformance with the recommendations of this report. We also recommend that GeoTek representatives be present during site grading and foundation construction to check for proper implementation of the geotechnical recommendations. The owner/developer should verify that GeoTek representatives perform at least the following duties:

- Observe site clearing and grubbing operations for proper removal of unsuitable materials.
- Observe and test bottom of removals prior to fill placement.
- Evaluate the suitability of onsite and import materials for fill placement and collect soil samples for laboratory testing where necessary.
- Observe the fill for uniformity during placement, including utility trenches.
- Perform field density testing of the fill materials.
- Observe and probe foundation excavations to confirm suitability of bearing materials.

If requested, a construction observation and compaction report can be provided by GeoTek, which can comply with the requirements of the governmental agencies having jurisdiction over the project. We recommend that these agencies be notified prior to commencement of construction so that necessary grading permits can be obtained.

6. INTENT

It is the intent of this report to aid in the design and construction of the proposed development. Implementation of the advice presented in this report is intended to reduce risk associated with construction projects. The professional opinions and geotechnical advice contained in this report are not intended to imply total performance of the project or guarantee that unusual or variable conditions will not be discovered during or after construction.

The scope of our evaluation is limited to the boundaries of the subject site. This review does not and should in no way be construed to encompass any areas beyond the specific area of the proposed construction as indicated to us by the client. Further, no evaluation of any existing site improvements is included. The scope is based on our understanding of the project and the client's needs, our fee estimate (P-0503019r) dated May 22, 2019 and geotechnical engineering standards normally used on similar projects in this region.

7. LIMITATIONS

The materials observed on the project site appear to be representative of the area; however, soil materials vary in character between excavations or conditions exposed during site construction. Site conditions may vary due to seasonal changes or other factors. GeoTek, Inc. assumes no responsibility or liability for work, testing or recommendations performed or provided by others.

Since our recommendations are based on the site conditions observed and encountered, and laboratory testing, our conclusion and recommendations are professional opinions that are limited to the extent of the available data. Observations during construction are important to allow for any change in recommendations found to be warranted. These opinions have been derived in accordance with current standards of practice and no warranty is expressed or implied. Standards of practice are subject to change with time.

8. SELECTED REFERENCES

ASCE, 2006, "Minimum Design Loads for Buildings and Other Structures, ASCE Standard ASCE/SEI 7-05".

ASTM, 2011, "Soil and Rock: American Society for Testing and Materials", vol. 4.08 and 4.09.

Bassenian Lagoni Architects, Inc, 2019, "Conceptual Site Plan, Cypress Town Center", dated April 18.

Bryant, W.A., and Hart, E.W., 2007, "Fault Rupture Hazard Zones in California, Alquist-Priolo Earthquake Fault Zoning Act with Index to Earthquake Fault Zones Maps", California Geological Survey: Special Publication 42.

California Code of Regulations, Title 24, 2016 "California Building Code", 3 volumes.

California Department of Conservation, 1998, "Seismic Hazard Zone Report for the Los Alamitos 7.5-Minute Quadrangle, Los Angeles and Orange Counties, California", Report #019.

_____, 2008, "Guidelines for Evaluating and Mitigating Seismic Hazards in California," Special Publication 117A.

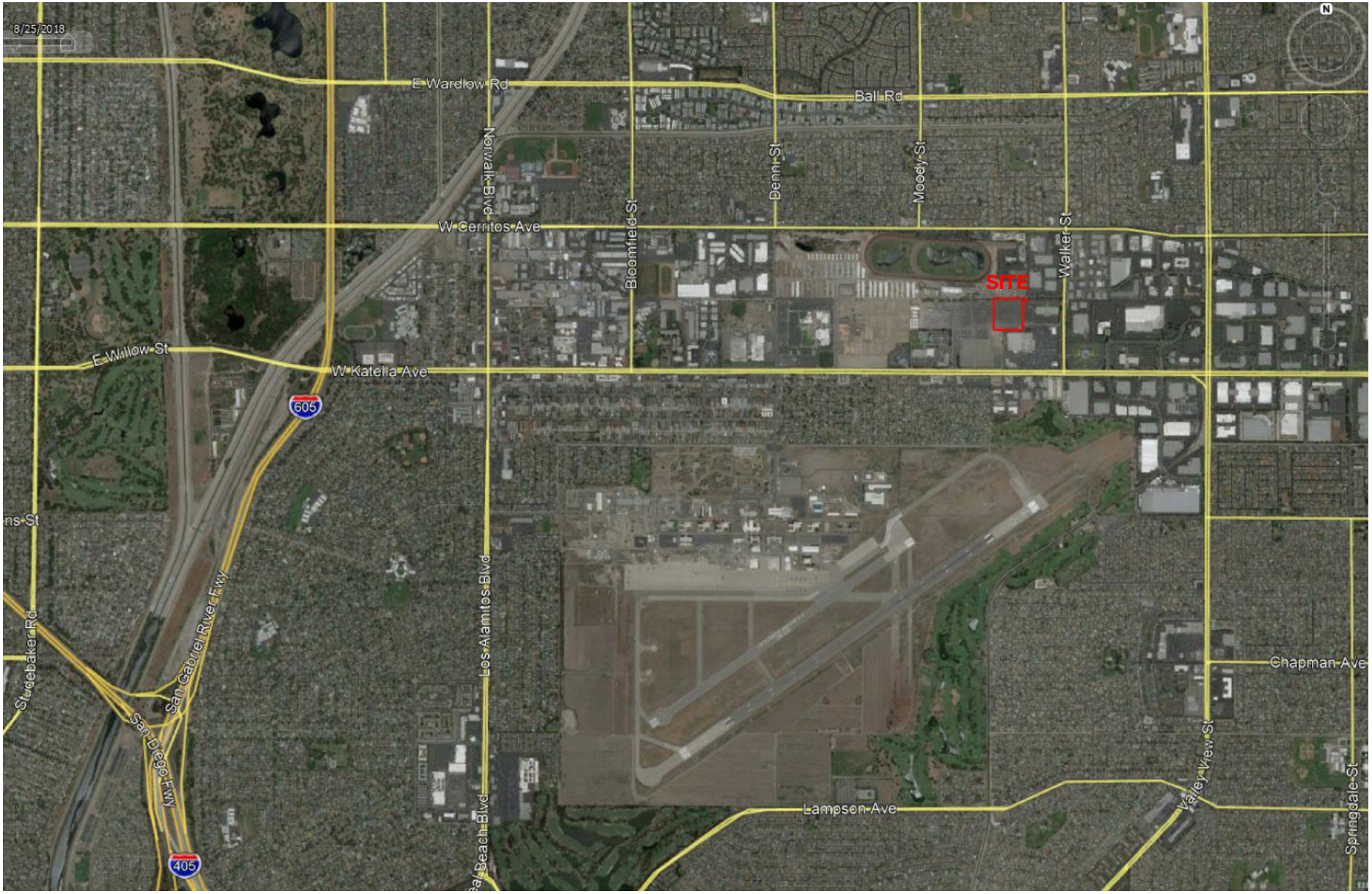
City of Cypress, 1999, "Standard Local & Cul-de-Sac Street Sections, Standard Plan No. 105".

Orange County, 2011, "Technical Guidance Document Appendix VII".

Roberge, P.R., 2005, "Corrosion Basics: An Introduction", 2nd Edition.

Roffers, Peter, D and Bedrossian, T.L., 2010, "geologic Compilation of Quaternary Surficial Deposits in Southern California Onshore Portion of the Long Beach 30 x 60 Quadrangle", Scale: 1:100,000

Seismic Design Values for Buildings (http://earthquake.usgs.gov/research/hazmaps/design).



Melia Homes
Multi-Family Residential Project
South of Vessels Circle and West of Walker Street
Cypress, Orange County, California

Project No. 2155-CR

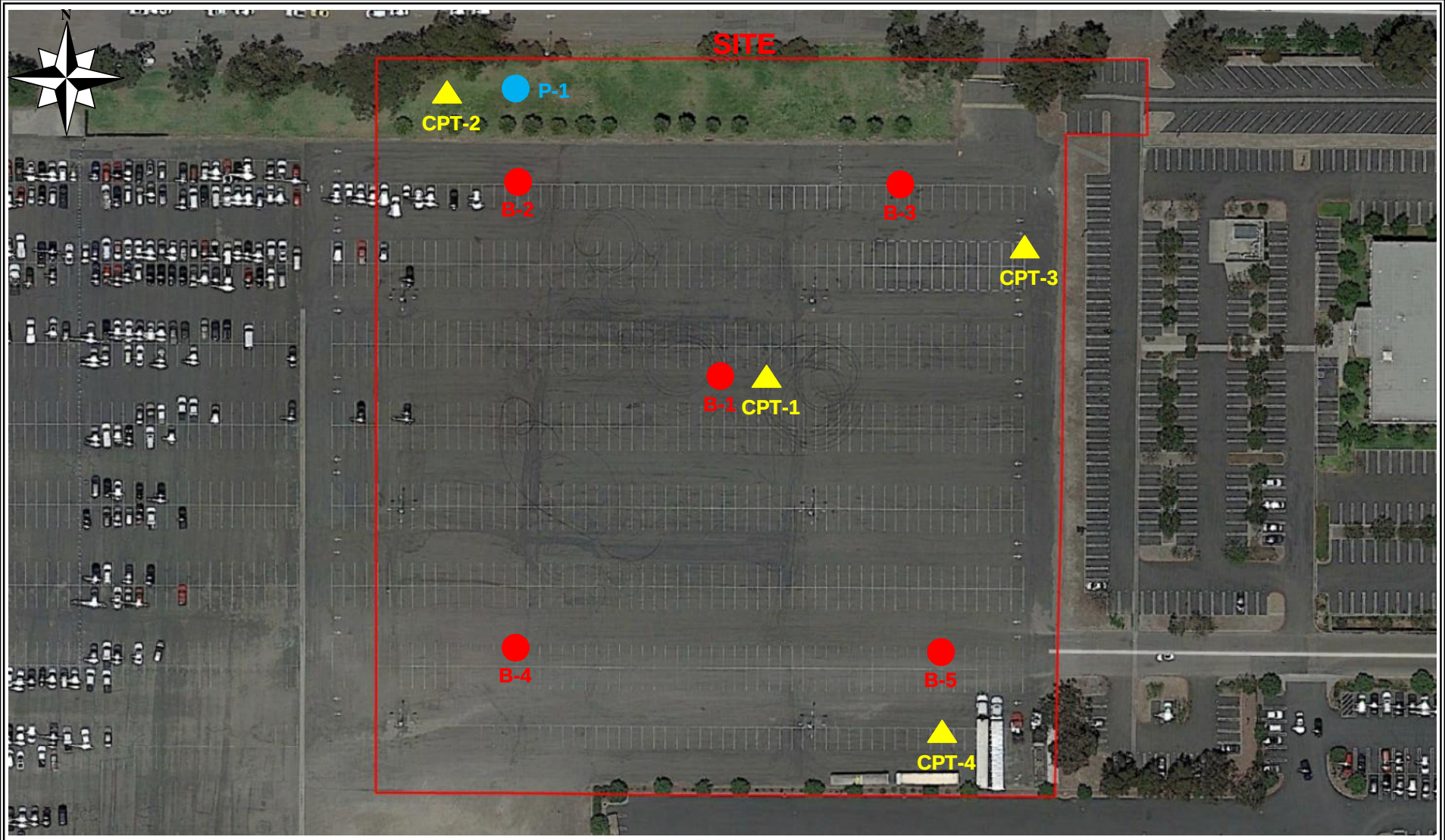
Scale: As Shown

0 0.5 mi

Figure 1

Site Location Map

GEOTEK



Legend:
(Locations are approximate)

CPT-4 - CPT Sounding

B-5 - Exploratory Boring

P-1 - Groundwater Monitoring Well

Melia Homes Multi-Family Residential Project South of Vessels Circle and West of Walker Street Cypress, Orange County, California Project No. 2155-CR	Scale: As Shown 0 — 100 ft	**Figure 2** **Exploration Location Map**	GEOTEK

APPENDIX A

EXPLORATORY BORING LOGS

Geotechnical Evaluation
Proposed Multi-Family Residential Development, Cypress, California
Project No. 2155-CR

GEOTEK

A - FIELD TESTING AND SAMPLING PROCEDURES

The Modified Split-Barrel Sampler (Ring)

The ring sampler is driven into the ground in accordance with ASTM Test Method D 3550. The sampler, with an external diameter of 3.0 inches, is lined with 1-inch long, thin brass rings with inside diameters of approximately 2.4 inches. The sampler is typically driven into the ground 12 or 18 inches with a 140-pound hammer free falling from a height of 30 inches. Blow counts are recorded for every 6 inches of penetration as indicated on the logs of borings. The samples are removed from the sample barrel in the brass rings, sealed, and transported to the laboratory for testing.

Bulk Samples (Large)

These samples are normally large bags of earth materials over 20 pounds in weight collected from the field by means of hand digging or exploratory cuttings.

Bulk Samples (Small)

These are plastic bag samples which are normally airtight and contain less than five pounds in weight of earth materials collected from the field by means of hand digging or exploratory cuttings. These samples are primarily used for determining natural moisture content and classification indices.

B – BORING LOG LEGEND

The following abbreviations and symbols often appear in the classification and description of soil and rock on the logs of borings:

SOILS

USCS	Unified Soil Classification System
f-c	Fine to coarse
f-m	Fine to medium

GEOLOGIC

B: Attitudes	Bedding: strike/dip
J: Attitudes	Joint: strike/dip
C: Contact line	
……..	Dashed line denotes USCS material change
———	Solid Line denotes unit / formational change
———	Thick solid line denotes end of boring

(Additional denotations and symbols are provided on the logs of borings)

GeoTek, Inc.

LOG OF EXPLORATORY BORING

CLIENT:	Melia Homes	**DRILLER:**	2R Drilling	**LOGGED BY:**	D.Alvarez
PROJECT NAME:	7-Acre Site Cypress Town Center	**DRILL METHOD:**	Hollow-Stem	**OPERATOR:**	Ish/Kyle
PROJECT NO.:	2155-CR	**HAMMER:**	140#/30"	**RIG TYPE:**	CME 75
LOCATION:	See Exploration Location Map			**DATE:**	7/29/2019

Boring No.: B-1

Depth (ft)	SAMPLES: Sample Type	SAMPLES: Blows/ 6 in	SAMPLES: Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Laboratory Testing: Dry Density (pcf)	Laboratory Testing: Others
0					3" Asphaltic Concrete			
					Fill:			MD, SH, EI, AL, SR
				CL	Sandy CLAY, moderate brown, moist to very moist, soft			
				SM	Silty f SAND, light brown, moist, loose			
				SC	Silty f SAND with clay, moderate brown, moist to very moist, loose			
5		2 3 3		SM	**Alluvium:** Silty f-m SAND, light brown, very moist, loose	23.0		SA
10		1 2 4		SM-ML	Silty f SAND to sandy SILT, moderate brown, very moist, loose	30.0		
15		1 1 2	▽	SM	Silty f SAND, olive-brown, wet, very loose	27.4		SA
20		2 3 5		SP	F SAND, brown, wet, loose	25.3		
25		1 1 1		CL	Clay, moderate dark brown, wet, very soft	32.6		SA
30		1 2 4			Clay, moderate dark brown, wet, medium stiff	30.9		

LEGEND

Sample type: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

Lab testing: AL = Atterberg Limits; EI = Expansion Index; SA = Sieve Analysis; RV = R-Value Test; SR = Sulfate/Resisitivity Test; SH = Shear Test; HC= Consolidation; MD = Maximum Density

GeoTek, Inc.

LOG OF EXPLORATORY BORING

CLIENT:	Melia Homes	**DRILLER:**	2R Drilling	**LOGGED BY:**	D.Alvarez
PROJECT NAME:	7-Acre Site Cypress Town Center	**DRILL METHOD:**	Hollow-Stem	**OPERATOR:**	Ish/Kyle
PROJECT NO.:	2155-CR	**HAMMER:**	140#/30"	**RIG TYPE:**	CME 75
LOCATION:	See Exploration Location Map			**DATE:**	7/29/2019

Boring No.: B-1 (Continued)

Depth (ft)	SAMPLES: Sample Type	SAMPLES: Blows/ 6 in	SAMPLES: Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Laboratory Testing: Dry Density (pcf)	Laboratory Testing: Others
30								
35		1 7 4		SP-SM	M SAND with silt, brown, wet, medium dense	24.8		SA
40		4 6 6		SP	M-c SAND, brown, wet, medium dense	24.5		
45		8 8 18		SP	F SAND with some silt, gray, wet, medium dense	18.3		
50		4 18 35			M SAND, brown, wet, very dense	21.9		
					BORING TERMINATED AT 51.5 FEET Boring backfilled with bentonite. Groundwater encountered at 15.0 feet.			
55								
60								

LEGEND

Sample type: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

Lab testing: AL = Atterberg Limits; EI = Expansion Index; SA = Sieve Analysis; RV = R-Value Test; SR = Sulfate/Resisitivity Test; SH = Shear Test; HC= Consolidation; MD = Maximum Density

GeoTek, Inc.

LOG OF EXPLORATORY BORING

CLIENT:	Melia Homes	**DRILLER:**	2R Drilling	**LOGGED BY:**	D.Alvarez
PROJECT NAME:	7-Acre Site Cypress Town Center	**DRILL METHOD:**	Hollow-Stem	**OPERATOR:**	Ish/Kyle
PROJECT NO.:	2155-CR	**HAMMER:**	140#/30"	**RIG TYPE:**	CME 75
LOCATION:	See Exploration Location Map			**DATE:**	7/29/2019

Boring No.: B-2

Depth (ft)	SAMPLES: Sample Type	SAMPLES: Blows/ 6 in	SAMPLES: Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Laboratory Testing: Dry Density (pcf)	Laboratory Testing: Others
0					2.5" Asphaltic Concrete			
					Fill:			
				SM-ML	Sandy SILT to silty SAND, brown, moist, medium dense			
				SC	Silty SAND with some clay, moderate brown, moist to very moist, medium dense			
					Alluvium:			
5	■	7 10 12		SP	F-m SAND, brown, very moist, medium dense	22.8	104.4	
	■	5 9 6			F-m SAND, brown, very moist, loose	23.9	102.0	
10	■	1 2 3	▽	ML	SILT with few sand, moderate brown-olive, very moist, soft	31.7	91.5	HC
15	■	2 4 5			SILT with few sand, moderate brown-olive, wet, medium stiff	24.6	102.6	
20	■	4 9 14		SP	F-m SAND, brown, wet, medium dense	22.7	102.8	
					BORING TERMINATED AT 21.5 FEET			
25					Boring backfilled with bentonite. Groundwater encountered at 12.0 feet.			
30								

LEGEND

Sample type: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

Lab testing: AL = Atterberg Limits; EI = Expansion Index; SA = Sieve Analysis; RV = R-Value Test; SR = Sulfate/Resisitivity Test; SH = Shear Test; HC= Consolidation; MD = Maximum Density

GeoTek, Inc.

LOG OF EXPLORATORY BORING

CLIENT:	Melia Homes	**DRILLER:**	2R Drilling	**LOGGED BY:**	D.Alvarez
PROJECT NAME:	7-Acre Site Cypress Town Center	**DRILL METHOD:**	Hollow-Stem	**OPERATOR:**	Ish/Kyle
PROJECT NO.:	2155-CR	**HAMMER:**	140#/30"	**RIG TYPE:**	CME 75
LOCATION:	See Exploration Location Map			**DATE:**	7/29/2019

Boring No.: B-3

Depth (ft)	SAMPLES: Sample Type	SAMPLES: Blows/ 6 in	SAMPLES: Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Laboratory Testing: Dry Density (pcf)	Laboratory Testing: Others
0					3" Asphaltic Concrete			
				SM-ML	**Fill:** Silty f SAND to silty SAND, light brown, moist, medium dense			
				SP	**Alluvium:** F-m SAND, brown, moist, medium dense			
5	■	6 9 13			F-m SAND brown, moist, medium dense	11.6	109.0	
	■	7 10 11			M SAND, brown, moist, medium dense	22.8	100.3	
10	■	2 2 3		ML-CL	Clayey SILT to Silty CLAY, moderate dark brown, very moist to wet, soft	36.6	87.2	
15	■	2 3 4	▽	SM-ML	Silty f SAND to sandy SILT, moderate dark brown, wet, very loose	25.2	101.2	
20	■	8 12 16		SP	F SAND, olive brown, wet, medium dense	25.3	100.6	
					BORING TERMINATED AT 21.0 FEET Boring backfilled with bentonite. Groundwater encountered at 15.0 feet.			
25								
30								

LEGEND

Sample type: ■ ---Ring ■ ---SPT ▨ ---Small Bulk ▩ ---Large Bulk □ ---No Recovery ▽ ---Water Table

Lab testing: AL = Atterberg Limits; EI = Expansion Index; SA = Sieve Analysis; RV = R-Value Test; SR = Sulfate/Resisitivity Test; SH = Shear Test; HC= Consolidation; MD = Maximum Density

GeoTek, Inc.

LOG OF EXPLORATORY BORING

CLIENT:	Melia Homes	**DRILLER:**	2R Drilling	**LOGGED BY:**	D.Alvarez
PROJECT NAME:	7-Acre Site Cypress Town Center	**DRILL METHOD:**	Hollow-Stem	**OPERATOR:**	Ish/Kyle
PROJECT NO.:	2155-CR	**HAMMER:**	140#/30"	**RIG TYPE:**	CME 75
LOCATION:	See Exploration Location Map			**DATE:**	7/29/2019

Boring No.: B-4

Depth (ft)	SAMPLES: Sample Type	SAMPLES: Blows/ 6 in	SAMPLES: Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Laboratory Testing: Dry Density (pcf)	Laboratory Testing: Others
0					4" Asphaltic Concrete			
					Fill:			MD, EI, SH, SR
				SC-SM	Clayey sandy SILT to silty f SAND, brown, moist to very moist, medium dense			
				SP	**Alluvium:** F-m SAND, light brown, moist, medium dense			
5		4 6			M-c SAND, brown, moist, loose	21.5	101.2	
		10 3 4 6		SM-ML	Silty f SAND to sandy SILT, brown, very moist, loose	29.2	96.4	HC
10		5 6 9		SP	F SAND, brown, very moist, loose	25.3	100.4	
15		3 4 9	▽	SM-ML	Silty f SAND to sandy SILT, brown, very moist, loose to medium stiff	23.4	104.3	
20		4 7 8						
					BORING TERMINATED AT 21.5 FEET			
					Boring backfilled with bentonite. Groundwater encountered at 18.0 feet.			
25								
30								

LEGEND

Sample type: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

Lab testing: AL = Atterberg Limits; EI = Expansion Index; SA = Sieve Analysis; RV = R-Value Test; SR = Sulfate/Resisitivity Test; SH = Shear Test; HC= Consolidation; MD = Maximum Density

GeoTek, Inc.

LOG OF EXPLORATORY BORING

CLIENT:	Melia Homes	**DRILLER:**	2R Drilling	**LOGGED BY:**	D.Alvarez
PROJECT NAME:	7-Acre Site Cypress Town Center	**DRILL METHOD:**	Hollow-Stem	**OPERATOR:**	Ish/Kyle
PROJECT NO.:	2155-CR	**HAMMER:**	140#/30"	**RIG TYPE:**	CME 75
LOCATION:	See Exploration Location Map			**DATE:**	7/29/2019

Boring No.: B-5

Depth (ft)	SAMPLES: Sample Type	SAMPLES: Blows/ 6 in	SAMPLES: Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Laboratory Testing: Dry Density (pcf)	Laboratory Testing: Others
0					3.0" Asphaltic Concrete			
					Fill:			
				SM-ML	Sandy SILT to silty SAND, light brown, moist, medium dense			
				ML-SC	Sandy SILT to silty SAND with some clay, light brown, moist, medium dense			
					Alluvium:			
5	■	11 12 15		SP	F-m SAND, light brown, moist, medium dense	16.6	104.1	
	■	3 4 9			F-m SAND, light brown, very moist, medium dense	23.0	101.2	
10	■	9 14 14		SM	F SAND with some silt, brown, very moist, dense	18.6	107.0	
	■	3 5 6			Silty f SAND, moderate brown, very moist, loose	23.2	105	
15			▽					
20	■	3 5 8		SM-ML	Silty f SAND to sandy SILT, brown, wet, loose	26.0	98.7	
					BORING TERMINATED AT 21.5 FEET			
					Boring backfilled with bentonite. Groundwater encountered at 18.0 feet.			
25								
30								

LEGEND

Sample type: ■ ---Ring ■ ---SPT ▨ ---Small Bulk ▩ ---Large Bulk □ ---No Recovery ▽ ---Water Table

Lab testing: AL = Atterberg Limits; EI = Expansion Index; SA = Sieve Analysis; RV = R-Value Test; SR = Sulfate/Resisitivity Test; SH = Shear Test; HC= Consolidation; MD = Maximum Density

APPENDIX B

LOGS OF CPT SOUNDINGS

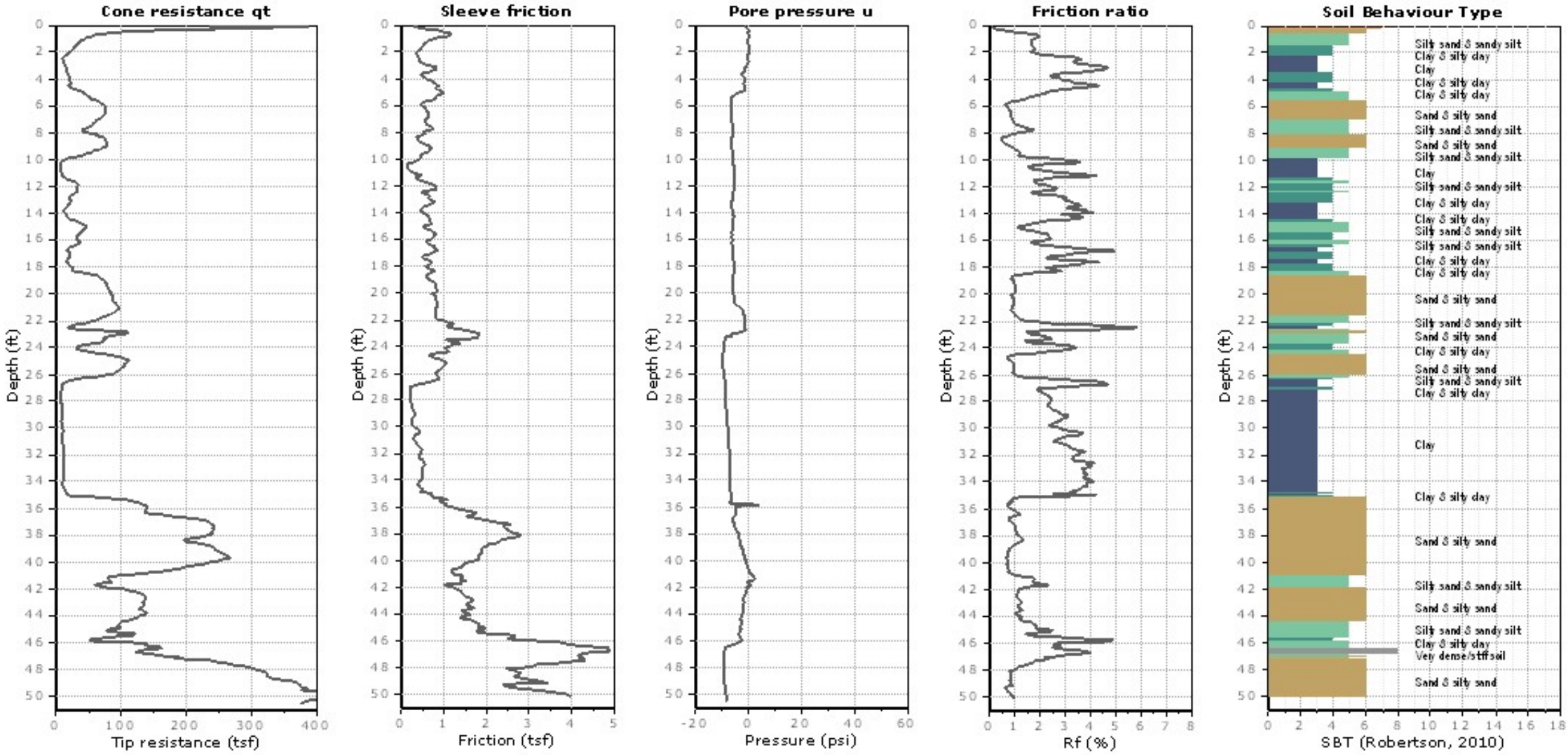
Geotechnical Evaluation
Proposed Multi-Family Residential Development, Cypress, California
Project No. 2155-CR

GEOTEK

Kehoe Testing and Engineering
714-901-7270
steve@kehoetesting.com
www.kehoetesting.com

Project: GeoTek
Location: 5401 Katella Ave, Cypress, CA

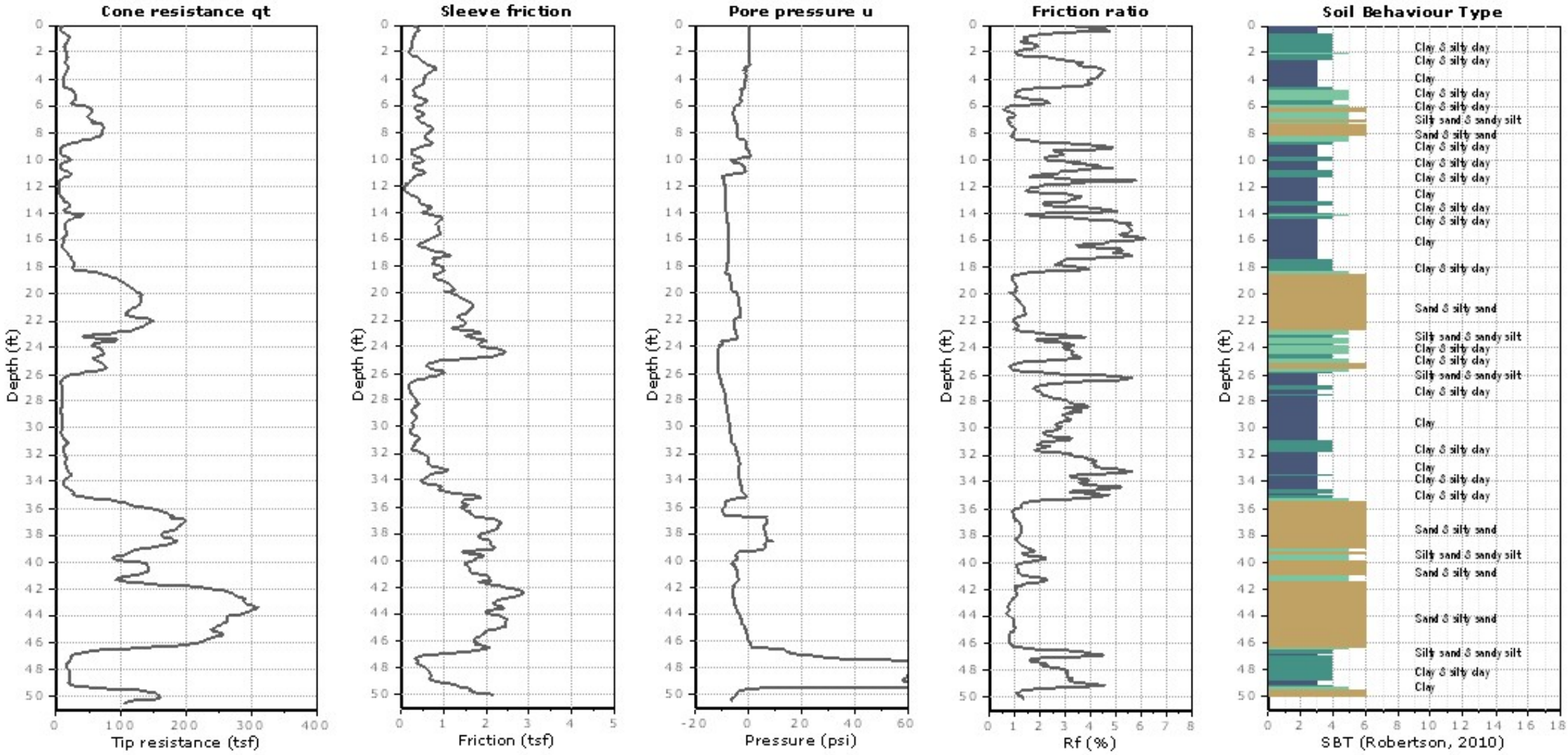
CPT-1
Total depth: 50.47 ft, Date: 7/12/2019



Kehoe Testing and Engineering
714-901-7270
steve@kehoetesting.com
www.kehoetesting.com

Project: GeoTek
Location: 5401 Katella Ave, Cypress, CA

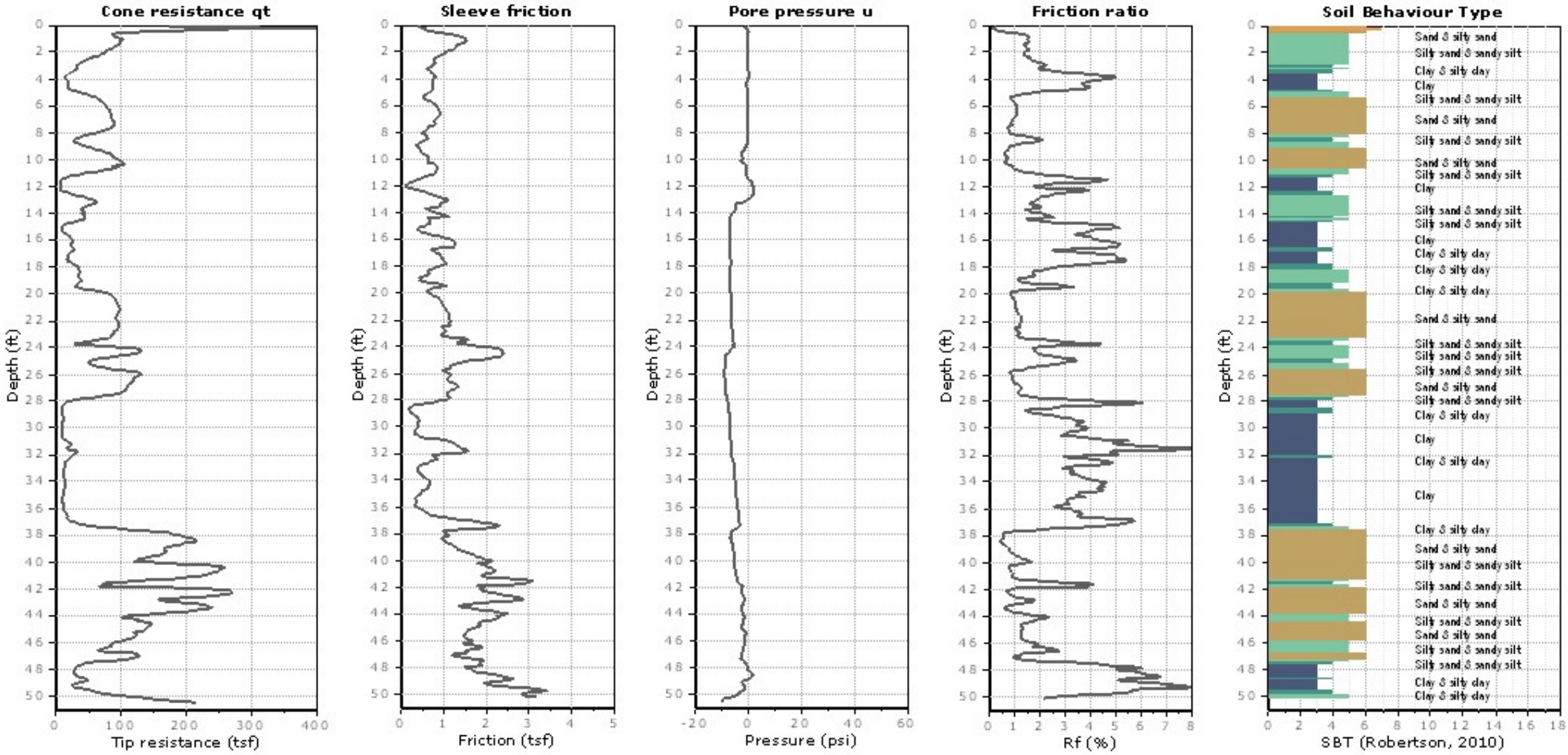
CPT-2
Total depth: 50.48 ft, Date: 7/12/2019



Kehoe Testing and Engineering
714-901-7270
steve@kehoetesting.com
www.kehoetesting.com

Project: GeoTek
Location: 5401 Katella Ave, Cypress, CA

CPT-3
Total depth: 50.53 ft, Date: 7/12/2019



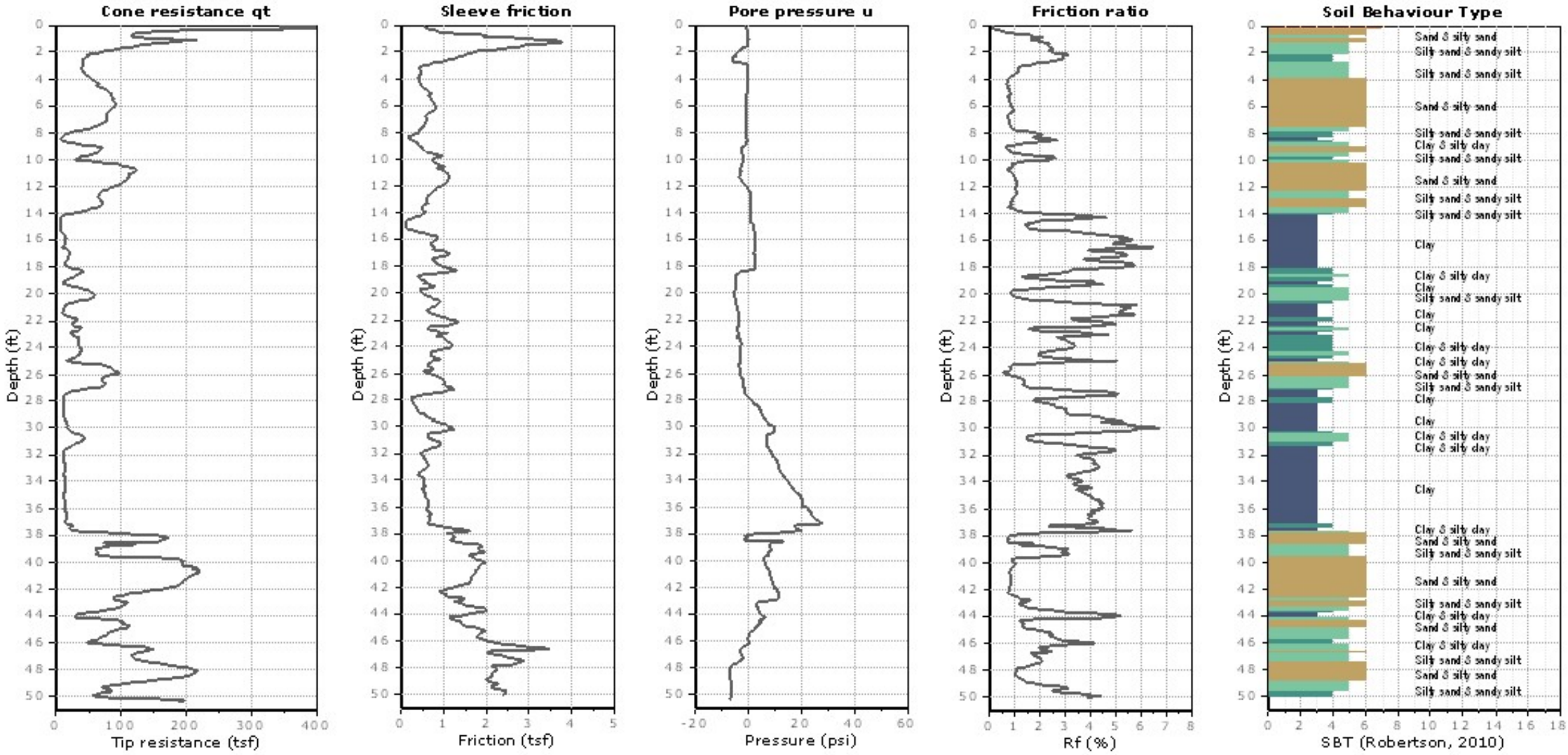
Kehoe Testing and Engineering
714-901-7270
steve@kehoetesting.com
www.kehoetesting.com

Project: GeoTek

CPT-4

Location: 5401 Katella Ave, Cypress, CA

Total depth: 50.40 ft, Date: 7/12/2019



APPENDIX C

LABORATORY TEST RESULTS

Geotechnical Evaluation
Proposed Multi-Family Residential Development, Cypress, California
Project No. 2155-CR

GEOTEK

SUMMARY OF LABORATORY TESTING

Classification
Soils were classified visually in general accordance to the Unified Soil Classification System (ASTM Test Method D 2487). The soil classifications are shown on the logs of exploratory borings in Appendix A.

In Situ Moisture Content and Unit Weight
The field moisture content was measured in the laboratory on selected samples collected during the field investigation. The field moisture content is determined as a percentage of the dry unit weight. The dry density was measured in the laboratory on selected ring samples. The results are shown on the logs of exploratory borings in Appendix A.

Moisture-Density Relationship
Laboratory testing was performed on two samples collected during the subsurface exploration. The laboratory maximum dry density and optimum moisture content for the soil type was determined in general accordance with test method ASTM Test Procedure D 1557. The results are presented herein.

Direct Shear
Direct shear testing was performed on remolded samples of the surficial soils according to ASTM Test Method D 3080. The results of these tests are presented herein.

Expansion Index
The expansion potential of the soils was determined by performing expansion index tests on two representative soil samples from the site in general accordance with ASTM D 4829. The results of these tests are presented herein.

Consolidation/Collapse
Consolidation/collapse tests were conducted in accordance with ASTM D2435. The results of these tests are presented herein.

Atterberg Limits
Atterberg limits testing were performed on two fine-grained samples collected from the site. The tests were performed in general accordance with ASTM D 4318. The test results are presented herein.

Percent of Soil Finer than No. 200 Sieve
Tests to determine the percent of soil finer than No. 200 sieve were performed on selected samples obtained from the property. The tests were conducted in general accordance with ASTM D1140. The results of these tests are presented herein.

Sulfate Content, Resistivity and Chloride Content
Testing to determine the water-soluble sulfate content was performed by others in general accordance with California Test No. 417. Resistivity testing was completed by others in general accordance with California Test No. 643. Testing to determine the chloride content was performed by others in general accordance with California Test No. 422. The results are included herein.

GEOTEK

MOISTURE/DENSITY RELATIONSHIP

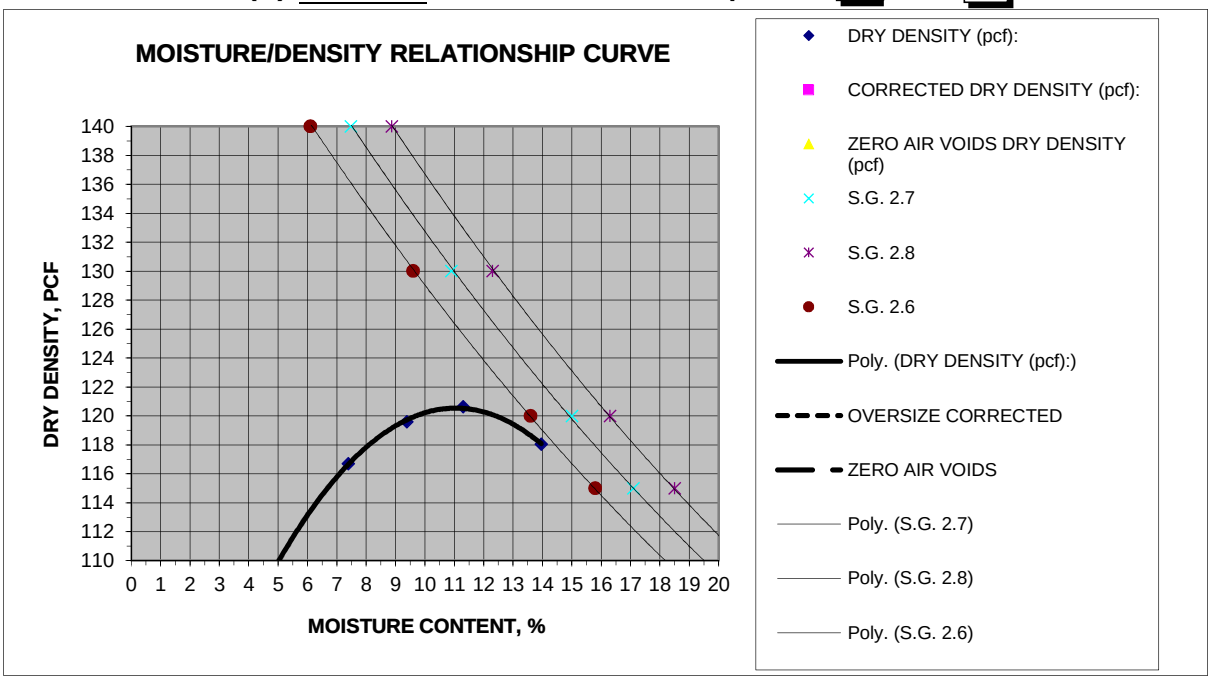
Client: Melia Homes
Project: 7 Acre Site
Location: Cypress
Material Type: Light Gray Brown Silty Sand w/Clay
Material Supplier: -
Material Source: -
Sample Location: B-1 @ 1 - 5 ft
-

Job No.: 2155-CR
Lab No.: Corona

Sampled By: DA
Received By: DLI
Tested By: MC
Reviewed By: -

Date Sampled: 7/29/2019
Date Received: 7/30/2019
Date Tested: 7/30/2019
Date Reviewed: -

Test Procedure: ASTM D1557 **Method:** A
Oversized Material (%): 0.0 **Correction Required:** [ ] yes [x] no



MOISTURE DENSITY RELATIONSHIP VALUES

Maximum Dry Density, pcf	121.0	**@ Optimum Moisture, %**	11.5
Corrected Maximum Dry Density, pcf		**@ Optimum Moisture, %**	

MATERIAL DESCRIPTION

Grain Size Distribution:

	% Gravel (retained on No. 4)
	% Sand (Passing No. 4, Retained on No. 200)
	% Silt and Clay (Passing No. 200)

Atterberg Limits:

	Liquid Limit, %
	Plastic Limit, %
	Plasticity Index, %

Classification:

Unified Soils Classification: _____

AASHTO Soils Classification: _____

GEOTEK

MOISTURE/DENSITY RELATIONSHIP

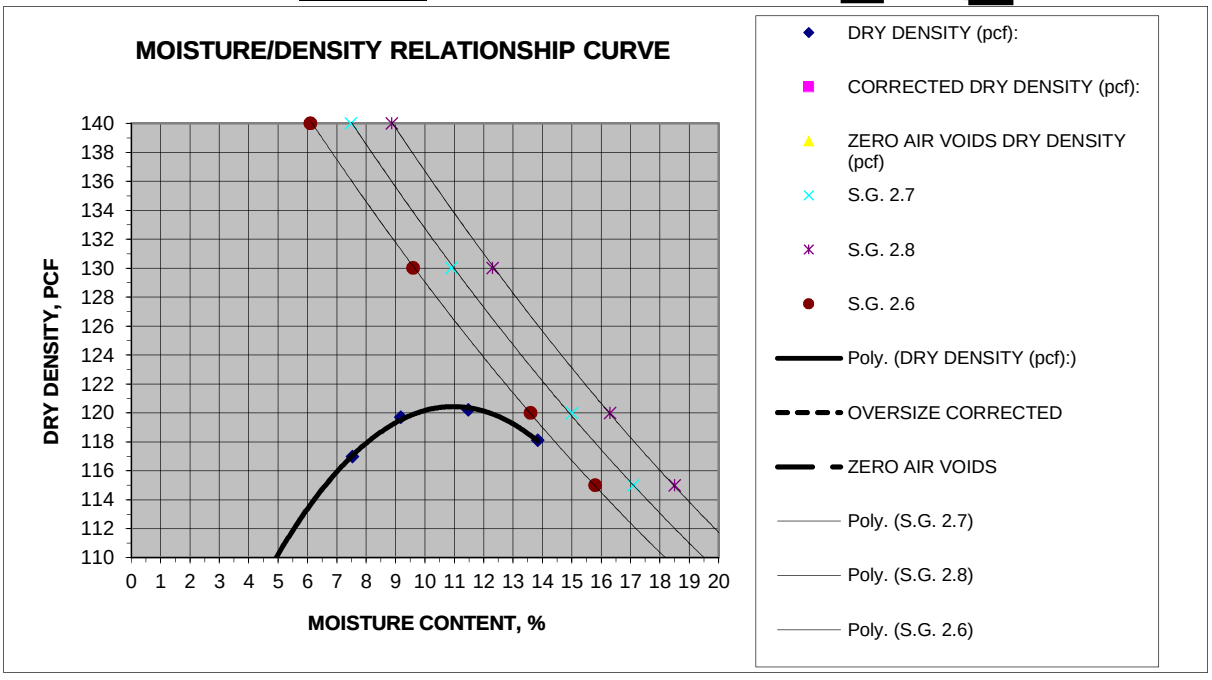
Client: Melia Homes
Project: 7 Acre Site
Location: Cypress
Material Type: Light Brown F - M Sand w/Silt
Material Supplier: -
Material Source: -
Sample Location: B-4 @ 1 - 2 ft
-

Job No.: 2155-CR
Lab No.: Corona

Sampled By: DA
Received By: DLI
Tested By: MC
Reviewed By: -

Date Sampled: 7/29/2019
Date Received: 7/30/2019
Date Tested: 7/30/2019
Date Reviewed: -

Test Procedure: ASTM D1557 **Method:** A
Oversized Material (%): 1.1 **Correction Required:** [ ] yes [x] no



MOISTURE DENSITY RELATIONSHIP VALUES

Maximum Dry Density, pcf	120.5	**@ Optimum Moisture, %**	11.0
Corrected Maximum Dry Density, pcf		**@ Optimum Moisture, %**	

MATERIAL DESCRIPTION

Grain Size Distribution:

	% Gravel (retained on No. 4)
	% Sand (Passing No. 4, Retained on No. 200)
	% Silt and Clay (Passing No. 200)

Atterberg Limits:

	Liquid Limit, %
	Plastic Limit, %
	Plasticity Index, %

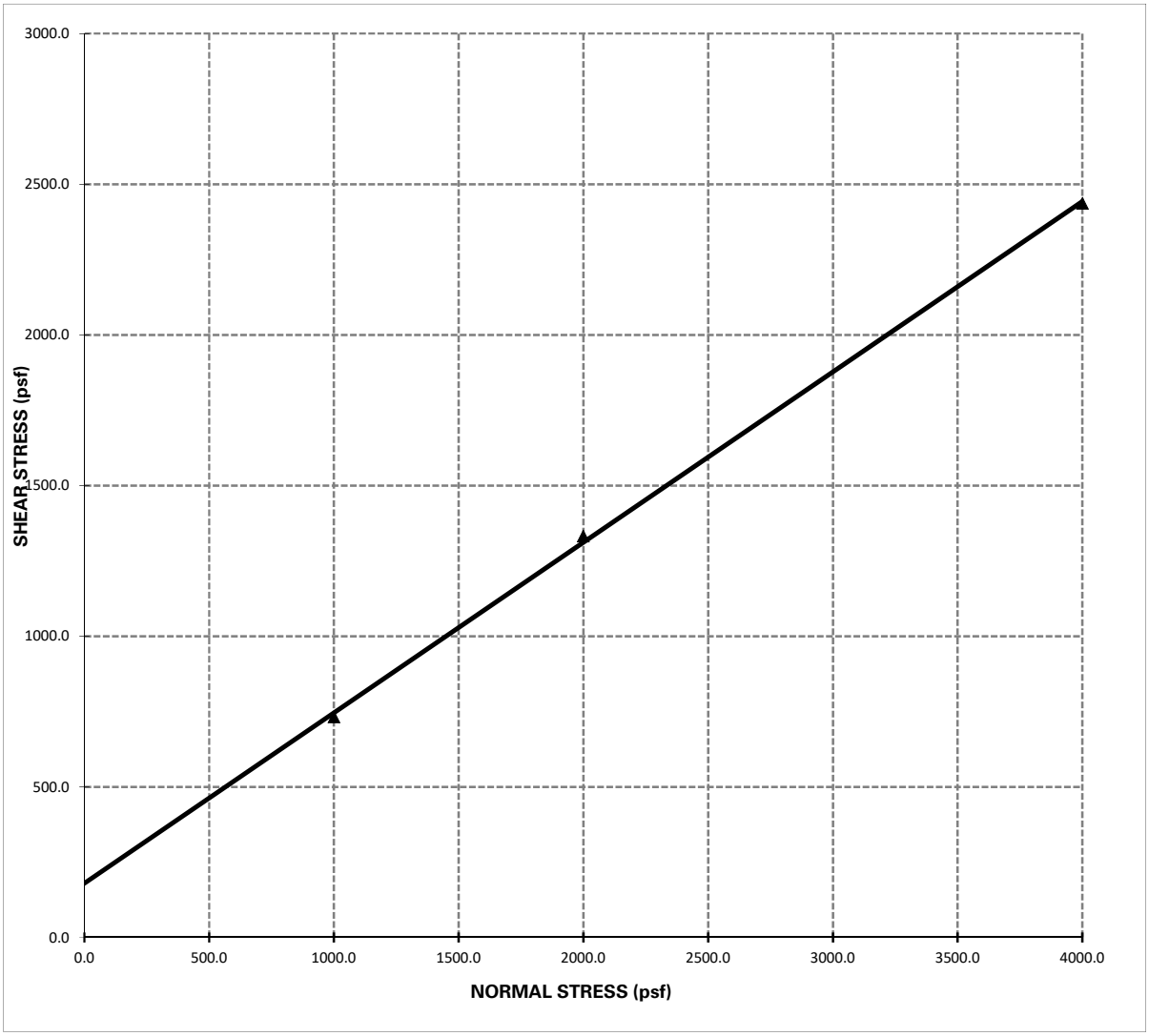
Classification:

Unified Soils Classification: _____

AASHTO Soils Classification: _____

DIRECT SHEAR TEST

Project Name:	7 Acre Site Cypress	***Sample Location:***	B-1 @ 1 - 5 ft
Project Number:	2155-CR	***Date Tested:***	8/2/2019



Shear Strength: Φ = **29.5** ° , **C = 180.00 psf**

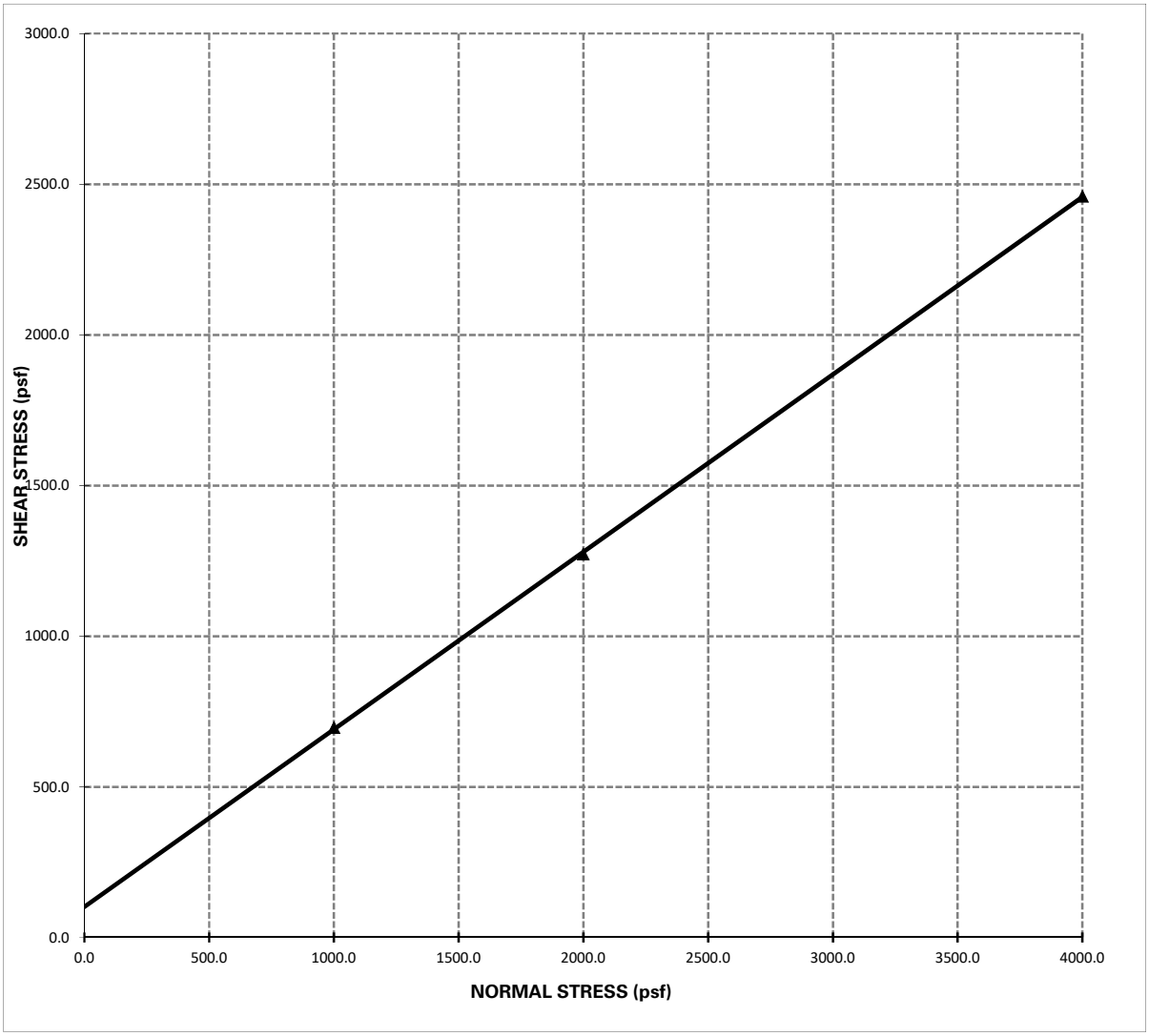
Notes: 1 - The soil specimen used in the shear box was a ring sample remolded to approximately 90% relative compaction from a bulk sample collected during the field investigation.

2 - The above reflect direct shear strength at saturated conditions.

3 - The tests were run at a shear rate of 0.035 in/min.

DIRECT SHEAR TEST

Project Name:	7 Acre Site Cypress	***Sample Location:***	B-4 @ 1 - 2 ft
Project Number:	2155-CR	***Date Tested:***	8/2/2019



Shear Strength: Φ = **30.5** ^{o} , **C = 102.00 psf**

Notes: 1 - The soil specimen used in the shear box was a ring sample remolded to approximately 90% relative compaction from a bulk sample collected during the field investigation.

2 - The above reflect direct shear strength at saturated conditions.

3 - The tests were run at a shear rate of 0.035 in/min.

GEOTEK

EXPANSION INDEX TEST

(ASTM D4829)

Client:	Melia Homes	***Tested/ Checked By:***	MC Lab No Corona
Project Number:	2155-CR	***Date Tested:***	8/1/2019
Project Location:	7 Acre Site Cypress	***Sample Source:***	B-1 @ 1 - 5 ft
		Sample Description:	

Ring #: _____ Ring Dia. : 4.01" Ring Ht.1"

DENSITY DETERMINATION

A	Weight of compacted sample & ring (gm)	759.4
B	Weight of ring (gm)	366.8
C	Net weight of sample (gm)	**392.6**
D	Wet Density, lb / ft3 (C*0.3016)	**118.4**
E	Dry Density, lb / ft3 (D/1.F)	**107.4**

SATURATION DETERMINATION

F	Moisture Content, %	10.3
G	Specific Gravity, assumed	**2.70**
H	Unit Wt. of Water @ 20 °C, (pcf)	**62.4**
I	% Saturation	**48.8**

READINGS

DATE	TIME	READING	
8/1/2019	13:00	0.2350	Initial
	13:10	0.2340	10 min/Dry
8/4/2019	7:55	0.2560	Final

FINAL MOISTURE

Final Weight of wet sample & tare	% Moisture
802.7	**21.3**

EXPANSION INDEX = 22

GEOTEK

EXPANSION INDEX TEST

(ASTM D4829)

Client:	Melia Homes	***Tested/ Checked By:***	DI Lab No Corona
Project Number:	2155-CR	***Date Tested:***	8/1/2019
Project Location:	7 Acre Site Cypress	***Sample Source:***	B-4 @ 1 - 2 ft
		Sample Description:	

Ring #: _____ Ring Dia. : 4.01" Ring Ht.1"

DENSITY DETERMINATION

A	Weight of compacted sample & ring (gm)	757.9
B	Weight of ring (gm)	362.4
C	Net weight of sample (gm)	**395.5**
D	Wet Density, lb / ft3 (C*0.3016)	**119.3**
E	Dry Density, lb / ft3 (D/1.F)	**107.7**

SATURATION DETERMINATION

F	Moisture Content, %	10.8
G	Specific Gravity, assumed	**2.70**
H	Unit Wt. of Water @ 20 °C, (pcf)	**62.4**
I	% Saturation	**51.6**

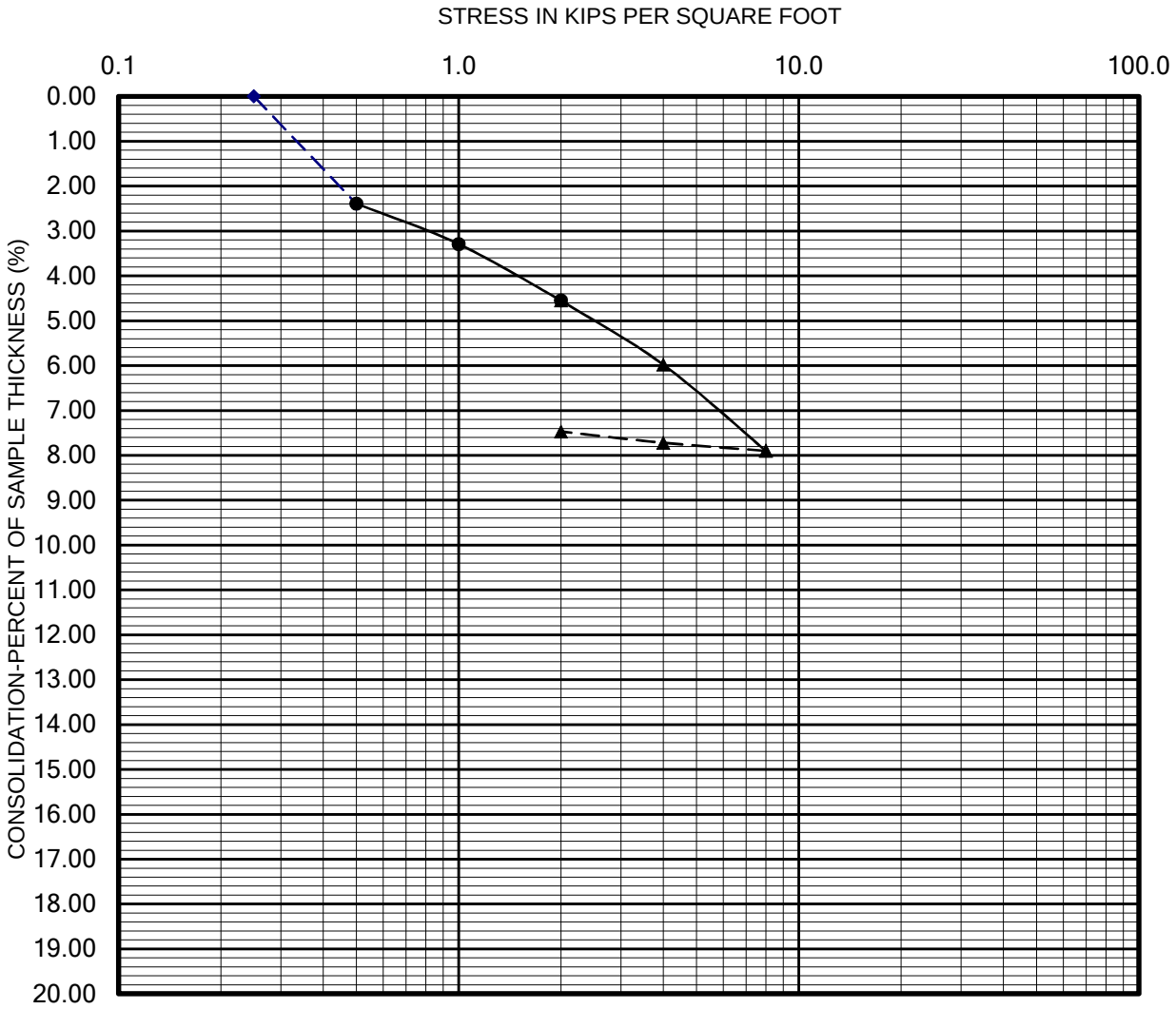
READINGS

DATE	TIME	READING	
8/1/2019	7:44	0.1780	Initial
	7:54	0.1780	10 min/Dry
8/4/2019	7:55	0.1780	Final

FINAL MOISTURE

Final Weight of wet sample & tare	% Moisture
778.8	**16.1**

EXPANSION INDEX = 0



Seating Cycle
Loading Prior to Inundation
Loading After Inundation
Rebound Cycle

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 2435

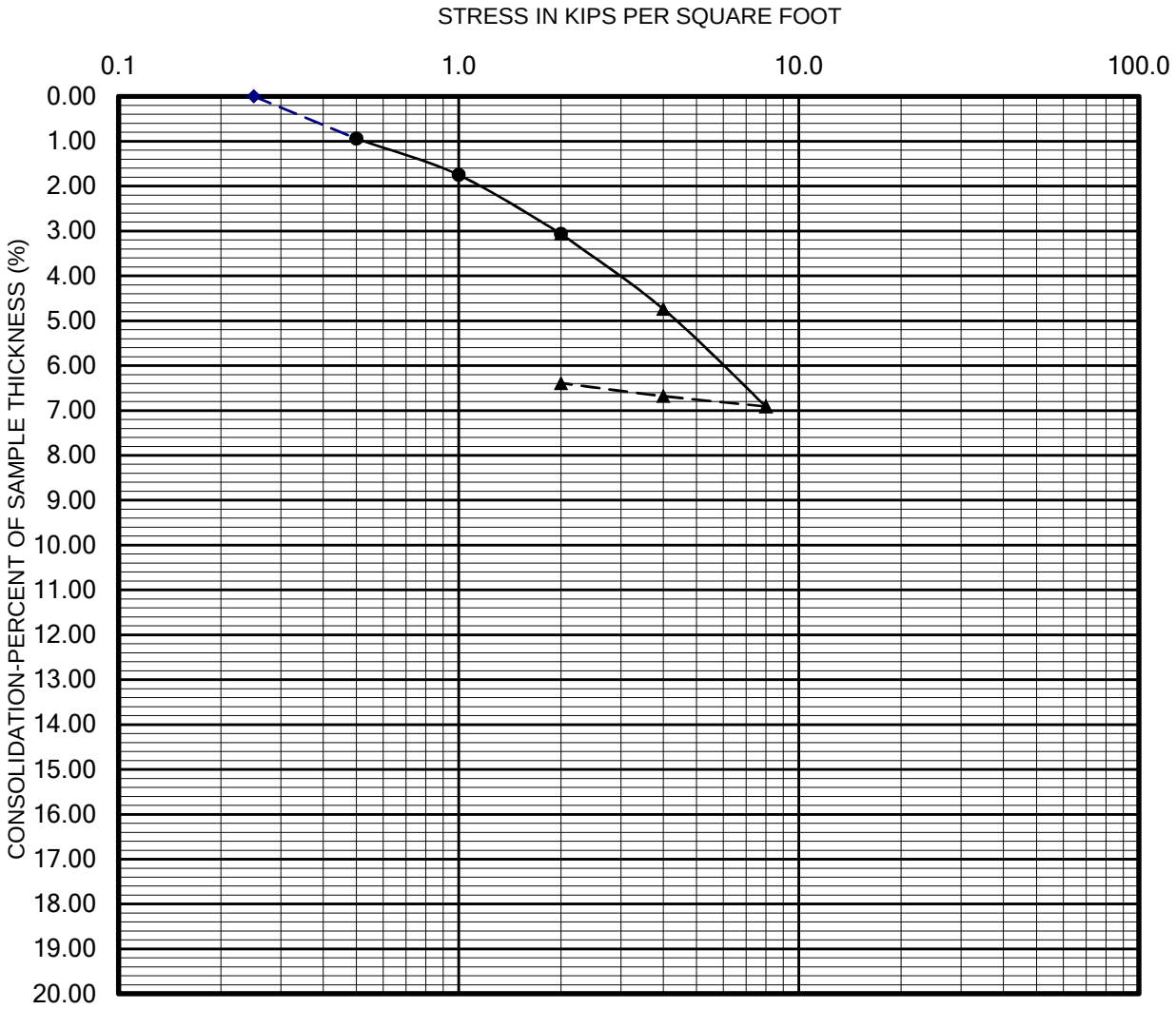
GEOTEK

CHECKED BY:	Lab:
PROJECT NO.: 2155-CR	Date: 7/31/2019

CONSOLIDATION REPORT

Sample:

B-2 @ 10 ft



Seating Cycle
Loading Prior to Inundation
Loading After Inundation
Rebound Cycle

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 2435

GEOTEK

CONSOLIDATION REPORT

Sample:

B-4 @ 6.5

CHECKED BY:	Lab:
PROJECT NO.: 2155-CR	Date: 7/31/2019

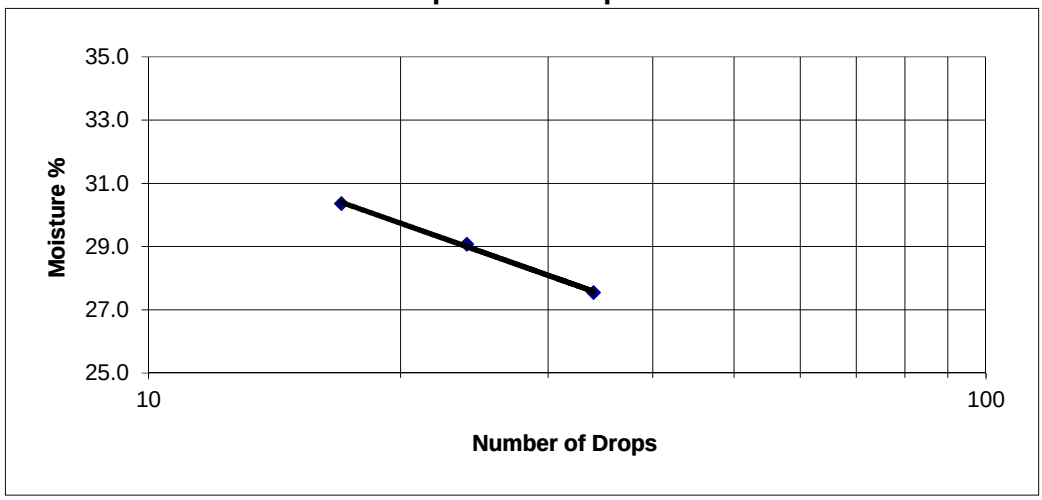
GEOTEK

ATTERBERG LIMITS DATA

Field Classification		Job No.	2155-CR
Sample Number		Client	Melia Homes
Sample Type	Bulk	Project	7 Acre Site Cypress
Location	B-1 @ 1 - 5 ft		
Tested by:	DI		

	Plastic Limit			Liquid Limit		
Number of Blows				34	24	17
Wt. of Dish + Wet Soil	13.49	13.62		20.41	20.36	20.38
Wt. of Dish + Dry Soil	12.37	12.49		17.32	17.15	17.05
Wt. of Moisture	1.12	1.13		3.09	3.21	3.33
Wt. of Dish	6.08	6.11		6.10	6.11	6.08
Wt. of Dry Soil	6.29	6.38		11.22	11.04	10.97
Moisture Content %	17.8	17.7		27.5	29.1	30.4

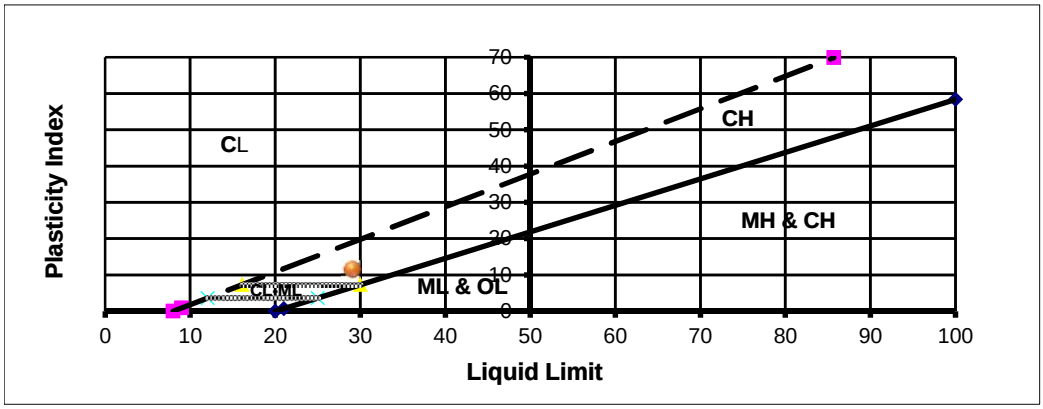
Liquid Limit Graph



Liquid Limit
29

Plastic Limit
18

Plasticity Index
11



GEOTEK

-200 WASH

Date:	8/5/2019		
W.O.:	2155-CR	sample ID	B-1
Client:	Melia Homes	depth	1-5 ft
Project:	7 Acre Site Cypress		

Sieve Size	Particle Diameter		Wt. Retained	Wt. Passing	% Passing	Specs
	in.	mm.				
#200	0.0029	0.074	85	115	57.5%	

Dry Weight 200

Soak Time 1440 Minutes

GEOTEK

-200 WASH

Date: 8/2/2019
W.O.: 2155-CR sample ID B-1
Client: Melia Homes depth 5 ft
Project: 7 Acre Sitew Cypress

Sieve Size	Particle Diameter		Wt. Retained	Wt. Passing	% Passing	Specs
	in.	mm.				
#200	0.0029	0.074	151	49	24.5%	

Dry Weight 200

Soak Time 1440 Minutes

GEOTEK

-200 WASH

Date: 8/2/2019
W.O.: 2155-CR sample ID B-1
Client: Melia Homes depth 15 ft
Project: 7 Acre Sitew Cypress

Sieve Size	Particle Diameter		Wt. Retained	Wt. Passing	% Passing	Specs
	in.	mm.				
#200	0.0029	0.074	106.5	93.5	46.8%	

Dry Weight 200

Soak Time 1440 Minutes

GEOTEK

-200 WASH

Date:	8/2/2019		
W.O.:	2155-CR	sample ID	B-1 ft
Client:	Melia Homes	depth	25
Project:	7 Acre Sitew Cypress		

Sieve Size	Particle Diameter		Wt. Retained	Wt. Passing	% Passing	Specs
	in.	mm.				
#200	0.0029	0.074	13.4	186.6	93.3%	

Dry Weight 200

Soak Time 1440 Minutes

GEOTEK

-200 WASH

Date:	8/2/2019		
W.O.:	2155-CR	sample ID	B-1
Client:	Melia Homes	depth	35 ft
Project:	7 Acre Sitew Cypress		

Sieve Size	Particle Diameter		Wt. Retained	Wt. Passing	% Passing	Specs
	in.	mm.				
#200	0.0029	0.074	178.9	21.1	10.6%	

Dry Weight 200

Soak Time 1440 Minutes

Soil Analysis Lab Results

Client: GeoTek, Inc.
Job Name: 7 Acre Site, Cypress
Client Job Number: 2155-CR
Project X Job Number: S190802C
August 6, 2019

	Method	ASTM D4327		ASTM D4327		ASTM G187		ASTM G51	ASTM G200	SM 4500-S2-D	ASTM D4327	ASTM D4327	ASTM D4327	ASTM D4327	ASTM D4327	ASTM D4327	ASTM D4327	ASTM D4327	ASTM D4327	SM-2320B
Bore# / Description	**Depth**	**Sulfates** SO_4^{2-}		**Chlorides** Cl^-		**Resistivity** As Rec'd	Minimum	**pH**	**Redox**	**Sulfide** S^{2-}	**Nitrate** NO_3^-	**Ammonium** NH_4^+	**Lithium** Li^+	**Sodium** Na^+	**Potassium** K^+	**Magnesium** Mg^{2+}	**Calcium** Ca^{2+}	**Flouride** F_2^{--}	**Phosphate** PO_4^{3-}	**Bicarbonate** HCO_3^-
	(ft)	(mg/kg)	(wt%)	(mg/kg)	(wt%)	(Ohm-cm)	(Ohm-cm)		(mV)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
B-1	1.0-5.0	192.3	0.0192	35.4	0.0035	4,958	2,010	9.8	108.0	0.6	118.9	2.6	0.6	432.5	11.4	59.8	205.2	12.2	0.7	214
B-4	1.0-2.0	71.4	0.0071	26.5	0.0027	5,762	2,010	10.0	98.0	0.6	54.7	3.4	0.3	317.4	7.0	28.0	171.6	8.6	0.9	55

Cations and Anions, except Sulfide and Bicarbonate, tested with Ion Chromatography
mg/kg = milligrams per kilogram (parts per million) of dry soil weight
ND = 0 = Not Detected | NT = Not Tested | Unk = Unknown
Chemical Analysis performed on 1:3 Soil-To-Water extract

APPENDIX D

RESULTS OF LIQUEFACTION ANALYSES

Geotechnical Evaluation
Proposed Multi-Family Residential Development, Cypress, California
Project No. 2155-CR

GEOTEK

GeoTek, Inc.
1548 N. Maple Street
Corona, CA 92880
http://www.geotekusa.com

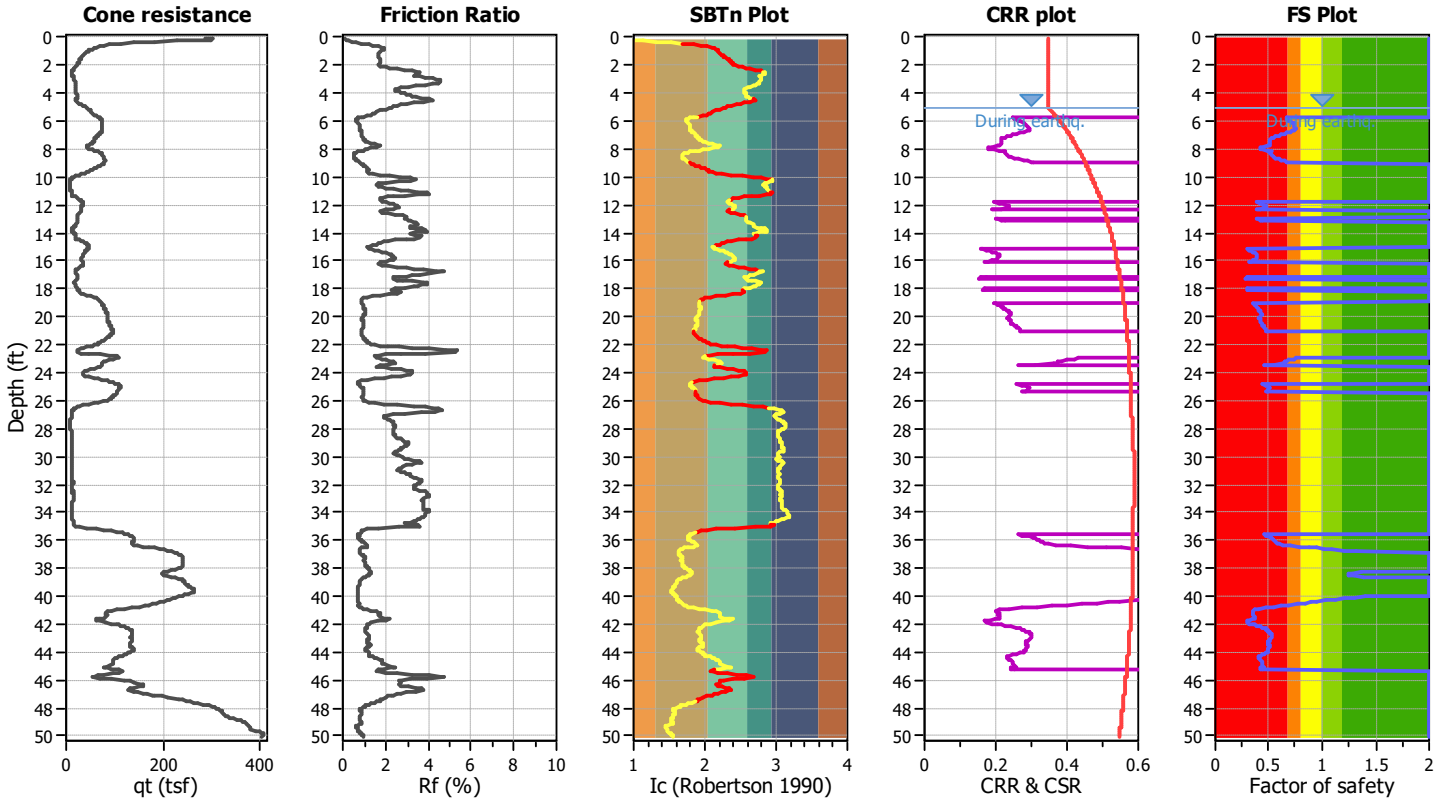
LIQUEFACTION ANALYSIS REPORT

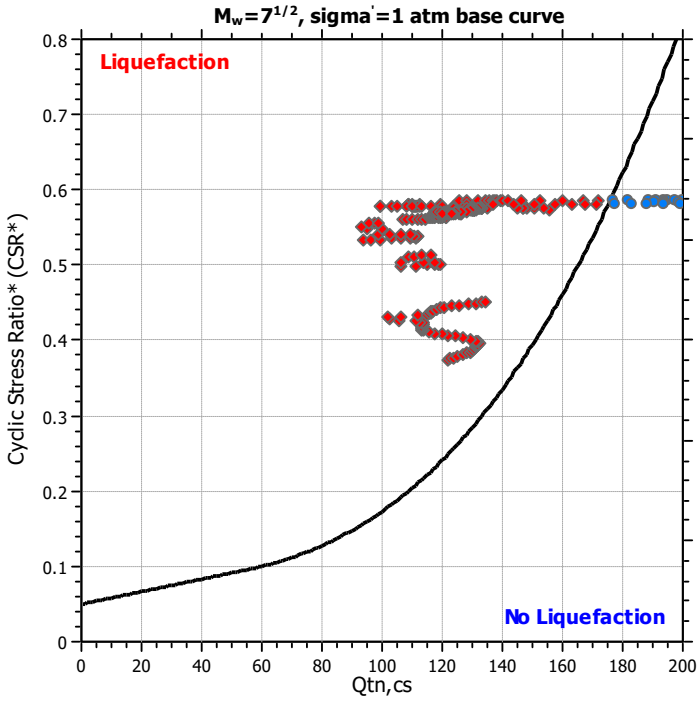
Project title : 7-Acre Site, Cypress Town Center **Location : Cypress, CA**

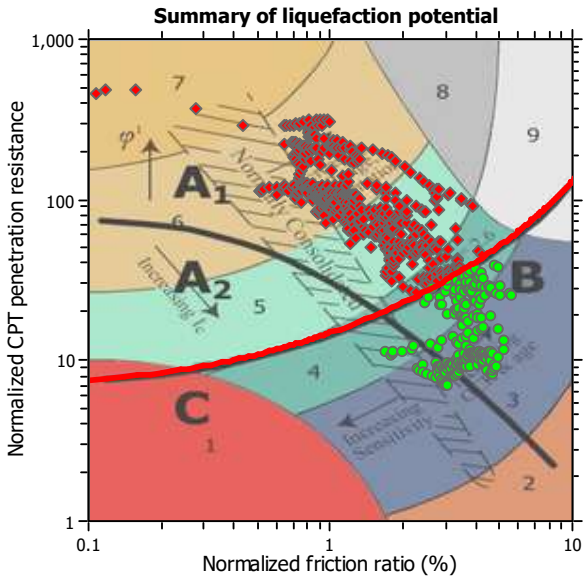
CPT file : CPT-1

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	6.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	5.00 ft	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	50.00 ft
Earthquake magnitude M_w:	6.71	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.55	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

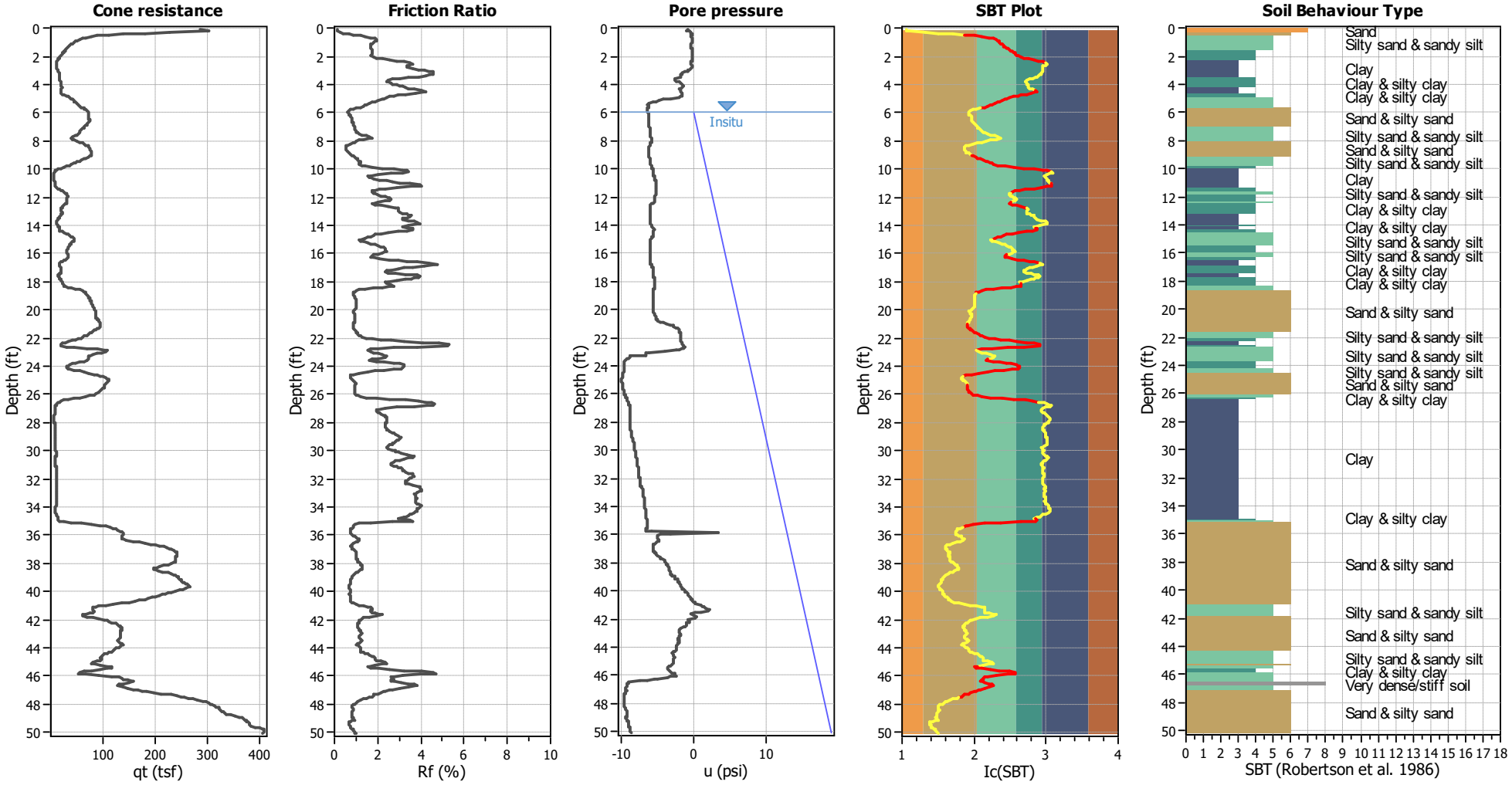






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



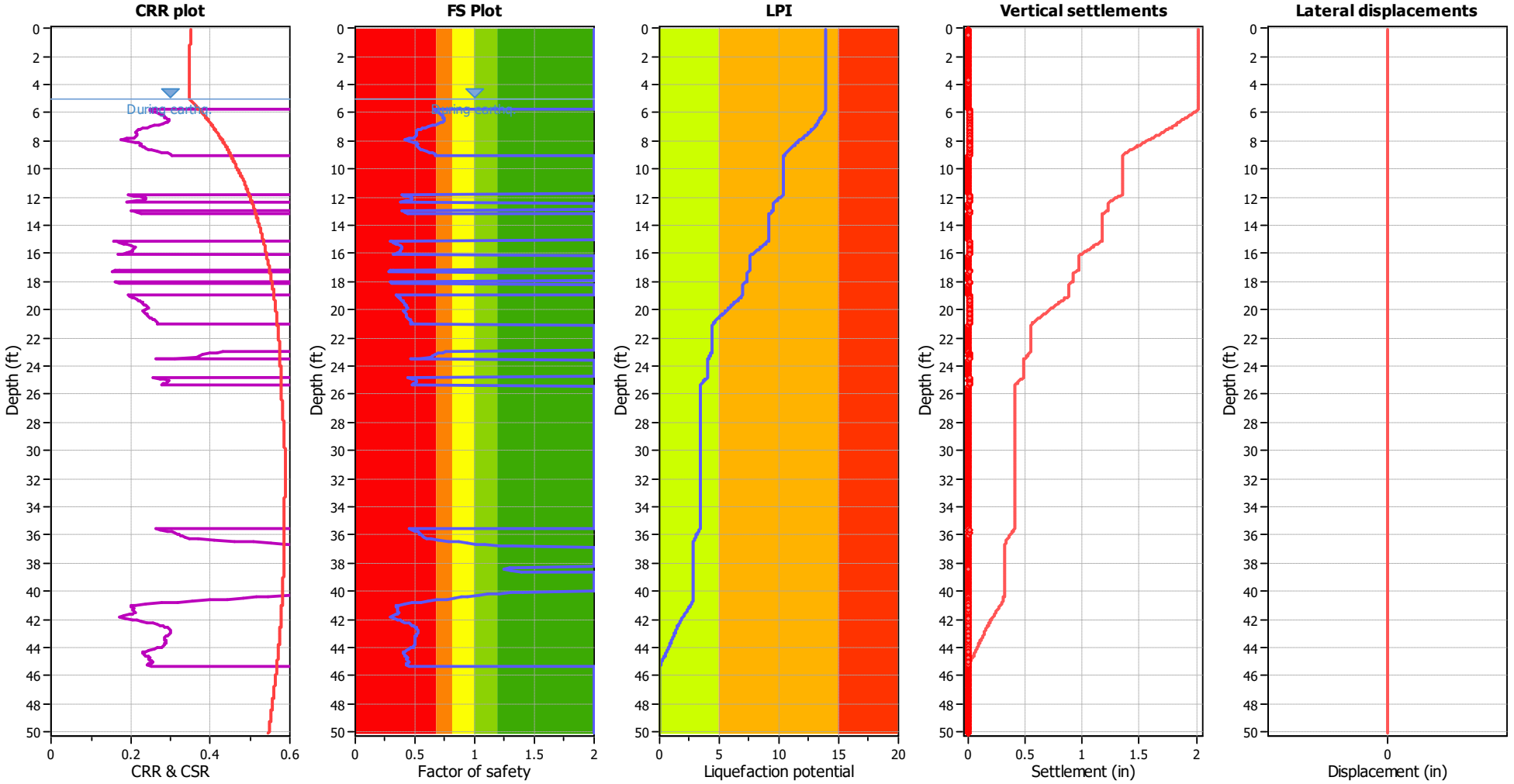
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.71	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.55	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	6.00 ft	Fill height:	N/A	Limit depth:	50.00 ft

SBT legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.71	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.55	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	6.00 ft	Fill height:	N/A	Limit depth:	50.00 ft

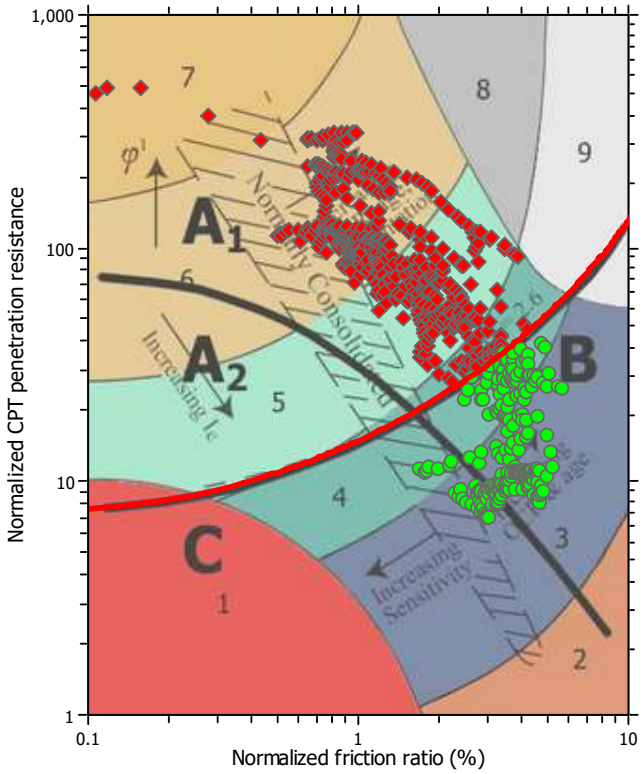
F.S. color scheme

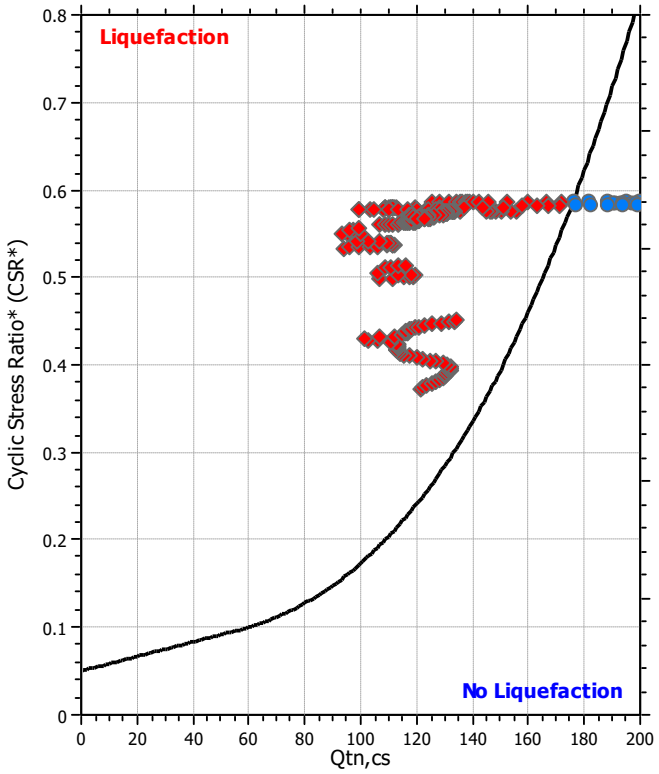
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

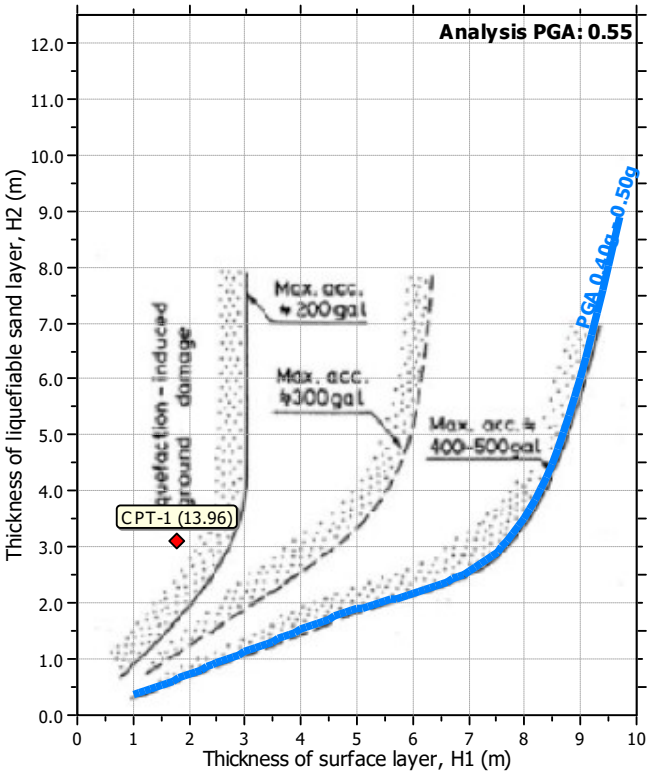
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots







Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.71	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.55	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	6.00 ft	Fill height:	N/A	Limit depth:	50.00 ft

:: Post-earthquake settlement of dry sands ::

Depth (ft)	Ic	Q_{tn}	Kc	$Q_{tn,cs}$	$N_{1,60}$ (blows)	G_{max} (tsf)	CSR	Shear, γ (%)	$e_{vol(15)}$ (%)	N_c	e_v (%)	Settle. (in)
0.08	0.85	458.76	1.00	458.76	66	750	0.35	0.000	0.00	8.70	0.00	0.000
0.14	0.83	488.99	1.00	488.99	70	786	0.35	0.000	0.00	8.70	0.00	0.000
0.21	0.89	482.55	1.00	482.55	70	835	0.35	0.001	0.00	8.70	0.00	0.000
0.27	1.12	368.91	1.00	368.91	57	853	0.35	0.001	0.00	8.70	0.00	0.000
0.34	1.32	289.92	1.00	289.92	48	867	0.35	0.001	0.00	8.70	0.00	0.000
0.40	1.52	223.48	1.00	223.48	39	861	0.35	0.001	0.00	8.70	0.00	0.000
0.47	1.68	179.49	1.03	184.39	34	849	0.35	0.001	0.00	8.70	0.00	0.000
0.53	1.84	144.42	1.14	164.56	0	0	0.35	0.000	0.00	8.70	0.00	0.000
0.60	1.94	126.91	1.23	155.72	0	0	0.35	0.000	0.00	8.70	0.00	0.000
0.66	2.03	109.87	1.35	147.96	0	0	0.35	0.000	0.00	8.70	0.00	0.000
0.73	2.10	98.39	1.45	143.01	0	0	0.35	0.000	0.00	8.70	0.00	0.000
0.79	2.13	90.75	1.52	138.08	0	0	0.35	0.000	0.00	8.70	0.00	0.000
0.86	2.16	83.79	1.57	131.41	0	0	0.35	0.000	0.00	8.70	0.00	0.000
0.93	2.17	77.23	1.61	124.13	0	0	0.35	0.000	0.00	8.70	0.00	0.000
1.00	2.18	72.03	1.63	117.30	0	0	0.35	0.000	0.00	8.70	0.00	0.000
1.06	2.19	67.92	1.65	111.85	0	0	0.35	0.000	0.00	8.70	0.00	0.000
1.12	2.20	63.87	1.68	107.20	0	0	0.35	0.000	0.00	8.70	0.00	0.000
1.20	2.22	60.22	1.72	103.58	0	0	0.35	0.000	0.00	8.70	0.00	0.000
1.26	2.24	57.15	1.77	100.89	0	0	0.35	0.000	0.00	8.70	0.00	0.000
1.31	2.25	54.45	1.81	98.60	0	0	0.35	0.000	0.00	8.70	0.00	0.000
1.39	2.27	52.06	1.86	96.95	0	0	0.35	0.000	0.00	8.70	0.00	0.000
1.45	2.29	49.51	1.93	95.35	0	0	0.35	0.000	0.00	8.70	0.00	0.000
1.52	2.31	47.37	1.99	94.06	0	0	0.35	0.000	0.00	8.70	0.00	0.000
1.59	2.33	45.24	2.05	92.69	0	0	0.35	0.000	0.00	8.70	0.00	0.000
1.65	2.35	43.26	2.11	91.36	0	0	0.35	0.000	0.00	8.70	0.00	0.000
1.72	2.36	41.49	2.17	90.02	0	0	0.35	0.000	0.00	8.70	0.00	0.000
1.78	2.38	39.71	2.23	88.53	0	0	0.35	0.000	0.00	8.70	0.00	0.000
1.84	2.39	37.94	2.26	85.80	0	0	0.35	0.000	0.00	8.70	0.00	0.000
1.91	2.40	35.86	2.32	83.23	0	0	0.35	0.000	0.00	8.70	0.00	0.000
1.98	2.42	33.77	2.41	81.33	0	0	0.35	0.000	0.00	8.70	0.00	0.000
2.04	2.46	31.48	2.59	81.55	0	0	0.35	0.000	0.00	8.70	0.00	0.000
2.11	2.52	29.09	2.85	83.01	0	0	0.35	0.000	0.00	8.70	0.00	0.000
2.17	2.58	26.79	3.18	85.30	0	0	0.35	0.000	0.00	8.70	0.00	0.000
2.25	2.64	24.45	3.60	88.01	0	0	0.35	0.000	0.00	0.00	0.00	0.000
2.32	2.71	22.16	4.07	90.29	0	0	0.35	0.000	0.00	0.00	0.00	0.000
2.38	2.78	20.08	4.59	92.10	0	0	0.35	0.000	0.00	0.00	0.00	0.000
2.44	2.82	18.77	4.95	92.98	0	0	0.35	0.000	0.00	0.00	0.00	0.000
2.52	2.84	18.25	5.12	93.42	0	0	0.35	0.000	0.00	0.00	0.00	0.000
2.56	2.83	18.40	5.05	92.87	0	0	0.35	0.000	0.00	0.00	0.00	0.000
2.64	2.81	18.97	4.89	92.71	0	0	0.35	0.000	0.00	0.00	0.00	0.000
2.70	2.78	20.16	4.64	93.47	0	0	0.35	0.000	0.00	0.00	0.00	0.000
2.78	2.77	21.08	4.55	95.85	0	0	0.35	0.000	0.00	0.00	0.00	0.000
2.83	2.77	22.12	4.56	100.81	0	0	0.35	0.000	0.00	0.00	0.00	0.000
2.91	2.78	22.93	4.63	106.22	0	0	0.35	0.000	0.00	0.00	0.00	0.000
2.96	2.79	24.12	4.68	112.91	0	0	0.35	0.000	0.00	0.00	0.00	0.000
3.04	2.78	25.46	4.64	118.04	0	0	0.35	0.000	0.00	0.00	0.00	0.000
3.09	2.78	26.74	4.60	122.91	0	0	0.35	0.000	0.00	0.00	0.00	0.000
3.17	2.77	27.77	4.52	125.65	0	0	0.35	0.000	0.00	0.00	0.00	0.000

:: Post-earthquake settlement of dry sands :: (continued)

Depth (ft)	Ic	Q_{tn}	Kc	$Q_{tn,cs}$	$N_{1,60}$ (blows)	G_{max} (tsf)	CSR	Shear, γ (%)	$e_{vol(15)}$ (%)	N_c	e_v (%)	Settle. (in)
3.23	2.76	28.33	4.47	126.58	0	0	0.35	0.000	0.00	0.00	0.00	0.000
3.30	2.75	28.53	4.39	125.14	0	0	0.35	0.000	0.00	0.00	0.00	0.000
3.36	2.73	28.53	4.25	121.34	0	0	0.35	0.000	0.00	0.00	0.00	0.000
3.44	2.71	28.41	4.08	115.95	0	0	0.35	0.000	0.00	0.00	0.00	0.000
3.49	2.68	28.50	3.83	109.03	0	0	0.35	0.000	0.00	0.00	0.00	0.000
3.57	2.64	28.80	3.56	102.64	0	0	0.35	0.000	0.00	0.00	0.00	0.000
3.62	2.59	29.62	3.29	97.57	26	443	0.35	0.047	0.03	8.70	0.02	0.000
3.70	2.56	30.60	3.11	95.25	25	441	0.35	0.050	0.04	8.70	0.03	0.001
3.76	2.54	31.75	3.00	95.35	25	446	0.35	0.050	0.04	8.70	0.03	0.000
3.83	2.54	32.43	2.99	97.02	26	454	0.35	0.049	0.04	8.70	0.03	0.000
3.88	2.55	32.63	3.05	99.48	26	463	0.35	0.047	0.03	8.70	0.02	0.000
3.96	2.57	32.60	3.12	101.70	27	470	0.35	0.047	0.03	8.70	0.02	0.000
4.01	2.58	32.55	3.23	105.02	28	480	0.35	0.045	0.03	8.70	0.02	0.000
4.09	2.59	33.48	3.25	108.72	29	496	0.35	0.042	0.03	8.70	0.02	0.000
4.14	2.59	34.85	3.26	113.48	31	518	0.35	0.039	0.02	8.70	0.02	0.000
4.22	2.59	35.88	3.25	116.71	31	533	0.35	0.037	0.02	8.70	0.02	0.000
4.27	2.61	35.30	3.37	119.11	0	0	0.35	0.000	0.00	0.00	0.00	0.000
4.35	2.64	33.58	3.61	121.25	0	0	0.35	0.000	0.00	0.00	0.00	0.000
4.42	2.68	32.11	3.88	124.47	0	0	0.35	0.000	0.00	0.00	0.00	0.000
4.47	2.70	31.74	4.01	127.43	0	0	0.35	0.000	0.00	0.00	0.00	0.000
4.55	2.69	32.62	3.91	127.40	0	0	0.35	0.000	0.00	0.00	0.00	0.000
4.60	2.63	35.32	3.53	124.63	0	0	0.35	0.000	0.00	0.00	0.00	0.000
4.68	2.56	38.95	3.12	121.42	0	0	0.35	0.000	0.00	8.70	0.00	0.000
4.72	2.49	44.09	2.73	120.29	0	0	0.35	0.000	0.00	8.70	0.00	0.000
4.81	2.44	49.11	2.46	120.95	0	0	0.35	0.000	0.00	8.70	0.00	0.000
4.86	2.38	55.03	2.23	122.58	0	0	0.35	0.000	0.00	8.70	0.00	0.000
4.92	2.33	60.93	2.04	124.07	0	0	0.35	0.000	0.00	8.70	0.00	0.000
5.00	2.29	66.00	1.90	125.59	0	0	0.35	0.000	0.00	8.70	0.00	0.000

Total estimated settlement: 0.00

Abbreviations

Q_{tn}: Equivalent clean sand normalized cone resistance
K_c: Fines correction factor
$Q_{tn,cs}$: Post-liquefaction volumentric strain
G_{max}: Small strain shear modulus
CSR: Soil cyclic stress ratio
γ: Cyclic shear strain
$e_{vol(15)}$: Volumetric strain after 15 cycles
N_c: Equivalent number of cycles
e_v: Volumetric strain
Settle.: Calculated settlement

:: Post-earthquake settlement due to soil liquefaction ::

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
5.06	126.69	2.00	0.00	0.91	0.00	5.13	125.05	2.00	0.00	0.91	0.00
5.21	122.83	2.00	0.00	0.91	0.00	5.25	120.40	2.00	0.00	0.91	0.00
5.33	120.55	2.00	0.00	0.91	0.00	5.41	121.40	2.00	0.00	0.91	0.00
5.46	121.34	2.00	0.00	0.91	0.00	5.52	121.58	2.00	0.00	0.91	0.00
5.59	121.15	2.00	0.00	0.91	0.00	5.66	122.02	2.00	0.00	0.90	0.00
5.72	121.51	2.00	0.00	0.90	0.00	5.78	121.75	0.66	1.68	0.90	0.01
5.86	122.38	0.67	1.66	0.90	0.01	5.91	123.69	0.68	1.64	0.90	0.01

:: Post-earthquake settlement due to soil liquefaction :: (continued)

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
5.99	125.20	0.69	1.61	0.90	0.02	6.04	126.96	0.71	1.57	0.90	0.01
6.11	128.35	0.72	1.55	0.90	0.01	6.17	129.29	0.73	1.53	0.90	0.01
6.24	129.99	0.73	1.51	0.89	0.01	6.32	130.41	0.74	1.51	0.89	0.01
6.38	131.08	0.74	1.49	0.89	0.01	6.45	131.53	0.74	1.48	0.89	0.01
6.51	132.17	0.75	1.47	0.89	0.01	6.58	132.34	0.75	1.47	0.89	0.01
6.64	131.90	0.74	1.47	0.89	0.01	6.71	130.97	0.72	1.49	0.89	0.01
6.76	129.32	0.70	1.51	0.89	0.01	6.83	126.99	0.67	1.55	0.88	0.01
6.91	124.51	0.64	1.72	0.88	0.02	6.96	121.93	0.61	1.75	0.88	0.01
7.04	119.84	0.59	1.77	0.88	0.02	7.09	117.63	0.56	1.80	0.88	0.01
7.16	115.71	0.54	1.82	0.88	0.02	7.23	114.06	0.53	1.84	0.88	0.02
7.29	113.09	0.52	1.85	0.88	0.01	7.36	112.89	0.51	1.85	0.88	0.02
7.42	112.92	0.51	1.85	0.87	0.01	7.48	113.11	0.51	1.84	0.87	0.02
7.56	113.47	0.51	1.84	0.87	0.02	7.62	113.50	0.51	1.83	0.87	0.01
7.69	112.58	0.50	1.84	0.87	0.02	7.77	110.95	0.49	1.86	0.87	0.02
7.81	105.87	0.45	1.93	0.87	0.01	7.88	102.41	0.42	1.99	0.87	0.02
7.96	101.57	0.41	2.00	0.87	0.02	8.01	106.52	0.45	1.92	0.86	0.01
8.08	111.99	0.49	1.84	0.86	0.02	8.16	114.70	0.51	1.80	0.86	0.02
8.21	116.47	0.52	1.78	0.86	0.01	8.29	115.78	0.51	1.78	0.86	0.02
8.34	116.44	0.52	1.77	0.86	0.01	8.40	117.18	0.52	1.76	0.86	0.01
8.47	118.26	0.53	1.74	0.86	0.01	8.55	119.28	0.54	1.73	0.86	0.02
8.60	120.80	0.55	1.71	0.85	0.01	8.68	122.83	0.57	1.68	0.85	0.02
8.73	125.84	0.59	1.65	0.85	0.01	8.80	128.74	0.62	1.62	0.85	0.01
8.86	131.45	0.65	1.59	0.85	0.01	8.93	133.30	0.67	1.39	0.85	0.01
9.01	134.24	0.68	1.37	0.85	0.01	9.06	133.93	2.00	0.00	0.85	0.00
9.14	131.93	2.00	0.00	0.85	0.00	9.21	129.03	2.00	0.00	0.84	0.00
9.25	124.75	2.00	0.00	0.84	0.00	9.33	120.30	2.00	0.00	0.84	0.00
9.41	115.98	2.00	0.00	0.84	0.00	9.45	110.97	2.00	0.00	0.84	0.00
9.53	105.98	2.00	0.00	0.84	0.00	9.58	100.12	2.00	0.00	0.84	0.00
9.65	95.52	2.00	0.00	0.84	0.00	9.73	91.57	2.00	0.00	0.84	0.00
9.81	89.81	2.00	0.00	0.83	0.00	9.85	90.23	2.00	0.00	0.83	0.00
9.92	91.64	2.00	0.00	0.83	0.00	10.00	92.82	2.00	0.00	0.83	0.00
10.05	91.29	2.00	0.00	0.83	0.00	10.12	88.06	2.00	0.00	0.83	0.00
10.19	83.54	2.00	0.00	0.83	0.00	10.24	77.58	2.00	0.00	0.83	0.00
10.31	70.14	2.00	0.00	0.83	0.00	10.39	62.52	2.00	0.00	0.82	0.00
10.46	57.57	2.00	0.00	0.82	0.00	10.51	55.79	2.00	0.00	0.82	0.00
10.57	55.88	2.00	0.00	0.82	0.00	10.63	56.73	2.00	0.00	0.82	0.00
10.70	59.40	2.00	0.00	0.82	0.00	10.77	63.68	2.00	0.00	0.82	0.00
10.85	69.11	2.00	0.00	0.82	0.00	10.92	73.90	2.00	0.00	0.81	0.00
10.96	79.62	2.00	0.00	0.81	0.00	11.04	86.21	2.00	0.00	0.81	0.00
11.12	92.90	2.00	0.00	0.81	0.00	11.18	95.89	2.00	0.00	0.81	0.00
11.23	92.18	2.00	0.00	0.81	0.00	11.31	87.68	2.00	0.00	0.81	0.00
11.37	83.97	2.00	0.00	0.81	0.00	11.42	84.44	2.00	0.00	0.81	0.00
11.48	85.36	2.00	0.00	0.81	0.00	11.55	88.05	2.00	0.00	0.80	0.00
11.62	92.19	2.00	0.00	0.80	0.00	11.69	96.94	2.00	0.00	0.80	0.00
11.75	101.46	2.00	0.00	0.80	0.00	11.81	106.50	0.39	1.77	0.80	0.01
11.89	111.25	0.42	1.71	0.80	0.01	11.96	115.27	0.45	1.66	0.80	0.02
12.01	117.70	0.46	1.63	0.80	0.01	12.08	118.91	0.47	1.61	0.80	0.01
12.14	119.20	0.47	1.61	0.79	0.01	12.21	117.80	0.46	1.62	0.79	0.01

:: Post-earthquake settlement due to soil liquefaction :: (continued)

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
12.28	113.46	0.43	1.67	0.79	0.01	12.34	105.96	0.38	1.76	0.79	0.01
12.41	98.72	2.00	0.00	0.79	0.00	12.47	94.26	2.00	0.00	0.79	0.00
12.54	94.93	2.00	0.00	0.79	0.00	12.60	98.54	2.00	0.00	0.79	0.00
12.67	103.58	2.00	0.00	0.79	0.00	12.74	107.67	2.00	0.00	0.78	0.00
12.80	109.43	2.00	0.00	0.78	0.00	12.87	109.16	2.00	0.00	0.78	0.00
12.95	108.86	0.39	1.70	0.78	0.02	13.00	110.52	0.40	1.68	0.78	0.01
13.07	113.38	0.42	1.64	0.78	0.01	13.15	116.03	0.44	1.61	0.78	0.02
13.19	117.23	2.00	0.00	0.78	0.00	13.27	117.00	2.00	0.00	0.78	0.00
13.32	115.61	2.00	0.00	0.77	0.00	13.40	112.20	2.00	0.00	0.77	0.00
13.47	107.56	2.00	0.00	0.77	0.00	13.52	102.35	2.00	0.00	0.77	0.00
13.60	99.16	2.00	0.00	0.77	0.00	13.67	97.90	2.00	0.00	0.77	0.00
13.72	98.12	2.00	0.00	0.77	0.00	13.79	98.72	2.00	0.00	0.77	0.00
13.87	100.14	2.00	0.00	0.76	0.00	13.94	100.99	2.00	0.00	0.76	0.00
13.98	101.08	2.00	0.00	0.76	0.00	14.06	101.59	2.00	0.00	0.76	0.00
14.12	104.54	2.00	0.00	0.76	0.00	14.20	108.54	2.00	0.00	0.76	0.00
14.24	110.96	2.00	0.00	0.76	0.00	14.33	111.71	2.00	0.00	0.76	0.00
14.39	111.65	2.00	0.00	0.76	0.00	14.45	110.86	2.00	0.00	0.76	0.00
14.51	108.11	2.00	0.00	0.75	0.00	14.60	105.82	2.00	0.00	0.75	0.00
14.66	104.23	2.00	0.00	0.75	0.00	14.72	103.86	2.00	0.00	0.75	0.00
14.78	103.45	2.00	0.00	0.75	0.00	14.84	102.78	2.00	0.00	0.75	0.00
14.90	99.74	2.00	0.00	0.75	0.00	14.99	96.22	2.00	0.00	0.75	0.00
15.05	93.67	2.00	0.00	0.75	0.00	15.11	94.01	0.29	1.83	0.74	0.01
15.17	96.29	0.31	1.79	0.74	0.01	15.24	99.44	0.32	1.74	0.74	0.01
15.31	103.07	0.34	1.69	0.74	0.01	15.38	106.25	0.36	1.64	0.74	0.01
15.44	109.08	0.37	1.61	0.74	0.01	15.50	111.09	0.39	1.58	0.74	0.01
15.56	112.02	0.39	1.57	0.74	0.01	15.63	111.57	0.39	1.57	0.74	0.01
15.71	110.67	0.38	1.58	0.73	0.02	15.77	110.29	0.38	1.58	0.73	0.01
15.83	110.44	0.38	1.58	0.73	0.01	15.88	109.34	0.37	1.59	0.73	0.01
15.95	106.38	0.36	1.62	0.73	0.01	16.04	102.50	0.33	1.67	0.73	0.02
16.09	98.88	0.31	1.72	0.73	0.01	16.15	97.87	2.00	0.00	0.73	0.00
16.22	96.32	2.00	0.00	0.73	0.00	16.29	97.88	2.00	0.00	0.72	0.00
16.36	101.32	2.00	0.00	0.72	0.00	16.42	108.32	2.00	0.00	0.72	0.00
16.48	112.83	2.00	0.00	0.72	0.00	16.55	116.28	2.00	0.00	0.72	0.00
16.61	118.97	2.00	0.00	0.72	0.00	16.69	123.38	2.00	0.00	0.72	0.00
16.75	126.22	2.00	0.00	0.72	0.00	16.81	126.06	2.00	0.00	0.72	0.00
16.88	122.16	2.00	0.00	0.71	0.00	16.96	116.45	2.00	0.00	0.71	0.00
17.03	110.82	2.00	0.00	0.71	0.00	17.08	105.81	2.00	0.00	0.71	0.00
17.14	99.89	0.31	1.66	0.71	0.01	17.20	95.14	0.29	1.72	0.71	0.01
17.29	93.06	0.28	1.75	0.71	0.02	17.35	93.92	2.00	0.00	0.71	0.00
17.41	98.03	2.00	0.00	0.70	0.00	17.48	102.79	2.00	0.00	0.70	0.00
17.53	108.98	2.00	0.00	0.70	0.00	17.59	112.29	2.00	0.00	0.70	0.00
17.65	113.55	2.00	0.00	0.70	0.00	17.74	112.73	2.00	0.00	0.70	0.00
17.79	111.50	2.00	0.00	0.70	0.00	17.86	108.69	2.00	0.00	0.70	0.00
17.92	102.79	2.00	0.00	0.70	0.00	18.00	97.56	0.30	1.66	0.69	0.02
18.06	95.76	0.29	1.68	0.69	0.01	18.12	99.05	0.31	1.63	0.69	0.01
18.19	103.99	2.00	0.00	0.69	0.00	18.27	107.62	2.00	0.00	0.69	0.00
18.33	108.43	2.00	0.00	0.69	0.00	18.38	105.84	2.00	0.00	0.69	0.00
18.45	102.11	2.00	0.00	0.69	0.00	18.51	99.60	2.00	0.00	0.69	0.00

:: Post-earthquake settlement due to soil liquefaction :: (continued)

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
18.58	99.07	2.00	0.00	0.69	0.00	18.64	99.80	2.00	0.00	0.68	0.00
18.71	100.67	2.00	0.00	0.68	0.00	18.77	101.87	2.00	0.00	0.68	0.00
18.85	103.35	2.00	0.00	0.68	0.00	18.91	104.98	2.00	0.00	0.68	0.00
18.97	106.61	0.34	1.50	0.68	0.01	19.03	108.43	0.35	1.48	0.68	0.01
19.11	110.10	0.36	1.46	0.68	0.01	19.17	111.68	0.37	1.44	0.68	0.01
19.23	113.15	0.38	1.42	0.67	0.01	19.32	114.39	0.39	1.41	0.67	0.02
19.37	115.50	0.40	1.39	0.67	0.01	19.43	116.19	0.40	1.39	0.67	0.01
19.49	116.99	0.41	1.38	0.67	0.01	19.57	117.74	0.41	1.37	0.67	0.01
19.63	118.54	0.42	1.36	0.67	0.01	19.69	119.26	0.42	1.35	0.67	0.01
19.75	120.15	0.43	1.34	0.67	0.01	19.83	120.99	0.43	1.33	0.66	0.01
19.89	120.98	0.43	1.32	0.66	0.01	19.98	119.36	0.42	1.34	0.66	0.01
20.04	117.86	0.41	1.35	0.66	0.01	20.09	117.31	0.41	1.35	0.66	0.01
20.14	118.40	0.41	1.34	0.66	0.01	20.24	119.40	0.42	1.33	0.66	0.01
20.29	120.20	0.43	1.32	0.66	0.01	20.35	120.50	0.43	1.31	0.66	0.01
20.43	120.59	0.43	1.31	0.65	0.01	20.49	120.89	0.43	1.31	0.65	0.01
20.55	121.78	0.44	1.30	0.65	0.01	20.63	122.84	0.44	1.28	0.65	0.01
20.68	123.92	0.45	1.27	0.65	0.01	20.74	124.66	0.46	1.26	0.65	0.01
20.81	125.41	0.46	1.26	0.65	0.01	20.89	125.96	0.47	1.25	0.65	0.01
20.94	126.24	0.47	1.25	0.65	0.01	21.01	126.04	0.47	1.24	0.64	0.01
21.07	125.52	2.00	0.00	0.64	0.00	21.16	124.71	2.00	0.00	0.64	0.00
21.21	123.60	2.00	0.00	0.64	0.00	21.27	122.00	2.00	0.00	0.64	0.00
21.34	120.23	2.00	0.00	0.64	0.00	21.40	118.49	2.00	0.00	0.64	0.00
21.47	116.94	2.00	0.00	0.64	0.00	21.53	115.13	2.00	0.00	0.64	0.00
21.60	113.07	2.00	0.00	0.63	0.00	21.67	110.90	2.00	0.00	0.63	0.00
21.75	108.77	2.00	0.00	0.63	0.00	21.82	107.09	2.00	0.00	0.63	0.00
21.85	105.73	2.00	0.00	0.63	0.00	21.92	105.51	2.00	0.00	0.63	0.00
22.00	106.46	2.00	0.00	0.63	0.00	22.06	109.86	2.00	0.00	0.63	0.00
22.14	114.64	2.00	0.00	0.62	0.00	22.18	120.51	2.00	0.00	0.62	0.00
22.24	126.70	2.00	0.00	0.62	0.00	22.31	132.21	2.00	0.00	0.62	0.00
22.38	134.03	2.00	0.00	0.62	0.00	22.45	133.45	2.00	0.00	0.62	0.00
22.52	133.28	2.00	0.00	0.62	0.00	22.60	130.96	2.00	0.00	0.62	0.00
22.67	128.52	2.00	0.00	0.62	0.00	22.70	132.26	2.00	0.00	0.62	0.00
22.77	140.67	2.00	0.00	0.61	0.00	22.84	150.25	2.00	0.00	0.61	0.00
22.90	154.73	2.00	0.00	0.61	0.00	22.98	155.68	0.75	0.65	0.61	0.01
23.04	153.86	0.73	0.81	0.61	0.01	23.10	150.63	0.69	0.84	0.61	0.01
23.18	148.08	0.66	0.85	0.61	0.01	23.26	146.88	0.65	0.86	0.61	0.01
23.30	146.63	0.65	1.03	0.61	0.00	23.36	145.18	0.63	1.04	0.60	0.01
23.43	135.28	0.54	1.10	0.60	0.01	23.50	125.70	0.46	1.17	0.60	0.01
23.57	118.33	2.00	0.00	0.60	0.00	23.64	121.32	2.00	0.00	0.60	0.00
23.72	125.47	2.00	0.00	0.60	0.00	23.76	128.10	2.00	0.00	0.60	0.00
23.82	127.55	2.00	0.00	0.60	0.00	23.89	125.59	2.00	0.00	0.60	0.00
23.96	121.82	2.00	0.00	0.59	0.00	24.03	119.04	2.00	0.00	0.59	0.00
24.11	117.30	2.00	0.00	0.59	0.00	24.18	117.15	2.00	0.00	0.59	0.00
24.22	116.05	2.00	0.00	0.59	0.00	24.28	114.40	2.00	0.00	0.59	0.00
24.35	112.76	2.00	0.00	0.59	0.00	24.43	110.68	2.00	0.00	0.59	0.00
24.49	107.98	2.00	0.00	0.58	0.00	24.57	107.85	2.00	0.00	0.58	0.00
24.64	109.61	2.00	0.00	0.58	0.00	24.68	113.91	2.00	0.00	0.58	0.00
24.74	118.60	2.00	0.00	0.58	0.00	24.82	123.79	0.44	1.14	0.58	0.01

:: Post-earthquake settlement due to soil liquefaction :: (continued)

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
24.89	127.78	0.47	1.10	0.58	0.01	24.96	130.47	0.50	1.08	0.58	0.01
25.03	131.73	0.51	1.07	0.58	0.01	25.07	132.25	0.51	1.07	0.58	0.00
25.14	131.82	0.51	1.07	0.57	0.01	25.21	130.90	0.50	1.07	0.57	0.01
25.28	129.64	0.49	1.08	0.57	0.01	25.35	128.27	0.48	1.09	0.57	0.01
25.42	126.88	2.00	0.00	0.57	0.00	25.49	125.28	2.00	0.00	0.57	0.00
25.56	123.79	2.00	0.00	0.57	0.00	25.59	122.07	2.00	0.00	0.57	0.00
25.67	120.18	2.00	0.00	0.56	0.00	25.73	118.05	2.00	0.00	0.56	0.00
25.80	116.12	2.00	0.00	0.56	0.00	25.87	114.23	2.00	0.00	0.56	0.00
25.94	111.68	2.00	0.00	0.56	0.00	26.01	108.23	2.00	0.00	0.56	0.00
26.08	104.24	2.00	0.00	0.56	0.00	26.14	100.66	2.00	0.00	0.56	0.00
26.21	98.77	2.00	0.00	0.56	0.00	26.28	99.90	2.00	0.00	0.55	0.00
26.34	103.89	2.00	0.00	0.55	0.00	26.41	107.71	2.00	0.00	0.55	0.00
26.45	108.34	2.00	0.00	0.55	0.00	26.52	105.92	2.00	0.00	0.55	0.00
26.59	101.37	2.00	0.00	0.55	0.00	26.66	95.95	2.00	0.00	0.55	0.00
26.73	90.41	2.00	0.00	0.55	0.00	26.79	84.32	2.00	0.00	0.55	0.00
26.86	77.27	2.00	0.00	0.54	0.00	26.93	69.75	2.00	0.00	0.54	0.00
26.98	63.48	2.00	0.00	0.54	0.00	27.05	59.59	2.00	0.00	0.54	0.00
27.12	57.79	2.00	0.00	0.54	0.00	27.18	57.37	2.00	0.00	0.54	0.00
27.25	57.52	2.00	0.00	0.54	0.00	27.32	57.74	2.00	0.00	0.54	0.00
27.39	57.97	2.00	0.00	0.54	0.00	27.46	58.17	2.00	0.00	0.53	0.00
27.53	58.28	2.00	0.00	0.53	0.00	27.57	58.12	2.00	0.00	0.53	0.00
27.64	57.92	2.00	0.00	0.53	0.00	27.70	57.68	2.00	0.00	0.53	0.00
27.77	57.71	2.00	0.00	0.53	0.00	27.84	57.84	2.00	0.00	0.53	0.00
27.91	58.15	2.00	0.00	0.53	0.00	27.98	58.57	2.00	0.00	0.53	0.00
28.05	59.04	2.00	0.00	0.52	0.00	28.09	59.80	2.00	0.00	0.52	0.00
28.15	60.58	2.00	0.00	0.52	0.00	28.23	61.47	2.00	0.00	0.52	0.00
28.29	62.16	2.00	0.00	0.52	0.00	28.36	62.63	2.00	0.00	0.52	0.00
28.43	62.93	2.00	0.00	0.52	0.00	28.50	63.14	2.00	0.00	0.52	0.00
28.57	63.65	2.00	0.00	0.52	0.00	28.65	64.23	2.00	0.00	0.51	0.00
28.69	65.44	2.00	0.00	0.51	0.00	28.74	66.37	2.00	0.00	0.51	0.00
28.81	67.37	2.00	0.00	0.51	0.00	28.88	68.20	2.00	0.00	0.51	0.00
28.95	69.26	2.00	0.00	0.51	0.00	29.02	70.09	2.00	0.00	0.51	0.00
29.08	70.16	2.00	0.00	0.51	0.00	29.16	69.66	2.00	0.00	0.51	0.00
29.22	68.50	2.00	0.00	0.50	0.00	29.29	66.94	2.00	0.00	0.50	0.00
29.36	65.30	2.00	0.00	0.50	0.00	29.43	64.03	2.00	0.00	0.50	0.00
29.49	63.11	2.00	0.00	0.50	0.00	29.53	62.65	2.00	0.00	0.50	0.00
29.59	62.12	2.00	0.00	0.50	0.00	29.66	62.36	2.00	0.00	0.50	0.00
29.73	62.51	2.00	0.00	0.50	0.00	29.80	63.47	2.00	0.00	0.49	0.00
29.87	64.74	2.00	0.00	0.49	0.00	29.93	66.62	2.00	0.00	0.49	0.00
29.99	68.54	2.00	0.00	0.49	0.00	30.06	70.23	2.00	0.00	0.49	0.00
30.12	72.31	2.00	0.00	0.49	0.00	30.20	75.12	2.00	0.00	0.49	0.00
30.27	77.40	2.00	0.00	0.49	0.00	30.35	78.08	2.00	0.00	0.49	0.00
30.42	77.20	2.00	0.00	0.48	0.00	30.45	75.68	2.00	0.00	0.48	0.00
30.51	73.74	2.00	0.00	0.48	0.00	30.58	71.41	2.00	0.00	0.48	0.00
30.65	69.33	2.00	0.00	0.48	0.00	30.72	68.03	2.00	0.00	0.48	0.00
30.79	67.23	2.00	0.00	0.48	0.00	30.86	66.42	2.00	0.00	0.48	0.00
30.94	65.99	2.00	0.00	0.48	0.00	31.00	66.43	2.00	0.00	0.47	0.00
31.07	67.92	2.00	0.00	0.47	0.00	31.14	69.60	2.00	0.00	0.47	0.00

:: Post-earthquake settlement due to soil liquefaction :: (continued)

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
31.20	70.90	2.00	0.00	0.47	0.00	31.24	72.07	2.00	0.00	0.47	0.00
31.31	73.26	2.00	0.00	0.47	0.00	31.38	74.37	2.00	0.00	0.47	0.00
31.45	75.62	2.00	0.00	0.47	0.00	31.52	77.04	2.00	0.00	0.47	0.00
31.59	78.52	2.00	0.00	0.46	0.00	31.65	79.77	2.00	0.00	0.46	0.00
31.72	80.38	2.00	0.00	0.46	0.00	31.80	80.63	2.00	0.00	0.46	0.00
31.83	80.49	2.00	0.00	0.46	0.00	31.90	80.17	2.00	0.00	0.46	0.00
31.97	79.38	2.00	0.00	0.46	0.00	32.04	78.29	2.00	0.00	0.46	0.00
32.11	77.49	2.00	0.00	0.46	0.00	32.18	77.12	2.00	0.00	0.45	0.00
32.25	77.02	2.00	0.00	0.45	0.00	32.31	77.11	2.00	0.00	0.45	0.00
32.37	78.33	2.00	0.00	0.45	0.00	32.44	80.20	2.00	0.00	0.45	0.00
32.51	81.93	2.00	0.00	0.45	0.00	32.56	82.86	2.00	0.00	0.45	0.00
32.62	83.45	2.00	0.00	0.45	0.00	32.68	84.18	2.00	0.00	0.45	0.00
32.76	84.71	2.00	0.00	0.44	0.00	32.82	84.47	2.00	0.00	0.44	0.00
32.89	83.52	2.00	0.00	0.44	0.00	32.95	82.34	2.00	0.00	0.44	0.00
33.02	81.63	2.00	0.00	0.44	0.00	33.09	81.24	2.00	0.00	0.44	0.00
33.16	80.87	2.00	0.00	0.44	0.00	33.24	80.47	2.00	0.00	0.44	0.00
33.27	80.17	2.00	0.00	0.44	0.00	33.34	80.06	2.00	0.00	0.43	0.00
33.40	80.05	2.00	0.00	0.43	0.00	33.47	80.00	2.00	0.00	0.43	0.00
33.55	79.83	2.00	0.00	0.43	0.00	33.61	79.61	2.00	0.00	0.43	0.00
33.68	79.56	2.00	0.00	0.43	0.00	33.75	79.66	2.00	0.00	0.43	0.00
33.80	79.57	2.00	0.00	0.43	0.00	33.86	79.12	2.00	0.00	0.43	0.00
33.93	78.05	2.00	0.00	0.42	0.00	33.99	76.77	2.00	0.00	0.42	0.00
34.06	75.52	2.00	0.00	0.42	0.00	34.13	74.52	2.00	0.00	0.42	0.00
34.19	73.80	2.00	0.00	0.42	0.00	34.25	73.24	2.00	0.00	0.42	0.00
34.33	73.22	2.00	0.00	0.42	0.00	34.39	73.95	2.00	0.00	0.42	0.00
34.47	75.38	2.00	0.00	0.42	0.00	34.53	77.06	2.00	0.00	0.41	0.00
34.60	78.21	2.00	0.00	0.41	0.00	34.67	78.87	2.00	0.00	0.41	0.00
34.71	79.59	2.00	0.00	0.41	0.00	34.81	78.12	2.00	0.00	0.41	0.00
34.84	81.26	2.00	0.00	0.41	0.00	34.91	85.55	2.00	0.00	0.41	0.00
34.98	90.68	2.00	0.00	0.41	0.00	35.04	89.83	2.00	0.00	0.41	0.00
35.12	84.71	2.00	0.00	0.40	0.00	35.18	86.14	2.00	0.00	0.40	0.00
35.25	93.82	2.00	0.00	0.40	0.00	35.30	104.49	2.00	0.00	0.40	0.00
35.38	113.67	2.00	0.00	0.40	0.00	35.45	120.07	2.00	0.00	0.40	0.00
35.52	123.49	2.00	0.00	0.40	0.00	35.57	125.47	0.45	0.77	0.40	0.00
35.65	128.22	0.47	0.75	0.40	0.01	35.70	131.72	0.50	0.74	0.39	0.00
35.77	134.12	0.52	0.72	0.39	0.01	35.85	135.77	0.53	0.71	0.39	0.01
35.92	136.58	0.54	0.71	0.39	0.01	35.97	137.55	0.55	0.70	0.39	0.00
36.03	138.24	0.56	0.70	0.39	0.01	36.11	139.23	0.56	0.69	0.39	0.01
36.18	140.22	0.57	0.69	0.39	0.01	36.24	142.13	0.59	0.68	0.39	0.00
36.31	145.94	0.63	0.66	0.38	0.01	36.37	152.26	0.70	0.52	0.38	0.00
36.44	159.89	0.78	0.39	0.38	0.00	36.50	166.63	0.87	0.28	0.38	0.00
36.57	172.08	0.94	0.27	0.38	0.00	36.63	176.60	1.01	0.20	0.38	0.00
36.69	181.58	1.09	0.14	0.38	0.00	36.76	188.76	1.20	0.10	0.38	0.00
36.82	195.10	1.31	0.07	0.38	0.00	36.88	200.18	2.00	0.00	0.37	0.00
36.94	204.27	2.00	0.00	0.37	0.00	37.03	207.84	2.00	0.00	0.37	0.00
37.09	212.15	2.00	0.00	0.37	0.00	37.16	216.79	2.00	0.00	0.37	0.00
37.22	220.04	2.00	0.00	0.37	0.00	37.28	220.95	2.00	0.00	0.37	0.00
37.34	220.20	2.00	0.00	0.37	0.00	37.42	218.75	2.00	0.00	0.37	0.00

:: Post-earthquake settlement due to soil liquefaction :: (continued)

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
37.48	218.17	2.00	0.00	0.36	0.00	37.54	218.31	2.00	0.00	0.36	0.00
37.61	218.21	2.00	0.00	0.36	0.00	37.68	217.82	2.00	0.00	0.36	0.00
37.75	217.88	2.00	0.00	0.36	0.00	37.82	218.50	2.00	0.00	0.36	0.00
37.86	219.54	2.00	0.00	0.36	0.00	37.95	219.19	2.00	0.00	0.36	0.00
38.00	217.28	2.00	0.00	0.36	0.00	38.07	213.59	2.00	0.00	0.35	0.00
38.14	208.33	2.00	0.00	0.35	0.00	38.21	202.64	2.00	0.00	0.35	0.00
38.27	197.57	1.36	0.00	0.35	0.00	38.32	193.45	1.29	0.06	0.35	0.00
38.39	191.17	1.25	0.09	0.35	0.00	38.48	190.84	1.24	0.09	0.35	0.00
38.52	194.03	1.30	0.06	0.35	0.00	38.60	198.81	1.39	0.00	0.35	0.00
38.67	202.13	2.00	0.00	0.34	0.00	38.72	204.12	2.00	0.00	0.34	0.00
38.79	205.54	2.00	0.00	0.34	0.00	38.85	209.28	2.00	0.00	0.34	0.00
38.92	211.36	2.00	0.00	0.34	0.00	38.98	212.64	2.00	0.00	0.34	0.00
39.06	213.66	2.00	0.00	0.34	0.00	39.13	215.01	2.00	0.00	0.34	0.00
39.18	216.88	2.00	0.00	0.34	0.00	39.26	218.25	2.00	0.00	0.33	0.00
39.32	220.25	2.00	0.00	0.33	0.00	39.39	222.24	2.00	0.00	0.33	0.00
39.44	224.72	2.00	0.00	0.33	0.00	39.51	226.73	2.00	0.00	0.33	0.00
39.58	228.88	2.00	0.00	0.33	0.00	39.64	229.52	2.00	0.00	0.33	0.00
39.71	227.81	2.00	0.00	0.33	0.00	39.78	224.06	2.00	0.00	0.33	0.00
39.84	218.19	2.00	0.00	0.32	0.00	39.90	211.79	2.00	0.00	0.32	0.00
39.98	205.01	2.00	0.00	0.32	0.00	40.03	199.26	1.40	0.00	0.32	0.00
40.10	193.68	1.30	0.06	0.32	0.00	40.17	188.38	1.21	0.08	0.32	0.00
40.23	182.83	1.12	0.12	0.32	0.00	40.29	177.46	1.03	0.16	0.32	0.00
40.37	171.11	0.94	0.22	0.32	0.00	40.43	167.31	0.89	0.23	0.31	0.00
40.49	163.21	0.83	0.31	0.31	0.00	40.56	157.61	0.76	0.33	0.31	0.00
40.63	150.73	0.69	0.43	0.31	0.00	40.70	143.72	0.61	0.54	0.31	0.00
40.75	136.69	0.55	0.56	0.31	0.00	40.82	128.28	0.48	0.59	0.31	0.00
40.89	119.27	0.41	0.62	0.31	0.00	40.96	112.42	0.37	0.65	0.31	0.01
41.02	108.97	0.35	0.66	0.30	0.00	41.09	108.97	0.35	0.66	0.30	0.01
41.14	110.31	0.35	0.65	0.30	0.00	41.21	111.28	0.36	0.65	0.30	0.01
41.28	110.85	0.36	0.64	0.30	0.01	41.35	110.46	0.35	0.64	0.30	0.01
41.41	111.30	0.36	0.64	0.30	0.00	41.48	112.35	0.37	0.63	0.30	0.01
41.55	111.68	0.36	0.63	0.30	0.01	41.61	110.28	0.35	0.64	0.29	0.00
41.67	108.29	0.34	0.64	0.29	0.00	41.74	103.26	0.32	0.67	0.29	0.01
41.81	99.20	0.30	0.69	0.29	0.01	41.87	99.32	0.30	0.68	0.29	0.01
41.95	104.86	0.32	0.65	0.29	0.01	42.01	110.15	0.35	0.62	0.29	0.00
42.06	113.39	0.37	0.61	0.29	0.00	42.14	116.47	0.39	0.59	0.29	0.01
42.20	119.98	0.42	0.57	0.28	0.00	42.27	124.00	0.45	0.56	0.28	0.01
42.33	126.59	0.47	0.54	0.28	0.00	42.42	128.06	0.48	0.54	0.28	0.01
42.47	129.31	0.49	0.53	0.28	0.00	42.53	130.47	0.50	0.52	0.28	0.00
42.60	131.66	0.51	0.52	0.28	0.00	42.68	132.58	0.52	0.51	0.28	0.00
42.73	133.12	0.52	0.51	0.28	0.00	42.79	133.23	0.52	0.51	0.27	0.00
42.88	133.19	0.52	0.50	0.27	0.00	42.93	133.26	0.52	0.50	0.27	0.00
42.99	133.13	0.52	0.50	0.27	0.00	43.05	132.70	0.52	0.50	0.27	0.00
43.13	131.93	0.51	0.50	0.27	0.01	43.18	131.11	0.50	0.50	0.27	0.00
43.25	130.39	0.50	0.50	0.27	0.00	43.33	129.91	0.49	0.50	0.27	0.00
43.39	129.87	0.49	0.50	0.26	0.00	43.44	130.30	0.50	0.50	0.26	0.00
43.52	130.78	0.50	0.49	0.26	0.00	43.58	130.83	0.50	0.49	0.26	0.00
43.64	130.70	0.50	0.49	0.26	0.00	43.72	130.42	0.50	0.49	0.26	0.00

:: Post-earthquake settlement due to soil liquefaction :: (continued)

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
43.77	130.42	0.50	0.49	0.26	0.00	43.84	129.99	0.50	0.48	0.26	0.00
43.91	129.37	0.49	0.48	0.26	0.00	43.97	128.28	0.48	0.49	0.25	0.00
44.03	126.44	0.47	0.49	0.25	0.00	44.12	124.30	0.45	0.49	0.25	0.00
44.16	121.24	0.43	0.50	0.25	0.00	44.25	118.87	0.41	0.51	0.25	0.01
44.30	117.61	0.41	0.51	0.25	0.00	44.36	117.72	0.41	0.51	0.25	0.00
44.42	117.94	0.41	0.50	0.25	0.00	44.49	118.11	0.41	0.50	0.25	0.00
44.56	119.08	0.42	0.50	0.24	0.00	44.63	120.75	0.43	0.49	0.24	0.00
44.70	121.50	0.43	0.48	0.24	0.00	44.76	121.85	0.44	0.48	0.24	0.00
44.82	121.35	0.43	0.48	0.24	0.00	44.90	122.04	0.44	0.47	0.24	0.00
44.96	122.80	0.44	0.47	0.24	0.00	45.04	123.98	0.45	0.46	0.24	0.00
45.10	122.75	0.44	0.47	0.24	0.00	45.15	120.73	0.43	0.47	0.23	0.00
45.23	120.08	0.42	0.47	0.23	0.00	45.28	123.00	0.45	0.46	0.23	0.00
45.34	126.82	2.00	0.00	0.23	0.00	45.43	129.29	2.00	0.00	0.23	0.00
45.48	132.70	2.00	0.00	0.23	0.00	45.54	137.25	2.00	0.00	0.23	0.00
45.62	142.56	2.00	0.00	0.23	0.00	45.68	147.24	2.00	0.00	0.23	0.00
45.74	147.50	2.00	0.00	0.22	0.00	45.81	148.27	2.00	0.00	0.22	0.00
45.87	148.08	2.00	0.00	0.22	0.00	45.95	151.42	2.00	0.00	0.22	0.00
46.00	159.75	2.00	0.00	0.22	0.00	46.08	167.44	2.00	0.00	0.22	0.00
46.13	173.16	2.00	0.00	0.22	0.00	46.21	175.75	2.00	0.00	0.22	0.00
46.27	179.15	2.00	0.00	0.22	0.00	46.35	183.61	2.00	0.00	0.21	0.00
46.40	189.25	2.00	0.00	0.21	0.00	46.49	193.63	2.00	0.00	0.21	0.00
46.53	196.05	2.00	0.00	0.21	0.00	46.62	196.15	2.00	0.00	0.21	0.00
46.68	196.25	2.00	0.00	0.21	0.00	46.72	196.16	2.00	0.00	0.21	0.00
46.81	192.87	2.00	0.00	0.21	0.00	46.86	189.24	2.00	0.00	0.21	0.00
46.94	187.09	2.00	0.00	0.20	0.00	46.99	188.19	2.00	0.00	0.20	0.00
47.07	190.08	2.00	0.00	0.20	0.00	47.12	191.87	2.00	0.00	0.20	0.00
47.18	197.04	2.00	0.00	0.20	0.00	47.27	203.44	2.00	0.00	0.20	0.00
47.33	213.40	2.00	0.00	0.20	0.00	47.41	218.53	2.00	0.00	0.20	0.00
47.46	222.73	2.00	0.00	0.20	0.00	47.51	225.17	2.00	0.00	0.19	0.00
47.59	226.75	2.00	0.00	0.19	0.00	47.65	228.71	2.00	0.00	0.19	0.00
47.73	230.67	2.00	0.00	0.19	0.00	47.78	233.29	2.00	0.00	0.19	0.00
47.86	235.12	2.00	0.00	0.19	0.00	47.92	236.58	2.00	0.00	0.19	0.00
47.97	238.77	2.00	0.00	0.19	0.00	48.05	241.47	2.00	0.00	0.19	0.00
48.10	245.01	2.00	0.00	0.18	0.00	48.18	248.01	2.00	0.00	0.18	0.00
48.25	250.81	2.00	0.00	0.18	0.00	48.31	252.06	2.00	0.00	0.18	0.00
48.38	252.33	2.00	0.00	0.18	0.00	48.44	253.16	2.00	0.00	0.18	0.00
48.52	254.41	2.00	0.00	0.18	0.00	48.57	256.33	2.00	0.00	0.18	0.00
48.63	258.47	2.00	0.00	0.18	0.00	48.71	261.57	2.00	0.00	0.17	0.00
48.76	266.95	2.00	0.00	0.17	0.00	48.84	272.85	2.00	0.00	0.17	0.00
48.89	279.27	2.00	0.00	0.17	0.00	48.97	283.58	2.00	0.00	0.17	0.00
49.03	286.79	2.00	0.00	0.17	0.00	49.10	288.01	2.00	0.00	0.17	0.00
49.15	288.95	2.00	0.00	0.17	0.00	49.23	289.56	2.00	0.00	0.17	0.00
49.29	291.74	2.00	0.00	0.16	0.00	49.36	293.86	2.00	0.00	0.16	0.00
49.42	294.03	2.00	0.00	0.16	0.00	49.49	292.03	2.00	0.00	0.16	0.00
49.54	294.54	2.00	0.00	0.16	0.00	49.63	300.38	2.00	0.00	0.16	0.00
49.68	308.14	2.00	0.00	0.16	0.00	49.75	311.55	2.00	0.00	0.16	0.00
49.81	312.96	2.00	0.00	0.16	0.00	49.89	312.92	2.00	0.00	0.15	0.00
49.94	311.89	2.00	0.00	0.15	0.00	50.03	310.62	2.00	0.00	0.15	0.00

:: Post-earthquake settlement due to soil liquefaction :: (continued)

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
50.08	309.61	2.00	0.00	0.15	0.00						

Total estimated settlement: 2.01

Abbreviations

$Q_{tn,cs}$: Equivalent clean sand normalized cone resistance
FS: Factor of safety against liquefaction
e_v (%): Post-liquefaction volumentric strain
DF: e_v depth weighting factor
Settlement: Calculated settlement

GeoTek, Inc.
1548 N. Maple Street
Corona, CA 92880
http://www.geotekusa.com

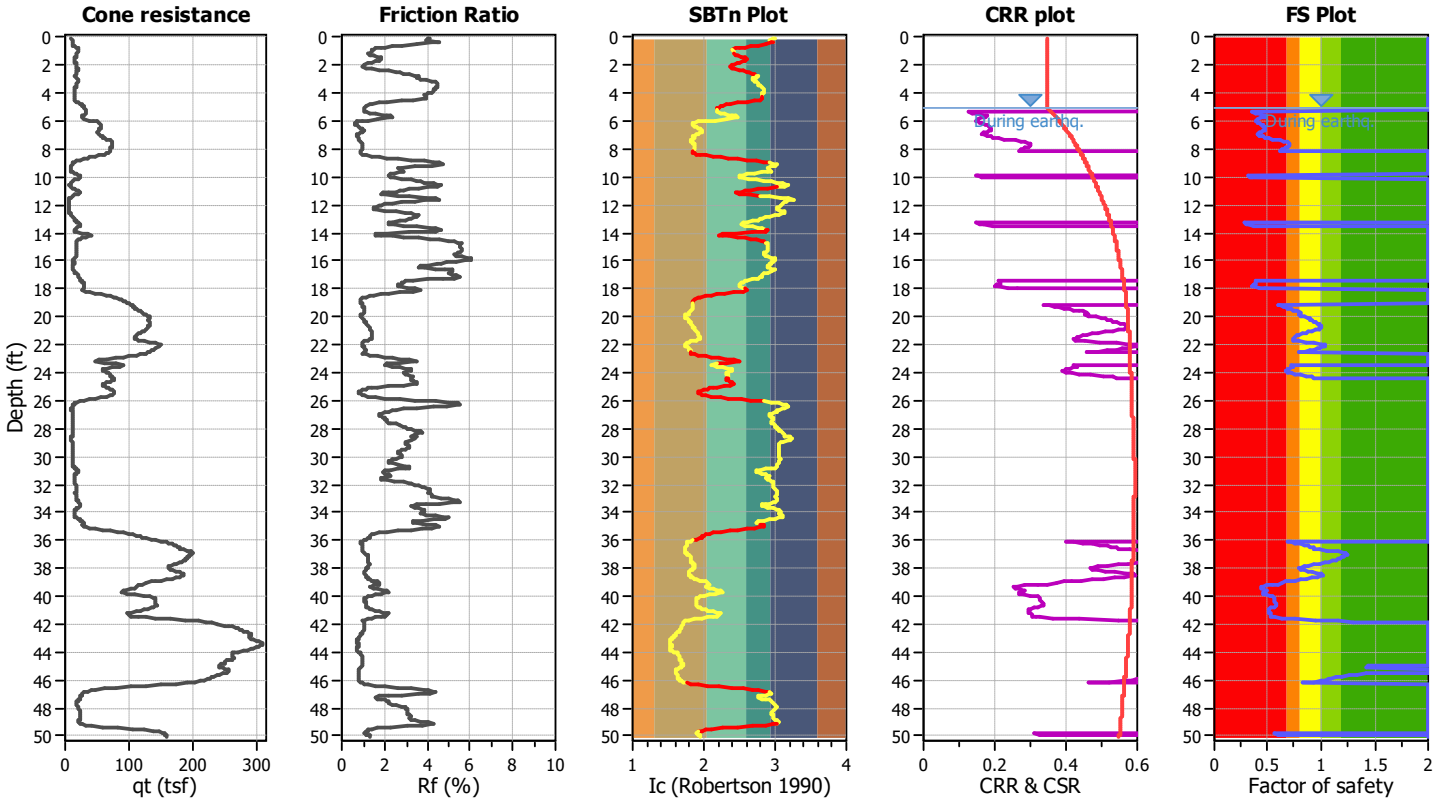
LIQUEFACTION ANALYSIS REPORT

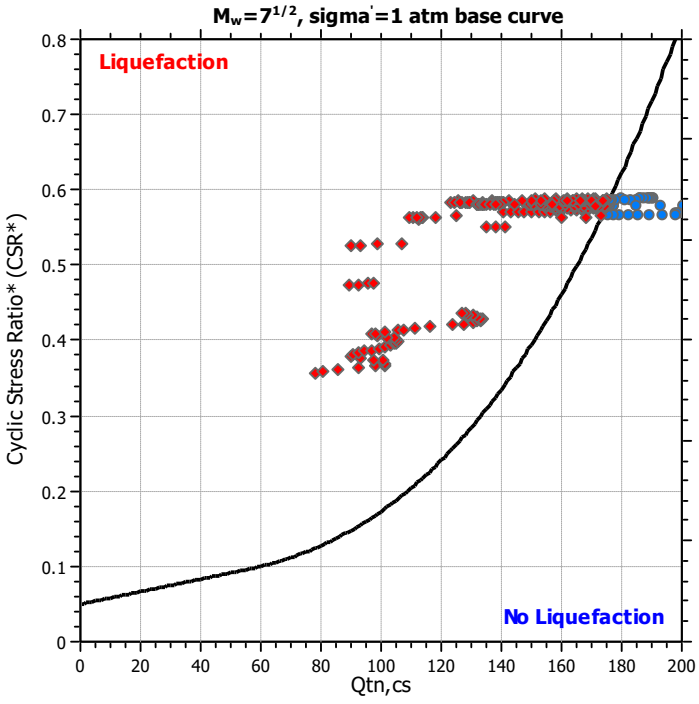
Project title : 7-Acre Site, Cypress Town Center **Location : Cypress, CA**

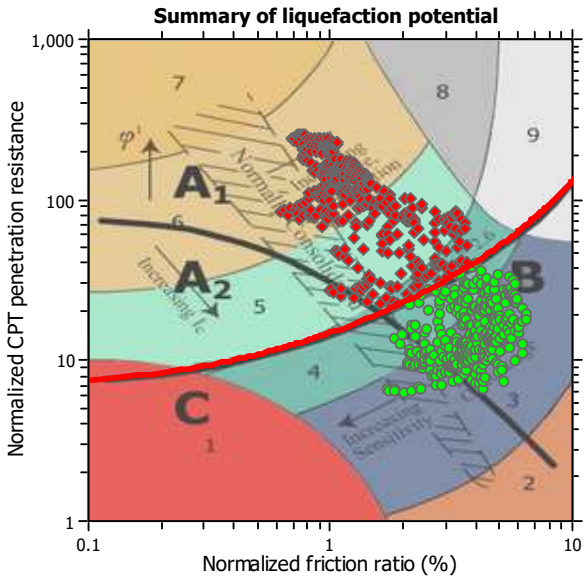
CPT file : CPT-2

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	6.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	5.00 ft	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	50.00 ft
Earthquake magnitude M_w:	6.71	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.55	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

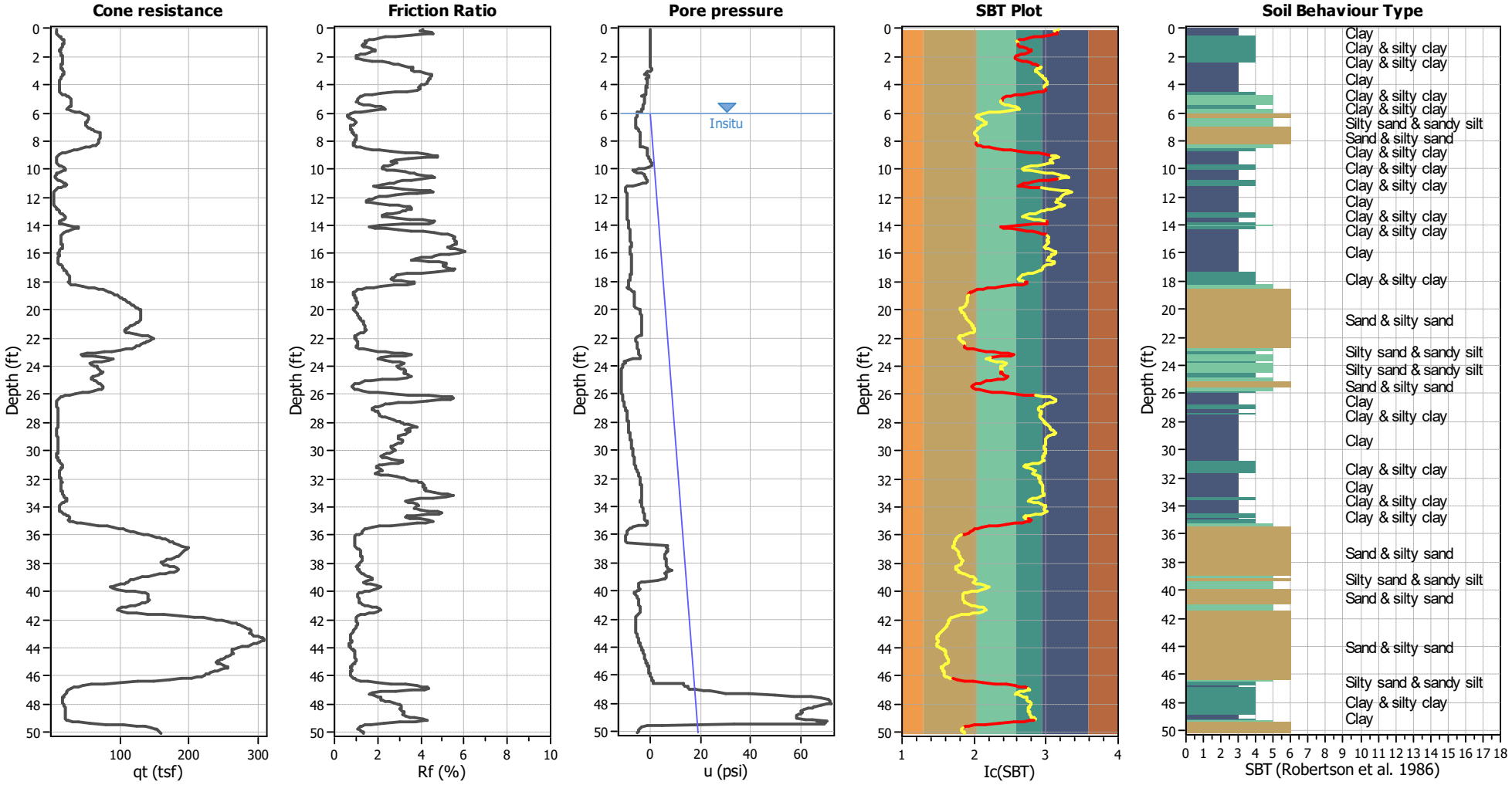






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



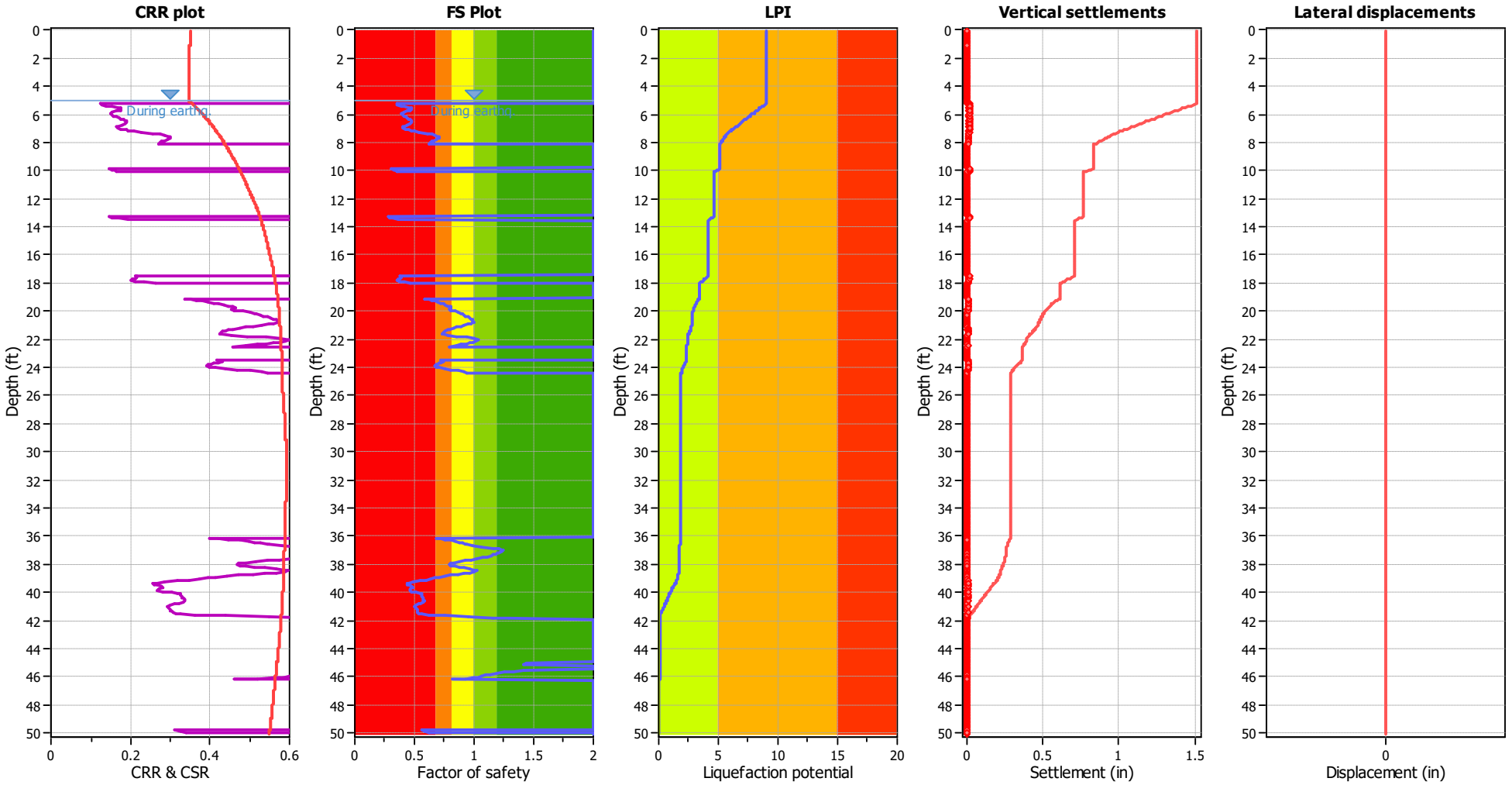
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.71	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.55	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	6.00 ft	Fill height:	N/A	Limit depth:	50.00 ft

SBT legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.71	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.55	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	6.00 ft	Fill height:	N/A	Limit depth:	50.00 ft

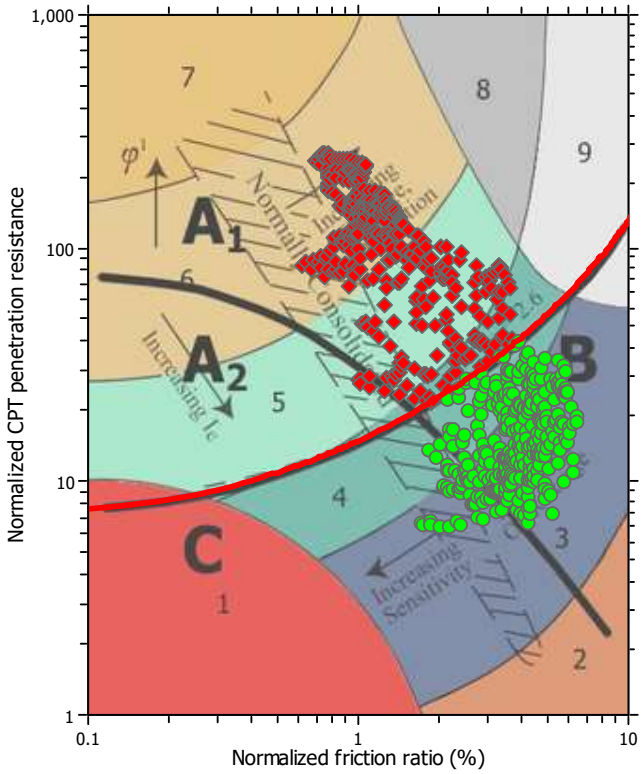
F.S. color scheme

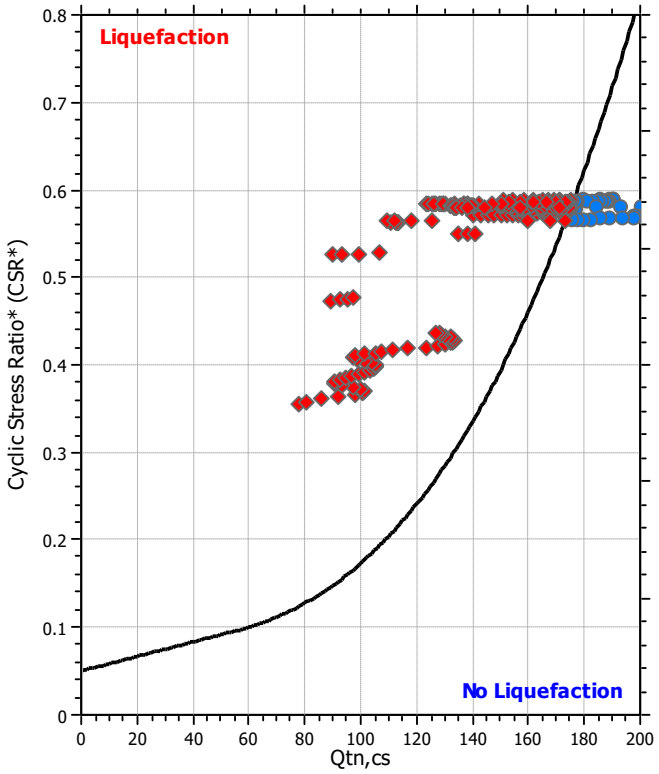
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

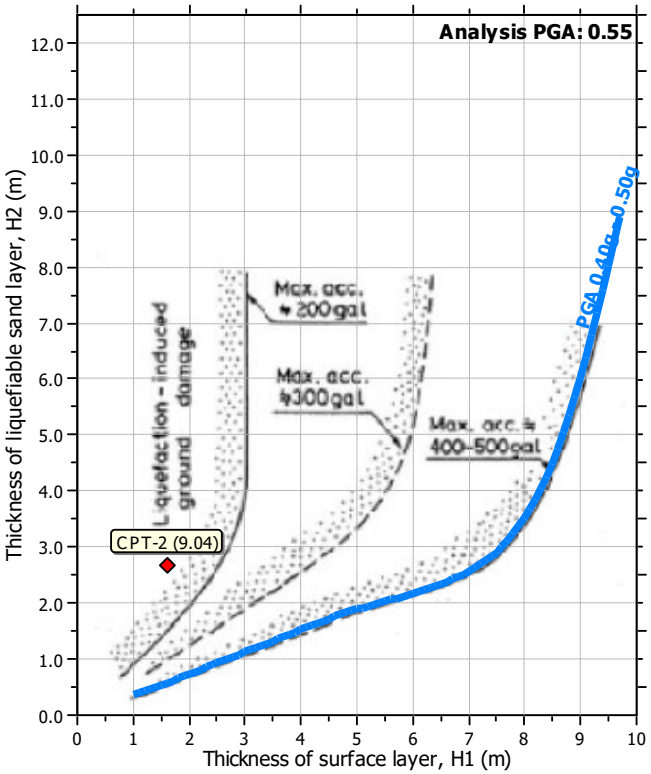
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots







Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.71	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.55	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	6.00 ft	Fill height:	N/A	Limit depth:	50.00 ft

:: Post-earthquake settlement of dry sands ::

Depth (ft)	Ic	Q_{tn}	Kc	$Q_{tn,cs}$	$N_{1,60}$ (blows)	G_{max} (tsf)	CSR	Shear, γ (%)	$e_{vol(15)}$ (%)	N_c	e_v (%)	Settle. (in)
0.07	3.00	12.46	6.73	83.86	0	0	0.35	0.000	0.00	0.00	0.00	0.000
0.14	2.96	13.70	6.34	86.82	0	0	0.35	0.000	0.00	0.00	0.00	0.000
0.21	2.92	15.30	5.91	90.48	0	0	0.35	0.000	0.00	0.00	0.00	0.000
0.27	2.97	14.51	6.43	93.26	0	0	0.35	0.000	0.00	0.00	0.00	0.000
0.35	2.98	14.50	6.51	94.47	0	0	0.35	0.000	0.00	0.00	0.00	0.000
0.40	2.94	15.02	6.15	92.36	0	0	0.35	0.000	0.00	0.00	0.00	0.000
0.49	2.86	16.57	5.35	88.58	0	0	0.35	0.000	0.00	0.00	0.00	0.000
0.55	2.76	19.16	4.42	84.60	0	0	0.35	0.000	0.00	0.00	0.00	0.000
0.59	2.65	22.74	3.62	82.31	0	0	0.35	0.000	0.00	0.00	0.00	0.000
0.69	2.57	25.64	3.14	80.51	0	0	0.35	0.000	0.00	8.70	0.00	0.000
0.74	2.50	28.18	2.78	78.34	0	0	0.35	0.000	0.00	8.70	0.00	0.000
0.79	2.45	30.26	2.52	76.36	0	0	0.35	0.000	0.00	8.70	0.00	0.000
0.88	2.40	32.22	2.32	74.80	0	0	0.35	0.000	0.00	8.70	0.00	0.000
0.93	2.39	32.42	2.28	73.86	0	0	0.35	0.000	0.00	8.70	0.00	0.000
1.01	2.41	30.91	2.37	73.23	18	368	0.35	0.009	0.01	8.70	0.01	0.000
1.06	2.43	29.19	2.43	70.98	18	354	0.35	0.011	0.01	8.70	0.01	0.000
1.14	2.42	28.51	2.40	68.51	17	343	0.35	0.013	0.02	8.70	0.01	0.000
1.19	2.42	27.83	2.40	66.74	0	0	0.35	0.000	0.00	8.70	0.00	0.000
1.27	2.44	27.21	2.50	67.89	0	0	0.35	0.000	0.00	8.70	0.00	0.000
1.32	2.49	26.01	2.69	70.08	0	0	0.35	0.000	0.00	8.70	0.00	0.000
1.40	2.53	24.50	2.95	72.27	0	0	0.35	0.000	0.00	8.70	0.00	0.000
1.47	2.57	23.24	3.17	73.60	0	0	0.35	0.000	0.00	8.70	0.00	0.000
1.52	2.60	22.31	3.30	73.61	0	0	0.35	0.000	0.00	8.70	0.00	0.000
1.60	2.60	21.99	3.31	72.77	0	0	0.35	0.000	0.00	8.70	0.00	0.000
1.66	2.58	22.08	3.23	71.42	0	0	0.35	0.000	0.00	8.70	0.00	0.000
1.72	2.55	22.70	3.05	69.12	0	0	0.35	0.000	0.00	8.70	0.00	0.000
1.79	2.51	23.52	2.82	66.22	0	0	0.35	0.000	0.00	8.70	0.00	0.000
1.85	2.47	24.25	2.60	63.05	0	0	0.35	0.000	0.00	8.70	0.00	0.000
1.92	2.42	25.18	2.41	60.74	0	0	0.35	0.000	0.00	8.70	0.00	0.000
1.98	2.39	26.21	2.28	59.67	0	0	0.35	0.000	0.00	8.70	0.00	0.000
2.05	2.37	27.04	2.21	59.70	0	0	0.35	0.000	0.00	8.70	0.00	0.000
2.10	2.37	27.71	2.19	60.64	0	0	0.35	0.000	0.00	8.70	0.00	0.000
2.18	2.38	28.27	2.24	63.34	0	0	0.35	0.000	0.00	8.70	0.00	0.000
2.23	2.43	28.78	2.42	69.77	0	0	0.35	0.000	0.00	8.70	0.00	0.000
2.31	2.49	28.83	2.72	78.49	0	0	0.35	0.000	0.00	8.70	0.00	0.000
2.39	2.55	28.41	3.04	86.39	0	0	0.35	0.000	0.00	8.70	0.00	0.000
2.44	2.60	27.26	3.35	91.42	0	0	0.35	0.000	0.00	0.00	0.00	0.000
2.51	2.64	26.32	3.56	93.71	0	0	0.35	0.000	0.00	0.00	0.00	0.000
2.56	2.67	25.12	3.80	95.56	0	0	0.35	0.000	0.00	0.00	0.00	0.000
2.64	2.71	24.08	4.05	97.64	0	0	0.35	0.000	0.00	0.00	0.00	0.000
2.70	2.75	23.09	4.35	100.42	0	0	0.35	0.000	0.00	0.00	0.00	0.000
2.76	2.76	23.40	4.42	103.32	0	0	0.35	0.000	0.00	0.00	0.00	0.000
2.84	2.74	24.80	4.26	105.66	0	0	0.35	0.000	0.00	0.00	0.00	0.000
2.90	2.70	26.72	4.03	107.69	0	0	0.35	0.000	0.00	0.00	0.00	0.000
2.96	2.69	28.16	3.92	110.45	0	0	0.35	0.000	0.00	0.00	0.00	0.000
3.04	2.69	29.28	3.89	114.01	0	0	0.35	0.000	0.00	0.00	0.00	0.000
3.09	2.70	29.63	4.01	118.83	0	0	0.35	0.000	0.00	0.00	0.00	0.000
3.17	2.72	29.71	4.13	122.79	0	0	0.35	0.000	0.00	0.00	0.00	0.000

:: Post-earthquake settlement of dry sands :: (continued)

Depth (ft)	Ic	Q_{tn}	Kc	$Q_{tn,cs}$	$N_{1,60}$ (blows)	G_{max} (tsf)	CSR	Shear, γ (%)	$e_{vol(15)}$ (%)	N_c	e_v (%)	Settle. (in)
3.23	2.74	29.13	4.30	125.37	0	0	0.35	0.000	0.00	0.00	0.00	0.000
3.29	2.75	28.35	4.41	125.03	0	0	0.35	0.000	0.00	0.00	0.00	0.000
3.37	2.77	27.20	4.53	123.19	0	0	0.35	0.000	0.00	0.00	0.00	0.000
3.42	2.78	26.12	4.62	120.66	0	0	0.35	0.000	0.00	0.00	0.00	0.000
3.48	2.79	25.02	4.73	118.33	0	0	0.35	0.000	0.00	0.00	0.00	0.000
3.55	2.81	23.81	4.86	115.82	0	0	0.35	0.000	0.00	0.00	0.00	0.000
3.61	2.82	22.77	4.96	112.96	0	0	0.35	0.000	0.00	0.00	0.00	0.000
3.68	2.83	21.78	5.06	110.27	0	0	0.35	0.000	0.00	0.00	0.00	0.000
3.75	2.84	20.99	5.16	108.22	0	0	0.35	0.000	0.00	0.00	0.00	0.000
3.81	2.85	20.41	5.24	107.01	0	0	0.35	0.000	0.00	0.00	0.00	0.000
3.88	2.85	20.20	5.26	106.33	0	0	0.35	0.000	0.00	0.00	0.00	0.000
3.94	2.84	20.45	5.16	105.49	0	0	0.35	0.000	0.00	0.00	0.00	0.000
4.02	2.83	20.86	5.02	104.80	0	0	0.35	0.000	0.00	0.00	0.00	0.000
4.07	2.81	21.37	4.88	104.28	0	0	0.35	0.000	0.00	0.00	0.00	0.000
4.16	2.81	21.57	4.83	104.21	0	0	0.35	0.000	0.00	0.00	0.00	0.000
4.21	2.81	21.41	4.87	104.36	0	0	0.35	0.000	0.00	0.00	0.00	0.000
4.28	2.82	21.14	4.94	104.33	0	0	0.35	0.000	0.00	0.00	0.00	0.000
4.35	2.82	20.67	5.00	103.28	0	0	0.35	0.000	0.00	0.00	0.00	0.000
4.43	2.82	20.45	4.94	101.07	0	0	0.35	0.000	0.00	0.00	0.00	0.000
4.48	2.78	20.70	4.60	95.31	0	0	0.35	0.000	0.00	0.00	0.00	0.000
4.56	2.71	21.79	4.07	88.68	0	0	0.35	0.000	0.00	0.00	0.00	0.000
4.61	2.59	24.79	3.28	81.34	0	0	0.35	0.000	0.00	8.70	0.00	0.000
4.68	2.49	28.78	2.70	77.66	0	0	0.35	0.000	0.00	8.70	0.00	0.000
4.74	2.38	34.06	2.23	75.90	0	0	0.35	0.000	0.00	8.70	0.00	0.000
4.81	2.32	37.84	2.00	75.66	0	0	0.35	0.000	0.00	8.70	0.00	0.000
4.86	2.26	41.47	1.83	75.91	0	0	0.35	0.000	0.00	8.70	0.00	0.000
4.92	2.23	43.71	1.74	76.18	0	0	0.35	0.000	0.00	8.70	0.00	0.000

Total estimated settlement: 0.00

Abbreviations

Q_{tn}: Equivalent clean sand normalized cone resistance
K_c: Fines correction factor
$Q_{tn,cs}$: Post-liquefaction volumentric strain
G_{max}: Small strain shear modulus
CSR: Soil cyclic stress ratio
γ: Cyclic shear strain
$e_{vol(15)}$: Volumetric strain after 15 cycles
N_c: Equivalent number of cycles
e_v: Volumetric strain
Settle.: Calculated settlement

:: Post-earthquake settlement due to soil liquefaction ::

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
5.00	76.61	2.00	0.00	0.92	0.00	5.07	76.95	2.00	0.00	0.91	0.00
5.12	76.98	2.00	0.00	0.91	0.00	5.20	76.97	2.00	0.00	0.91	0.00
5.25	77.97	0.35	2.61	0.91	0.02	5.32	80.66	0.36	2.54	0.91	0.02
5.39	85.92	0.39	2.40	0.91	0.02	5.47	92.20	0.42	2.27	0.91	0.02
5.54	97.85	0.46	2.16	0.91	0.02	5.58	100.98	0.48	2.10	0.91	0.01
5.65	101.35	0.48	2.09	0.90	0.02	5.74	100.33	0.47	2.10	0.90	0.02
5.78	97.25	0.44	2.16	0.90	0.01	5.85	92.99	0.41	2.23	0.90	0.02
5.93	90.29	0.39	2.29	0.90	0.02	6.00	90.83	0.39	2.27	0.90	0.02

:: Post-earthquake settlement due to soil liquefaction :: (continued)

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
6.05	92.37	0.40	2.24	0.90	0.01	6.13	94.52	0.41	2.19	0.90	0.02
6.17	96.84	0.43	2.15	0.90	0.01	6.24	99.31	0.44	2.10	0.89	0.02
6.32	101.38	0.45	2.06	0.89	0.02	6.39	103.40	0.46	2.03	0.89	0.02
6.45	104.65	0.47	2.01	0.89	0.01	6.51	105.27	0.47	1.99	0.89	0.02
6.58	105.52	0.47	1.99	0.89	0.02	6.63	105.09	0.47	1.99	0.89	0.01
6.71	104.13	0.46	2.00	0.89	0.02	6.78	101.65	0.44	2.04	0.89	0.02
6.85	98.90	0.42	2.08	0.88	0.02	6.90	96.99	0.40	2.12	0.88	0.01
6.97	97.96	0.41	2.10	0.88	0.02	7.04	101.21	0.43	2.04	0.88	0.02
7.11	105.36	0.46	1.97	0.88	0.02	7.16	107.36	0.47	1.94	0.88	0.01
7.22	111.55	0.50	1.87	0.88	0.01	7.30	116.48	0.54	1.81	0.88	0.02
7.36	123.65	0.61	1.72	0.88	0.01	7.43	127.74	0.65	1.67	0.87	0.01
7.49	130.42	0.68	1.47	0.87	0.01	7.56	132.15	0.69	1.44	0.87	0.01
7.63	133.21	0.70	1.42	0.87	0.01	7.68	133.53	0.70	1.42	0.87	0.01
7.74	133.03	0.70	1.42	0.87	0.01	7.82	131.90	0.68	1.44	0.87	0.01
7.88	130.36	0.66	1.46	0.87	0.01	7.95	129.04	0.64	1.64	0.87	0.01
8.01	128.04	0.63	1.65	0.86	0.01	8.08	127.08	0.62	1.66	0.86	0.01
8.14	125.41	2.00	0.00	0.86	0.00	8.21	122.86	2.00	0.00	0.86	0.00
8.28	119.76	2.00	0.00	0.86	0.00	8.34	116.36	2.00	0.00	0.86	0.00
8.41	112.94	2.00	0.00	0.86	0.00	8.47	108.23	2.00	0.00	0.86	0.00
8.54	105.93	2.00	0.00	0.86	0.00	8.60	105.81	2.00	0.00	0.85	0.00
8.67	108.20	2.00	0.00	0.85	0.00	8.74	112.21	2.00	0.00	0.85	0.00
8.80	115.04	2.00	0.00	0.85	0.00	8.87	114.25	2.00	0.00	0.85	0.00
8.93	110.38	2.00	0.00	0.85	0.00	9.00	105.51	2.00	0.00	0.85	0.00
9.07	100.61	2.00	0.00	0.85	0.00	9.14	95.82	2.00	0.00	0.85	0.00
9.19	89.38	2.00	0.00	0.84	0.00	9.25	81.75	2.00	0.00	0.84	0.00
9.34	75.05	2.00	0.00	0.84	0.00	9.41	72.02	2.00	0.00	0.84	0.00
9.48	72.38	2.00	0.00	0.84	0.00	9.55	73.04	2.00	0.00	0.84	0.00
9.58	75.17	2.00	0.00	0.84	0.00	9.68	78.00	2.00	0.00	0.84	0.00
9.71	82.08	2.00	0.00	0.84	0.00	9.80	85.40	2.00	0.00	0.83	0.00
9.86	89.35	0.31	2.13	0.83	0.02	9.93	92.54	0.32	2.07	0.83	0.02
9.99	95.40	0.34	2.02	0.83	0.02	10.06	97.30	0.35	1.98	0.83	0.02
10.12	98.66	2.00	0.00	0.83	0.00	10.18	98.28	2.00	0.00	0.83	0.00
10.24	92.92	2.00	0.00	0.83	0.00	10.31	86.83	2.00	0.00	0.83	0.00
10.39	81.71	2.00	0.00	0.82	0.00	10.43	80.42	2.00	0.00	0.82	0.00
10.53	79.15	2.00	0.00	0.82	0.00	10.59	78.39	2.00	0.00	0.82	0.00
10.64	80.90	2.00	0.00	0.82	0.00	10.71	85.61	2.00	0.00	0.82	0.00
10.77	90.45	2.00	0.00	0.82	0.00	10.83	94.46	2.00	0.00	0.82	0.00
10.90	98.03	2.00	0.00	0.82	0.00	10.97	100.77	2.00	0.00	0.81	0.00
11.03	101.48	2.00	0.00	0.81	0.00	11.10	96.77	2.00	0.00	0.81	0.00
11.16	88.04	2.00	0.00	0.81	0.00	11.23	80.54	2.00	0.00	0.81	0.00
11.29	78.17	2.00	0.00	0.81	0.00	11.35	80.18	2.00	0.00	0.81	0.00
11.42	80.10	2.00	0.00	0.81	0.00	11.49	78.65	2.00	0.00	0.81	0.00
11.55	75.96	2.00	0.00	0.80	0.00	11.62	72.48	2.00	0.00	0.80	0.00
11.68	69.65	2.00	0.00	0.80	0.00	11.75	65.78	2.00	0.00	0.80	0.00
11.81	60.84	2.00	0.00	0.80	0.00	11.89	56.08	2.00	0.00	0.80	0.00
11.96	51.65	2.00	0.00	0.80	0.00	12.03	49.55	2.00	0.00	0.80	0.00
12.09	48.07	2.00	0.00	0.80	0.00	12.15	47.12	2.00	0.00	0.79	0.00
12.23	46.26	2.00	0.00	0.79	0.00	12.29	46.08	2.00	0.00	0.79	0.00

:: Post-earthquake settlement due to soil liquefaction :: (continued)

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
12.35	47.64	2.00	0.00	0.79	0.00	12.41	51.67	2.00	0.00	0.79	0.00
12.50	56.69	2.00	0.00	0.79	0.00	12.56	62.45	2.00	0.00	0.79	0.00
12.62	68.59	2.00	0.00	0.79	0.00	12.68	74.87	2.00	0.00	0.79	0.00
12.73	81.11	2.00	0.00	0.78	0.00	12.82	86.07	2.00	0.00	0.78	0.00
12.89	89.76	2.00	0.00	0.78	0.00	12.95	91.89	2.00	0.00	0.78	0.00
13.00	92.74	2.00	0.00	0.78	0.00	13.09	92.42	2.00	0.00	0.78	0.00
13.14	91.14	2.00	0.00	0.78	0.00	13.20	89.79	2.00	0.00	0.78	0.00
13.26	90.06	0.28	1.97	0.78	0.01	13.34	93.27	0.30	1.91	0.77	0.02
13.41	99.04	0.32	1.82	0.77	0.01	13.46	106.71	0.37	1.71	0.77	0.01
13.54	113.36	2.00	0.00	0.77	0.00	13.60	116.91	2.00	0.00	0.77	0.00
13.67	115.77	2.00	0.00	0.77	0.00	13.73	114.31	2.00	0.00	0.77	0.00
13.80	112.45	2.00	0.00	0.77	0.00	13.86	110.49	2.00	0.00	0.77	0.00
13.92	103.54	2.00	0.00	0.76	0.00	13.99	96.75	2.00	0.00	0.76	0.00
14.07	97.09	2.00	0.00	0.76	0.00	14.12	103.52	2.00	0.00	0.76	0.00
14.18	111.21	2.00	0.00	0.76	0.00	14.25	119.05	2.00	0.00	0.76	0.00
14.32	125.14	2.00	0.00	0.76	0.00	14.38	130.39	2.00	0.00	0.76	0.00
14.44	132.86	2.00	0.00	0.76	0.00	14.52	133.42	2.00	0.00	0.75	0.00
14.58	132.61	2.00	0.00	0.75	0.00	14.64	131.64	2.00	0.00	0.75	0.00
14.71	130.98	2.00	0.00	0.75	0.00	14.78	130.61	2.00	0.00	0.75	0.00
14.83	129.98	2.00	0.00	0.75	0.00	14.91	130.59	2.00	0.00	0.75	0.00
14.97	131.69	2.00	0.00	0.75	0.00	15.05	133.24	2.00	0.00	0.74	0.00
15.10	133.83	2.00	0.00	0.74	0.00	15.16	133.99	2.00	0.00	0.74	0.00
15.24	134.10	2.00	0.00	0.74	0.00	15.30	134.42	2.00	0.00	0.74	0.00
15.36	135.42	2.00	0.00	0.74	0.00	15.44	136.27	2.00	0.00	0.74	0.00
15.49	136.17	2.00	0.00	0.74	0.00	15.55	134.49	2.00	0.00	0.74	0.00
15.63	132.69	2.00	0.00	0.74	0.00	15.69	130.87	2.00	0.00	0.73	0.00
15.76	128.57	2.00	0.00	0.73	0.00	15.82	125.67	2.00	0.00	0.73	0.00
15.88	122.18	2.00	0.00	0.73	0.00	15.96	118.53	2.00	0.00	0.73	0.00
16.01	114.60	2.00	0.00	0.73	0.00	16.10	111.13	2.00	0.00	0.73	0.00
16.15	107.84	2.00	0.00	0.73	0.00	16.24	104.73	2.00	0.00	0.72	0.00
16.29	99.26	2.00	0.00	0.72	0.00	16.37	95.05	2.00	0.00	0.72	0.00
16.42	92.44	2.00	0.00	0.72	0.00	16.47	95.32	2.00	0.00	0.72	0.00
16.57	100.10	2.00	0.00	0.72	0.00	16.62	105.68	2.00	0.00	0.72	0.00
16.67	111.03	2.00	0.00	0.72	0.00	16.73	117.07	2.00	0.00	0.72	0.00
16.82	123.30	2.00	0.00	0.71	0.00	16.89	129.32	2.00	0.00	0.71	0.00
16.95	135.33	2.00	0.00	0.71	0.00	17.03	140.97	2.00	0.00	0.71	0.00
17.09	145.82	2.00	0.00	0.71	0.00	17.14	148.41	2.00	0.00	0.71	0.00
17.22	148.32	2.00	0.00	0.71	0.00	17.27	141.91	2.00	0.00	0.71	0.00
17.35	129.64	2.00	0.00	0.71	0.00	17.41	117.75	2.00	0.00	0.70	0.00
17.45	112.53	0.38	1.49	0.70	0.01	17.54	113.45	0.38	1.48	0.70	0.02
17.59	113.53	0.38	1.48	0.70	0.01	17.67	112.83	0.38	1.48	0.70	0.01
17.73	110.71	0.37	1.50	0.70	0.01	17.80	109.39	0.36	1.52	0.70	0.01
17.86	112.04	0.37	1.48	0.70	0.01	17.94	118.38	0.42	1.42	0.70	0.01
18.00	125.28	0.47	1.35	0.69	0.01	18.05	128.99	2.00	0.00	0.69	0.00
18.13	129.65	2.00	0.00	0.69	0.00	18.18	127.44	2.00	0.00	0.69	0.00
18.26	123.62	2.00	0.00	0.69	0.00	18.31	120.63	2.00	0.00	0.69	0.00
18.39	119.58	2.00	0.00	0.69	0.00	18.44	119.21	2.00	0.00	0.69	0.00
18.51	118.58	2.00	0.00	0.69	0.00	18.58	118.52	2.00	0.00	0.69	0.00

:: Post-earthquake settlement due to soil liquefaction :: (continued)

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
18.65	118.94	2.00	0.00	0.68	0.00	18.71	121.11	2.00	0.00	0.68	0.00
18.78	123.88	2.00	0.00	0.68	0.00	18.84	127.29	2.00	0.00	0.68	0.00
18.91	130.39	2.00	0.00	0.68	0.00	18.96	133.89	2.00	0.00	0.68	0.00
19.04	137.19	2.00	0.00	0.68	0.00	19.11	140.36	0.59	1.20	0.68	0.01
19.17	143.00	0.62	1.18	0.68	0.01	19.24	145.42	0.64	1.16	0.67	0.01
19.30	147.78	0.67	0.95	0.67	0.01	19.36	150.14	0.69	0.93	0.67	0.01
19.43	152.41	0.72	0.91	0.67	0.01	19.50	154.41	0.74	0.89	0.67	0.01
19.56	156.25	0.76	0.71	0.67	0.01	19.62	157.84	0.78	0.70	0.67	0.01
19.69	159.72	0.80	0.68	0.67	0.01	19.78	160.31	0.81	0.68	0.66	0.01
19.82	159.53	0.80	0.68	0.66	0.00	19.88	158.94	0.79	0.68	0.66	0.00
19.95	160.06	0.80	0.68	0.66	0.01	20.02	163.20	0.84	0.66	0.66	0.01
20.09	165.29	0.87	0.49	0.66	0.00	20.15	166.66	0.89	0.48	0.66	0.00
20.21	167.53	0.90	0.48	0.66	0.00	20.29	168.60	0.92	0.47	0.66	0.00
20.36	169.64	0.93	0.47	0.65	0.00	20.42	170.84	0.95	0.46	0.65	0.00
20.49	171.93	0.96	0.35	0.65	0.00	20.55	172.92	0.98	0.35	0.65	0.00
20.62	173.60	0.98	0.34	0.65	0.00	20.68	174.14	0.99	0.34	0.65	0.00
20.75	174.40	1.00	0.34	0.65	0.00	20.81	174.06	0.99	0.34	0.65	0.00
20.88	172.96	0.97	0.34	0.65	0.00	20.95	171.32	0.95	0.35	0.65	0.00
21.00	169.01	0.92	0.46	0.64	0.00	21.08	166.62	0.89	0.47	0.64	0.00
21.13	164.20	0.85	0.48	0.64	0.00	21.20	161.92	0.82	0.64	0.64	0.01
21.27	159.72	0.80	0.66	0.64	0.01	21.33	157.99	0.77	0.67	0.64	0.00
21.39	156.92	0.76	0.67	0.64	0.00	21.46	156.04	0.75	0.68	0.64	0.01
21.53	155.10	0.74	0.84	0.64	0.01	21.59	154.54	0.73	0.84	0.63	0.01
21.67	155.02	0.74	0.83	0.63	0.01	21.73	158.93	0.78	0.65	0.63	0.00
21.79	164.25	0.85	0.47	0.63	0.00	21.86	170.46	0.94	0.45	0.63	0.00
21.92	174.74	1.00	0.33	0.63	0.00	21.99	177.24	1.03	0.33	0.63	0.00
22.05	177.44	1.04	0.32	0.63	0.00	22.12	176.04	1.02	0.33	0.63	0.00
22.19	174.41	0.99	0.33	0.62	0.00	22.25	172.64	0.96	0.33	0.62	0.00
22.32	170.48	0.93	0.44	0.62	0.00	22.38	167.65	0.89	0.45	0.62	0.00
22.46	164.24	0.85	0.61	0.62	0.01	22.51	159.27	0.79	0.64	0.62	0.00
22.59	154.84	2.00	0.00	0.62	0.00	22.64	151.84	2.00	0.00	0.62	0.00
22.72	151.81	2.00	0.00	0.61	0.00	22.79	151.20	2.00	0.00	0.61	0.00
22.84	151.25	2.00	0.00	0.61	0.00	22.91	151.00	2.00	0.00	0.61	0.00
22.98	150.26	2.00	0.00	0.61	0.00	23.04	147.91	2.00	0.00	0.61	0.00
23.11	145.24	2.00	0.00	0.61	0.00	23.17	144.37	2.00	0.00	0.61	0.00
23.24	142.52	2.00	0.00	0.61	0.00	23.30	140.68	2.00	0.00	0.61	0.00
23.37	143.47	2.00	0.00	0.60	0.00	23.44	149.69	2.00	0.00	0.60	0.00
23.50	153.86	0.72	0.80	0.60	0.01	23.57	155.53	0.74	0.79	0.60	0.01
23.63	154.22	0.72	0.80	0.60	0.01	23.70	152.69	0.71	0.81	0.60	0.01
23.77	151.32	0.69	0.82	0.60	0.01	23.84	150.03	0.68	0.82	0.60	0.01
23.89	149.63	0.67	0.83	0.60	0.01	23.97	150.59	0.68	0.82	0.59	0.01
24.02	153.04	0.71	0.80	0.59	0.00	24.09	156.64	0.75	0.62	0.59	0.01
24.16	161.04	0.81	0.60	0.59	0.01	24.23	165.69	0.86	0.44	0.59	0.00
24.29	169.07	0.91	0.42	0.59	0.00	24.36	170.83	0.93	0.42	0.59	0.00
24.43	171.26	2.00	0.00	0.59	0.00	24.49	170.87	2.00	0.00	0.58	0.00
24.54	169.78	2.00	0.00	0.58	0.00	24.61	167.87	2.00	0.00	0.58	0.00
24.68	165.05	2.00	0.00	0.58	0.00	24.75	161.25	2.00	0.00	0.58	0.00
24.81	154.32	2.00	0.00	0.58	0.00	24.87	142.18	2.00	0.00	0.58	0.00

:: Post-earthquake settlement due to soil liquefaction :: (continued)

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
24.94	126.22	2.00	0.00	0.58	0.00	25.02	113.02	2.00	0.00	0.58	0.00
25.07	105.99	2.00	0.00	0.58	0.00	25.14	103.59	2.00	0.00	0.57	0.00
25.20	101.35	2.00	0.00	0.57	0.00	25.27	98.92	2.00	0.00	0.57	0.00
25.34	97.57	2.00	0.00	0.57	0.00	25.41	97.67	2.00	0.00	0.57	0.00
25.46	98.44	2.00	0.00	0.57	0.00	25.53	98.84	2.00	0.00	0.57	0.00
25.61	98.91	2.00	0.00	0.57	0.00	25.66	98.93	2.00	0.00	0.57	0.00
25.72	99.33	2.00	0.00	0.56	0.00	25.80	101.53	2.00	0.00	0.56	0.00
25.87	105.62	2.00	0.00	0.56	0.00	25.92	110.30	2.00	0.00	0.56	0.00
26.02	113.80	2.00	0.00	0.56	0.00	26.05	114.94	2.00	0.00	0.56	0.00
26.12	112.74	2.00	0.00	0.56	0.00	26.19	107.45	2.00	0.00	0.56	0.00
26.26	100.96	2.00	0.00	0.55	0.00	26.33	94.41	2.00	0.00	0.55	0.00
26.38	87.23	2.00	0.00	0.55	0.00	26.46	79.82	2.00	0.00	0.55	0.00
26.52	72.21	2.00	0.00	0.55	0.00	26.59	66.45	2.00	0.00	0.55	0.00
26.64	62.77	2.00	0.00	0.55	0.00	26.71	61.13	2.00	0.00	0.55	0.00
26.78	59.92	2.00	0.00	0.55	0.00	26.85	58.53	2.00	0.00	0.55	0.00
26.91	57.14	2.00	0.00	0.54	0.00	26.98	56.79	2.00	0.00	0.54	0.00
27.05	57.02	2.00	0.00	0.54	0.00	27.11	57.31	2.00	0.00	0.54	0.00
27.18	57.96	2.00	0.00	0.54	0.00	27.24	59.07	2.00	0.00	0.54	0.00
27.31	59.97	2.00	0.00	0.54	0.00	27.38	60.49	2.00	0.00	0.54	0.00
27.44	60.98	2.00	0.00	0.53	0.00	27.51	62.07	2.00	0.00	0.53	0.00
27.56	63.81	2.00	0.00	0.53	0.00	27.64	65.57	2.00	0.00	0.53	0.00
27.69	67.96	2.00	0.00	0.53	0.00	27.78	70.14	2.00	0.00	0.53	0.00
27.86	72.03	2.00	0.00	0.53	0.00	27.89	73.26	2.00	0.00	0.53	0.00
27.99	73.85	2.00	0.00	0.53	0.00	28.04	74.35	2.00	0.00	0.52	0.00
28.09	75.03	2.00	0.00	0.52	0.00	28.15	76.37	2.00	0.00	0.52	0.00
28.22	77.87	2.00	0.00	0.52	0.00	28.30	78.65	2.00	0.00	0.52	0.00
28.35	75.32	2.00	0.00	0.52	0.00	28.44	71.86	2.00	0.00	0.52	0.00
28.51	68.73	2.00	0.00	0.52	0.00	28.55	68.73	2.00	0.00	0.52	0.00
28.61	67.54	2.00	0.00	0.52	0.00	28.70	65.77	2.00	0.00	0.51	0.00
28.76	64.17	2.00	0.00	0.51	0.00	28.81	64.35	2.00	0.00	0.51	0.00
28.88	65.17	2.00	0.00	0.51	0.00	28.94	66.43	2.00	0.00	0.51	0.00
29.01	67.94	2.00	0.00	0.51	0.00	29.10	69.73	2.00	0.00	0.51	0.00
29.15	71.70	2.00	0.00	0.51	0.00	29.20	72.86	2.00	0.00	0.51	0.00
29.27	73.14	2.00	0.00	0.50	0.00	29.36	72.63	2.00	0.00	0.50	0.00
29.42	71.57	2.00	0.00	0.50	0.00	29.47	69.83	2.00	0.00	0.50	0.00
29.53	67.91	2.00	0.00	0.50	0.00	29.62	66.25	2.00	0.00	0.50	0.00
29.68	65.52	2.00	0.00	0.50	0.00	29.73	65.77	2.00	0.00	0.50	0.00
29.82	66.40	2.00	0.00	0.49	0.00	29.87	67.10	2.00	0.00	0.49	0.00
29.95	67.30	2.00	0.00	0.49	0.00	30.01	66.97	2.00	0.00	0.49	0.00
30.07	65.56	2.00	0.00	0.49	0.00	30.15	63.44	2.00	0.00	0.49	0.00
30.21	60.87	2.00	0.00	0.49	0.00	30.27	59.06	2.00	0.00	0.49	0.00
30.35	58.23	2.00	0.00	0.49	0.00	30.40	58.38	2.00	0.00	0.48	0.00
30.46	59.24	2.00	0.00	0.48	0.00	30.51	62.08	2.00	0.00	0.48	0.00
30.60	66.32	2.00	0.00	0.48	0.00	30.65	71.49	2.00	0.00	0.48	0.00
30.71	75.29	2.00	0.00	0.48	0.00	30.80	77.59	2.00	0.00	0.48	0.00
30.86	77.87	2.00	0.00	0.48	0.00	30.92	76.17	2.00	0.00	0.48	0.00
30.99	73.87	2.00	0.00	0.47	0.00	31.05	72.20	2.00	0.00	0.47	0.00
31.11	70.73	2.00	0.00	0.47	0.00	31.19	69.20	2.00	0.00	0.47	0.00

:: Post-earthquake settlement due to soil liquefaction :: (continued)

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
31.25	67.93	2.00	0.00	0.47	0.00	31.31	67.70	2.00	0.00	0.47	0.00
31.37	67.13	2.00	0.00	0.47	0.00	31.44	65.31	2.00	0.00	0.47	0.00
31.50	62.90	2.00	0.00	0.47	0.00	31.58	61.02	2.00	0.00	0.46	0.00
31.64	61.33	2.00	0.00	0.46	0.00	31.70	64.59	2.00	0.00	0.46	0.00
31.77	69.19	2.00	0.00	0.46	0.00	31.84	74.52	2.00	0.00	0.46	0.00
31.91	78.26	2.00	0.00	0.46	0.00	31.97	80.85	2.00	0.00	0.46	0.00
32.03	83.43	2.00	0.00	0.46	0.00	32.10	86.25	2.00	0.00	0.46	0.00
32.16	89.52	2.00	0.00	0.45	0.00	32.24	91.25	2.00	0.00	0.45	0.00
32.29	92.08	2.00	0.00	0.45	0.00	32.37	92.17	2.00	0.00	0.45	0.00
32.43	91.34	2.00	0.00	0.45	0.00	32.48	90.24	2.00	0.00	0.45	0.00
32.57	89.93	2.00	0.00	0.45	0.00	32.63	90.25	2.00	0.00	0.45	0.00
32.70	91.17	2.00	0.00	0.45	0.00	32.77	91.53	2.00	0.00	0.44	0.00
32.81	92.93	2.00	0.00	0.44	0.00	32.90	95.15	2.00	0.00	0.44	0.00
32.95	99.07	2.00	0.00	0.44	0.00	33.03	103.31	2.00	0.00	0.44	0.00
33.09	107.85	2.00	0.00	0.44	0.00	33.14	112.18	2.00	0.00	0.44	0.00
33.22	114.87	2.00	0.00	0.44	0.00	33.28	114.35	2.00	0.00	0.44	0.00
33.36	110.30	2.00	0.00	0.43	0.00	33.41	104.52	2.00	0.00	0.43	0.00
33.47	99.53	2.00	0.00	0.43	0.00	33.54	95.56	2.00	0.00	0.43	0.00
33.60	92.67	2.00	0.00	0.43	0.00	33.67	90.39	2.00	0.00	0.43	0.00
33.74	88.19	2.00	0.00	0.43	0.00	33.81	86.00	2.00	0.00	0.43	0.00
33.87	83.47	2.00	0.00	0.43	0.00	33.94	81.20	2.00	0.00	0.42	0.00
34.00	79.77	2.00	0.00	0.42	0.00	34.07	79.72	2.00	0.00	0.42	0.00
34.13	81.29	2.00	0.00	0.42	0.00	34.21	83.72	2.00	0.00	0.42	0.00
34.26	87.72	2.00	0.00	0.42	0.00	34.32	93.42	2.00	0.00	0.42	0.00
34.39	100.51	2.00	0.00	0.42	0.00	34.49	104.79	2.00	0.00	0.42	0.00
34.52	105.36	2.00	0.00	0.41	0.00	34.60	103.29	2.00	0.00	0.41	0.00
34.66	101.51	2.00	0.00	0.41	0.00	34.72	101.98	2.00	0.00	0.41	0.00
34.80	105.19	2.00	0.00	0.41	0.00	34.85	110.74	2.00	0.00	0.41	0.00
34.91	115.79	2.00	0.00	0.41	0.00	34.99	121.36	2.00	0.00	0.41	0.00
35.07	126.51	2.00	0.00	0.41	0.00	35.12	132.00	2.00	0.00	0.40	0.00
35.17	134.72	2.00	0.00	0.40	0.00	35.25	134.86	2.00	0.00	0.40	0.00
35.32	133.15	2.00	0.00	0.40	0.00	35.38	128.65	2.00	0.00	0.40	0.00
35.46	125.36	2.00	0.00	0.40	0.00	35.52	124.12	2.00	0.00	0.40	0.00
35.57	126.22	2.00	0.00	0.40	0.00	35.65	128.50	2.00	0.00	0.40	0.00
35.71	131.92	2.00	0.00	0.39	0.00	35.78	135.18	2.00	0.00	0.39	0.00
35.83	139.23	2.00	0.00	0.39	0.00	35.90	142.27	2.00	0.00	0.39	0.00
35.98	145.58	2.00	0.00	0.39	0.00	36.07	148.25	2.00	0.00	0.39	0.00
36.11	151.03	0.68	0.53	0.39	0.00	36.16	154.29	0.72	0.51	0.39	0.00
36.22	158.08	0.76	0.40	0.39	0.00	36.29	161.95	0.81	0.39	0.38	0.00
36.36	164.95	0.85	0.38	0.38	0.00	36.42	167.09	0.87	0.28	0.38	0.00
36.49	168.92	0.90	0.28	0.38	0.00	36.55	170.90	0.93	0.27	0.38	0.00
36.62	171.45	0.93	0.27	0.38	0.00	36.68	175.25	0.99	0.20	0.38	0.00
36.76	179.87	1.06	0.14	0.38	0.00	36.83	186.16	1.16	0.10	0.38	0.00
36.88	189.21	1.21	0.10	0.37	0.00	36.95	190.60	1.23	0.10	0.37	0.00
37.03	190.92	1.24	0.10	0.37	0.00	37.07	190.30	1.23	0.10	0.37	0.00
37.16	189.43	1.21	0.10	0.37	0.00	37.21	188.53	1.20	0.10	0.37	0.00
37.28	187.61	1.18	0.10	0.37	0.00	37.34	186.37	1.16	0.10	0.37	0.00
37.42	185.08	1.14	0.14	0.37	0.00	37.48	183.25	1.11	0.14	0.36	0.00

:: Post-earthquake settlement due to soil liquefaction :: (continued)

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
37.54	181.04	1.08	0.14	0.36	0.00	37.61	177.99	1.03	0.19	0.36	0.00
37.67	174.65	0.98	0.19	0.36	0.00	37.75	171.01	0.93	0.26	0.36	0.00
37.81	167.42	0.88	0.26	0.36	0.00	37.88	163.95	0.84	0.35	0.36	0.00
37.94	161.53	0.80	0.36	0.36	0.00	37.99	160.78	0.80	0.36	0.36	0.00
38.07	161.87	0.81	0.36	0.35	0.00	38.13	163.98	0.84	0.35	0.35	0.00
38.19	166.96	0.87	0.26	0.35	0.00	38.27	170.00	0.92	0.25	0.35	0.00
38.33	173.60	0.97	0.19	0.35	0.00	38.40	176.17	1.00	0.18	0.35	0.00
38.46	177.18	1.02	0.18	0.35	0.00	38.52	176.11	1.00	0.18	0.35	0.00
38.60	173.46	0.97	0.18	0.35	0.00	38.67	170.11	0.92	0.25	0.34	0.00
38.73	166.22	0.87	0.25	0.34	0.00	38.78	161.74	0.81	0.35	0.34	0.00
38.88	157.27	0.76	0.36	0.34	0.00	38.93	153.11	0.71	0.46	0.34	0.00
38.98	150.07	0.67	0.47	0.34	0.00	39.04	146.73	0.64	0.58	0.34	0.00
39.14	142.46	0.60	0.59	0.34	0.01	39.20	136.93	0.55	0.61	0.34	0.00
39.24	130.40	0.49	0.63	0.33	0.00	39.34	125.82	0.45	0.65	0.33	0.01
39.39	123.33	0.44	0.65	0.33	0.00	39.44	124.34	0.44	0.65	0.33	0.00
39.50	126.20	0.46	0.64	0.33	0.00	39.59	128.39	0.47	0.63	0.33	0.01
39.64	129.62	0.48	0.62	0.33	0.00	39.70	128.61	0.48	0.62	0.33	0.00
39.79	126.91	0.46	0.63	0.33	0.01	39.83	126.48	0.46	0.63	0.32	0.00
39.93	129.24	0.48	0.61	0.32	0.01	39.99	133.70	0.52	0.59	0.32	0.00
40.04	137.15	0.55	0.58	0.32	0.00	40.09	138.43	0.56	0.57	0.32	0.00
40.18	138.38	0.56	0.57	0.32	0.01	40.23	138.49	0.56	0.57	0.32	0.00
40.31	138.67	0.56	0.57	0.32	0.01	40.36	139.21	0.57	0.56	0.32	0.00
40.43	139.41	0.57	0.56	0.31	0.01	40.50	139.94	0.58	0.56	0.31	0.00
40.56	140.35	0.58	0.55	0.31	0.00	40.64	140.40	0.58	0.55	0.31	0.01
40.70	139.65	0.57	0.55	0.31	0.00	40.76	137.64	0.55	0.56	0.31	0.00
40.83	135.27	0.53	0.56	0.31	0.00	40.89	133.05	0.51	0.57	0.31	0.00
40.97	132.02	0.51	0.57	0.31	0.01	41.03	131.96	0.51	0.57	0.30	0.00
41.08	132.28	0.51	0.56	0.30	0.00	41.15	132.66	0.51	0.56	0.30	0.00
41.22	133.52	0.52	0.56	0.30	0.00	41.27	133.55	0.52	0.55	0.30	0.00
41.35	133.87	0.52	0.55	0.30	0.00	41.43	134.46	0.53	0.55	0.30	0.01
41.48	135.98	0.54	0.54	0.30	0.00	41.54	138.06	0.56	0.53	0.30	0.00
41.61	144.63	0.62	0.51	0.29	0.00	41.67	156.85	0.76	0.31	0.29	0.00
41.74	171.43	0.95	0.21	0.29	0.00	41.80	184.88	1.15	0.08	0.29	0.00
41.87	193.10	1.29	0.05	0.29	0.00	41.94	200.80	2.00	0.00	0.29	0.00
42.00	206.91	2.00	0.00	0.29	0.00	42.08	213.64	2.00	0.00	0.29	0.00
42.14	219.27	2.00	0.00	0.29	0.00	42.20	224.54	2.00	0.00	0.28	0.00
42.28	228.72	2.00	0.00	0.28	0.00	42.33	231.00	2.00	0.00	0.28	0.00
42.39	231.99	2.00	0.00	0.28	0.00	42.47	232.83	2.00	0.00	0.28	0.00
42.56	233.93	2.00	0.00	0.28	0.00	42.61	237.47	2.00	0.00	0.28	0.00
42.65	240.21	2.00	0.00	0.28	0.00	42.72	241.55	2.00	0.00	0.28	0.00
42.79	241.21	2.00	0.00	0.27	0.00	42.87	240.15	2.00	0.00	0.27	0.00
42.92	239.48	2.00	0.00	0.27	0.00	43.01	239.91	2.00	0.00	0.27	0.00
43.05	241.65	2.00	0.00	0.27	0.00	43.14	244.41	2.00	0.00	0.27	0.00
43.18	248.15	2.00	0.00	0.27	0.00	43.27	251.39	2.00	0.00	0.27	0.00
43.32	254.09	2.00	0.00	0.27	0.00	43.40	255.01	2.00	0.00	0.26	0.00
43.45	254.21	2.00	0.00	0.26	0.00	43.53	251.98	2.00	0.00	0.26	0.00
43.58	248.79	2.00	0.00	0.26	0.00	43.66	245.93	2.00	0.00	0.26	0.00
43.71	242.41	2.00	0.00	0.26	0.00	43.78	238.70	2.00	0.00	0.26	0.00

:: Post-earthquake settlement due to soil liquefaction :: (continued)

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
43.86	234.49	2.00	0.00	0.26	0.00	43.91	227.82	2.00	0.00	0.26	0.00
43.97	221.53	2.00	0.00	0.25	0.00	44.05	215.81	2.00	0.00	0.25	0.00
44.10	214.68	2.00	0.00	0.25	0.00	44.18	213.70	2.00	0.00	0.25	0.00
44.23	213.86	2.00	0.00	0.25	0.00	44.31	214.59	2.00	0.00	0.25	0.00
44.38	215.26	2.00	0.00	0.25	0.00	44.43	214.82	2.00	0.00	0.25	0.00
44.50	213.33	2.00	0.00	0.25	0.00	44.57	211.50	2.00	0.00	0.24	0.00
44.63	209.48	2.00	0.00	0.24	0.00	44.70	207.71	2.00	0.00	0.24	0.00
44.78	206.26	2.00	0.00	0.24	0.00	44.82	205.17	2.00	0.00	0.24	0.00
44.90	203.60	2.00	0.00	0.24	0.00	44.97	201.21	2.00	0.00	0.24	0.00
45.04	199.21	1.43	0.00	0.24	0.00	45.09	198.30	1.42	0.00	0.24	0.00
45.16	198.75	1.43	0.00	0.23	0.00	45.21	202.02	2.00	0.00	0.23	0.00
45.29	205.16	2.00	0.00	0.23	0.00	45.36	206.73	2.00	0.00	0.23	0.00
45.41	205.57	2.00	0.00	0.23	0.00	45.49	202.13	2.00	0.00	0.23	0.00
45.56	198.06	1.42	0.00	0.23	0.00	45.62	193.72	1.33	0.04	0.23	0.00
45.68	189.58	1.26	0.04	0.23	0.00	45.75	185.73	1.19	0.06	0.22	0.00
45.80	182.45	1.14	0.08	0.22	0.00	45.88	179.58	1.09	0.08	0.22	0.00
45.94	177.69	1.06	0.08	0.22	0.00	46.01	175.67	1.03	0.12	0.22	0.00
46.08	173.01	0.99	0.12	0.22	0.00	46.14	167.97	0.92	0.16	0.22	0.00
46.21	160.06	0.82	0.22	0.22	0.00	46.28	150.50	2.00	0.00	0.22	0.00
46.33	139.46	2.00	0.00	0.21	0.00	46.40	130.85	2.00	0.00	0.21	0.00
46.46	125.83	2.00	0.00	0.21	0.00	46.53	125.35	2.00	0.00	0.21	0.00
46.59	125.35	2.00	0.00	0.21	0.00	46.68	122.96	2.00	0.00	0.21	0.00
46.74	117.60	2.00	0.00	0.21	0.00	46.81	112.04	2.00	0.00	0.21	0.00
46.87	105.84	2.00	0.00	0.21	0.00	46.94	98.90	2.00	0.00	0.20	0.00
47.00	90.20	2.00	0.00	0.20	0.00	47.07	80.71	2.00	0.00	0.20	0.00
47.12	71.53	2.00	0.00	0.20	0.00	47.18	64.85	2.00	0.00	0.20	0.00
47.25	61.30	2.00	0.00	0.20	0.00	47.34	61.11	2.00	0.00	0.20	0.00
47.39	61.97	2.00	0.00	0.20	0.00	47.45	62.79	2.00	0.00	0.20	0.00
47.52	63.12	2.00	0.00	0.19	0.00	47.58	62.81	2.00	0.00	0.19	0.00
47.67	62.84	2.00	0.00	0.19	0.00	47.72	63.37	2.00	0.00	0.19	0.00
47.78	65.17	2.00	0.00	0.19	0.00	47.85	67.53	2.00	0.00	0.19	0.00
47.91	70.11	2.00	0.00	0.19	0.00	47.98	72.49	2.00	0.00	0.19	0.00
48.03	74.56	2.00	0.00	0.19	0.00	48.13	76.09	2.00	0.00	0.18	0.00
48.19	77.52	2.00	0.00	0.18	0.00	48.25	78.35	2.00	0.00	0.18	0.00
48.31	78.68	2.00	0.00	0.18	0.00	48.37	78.65	2.00	0.00	0.18	0.00
48.46	78.86	2.00	0.00	0.18	0.00	48.52	79.39	2.00	0.00	0.18	0.00
48.58	79.81	2.00	0.00	0.18	0.00	48.65	79.64	2.00	0.00	0.18	0.00
48.71	78.87	2.00	0.00	0.17	0.00	48.77	78.53	2.00	0.00	0.17	0.00
48.83	79.52	2.00	0.00	0.17	0.00	48.92	80.87	2.00	0.00	0.17	0.00
48.97	82.97	2.00	0.00	0.17	0.00	49.04	86.85	2.00	0.00	0.17	0.00
49.10	92.21	2.00	0.00	0.17	0.00	49.17	97.26	2.00	0.00	0.17	0.00
49.23	100.34	2.00	0.00	0.17	0.00	49.28	101.31	2.00	0.00	0.16	0.00
49.37	100.34	2.00	0.00	0.16	0.00	49.43	102.40	2.00	0.00	0.16	0.00
49.49	109.81	2.00	0.00	0.16	0.00	49.56	118.77	2.00	0.00	0.16	0.00
49.61	125.67	2.00	0.00	0.16	0.00	49.69	129.97	2.00	0.00	0.16	0.00
49.76	132.85	2.00	0.00	0.16	0.00	49.82	135.21	0.56	0.28	0.16	0.00
49.88	138.07	0.59	0.28	0.15	0.00	49.95	141.15	0.62	0.27	0.15	0.00
50.00	143.33	2.00	0.00	0.15	0.00	50.08	144.29	2.00	0.00	0.15	0.00

:: Post-earthquake settlement due to soil liquefaction :: (continued)

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)

Total estimated settlement: 1.51

Abbreviations

$Q_{tn,cs}$:	Equivalent clean sand normalized cone resistance
FS:	Factor of safety against liquefaction
e_v (%):	Post-liquefaction volumentric strain
DF:	e_v depth weighting factor
Settlement:	Calculated settlement

GeoTek, Inc.
1548 N. Maple Street
Corona, CA 92880
http://www.geotekusa.com

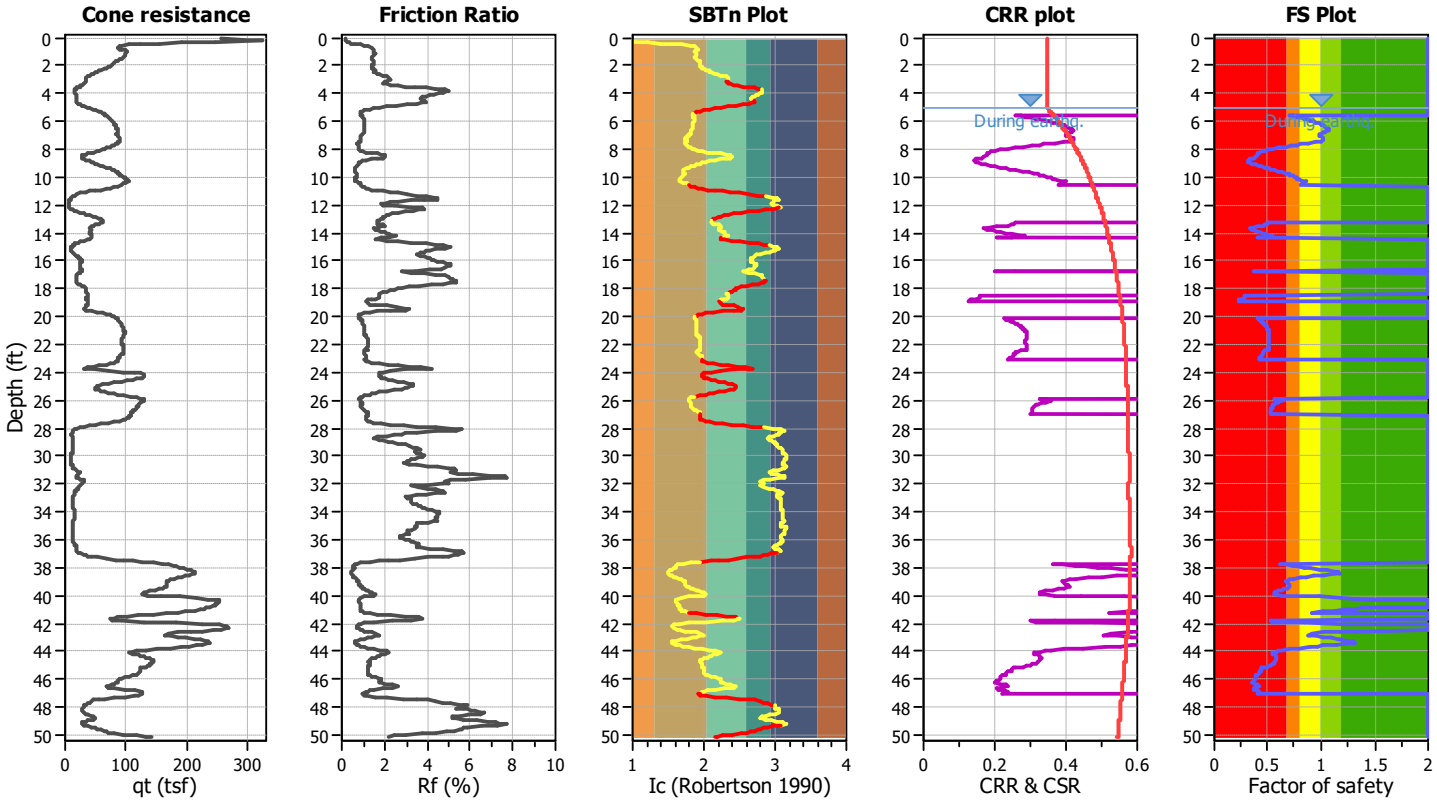
LIQUEFACTION ANALYSIS REPORT

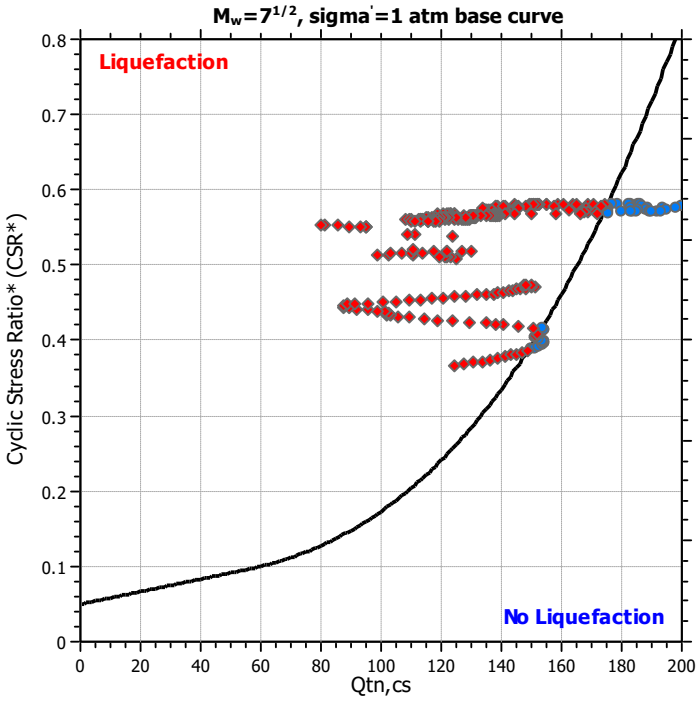
Project title : 7-Acre Site, Cypress Town Center **Location : Cypress, CA**

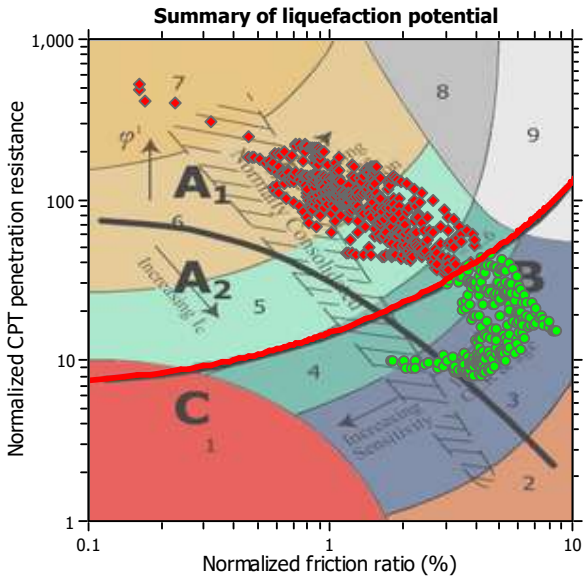
CPT file : CPT-3

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	6.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	5.00 ft	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	50.00 ft
Earthquake magnitude M_w:	6.71	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.55	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

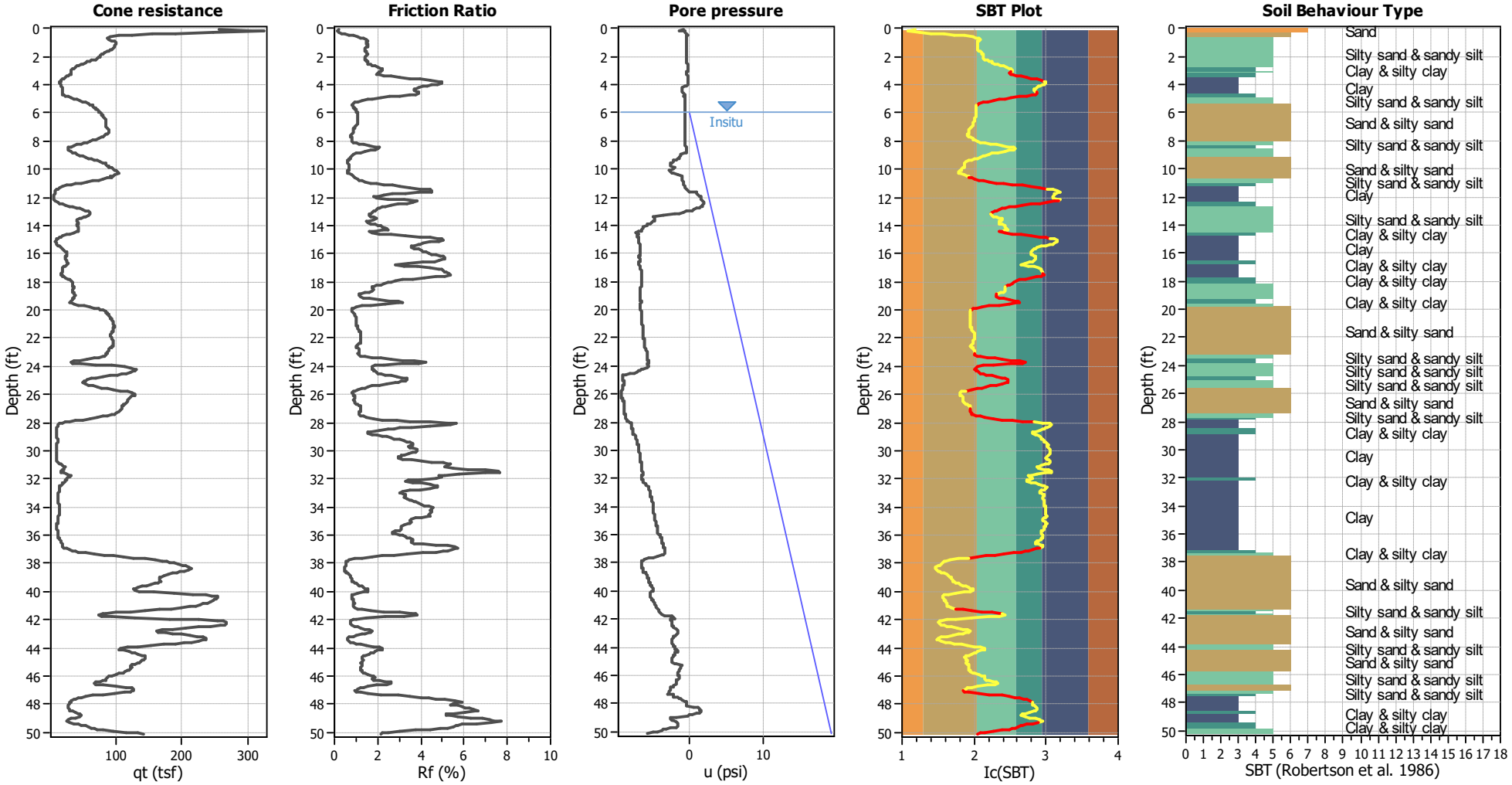






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



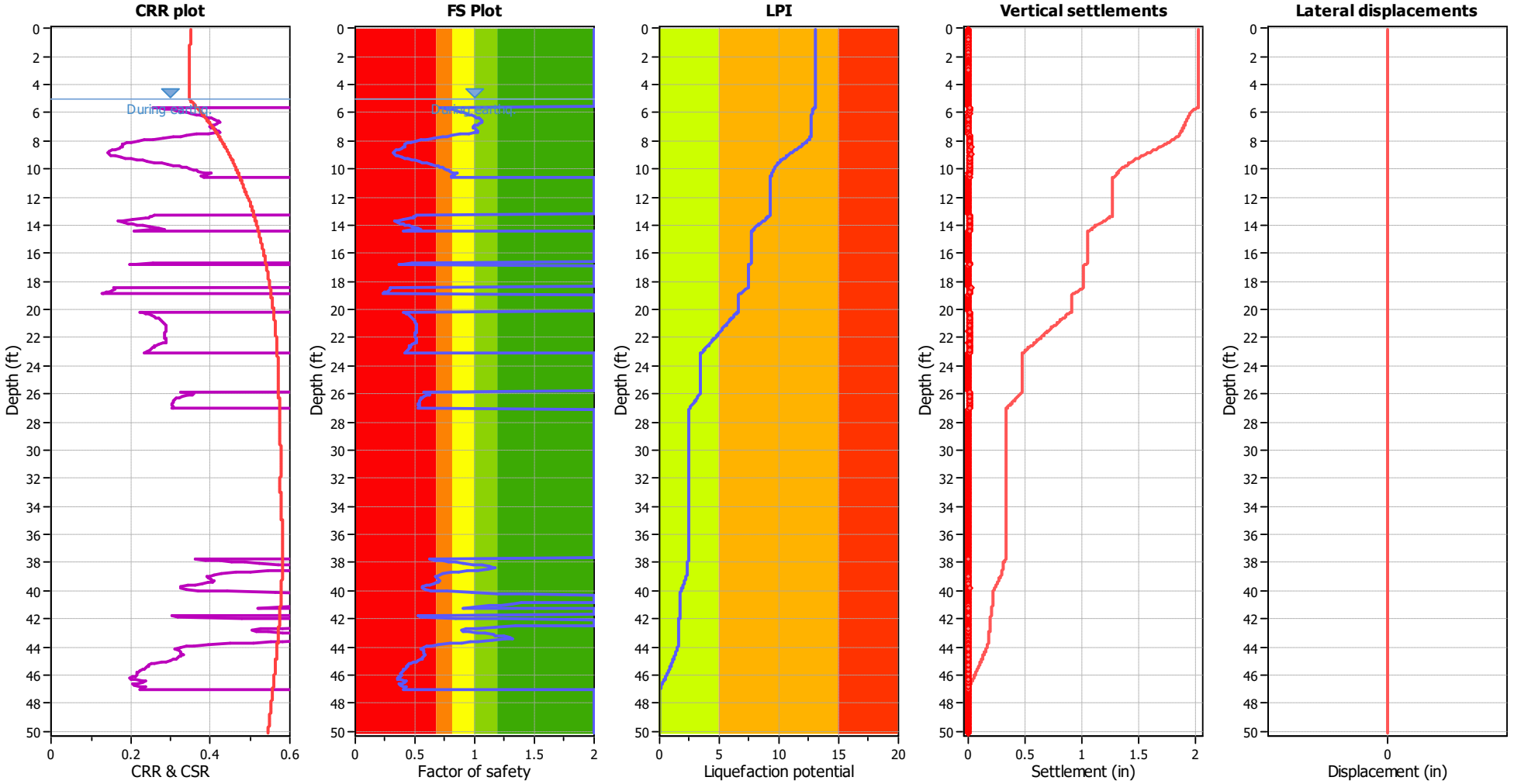
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.71	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.55	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	6.00 ft	Fill height:	N/A	Limit depth:	50.00 ft

SBT legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.71	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.55	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	6.00 ft	Fill height:	N/A	Limit depth:	50.00 ft

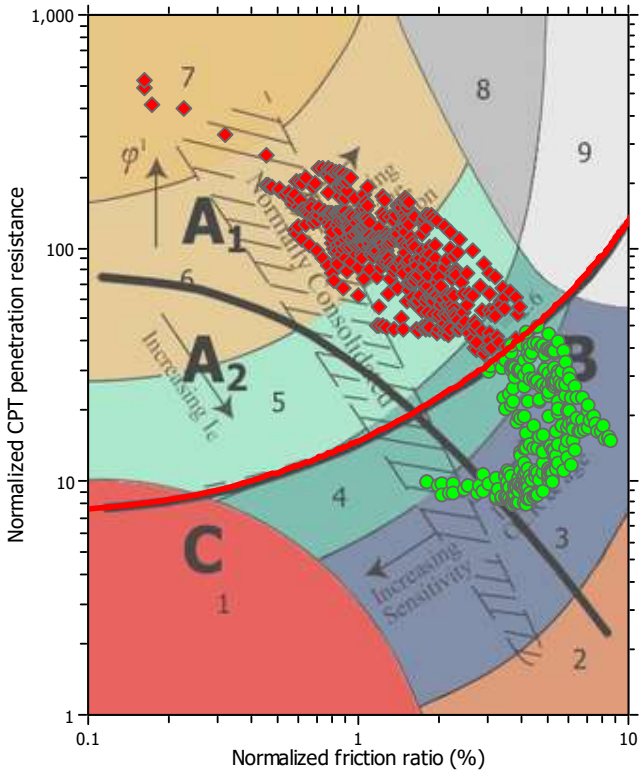
F.S. color scheme

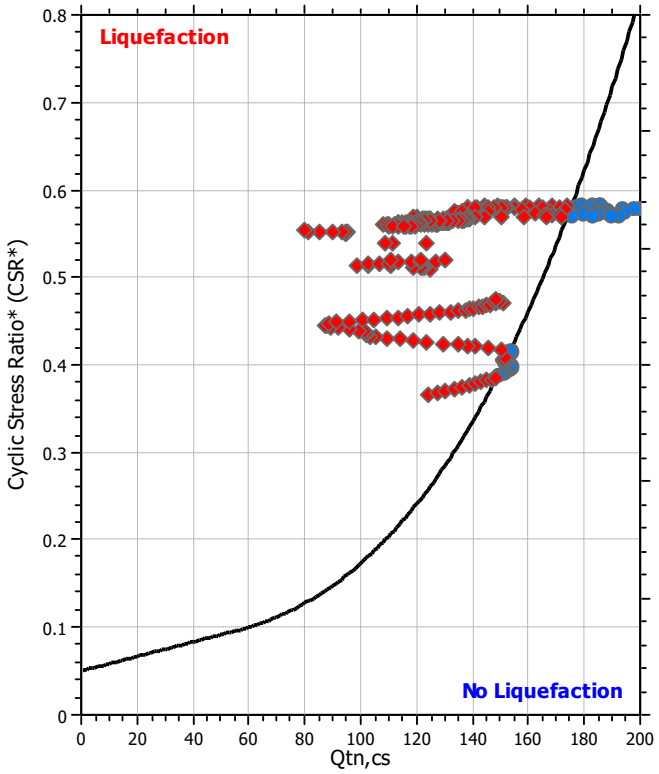
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

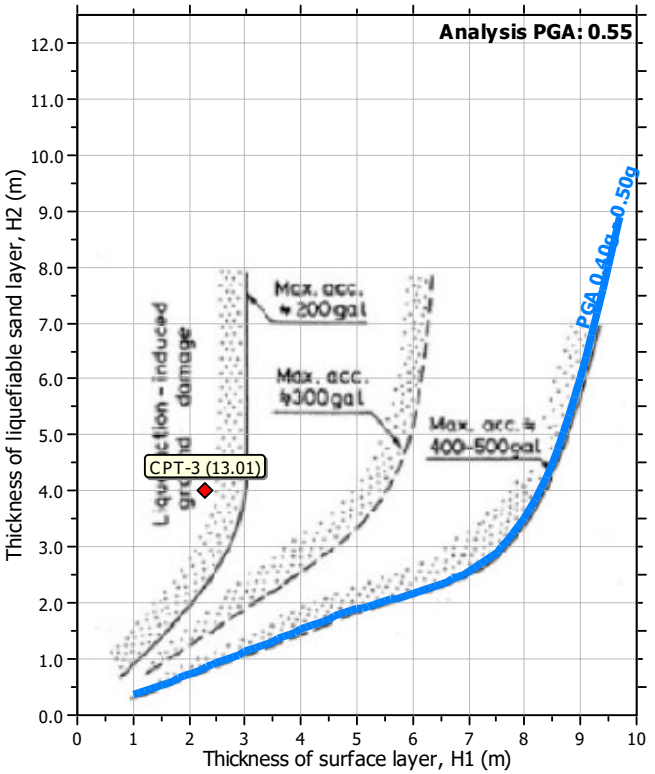
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots







Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.71	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.55	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	6.00 ft	Fill height:	N/A	Limit depth:	50.00 ft

:: Post-earthquake settlement of dry sands ::

Depth (ft)	Ic	Q_{tn}	Kc	$Q_{tn,cs}$	$N_{1,60}$ (blows)	G_{max} (tsf)	CSR	Shear, γ (%)	$e_{vol(15)}$ (%)	N_c	e_v (%)	Settle. (in)
0.07	0.97	411.35	1.00	411.35	61	785	0.35	0.000	0.00	8.70	0.00	0.000
0.15	0.89	489.36	1.00	489.36	71	846	0.35	0.000	0.00	8.70	0.00	0.000
0.20	0.87	522.21	1.00	522.21	76	877	0.35	0.001	0.00	8.70	0.00	0.000
0.28	1.04	398.67	1.00	398.67	61	837	0.35	0.001	0.00	8.70	0.00	0.000
0.35	1.22	308.09	1.00	308.09	49	810	0.35	0.001	0.00	8.70	0.00	0.000
0.41	1.39	248.91	1.00	248.91	42	811	0.35	0.001	0.00	8.70	0.00	0.000
0.47	1.56	200.21	1.00	200.21	36	804	0.35	0.001	0.00	8.70	0.00	0.000
0.53	1.70	167.77	1.04	173.70	32	805	0.35	0.002	0.00	8.70	0.00	0.000
0.61	1.80	147.30	1.11	163.48	32	811	0.35	0.002	0.00	8.70	0.00	0.000
0.66	1.86	142.16	1.15	163.62	32	836	0.35	0.002	0.00	8.70	0.00	0.000
0.72	1.90	139.76	1.19	165.66	33	864	0.35	0.002	0.00	8.70	0.00	0.000
0.81	1.92	142.35	1.20	171.39	35	902	0.35	0.002	0.00	8.70	0.00	0.000
0.88	1.91	149.61	1.20	179.01	36	939	0.35	0.002	0.00	8.70	0.00	0.000
0.94	1.89	157.91	1.18	186.14	37	968	0.35	0.002	0.00	8.70	0.00	0.000
1.01	1.88	162.83	1.17	190.00	38	981	0.35	0.003	0.00	8.70	0.00	0.000
1.07	1.88	162.78	1.17	190.39	38	985	0.35	0.003	0.00	8.70	0.00	0.000
1.14	1.89	160.65	1.18	189.30	38	984	0.35	0.003	0.00	8.70	0.00	0.000
1.19	1.90	159.08	1.18	188.40	38	982	0.35	0.003	0.00	8.70	0.00	0.000
1.25	1.89	158.45	1.18	187.13	37	974	0.35	0.003	0.00	8.70	0.00	0.000
1.33	1.88	157.92	1.17	185.10	37	959	0.35	0.004	0.00	8.70	0.00	0.000
1.38	1.88	155.42	1.17	181.38	36	937	0.35	0.004	0.00	8.70	0.00	0.000
1.46	1.88	152.04	1.17	177.66	35	918	0.35	0.004	0.00	8.70	0.00	0.000
1.53	1.89	147.41	1.18	173.81	35	904	0.35	0.004	0.00	8.70	0.00	0.000
1.59	1.90	143.36	1.19	170.93	34	895	0.35	0.005	0.00	8.70	0.00	0.000
1.64	1.92	138.78	1.21	167.84	34	885	0.35	0.005	0.00	8.70	0.00	0.000
1.73	1.94	134.57	1.23	164.85	33	875	0.35	0.005	0.00	8.70	0.00	0.000
1.79	1.95	130.31	1.24	161.71	33	864	0.35	0.006	0.00	8.70	0.00	0.000
1.86	1.96	127.19	1.25	158.95	33	851	0.35	0.006	0.00	8.70	0.00	0.000
1.90	1.96	124.23	1.25	155.04	32	830	0.35	0.006	0.00	8.70	0.00	0.000
1.98	1.95	121.73	1.24	151.49	31	810	0.35	0.007	0.00	8.70	0.00	0.000
2.04	1.95	118.97	1.24	148.02	30	791	0.35	0.007	0.00	8.70	0.00	0.000
2.10	1.96	115.75	1.25	145.17	30	778	0.35	0.008	0.00	8.70	0.00	0.000
2.18	1.97	111.54	1.27	141.38	29	761	0.35	0.008	0.01	8.70	0.00	0.000
2.24	2.01	102.65	1.32	135.09	28	735	0.35	0.009	0.01	8.70	0.00	0.000
2.30	2.04	96.21	1.35	130.32	28	713	0.35	0.010	0.01	8.70	0.01	0.000
2.37	2.07	89.56	1.40	125.65	27	690	0.35	0.011	0.01	8.70	0.01	0.000
2.43	2.08	86.65	1.41	122.58	26	674	0.35	0.012	0.01	8.70	0.01	0.000
2.50	2.11	80.98	1.47	118.93	26	654	0.35	0.012	0.01	8.70	0.01	0.000
2.57	2.15	75.11	1.55	116.15	26	638	0.35	0.014	0.01	8.70	0.01	0.000
2.65	2.19	69.91	1.64	114.61	26	626	0.35	0.015	0.01	8.70	0.01	0.000
2.69	2.23	65.14	1.75	114.06	26	617	0.35	0.015	0.01	8.70	0.01	0.000
2.78	2.27	61.39	1.86	114.02	26	610	0.35	0.016	0.01	8.70	0.01	0.000
2.82	2.31	57.49	1.98	113.78	27	600	0.35	0.017	0.01	8.70	0.01	0.000
2.90	2.34	54.27	2.08	112.99	27	588	0.35	0.018	0.01	8.70	0.01	0.000
2.98	2.35	52.18	2.14	111.46	27	576	0.35	0.020	0.01	8.70	0.01	0.000
3.04	2.35	51.92	2.11	109.65	26	569	0.35	0.021	0.02	8.70	0.01	0.000
3.10	2.33	52.43	2.05	107.35	26	561	0.35	0.022	0.02	8.70	0.01	0.000
3.17	2.32	51.96	2.02	104.87	0	0	0.35	0.000	0.00	8.70	0.00	0.000

:: Post-earthquake settlement of dry sands :: (continued)

Depth (ft)	Ic	Q_{tn}	Kc	$Q_{tn,cs}$	$N_{1,60}$ (blows)	G_{max} (tsf)	CSR	Shear, γ (%)	$e_{vol(15)}$ (%)	N_c	e_v (%)	Settle. (in)
3.25	2.33	50.39	2.05	103.19	0	0	0.35	0.000	0.00	8.70	0.00	0.000
3.30	2.36	47.79	2.17	103.60	0	0	0.35	0.000	0.00	8.70	0.00	0.000
3.37	2.41	44.93	2.36	106.14	0	0	0.35	0.000	0.00	8.70	0.00	0.000
3.42	2.48	41.09	2.67	109.62	0	0	0.35	0.000	0.00	8.70	0.00	0.000
3.50	2.55	37.03	3.05	113.12	0	0	0.35	0.000	0.00	8.70	0.00	0.000
3.57	2.63	33.19	3.51	116.39	0	0	0.35	0.000	0.00	0.00	0.00	0.000
3.62	2.70	29.96	3.99	119.59	0	0	0.35	0.000	0.00	0.00	0.00	0.000
3.69	2.76	27.41	4.47	122.48	0	0	0.35	0.000	0.00	0.00	0.00	0.000
3.76	2.81	25.67	4.86	124.65	0	0	0.35	0.000	0.00	0.00	0.00	0.000
3.83	2.83	24.96	5.03	125.52	0	0	0.35	0.000	0.00	0.00	0.00	0.000
3.88	2.83	24.90	5.02	124.87	0	0	0.35	0.000	0.00	0.00	0.00	0.000
3.95	2.81	25.44	4.85	123.37	0	0	0.35	0.000	0.00	0.00	0.00	0.000
4.02	2.78	26.18	4.65	121.72	0	0	0.35	0.000	0.00	0.00	0.00	0.000
4.07	2.76	27.27	4.42	120.45	0	0	0.35	0.000	0.00	0.00	0.00	0.000
4.14	2.73	28.24	4.23	119.38	0	0	0.35	0.000	0.00	0.00	0.00	0.000
4.22	2.70	29.37	4.03	118.23	0	0	0.35	0.000	0.00	0.00	0.00	0.000
4.28	2.68	30.51	3.85	117.47	0	0	0.35	0.000	0.00	0.00	0.00	0.000
4.34	2.67	31.12	3.77	117.41	0	0	0.35	0.000	0.00	0.00	0.00	0.000
4.40	2.67	31.12	3.78	117.75	0	0	0.35	0.000	0.00	0.00	0.00	0.000
4.48	2.68	30.43	3.89	118.33	0	0	0.35	0.000	0.00	0.00	0.00	0.000
4.54	2.70	29.71	3.99	118.60	0	0	0.35	0.000	0.00	0.00	0.00	0.000
4.59	2.70	29.55	4.02	118.82	0	0	0.35	0.000	0.00	0.00	0.00	0.000
4.67	2.68	30.43	3.88	118.12	0	0	0.35	0.000	0.00	0.00	0.00	0.000
4.74	2.64	32.60	3.58	116.66	0	0	0.35	0.000	0.00	0.00	0.00	0.000
4.79	2.56	37.01	3.08	113.84	0	0	0.35	0.000	0.00	8.70	0.00	0.000
4.86	2.45	43.39	2.55	110.54	0	0	0.35	0.000	0.00	8.70	0.00	0.000
4.93	2.35	51.17	2.10	107.64	0	0	0.35	0.000	0.00	8.70	0.00	0.000
5.00	2.25	59.31	1.79	105.92	0	0	0.35	0.000	0.00	8.70	0.00	0.000

Total estimated settlement: 0.00

Abbreviations

Q_{tn}: Equivalent clean sand normalized cone resistance
K_c: Fines correction factor
$Q_{tn,cs}$: Post-liquefaction volumentric strain
G_{max}: Small strain shear modulus
CSR: Soil cyclic stress ratio
γ: Cyclic shear strain
$e_{vol(15)}$: Volumetric strain after 15 cycles
N_c: Equivalent number of cycles
e_v: Volumetric strain
Settle.: Calculated settlement

:: Post-earthquake settlement due to soil liquefaction ::

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
5.07	105.47	2.00	0.00	0.91	0.00	5.12	105.58	2.00	0.00	0.91	0.00
5.19	106.04	2.00	0.00	0.91	0.00	5.26	108.04	2.00	0.00	0.91	0.00
5.32	111.06	2.00	0.00	0.91	0.00	5.39	114.59	2.00	0.00	0.91	0.00
5.45	118.13	2.00	0.00	0.91	0.00	5.52	121.08	2.00	0.00	0.91	0.00
5.59	124.13	0.70	1.64	0.91	0.01	5.65	127.21	0.74	1.58	0.90	0.01
5.72	130.42	0.77	1.24	0.90	0.01	5.78	133.68	0.81	1.20	0.90	0.01
5.87	136.32	0.84	1.16	0.90	0.01	5.92	138.83	0.87	0.87	0.90	0.01

:: Post-earthquake settlement due to soil liquefaction :: (continued)

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
5.98	141.05	0.90	0.85	0.90	0.01	6.05	143.17	0.93	0.83	0.90	0.01
6.12	145.11	0.95	0.56	0.90	0.00	6.17	146.91	0.98	0.55	0.90	0.00
6.25	148.51	1.00	0.55	0.89	0.01	6.31	149.98	1.02	0.54	0.89	0.00
6.37	151.36	1.03	0.54	0.89	0.00	6.46	152.62	1.05	0.53	0.89	0.01
6.52	153.72	1.06	0.37	0.89	0.00	6.60	154.25	1.07	0.37	0.89	0.00
6.63	154.46	1.07	0.37	0.89	0.00	6.70	154.27	1.06	0.37	0.89	0.00
6.76	153.52	1.04	0.53	0.89	0.00	6.84	152.50	1.02	0.53	0.88	0.00
6.90	151.46	1.00	0.53	0.88	0.00	6.96	151.00	0.99	0.53	0.88	0.00
7.05	151.17	0.99	0.53	0.88	0.01	7.11	151.91	0.99	0.53	0.88	0.00
7.17	153.02	1.01	0.52	0.88	0.00	7.26	153.88	1.02	0.52	0.88	0.01
7.31	154.35	1.02	0.52	0.88	0.00	7.38	154.47	1.02	0.52	0.87	0.00
7.44	153.71	1.00	0.52	0.87	0.00	7.48	150.36	0.95	0.75	0.87	0.00
7.55	145.41	0.87	0.79	0.87	0.01	7.64	140.60	0.81	1.08	0.87	0.01
7.70	138.39	0.77	1.10	0.87	0.01	7.75	134.76	0.73	1.40	0.87	0.01
7.82	129.22	0.66	1.48	0.87	0.01	7.89	123.67	0.60	1.70	0.87	0.01
7.95	118.58	0.55	1.76	0.87	0.01	8.03	114.09	0.51	1.81	0.86	0.02
8.09	109.18	0.47	1.88	0.86	0.02	8.15	105.42	0.44	1.93	0.86	0.01
8.21	103.11	0.42	1.96	0.86	0.01	8.27	102.15	0.41	1.97	0.86	0.01
8.33	102.17	0.41	1.97	0.86	0.02	8.42	102.26	0.41	1.97	0.86	0.02
8.48	101.55	0.40	1.98	0.86	0.01	8.54	99.01	0.39	2.01	0.86	0.02
8.62	95.64	0.37	2.07	0.85	0.02	8.68	92.12	0.35	2.13	0.85	0.02
8.74	89.28	0.33	2.18	0.85	0.02	8.80	87.79	0.32	2.21	0.85	0.02
8.86	87.52	0.32	2.22	0.85	0.02	8.94	88.70	0.32	2.19	0.85	0.02
9.00	91.47	0.34	2.13	0.85	0.02	9.06	95.64	0.36	2.05	0.85	0.02
9.13	100.59	0.39	1.97	0.85	0.01	9.21	104.98	0.41	1.89	0.84	0.02
9.27	109.41	0.45	1.83	0.84	0.01	9.32	113.21	0.47	1.78	0.84	0.01
9.39	117.11	0.50	1.73	0.84	0.01	9.47	120.60	0.53	1.68	0.84	0.02
9.53	124.54	0.57	1.64	0.84	0.01	9.59	128.33	0.60	1.60	0.84	0.01
9.65	132.12	0.64	1.56	0.84	0.01	9.73	135.03	0.67	1.34	0.84	0.01
9.79	137.29	0.69	1.31	0.83	0.01	9.85	138.83	0.71	1.29	0.83	0.01
9.91	140.60	0.73	1.26	0.83	0.01	9.99	142.35	0.75	1.24	0.83	0.01
10.05	143.89	0.77	0.99	0.83	0.01	10.11	145.12	0.78	0.98	0.83	0.01
10.17	146.24	0.79	0.97	0.83	0.01	10.26	148.41	0.82	0.94	0.83	0.01
10.31	151.33	0.86	0.70	0.83	0.00	10.40	149.71	0.83	0.93	0.82	0.01
10.44	149.70	0.83	0.93	0.82	0.01	10.50	147.53	0.80	0.95	0.82	0.01
10.58	148.30	0.81	0.94	0.82	0.01	10.64	143.79	2.00	0.00	0.82	0.00
10.72	138.90	2.00	0.00	0.82	0.00	10.78	133.81	2.00	0.00	0.82	0.00
10.83	128.12	2.00	0.00	0.82	0.00	10.92	122.47	2.00	0.00	0.81	0.00
10.97	118.21	2.00	0.00	0.81	0.00	11.03	114.04	2.00	0.00	0.81	0.00
11.11	111.83	2.00	0.00	0.81	0.00	11.16	109.73	2.00	0.00	0.81	0.00
11.25	106.84	2.00	0.00	0.81	0.00	11.31	103.42	2.00	0.00	0.81	0.00
11.38	100.57	2.00	0.00	0.81	0.00	11.44	98.26	2.00	0.00	0.81	0.00
11.49	94.23	2.00	0.00	0.81	0.00	11.58	89.13	2.00	0.00	0.80	0.00
11.63	82.01	2.00	0.00	0.80	0.00	11.71	75.23	2.00	0.00	0.80	0.00
11.76	67.99	2.00	0.00	0.80	0.00	11.81	61.91	2.00	0.00	0.80	0.00
11.90	57.26	2.00	0.00	0.80	0.00	11.96	54.76	2.00	0.00	0.80	0.00
12.04	56.28	2.00	0.00	0.80	0.00	12.09	61.87	2.00	0.00	0.80	0.00
12.16	70.17	2.00	0.00	0.79	0.00	12.23	79.07	2.00	0.00	0.79	0.00

:: Post-earthquake settlement due to soil liquefaction :: (continued)

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
12.28	87.94	2.00	0.00	0.79	0.00	12.36	94.90	2.00	0.00	0.79	0.00
12.42	100.11	2.00	0.00	0.79	0.00	12.47	103.55	2.00	0.00	0.79	0.00
12.55	106.56	2.00	0.00	0.79	0.00	12.61	110.21	2.00	0.00	0.79	0.00
12.69	113.82	2.00	0.00	0.78	0.00	12.75	117.33	2.00	0.00	0.78	0.00
12.80	121.32	2.00	0.00	0.78	0.00	12.88	125.42	2.00	0.00	0.78	0.00
12.94	129.08	2.00	0.00	0.78	0.00	13.01	131.27	2.00	0.00	0.78	0.00
13.07	132.11	2.00	0.00	0.78	0.00	13.13	130.63	2.00	0.00	0.78	0.00
13.21	127.82	2.00	0.00	0.78	0.00	13.27	124.71	0.51	1.51	0.78	0.01
13.35	122.82	0.49	1.53	0.77	0.01	13.40	122.02	0.49	1.53	0.77	0.01
13.46	121.42	0.48	1.54	0.77	0.01	13.53	119.10	0.46	1.56	0.77	0.01
13.59	110.46	0.40	1.66	0.77	0.01	13.67	102.80	0.35	1.76	0.77	0.02
13.72	98.86	0.33	1.81	0.77	0.01	13.80	102.85	0.35	1.75	0.77	0.02
13.85	106.79	0.38	1.69	0.77	0.01	13.93	110.26	0.40	1.65	0.76	0.02
13.99	113.70	0.42	1.60	0.76	0.01	14.05	117.79	0.45	1.56	0.76	0.01
14.13	121.74	0.48	1.51	0.76	0.02	14.18	127.18	0.52	1.46	0.76	0.01
14.26	130.14	0.55	1.43	0.76	0.01	14.31	121.61	0.48	1.51	0.76	0.01
14.40	110.92	0.40	1.62	0.76	0.02	14.45	100.59	2.00	0.00	0.76	0.00
14.53	101.05	2.00	0.00	0.75	0.00	14.57	102.87	2.00	0.00	0.75	0.00
14.66	106.44	2.00	0.00	0.75	0.00	14.70	111.39	2.00	0.00	0.75	0.00
14.78	114.25	2.00	0.00	0.75	0.00	14.84	113.99	2.00	0.00	0.75	0.00
14.92	111.45	2.00	0.00	0.75	0.00	14.98	107.45	2.00	0.00	0.75	0.00
15.03	102.43	2.00	0.00	0.75	0.00	15.11	97.59	2.00	0.00	0.74	0.00
15.17	93.38	2.00	0.00	0.74	0.00	15.24	91.53	2.00	0.00	0.74	0.00
15.30	92.03	2.00	0.00	0.74	0.00	15.37	94.82	2.00	0.00	0.74	0.00
15.43	98.52	2.00	0.00	0.74	0.00	15.49	102.58	2.00	0.00	0.74	0.00
15.56	107.38	2.00	0.00	0.74	0.00	15.62	114.03	2.00	0.00	0.74	0.00
15.70	120.94	2.00	0.00	0.73	0.00	15.76	127.20	2.00	0.00	0.73	0.00
15.81	133.01	2.00	0.00	0.73	0.00	15.91	137.85	2.00	0.00	0.73	0.00
15.96	142.33	2.00	0.00	0.73	0.00	16.02	145.51	2.00	0.00	0.73	0.00
16.09	148.14	2.00	0.00	0.73	0.00	16.15	150.04	2.00	0.00	0.73	0.00
16.22	151.18	2.00	0.00	0.73	0.00	16.28	151.62	2.00	0.00	0.72	0.00
16.34	151.20	2.00	0.00	0.72	0.00	16.41	149.91	2.00	0.00	0.72	0.00
16.51	148.12	2.00	0.00	0.72	0.00	16.56	146.27	2.00	0.00	0.72	0.00
16.63	137.44	2.00	0.00	0.72	0.00	16.69	123.80	0.48	1.41	0.72	0.01
16.75	111.22	0.39	1.53	0.72	0.01	16.80	108.51	0.37	1.56	0.72	0.01
16.87	113.11	2.00	0.00	0.71	0.00	16.94	118.69	2.00	0.00	0.71	0.00
17.00	124.26	2.00	0.00	0.71	0.00	17.07	128.34	2.00	0.00	0.71	0.00
17.13	130.71	2.00	0.00	0.71	0.00	17.19	131.45	2.00	0.00	0.71	0.00
17.28	132.11	2.00	0.00	0.71	0.00	17.34	132.77	2.00	0.00	0.71	0.00
17.41	133.63	2.00	0.00	0.70	0.00	17.47	134.45	2.00	0.00	0.70	0.00
17.53	135.26	2.00	0.00	0.70	0.00	17.60	135.33	2.00	0.00	0.70	0.00
17.65	134.51	2.00	0.00	0.70	0.00	17.73	132.32	2.00	0.00	0.70	0.00
17.78	128.05	2.00	0.00	0.70	0.00	17.87	123.12	2.00	0.00	0.70	0.00
17.94	118.13	2.00	0.00	0.70	0.00	18.00	114.48	2.00	0.00	0.69	0.00
18.06	111.13	2.00	0.00	0.69	0.00	18.12	107.28	2.00	0.00	0.69	0.00
18.19	102.76	2.00	0.00	0.69	0.00	18.25	98.28	2.00	0.00	0.69	0.00
18.31	95.52	2.00	0.00	0.69	0.00	18.38	94.38	2.00	0.00	0.69	0.00
18.48	94.69	0.29	1.68	0.69	0.02	18.54	95.15	0.29	1.67	0.69	0.01

:: Post-earthquake settlement due to soil liquefaction :: (continued)

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
18.59	94.81	0.29	1.67	0.68	0.01	18.66	93.21	0.28	1.69	0.68	0.01
18.71	89.67	0.27	1.74	0.68	0.01	18.78	85.41	0.25	1.81	0.68	0.02
18.84	81.39	0.24	1.88	0.68	0.01	18.90	80.07	0.23	1.91	0.68	0.01
18.96	79.77	2.00	0.00	0.68	0.00	19.05	80.87	2.00	0.00	0.68	0.00
19.11	83.08	2.00	0.00	0.68	0.00	19.17	89.35	2.00	0.00	0.68	0.00
19.24	99.38	2.00	0.00	0.67	0.00	19.33	109.37	2.00	0.00	0.67	0.00
19.39	117.25	2.00	0.00	0.67	0.00	19.45	121.67	2.00	0.00	0.67	0.00
19.52	118.80	2.00	0.00	0.67	0.00	19.58	109.39	2.00	0.00	0.67	0.00
19.64	100.11	2.00	0.00	0.67	0.00	19.70	96.74	2.00	0.00	0.67	0.00
19.76	98.60	2.00	0.00	0.67	0.00	19.85	99.91	2.00	0.00	0.66	0.00
19.89	103.17	2.00	0.00	0.66	0.00	19.97	106.36	2.00	0.00	0.66	0.00
20.03	110.86	2.00	0.00	0.66	0.00	20.09	113.62	2.00	0.00	0.66	0.00
20.16	115.83	0.40	1.36	0.66	0.01	20.22	117.69	0.41	1.34	0.66	0.01
20.28	119.51	0.43	1.33	0.66	0.01	20.35	121.17	0.44	1.31	0.66	0.01
20.41	122.77	0.45	1.29	0.65	0.01	20.47	124.32	0.46	1.28	0.65	0.01
20.56	125.62	0.47	1.26	0.65	0.01	20.63	126.74	0.48	1.25	0.65	0.01
20.69	127.49	0.49	1.24	0.65	0.01	20.75	128.15	0.49	1.24	0.65	0.01
20.82	128.69	0.50	1.23	0.65	0.01	20.87	129.20	0.50	1.22	0.65	0.01
20.94	129.64	0.50	1.22	0.65	0.01	21.00	130.18	0.51	1.21	0.64	0.01
21.09	130.69	0.51	1.21	0.64	0.01	21.16	131.12	0.51	1.20	0.64	0.01
21.22	131.32	0.52	1.20	0.64	0.01	21.28	131.33	0.52	1.19	0.64	0.01
21.34	131.30	0.52	1.19	0.64	0.01	21.40	131.30	0.52	1.19	0.64	0.01
21.49	131.16	0.51	1.19	0.64	0.01	21.53	130.99	0.51	1.19	0.64	0.00
21.62	130.60	0.51	1.19	0.63	0.01	21.68	130.29	0.51	1.19	0.63	0.01
21.74	130.11	0.50	1.19	0.63	0.01	21.80	129.99	0.50	1.19	0.63	0.01
21.86	130.02	0.50	1.19	0.63	0.01	21.92	130.25	0.51	1.18	0.63	0.01
22.01	130.55	0.51	1.18	0.63	0.01	22.07	130.92	0.51	1.17	0.63	0.01
22.14	131.04	0.51	1.17	0.62	0.01	22.20	130.98	0.51	1.17	0.62	0.01
22.25	130.78	0.51	1.17	0.62	0.01	22.34	130.78	0.51	1.17	0.62	0.01
22.38	129.57	0.50	1.17	0.62	0.01	22.47	127.39	0.48	1.19	0.62	0.01
22.53	125.13	0.46	1.20	0.62	0.01	22.59	124.31	0.46	1.21	0.62	0.01
22.66	124.51	0.46	1.20	0.62	0.01	22.72	123.42	0.45	1.21	0.61	0.01
22.77	123.03	0.45	1.21	0.61	0.01	22.85	122.34	0.44	1.21	0.61	0.01
22.91	122.06	0.44	1.21	0.61	0.01	22.98	120.44	0.43	1.22	0.61	0.01
23.04	118.49	0.41	1.24	0.61	0.01	23.10	117.41	2.00	0.00	0.61	0.00
23.19	117.49	2.00	0.00	0.61	0.00	23.25	118.68	2.00	0.00	0.61	0.00
23.31	120.90	2.00	0.00	0.60	0.00	23.37	125.30	2.00	0.00	0.60	0.00
23.43	130.35	2.00	0.00	0.60	0.00	23.50	132.71	2.00	0.00	0.60	0.00
23.56	133.43	2.00	0.00	0.60	0.00	23.65	133.41	2.00	0.00	0.60	0.00
23.70	135.20	2.00	0.00	0.60	0.00	23.76	133.69	2.00	0.00	0.60	0.00
23.82	132.01	2.00	0.00	0.60	0.00	23.91	135.93	2.00	0.00	0.59	0.00
23.96	148.28	2.00	0.00	0.59	0.00	24.02	161.11	2.00	0.00	0.59	0.00
24.09	170.73	2.00	0.00	0.59	0.00	24.18	176.28	2.00	0.00	0.59	0.00
24.24	178.85	2.00	0.00	0.59	0.00	24.30	178.63	2.00	0.00	0.59	0.00
24.36	177.16	2.00	0.00	0.59	0.00	24.43	175.22	2.00	0.00	0.59	0.00
24.49	173.18	2.00	0.00	0.58	0.00	24.56	171.01	2.00	0.00	0.58	0.00
24.62	168.30	2.00	0.00	0.58	0.00	24.68	165.38	2.00	0.00	0.58	0.00
24.75	163.12	2.00	0.00	0.58	0.00	24.80	160.49	2.00	0.00	0.58	0.00

:: Post-earthquake settlement due to soil liquefaction :: (continued)

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
24.89	156.48	2.00	0.00	0.58	0.00	24.95	150.27	2.00	0.00	0.58	0.00
25.02	143.32	2.00	0.00	0.58	0.00	25.08	137.13	2.00	0.00	0.57	0.00
25.14	132.46	2.00	0.00	0.57	0.00	25.20	128.23	2.00	0.00	0.57	0.00
25.27	122.53	2.00	0.00	0.57	0.00	25.36	117.32	2.00	0.00	0.57	0.00
25.41	114.63	2.00	0.00	0.57	0.00	25.47	115.06	2.00	0.00	0.57	0.00
25.54	117.18	2.00	0.00	0.57	0.00	25.60	119.62	2.00	0.00	0.57	0.00
25.66	122.72	2.00	0.00	0.57	0.00	25.75	127.07	2.00	0.00	0.56	0.00
25.80	132.75	2.00	0.00	0.56	0.00	25.87	138.23	0.57	1.01	0.56	0.01
25.93	142.36	0.61	0.98	0.56	0.01	25.99	144.21	0.63	0.97	0.56	0.01
26.06	143.65	0.62	0.97	0.56	0.01	26.12	141.39	0.60	0.98	0.56	0.01
26.20	139.02	0.58	0.99	0.56	0.01	26.26	137.23	0.56	1.00	0.55	0.01
26.32	136.14	0.55	1.00	0.55	0.01	26.39	135.40	0.54	1.01	0.55	0.01
26.47	134.88	0.54	1.01	0.55	0.01	26.54	134.62	0.54	1.01	0.55	0.01
26.59	134.36	0.53	1.01	0.55	0.01	26.66	134.09	0.53	1.01	0.55	0.01
26.72	133.94	0.53	1.01	0.55	0.01	26.79	134.02	0.53	1.00	0.55	0.01
26.85	134.25	0.53	1.00	0.54	0.01	26.91	134.49	0.53	1.00	0.54	0.01
26.98	134.39	0.53	1.00	0.54	0.01	27.04	133.66	0.53	1.00	0.54	0.01
27.10	132.36	2.00	0.00	0.54	0.00	27.17	130.25	2.00	0.00	0.54	0.00
27.26	127.65	2.00	0.00	0.54	0.00	27.32	124.80	2.00	0.00	0.54	0.00
27.38	121.90	2.00	0.00	0.54	0.00	27.44	118.82	2.00	0.00	0.54	0.00
27.51	115.38	2.00	0.00	0.53	0.00	27.57	112.06	2.00	0.00	0.53	0.00
27.63	109.53	2.00	0.00	0.53	0.00	27.70	108.73	2.00	0.00	0.53	0.00
27.79	110.29	2.00	0.00	0.53	0.00	27.82	113.47	2.00	0.00	0.53	0.00
27.92	115.23	2.00	0.00	0.53	0.00	27.98	115.67	2.00	0.00	0.53	0.00
28.03	112.62	2.00	0.00	0.52	0.00	28.09	106.45	2.00	0.00	0.52	0.00
28.15	96.94	2.00	0.00	0.52	0.00	28.25	86.44	2.00	0.00	0.52	0.00
28.31	76.46	2.00	0.00	0.52	0.00	28.37	70.41	2.00	0.00	0.52	0.00
28.43	67.11	2.00	0.00	0.52	0.00	28.49	63.76	2.00	0.00	0.52	0.00
28.55	60.17	2.00	0.00	0.52	0.00	28.61	56.00	2.00	0.00	0.52	0.00
28.68	54.41	2.00	0.00	0.51	0.00	28.77	54.60	2.00	0.00	0.51	0.00
28.83	56.91	2.00	0.00	0.51	0.00	28.90	59.23	2.00	0.00	0.51	0.00
28.95	61.83	2.00	0.00	0.51	0.00	29.01	64.29	2.00	0.00	0.51	0.00
29.08	67.03	2.00	0.00	0.51	0.00	29.14	69.94	2.00	0.00	0.51	0.00
29.20	72.73	2.00	0.00	0.51	0.00	29.30	74.60	2.00	0.00	0.50	0.00
29.36	75.85	2.00	0.00	0.50	0.00	29.43	76.46	2.00	0.00	0.50	0.00
29.48	76.53	2.00	0.00	0.50	0.00	29.54	75.79	2.00	0.00	0.50	0.00
29.61	74.68	2.00	0.00	0.50	0.00	29.66	73.72	2.00	0.00	0.50	0.00
29.76	73.67	2.00	0.00	0.50	0.00	29.82	74.17	2.00	0.00	0.49	0.00
29.88	74.82	2.00	0.00	0.49	0.00	29.93	74.97	2.00	0.00	0.49	0.00
29.99	74.83	2.00	0.00	0.49	0.00	30.06	73.81	2.00	0.00	0.49	0.00
30.14	72.06	2.00	0.00	0.49	0.00	30.20	69.67	2.00	0.00	0.49	0.00
30.27	67.78	2.00	0.00	0.49	0.00	30.33	66.95	2.00	0.00	0.49	0.00
30.39	66.87	2.00	0.00	0.48	0.00	30.46	66.81	2.00	0.00	0.48	0.00
30.52	66.95	2.00	0.00	0.48	0.00	30.58	69.25	2.00	0.00	0.48	0.00
30.68	72.59	2.00	0.00	0.48	0.00	30.71	78.08	2.00	0.00	0.48	0.00
30.80	84.17	2.00	0.00	0.48	0.00	30.86	92.15	2.00	0.00	0.48	0.00
30.93	99.89	2.00	0.00	0.48	0.00	30.98	107.45	2.00	0.00	0.47	0.00
31.05	113.68	2.00	0.00	0.47	0.00	31.11	117.69	2.00	0.00	0.47	0.00

:: Post-earthquake settlement due to soil liquefaction :: (continued)

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
31.17	120.60	2.00	0.00	0.47	0.00	31.26	122.83	2.00	0.00	0.47	0.00
31.33	125.22	2.00	0.00	0.47	0.00	31.39	126.56	2.00	0.00	0.47	0.00
31.46	127.36	2.00	0.00	0.47	0.00	31.51	128.90	2.00	0.00	0.47	0.00
31.57	131.33	2.00	0.00	0.46	0.00	31.64	133.43	2.00	0.00	0.46	0.00
31.72	134.29	2.00	0.00	0.46	0.00	31.79	134.40	2.00	0.00	0.46	0.00
31.85	133.65	2.00	0.00	0.46	0.00	31.91	129.97	2.00	0.00	0.46	0.00
31.98	122.03	2.00	0.00	0.46	0.00	32.04	109.23	2.00	0.00	0.46	0.00
32.11	99.42	2.00	0.00	0.46	0.00	32.16	95.89	2.00	0.00	0.45	0.00
32.25	98.34	2.00	0.00	0.45	0.00	32.31	100.32	2.00	0.00	0.45	0.00
32.37	100.31	2.00	0.00	0.45	0.00	32.44	99.05	2.00	0.00	0.45	0.00
32.50	96.33	2.00	0.00	0.45	0.00	32.57	93.39	2.00	0.00	0.45	0.00
32.63	90.80	2.00	0.00	0.45	0.00	32.68	87.84	2.00	0.00	0.45	0.00
32.75	83.80	2.00	0.00	0.44	0.00	32.84	79.22	2.00	0.00	0.44	0.00
32.90	75.27	2.00	0.00	0.44	0.00	32.96	72.95	2.00	0.00	0.44	0.00
33.03	72.15	2.00	0.00	0.44	0.00	33.09	72.18	2.00	0.00	0.44	0.00
33.15	72.37	2.00	0.00	0.44	0.00	33.22	72.23	2.00	0.00	0.44	0.00
33.27	72.23	2.00	0.00	0.44	0.00	33.35	72.82	2.00	0.00	0.43	0.00
33.42	74.06	2.00	0.00	0.43	0.00	33.48	75.46	2.00	0.00	0.43	0.00
33.55	76.90	2.00	0.00	0.43	0.00	33.61	78.37	2.00	0.00	0.43	0.00
33.67	79.96	2.00	0.00	0.43	0.00	33.73	81.42	2.00	0.00	0.43	0.00
33.79	83.14	2.00	0.00	0.43	0.00	33.88	85.08	2.00	0.00	0.43	0.00
33.95	86.92	2.00	0.00	0.42	0.00	34.01	87.99	2.00	0.00	0.42	0.00
34.07	88.29	2.00	0.00	0.42	0.00	34.13	88.35	2.00	0.00	0.42	0.00
34.22	88.34	2.00	0.00	0.42	0.00	34.27	88.23	2.00	0.00	0.42	0.00
34.34	87.69	2.00	0.00	0.42	0.00	34.39	86.88	2.00	0.00	0.42	0.00
34.46	86.15	2.00	0.00	0.42	0.00	34.52	85.56	2.00	0.00	0.41	0.00
34.61	85.13	2.00	0.00	0.41	0.00	34.67	83.92	2.00	0.00	0.41	0.00
34.73	81.20	2.00	0.00	0.41	0.00	34.79	78.89	2.00	0.00	0.41	0.00
34.85	76.94	2.00	0.00	0.41	0.00	34.91	76.57	2.00	0.00	0.41	0.00
35.00	75.21	2.00	0.00	0.41	0.00	35.06	73.58	2.00	0.00	0.41	0.00
35.12	71.68	2.00	0.00	0.40	0.00	35.18	69.44	2.00	0.00	0.40	0.00
35.27	67.83	2.00	0.00	0.40	0.00	35.33	66.62	2.00	0.00	0.40	0.00
35.39	66.33	2.00	0.00	0.40	0.00	35.45	66.48	2.00	0.00	0.40	0.00
35.51	67.14	2.00	0.00	0.40	0.00	35.59	67.76	2.00	0.00	0.40	0.00
35.66	67.13	2.00	0.00	0.40	0.00	35.72	65.65	2.00	0.00	0.39	0.00
35.78	64.62	2.00	0.00	0.39	0.00	35.84	65.05	2.00	0.00	0.39	0.00
35.92	66.18	2.00	0.00	0.39	0.00	35.98	67.51	2.00	0.00	0.39	0.00
36.03	69.49	2.00	0.00	0.39	0.00	36.11	71.61	2.00	0.00	0.39	0.00
36.17	73.90	2.00	0.00	0.39	0.00	36.24	76.81	2.00	0.00	0.39	0.00
36.32	80.08	2.00	0.00	0.38	0.00	36.38	82.83	2.00	0.00	0.38	0.00
36.44	84.23	2.00	0.00	0.38	0.00	36.50	85.61	2.00	0.00	0.38	0.00
36.57	88.49	2.00	0.00	0.38	0.00	36.63	92.73	2.00	0.00	0.38	0.00
36.69	98.20	2.00	0.00	0.38	0.00	36.76	103.34	2.00	0.00	0.38	0.00
36.81	110.23	2.00	0.00	0.38	0.00	36.91	117.30	2.00	0.00	0.37	0.00
36.96	124.89	2.00	0.00	0.37	0.00	37.02	131.32	2.00	0.00	0.37	0.00
37.09	136.79	2.00	0.00	0.37	0.00	37.15	141.08	2.00	0.00	0.37	0.00
37.21	144.11	2.00	0.00	0.37	0.00	37.28	144.98	2.00	0.00	0.37	0.00
37.36	144.02	2.00	0.00	0.37	0.00	37.42	142.29	2.00	0.00	0.37	0.00

:: Post-earthquake settlement due to soil liquefaction :: (continued)

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
37.48	139.60	2.00	0.00	0.36	0.00	37.54	136.77	2.00	0.00	0.36	0.00
37.61	136.29	2.00	0.00	0.36	0.00	37.67	139.91	2.00	0.00	0.36	0.00
37.75	144.60	0.62	0.62	0.36	0.01	37.82	149.21	0.67	0.50	0.36	0.00
37.87	154.74	0.73	0.47	0.36	0.00	37.94	158.93	0.78	0.37	0.36	0.00
38.00	163.59	0.84	0.35	0.36	0.00	38.08	168.46	0.90	0.26	0.35	0.00
38.15	174.07	0.98	0.19	0.35	0.00	38.20	179.02	1.06	0.13	0.35	0.00
38.27	183.25	1.12	0.13	0.35	0.00	38.33	185.66	1.16	0.09	0.35	0.00
38.39	185.97	1.17	0.09	0.35	0.00	38.46	182.74	1.12	0.13	0.35	0.00
38.53	176.88	1.02	0.18	0.35	0.00	38.60	170.81	0.94	0.25	0.35	0.00
38.66	165.30	0.86	0.26	0.34	0.00	38.72	160.39	0.80	0.35	0.34	0.00
38.78	155.13	0.74	0.45	0.34	0.00	38.85	152.46	0.71	0.46	0.34	0.00
38.95	150.52	0.68	0.47	0.34	0.01	39.01	149.63	0.68	0.47	0.34	0.00
39.06	149.92	0.68	0.47	0.34	0.00	39.12	150.48	0.68	0.46	0.34	0.00
39.18	151.30	0.69	0.46	0.34	0.00	39.25	152.08	0.70	0.45	0.33	0.00
39.31	152.42	0.71	0.45	0.33	0.00	39.37	151.95	0.70	0.45	0.33	0.00
39.44	150.38	0.68	0.46	0.33	0.00	39.53	147.89	0.66	0.47	0.33	0.01
39.58	144.76	0.63	0.57	0.33	0.00	39.64	141.54	0.59	0.58	0.33	0.00
39.71	138.54	0.57	0.58	0.33	0.00	39.77	138.30	0.56	0.58	0.33	0.00
39.86	138.05	0.56	0.58	0.32	0.01	39.92	140.79	0.59	0.57	0.32	0.00
39.98	145.88	0.64	0.55	0.32	0.00	40.03	157.45	0.77	0.34	0.32	0.00
40.09	173.24	0.97	0.17	0.32	0.00	40.19	186.94	1.19	0.08	0.32	0.00
40.25	199.76	1.42	0.00	0.32	0.00	40.31	208.46	2.00	0.00	0.32	0.00
40.37	214.20	2.00	0.00	0.32	0.00	40.42	214.62	2.00	0.00	0.31	0.00
40.49	212.88	2.00	0.00	0.31	0.00	40.57	210.27	2.00	0.00	0.31	0.00
40.63	209.62	2.00	0.00	0.31	0.00	40.69	207.85	2.00	0.00	0.31	0.00
40.75	205.35	2.00	0.00	0.31	0.00	40.81	202.46	2.00	0.00	0.31	0.00
40.88	198.09	1.39	0.00	0.31	0.00	40.98	193.98	1.32	0.06	0.31	0.00
41.01	188.67	1.22	0.08	0.30	0.00	41.10	182.96	1.13	0.11	0.30	0.00
41.16	175.51	1.01	0.16	0.30	0.00	41.21	168.04	0.91	0.22	0.30	0.00
41.27	160.65	2.00	0.00	0.30	0.00	41.34	154.61	2.00	0.00	0.30	0.00
41.43	154.15	2.00	0.00	0.30	0.00	41.50	157.83	2.00	0.00	0.30	0.00
41.55	160.58	2.00	0.00	0.30	0.00	41.61	159.84	2.00	0.00	0.29	0.00
41.67	155.85	2.00	0.00	0.29	0.00	41.76	145.88	0.64	0.50	0.29	0.01
41.82	133.73	0.53	0.54	0.29	0.00	41.88	136.58	0.55	0.53	0.29	0.00
41.93	162.67	0.84	0.29	0.29	0.00	42.02	187.96	1.22	0.08	0.29	0.00
42.08	209.88	2.00	0.00	0.29	0.00	42.13	218.30	2.00	0.00	0.29	0.00
42.22	220.99	2.00	0.00	0.28	0.00	42.28	221.33	2.00	0.00	0.28	0.00
42.35	219.35	2.00	0.00	0.28	0.00	42.41	212.49	2.00	0.00	0.28	0.00
42.47	203.78	2.00	0.00	0.28	0.00	42.54	194.84	1.34	0.05	0.28	0.00
42.59	185.39	1.18	0.07	0.28	0.00	42.65	175.45	1.02	0.15	0.28	0.00
42.75	168.73	0.92	0.20	0.28	0.00	42.81	166.03	0.88	0.20	0.27	0.00
42.87	167.34	0.90	0.20	0.27	0.00	42.93	171.02	0.95	0.15	0.27	0.00
42.99	175.43	1.02	0.14	0.27	0.00	43.05	179.97	1.09	0.10	0.27	0.00
43.11	183.87	1.15	0.07	0.27	0.00	43.20	185.06	1.17	0.07	0.27	0.00
43.26	189.24	1.25	0.07	0.27	0.00	43.32	192.13	1.30	0.05	0.27	0.00
43.39	192.88	1.31	0.05	0.26	0.00	43.45	189.78	1.26	0.05	0.26	0.00
43.53	183.32	1.15	0.10	0.26	0.00	43.60	175.51	1.02	0.14	0.26	0.00
43.65	171.79	0.97	0.14	0.26	0.00	43.71	166.43	0.89	0.19	0.26	0.00

:: Post-earthquake settlement due to soil liquefaction :: (continued)

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
43.78	158.24	0.79	0.27	0.26	0.00	43.86	150.06	0.69	0.35	0.26	0.00
43.91	144.26	0.63	0.44	0.26	0.00	43.97	140.95	0.60	0.45	0.25	0.00
44.04	137.97	0.57	0.46	0.25	0.00	44.10	135.71	0.55	0.46	0.25	0.00
44.20	135.52	0.55	0.46	0.25	0.01	44.25	137.80	0.57	0.45	0.25	0.00
44.31	138.03	0.57	0.45	0.25	0.00	44.36	138.28	0.57	0.44	0.25	0.00
44.42	138.27	0.57	0.44	0.25	0.00	44.52	139.26	0.58	0.44	0.25	0.00
44.58	138.73	0.58	0.44	0.24	0.00	44.63	137.95	0.57	0.44	0.24	0.00
44.69	137.40	0.57	0.44	0.24	0.00	44.75	136.96	0.56	0.44	0.24	0.00
44.84	136.19	0.56	0.44	0.24	0.00	44.90	134.74	0.54	0.44	0.24	0.00
44.98	132.97	0.53	0.44	0.24	0.00	45.04	130.67	0.51	0.44	0.24	0.00
45.11	128.43	0.49	0.45	0.24	0.00	45.16	124.73	0.46	0.46	0.23	0.00
45.22	122.55	0.45	0.46	0.23	0.00	45.31	121.02	0.43	0.46	0.23	0.00
45.37	121.15	0.44	0.46	0.23	0.00	45.43	120.48	0.43	0.46	0.23	0.00
45.49	119.48	0.42	0.46	0.23	0.00	45.55	118.27	0.42	0.46	0.23	0.00
45.63	117.04	0.41	0.47	0.23	0.00	45.70	115.87	0.40	0.47	0.23	0.00
45.75	114.79	0.39	0.47	0.22	0.00	45.82	113.70	0.39	0.47	0.22	0.00
45.90	113.27	0.38	0.47	0.22	0.00	45.96	113.49	0.38	0.47	0.22	0.00
46.02	113.41	0.38	0.46	0.22	0.00	46.08	112.25	0.38	0.47	0.22	0.00
46.14	109.92	0.36	0.47	0.22	0.00	46.20	108.19	0.35	0.48	0.22	0.00
46.29	109.23	0.36	0.47	0.22	0.01	46.35	112.95	0.38	0.45	0.21	0.00
46.41	117.36	0.41	0.44	0.21	0.00	46.46	118.93	0.42	0.43	0.21	0.00
46.55	117.32	0.41	0.43	0.21	0.00	46.61	113.28	0.38	0.44	0.21	0.00
46.67	109.86	0.36	0.45	0.21	0.00	46.73	111.23	0.37	0.45	0.21	0.00
46.81	115.90	0.40	0.43	0.21	0.00	46.87	119.29	0.43	0.42	0.21	0.00
46.93	117.87	0.42	0.42	0.20	0.00	47.00	115.59	0.40	0.42	0.20	0.00
47.07	113.43	2.00	0.00	0.20	0.00	47.13	112.08	2.00	0.00	0.20	0.00
47.19	111.08	2.00	0.00	0.20	0.00	47.25	111.22	2.00	0.00	0.20	0.00
47.33	114.69	2.00	0.00	0.20	0.00	47.39	120.60	2.00	0.00	0.20	0.00
47.44	123.38	2.00	0.00	0.20	0.00	47.51	123.97	2.00	0.00	0.19	0.00
47.59	123.46	2.00	0.00	0.19	0.00	47.65	123.36	2.00	0.00	0.19	0.00
47.70	124.07	2.00	0.00	0.19	0.00	47.79	124.41	2.00	0.00	0.19	0.00
47.85	124.37	2.00	0.00	0.19	0.00	47.91	120.09	2.00	0.00	0.19	0.00
47.97	116.86	2.00	0.00	0.19	0.00	48.05	114.30	2.00	0.00	0.19	0.00
48.11	115.85	2.00	0.00	0.18	0.00	48.16	117.05	2.00	0.00	0.18	0.00
48.26	118.66	2.00	0.00	0.18	0.00	48.31	121.36	2.00	0.00	0.18	0.00
48.38	125.18	2.00	0.00	0.18	0.00	48.44	130.09	2.00	0.00	0.18	0.00
48.51	134.52	2.00	0.00	0.18	0.00	48.56	137.15	2.00	0.00	0.18	0.00
48.64	138.50	2.00	0.00	0.18	0.00	48.71	139.63	2.00	0.00	0.17	0.00
48.77	141.48	2.00	0.00	0.17	0.00	48.83	143.53	2.00	0.00	0.17	0.00
48.89	143.96	2.00	0.00	0.17	0.00	48.96	140.37	2.00	0.00	0.17	0.00
49.03	134.45	2.00	0.00	0.17	0.00	49.10	128.37	2.00	0.00	0.17	0.00
49.16	126.27	2.00	0.00	0.17	0.00	49.22	127.96	2.00	0.00	0.17	0.00
49.29	132.95	2.00	0.00	0.16	0.00	49.37	137.87	2.00	0.00	0.16	0.00
49.43	142.72	2.00	0.00	0.16	0.00	49.49	148.02	2.00	0.00	0.16	0.00
49.55	153.94	2.00	0.00	0.16	0.00	49.61	159.27	2.00	0.00	0.16	0.00
49.70	161.34	2.00	0.00	0.16	0.00	49.76	160.14	2.00	0.00	0.16	0.00
49.82	155.80	2.00	0.00	0.16	0.00	49.87	149.85	2.00	0.00	0.15	0.00
49.94	144.52	2.00	0.00	0.15	0.00	50.02	144.06	2.00	0.00	0.15	0.00

:: Post-earthquake settlement due to soil liquefaction :: (continued)

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
50.08	148.96	2.00	0.00	0.15	0.00	50.14	153.17	2.00	0.00	0.15	0.00

Total estimated settlement: 2.03

Abbreviations

$Q_{tn,cs}$: Equivalent clean sand normalized cone resistance
FS: Factor of safety against liquefaction
e_v (%): Post-liquefaction volumentric strain
DF: e_v depth weighting factor
Settlement: Calculated settlement

GeoTek, Inc.
1548 N. Maple Street
Corona, CA 92880
http://www.geotekusa.com

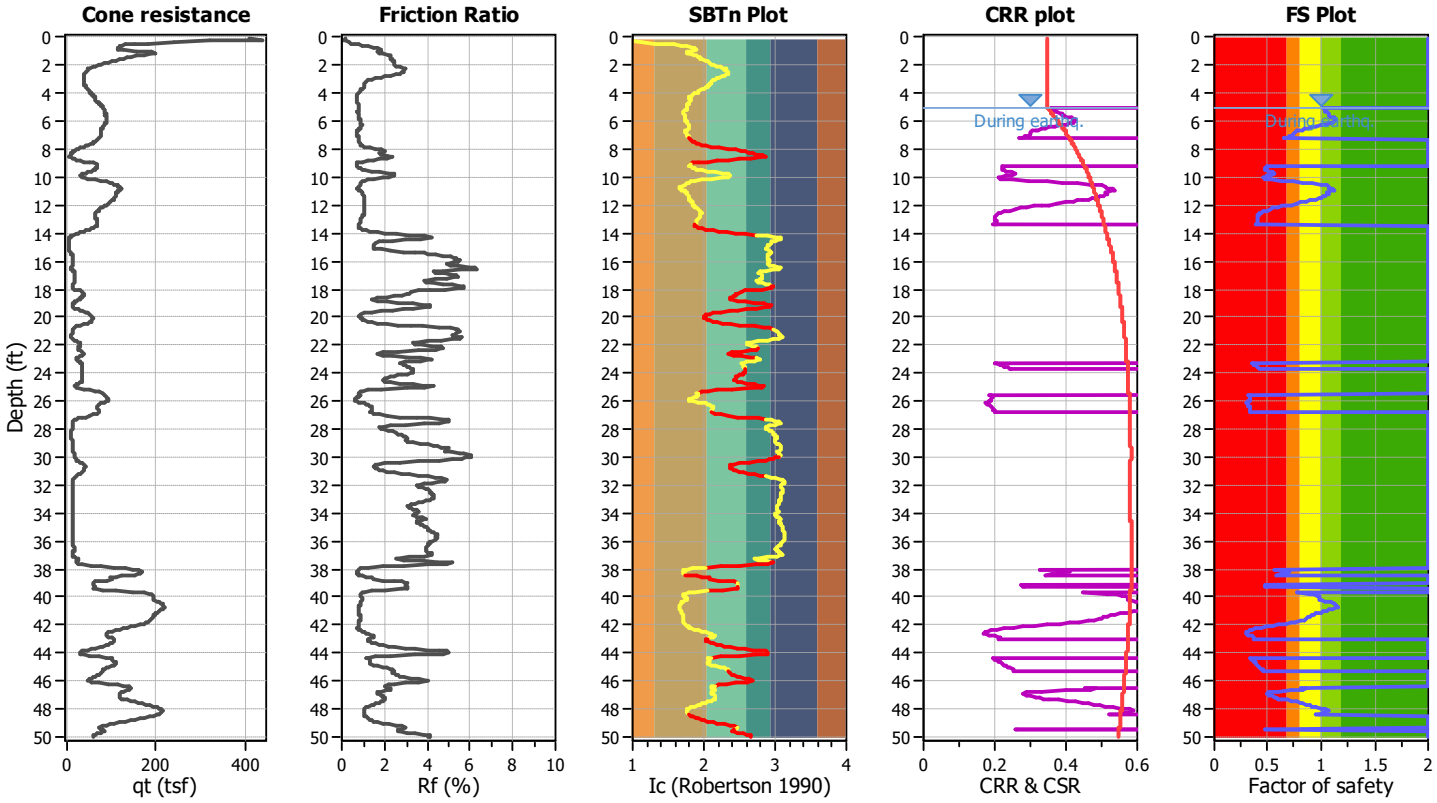
LIQUEFACTION ANALYSIS REPORT

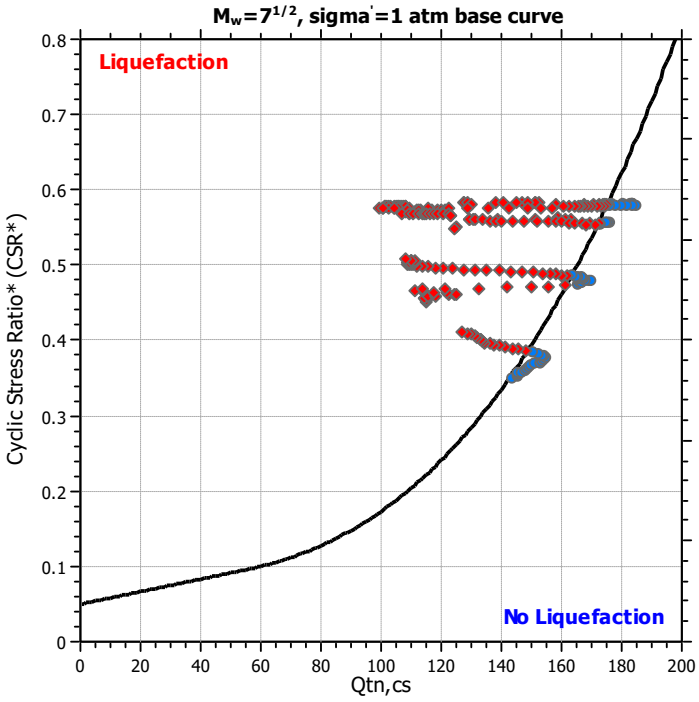
Project title : 7-Acre Site, Cypress Town Center **Location : Cypress, CA**

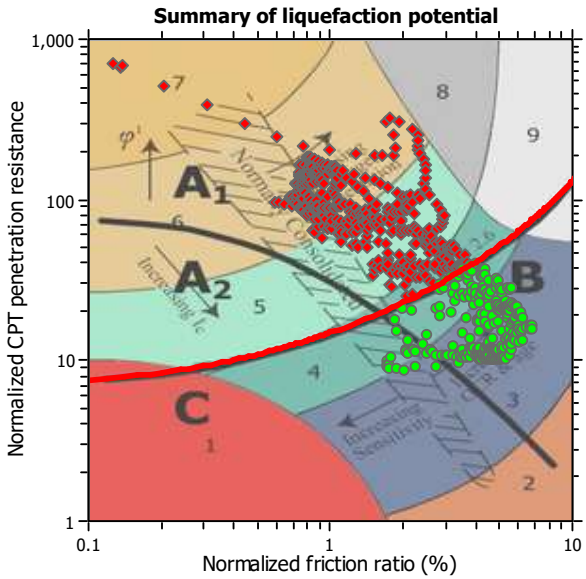
CPT file : CPT-4

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	7.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	5.00 ft	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	50.00 ft
Earthquake magnitude M_w:	6.71	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.55	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

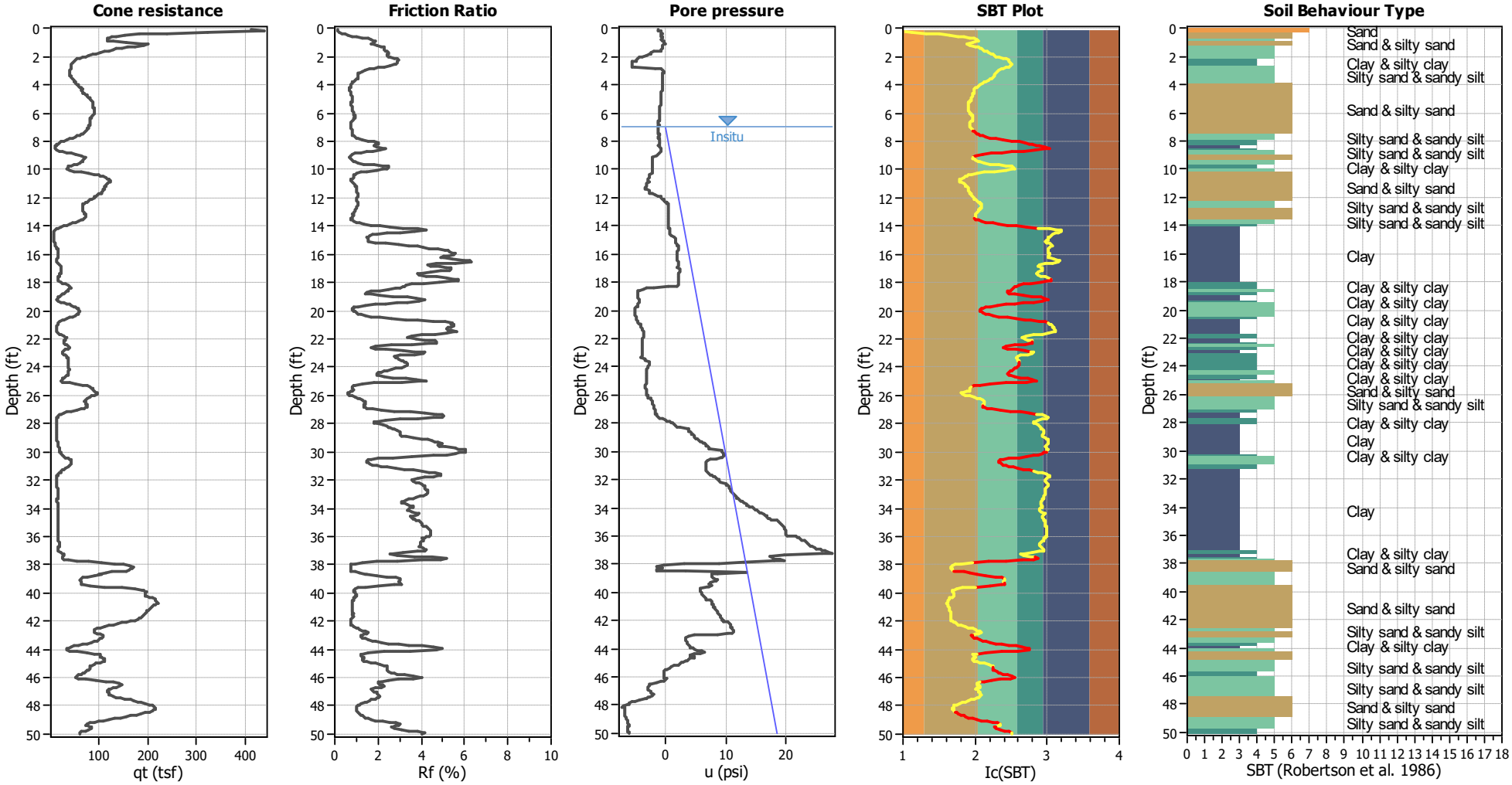






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



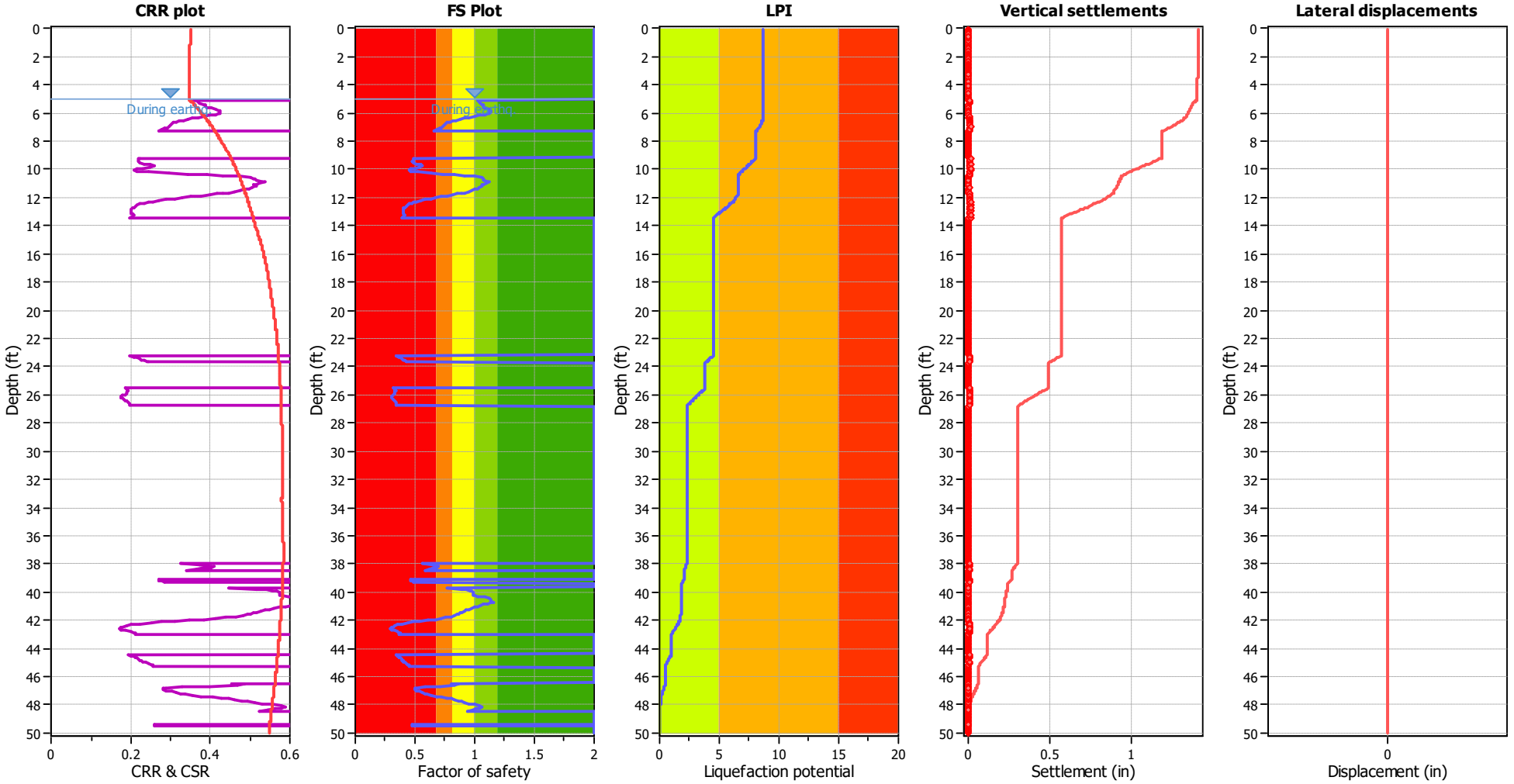
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.71	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.55	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	7.00 ft	Fill height:	N/A	Limit depth:	50.00 ft

SBT legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.71	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.55	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	7.00 ft	Fill height:	N/A	Limit depth:	50.00 ft

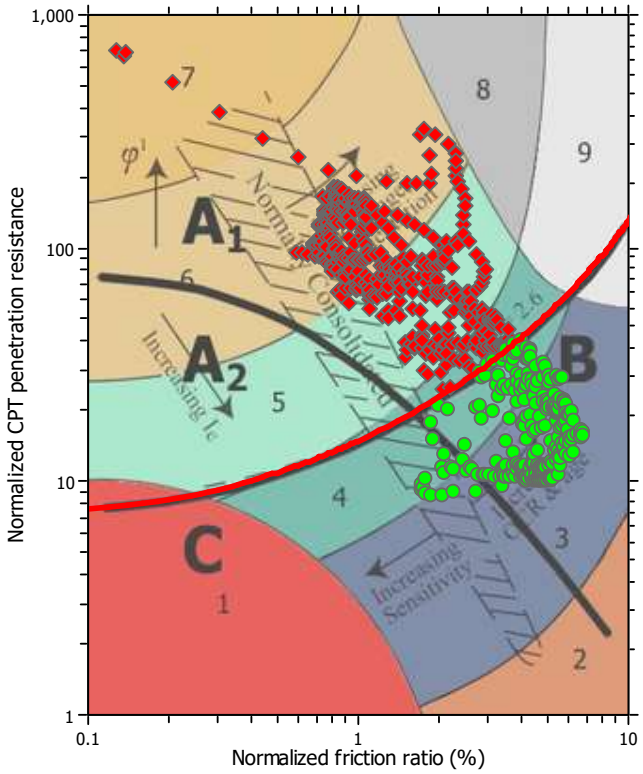
F.S. color scheme

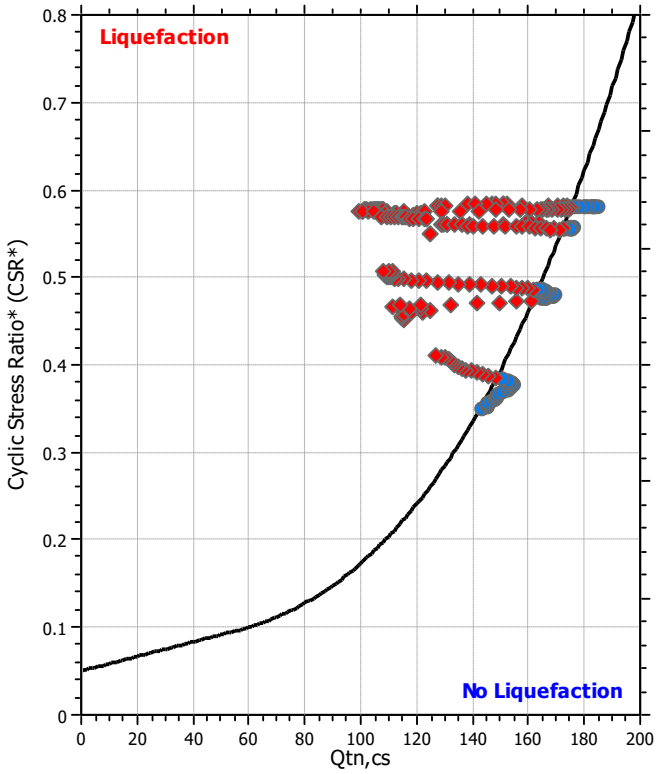
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

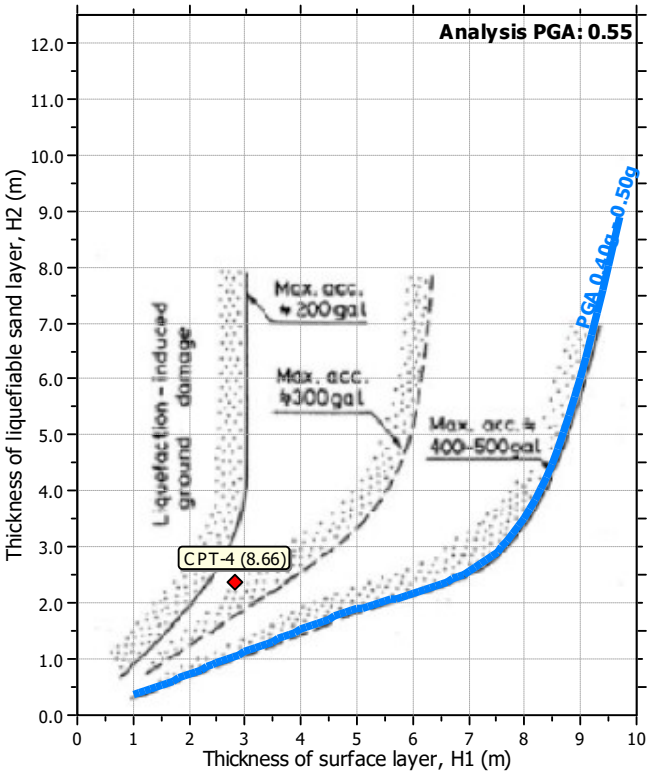
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots







Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.71	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.55	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	7.00 ft	Fill height:	N/A	Limit depth:	50.00 ft

:: Post-earthquake settlement of dry sands ::

Depth (ft)	Ic	Q_{tn}	Kc	$Q_{tn,cs}$	$N_{1,60}$ (blows)	G_{max} (tsf)	CSR	Shear, γ (%)	$e_{vol(15)}$ (%)	N_c	e_v (%)	Settle. (in)
0.07	0.74	662.13	1.00	662.13	93	945	0.35	0.000	0.00	8.70	0.00	0.000
0.14	0.70	706.53	1.00	706.53	98	960	0.35	0.000	0.00	8.70	0.00	0.000
0.20	0.73	690.58	1.00	690.58	96	971	0.35	0.000	0.00	8.70	0.00	0.000
0.27	0.92	517.33	1.00	517.33	76	933	0.35	0.001	0.00	8.70	0.00	0.000
0.34	1.13	385.77	1.00	385.77	60	907	0.35	0.001	0.00	8.70	0.00	0.000
0.42	1.32	294.99	1.00	294.99	49	883	0.35	0.001	0.00	8.70	0.00	0.000
0.47	1.47	244.82	1.00	244.82	42	883	0.35	0.001	0.00	8.70	0.00	0.000
0.54	1.59	214.74	1.00	214.74	39	901	0.35	0.001	0.00	8.70	0.00	0.000
0.60	1.68	202.58	1.02	207.52	38	953	0.35	0.002	0.00	8.70	0.00	0.000
0.67	1.77	193.28	1.09	210.37	40	1024	0.35	0.002	0.00	8.70	0.00	0.000
0.73	1.84	189.89	1.14	215.79	42	1092	0.35	0.002	0.00	8.70	0.00	0.000
0.79	1.87	188.92	1.16	219.16	43	1127	0.35	0.002	0.00	8.70	0.00	0.000
0.86	1.90	188.45	1.19	224.53	45	1175	0.35	0.002	0.00	8.70	0.00	0.000
0.92	1.88	208.29	1.17	244.61	49	1268	0.35	0.002	0.00	8.70	0.00	0.000
0.99	1.83	252.04	1.13	284.33	56	1430	0.35	0.002	0.00	8.70	0.00	0.000
1.07	1.75	304.64	1.07	327.46	62	1575	0.35	0.002	0.00	8.70	0.00	0.000
1.13	1.75	321.20	1.07	344.93	66	1657	0.35	0.002	0.00	8.70	0.00	0.000
1.19	1.80	306.90	1.10	338.83	65	1672	0.35	0.002	0.00	8.70	0.00	0.000
1.26	1.86	277.13	1.16	320.44	63	1644	0.35	0.002	0.00	8.70	0.00	0.000
1.32	1.90	255.78	1.19	304.63	61	1593	0.35	0.002	0.00	8.70	0.00	0.000
1.39	1.93	235.47	1.22	286.38	58	1515	0.35	0.002	0.00	8.70	0.00	0.000
1.46	1.94	218.75	1.23	269.92	55	1438	0.35	0.003	0.00	8.70	0.00	0.000
1.52	1.96	206.06	1.25	257.23	53	1377	0.35	0.003	0.00	8.70	0.00	0.000
1.58	1.98	192.44	1.28	246.18	51	1329	0.35	0.003	0.00	8.70	0.00	0.000
1.65	2.01	177.98	1.32	234.67	49	1277	0.35	0.003	0.00	8.70	0.00	0.000
1.71	2.04	163.68	1.36	223.12	47	1222	0.35	0.004	0.00	8.70	0.00	0.000
1.77	2.07	150.63	1.40	211.03	45	1159	0.35	0.004	0.00	8.70	0.00	0.000
1.85	2.09	138.36	1.43	198.10	43	1089	0.35	0.004	0.00	8.70	0.00	0.000
1.91	2.11	126.03	1.47	185.78	40	1022	0.35	0.005	0.00	8.70	0.00	0.000
1.99	2.14	115.78	1.53	176.86	39	972	0.35	0.006	0.00	8.70	0.00	0.000
2.04	2.18	106.21	1.61	170.97	38	936	0.35	0.006	0.00	8.70	0.00	0.000
2.10	2.23	94.67	1.75	165.81	38	897	0.35	0.007	0.00	8.70	0.00	0.000
2.17	2.27	86.97	1.86	161.90	38	865	0.35	0.007	0.00	8.70	0.00	0.000
2.24	2.30	80.68	1.96	158.41	37	837	0.35	0.008	0.00	8.70	0.00	0.000
2.30	2.30	79.05	1.96	154.71	36	818	0.35	0.008	0.00	8.70	0.00	0.000
2.38	2.32	75.46	2.00	151.04	36	794	0.35	0.009	0.00	8.70	0.00	0.000
2.43	2.33	71.76	2.05	147.00	35	768	0.35	0.010	0.00	8.70	0.00	0.000
2.50	2.34	68.64	2.08	142.63	34	743	0.35	0.011	0.01	8.70	0.00	0.000
2.57	2.34	66.24	2.07	137.30	33	716	0.35	0.012	0.01	8.70	0.00	0.000
2.63	2.32	65.20	2.01	131.13	31	689	0.35	0.013	0.01	8.70	0.01	0.000
2.70	2.29	65.04	1.92	124.78	29	663	0.35	0.014	0.01	8.70	0.01	0.000
2.76	2.25	65.17	1.81	117.84	27	633	0.35	0.016	0.01	8.70	0.01	0.000
2.84	2.22	65.30	1.72	112.03	25	608	0.35	0.018	0.01	8.70	0.01	0.000
2.89	2.18	65.12	1.63	106.16	24	580	0.35	0.020	0.02	8.70	0.01	0.000
2.96	2.16	64.45	1.57	100.97	22	554	0.35	0.022	0.02	8.70	0.01	0.000
3.04	2.13	63.51	1.51	95.75	21	527	0.35	0.026	0.02	8.70	0.02	0.000
3.11	2.11	62.88	1.47	92.43	20	509	0.35	0.029	0.03	8.70	0.02	0.000
3.15	2.10	62.62	1.45	90.90	20	500	0.35	0.031	0.03	8.70	0.02	0.000

:: Post-earthquake settlement of dry sands :: (continued)

Depth (ft)	Ic	Q_{tn}	Kc	$Q_{tn,cs}$	$N_{1,60}$ (blows)	G_{max} (tsf)	CSR	Shear, γ (%)	$e_{vol(15)}$ (%)	N_c	e_v (%)	Settle. (in)
3.24	2.09	62.92	1.44	90.79	20	499	0.35	0.032	0.03	8.70	0.02	0.000
3.30	2.09	63.59	1.44	91.29	20	502	0.35	0.033	0.03	8.70	0.02	0.000
3.35	2.08	64.84	1.43	92.39	20	508	0.35	0.033	0.03	8.70	0.02	0.000
3.42	2.07	66.44	1.41	93.69	20	515	0.35	0.032	0.03	8.70	0.02	0.000
3.49	2.06	68.51	1.39	95.10	20	522	0.35	0.032	0.03	8.70	0.02	0.000
3.56	2.04	70.63	1.36	96.22	20	527	0.35	0.033	0.03	8.70	0.02	0.000
3.61	2.02	73.07	1.33	97.12	20	529	0.35	0.033	0.03	8.70	0.02	0.000
3.68	2.00	75.60	1.29	97.83	20	530	0.35	0.034	0.03	8.70	0.02	0.000
3.75	1.96	78.45	1.26	98.53	20	529	0.35	0.035	0.03	8.70	0.03	0.000
3.83	1.93	81.30	1.22	99.41	20	527	0.35	0.036	0.04	8.70	0.03	0.000
3.90	1.91	83.89	1.20	100.46	20	527	0.35	0.037	0.04	8.70	0.03	0.000
3.95	1.89	86.64	1.18	102.02	20	530	0.35	0.037	0.04	8.70	0.03	0.000
4.01	1.87	89.64	1.16	104.26	21	537	0.35	0.037	0.04	8.70	0.03	0.000
4.09	1.85	93.12	1.15	106.84	21	545	0.35	0.037	0.03	8.70	0.03	0.000
4.16	1.83	96.65	1.13	109.46	21	553	0.35	0.036	0.03	8.70	0.02	0.000
4.22	1.82	99.60	1.12	111.47	22	557	0.35	0.037	0.03	8.70	0.02	0.000
4.27	1.80	102.19	1.11	113.17	22	560	0.35	0.037	0.03	8.70	0.02	0.000
4.34	1.79	104.52	1.10	114.99	22	566	0.35	0.037	0.03	8.70	0.02	0.000
4.41	1.81	103.01	1.11	114.45	22	568	0.35	0.037	0.03	8.70	0.02	0.000
4.47	1.81	104.77	1.11	116.45	23	578	0.35	0.036	0.03	8.70	0.02	0.000
4.55	1.81	106.37	1.11	118.23	23	587	0.35	0.036	0.03	8.70	0.02	0.000
4.60	1.79	112.18	1.10	122.97	24	603	0.35	0.034	0.03	8.70	0.02	0.000
4.67	1.78	115.09	1.09	125.92	24	616	0.35	0.033	0.03	8.70	0.02	0.000
4.74	1.78	118.56	1.09	129.47	25	632	0.35	0.032	0.02	8.70	0.02	0.000
4.81	1.78	122.19	1.09	133.09	26	648	0.35	0.031	0.02	8.70	0.02	0.000
4.88	1.77	125.72	1.09	136.53	26	663	0.35	0.030	0.02	8.70	0.02	0.000
4.95	1.77	128.51	1.08	139.21	27	675	0.35	0.030	0.02	8.70	0.02	0.000
4.99	1.76	131.15	1.08	141.69	27	685	0.35	0.029	0.02	8.70	0.01	0.000

Total estimated settlement: 0.01

Abbreviations

Q_{tn}: Equivalent clean sand normalized cone resistance
K_c: Fines correction factor
$Q_{tn,cs}$: Post-liquefaction volumentric strain
G_{max}: Small strain shear modulus
CSR: Soil cyclic stress ratio
γ: Cyclic shear strain
$e_{vol(15)}$: Volumetric strain after 15 cycles
N_c: Equivalent number of cycles
e_v: Volumetric strain
Settle.: Calculated settlement

:: Post-earthquake settlement due to soil liquefaction ::

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
5.09	143.88	1.02	0.58	0.91	0.01	5.13	145.35	1.04	0.57	0.91	0.00
5.20	145.71	1.04	0.57	0.91	0.00	5.27	145.92	1.04	0.57	0.91	0.00
5.34	146.91	1.05	0.56	0.91	0.00	5.41	148.43	1.07	0.39	0.91	0.00
5.45	149.06	1.07	0.39	0.91	0.00	5.52	149.09	1.07	0.39	0.91	0.00
5.58	149.79	1.07	0.38	0.91	0.00	5.66	151.17	1.09	0.38	0.90	0.00
5.71	153.01	1.12	0.38	0.90	0.00	5.80	153.99	1.13	0.38	0.90	0.00
5.85	154.64	1.13	0.37	0.90	0.00	5.94	154.78	1.13	0.37	0.90	0.00

:: Post-earthquake settlement due to soil liquefaction :: (continued)

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
5.99	154.56	1.12	0.37	0.90	0.00	6.05	153.96	1.10	0.37	0.90	0.00
6.12	152.79	1.08	0.38	0.90	0.00	6.18	150.83	1.04	0.54	0.90	0.00
6.27	148.40	1.00	0.55	0.89	0.01	6.33	145.85	0.95	0.56	0.89	0.00
6.39	143.55	0.91	0.82	0.89	0.01	6.46	141.38	0.88	0.84	0.89	0.01
6.52	139.40	0.85	1.11	0.89	0.01	6.58	137.74	0.82	1.13	0.89	0.01
6.65	136.29	0.80	1.15	0.89	0.01	6.71	134.67	0.77	1.17	0.89	0.01
6.77	133.71	0.76	1.18	0.89	0.01	6.83	133.32	0.75	1.45	0.88	0.01
6.89	132.95	0.74	1.45	0.88	0.01	6.99	132.14	0.73	1.46	0.88	0.02
7.05	131.44	0.72	1.47	0.88	0.01	7.11	130.31	0.70	1.48	0.88	0.01
7.18	128.73	0.68	1.51	0.88	0.01	7.23	126.76	0.66	1.54	0.88	0.01
7.29	124.35	2.00	0.00	0.88	0.00	7.36	121.22	2.00	0.00	0.88	0.00
7.44	117.82	2.00	0.00	0.87	0.00	7.50	114.27	2.00	0.00	0.87	0.00
7.57	110.70	2.00	0.00	0.87	0.00	7.63	106.19	2.00	0.00	0.87	0.00
7.69	100.51	2.00	0.00	0.87	0.00	7.76	94.16	2.00	0.00	0.87	0.00
7.83	88.84	2.00	0.00	0.87	0.00	7.88	85.83	2.00	0.00	0.87	0.00
7.97	85.73	2.00	0.00	0.86	0.00	8.03	85.99	2.00	0.00	0.86	0.00
8.09	84.07	2.00	0.00	0.86	0.00	8.16	79.60	2.00	0.00	0.86	0.00
8.23	73.80	2.00	0.00	0.86	0.00	8.29	67.94	2.00	0.00	0.86	0.00
8.35	64.78	2.00	0.00	0.86	0.00	8.42	64.05	2.00	0.00	0.86	0.00
8.47	66.95	2.00	0.00	0.86	0.00	8.54	71.30	2.00	0.00	0.86	0.00
8.60	76.07	2.00	0.00	0.85	0.00	8.69	79.07	2.00	0.00	0.85	0.00
8.75	81.87	2.00	0.00	0.85	0.00	8.82	84.78	2.00	0.00	0.85	0.00
8.87	90.39	2.00	0.00	0.85	0.00	8.93	97.60	2.00	0.00	0.85	0.00
8.99	105.99	2.00	0.00	0.85	0.00	9.08	112.03	2.00	0.00	0.85	0.00
9.15	115.03	2.00	0.00	0.84	0.00	9.21	115.17	0.49	1.76	0.84	0.01
9.28	114.91	0.49	1.76	0.84	0.01	9.34	114.71	0.48	1.76	0.84	0.01
9.40	114.55	0.48	1.76	0.84	0.01	9.46	114.55	0.48	1.76	0.84	0.01
9.52	115.77	0.49	1.74	0.84	0.01	9.60	118.28	0.51	1.70	0.84	0.02
9.67	122.21	0.54	1.66	0.84	0.01	9.73	124.64	0.56	1.63	0.84	0.01
9.79	124.73	0.56	1.63	0.83	0.01	9.86	121.69	0.53	1.66	0.83	0.01
9.91	117.32	0.50	1.71	0.83	0.01	10.00	113.66	0.47	1.75	0.83	0.02
10.06	111.47	0.45	1.77	0.83	0.01	10.12	113.91	0.47	1.74	0.83	0.01
10.18	121.35	0.53	1.65	0.83	0.01	10.24	132.24	0.63	1.54	0.83	0.01
10.32	141.82	0.73	1.24	0.83	0.01	10.39	149.70	0.83	0.93	0.82	0.01
10.45	155.56	0.91	0.67	0.82	0.01	10.51	161.31	0.99	0.47	0.82	0.00
10.58	165.43	1.06	0.33	0.82	0.00	10.64	166.45	1.07	0.32	0.82	0.00
10.71	166.70	1.07	0.32	0.82	0.00	10.79	167.18	1.08	0.32	0.82	0.00
10.85	169.24	1.11	0.32	0.82	0.00	10.91	169.99	1.12	0.32	0.82	0.00
10.97	168.36	1.09	0.32	0.81	0.00	11.04	167.36	1.07	0.32	0.81	0.00
11.10	166.33	1.06	0.32	0.81	0.00	11.16	167.13	1.07	0.32	0.81	0.00
11.22	166.68	1.06	0.32	0.81	0.00	11.32	165.80	1.04	0.45	0.81	0.01
11.39	164.78	1.02	0.45	0.81	0.00	11.44	163.55	1.00	0.45	0.81	0.00
11.50	162.06	0.98	0.45	0.81	0.00	11.55	160.02	0.95	0.63	0.80	0.00
11.66	157.95	0.91	0.64	0.80	0.01	11.68	155.96	0.89	0.65	0.80	0.00
11.75	153.86	0.86	0.66	0.80	0.01	11.81	150.65	0.81	0.89	0.80	0.01
11.90	146.96	0.76	0.92	0.80	0.01	11.96	143.01	0.72	1.18	0.80	0.01
12.02	139.17	0.67	1.22	0.80	0.01	12.08	135.16	0.63	1.45	0.80	0.01
12.14	131.32	0.59	1.48	0.79	0.01	12.21	127.39	0.55	1.52	0.79	0.01

:: Post-earthquake settlement due to soil liquefaction :: (continued)

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
12.30	123.80	0.52	1.55	0.79	0.02	12.36	120.68	0.49	1.58	0.79	0.01
12.42	118.20	0.47	1.61	0.79	0.01	12.48	115.75	0.45	1.63	0.79	0.01
12.56	113.72	0.43	1.66	0.79	0.02	12.60	112.04	0.42	1.67	0.79	0.01
12.69	110.86	0.41	1.69	0.78	0.02	12.75	109.82	0.41	1.70	0.78	0.01
12.81	109.21	0.40	1.70	0.78	0.01	12.87	108.98	0.40	1.70	0.78	0.01
12.95	108.90	0.40	1.70	0.78	0.02	13.01	109.07	0.40	1.70	0.78	0.01
13.07	109.26	0.40	1.69	0.78	0.01	13.14	109.70	0.40	1.68	0.78	0.01
13.20	110.20	0.40	1.68	0.78	0.01	13.29	111.11	0.41	1.66	0.77	0.02
13.35	110.13	0.40	1.67	0.77	0.01	13.41	108.00	0.39	1.70	0.77	0.01
13.47	104.58	2.00	0.00	0.77	0.00	13.53	102.09	2.00	0.00	0.77	0.00
13.59	99.62	2.00	0.00	0.77	0.00	13.65	96.03	2.00	0.00	0.77	0.00
13.72	93.06	2.00	0.00	0.77	0.00	13.78	91.13	2.00	0.00	0.77	0.00
13.87	91.35	2.00	0.00	0.76	0.00	13.93	93.16	2.00	0.00	0.76	0.00
13.99	95.51	2.00	0.00	0.76	0.00	14.04	97.42	2.00	0.00	0.76	0.00
14.14	98.14	2.00	0.00	0.76	0.00	14.20	96.95	2.00	0.00	0.76	0.00
14.25	92.18	2.00	0.00	0.76	0.00	14.32	85.24	2.00	0.00	0.76	0.00
14.40	77.34	2.00	0.00	0.76	0.00	14.46	69.15	2.00	0.00	0.75	0.00
14.52	62.25	2.00	0.00	0.75	0.00	14.58	57.42	2.00	0.00	0.75	0.00
14.64	54.51	2.00	0.00	0.75	0.00	14.70	52.93	2.00	0.00	0.75	0.00
14.78	51.96	2.00	0.00	0.75	0.00	14.84	52.04	2.00	0.00	0.75	0.00
14.92	52.67	2.00	0.00	0.75	0.00	14.98	53.05	2.00	0.00	0.75	0.00
15.04	53.40	2.00	0.00	0.75	0.00	15.11	55.05	2.00	0.00	0.74	0.00
15.16	59.76	2.00	0.00	0.74	0.00	15.25	66.72	2.00	0.00	0.74	0.00
15.31	75.29	2.00	0.00	0.74	0.00	15.37	83.71	2.00	0.00	0.74	0.00
15.43	91.77	2.00	0.00	0.74	0.00	15.49	99.52	2.00	0.00	0.74	0.00
15.57	107.11	2.00	0.00	0.74	0.00	15.63	114.62	2.00	0.00	0.74	0.00
15.69	121.16	2.00	0.00	0.73	0.00	15.76	125.05	2.00	0.00	0.73	0.00
15.84	126.92	2.00	0.00	0.73	0.00	15.90	127.45	2.00	0.00	0.73	0.00
15.96	127.63	2.00	0.00	0.73	0.00	16.02	126.01	2.00	0.00	0.73	0.00
16.09	123.38	2.00	0.00	0.73	0.00	16.15	120.34	2.00	0.00	0.73	0.00
16.22	117.98	2.00	0.00	0.73	0.00	16.28	116.42	2.00	0.00	0.72	0.00
16.36	115.72	2.00	0.00	0.72	0.00	16.41	116.05	2.00	0.00	0.72	0.00
16.47	117.26	2.00	0.00	0.72	0.00	16.54	119.92	2.00	0.00	0.72	0.00
16.60	121.23	2.00	0.00	0.72	0.00	16.69	118.83	2.00	0.00	0.72	0.00
16.73	119.76	2.00	0.00	0.72	0.00	16.83	124.37	2.00	0.00	0.71	0.00
16.88	132.83	2.00	0.00	0.71	0.00	16.94	137.46	2.00	0.00	0.71	0.00
17.00	140.09	2.00	0.00	0.71	0.00	17.08	140.03	2.00	0.00	0.71	0.00
17.13	137.77	2.00	0.00	0.71	0.00	17.20	131.60	2.00	0.00	0.71	0.00
17.29	123.93	2.00	0.00	0.71	0.00	17.35	116.86	2.00	0.00	0.71	0.00
17.41	113.46	2.00	0.00	0.70	0.00	17.46	112.91	2.00	0.00	0.70	0.00
17.55	114.33	2.00	0.00	0.70	0.00	17.61	116.82	2.00	0.00	0.70	0.00
17.66	119.55	2.00	0.00	0.70	0.00	17.75	121.62	2.00	0.00	0.70	0.00
17.80	123.37	2.00	0.00	0.70	0.00	17.86	124.71	2.00	0.00	0.70	0.00
17.91	127.03	2.00	0.00	0.70	0.00	18.00	128.85	2.00	0.00	0.69	0.00
18.07	129.75	2.00	0.00	0.69	0.00	18.13	129.86	2.00	0.00	0.69	0.00
18.18	131.00	2.00	0.00	0.69	0.00	18.26	132.61	2.00	0.00	0.69	0.00
18.33	133.53	2.00	0.00	0.69	0.00	18.39	132.11	2.00	0.00	0.69	0.00
18.44	125.04	2.00	0.00	0.69	0.00	18.53	113.65	2.00	0.00	0.69	0.00

:: Post-earthquake settlement due to soil liquefaction :: (continued)

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
18.59	100.02	2.00	0.00	0.68	0.00	18.64	87.73	2.00	0.00	0.68	0.00
18.72	80.17	2.00	0.00	0.68	0.00	18.78	76.93	2.00	0.00	0.68	0.00
18.84	78.86	2.00	0.00	0.68	0.00	18.91	82.82	2.00	0.00	0.68	0.00
18.98	87.70	2.00	0.00	0.68	0.00	19.04	93.59	2.00	0.00	0.68	0.00
19.10	96.85	2.00	0.00	0.68	0.00	19.18	98.09	2.00	0.00	0.67	0.00
19.24	99.23	2.00	0.00	0.67	0.00	19.30	102.00	2.00	0.00	0.67	0.00
19.39	104.57	2.00	0.00	0.67	0.00	19.44	105.49	2.00	0.00	0.67	0.00
19.50	102.54	2.00	0.00	0.67	0.00	19.57	96.99	2.00	0.00	0.67	0.00
19.63	89.23	2.00	0.00	0.67	0.00	19.69	84.23	2.00	0.00	0.67	0.00
19.78	82.58	2.00	0.00	0.66	0.00	19.83	83.95	2.00	0.00	0.66	0.00
19.88	85.51	2.00	0.00	0.66	0.00	19.95	87.46	2.00	0.00	0.66	0.00
20.04	89.30	2.00	0.00	0.66	0.00	20.09	90.84	2.00	0.00	0.66	0.00
20.18	91.89	2.00	0.00	0.66	0.00	20.23	93.14	2.00	0.00	0.66	0.00
20.28	94.84	2.00	0.00	0.66	0.00	20.34	96.69	2.00	0.00	0.66	0.00
20.43	98.75	2.00	0.00	0.65	0.00	20.48	102.96	2.00	0.00	0.65	0.00
20.56	108.28	2.00	0.00	0.65	0.00	20.62	114.18	2.00	0.00	0.65	0.00
20.68	116.87	2.00	0.00	0.65	0.00	20.76	118.81	2.00	0.00	0.65	0.00
20.80	118.65	2.00	0.00	0.65	0.00	20.87	117.69	2.00	0.00	0.65	0.00
20.93	115.60	2.00	0.00	0.65	0.00	21.02	113.22	2.00	0.00	0.64	0.00
21.07	110.04	2.00	0.00	0.64	0.00	21.13	106.68	2.00	0.00	0.64	0.00
21.22	103.88	2.00	0.00	0.64	0.00	21.27	101.31	2.00	0.00	0.64	0.00
21.36	100.61	2.00	0.00	0.64	0.00	21.42	101.37	2.00	0.00	0.64	0.00
21.47	104.23	2.00	0.00	0.64	0.00	21.53	107.89	2.00	0.00	0.64	0.00
21.62	111.46	2.00	0.00	0.63	0.00	21.67	114.47	2.00	0.00	0.63	0.00
21.73	115.76	2.00	0.00	0.63	0.00	21.81	116.70	2.00	0.00	0.63	0.00
21.87	118.57	2.00	0.00	0.63	0.00	21.93	121.96	2.00	0.00	0.63	0.00
21.98	127.52	2.00	0.00	0.63	0.00	22.07	132.96	2.00	0.00	0.63	0.00
22.13	137.23	2.00	0.00	0.62	0.00	22.18	137.22	2.00	0.00	0.62	0.00
22.27	135.21	2.00	0.00	0.62	0.00	22.33	130.88	2.00	0.00	0.62	0.00
22.38	121.03	2.00	0.00	0.62	0.00	22.47	107.13	2.00	0.00	0.62	0.00
22.53	94.72	2.00	0.00	0.62	0.00	22.58	89.68	2.00	0.00	0.62	0.00
22.66	88.80	2.00	0.00	0.62	0.00	22.72	91.61	2.00	0.00	0.61	0.00
22.77	97.54	2.00	0.00	0.61	0.00	22.85	106.14	2.00	0.00	0.61	0.00
22.91	112.74	2.00	0.00	0.61	0.00	22.97	118.71	2.00	0.00	0.61	0.00
23.05	119.37	2.00	0.00	0.61	0.00	23.11	115.50	2.00	0.00	0.61	0.00
23.18	109.70	2.00	0.00	0.61	0.00	23.25	108.30	0.35	1.33	0.61	0.01
23.31	111.12	0.36	1.30	0.61	0.01	23.38	113.33	0.38	1.27	0.60	0.01
23.44	115.09	0.39	1.26	0.60	0.01	23.50	116.69	0.40	1.24	0.60	0.01
23.56	118.58	0.41	1.22	0.60	0.01	23.65	120.17	0.42	1.20	0.60	0.01
23.70	121.53	0.43	1.19	0.60	0.01	23.76	122.75	2.00	0.00	0.60	0.00
23.84	123.45	2.00	0.00	0.60	0.00	23.90	123.55	2.00	0.00	0.59	0.00
23.96	121.83	2.00	0.00	0.59	0.00	24.04	118.83	2.00	0.00	0.59	0.00
24.10	114.69	2.00	0.00	0.59	0.00	24.16	110.05	2.00	0.00	0.59	0.00
24.24	105.50	2.00	0.00	0.59	0.00	24.30	101.30	2.00	0.00	0.59	0.00
24.36	97.83	2.00	0.00	0.59	0.00	24.41	94.76	2.00	0.00	0.59	0.00
24.50	92.95	2.00	0.00	0.58	0.00	24.56	92.10	2.00	0.00	0.58	0.00
24.61	92.29	2.00	0.00	0.58	0.00	24.70	94.30	2.00	0.00	0.58	0.00
24.76	99.09	2.00	0.00	0.58	0.00	24.82	105.10	2.00	0.00	0.58	0.00

:: Post-earthquake settlement due to soil liquefaction :: (continued)

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
24.87	109.76	2.00	0.00	0.58	0.00	24.95	111.96	2.00	0.00	0.58	0.00
25.01	108.47	2.00	0.00	0.58	0.00	25.09	101.05	2.00	0.00	0.57	0.00
25.14	90.39	2.00	0.00	0.57	0.00	25.22	88.24	2.00	0.00	0.57	0.00
25.28	91.77	2.00	0.00	0.57	0.00	25.33	95.65	2.00	0.00	0.57	0.00
25.40	98.92	2.00	0.00	0.57	0.00	25.46	101.86	2.00	0.00	0.57	0.00
25.53	104.24	0.32	1.28	0.57	0.01	25.60	106.17	0.33	1.26	0.57	0.01
25.66	107.12	0.34	1.25	0.57	0.01	25.73	106.57	0.33	1.25	0.56	0.01
25.79	106.06	0.33	1.25	0.56	0.01	25.86	105.61	0.33	1.25	0.56	0.01
25.92	105.48	0.33	1.25	0.56	0.01	25.99	104.36	0.32	1.26	0.56	0.01
26.07	102.31	0.31	1.28	0.56	0.01	26.13	101.29	0.31	1.29	0.56	0.01
26.18	101.15	0.31	1.29	0.56	0.01	26.25	102.04	0.31	1.28	0.56	0.01
26.31	103.36	0.32	1.26	0.55	0.01	26.40	104.78	0.32	1.24	0.55	0.01
26.45	106.14	0.33	1.23	0.55	0.01	26.52	107.02	0.34	1.22	0.55	0.01
26.59	107.70	0.34	1.21	0.55	0.01	26.65	108.11	0.34	1.20	0.55	0.01
26.73	108.15	0.34	1.20	0.55	0.01	26.80	108.03	2.00	0.00	0.55	0.00
26.85	107.96	2.00	0.00	0.54	0.00	26.93	107.93	2.00	0.00	0.54	0.00
26.98	108.66	2.00	0.00	0.54	0.00	27.06	111.19	2.00	0.00	0.54	0.00
27.12	116.15	2.00	0.00	0.54	0.00	27.17	120.31	2.00	0.00	0.54	0.00
27.24	121.04	2.00	0.00	0.54	0.00	27.31	118.13	2.00	0.00	0.54	0.00
27.38	112.86	2.00	0.00	0.54	0.00	27.45	106.26	2.00	0.00	0.53	0.00
27.51	99.44	2.00	0.00	0.53	0.00	27.56	91.81	2.00	0.00	0.53	0.00
27.63	83.51	2.00	0.00	0.53	0.00	27.71	74.69	2.00	0.00	0.53	0.00
27.77	67.16	2.00	0.00	0.53	0.00	27.84	62.48	2.00	0.00	0.53	0.00
27.91	60.45	2.00	0.00	0.53	0.00	27.97	60.54	2.00	0.00	0.53	0.00
28.02	62.45	2.00	0.00	0.53	0.00	28.09	64.73	2.00	0.00	0.52	0.00
28.16	66.79	2.00	0.00	0.52	0.00	28.23	67.82	2.00	0.00	0.52	0.00
28.30	68.46	2.00	0.00	0.52	0.00	28.36	69.33	2.00	0.00	0.52	0.00
28.44	70.45	2.00	0.00	0.52	0.00	28.50	71.66	2.00	0.00	0.52	0.00
28.55	72.43	2.00	0.00	0.52	0.00	28.62	72.96	2.00	0.00	0.51	0.00
28.69	73.53	2.00	0.00	0.51	0.00	28.76	74.33	2.00	0.00	0.51	0.00
28.83	75.27	2.00	0.00	0.51	0.00	28.90	76.51	2.00	0.00	0.51	0.00
28.94	79.01	2.00	0.00	0.51	0.00	29.01	82.42	2.00	0.00	0.51	0.00
29.08	85.66	2.00	0.00	0.51	0.00	29.15	87.93	2.00	0.00	0.51	0.00
29.22	89.85	2.00	0.00	0.50	0.00	29.28	91.96	2.00	0.00	0.50	0.00
29.35	94.20	2.00	0.00	0.50	0.00	29.40	97.12	2.00	0.00	0.50	0.00
29.47	98.21	2.00	0.00	0.50	0.00	29.54	98.34	2.00	0.00	0.50	0.00
29.61	100.18	2.00	0.00	0.50	0.00	29.67	104.53	2.00	0.00	0.50	0.00
29.74	110.16	2.00	0.00	0.50	0.00	29.80	113.44	2.00	0.00	0.49	0.00
29.87	115.81	2.00	0.00	0.49	0.00	29.92	117.83	2.00	0.00	0.49	0.00
30.01	119.53	2.00	0.00	0.49	0.00	30.06	121.20	2.00	0.00	0.49	0.00
30.13	121.99	2.00	0.00	0.49	0.00	30.20	120.61	2.00	0.00	0.49	0.00
30.27	116.57	2.00	0.00	0.49	0.00	30.32	107.61	2.00	0.00	0.49	0.00
30.40	97.65	2.00	0.00	0.48	0.00	30.46	88.32	2.00	0.00	0.48	0.00
30.52	84.38	2.00	0.00	0.48	0.00	30.59	82.84	2.00	0.00	0.48	0.00
30.66	82.55	2.00	0.00	0.48	0.00	30.72	82.55	2.00	0.00	0.48	0.00
30.79	83.36	2.00	0.00	0.48	0.00	30.86	84.87	2.00	0.00	0.48	0.00
30.91	87.06	2.00	0.00	0.48	0.00	30.98	89.57	2.00	0.00	0.47	0.00
31.05	92.83	2.00	0.00	0.47	0.00	31.11	96.43	2.00	0.00	0.47	0.00

:: Post-earthquake settlement due to soil liquefaction :: (continued)

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
31.18	99.87	2.00	0.00	0.47	0.00	31.24	102.48	2.00	0.00	0.47	0.00
31.31	104.00	2.00	0.00	0.47	0.00	31.38	104.31	2.00	0.00	0.47	0.00
31.43	103.40	2.00	0.00	0.47	0.00	31.50	100.97	2.00	0.00	0.47	0.00
31.57	97.35	2.00	0.00	0.46	0.00	31.64	93.28	2.00	0.00	0.46	0.00
31.70	89.40	2.00	0.00	0.46	0.00	31.77	85.73	2.00	0.00	0.46	0.00
31.83	82.23	2.00	0.00	0.46	0.00	31.90	79.09	2.00	0.00	0.46	0.00
31.97	77.38	2.00	0.00	0.46	0.00	32.03	77.04	2.00	0.00	0.46	0.00
32.10	78.02	2.00	0.00	0.46	0.00	32.16	79.20	2.00	0.00	0.45	0.00
32.23	80.45	2.00	0.00	0.45	0.00	32.29	81.42	2.00	0.00	0.45	0.00
32.36	82.13	2.00	0.00	0.45	0.00	32.43	82.99	2.00	0.00	0.45	0.00
32.49	84.03	2.00	0.00	0.45	0.00	32.56	85.03	2.00	0.00	0.45	0.00
32.62	85.93	2.00	0.00	0.45	0.00	32.68	86.81	2.00	0.00	0.45	0.00
32.75	87.64	2.00	0.00	0.44	0.00	32.81	88.13	2.00	0.00	0.44	0.00
32.88	88.17	2.00	0.00	0.44	0.00	32.95	87.99	2.00	0.00	0.44	0.00
33.01	87.41	2.00	0.00	0.44	0.00	33.08	85.95	2.00	0.00	0.44	0.00
33.15	83.67	2.00	0.00	0.44	0.00	33.22	81.33	2.00	0.00	0.44	0.00
33.28	79.18	2.00	0.00	0.44	0.00	33.35	77.31	2.00	0.00	0.43	0.00
33.42	75.41	2.00	0.00	0.43	0.00	33.49	74.00	2.00	0.00	0.43	0.00
33.53	73.69	2.00	0.00	0.43	0.00	33.63	74.21	2.00	0.00	0.43	0.00
33.67	76.07	2.00	0.00	0.43	0.00	33.73	78.06	2.00	0.00	0.43	0.00
33.80	79.72	2.00	0.00	0.43	0.00	33.88	80.36	2.00	0.00	0.43	0.00
33.92	80.42	2.00	0.00	0.43	0.00	33.99	80.39	2.00	0.00	0.42	0.00
34.08	80.39	2.00	0.00	0.42	0.00	34.12	80.26	2.00	0.00	0.42	0.00
34.19	80.27	2.00	0.00	0.42	0.00	34.26	80.43	2.00	0.00	0.42	0.00
34.32	81.09	2.00	0.00	0.42	0.00	34.39	81.91	2.00	0.00	0.42	0.00
34.46	81.34	2.00	0.00	0.42	0.00	34.53	79.72	2.00	0.00	0.41	0.00
34.60	78.25	2.00	0.00	0.41	0.00	34.66	78.11	2.00	0.00	0.41	0.00
34.73	78.67	2.00	0.00	0.41	0.00	34.80	79.00	2.00	0.00	0.41	0.00
34.86	79.57	2.00	0.00	0.41	0.00	34.91	80.37	2.00	0.00	0.41	0.00
34.98	80.92	2.00	0.00	0.41	0.00	35.04	81.16	2.00	0.00	0.41	0.00
35.12	81.15	2.00	0.00	0.40	0.00	35.18	81.47	2.00	0.00	0.40	0.00
35.25	82.06	2.00	0.00	0.40	0.00	35.32	82.83	2.00	0.00	0.40	0.00
35.38	83.59	2.00	0.00	0.40	0.00	35.45	84.31	2.00	0.00	0.40	0.00
35.51	85.08	2.00	0.00	0.40	0.00	35.58	85.63	2.00	0.00	0.40	0.00
35.64	85.70	2.00	0.00	0.40	0.00	35.71	85.48	2.00	0.00	0.39	0.00
35.77	85.33	2.00	0.00	0.39	0.00	35.84	85.31	2.00	0.00	0.39	0.00
35.90	84.97	2.00	0.00	0.39	0.00	35.98	84.10	2.00	0.00	0.39	0.00
36.03	83.47	2.00	0.00	0.39	0.00	36.10	83.14	2.00	0.00	0.39	0.00
36.16	83.11	2.00	0.00	0.39	0.00	36.22	83.67	2.00	0.00	0.39	0.00
36.29	84.71	2.00	0.00	0.38	0.00	36.36	86.20	2.00	0.00	0.38	0.00
36.42	87.64	2.00	0.00	0.38	0.00	36.49	88.94	2.00	0.00	0.38	0.00
36.55	89.35	2.00	0.00	0.38	0.00	36.62	88.18	2.00	0.00	0.38	0.00
36.68	86.64	2.00	0.00	0.38	0.00	36.75	85.61	2.00	0.00	0.38	0.00
36.84	85.75	2.00	0.00	0.38	0.00	36.88	85.90	2.00	0.00	0.37	0.00
36.97	85.75	2.00	0.00	0.37	0.00	37.01	85.23	2.00	0.00	0.37	0.00
37.07	84.86	2.00	0.00	0.37	0.00	37.15	84.27	2.00	0.00	0.37	0.00
37.21	83.87	2.00	0.00	0.37	0.00	37.28	85.62	2.00	0.00	0.37	0.00
37.34	90.41	2.00	0.00	0.37	0.00	37.42	97.52	2.00	0.00	0.37	0.00

:: Post-earthquake settlement due to soil liquefaction :: (continued)

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
37.48	105.05	2.00	0.00	0.36	0.00	37.54	112.54	2.00	0.00	0.36	0.00
37.61	118.71	2.00	0.00	0.36	0.00	37.67	121.97	2.00	0.00	0.36	0.00
37.74	119.84	2.00	0.00	0.36	0.00	37.80	115.94	2.00	0.00	0.36	0.00
37.87	117.78	2.00	0.00	0.36	0.00	37.94	127.55	2.00	0.00	0.36	0.00
38.00	138.32	0.56	0.64	0.36	0.01	38.07	146.89	0.64	0.60	0.35	0.00
38.13	151.20	0.69	0.48	0.35	0.00	38.21	152.22	0.70	0.48	0.35	0.00
38.26	151.12	0.69	0.48	0.35	0.00	38.32	148.57	0.66	0.49	0.35	0.00
38.40	145.29	0.63	0.60	0.35	0.01	38.46	140.89	0.58	0.61	0.35	0.00
38.53	123.51	2.00	0.00	0.35	0.00	38.59	119.04	2.00	0.00	0.35	0.00
38.66	116.43	2.00	0.00	0.34	0.00	38.72	122.52	2.00	0.00	0.34	0.00
38.80	122.88	2.00	0.00	0.34	0.00	38.85	126.01	2.00	0.00	0.34	0.00
38.92	128.25	2.00	0.00	0.34	0.00	38.99	128.53	2.00	0.00	0.34	0.00
39.05	127.93	2.00	0.00	0.34	0.00	39.11	127.24	0.47	0.65	0.34	0.00
39.19	127.27	0.47	0.64	0.34	0.01	39.24	128.68	0.48	0.64	0.33	0.00
39.32	130.07	0.49	0.63	0.33	0.01	39.38	129.55	2.00	0.00	0.33	0.00
39.44	124.83	2.00	0.00	0.33	0.00	39.52	119.34	2.00	0.00	0.33	0.00
39.60	124.25	2.00	0.00	0.33	0.00	39.65	142.43	2.00	0.00	0.33	0.00
39.73	157.83	0.77	0.34	0.33	0.00	39.78	167.24	0.89	0.24	0.33	0.00
39.83	170.53	0.93	0.23	0.32	0.00	39.92	172.39	0.96	0.17	0.32	0.00
39.97	173.66	0.98	0.17	0.32	0.00	40.05	174.35	0.99	0.17	0.32	0.00
40.10	174.59	0.99	0.17	0.32	0.00	40.18	174.34	0.99	0.17	0.32	0.00
40.23	175.15	1.00	0.17	0.32	0.00	40.31	177.17	1.03	0.16	0.32	0.00
40.36	180.71	1.08	0.12	0.32	0.00	40.45	183.40	1.13	0.12	0.31	0.00
40.49	183.48	1.13	0.12	0.31	0.00	40.57	183.98	1.14	0.12	0.31	0.00
40.62	183.96	1.14	0.12	0.31	0.00	40.70	184.96	1.15	0.08	0.31	0.00
40.75	183.94	1.14	0.11	0.31	0.00	40.82	182.19	1.11	0.12	0.31	0.00
40.89	180.22	1.08	0.12	0.31	0.00	40.96	178.26	1.05	0.16	0.31	0.00
41.02	176.39	1.02	0.16	0.30	0.00	41.09	174.62	0.99	0.16	0.30	0.00
41.15	172.94	0.97	0.16	0.30	0.00	41.21	171.62	0.95	0.16	0.30	0.00
41.27	170.27	0.93	0.21	0.30	0.00	41.34	168.78	0.91	0.22	0.30	0.00
41.42	167.38	0.89	0.22	0.30	0.00	41.47	166.32	0.88	0.22	0.30	0.00
41.54	165.35	0.87	0.22	0.30	0.00	41.61	164.26	0.85	0.22	0.29	0.00
41.70	162.80	0.83	0.29	0.29	0.00	41.74	160.35	0.80	0.30	0.29	0.00
41.82	156.86	0.76	0.31	0.29	0.00	41.89	152.93	0.72	0.39	0.29	0.00
41.93	148.47	0.67	0.41	0.29	0.00	42.00	142.39	0.60	0.50	0.29	0.00
42.07	135.71	0.54	0.52	0.29	0.00	42.13	128.73	0.48	0.54	0.29	0.00
42.21	122.62	0.44	0.56	0.28	0.01	42.26	115.75	0.39	0.59	0.28	0.00
42.33	109.68	0.35	0.61	0.28	0.01	42.40	105.39	0.33	0.63	0.28	0.00
42.47	102.63	0.31	0.64	0.28	0.01	42.53	100.34	0.30	0.65	0.28	0.00
42.60	99.19	0.30	0.65	0.28	0.01	42.67	100.47	0.30	0.64	0.28	0.01
42.73	104.58	0.32	0.62	0.28	0.00	42.80	108.86	0.35	0.60	0.27	0.01
42.86	111.87	0.37	0.58	0.27	0.00	42.93	112.93	0.37	0.58	0.27	0.00
42.99	112.59	0.37	0.58	0.27	0.00	43.06	111.57	2.00	0.00	0.27	0.00
43.12	111.40	2.00	0.00	0.27	0.00	43.19	112.26	2.00	0.00	0.27	0.00
43.25	113.56	2.00	0.00	0.27	0.00	43.32	114.73	2.00	0.00	0.27	0.00
43.38	116.13	2.00	0.00	0.26	0.00	43.46	117.81	2.00	0.00	0.26	0.00
43.51	120.34	2.00	0.00	0.26	0.00	43.58	123.09	2.00	0.00	0.26	0.00
43.64	126.41	2.00	0.00	0.26	0.00	43.72	128.81	2.00	0.00	0.26	0.00

:: Post-earthquake settlement due to soil liquefaction :: (continued)

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
43.77	129.99	2.00	0.00	0.26	0.00	43.85	128.69	2.00	0.00	0.26	0.00
43.90	125.62	2.00	0.00	0.26	0.00	43.97	120.88	2.00	0.00	0.25	0.00
44.06	116.01	2.00	0.00	0.25	0.00	44.10	108.26	2.00	0.00	0.25	0.00
44.19	100.50	2.00	0.00	0.25	0.00	44.23	97.06	2.00	0.00	0.25	0.00
44.32	100.65	2.00	0.00	0.25	0.00	44.36	104.79	2.00	0.00	0.25	0.00
44.44	107.15	0.34	0.54	0.25	0.01	44.52	109.06	0.35	0.53	0.25	0.01
44.56	110.92	0.36	0.53	0.24	0.00	44.62	112.25	0.37	0.52	0.24	0.00
44.70	113.76	0.38	0.51	0.24	0.01	44.75	114.60	0.39	0.50	0.24	0.00
44.83	115.23	0.39	0.50	0.24	0.00	44.89	116.19	0.40	0.49	0.24	0.00
44.97	117.36	0.41	0.49	0.24	0.00	45.01	119.03	0.42	0.48	0.24	0.00
45.09	120.74	0.43	0.47	0.24	0.00	45.15	122.52	0.44	0.46	0.23	0.00
45.22	123.43	0.45	0.46	0.23	0.00	45.28	123.31	0.45	0.46	0.23	0.00
45.35	122.17	2.00	0.00	0.23	0.00	45.44	120.79	2.00	0.00	0.23	0.00
45.47	119.36	2.00	0.00	0.23	0.00	45.57	118.70	2.00	0.00	0.23	0.00
45.64	118.23	2.00	0.00	0.23	0.00	45.69	118.60	2.00	0.00	0.23	0.00
45.76	119.66	2.00	0.00	0.22	0.00	45.82	122.35	2.00	0.00	0.22	0.00
45.89	125.75	2.00	0.00	0.22	0.00	45.94	128.69	2.00	0.00	0.22	0.00
46.02	129.77	2.00	0.00	0.22	0.00	46.07	129.75	2.00	0.00	0.22	0.00
46.15	129.73	2.00	0.00	0.22	0.00	46.22	132.26	2.00	0.00	0.22	0.00
46.27	138.17	2.00	0.00	0.22	0.00	46.35	144.90	2.00	0.00	0.21	0.00
46.40	153.14	2.00	0.00	0.21	0.00	46.48	159.00	0.81	0.22	0.21	0.00
46.53	163.42	0.86	0.16	0.21	0.00	46.59	160.97	0.83	0.21	0.21	0.00
46.67	150.99	0.71	0.29	0.21	0.00	46.72	139.04	0.59	0.37	0.21	0.00
46.80	130.69	0.51	0.39	0.21	0.00	46.87	129.08	0.50	0.39	0.21	0.00
46.92	129.22	0.50	0.39	0.20	0.00	47.00	131.04	0.52	0.38	0.20	0.00
47.06	133.62	0.54	0.37	0.20	0.00	47.13	135.96	0.56	0.37	0.20	0.00
47.19	138.11	0.58	0.36	0.20	0.00	47.26	140.18	0.60	0.35	0.20	0.00
47.31	143.45	0.63	0.34	0.20	0.00	47.39	147.43	0.68	0.28	0.20	0.00
47.46	151.74	0.73	0.27	0.20	0.00	47.51	155.37	0.77	0.21	0.19	0.00
47.59	157.97	0.80	0.20	0.19	0.00	47.66	160.24	0.83	0.20	0.19	0.00
47.72	162.53	0.86	0.15	0.19	0.00	47.78	164.68	0.89	0.14	0.19	0.00
47.86	166.66	0.92	0.14	0.19	0.00	47.91	169.27	0.95	0.10	0.19	0.00
47.98	172.20	1.00	0.10	0.19	0.00	48.05	174.95	1.04	0.10	0.19	0.00
48.11	176.32	1.06	0.07	0.18	0.00	48.17	175.92	1.06	0.07	0.18	0.00
48.26	174.88	1.04	0.10	0.18	0.00	48.30	173.11	1.01	0.10	0.18	0.00
48.39	171.18	0.99	0.10	0.18	0.00	48.43	168.10	0.94	0.13	0.18	0.00
48.51	163.51	2.00	0.00	0.18	0.00	48.58	158.19	2.00	0.00	0.18	0.00
48.63	152.20	2.00	0.00	0.18	0.00	48.71	146.59	2.00	0.00	0.17	0.00
48.75	140.34	2.00	0.00	0.17	0.00	48.84	134.33	2.00	0.00	0.17	0.00
48.90	129.17	2.00	0.00	0.17	0.00	48.96	125.82	2.00	0.00	0.17	0.00
49.04	124.60	2.00	0.00	0.17	0.00	49.10	125.34	2.00	0.00	0.17	0.00
49.15	126.95	2.00	0.00	0.17	0.00	49.23	127.75	2.00	0.00	0.17	0.00
49.30	127.37	2.00	0.00	0.16	0.00	49.35	126.04	2.00	0.00	0.16	0.00
49.42	124.83	0.47	0.32	0.16	0.00	49.49	124.51	0.47	0.31	0.16	0.00
49.55	125.80	2.00	0.00	0.16	0.00	49.61	128.70	2.00	0.00	0.16	0.00
49.69	132.04	2.00	0.00	0.16	0.00	49.76	134.32	2.00	0.00	0.16	0.00
49.81	135.70	2.00	0.00	0.16	0.00	49.88	136.41	2.00	0.00	0.15	0.00
49.95	136.20	2.00	0.00	0.15	0.00	50.01	135.28	2.00	0.00	0.15	0.00

:: Post-earthquake settlement due to soil liquefaction :: (continued)

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)

Total estimated settlement: 1.40

Abbreviations

$Q_{tn,cs}$: Equivalent clean sand normalized cone resistance
FS: Factor of safety against liquefaction
e_v (%): Post-liquefaction volumentric strain
DF: e_v depth weighting factor
Settlement: Calculated settlement

APPENDIX E

GENERAL EARTHWORK AND GRADING GUIDELINES

Geotechnical Evaluation
Proposed Multi-Family Residential Development, Cypress, California
Project No. 2155-CR

GEOTEK

GENERAL GRADING GUIDELINES

Guidelines presented herein are intended to address general construction procedures for earthwork construction. Specific situations and conditions often arise which cannot reasonably be discussed in general guidelines, when anticipated these are discussed in the text of the report. Often unanticipated conditions are encountered which may necessitate modification or changes to these guidelines. It is our hope that these will assist the contractor to more efficiently complete the project by providing a reasonable understanding of the procedures that would be expected during earthwork and the testing and observation used to evaluate those procedures.

General

Grading should be performed to at least the minimum requirements of governing agencies, Chapters 18 and 33 of the California Building Code, CBC (2016) and the guidelines presented below.

Preconstruction Meeting

A preconstruction meeting should be held prior to site earthwork. Any questions the contractor has regarding our recommendations, general site conditions, apparent discrepancies between reported and actual conditions and/or differences in procedures the contractor intends to use should be brought up at that meeting. The contractor (including the main onsite representative) should review our report and these guidelines in advance of the meeting. Any comments the contractor may have regarding these guidelines should be brought up at that meeting.

Grading Observation and Testing

1. Observation of the fill placement should be provided by our representative during grading. Verbal communication during the course of each day will be used to inform the contractor of test results. The contractor should receive a copy of the "Daily Field Report" indicating results of field density tests that day. If our representative does not provide the contractor with these reports, our office should be notified.
2. Testing and observation procedures are, by their nature, specific to the work or area observed and location of the tests taken, variability may occur in other locations. The contractor is responsible for the uniformity of the grading operations; our observations and test results are intended to evaluate the contractor's overall level of efforts during grading. The contractor's personnel are the only individuals participating in all aspect of site work. Compaction testing and observation should not be considered as relieving the contractor's responsibility to properly compact the fill.
3. Cleanouts, processed ground to receive fill, key excavations, and subdrains should be observed by our representative prior to placing any fill. It will be the contractor's responsibility to notify our representative or office when such areas are ready for observation.
4. Density tests may be made on the surface material to receive fill, as considered warranted by this firm.
5. In general, density tests would be made at maximum intervals of two feet of fill height or every 1,000 cubic yards of fill placed. Criteria will vary depending on soil conditions and size of the fill. More frequent testing may be performed. In any case, an adequate number of field density tests should be made to evaluate the required compaction and moisture content is generally being obtained.

6. Laboratory testing to support field test procedures will be performed, as considered warranted, based on conditions encountered (e.g. change of material sources, types, etc.) Every effort will be made to process samples in the laboratory as quickly as possible and in progress construction projects are our first priority. However, laboratory workloads may cause in delays and some soils may require a **minimum of 48 to 72 hours to complete test procedures**. Whenever possible, our representative(s) should be informed in advance of operational changes that might result in different source areas for materials.
7. Procedures for testing of fill slopes are as follows:
   a) Density tests should be taken periodically during grading on the flat surface of the fill, three to five feet horizontally from the face of the slope.
   b) If a method other than over building and cutting back to the compacted core is to be employed, slope compaction testing during construction should include testing the outer six inches to three feet in the slope face to determine if the required compaction is being achieved.
8. Finish grade testing of slopes and pad surfaces should be performed after construction is complete.

Site Clearing

1. All vegetation, and other deleterious materials, should be removed from the site. If material is not immediately removed from the site it should be stockpiled in a designated area(s) well outside of all current work areas and delineated with flagging or other means. Site clearing should be performed in advance of any grading in a specific area.
2. Efforts should be made by the contractor to remove all organic or other deleterious material from the fill, as even the most diligent efforts may result in the incorporation of some materials. This is especially important when grading is occurring near the natural grade. All equipment operators should be aware of these efforts. Laborers may be required as root pickers.
3. Nonorganic debris or concrete may be placed in deeper fill areas provided the procedures used are observed and found acceptable by our representative.

Treatment of Existing Ground

1. Following site clearing, all surficial deposits of alluvium and colluvium as well as weathered or creep effected bedrock, should be removed unless otherwise specifically indicated in the text of this report.
2. In some cases, removal may be recommended to a specified depth (e.g. flat sites where partial alluvial removals may be sufficient). The contractor should not exceed these depths unless directed otherwise by our representative.
3. Groundwater existing in alluvial areas may make excavation difficult. Deeper removals than indicated in the text of the report may be necessary due to saturation during winter months.
4. Subsequent to removals, the natural ground should be processed to a depth of six inches, moistened to near optimum moisture conditions and compacted to fill standards.
5. Exploratory back hoe or dozer trenches still remaining after site removal should be excavated and filled with compacted fill if they can be located.

Fill Placement

1. Unless otherwise indicated, all site soil and bedrock may be reused for compacted fill; however, some special processing or handling may be required (see text of report).

2. Material used in the compacting process should be evenly spread, moisture conditioned, processed, and compacted in thin lifts six (6) to eight (8) inches in compacted thickness to obtain a uniformly dense layer. The fill should be placed and compacted on a nearly horizontal plane, unless otherwise found acceptable by our representative.
3. If the moisture content or relative density varies from that recommended by this firm, the contractor should rework the fill until it is in accordance with the following:
    a) Moisture content of the fill should be at or above optimum moisture. Moisture should be evenly distributed without wet and dry pockets. Pre-watering of cut or removal areas should be considered in addition to watering during fill placement, particularly in clay or dry surficial soils. The ability of the contractor to obtain the proper moisture content will control production rates.
    b) Each six-inch layer should be compacted to at least 90 percent of the maximum dry density in compliance with the testing method specified by the controlling governmental agency. In most cases, the testing method is ASTM Test Designation D 1557.
4. Rock fragments less than eight inches in diameter may be utilized in the fill, provided:
    a) They are not placed in concentrated pockets;
    b) There is a sufficient percentage of fine-grained material to surround the rocks;
    c) The distribution of the rocks is observed by, and acceptable to, our representative.
5. Rocks exceeding eight (8) inches in diameter should be taken off site, broken into smaller fragments, or placed in accordance with recommendations of this firm in areas designated suitable for rock disposal. On projects where significant large quantities of oversized materials are anticipated, alternate guidelines for placement may be included. If significant oversize materials are encountered during construction, these guidelines should be requested.
6. In clay soil, dry or large chunks or blocks are common. If in excess of eight (8) inches minimum dimension, then they are considered as oversized. Sheepsfoot compactors or other suitable methods should be used to break up blocks. When dry, they should be moisture conditioned to provide a uniform condition with the surrounding fill.

Slope Construction

1. The contractor should obtain a minimum relative compaction of 90 percent out to the finished slope face of fill slopes. This may be achieved by either overbuilding the slope and cutting back to the compacted core, or by direct compaction of the slope face with suitable equipment.
2. Slopes trimmed to the compacted core should be overbuilt by at least three (3) feet with compaction efforts out to the edge of the false slope. Failure to properly compact the outer edge results in trimming not exposing the compacted core and additional compaction after trimming may be necessary.
3. If fill slopes are built "at grade" using direct compaction methods, then the slope construction should be performed so that a constant gradient is maintained throughout construction. Soil should not be "spilled" over the slope face nor should slopes be "pushed out" to obtain grades. Compaction equipment should compact each lift along the immediate top of slope. Slopes should be back rolled or otherwise compacted at approximately every 4 feet vertically as the slope is built.
4. Corners and bends in slopes should have special attention during construction as these are the most difficult areas to obtain proper compaction.
5. Cut slopes should be cut to the finished surface. Excessive undercutting and smoothing of the face with fill may necessitate stabilization.

UTILITY TRENCH CONSTRUCTION AND BACKFILL

Utility trench excavation and backfill is the contractors responsibility. The geotechnical consultant typically provides periodic observation and testing of these operations. While efforts are made to make sufficient observations and tests to verify that the contractors' methods and procedures are adequate to achieve proper compaction, it is typically impractical to observe all backfill procedures. As such, it is critical that the contractor use consistent backfill procedures.

Compaction methods vary for trench compaction and experience indicates many methods can be successful. However, procedures that "worked" on previous projects may or may not prove effective on a given site. The contractor(s) should outline the procedures proposed, so that we may discuss them **prior** to construction. We will offer comments based on our knowledge of site conditions and experience.

1. Utility trench backfill in slopes, structural areas, in streets and beneath flat work or hardscape should be brought to at least optimum moisture and compacted to at least 90 percent of the laboratory standard. Soil should be moisture conditioned prior to placing in the trench.
2. Flooding and jetting are not typically recommended or acceptable for native soils. Flooding or jetting may be used with select sand having a Sand Equivalent (SE) of 30 or higher. This is typically limited to the following uses:
   a) shallow (12 + inches) under slab interior trenches and,
   b) as bedding in pipe zone.

   The water should be allowed to dissipate prior to pouring slabs or completing trench compaction.
3. Care should be taken not to place soils at high moisture content within the upper three feet of the trench backfill in street areas, as overly wet soils may impact subgrade preparation. Moisture may be reduced to 2% below optimum moisture in areas to be paved within the upper three feet below sub grade.
4. Sand backfill should not be allowed in exterior trenches adjacent to and within an area extending below a 1:1 projection from the outside bottom edge of a footing, unless it is similar to the surrounding soil.
5. Trench compaction testing is generally at the discretion of the geotechnical consultant. Testing frequency will be based on trench depth and the contractors procedures. A probing rod would be used to assess the consistency of compaction between tested areas and untested areas. If zones are found that are considered less compact than other areas, this would be brought to the contractors attention.

JOB SAFETY

General

Personnel safety is a primary concern on all job sites. The following summaries are safety considerations for use by all our employees on multi-employer construction sites. On ground personnel are at highest risk of injury and possible fatality on grading construction projects. The company recognizes that construction activities will vary on each site and that job site safety is the contractor's responsibility. However, it is, imperative that all personnel be safety conscious to avoid accidents and potential injury.

In an effort to minimize risks associated with geotechnical testing and observation, the following precautions are to be implemented for the safety of our field personnel on grading and construction projects.

1. Safety Meetings: Our field personnel are directed to attend the contractor's regularly scheduled safety meetings.
2. Safety Vests: Safety vests are provided for and are to be worn by our personnel while on the job site.
3. Safety Flags: Safety flags are provided to our field technicians; one is to be affixed to the vehicle when on site, the other is to be placed atop the spoil pile on all test pits.

In the event that the contractor's representative observes any of our personnel not following the above, we request that it be brought to the attention of our office.

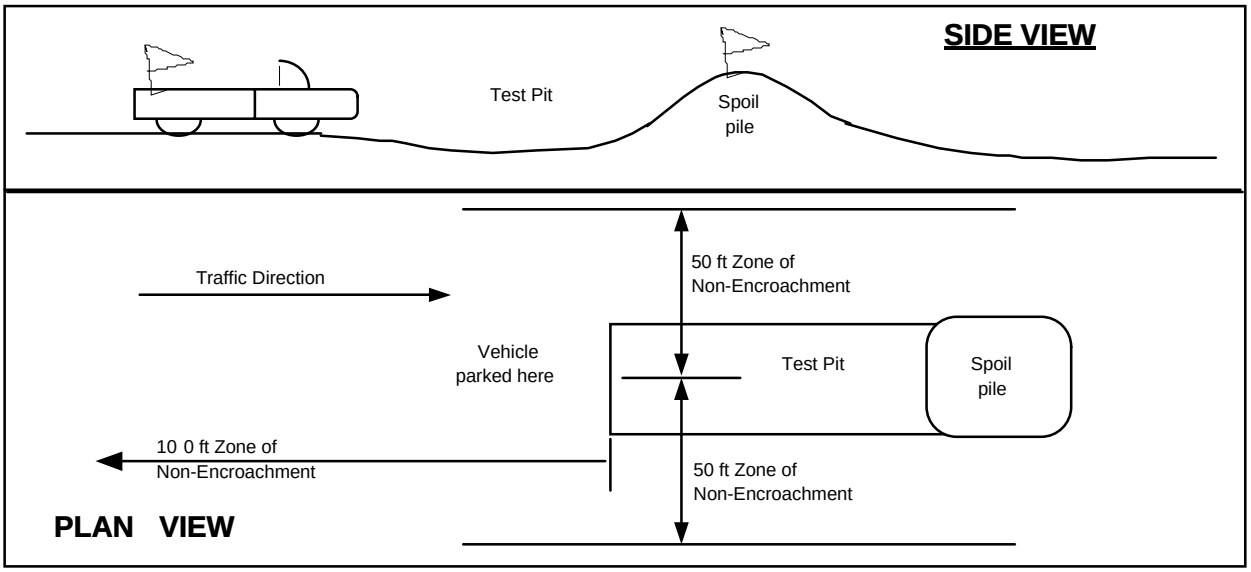
Test Pits Location, Orientation and Clearance

The technician is responsible for selecting test pit locations. The primary concern is the technician's safety. However, it is necessary to take sufficient tests at various locations to obtain a representative sampling of the fill. As such, efforts will be made to coordinate locations with the grading contractors authorized representatives (e.g. dump man, operator, supervisor, grade checker, etc.), and to select locations following or behind the established traffic pattern, preferably outside of current traffic. The contractors authorized representative should direct excavation of the pit and safety during the test period. Again, safety is the paramount concern.

Test pits should be excavated so that the spoil pile is placed away from oncoming traffic. The technician's vehicle is to be placed next to the test pit, opposite the spoil pile. This necessitates that the fill be maintained in a drivable condition. Alternatively, the contractor may opt to park a piece of equipment in front of test pits, particularly in small fill areas or those with limited access.

A zone of non-encroachment should be established for all test pits (see diagram below). No grading equipment should enter this zone during the test procedure. The zone should extend outward to the sides approximately 50 feet from the center of the test pit and 100 feet in the direction of traffic flow. This zone is established both for safety and to avoid excessive ground vibration, which typically decreases test results.

TEST PIT SAFETY PLAN



Slope Tests

When taking slope tests, the technician should park their vehicle directly above or below the test location on the slope. The contractor's representative should effectively keep all equipment at a safe operation distance (e.g. 50 feet) away from the slope during testing.

The technician is directed to withdraw from the active portion of the fill as soon as possible following testing. The technician's vehicle should be parked at the perimeter of the fill in a highly visible location.

Trench Safety

It is the contractor's responsibility to provide safe access into trenches where compaction testing is needed. Trenches for all utilities should be excavated in accordance with CAL-OSHA and any other applicable safety standards. Safe conditions will be required to enable compaction testing of the trench backfill.

All utility trench excavations in excess of 5 feet deep, which a person enters, are to be shored or laid back. Trench access should be provided in accordance with OSHA standards. Our personnel are directed not to enter any trench by being lowered or "riding down" on the equipment.

Our personnel are directed not to enter any excavation which;

1. is 5 feet or deeper unless shored or laid back,
2. exit points or ladders are not provided,
3. displays any evidence of instability, has any loose rock or other debris which could fall into the trench, or
4. displays any other evidence of any unsafe conditions regardless of depth.

If the contractor fails to provide safe access to trenches for compaction testing, our company policy requires that the soil technician withdraws and notifies their supervisor. The contractors representative will then be contacted in an effort to effect a solution. All backfill not tested due to safety concerns or other reasons is subject to reprocessing and/or removal.

Procedures

In the event that the technician's safety is jeopardized or compromised as a result of the contractor's failure to comply with any of the above, the technician is directed to inform both the developer's and contractor's representatives. If the condition is not rectified, the technician is required, by company policy, to immediately withdraw and notify their supervisor. The contractor's representative will then be contacted in an effort to effect a solution. No further testing will be performed until the situation is rectified. Any fill placed in the interim can be considered unacceptable and subject to reprocessing, recompaction or removal.

In the event that the soil technician does not comply with the above or other established safety guidelines, we request that the contractor bring this to technicians attention and notify our project manager or office. Effective communication and coordination between the contractors' representative and the field technician(s) is strongly encouraged in order to implement the above safety program and safety in general.

The safety procedures outlined above should be discussed at the contractor's safety meetings. This will serve to inform and remind equipment operators of these safety procedures particularly the zone of non-encroachment.

The safety procedures outlined above should be discussed at the contractor's safety meetings. This will serve to inform and remind equipment operators of these safety procedures particularly the zone of non-encroachment.