Storm Water Quality Management Plan (SWQMP)

For

CarMax of National City

NWC of Plaza Bonita Road and Sweetwater Road,
National City, CA 91950

September 24, 2020

Prepared by

WILLIAM O'GORMAN, PE 88286
REC CONSULTANTS, INC.
2442 SECOND AVE
SAN DIEGO, CA 92101
(619) 232-9200

REGISTERED PROFESSIONAL ENGINEER
WILLIAM M. O'GORMAN
No. 88286
CIVIL
STATE OF CALIFORNIA

Intentionally Left Blank

Table of Contents

Tables

Appendices

1 Project Information

Table 1 summarizes basic project information.

Table 1. Project Summary

Project Name	CarMax of National City
Address/Location	Northwest Corner of Plaza Bonita Road and Sweetwater Road
APN(s)	564-471-11-00
Total Project Size (acres or square feet)	15.08 acres
Project Description	The project proposes to develop the site into a ~7.2-acre CarMax pre-owned automobile dealership with an attached presentation area, a service area and a non-public carwash, access drives, utilities, parking lots and landscaping. An additional, ~7.9 acre remainder parcel will also be created as part of the project for a realigned channel. The site grading and drainage has been designed to convey stormwater runoff from the developed portion of the site to four modular wetland systems for water quality and two underground detention systems for hydromodification flow control. To develop the site the project proposes to add 166,000 cubic yards of import and construct a ~4.3 acre earthen channel along the northern edge of the site to convey runoff from the ~3 square miles of offsite contributing areas. The channel will also receive the post-development runoff from the subject development after it discharges from the underground detention systems. The low flow portions of the channel will be designated for conservation mitigation and the remainder of the channel will be utilized for flood control.

1.1 Requirements Applicability

A completed storm water requirements applicability checklist, comprised of forms I-1 and I-2, is included in Appendix A. Additional detail about applicable requirements is provided below

The site is subject to the City's hydromodification/additional flow control requirements. Table 2 summarizes the projects status with regards to exemptions from hydromodification and critical coarse sediment yield requirements. Projects that are exempt from hydromodification management requirements are automatically exempt from implementing critical coarse sediment yield area management measures. Supporting explanation for any exemptions claimed is provided in the table, and maps or figures are provided where applicable.

Table 2. Hydromodification Management Requirements Applicability

Requirement	Exempt (Y/N)	If Exempt, Explain Why
Hydromodification management	N	The site is not exempt from hydromodification management requirements, according to the Exempt River Reaches Exhibit and the Hydromodification Management Exemption Map included under the San Diego Bay Watershed Management Area Analysis (WMAA) Attachments B.1 and B.2, respectively).
Critical coarse sediment yield area management measures	Y	The site is not considered a critical coarse sediment yield area according to the Potential Critical Coarse Sediment Yield Areas Map included under the San Diego Bay WMAA Attachment A.5 and the City of National City Map of Potential Critical Coarse Sediment Yield Areas (available on their web page at http://www.ci.national-city.ca.us/index.aspx?page=164).

1.2 Eligibility for Special BMP Sizing or Selection Standards

Eligibility for reduced BMP sizing or using alternative BMPs is summarized in Table 3. Any items marked "Y" are explained briefly below the table.

Table 3. Applicability of Special BMP Sizing or Selection Standards

Project Type	Applicable (Y/N)
Redevelopment qualifying for reduced BMP sizing due to 50% rule (Y/N): See Form I-2 for details. Only impervious area created or replaced is considered to be a Priority Development Project for projects that meet this criterion. BMPs are therefore sized only for the impervious area created or replaced.	N
Retrofitting or redevelopment of existing paved alleys, streets or roads that are designed and constructed in accordance with the USEPA Green Streets Guidance (Y/N): Eligible projects may select and design BMPs in accordance with green streets guidance. See Appendix J of the BMP Design Manual for details.	N

2 Drainage Management Areas and Site Design BMPs

The subject property has been subdivided into Drainage Management Areas (DMA), in accordance with the approach described in BMP Design Manual Section 3.3.3. Site design Low Impact Development (LID) BMPs have also been selected for the project, as summarized in Appendix B. Based on DMA characteristics and the extent of site design BMP implementation, each DMA has been classified using one of the following categories:

A. Drains to a structural BMP
B. Self-mitigating
C. De Minimis ***– N/A***

D. Self-retaining DMA treated using only site design (i.e., DCV after accounting for site design BMPs is zero)

The design capture volume (DCV) has been calculated for each DMA in categories A and D above. DCV calculations for these DMAs, including reductions to the DCV from site design BMP implementation, are included in Appendix C. Tables listing self-mitigating and de Minimis DMAs and demonstrating how the listed BMPs meet the appropriate criteria from the BMP Design Manual are also included in Appendix C.

Table 4 summarizes the DMAs by category and identifies applicable structural BMPs for each DMA that drains to a structural BMP.

Table 4. DMA Summary

	A		B	C	D
DMA ID	Structural BMP ID(s) that Provide Pollutant Control	Structural BMP ID(s) that Provide Hydromodification (Flow) Control	No BMPs: Self-Mitigating DMA[1]	No BMPs: *De Minimis* DMA[2]	Self-Retaining DMA Treated Using Only Site Design[3]
A	☑ (BMP-A)	☑ (BMP-UG1)			
B	☑ (BMP-B)	☑ (BMP-UG1)			
C	☑ (BMP-C)	☑ (BMP-UG2)			
D	☑ (BMP-D)	☑ (BMP-UG2)			
E					☑ (BMP-E)
F					☑ (BMP-F)
G	☑ (BMP-G)				
H			☑ (Channel)		

Notes

1. See BMP Design Manual Section 5.2.1 for characteristics required to qualify.
2. See BMP Design Manual Section 5.2.2 for characteristics required to qualify.
3. See BMP Design Manual Section 5.2.3. If this option is selected, the site design BMPs must be shown to achieve a DCV of 0 using the DMA Summary Worksheet.

An exhibit illustrating the delineated DMAs is included in Appendix D. The exhibit includes the following:

- Delineated DMA areas, along with a DMA ID (i.e., a name or ID number) for each DMA

- Natural and engineered conveyances within the project area and connections to offsite drainage systems
- Proposed buildings, paved areas, and other impervious surfaces
- Hydromodification point(s) of compliance, if applicable
- Critical coarse sediment yield areas to be protected, if any [
- Pollutant source areas that require installation of pre-treatment BMPs, if applicable
- Location and size, as applicable, of all
    - Site design BMPs for which DCV reduction is claimed
    - Source control BMPs that can be mapped (operational source control BMPs, such as sweeping or education, are not included on the map)
    - Structural BMPs for pollutant control and hydromodification control

3 Structural BMPs

3.1 Pollutant Control BMPs

Structural BMPs for pollutant control must be designed to treat the DCV for all DMAs that drain to each structural pollutant control BMP, as calculated in Appendix C. Retention BMPs (infiltration, bioretention with no underdrain, or harvest and reuse) have been used to the maximum extent practicable. BMP sizing calculations and supporting information to justify the type of BMP selected are provided in Appendix E. All BMPs and necessary information to show conformance to the applicable design standards in the BMP Design Manual are reflected on the project's plan sheets.

3.2 Hydromodification Controls

Table 5 summarizes hydromodification points of compliance and design criteria. Hydromodification design calculations and other supporting information, including electronic copies of continuous simulation model files where applicable, are provided in Appendix F.

Table 5. Hydromodification Points of Compliance (POC) Summary

POC ID	Receiving Water Body	Low Flow Threshold[1]	DMA IDs that Drain to the POC	Area of DMAs Draining to POC (ft^2)
1	Unnamed Tributary to Sweetwater River (earthen channel on northern edge of site)	0.1Q2	A through H	695,600

Note

1. Possible values are 0.1Q2, 0.3Q2, and 0.5Q2. Any value other than 0.1Q2 must be supported by channel assessment data. See BMP Design Manual Chapter 6.

3.2.1 Critical Coarse Sediment Yield Area Management Measures

Critical coarse sediment yield area management measures are not applicable according to the Potential Critical Coarse Sediment Yield Areas Map included under the San Diego Bay WMAA Attachment A.5 and the City of National City Map of Potential Critical Coarse Sediment Yield Areas (available on their web page at http://www.ci.national-city.ca.us/index.aspx?page=164).

3.3 Summary of Structural BMPs

All structural BMPs, including BMPs for pollutant control and hydromodification (flow) control, are summarized in Table 6.

Table 6. Structural BMP Summary Table

BMP ID No.	Structural BMP Type *(Select from the list below this table)*	Purpose(s)		DMA(s) draining to BMP	Construction Plan Sheet No(s).
		Pollutant Control	Hydromodification Control		
A	Modular Wetland System (BF-3)	☑		A	C-5.0--C-5.3
B	Modular Wetland System (BF-3)	☑		B	C-5.0--C-5.3
C	Modular Wetland System (BF-3)	☑		C	C-5.0--C-5.3
D	Modular Wetland System (BF-3)	☑		D	C-5.0--C-5.3
E	Street Tree (SD-1)	☑		E	C-5.0--C-5.3
F	Street Tree (SD-1)	☑		F	C-5.0--C-5.3
G	Green Street Vegetated Swale (FT-1)	☑		G	C-5.0--C-5.3
UG1	Underground Storage Tank		☑	A & B	C-5.0--C-5.3
UG2	Underground Storage Tank		☑	C & D	C-5.0--C-5.3

Structural BMP Types:

- Harvest and use (HU-1)
- Infiltration basin (INF-1)
- Bioretention (INF-2)
- Permeable pavement (INF-3)
- Biofiltration with partial retention (PR-1)
- Biofiltration (without retention) (BF-1)
- Biofiltration with Nutrient Sensitive Media Design (BF-2)
- Detention pond or vault for hydromodification management
- Other (describe)

Notes

- Proprietary Biofiltration (BF-3) can only be used if it meets the requirements of Appendix F of the BMP Design Manual.
- Flow-thru treatment control BMPs, unless used solely for pre-treatment, may only be used as part of an alternative compliance program. See Section 1.8 of the BMP Design Manual for more information.

Pre-treatment BMPs

All structural BMPs that will be used for pre-treatment purposes only are described below, including the type of BMP and which of the BMPs from the table above it provides pre-treatment for. Sizing calculations are included in Appendix E.

4 Source Control BMPs

Source control BMPs have been implemented throughout the project, where applicable and feasible. Source control BMPs proposed for the project are indicated on a completed version of National City BMP Design Manual Appendix E.1, which is included as Appendix G of this SWQMP.

5 Operation and Maintenance

A copy of the maintenance agreement that the property owner will record against the property prior to project completion is also included in Appendix H. The project's operation and maintenance plan (O&M Plan) for proposed BMPs, which will be attached to the maintenance agreement is also included in Appendix H. The O&M Plan includes the following components:

- An exhibit showing the locations of all proposed structural pollutant control and hydromodification management (flow control) BMPs proposed. This exhibit may be the same as the DMA exhibit provided in Appendix D.
- An exhibit showing applicable cross sections for all proposed structural pollutant control and hydromodification management BMPs proposed.
- Specific maintenance indicators and actions for each class of proposed structural BMP(s), based on the tables provided in Section 7.7 of the National City BMP Design Manual.
- Additional information necessary to perform maintenance, if applicable:
  - Description of any features that are provided to facilitate inspection (e.g., observation ports, cleanouts, silt posts, or other features that allow the inspector to view necessary components of the structural BMP and compare to maintenance thresholds)
  - Instructions on how to access the structural BMP(s) to inspect and perform maintenance, if access is not straightforward
  - Recommended equipment to perform maintenance, if special equipment is required
  - Necessary special training or certification requirements for inspection and maintenance personnel such as confined space entry or hazardous waste management

A copy of the Stormwater Facilities Maintenance Agreement that the property owner will record against the property prior to project completion is also included in Appendix H.

Appendix A

Completed Applicability Checklists (Forms I-1 and I-2)

Intentionally Left Blank

City of National City
Engineering

Storm Water BMP Requirements Applicability Form
(Storm Water Intake Form for all Development Permit Applications)

Form I-1

Project Information

Project Title: CarMax of National City

Project Address/Location: Northwest Corner of Plaza Bonita Road and Sweetwater Road

Brief Description of Work Proposed:
Construct a ~7.2-acre CarMax pre-owned auto dealership with access drives, utilities, parking and landscaping, a realigned channel on a ~7.9 ac remainder parcel, and a sidewalk along

Determination of Requirements

Answer each step below, starting with Step 1 and progressing through each step until reaching "Stop". **Upon reaching a Stop, do not complete further Steps beyond the Stop.**

Step	Answer	Progression
Step 1: Does the project consist exclusively of one or both of the activity types below? - Project with no soil disturbance or change to building general exterior dimensions or structural framing. *Examples:* interior remodeling, electrical work, HVAC work, plumbing, etc. - Routine maintenance. *Examples:* roof repairs, pavement repairs or resurfacing, resurfacing or repairing existing sidewalks or pedestrian ramps, trenching and resurfacing associated with utility work, or rebuilding a structure to its original design after a fire or natural disaster.	☐ Yes	**STOP.** Project is Exempt No permanent storm water BMP plan is required. - Interior projects are not subject storm water requirements. - Outdoor, routine maintenance projects not requiring a grading plan must include the standard "Construction Storm Water BMP Notes" on their site plans.
	☒ No	Go to Step 2.
Step 2: Does the project create or replace less than 2,500 square feet of impervious area (rooftop or pavement, including roads, sidewalks, parking lots, concrete patios, etc.) AND is also not an automotive repair shop or a retail gasoline outlet?	☐ Yes	**STOP.** Project is a Standard Project Incorporate "Permanent Storm Water BMP Notes" into site plan. If no grading plan is required also include "Construction Storm Water BMP Notes."
	☒ No	Complete and attach Form I-2.

Certification

Name of Person Completing Form	William O'Gorman, PE		
Role	Project Engineer	**Phone**	(619) 232-9200
Company	REC Consultants, Inc.	**Email**	william@rec-consultants.com
Signature	William O'Gorman	**Date**	7-10-20

Owner Contact Information (if different from above signatory)

Name	John Thatcher		
Email	jthatcher@centerpoint-is.com		
Company	CENTERPOINT INTEGRATED SOLUTIONS	**Phone**	(720)445-4385

The following construction BMP notes shall be added to the site plan as determined in the completion of forms I-1 and I-2:

Construction Storm Water BMP Notes

1. All applicable construction BMPs and non-storm water discharge BMPs shall be implemented in accordance with the City of National City minimum BMP requirements included in the National City Municipal Code and the City of National City Jurisdictional Runoff Management Program (JRMP). All storm water BMPs shall be maintained for the duration of the project.
2. Erosion control BMPs shall be implemented for all portions of the project area in which no work has been done or is planned to be done over a period of 14 or more days. All onsite drainage pathways that convey concentrated flows shall be stabilized to prevent erosion.
3. Run-on from areas outside the project area shall be diverted around work areas to the extent feasible. Run-on that cannot be diverted shall be managed using appropriate erosion and sediment control BMPs.
4. Sediment control BMPs shall be implemented, including providing fiber rolls, gravel bags, or other equally effective BMPs around the perimeter of the project to prevent transport of soil and sediment offsite. Any sediment tracked onto offsite paved areas shall be removed via sweeping at least daily. All BMPs shall be installed and maintained in accordance with the applicable CASQA fact sheets.
5. Trash and other construction wastes shall be placed in a designated area at least daily and shall be disposed of in accordance with applicable requirements.
6. Materials shall be stored to avoid being transported in storm water runoff and non-storm water discharges. Concrete washout shall be directed to a washout area designed in accordance with CASQA standards; concrete shall not be washed out to the ground.
7. Stockpiles and other sources of pollutants shall be covered when the chance of rain within the next 48 hours is at least 50%.

The following post-construction (permanent) BMP notes listed shall be added to the site plan for all Standard Projects, except where not applicable and feasible as determined by the City of National City.

Permanent Storm Water BMP Notes

1. Landscaped areas shall be designed in accordance with Water Efficient Landscape Ordinance requirements.
2. Roof drainage shall be directed to landscaped areas or rain barrels.
3. Walkways shall be designed to drain to adjacent landscaped or natural areas or constructed using permeable materials.
4. Streets, sidewalks, and parking lot aisles shall be constructed to the minimum width necessary, provided public safety is not compromised.
5. Existing trees and natural areas, including but not limited to natural water bodies and natural storage reservoirs or drainage corridors (e.g., topographic depressions, natural swales, and areas of naturally permeable soils), shall be conserved or otherwise protected to the extent feasible.

6. The impervious footprint, including roofed areas and paved areas, of the project shall be minimized to the extent applicable and feasible.
7. Dumpsters, other trash receptacles, and waste cooking oil containers shall be stored inside buildings or in four-sided enclosures with a structural overhead canopy designed to prevent precipitation from contacting materials stored in the enclosure.
8. Onsite storm drains shall be stenciled or otherwise permanently labeled with “No Dumping, Drains to Ocean” or other equivalent language approved by the City.
9. Outdoor material storage areas and outdoor work areas shall be protected from rainfall, run-on, and wind dispersal.

Storm Water BMP Requirements for Standard and Priority Development Projects

Form I-2

Project Information

Project Title: CarMax of National City

Project Address/Location: Northwest corner of Sweetwater Road and Plaza Bonita Road

The project is (select one): ☒ New Development ☐ Redevelopment[†]

Project total disturbed area: 695,600 ft² *(Note: 1 acre = 43,560 ft²)*

Total proposed newly created or replaced impervious area: 288,361 ft²
(Impervious area includes rooftops and impermeable pavement, such as concrete or asphalt).

Step 1. Identify Applicable Project Categories

Mark whether each of the following categories describes the proposed project by indicating "Yes" or "No".

1.1) New development projects that create 10,000 square feet or more of impervious surfaces (collectively over the entire project site). This includes commercial, industrial, residential, mixed-use, and public development projects on public or private land.	Yes ☒	No ☐
1.2) Redevelopment projects that create and/or replace 5,000 square feet or more of impervious surface (collectively over the entire project site on an existing site of 10,000 square feet or more of impervious surfaces). This includes commercial, industrial, residential, mixed-use, and public development projects on public or private land.	Yes ☐	No ☒
1.3) New and redevelopment projects that create and/or replace 5,000 square feet or more of impervious surface (collectively over the entire project site), and support one or more of the following uses: (i) Restaurants. This category is defined as a facility that sells prepared foods and drinks for consumption, including stationary lunch counters and refreshment stands selling prepared foods and drinks for immediate consumption (Standard Industrial Classification (SIC) code 5812). (ii) Hillside development projects. This category includes development on any natural slope that is twenty-five percent or greater. (iii) Parking lots. This category is defined as a land area or facility for the temporary parking or storage of motor vehicles used personally, for business, or for commerce. (iv) Streets, roads, highways, freeways, and driveways. This category is defined as any paved impervious surface used for the transportation of automobiles, trucks, motorcycles, and other vehicles. *Note that this does not include routine maintenance projects as noted on Form I-1 and defined in more detail in Chapter 1 of the BMP Design Manual.*	Yes ☒	No ☐

[†] Redevelopment is any land-disturbing activity that results in the creation, addition, or replacement of exterior impervious surface on a site on which some past development has occurred. Examples include the expansion of a building footprint, road widening, and the addition to or replacement of a structure. Replacement of impervious surfaces includes any activity where impervious material(s) are removed, exposing underlying soil during construction. Redevelopment does not include routine maintenance activities, such as trenching, and resurfacing associated with utility work; pavement grinding and resurfacing of existing roadways; construction of new sidewalk, pedestrian ramps, or bike lanes on existing roadways; or routine replacement of damaged pavement such as pothole repair.

Storm Water BMP Requirements for Standard and Priority Development Projects

Form I-2

1.4) New or redevelopment projects that create or replace 2,500 square feet or more of impervious surface (collectively over the entire project site), and discharging directly to an Environmentally Sensitive Area (ESA). "Discharging directly to" includes flow that is conveyed overland a distance of 200 feet or less from the project to the ESA, or conveyed in a pipe or open channel any distance as an isolated flow from the project to the ESA (i.e. not commingled with flows from adjacent lands). *Note: a map of ESAs identified in the City of National City is available at the Engineering Counter and on the City's storm water website. See manual Section 1.4.2 for additional guidance.*	Yes ☐	No ☒
1.5) New development projects of any size, or redevelopment projects that create and/or replace 5,000 square feet or more of impervious surface, that support one or more of the following uses: (i) Automotive repair shops. This category is defined as a facility categorized in any one of the following SIC codes: 5013, 5014, 5541, 7532-7534, or 7536-7539. (ii) Retail gasoline outlets (RGOs). This category includes RGOs that meet the following criteria: (a) 5,000 square feet or more or (b) a projected Average Daily Traffic (ADT) of 100 or more vehicles per day.	Yes ☐	No ☒
1.6.a) New or redevelopment projects that result in the disturbance of one or more acres of land and are expected to generate pollutants after the completion of construction. *Note: most projects are expected to generate pollutants after the completion of construction. If your project is at least one acre but you believe it will not generate pollutants after the completion of construction, include an explanation below in box 1.6.b. See BMP Design Manual Section 1.4.2 for additional guidance.*	Yes ☒	No ☐
1.6.b) Explanation, if marked "No" and project is at least one acre :		

Are any of the categories above marked as "Yes"?

☒ Yes – Complete Step 2.

☐ No – **STOP.** The project is a Standard Project. Incorporate Permanent Storm Water BMP Notes into site plan. If no grading plan is required also include "Construction Storm Water BMP Notes."

Stormwater BMP Requirements for Standard and Priority Development Projects	**Form I-2**
Step 2. Priority Development Project (PDP) Exemptions	
Does the project consist exclusively of either of the activity types below?	
2.1) New or retrofit paved sidewalks, bicycle lanes, or trails that meet any of the following criteria: (i) Designed and constructed to direct storm water runoff to adjacent vegetated areas, or other non-erodible permeable areas (ii) Designed and constructed to be hydraulically disconnected from paved streets or roads (iii) Designed and constructed with permeable pavements or surfaces. *(Routine maintenance is always exempt, see form I-1)*	☐ Yes – **STOP.** The project is a <u>Standard Project.</u> Incorporate Construction Storm Water BMP Notes and Permanent Storm Water BMP Notes into site plan.
	☒ No. Answer box 2.2 below.
2.2) Retrofitting or redevelopment of existing paved alleys, streets or roads that are designed and constructed in accordance with the USEPA Green Streets guidance (see BMP Design Manual for details).	☐ Yes – **STOP.** The project is <u>not a PDP</u> but must meet Green Streets standards. Contact Engineering staff for details before proceeding with project design.
	☒ No. The project is a <u>PDP</u>*. Go to Step 3.
Step 3. Special Sizing for Redevelopment (Redevelopment Priority Development Projects only)	
3.1) Is the project a redevelopment project?	☐ Yes. Complete box 3.2 below.
	☒ No. Go to Step 4.
3.2) The area of existing (pre-project) impervious area at the project site is: ___________ ft^2 (A) The total proposed newly created or replaced impervious area is ___________ ft^2 (B) Percent impervious surface created or replaced, (B/A)*100 = ________% The percent impervious surface created or replaced is (select one based on the above calculation):	☐ less than or equal to 50%. Only created/replaced impervious areas are considered <u>PDP</u>*. Continue to Step 4.
	☐ greater than 50%. The entire project site is a <u>PDP</u>*. Continue to Step 4.

* If the project does not require a grading permit, a "Construction BMP Plan for Priority Development Projects without Grading Permits" is required. Construction BMP Plan must also include the "Construction Storm Water BMP Notes."

Stormwater BMP Requirements for Standard and Priority Development Projects

Form I-2

Step 4. Hydromodification Requirements (Priority Development Projects only)

4.1) Does the project discharge storm water runoff to any of the following? (i) Existing underground storm drains discharging directly to water storage reservoirs, lakes, enclosed embayments (including San Diego Bay), or the Pacific Ocean (ii) Conveyance channels whose bed and bank are concrete lined all the way from the point of discharge to water storage reservoirs, lakes, enclosed embayments (including San Diego Bay), or the Pacific Ocean (iii) Existing underground storm drains or conveyance channels whose bed and bank are concrete lined all the way from the point of discharge to the Sweetwater River. *This exemption cannot be claimed until the San Diego Bay WQIP has been approved. Check with Engineering staff for details.*	☐ Yes – **STOP.** The project is a PDP* that is exempt from hydromodification (flow) control requirements. Prepare and submit SWQMP documenting project compliance with numeric sizing standards for pollution control requirements.
	☒ No. Project is a PDP*. Answer the question in box 4.2 below to determine applicability of additional requirements. (At a minimum the project must meet numeric sizing standards for pollutant control **and** hydromodification (flow) control.)
4.2 Does protection of critical coarse sediment yield areas apply based on review of the Potential Critical Coarse Sediment Yield Area Map? *See the map on the City's Storm Water web page and at the Engineering Counter.*	☐ Yes – **STOP**. The project is a PDP*. Prepare and submit a SWQMP that meets sizing standards for pollutant control, hydromodification (flow) control and analysis of potential critical coarse sediment yield areas and associated management measures. See BMP Design Manual Section 6.2.
	☒ No – **STOP**. The project is a PDP*. Prepare and submit a SWQMP that meets sizing standards for pollutant control, and hydromodification (flow) control.

* If the project does not require a grading permit, a "Construction BMP Plan for Priority Development Projects without Grading Permits" is required. Construction BMP Plan must also include the "Construction Storm Water BMP Notes."

Intentionally Left Blank

Appendix B

Site Design BMP Checklist

Intentionally Left Blank

Site Design BMP Checklist
for All Development Projects
(Standard Projects and Priority Development Projects)

Appendix B

All development projects must implement site design BMPs SD-1 through SD-8 where applicable and feasible. See Chapter 4 and Appendix E of the BMP Design Manual for information to implement site design BMPs shown in this checklist.

Also note that landscaping designed in accordance with the City's Water Efficient Landscape Ordinance (Chapter 18.44 of the National City Municipal Code) will likely meet several of the stormwater site design requirements (e.g. draining impervious surfaces to landscaping, using soil amendments, etc.)

Answer each category below pursuant to the following.

- "Yes" means the project will implement the site design BMP as described in Chapter 4 and/or Appendix E of the BMP Design Manual. Discussion / justification is not required.
- "No" means the BMP is applicable to the project but it is not feasible to implement. Discussion / justification must be provided.
- "N/A" means the BMP is not applicable at the project site because the project does not include the feature that is addressed by the BMP (e.g., the project site has no existing natural areas to conserve). Discussion / justification may be provided.

Site Design Requirement	Applied?		
SD-1 Maintain Natural Drainage Pathways and Hydrologic Features	☑ Yes	☐ No	☐ N/A

Examples of BMPs in this category:

- Maintain natural drainage direction (typically, by minimizing grading that changes drainage directions and discharge points)
- Maintain natural drainage courses (e.g., maintain existing natural gullies, channels, depressions, etc.)
- Maintain, restore, or create buffer zones for natural water bodies
- Incorporate street trees

Discussion / justification if SD-1 not implemented:

Site development will reduce natural drainage features onsite. Drainage patterns will be modified, but efforts have been made to conserve portions of the existing stream bed and riparian resources. The project will also include conservation habitat within the realigned channel (planted with native vegetation as part of the wetlands mitigation). The channel has been designed to convey flows in a similar manner as pre-development conditions.

SD-2 Conserve Natural Areas, Soils, and Vegetation	☑ Yes	☐ No	☐ N/A

Examples of BMPs in this category:

- Preserve existing trees, bushes, and/or other vegetation
- Preserve natural areas on the site (leave them undisturbed)
- Comply with State and federal law for avoiding or mitigating impacts of development in sensitive or protected areas, such as natural streams, wetlands, and areas providing habitat for listed species

Discussion / justification if SD-2 not implemented:

Some of the natural resources including portions of the natural soils and vegetation will be preserved onsite. Additionally a conservation mitigation easement will be built within the realigned channel as part of the project.

SD-3 Minimize Impervious Area	☑ Yes	☐ No	☐ N/A

Examples of BMPs in this category:

- Construct roads, parking lot aisles, sidewalks, etc. to minimum necessary widths
- Share parking lots or driveways with adjacent properties
- Incorporate parking structures or underground parking
- Decrease building footprint through compact and/or taller structures
- Minimize impervious surfaces in landscape design
- Incorporate landscaped center of cul-de-sac
- Incorporate pervious (e.g., turf block) fire lane
- Green roofs and/or pervious pavement per SD-5 and SD-6 below

Discussion / justification if SD-3 not implemented:

Impervious surfaces including sidewalks, parking spaces and drive aisles have been reduced to the maximum extent practicable. Due to its use, the sales lot in particular has been designed with reduced parking spaces and drive aisles.

SD-4 Minimize Soil Compaction ☑ Yes ☐ No ☐ N/A

Examples of BMPs in this category:

- Protect planned green space and proposed landscaped areas during construction (i.e., so construction vehicles do not drive over them)
- Re-till soil and/or add soil amendments to proposed landscaped areas (toward the end of the project, but before final landscaping work)

Discussion / justification if SD-4 not implemented:

The majority of the site will receive imported (fill) soils to raise the elevation and for these areas soil compaction will be required. Portions of the channel are to be preserved and will be protected during construction.

SD-5 Impervious Area Dispersion, **SD-6** Runoff Collection, and **SD-8** Harvesting and Using Precipitation ☑ Yes ☐ No ☐ N/A

Examples of BMPs in this category:

- Drain rooftops to landscaping or planter boxes
- Drain impervious parking lots, sidewalks, patios, and/or other paved areas to landscaping
- Incorporate vegetated swales into the drainage design (e.g., instead of curb and gutter)
- Incorporate pervious pavement for low traffic areas and/or walkways *(see Appendix E fact sheet SD-6B* of the BMP Design Manual*)*
- Incorporate green roofs *(see Appendix E fact sheet SD-6A* of the BMP Design Manual*)*
- Rain barrels (see Appendix E fact sheet SD-8 of the BMP Design Manual)

Discussion / justification if SD-5 and SD-6 not implemented:

SD-6 has been incorporated into the site design but SD-5 & SD-8 has not. The entire project has been designed to convey stormwater runoff from impervious surfaces into the modular wetland system and underground detention system to improve water quality and manage the flowrates in accordance with the City's hydromodification requirements. A vegetated swale will be constructed in the right of way to treet runoff from the proposed sidewalk and a portion of the driveway. Since the impervious:pervious ratio is greater than 4.0, the project cannot claim the SD-5 credits to reduce the Design Capture Volume (DCV).

SD-7 Landscaping with Native or Drought Tolerant Species ☑ Yes ☐ No ☐ N/A

- See Appendix E, Fact Sheet PL of the BMP Design Manual for a recommended plant list

Discussion / justification if SD-7 not implemented:
Native and drought tolerant species have been incorporated into the landscaping plans for the entire development including the landscaped islands throughout the parking, slopes, and the realigned channel as part of the projects conservation mitigation.

Intentionally Left Blank

Appendix C

Drainage Management Area Characteristics and Calculations

Indicate which items are included behind this cover sheet

Contents	Included (Y/N)
C.1. Self-Mitigating DMAs	Y
C.2. De Minimis DMAs[1]	Y
C.3. DMA Design Capture Volume Calculations	Y

[1] Please note that project design does not include any De Minimis DMAs, and Appendix C.2 has been marked "*N/A*" to reflect this.

Intentionally Left Blank

Appendix C.1. Self-Mitigating DMAs

DMA ID	All Vegetation Is Native and/or Non-Invasive, Drought-Tolerant Vegetation not Requiring Regular Use of Pesticides and Fertilizers (Y/N)	Soil Is Undisturbed Native Topsoil or Equivalent[1] (Y/N)	DMA Total Area (ft^2)	DMA Impervious Area (ft^2)	DMA % Impervious (Must be <5%)	Impervious Area Is not Hydraulically Connected to Other Impervious Areas[2] (Y/N)	Does not Drain to a Structural Pollutant Control BMP (Y/N)
H	Y	Y	378,616	0.00	☑	Y	Y

Notes

1. I.e., disturbed soils that have been amended and aerated to promote water retention characteristics equivalent to undisturbed native topsoil.

2. Impervious area that is part of the storm water conveyance system, such as brow ditches, is exempted from this requirement. If storm water conveyance is the only impervious area within the DMA that is hydraulically connected to other impervious areas, this question can still be marked as "Y".

Appendix C.2. De Minimis DMAs

DMA ID	DMA Area Abuts the Perimeter of the Site (Y/N)	Is not Hydraulically Connected to Another De Minimis DMA (Y/N)	DMA Total Area (ft^2) (Must be <250 ft^2)	Explanation of Why Capturing or Treating Runoff Is not Feasible and How Site Design BMPs Have Been Used to the Maximum Extent Practicable[1]
N/A	N/A	N/A	N/A	N/A

Sum of De Minimis DMA Areas (ft^2)	0
Total Added/Replaced Impervious Area[2] (ft^2)	280,353
De Minimis Area/Impervious Area[3] (%)	0

Notes

1. The explanation indicates why, due to topography and/or land ownership constraints, site design BMP implementation to make the DMA self-retaining, site layout to make the DMA self-mitigating, and structural BMP construction to treat the DCV are all technically infeasible.

2. This total is for the entire project, not just for the de Minimis DMAs.

3. This percentage is calculated as (Sum of De Minimis DMA Areas)/(Total Added/Replaced Impervious Area for the entire project). The percentage must be less than 2% to meet BMP Design Manual Requirements.

N/A -- the subject development does not include any De Minimis DMAs

Appendix C.3 DMA Design Capture Volume Calculations

85th Percentile Rainfall (inches): 0.57

DMA ID: A

Hydrologic Soil Group (A, B, C, or D)	Post-Project Surface Type (*See Table B.1-1*)	Area of Surface Type (ft^2)	Post-Project Surface Runoff Factor (*C*) (*See Table B.1-1*)	Runoff Reduction from Site Design BMPs (*Select Only One*)	Tributary Impervious/ Receiving Pervious Area Ratio[1]	*C* Factor Adjustment[2] (*See Table B.2-1*)	Final *C* Factor	Street Tree Volume Reduction[3] (ft^3)	Rain Barrel Volume Reduction[4] (ft^3)	Design Capture Volume (DCV)[5] (ft^3)
C	Impervious parking lot	62,090	0.90	None Claimed	N/A	1	0.9	N/A	N/A	2,654
C	Landscaping	4,209	0.10	None Claimed	N/A	1	0.1	N/A	N/A	20
	Total DMA Area (ft^2)	66,299				**Weighted Average C Factor for DMA**	0.85		**Total DCV for DMA (ft^3)**	**2,674**

Additional Notes Documenting Rationale for Runoff Reduction from Site Design BMPs

Notes

1. If the area is pervious or if runoff dispersion site design BMPs are not proposed, enter "NA".
2. If the area is pervious or if runoff dispersion site design BMPs are not proposed, enter "1" in this column.
3. Include a separate line item in this table for each street tree and its tributary drainage area, or include supplemental information to demonstrate that the 85th percentile runoff of the impervious area draining to each street tree does not exceed the volume reduction credit being claimed for each street tree. Also include supplemental information documenting the mature tree canopy size of the street tree. Trees must be implemented in accordance with SD-1. Total tree volume reduction must be less than 0.25 times the DCV for the entire project, and each single tree volume credit must be less than 400 cu-ft (see Appendix B.2.2.1 for more information).
4. To be granted a credit here, rain barrels must meet the standards described in Section B.2 and fact sheet SD-8. Enter credit in cubic feet, not gallons.
5. DCV = (Final C Factor) x (85th Percentile Rainfall)/12 x (Area of Surface Type) - (Street Tree Volume Reduction) - (Rain Barrel Volume Reduction). Note that only one Site Design volume reduction credit can be applied for each area, however. For example, runoff dispersion and rain barrel volume reduction cannot both be claimed for the same line item area.

85th Percentile Rainfall (inches): 0.57

DMA ID:	B									
Hydrologic Soil Group (A, B, C, or D)	**Post-Project Surface Type (*See Table B.1-1*)**	**Area of Surface Type (ft^2)**	**Post-Project Surface Runoff Factor (*C*) (*See Table B.1-1*)**	**Runoff Reduction from Site Design BMPs (*Select Only One*)**	**Tributary Impervious/ Receiving Pervious Area Ratio[1]**	***C* Factor Adjustment[2] (*See Table B.2-1*)**	**Final *C* Factor**	**Street Tree Volume Reduction[3] (ft^3)**	**Rain Barrel Volume Reduction[4] (ft^3)**	**Design Capture Volume (DCV)[5] (ft^3)**
C	Impervious parking lot	56,876	0.90	None Claimed	N/A	1	0.9	N/A	N/A	2,431
C	Landscaping	921	0.10	None Claimed	N/A	1	0.1	N/A	N/A	4
	Total DMA Area (ft^2)	57,797		**Weighted Average C Factor for DMA**			0.89	**Total DCV for DMA (ft^3)**		**2,435**

Additional Notes Documenting Rationale for Runoff Reduction from Site Design BMPs

Notes

1. If the area is pervious or if runoff dispersion site design BMPs are not proposed, enter "NA".
2. If the area is pervious or if runoff dispersion site design BMPs are not proposed, enter "1" in this column.
3. Include a separate line item in this table for each street tree and its tributary drainage area, or include supplemental information to demonstrate that the 85th percentile runoff of the impervious area draining to each street tree does not exceed the volume reduction credit being claimed for each street tree. Also include supplemental information documenting the mature tree canopy size of the street tree. Trees must be implemented in accordance with SD-1. Total tree volume reduction must be less than 0.25 times the DCV for the entire project, and each single tree volume credit must be less than 400 cu-ft (see Appendix B.2.2.1 for more information).
4. To be granted a credit here, rain barrels must meet the standards described in Section B.2 and fact sheet SD-8. Enter credit in cubic feet, not gallons.
5. DCV = (Final C Factor) x (85th Percentile Rainfall)/12 x (Area of Surface Type) - (Street Tree Volume Reduction) - (Rain Barrel Volume Reduction). Note that only one Site Design volume reduction credit can be applied for each area, however. For example, runoff dispersion and rain barrel volume reduction cannot both be claimed for the same line item area.

85th Percentile Rainfall (inches): 0.57

DMA ID: C

Hydrologic Soil Group (A, B, C, or D)	Post-Project Surface Type (*See Table B.1-1*)	Area of Surface Type (ft²)	Post-Project Surface Runoff Factor (*C*) (*See Table B.1-1*)	Runoff Reduction from Site Design BMPs (*Select Only One*)	Tributary Impervious/ Receiving Pervious Area Ratio[1]	*C* Factor Adjustment[2] (*See Table B.2-1*)	Final *C* Factor	Street Tree Volume Reduction[3] (ft³)	Rain Barrel Volume Reduction[4] (ft³)	Design Capture Volume (DCV)[5] (ft³)
C	Impervious parking lot, Building	76,822	0.90	None Claimed	N/A	1	0.9	N/A	N/A	3,284
C	Landscaping	619	0.10	None Claimed	N/A	1	0.1	N/A	N/A	3
	Total DMA Area (ft²)	77,441			**Weighted Average C Factor for DMA**		0.89	**Total DCV for DMA (ft³)**		**3,287**

Additional Notes Documenting Rationale for Runoff Reduction from Site Design BMPs

Notes

6. If the area is pervious or if runoff dispersion site design BMPs are not proposed, enter "NA".
7. If the area is pervious or if runoff dispersion site design BMPs are not proposed, enter "1" in this column.
8. Include a separate line item in this table for each street tree and its tributary drainage area, or include supplemental information to demonstrate that the 85th percentile runoff of the impervious area draining to each street tree does not exceed the volume reduction credit being claimed for each street tree. Also include supplemental information documenting the mature tree canopy size of the street tree. Trees must be implemented in accordance with SD-1. Total tree volume reduction must be less than 0.25 times the DCV for the entire project, and each single tree volume credit must be less than 400 cu-ft (see Appendix B.2.2.1 for more information).
9. To be granted a credit here, rain barrels must meet the standards described in Section B.2 and fact sheet SD-8. Enter credit in cubic feet, <u>not</u> gallons.
10. DCV = (Final C Factor) x (85th Percentile Rainfall)/12 x (Area of Surface Type) - (Street Tree Volume Reduction) - (Rain Barrel Volume Reduction). Note that <u>only one</u> Site Design volume reduction credit can be applied for each area, however. For example, runoff dispersion and rain barrel volume reduction cannot both be claimed for the same line item area.

85th Percentile Rainfall (inches): 0.57

DMA ID: D

DMA ID:

Hydrologic Soil Group (A, B, C, or D)	Post-Project Surface Type (*See Table B.1-1*)	Area of Surface Type (ft^2)	Post-Project Surface Runoff Factor (*C*) (*See Table B.1-1*)	Runoff Reduction from Site Design BMPs (*Select Only One*)	Tributary Impervious/ Receiving Pervious Area Ratio[1]	*C* Factor Adjustment[2] (*See Table B.2-1*)	Final *C* Factor	Street Tree Volume Reduction[3] (ft^3)	Rain Barrel Volume Reduction[4] (ft^3)	Design Capture Volume (DCV)[5] (ft^3)
C	Impervious parking lot, Building	81,628	0.90	None Claimed	N/A	1	0.9	N/A	N/A	3,490
C	Landscaping	2,213	0.10	None Claimed	N/A	1	0.1	N/A	N/A	11
	Total DMA Area (ft^2)	83,841		**Weighted Average C Factor for DMA**			0.88	**Total DCV for DMA (ft^3)**		**3,501**

Additional Notes Documenting Rationale for Runoff Reduction from Site Design BMPs

Notes

Notes

1. If the area is pervious or if runoff dispersion site design BMPs are not proposed, enter "NA".
2. If the area is pervious or if runoff dispersion site design BMPs are not proposed, enter "1" in this column.
3. Include a separate line item in this table for each street tree and its tributary drainage area, or include supplemental information to demonstrate that the 85th percentile runoff of the impervious area draining to each street tree does not exceed the volume reduction credit being claimed for each street tree. Also include supplemental information documenting the mature tree canopy size of the street tree. Trees must be implemented in accordance with SD-1. Total tree volume reduction must be less than 0.25 times the DCV for the entire project, and each single tree volume credit must be less than 400 cu-ft (see Appendix B.2.2.1 for more information).
4. To be granted a credit here, rain barrels must meet the standards described in Section B.2 and fact sheet SD-8. Enter credit in cubic feet, <u>not</u> gallons.
5. DCV = (Final C Factor) x (85th Percentile Rainfall)/12 x (Area of Surface Type) - (Street Tree Volume Reduction) - (Rain Barrel Volume Reduction). Note that <u>only one</u> Site Design volume reduction credit can be applied for each area, however. For example, runoff dispersion and rain barrel volume reduction cannot both be claimed for the same line item area.

85th Percentile Rainfall (inches): 0.57

DMA ID: E

Hydrologic Soil Group (A, B, C, or D)	Post-Project Surface Type (*See Table B.1-1*)	Area of Surface Type (ft²)	Post-Project Surface Runoff Factor (*C*) (*See Table B.1-1*)	Runoff Reduction from Site Design BMPs (*Select Only One*)	Tributary Impervious/ Receiving Pervious Area Ratio[1]	*C* Factor Adjustment[2] (*See Table B.2-1*)	Final *C* Factor	Street Tree Volume Reduction[3] (ft³)	Rain Barrel Volume Reduction[4] (ft³)	Design Capture Volume (DCV)[5] (ft³)
C	Impervious driveway	1,279	0.90	(See below)	N/A	1	0.9	(See below)	N/A	55
C	Landscaping	1,126	0.10	(See below)	N/A	1	0.1	(See below)	N/A	5
-	-	-	-	15’ Street Tree	-	-	-	100	-	-100
	Total DMA Area (ft²)	2,405		**Weighted Average C Factor for DMA**			0.53	**Total DCV for DMA (ft³)**		**0**

Additional Notes Documenting Rationale for Runoff Reduction from Site Design BMPs

A slotted drain will be placed at along the driveway at the ROW to direct stormwater to a 15’ street tree. It was not feasible to drain this area to a structural BMP.

Notes

1. If the area is pervious or if runoff dispersion site design BMPs are not proposed, enter "NA".
2. If the area is pervious or if runoff dispersion site design BMPs are not proposed, enter "1" in this column.
3. Include a separate line item in this table for each street tree and its tributary drainage area, or include supplemental information to demonstrate that the 85th percentile runoff of the impervious area draining to each street tree does not exceed the volume reduction credit being claimed for each street tree. Also include supplemental information documenting the mature tree canopy size of the street tree. Trees must be implemented in accordance with SD-1. Total tree volume reduction must be less than 0.25 times the DCV for the entire project, and each single tree volume credit must be less than 400 cu-ft (see Appendix B.2.2.1 for more information).
4. To be granted a credit here, rain barrels must meet the standards described in Section B.2 and fact sheet SD-8. Enter credit in cubic feet, not gallons.
5. DCV = (Final C Factor) x (85th Percentile Rainfall)/12 x (Area of Surface Type) - (Street Tree Volume Reduction) - (Rain Barrel Volume Reduction). Note that only one Site Design volume reduction credit can be applied for each area, however. For example, runoff dispersion and rain barrel volume reduction cannot both be claimed for the same line item area.

85th Percentile Rainfall (inches): 0.57

DMA ID: F

Hydrologic Soil Group (A, B, C, or D)	Post-Project Surface Type (*See Table B.1-1*)	Area of Surface Type (ft^2)	Post-Project Surface Runoff Factor (*C*) (*See Table B.1-1*)	Runoff Reduction from Site Design BMPs (*Select Only One*)	Tributary Impervious/ Receiving Pervious Area Ratio[1]	*C* Factor Adjustment[2] (*See Table B.2-1*)	Final *C* Factor	Street Tree Volume Reduction[3] (ft^3)	Rain Barrel Volume Reduction[4] (ft^3)	Design Capture Volume (DCV)[5] (ft^3)
C	Impervious driveway	1,658	0.90	(See below)	N/A	1	0.9	(See below)	N/A	71
C	Landscaping	1,437	0.10	(See below)	N/A	1	0.1	(See below)	N/A	7
-	-	-	-	15' Street Tree	-	-	-	100	-	-100
	Total DMA Area (ft^2)	3,095			**Weighted Average C Factor for DMA**		0.53	**Total DCV for DMA (ft^3)**		**0**

Additional Notes Documenting Rationale for Runoff Reduction from Site Design BMPs

A slotted drain will be placed at along the driveway at the ROW to direct stormwater to a 15' street tree. It was not feasible to drain this area to a structural BMP.

Notes

1. If the area is pervious or if runoff dispersion site design BMPs are not proposed, enter "NA".
2. If the area is pervious or if runoff dispersion site design BMPs are not proposed, enter "1" in this column.
3. Include a separate line item in this table for each street tree and its tributary drainage area, or include supplemental information to demonstrate that the 85th percentile runoff of the impervious area draining to each street tree does not exceed the volume reduction credit being claimed for each street tree. Also include supplemental information documenting the mature tree canopy size of the street tree. Trees must be implemented in accordance with SD-1. Total tree volume reduction must be less than 0.25 times the DCV for the entire project, and each single tree volume credit must be less than 400 cu-ft (see Appendix B.2.2.1 for more information).
4. To be granted a credit here, rain barrels must meet the standards described in Section B.2 and fact sheet SD-8. Enter credit in cubic feet, not gallons.
5. DCV = (Final C Factor) x (85th Percentile Rainfall)/12 x (Area of Surface Type) - (Street Tree Volume Reduction) - (Rain Barrel Volume Reduction). Note that only one Site Design volume reduction credit can be applied for each area, however. For example, runoff dispersion and rain barrel volume reduction cannot both be claimed for the same line item area.

85th Percentile Rainfall (inches): 0.57

DMA ID: G

Hydrologic Soil Group (A, B, C, or D)	Post-Project Surface Type (*See Table B.1-1*)	Area of Surface Type (ft^2)	Post-Project Surface Runoff Factor (*C*) (*See Table B.1-1*)	Runoff Reduction from Site Design BMPs (*Select Only One*)	Tributary Impervious/ Receiving Pervious Area Ratio[1]	*C* Factor Adjustment[2] (*See Table B.2-1*)	Final *C* Factor	Street Tree Volume Reduction[3] (ft^3)	Rain Barrel Volume Reduction[4] (ft^3)	Design Capture Volume (DCV)[5] (ft^3)
C	Impervious sidewalk	18,098	0.90	None Claimed	N/A	1	0.9	N/A	N/A	774
C	Landscaping	8008	0.10	None Claimed	N/A	1	0.1	N/A	N/A	38
	Total DMA Area (ft^2)	26,106				**Weighted Average C Factor for DMA**	0.65		**Total DCV for DMA (ft^3)**	**802**

Additional Notes Documenting Rationale for Runoff Reduction from Site Design BMPs

Note: DMA G's water quality requirements will be satisfied by implementing a vegetated swale between the proposed sidewalk and existing curb via green street design practices.

Notes

1. If the area is pervious or if runoff dispersion site design BMPs are not proposed, enter "NA".
2. If the area is pervious or if runoff dispersion site design BMPs are not proposed, enter "1" in this column.
3. Include a separate line item in this table for each street tree and its tributary drainage area, or include supplemental information to demonstrate that the 85th percentile runoff of the impervious area draining to each street tree does not exceed the volume reduction credit being claimed for each street tree. Also include supplemental information documenting the mature tree canopy size of the street tree. Trees must be implemented in accordance with SD-1. Total tree volume reduction must be less than 0.25 times the DCV for the entire project, and each single tree volume credit must be less than 400 cu-ft (see Appendix B.2.2.1 for more information).
4. To be granted a credit here, rain barrels must meet the standards described in Section B.2 and fact sheet SD-8. Enter credit in cubic feet, not gallons.
5. DCV = (Final C Factor) x (85th Percentile Rainfall)/12 x (Area of Surface Type) - (Street Tree Volume Reduction) - (Rain Barrel Volume Reduction). Note that only one Site Design volume reduction credit can be applied for each area, however. For example, runoff dispersion and rain barrel volume reduction cannot both be claimed for the same line item area.

Intentionally Left Blank

Intentionally Left Blank

Appendix D

Drainage Management Area and Hydromodification Exhibit

Intentionally Left Blank

LEGEND

- ═ ═ EX. STORM DRAIN
- ═ ═ PROP. STORM DRAIN
- ▣ ▣ EX. INLET/CATCHBASIN/CLEANOUT
- ▬ ▬ DRAINAGE MANAGEMENT AREA BOUNDARY
- ← DRAINAGE DIRECTION

NOTES

1. CCSYA: NONE. SEE EXHIBIT IN ATTACHMENT F.1.1
2. HYDROLOGIC SOIL GROUP: TYPE C PER SAN DIEGO COUNTY SOIL MAP
3. APPROXIMATE DEPTH TO GROUNDWATER: 6' ± FROM EXISTING GRADE PER GEOTECHNICAL REPORT
4. EXISTING HYDRAULIC FEATURES: CHANNEL TRIBUTARY TO SWEETWATER RIVER TO BE REALIGNED ALONG NORTH PROPERTY LINE

SOURCE CONTROL BMPS

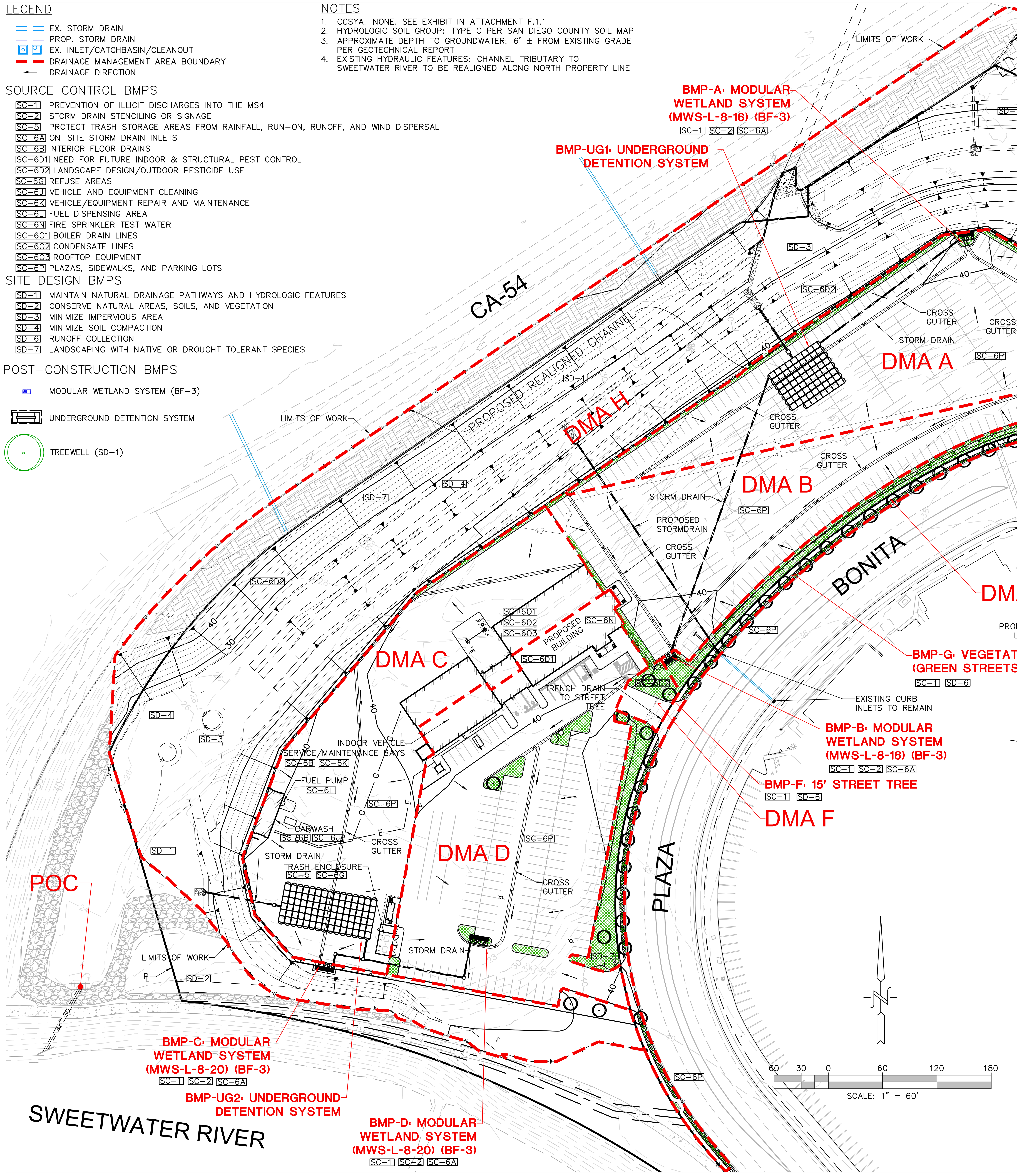
SC-1	PREVENTION OF ILLICIT DISCHARGES INTO THE MS4
SC-2	STORM DRAIN STENCILING OR SIGNAGE
SC-5	PROTECT TRASH STORAGE AREAS FROM RAINFALL, RUN-ON, RUNOFF, AND WIND DISPERSAL
SC-6A	ON-SITE STORM DRAIN INLETS
SC-6B	INTERIOR FLOOR DRAINS
SC-6D1	NEED FOR FUTURE INDOOR & STRUCTURAL PEST CONTROL
SC-6D2	LANDSCAPE DESIGN/OUTDOOR PESTICIDE USE
SC-6G	REFUSE AREAS
SC-6J	VEHICLE AND EQUIPMENT CLEANING
SC-6K	VEHICLE/EQUIPMENT REPAIR AND MAINTENANCE
SC-6L	FUEL DISPENSING AREA
SC-6N	FIRE SPRINKLER TEST WATER
SC-6O1	BOILER DRAIN LINES
SC-6O2	CONDENSATE LINES
SC-6O3	ROOFTOP EQUIPMENT
SC-6P	PLAZAS, SIDEWALKS, AND PARKING LOTS

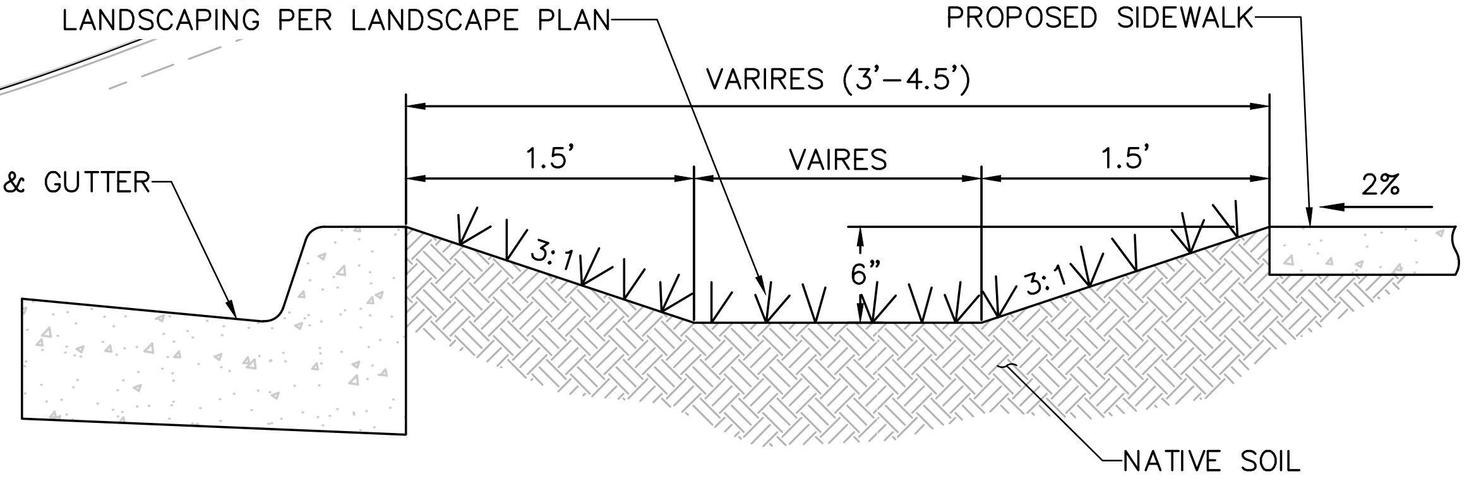
SITE DESIGN BMPS

SD-1	MAINTAIN NATURAL DRAINAGE PATHWAYS AND HYDROLOGIC FEATURES
SD-2	CONSERVE NATURAL AREAS, SOILS, AND VEGETATION
SD-3	MINIMIZE IMPERVIOUS AREA
SD-4	MINIMIZE SOIL COMPACTION
SD-6	RUNOFF COLLECTION
SD-7	LANDSCAPING WITH NATIVE OR DROUGHT TOLERANT SPECIES

POST-CONSTRUCTION BMPS

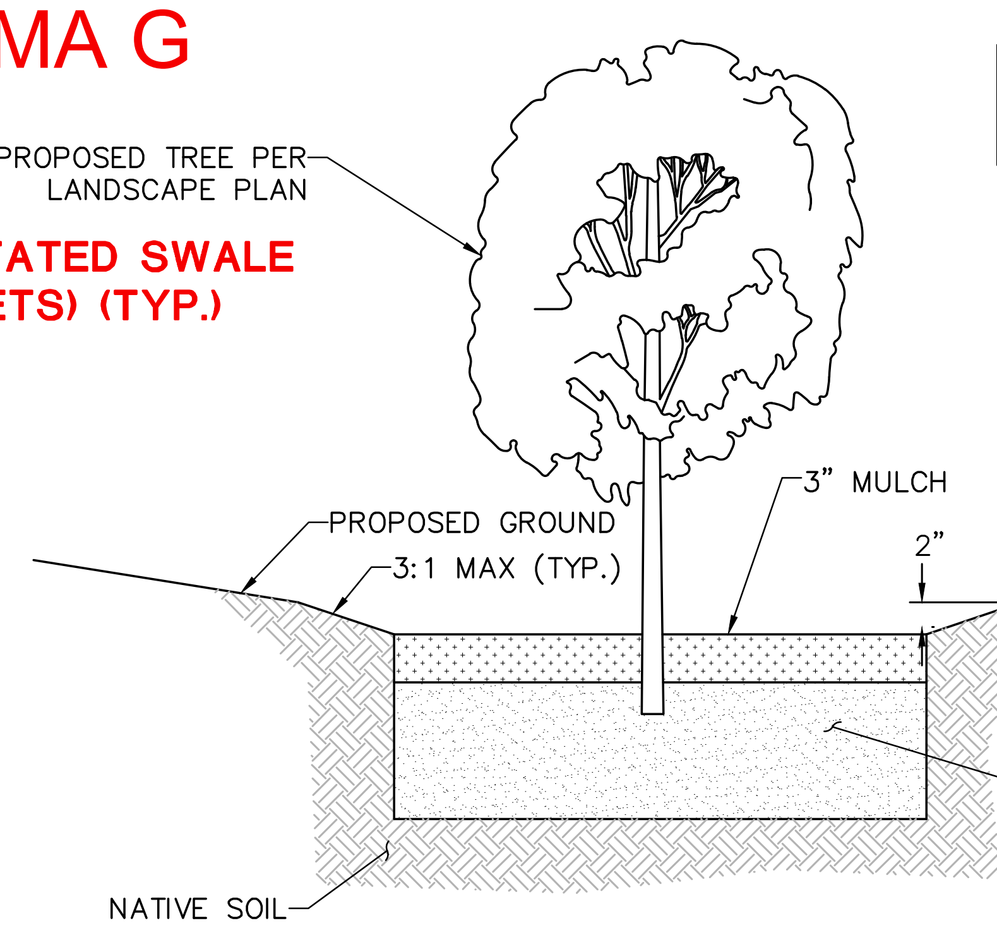
- ▪ MODULAR WETLAND SYSTEM (BF-3)
- ▭ UNDERGROUND DETENTION SYSTEM
- ○ TREEWELL (SD-1)





A VEGETATED SWALE DETAIL

NOT TO SCALE



B STREET TREE DETAIL

NOT TO SCALE

AMENDED SOIL NOTE:

1. SOIL MIX PER COUNTY OF SAN DIEGO COUNTY BMP MANUAL
2. "WELL DRAINED SOIL" SHALL BE "SANDY LOAM" SOIL MIX WITH NO MORE THAN 5% CLAY CONTENT. THE MIX SHALL CONTAIN 50-60% SAND, 20-30% COMPOST OR HARDWOOD MULCH, AND 20-30% TOPSOIL.

SAMPLE PROHIBITIVE SIGNAGE

NTS

POST-DEVELOPED DMA & BMP SUMMARY TABLE

DMA NAME	DMA TYPE	PERVIOUS AREA (SF)	IMPERVIOUS AREA (SF)	TOTAL AREA (SF)	BMP
A	DRAINS TO BMP	4209	62090	66299	MODULAR WETLAND SYSTEM (BMP-A) & UNDERGROUND DETENTION SYSTEM (BMP-UG1)
B	DRAINS TO BMP	921	56876	57797	MODULAR WETLAND SYSTEM (BMP-B) & UNDERGROUND DETENTION SYSTEM (BMP-UG1)
C	DRAINS TO BMP	619	76822	77441	MODULAR WETLAND SYSTEM (BMP-C) & UNDERGROUND DETENTION SYSTEM (BMP-UG2)
D	DRAINS TO BMP	2213	81628	83841	MODULAR WETLAND SYSTEM (BMP-D) & UNDERGROUND DETENTION SYSTEM (BMP-UG2)
E	SELF-RETAINING	1126	1279	2405	STREET TREE (BMP-E)
F	SELF-RETAINING	1437	1658	3095	STREET TREE (BMP-F)
G(1)	DRAINS TO BMP	18098	8008	26106	GREEN STREET VEGETATED SWALE (BMP-G)
H	SELF-MITIGATING	378616	0	378616	–
TOTAL		407239	288361	695600	

NOTE: DMA G IS A GREEN STREET DMA. A VEGETATED SWALE IS PROPOSED TO TREAT RUNOFF FROM THE PROPOSED SIDEWALK.

REVISIONS

NO.	DESCRIPTION	DATE	APP'D

R·E·C
Consultants, Inc.
Civil Engineering • Environmental
Land Surveying
2442 Second Avenue
San Diego, CA 92101
(619)232-9200 (619)232-9210 Fax

DATE: 7-1-20
SCALE: 1" = 60'
DRAWN: WOG
CHECKED: WOG

SHEET TITLE
DMA MAP

PROJECT
CARMAX NATIONAL CITY
PLAZA BONITA RD
NATIONAL CITY, CA 91950

SAVE DATE: 8/7/2020 ~ PLOT DATE: 9/24/2020 ~ FILE NAME: P:\Acad\1253 Carmax of National City\Civil\Exhibits\DMA Map for SWQMP.dwg

SITE SPECIFIC DATA			
PROJECT NUMBER			
ORDER NUMBER			
PROJECT NAME			
PROJECT LOCATION			
STRUCTURE ID			
TREATMENT REQUIRED			
VOLUME BASED (CF)		FLOW BASED (CFS)	
TREATMENT HGL AVAILABLE (FT)			
PEAK BYPASS REQUIRED (CFS) – IF APPLICABLE			
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE 1			
INLET PIPE 2			
OUTLET PIPE			
	PRETREATMENT	BIOFILTRATION	DISCHARGE
RIM ELEVATION			
SURFACE LOAD	PEDESTRIAN	OPEN PLANTER	PEDESTRIAN
FRAME & COVER	2EA ø30"	N/A	ø24"
WETLANDMEDIA VOLUME (CY)			TBD
ORIFICE SIZE (DIA. INCHES)			TBD

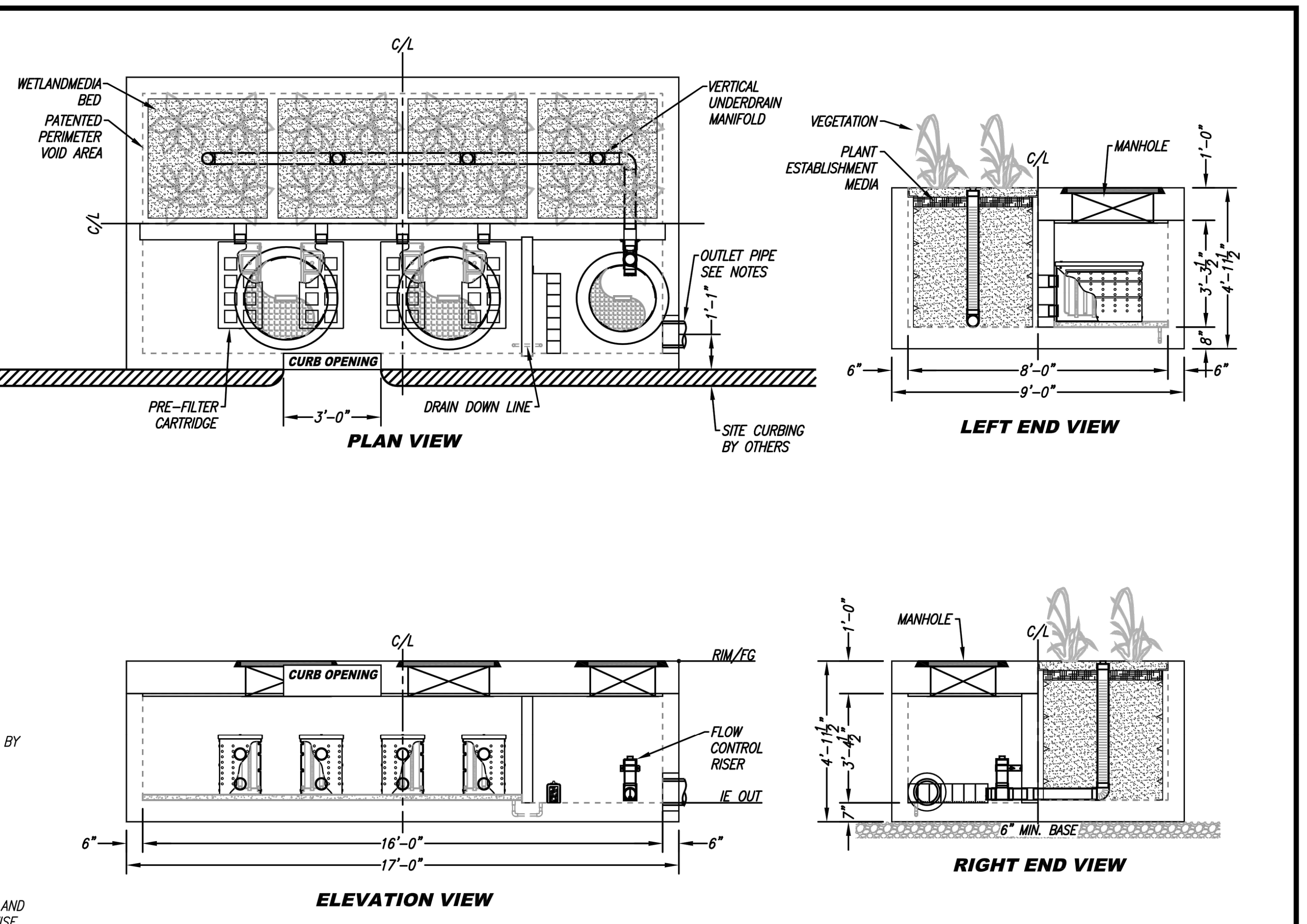
NOTES: PRELIMINARY NOT FOR CONSTRUCTION.

INSTALLATION NOTES

1. CONTRACTOR TO PROVIDE ALL LABOR, EQUIPMENT, MATERIALS AND INCIDENTALS REQUIRED TO OFFLOAD AND INSTALL THE SYSTEM AND APPURTENANCES IN ACCORDANCE WITH THIS DRAWING AND THE MANUFACTURERS SPECIFICATIONS, UNLESS OTHERWISE STATED IN MANUFACTURERS CONTRACT.
2. UNIT MUST BE INSTALLED ON LEVEL BASE. MANUFACTURER RECOMMENDS A MINIMUM 6" LEVEL ROCK BASE UNLESS SPECIFIED BY THE PROJECT ENGINEER. CONTRACTOR IS RESPONSIBLE TO VERIFY PROJECT ENGINEERS RECOMMENDED BASE SPECIFICATIONS.
4. CONTRACTOR TO SUPPLY AND INSTALL ALL EXTERNAL CONNECTING PIPES. ALL PIPES MUST BE FLUSH WITH INSIDE SURFACE OF CONCRETE. (PIPES CANNOT INTRUDE BEYOND FLUSH). INVERT OF OUTFLOW PIPE MUST BE FLUSH WITH DISCHARGE CHAMBER FLOOR. ALL PIPES SHALL BE SEALED WATER TIGHT PER MANUFACTURERS STANDARD CONNECTION DETAIL.
5. CONTRACTOR RESPONSIBLE FOR INSTALLATION OF ALL RISERS, MANHOLES, AND HATCHES. CONTRACTOR TO GROUT ALL MANHOLES AND HATCHES TO MATCH FINISHED SURFACE UNLESS SPECIFIED OTHERWISE.
6. VEGETATION SUPPLIED AND INSTALLED BY OTHERS. ALL UNITS WITH VEGETATION MUST HAVE DRIP OR SPRAY IRRIGATION SUPPLIED AND INSTALLED BY OTHERS.
7. CONTRACTOR RESPONSIBLE FOR CONTACTING BIO CLEAN FOR ACTIVATION OF UNIT. MANUFACTURERS WARRANTY IS VOID WITH OUT PROPER ACTIVATION BY A BIO CLEAN REPRESENTATIVE.

GENERAL NOTES

1. MANUFACTURER TO PROVIDE ALL MATERIALS UNLESS OTHERWISE NOTED.
2. ALL DIMENSIONS, ELEVATIONS, SPECIFICATIONS AND CAPACITIES ARE SUBJECT TO CHANGE. FOR PROJECT SPECIFIC DRAWINGS DETAILING EXACT DIMENSIONS, WEIGHTS AND ACCESSORIES PLEASE CONTACT BIO CLEAN.



TREATMENT FLOW (CFS)	0.462
OPERATING HEAD (FT)	3.4
PRETREATMENT LOADING RATE (GPM/SF)	2.0
WETLAND MEDIA LOADING RATE (GPM/SF)	1.0

MODULAR WETLANDS

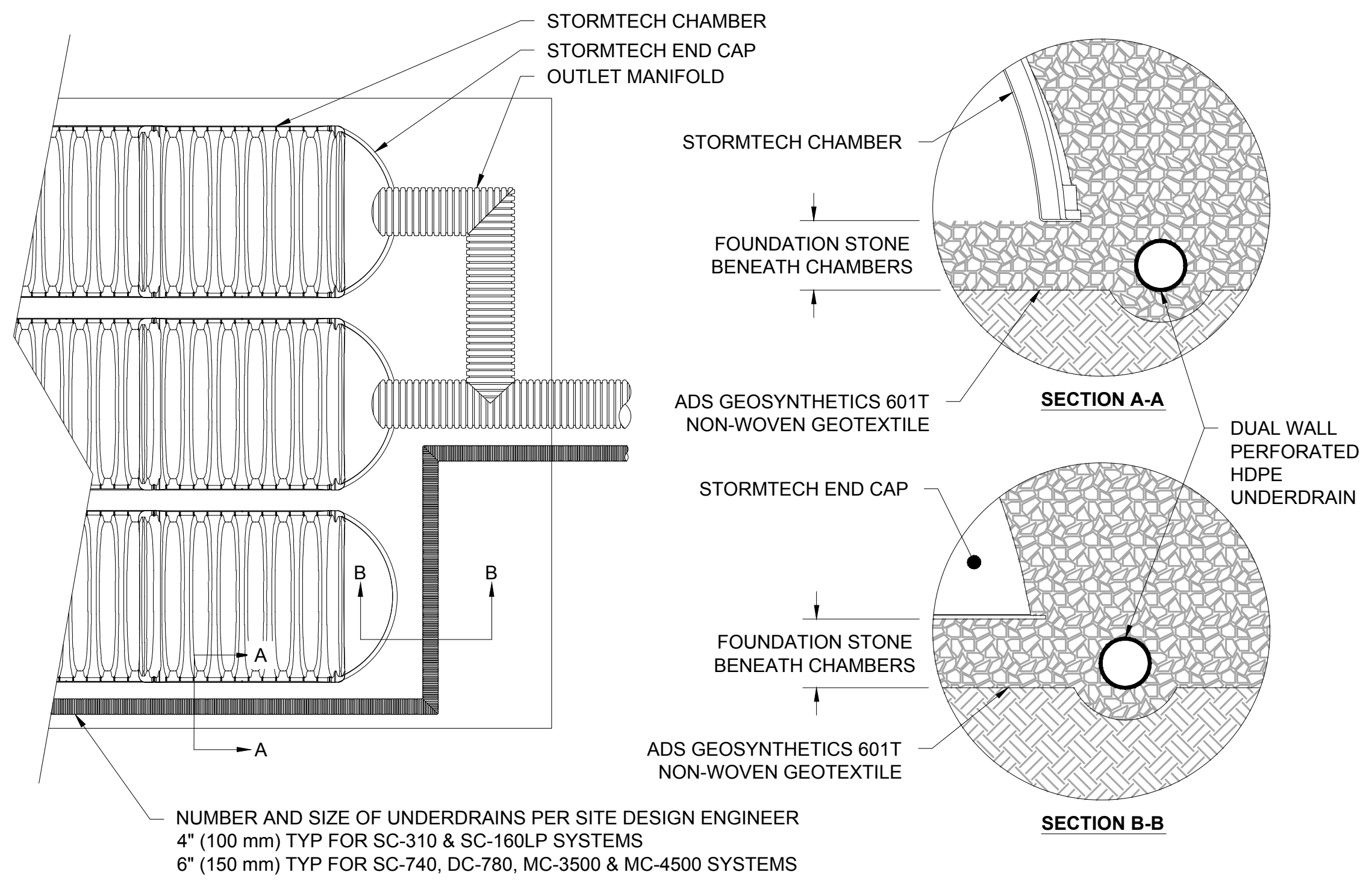
THIS PRODUCT MAY BE PROTECTED BY ONE OR MORE OF THE FOLLOWING US PATENTS: 7,425,262; 7,470,362; 7,674,378; 8,303,816; RELATED FOREIGN PATENTS OR OTHER PATENTS PENDING

PROPRIETARY AND CONFIDENTIAL:

THE INFORMATION CONTAINED IN THIS DOCUMENT IS THE SOLE PROPERTY OF FORTERRA AND ITS COMPANIES. THIS DOCUMENT, NOR ANY PART THEREOF, MAY BE USED, REPRODUCED OR MODIFIED IN ANY MANNER WITH OUT THE WRITTEN CONSENT OF FORTERRA.

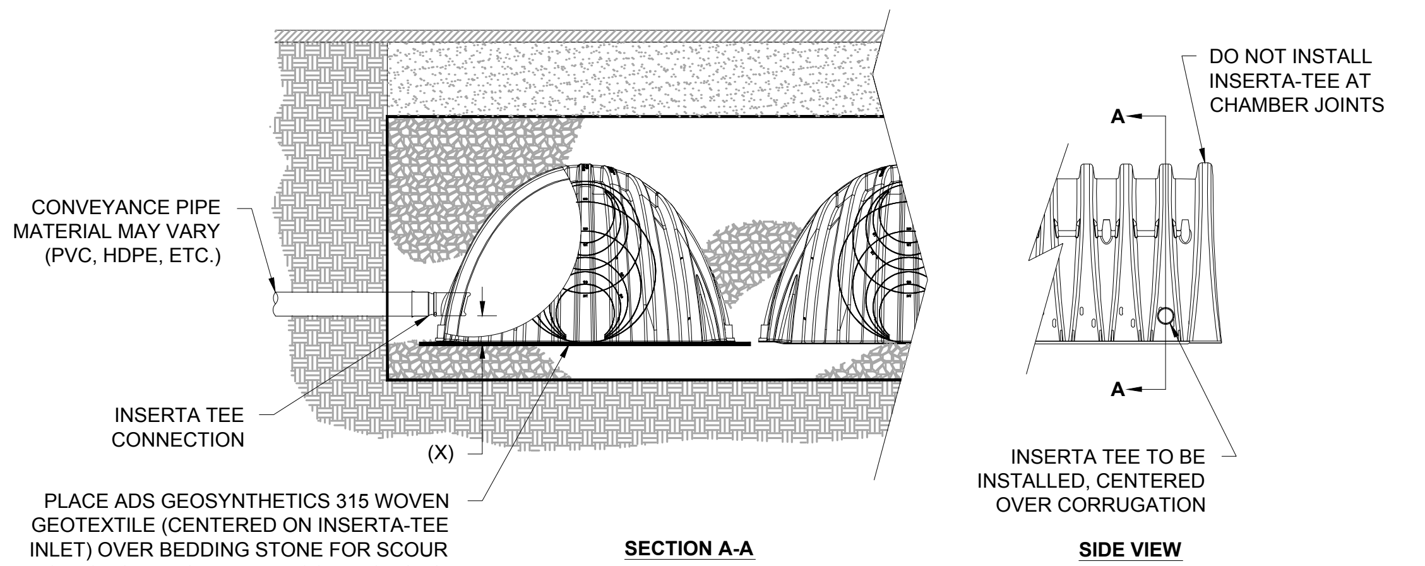
Bio Clean
A Forterra Company

MWS-L-8-16-C
STORMWATER BIOFILTRATION SYSTEM
STANDARD DETAIL



NUMBER AND SIZE OF UNDERDRAINS PER SITE DESIGN ENGINEER
4" (100 mm) TYP FOR SC-310 & SC-160LP SYSTEMS
6" (150 mm) TYP FOR SC-740, DC-780, MC-3500 & MC-4500 SYSTEMS

5 UNDERDRAIN DETAIL

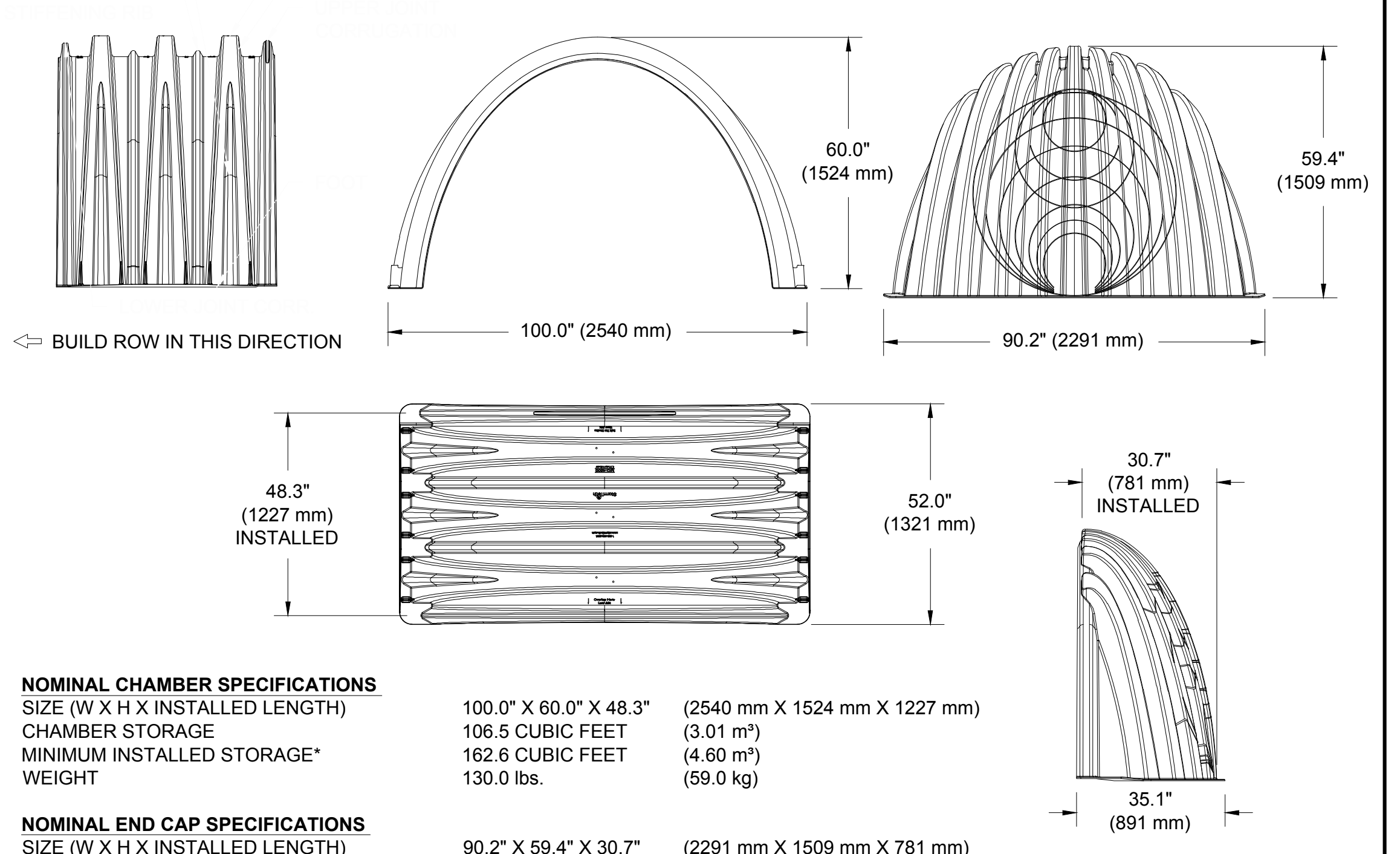


PLACE ADS GEOSYNTHETICS 315 WOVEN GEOTEXTILE (CENTERED ON INSERTA-TEE INLET) OVER BEDDING STONE FOR SCOUR PROTECTION AT SIDE INLET CONNECTIONS. GEOTEXTILE MUST EXTEND 6" (150 mm) PAST CHAMBER FOOT

CHAMBER	MAX DIAMETER OF INSERTA TEE	HEIGHT FROM BASE OF CHAMBER (X)
SC-310	6" (150 mm)	4" (100 mm)
SC-740	10" (250 mm)	4" (100 mm)
DC-780	10" (250 mm)	4" (100 mm)
MC-3500	12" (300 mm)	6" (150 mm)
MC-4500	12" (300 mm)	8" (200 mm)
INSERTA TEE FITTINGS AVAILABLE FOR SDR 26, SDR 35, SCH 40 IPS GASKETED & SOLVENT WELD, N-12, HP STORM, C-900 OR DUCTILE IRON		

NOTE:
PART NUMBERS WILL VARY BASED ON INLET PIPE MATERIALS. CONTACT STORMTECH FOR MORE INFORMATION.

6 INSERTA-TEE SIDE INLET DETAIL



NOMINAL CHAMBER SPECIFICATIONS

SIZE (W X H X INSTALLED LENGTH)	100.0" X 60.0" X 48.3"	(2540 mm X 1524 mm X 1227 mm)
CHAMBER STORAGE	106.5 CUBIC FEET	(3.01 m³)
MINIMUM INSTALLED STORAGE*	162.6 CUBIC FEET	(4.60 m³)
WEIGHT	130.0 lbs.	(59.0 kg)

NOMINAL END CAP SPECIFICATIONS

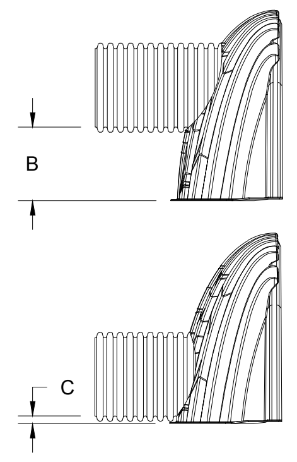
SIZE (W X H X INSTALLED LENGTH)	90.2" X 59.4" X 30.7"	(2291 mm X 1509 mm X 781 mm)
END CAP STORAGE	35.7 CUBIC FEET	(1.01 m³)
MINIMUM INSTALLED STORAGE*	108.7 CUBIC FEET	(3.08 m³)
WEIGHT	135.0 lbs.	(61.2 kg)

*ASSUMES 12" (305 mm) STONE ABOVE, 9" (229 mm) STONE FOUNDATION AND BETWEEN CHAMBERS, 12" (305 mm) STONE PERIMETER IN FRONT OF END CAPS AND 40% STONE POROSITY.

STUBS AT BOTTOM OF END CAP FOR PART NUMBERS ENDING WITH "B"
STUBS AT TOP OF END CAP FOR PART NUMBERS ENDING WITH "T"
END CAPS WITH A WELDED CROWN PLATE END WITH "C"
END CAPS WITH A PREFABRICATED WELDED STUB END WITH "W"

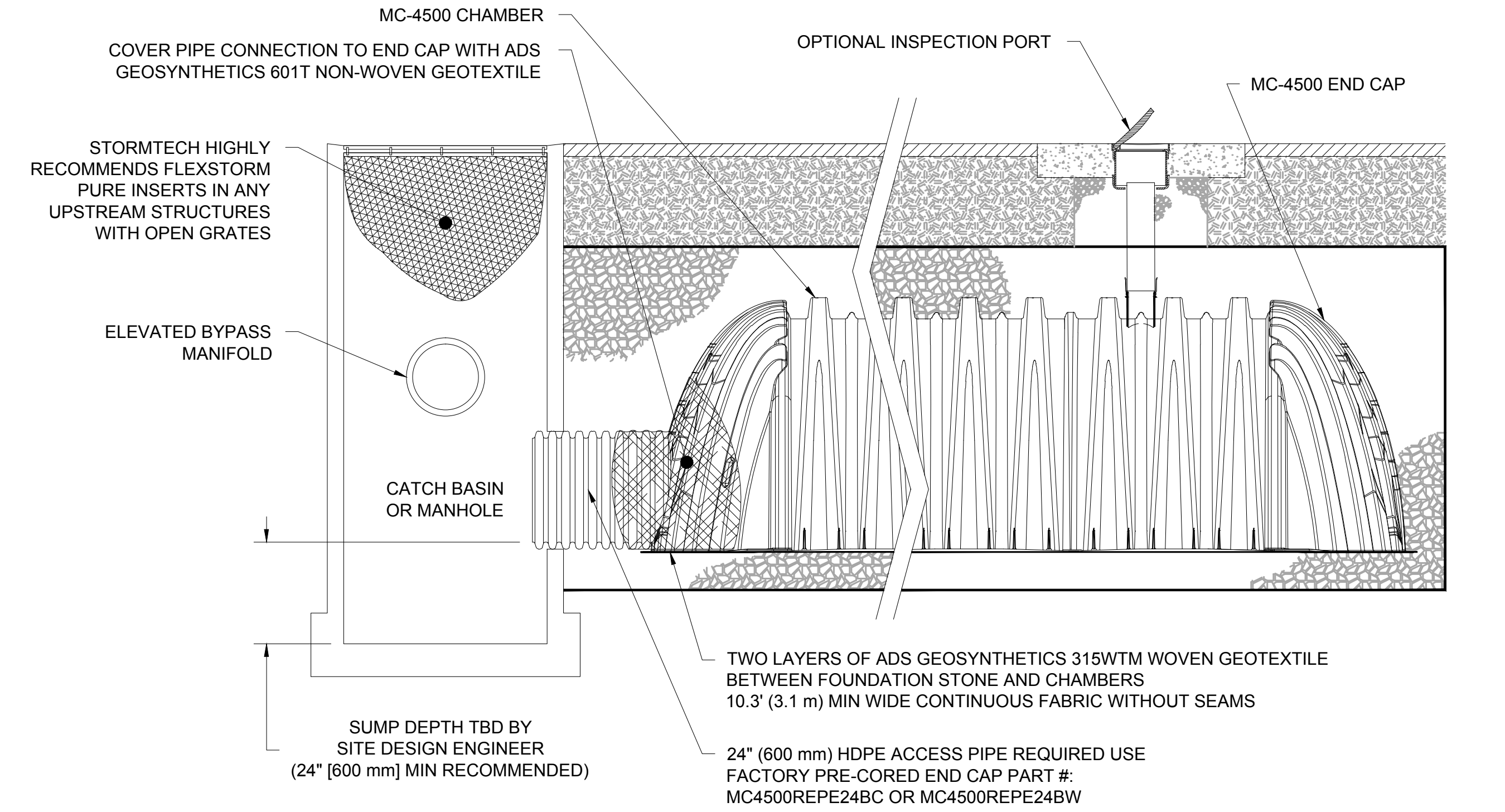
PART #	STUB	B	C
MC4500REPE06T	6" (150 mm)	42.54" (1.081 m)	---
MC4500REPE06B		---	0.86" (22 mm)
MC4500REPE08T	8" (200 mm)	40.50" (1.029 m)	---
MC4500REPE08B		---	1.01" (26 mm)
MC4500REPE10T	10" (250 mm)	38.37" (975 mm)	---
MC4500REPE10B		---	1.33" (34 mm)
MC4500REPE12T	12" (300 mm)	35.69" (907 mm)	---
MC4500REPE12B		---	1.55" (39 mm)
MC4500REPE15T	15" (375 mm)	32.72" (831 mm)	---
MC4500REPE15B		---	1.70" (43 mm)
MC4500REPE18TC	18" (450 mm)	29.36" (746 mm)	---
MC4500REPE18TW			
MC4500REPE18BC		---	1.97" (50 mm)
MC4500REPE18BW			
MC4500REPE24TC	24" (600 mm)	23.05" (585 mm)	---
MC4500REPE24TW			
MC4500REPE24BC		---	2.26" (57 mm)
MC4500REPE24BW			
MC4500REPE30BC	30" (750 mm)	---	2.95" (75 mm)
MC4500REPE36BC	36" (900 mm)	---	3.25" (83 mm)
MC4500REPE42BC	42" (1050 mm)	---	3.55" (90 mm)

NOTE: ALL DIMENSIONS ARE NOMINAL



CUSTOM PRECORED INVERTS ARE AVAILABLE UPON REQUEST. INVENTORIED MANIFOLDS INCLUDE 12-24" (300-600 mm) SIZE ON SIZE AND 15-48" (375-1200 mm) ECCENTRIC MANIFOLDS. CUSTOM INVERT LOCATIONS ON THE MC-4500 END CAP CUT IN THE FIELD ARE NOT RECOMMENDED FOR PIPE SIZES GREATER THAN 10" (250 mm). THE INVERT LOCATION IN COLUMN 'B' ARE THE HIGHEST POSSIBLE FOR THE PIPE SIZE.

2 MC-4500 TECHNICAL SPECIFICATIONS



INSPECTION & MAINTENANCE

STEP 1) INSPECT ISOLATOR ROW FOR SEDIMENT
- A. INSPECTION PORTS (IF PRESENT)
  - A.1. REMOVE/OPEN LID ON NYLOPLAST INLINE DRAIN
  - A.2. REMOVE AND CLEAN FLEXSTORM FILTER IF INSTALLED
  - A.3. USING A FLASHLIGHT AND STADIA ROD, MEASURE DEPTH OF SEDIMENT AND RECORD ON MAINTENANCE LOG
  - A.4. LOWER A CAMERA INTO ISOLATOR ROW FOR VISUAL INSPECTION OF SEDIMENT LEVELS (OPTIONAL)
  - A.5. IF SEDIMENT IS AT, OR ABOVE, 3" (80 mm) PROCEED TO STEP 2. IF NOT, PROCEED TO STEP 3.
- B. ALL ISOLATOR ROWS
  - B.1. REMOVE COVER FROM STRUCTURE AT UPSTREAM END OF ISOLATOR ROW
  - B.2. USING A FLASHLIGHT, INSPECT DOWN THE ISOLATOR ROW THROUGH OUTLET PIPE
    - i) MIRRORS ON POLES OR CAMERAS MAY BE USED TO AVOID A CONFINED SPACE ENTRY
    - ii) FOLLOW OSHA REGULATIONS FOR CONFINED SPACE ENTRY IF ENTERING MANHOLE
  - B.3. IF SEDIMENT IS AT, OR ABOVE, 3" (80 mm) PROCEED TO STEP 2. IF NOT, PROCEED TO STEP 3.

STEP 2) CLEAN OUT ISOLATOR ROW USING THE JETVAC PROCESS
- A. A FIXED CULVERT CLEANING NOZZLE WITH REAR FACING SPREAD OF 45" (1.1 m) OR MORE IS PREFERRED
- B. APPLY MULTIPLE PASSES OF JETVAC UNTIL BACKFLUSH WATER IS CLEAN
- C. VACUUM STRUCTURE SUMP AS REQUIRED

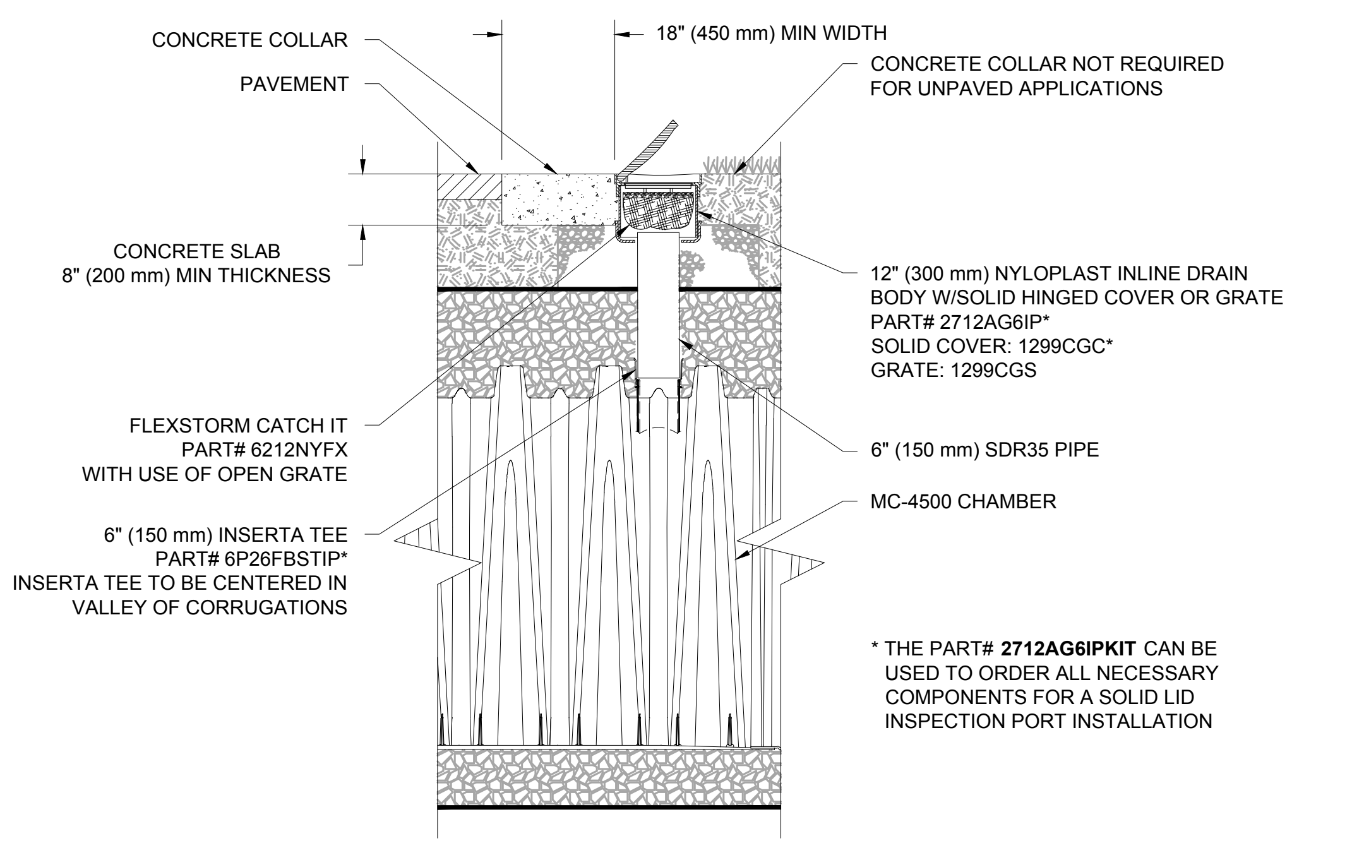
STEP 3) REPLACE ALL COVERS, GRATES, FILTERS, AND LIDS; RECORD OBSERVATIONS AND ACTIONS.

STEP 4) INSPECT AND CLEAN BASINS AND MANHOLES UPSTREAM OF THE STORMTECH SYSTEM.

NOTES

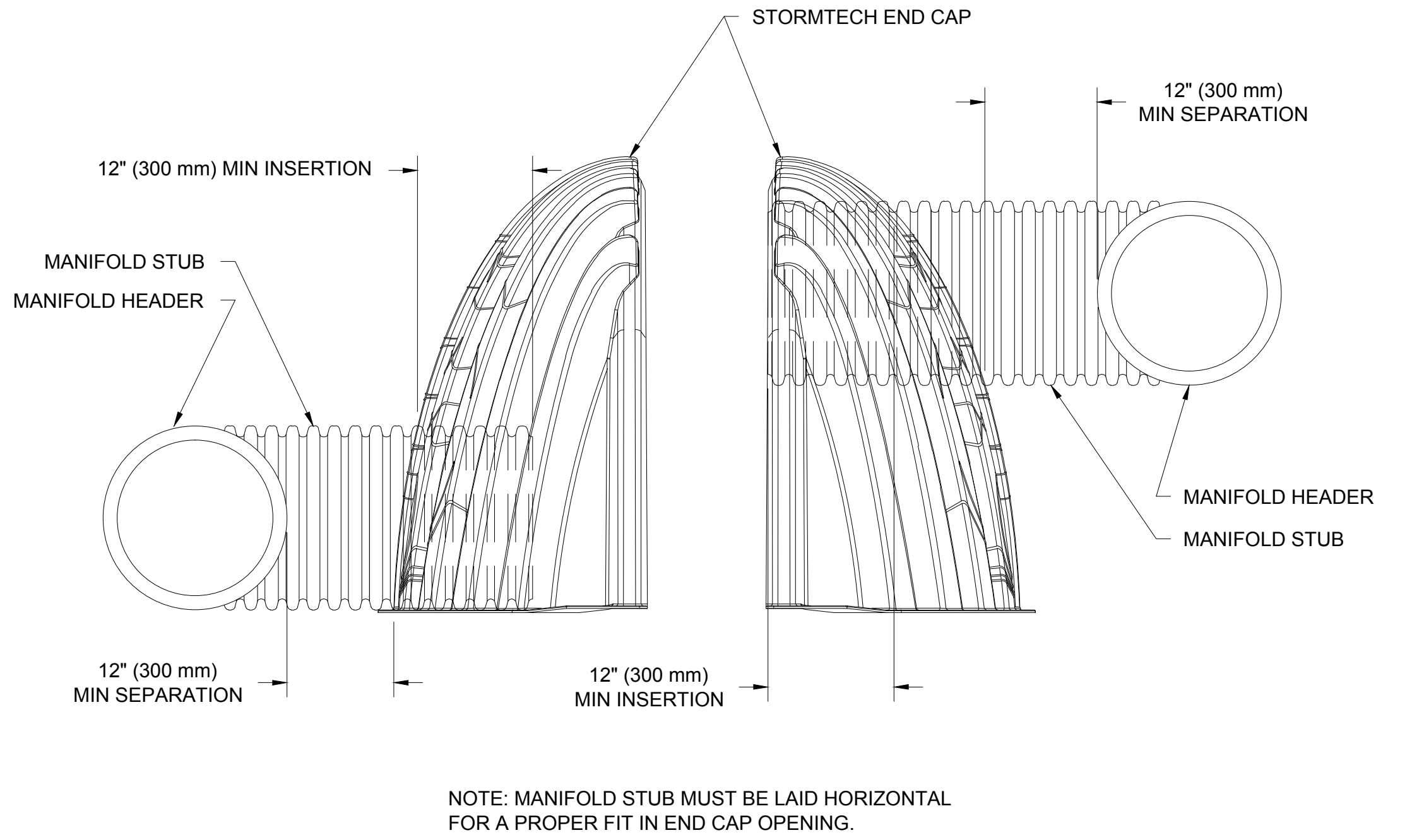
1. INSPECT EVERY 6 MONTHS DURING THE FIRST YEAR OF OPERATION. ADJUST THE INSPECTION INTERVAL BASED ON PREVIOUS OBSERVATIONS OF SEDIMENT ACCUMULATION AND HIGH WATER ELEVATIONS.
2. CONDUCT JETTING AND VACTORING ANNUALLY OR WHEN INSPECTION SHOWS THAT MAINTENANCE IS NECESSARY.

3 MC-4500 ISOLATOR ROW DETAIL



* THE PART# **2712AG6IPKIT** CAN BE USED TO ORDER ALL NECESSARY COMPONENTS FOR A SOLID LID INSPECTION PORT INSTALLATION

4 MC-4500 6" (150 mm) INSPECTION PORT DETAIL



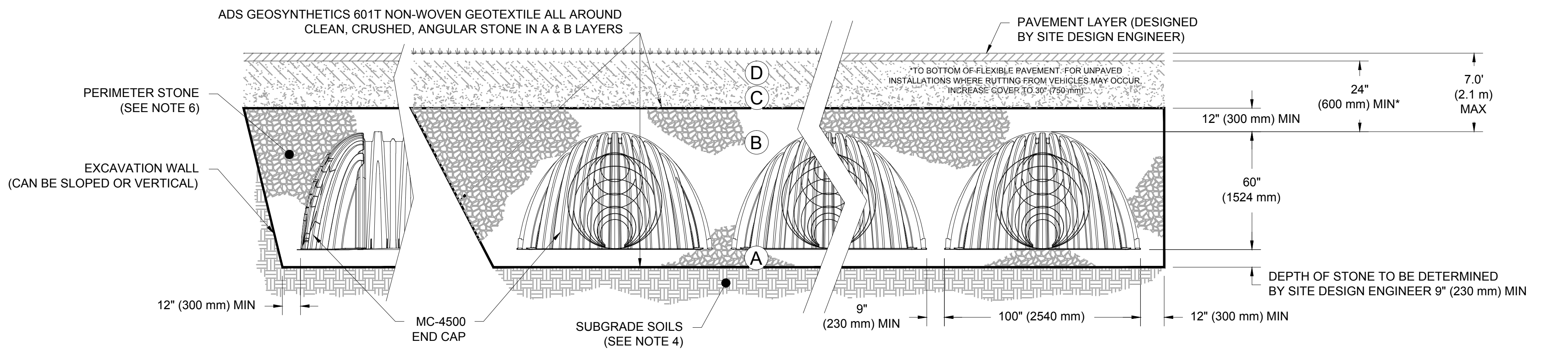
NOTE: MANIFOLD STUB MUST BE LAID HORIZONTAL FOR A PROPER FIT IN END CAP OPENING.

7 MC-SERIES END CAP INSERTION DETAIL

ACCEPTABLE FILL MATERIALS: STORMTECH MC-4500 CHAMBER SYSTEMS

MATERIAL LOCATION		DESCRIPTION	AASHTO MATERIAL CLASSIFICATIONS	COMPACTION / DENSITY REQUIREMENT
D	**FINAL FILL:** FILL MATERIAL FOR LAYER 'D' STARTS FROM THE TOP OF THE 'C' LAYER TO THE BOTTOM OF FLEXIBLE PAVEMENT OR UNPAVED FINISHED GRADE ABOVE. NOTE THAT PAVEMENT SUBBASE MAY BE PART OF THE 'D' LAYER	ANY SOIL/ROCK MATERIALS, NATIVE SOILS, OR PER ENGINEER'S PLANS. CHECK PLANS FOR PAVEMENT SUBGRADE REQUIREMENTS.	N/A	PREPARE PER SITE DESIGN ENGINEER'S PLANS. PAVED INSTALLATIONS MAY HAVE STRINGENT MATERIAL AND PREPARATION REQUIREMENTS.
C	**INITIAL FILL:** FILL MATERIAL FOR LAYER 'C' STARTS FROM THE TOP OF THE EMBEDMENT STONE ('B' LAYER) TO 24" (600 mm) ABOVE THE TOP OF THE CHAMBER. NOTE THAT PAVEMENT SUBBASE MAY BE A PART OF THE 'C' LAYER.	GRANULAR WELL-GRADED SOIL/AGGREGATE MIXTURES, <35% FINES OR PROCESSED AGGREGATE. MOST PAVEMENT SUBBASE MATERIALS CAN BE USED IN LIEU OF THIS LAYER.	AASHTO M145[1] A-1, A-2-4, A-3 OR AASHTO M43[1] 3, 357, 4, 467, 5, 56, 57, 6, 67, 68, 7, 78, 8, 89, 9, 10	BEGIN COMPACTIONS AFTER 24" (600 mm) OF MATERIAL OVER THE CHAMBERS IS REACHED. COMPACT ADDITIONAL LAYERS IN 12" (300 mm) MAX LIFTS TO A MIN. 95% PROCTOR DENSITY FOR WELL GRADED MATERIAL AND 95% RELATIVE DENSITY FOR PROCESSED AGGREGATE MATERIALS.
B	**EMBEDMENT STONE:** FILL SURROUNDING THE CHAMBERS FROM THE FOUNDATION STONE ('A' LAYER) TO THE 'C' LAYER ABOVE.	CLEAN, CRUSHED, ANGULAR STONE	AASHTO M43[1] 3, 4	NO COMPACTION REQUIRED.
A	**FOUNDATION STONE:** FILL BELOW CHAMBERS FROM THE SUBGRADE UP TO THE FOOT (BOTTOM) OF THE CHAMBER.	CLEAN, CRUSHED, ANGULAR STONE	AASHTO M43[1] 3, 4	PLATE COMPACT OR ROLL TO ACHIEVE A FLAT SURFACE.[2,3]

PLEASE NOTE:
1. THE LISTED AASHTO DESIGNATIONS ARE FOR GRADATIONS ONLY. THE STONE MUST ALSO BE CLEAN, CRUSHED, ANGULAR. FOR EXAMPLE, A SPECIFICATION FOR #4 STONE WOULD STATE: "CLEAN, CRUSHED, ANGULAR NO. 4 (AASHTO M43) STONE".
2. STORMTECH COMPACTION REQUIREMENTS ARE MET FOR 'A' LOCATION MATERIALS WHEN PLACED AND COMPACTED IN 9" (230 mm) (MAX) LIFTS USING TWO FULL COVERAGES WITH A VIBRATORY COMPACTOR.
3. WHERE INFILTRATION SURFACES MAY BE COMPROMISED BY COMPACTION, FOR STANDARD DESIGN LOAD CONDITIONS, A FLAT SURFACE MAY BE ACHIEVED BY RAKING OR DRAGGING WITHOUT COMPACTION EQUIPMENT. FOR SPECIAL LOAD DESIGNS, CONTACT STORMTECH FOR COMPACTION REQUIREMENTS.



NOTES:

1. MC-4500 CHAMBERS SHALL CONFORM TO THE REQUIREMENTS OF ASTM F2418 "STANDARD SPECIFICATION FOR POLYPROPYLENE (PP) CORRUGATED WALL STORMWATER COLLECTION CHAMBERS".
2. MC-4500 CHAMBERS SHALL BE DESIGNED IN ACCORDANCE WITH ASTM F2787 "STANDARD PRACTICE FOR STRUCTURAL DESIGN OF THERMOPLASTIC CORRUGATED WALL STORMWATER COLLECTION CHAMBERS".
3. "ACCEPTABLE FILL MATERIALS" TABLE ABOVE PROVIDES MATERIAL LOCATIONS, DESCRIPTIONS, GRADATIONS, AND COMPACTION REQUIREMENTS FOR FOUNDATION, EMBEDMENT, AND FILL MATERIALS.
4. THE SITE DESIGN ENGINEER IS RESPONSIBLE FOR ASSESSING THE BEARING RESISTANCE (ALLOWABLE BEARING CAPACITY) OF THE SUBGRADE SOILS AND THE DEPTH OF FOUNDATION STONE WITH CONSIDERATION FOR THE RANGE OF EXPECTED SOIL MOISTURE CONDITIONS.
5. ONCE LAYER 'C' IS PLACED, ANY SOIL/MATERIAL CAN BE PLACED IN LAYER 'D' UP TO THE FINISHED GRADE. MOST PAVEMENT SUBBASE SOILS CAN BE USED TO REPLACE THE MATERIAL REQUIREMENTS OF LAYER 'C' OR 'D' AT THE SITE DESIGN ENGINEER'S DISCRETION.
6. PERIMETER STONE MUST BE EXTENDED HORIZONTALLY TO THE EXCAVATION WALL FOR BOTH VERTICAL AND SLOPED EXCAVATION WALLS.

1 MC-4500 CROSS SECTION DETAIL

REVISIONS			
NO.	DESCRIPTION	DATE	APP'D

R·E·C Consultants, Inc.
Civil Engineering · Environmental
Land Surveying
2442 Second Avenue
San Diego, CA 92101
(619)232-9200 (619)232-9210 Fax

DATE: 7-1-20
SCALE: 1" = 30'
DRAWN: ERF
CHECKED: WOG

SHEET TITLE
DMA MAP

PROJECT
CARMAX NATIONAL CITY
PLAZA BONITA RD
NATIONAL CITY, CA 91950

SHEET
2
OF 2 SHEETS

SAVE DATE: 8/7/2020 ~ PLOT DATE: 9/24/2020 ~ FILE NAME: P:\Acad\1253 Carmax of National City\Civil\Exhibits\DMA Map for SWQMP.dwg

Appendix E

Structural Pollutant Control BMP Design Backup

Indicate which items are included behind this cover sheet

Contents	Included (Y/N)
E.1. Harvest and Use Feasibility Screening (when applicable) *Required unless the entire project will use infiltration BMPs*	Y
E.2. Categorization of Infiltration Feasibility Condition (when applicable) *Required unless the project will use harvest and use BMPs*	Y
E.3. Pollutant Control BMP Design Worksheets / Calculations	Y
E.4. Geotechnical Report (when applicable)	Y
E.5. Impairments and Pollutants of Concern (when applicable) *Only required if the project pursues alternative compliance. Projects wishing to pursue alternative compliance must discuss their intent to do so with Engineering staff before submitting a SWQMP.*	N

Intentionally Left Blank

Harvest and Use Feasibility Checklist

Appendix E.1

1. Is there a demand for harvested water (check all that apply) at the project site that is reliably present during the wet season?

☑ Toilet and urinal flushing
☑ Landscape irrigation
☑ Other: Car Wash______

2. If there is a demand; estimate the anticipated average wet season demand over a period of 36 hours. Guidance for planning level demand calculations for toilet/urinal flushing and landscape irrigation is provided in BMP Design Manual Appendix B, Section B.3.2.

- Toilet/Urinal Demand was determined using BMP Design Manual Table B.3-1 as follows:
    - Assumptions – retail use, assumed max of 20 employees/customer at any one time →7 flushes/person/day
    - Toilet/Urinal Demand = 140 flushes * 1.6 gallons/flush = 224 gpd, which converts 336 gallons/36-hours or 45 cu-ft → **36-Hour Toilet Demand =45 cu-ft**
- Landscape Demand was calculated using the simplified planning level irrigation demand as outlined under BMP Design Manual Section B.3.2.2.2:

Onsite Landscaped Area	0.657	Ac (28,623 ft2)
Hydrozone Moderate plant water use =	1,470	gallons per irrigated acre per 36-hour period via Table B.3-3
36-hr Landscape Demand =	966	gallons per 36-hour period
36-hr Landscape Demand =	129	cu-ft

- Other Demands related to the proposed private car were considered but not included due to the water quality and quantity needs of the car washing machinery → **Other Demands = 0 (N/A)**
- Estimated Total Daily Use (for wet season) = Toilet Demand + Landscape Demand + Other Demand = 45 cu-ft + 129 cu-ft + 0 cu-ft = 174 cu-ft → **Estimated Total 36-Hour Use = 174 cu-ft**

3. Provide the total DCV calculated for the project site, as presented in Appendix C.

DCV = 11,897____ (cubic feet) (Note: this is the DCV for just the onsite DMAs, doesn't include DMA G or H)

3a. Is the 36 hour demand greater than or equal to the DCV?	3b. Is the 36 hour demand greater than 0.25DCV but less than the full DCV?	3c. Is the 36 hour demand less than 0.25DCV?
☐ Yes / ☑ No ⇨ ⇩	☐ Yes / ☑ No ⇨ ⇩	☑ Yes ⇩

Harvest and use appears to be feasible. Conduct more detailed evaluation and sizing calculations to confirm that DCV can be used at an adequate rate to meet drawdown criteria.	Harvest and use may be feasible. Conduct more detailed evaluation and sizing calculations to determine feasibility. Harvest and use may only be able to be used for a portion of the site, or (optionally) the storage may need to be upsized to meet long term capture targets while draining in longer than 36 hours.	Harvest and use is considered to be infeasible.
Is harvest and use feasible based on further evaluation? ☐ Yes, refer to Appendix E to select and size harvest and use BMPs. ☑ No, select alternate BMPs.		

<table>
<tr><th colspan="2">Categorization of Infiltration Feasibility Condition</th><th colspan="2">Appendix E.2</th></tr>
<tr><td colspan="4">Part 1 - Full Infiltration Feasibility Screening Criteria
Would infiltration of the full design volume be feasible from a physical perspective without any undesirable consequences that cannot be reasonably mitigated?</td></tr>
<tr><th>Criteria</th><th>Screening Question</th><th>Yes</th><th>No</th></tr>
<tr><td>1</td><td>Is the estimated reliable infiltration rate below proposed facility locations greater than 0.5 inches per hour? The response to this Screening Question shall be based on a comprehensive evaluation of the factors presented in BMP Design Manual Appendix C.2 and Appendix D.</td><td></td><td>☑</td></tr>
<tr><td colspan="4">Provide basis:
According to the infiltration tests performed by EEI Geotechnical and Environmental Solutions in their Geotechnical Evaluation dated 11/06/2015, the infiltration rates varied considerably from the five bore locations ranging from 0.03 to 233.5 in/hr. Based on a weighted infiltration rate estimate (See attachment 8 in HMP), the infiltration rates are approximately 0.29 in/hr and 1.30 in/hr below the basin.</td></tr>
<tr><td>2</td><td>Can infiltration greater than 0.5 inches per hour be allowed without increasing risk of geotechnical hazards (slope stability, groundwater mounding, utilities, or other factors) that cannot be mitigated to an acceptable level? The response to this Screening Question shall be based on a comprehensive evaluation of the factors presented in BMP Design Manual Appendix C.2.</td><td></td><td>☑</td></tr>
<tr><td colspan="4">Provide basis:
According to the Geotechnical Evaluation, soils onsite range from conducive to not conducive to stormwater infiltration depending on specific location and depth. The Geotechnical study did not evaluate groundwater mounding however it may be a concern given that groundwater was encountered in several borings at depths ranging from 6-to-16 feet below existing grades.
For further details please refer to the Geotechnical Evaluation performed by EEI Geotechnical and Environmental Solutions (11/06/2015) included under Appendix E.4 of this SWQMP.</td></tr>
<tr><th>Criteria</th><th>Screening Question</th><th>Yes</th><th>No</th></tr>
<tr><td>3</td><td>Can infiltration greater than 0.5 inches per hour be allowed without increasing risk of groundwater contamination (shallow water table, stormwater pollutants or other factors) that cannot be mitigated to an acceptable level? The response to this Screening Question shall be based on a comprehensive evaluation of the factors presented in Appendix C.3.</td><td></td><td>☑</td></tr>
</table>

Provide basis:

According to the Geotechnical Evaluation, soils onsite range from conducive to not conducive to stormwater infiltration depending on specific location and depth. The Geotechnical study did not evaluate risk of groundwater contamination related to infiltrating stormwater onsite; however it may be a concern given that groundwater was encountered in several borings at depths ranging from 6-to-16 feet below existing grades.

For further details please refer to the Geotechnical Evaluation performed by EEI Geotechnical and Environmental Solutions (11/06/2015) included under Appendix E.4 of this SWQMP.

4	**Can infiltration greater than 0.5 inches per hour be allowed without causing potential water balance issues such as change of seasonality of ephemeral streams or increased discharge of contaminated groundwater to surface waters?** The response to this Screening Question shall be based on a comprehensive evaluation of the factors presented in Appendix C.3.		☑

Provide basis:

The channel bisecting the property that receives runoff from the site may be considered an ephemeral stream (this channel will be realigned as part of the project). Infiltrating stormwater may potentially impact the existing water balance.

For further details regarding the stream and wetlands habitat associated with the channel onsite, please refer to the Environmental Studies prepared by ICF International in support of the projects 401 and 404 permitting.

Part 1 Result*	If all answers to rows 1 - 4 are "**Yes**" a full infiltration design is potentially feasible. The feasibility screening category is **Full Infiltration** If any answer from row 1-4 is "**No**", infiltration may be possible to some extent but would not generally be feasible or desirable to achieve a "full infiltration" design. Proceed to Part 2	**Partial Infiltration may be feasible**

**To be completed using gathered site information and best professional judgment considering the definition of MEP in the MS4 Permit. Additional testing and/or studies may be required by Agency/Jurisdictions to substantiate findings*

<u>Part 2 – Partial Infiltration vs. No Infiltration Feasibility Screening Criteria</u>

Would infiltration of water in any appreciable amount be physically feasible without any negative consequences that cannot be reasonably mitigated?

Categorization of Infiltration Feasibility Condition | Appendix E.2

Criteria	Screening Question	Yes	No
5	**Do soil and geologic conditions allow for infiltration in any appreciable rate or volume?** The response to this Screening Question shall be based on a comprehensive evaluation of the factors presented in Appendix C.2 and Appendix D.	☑	

Provide basis:

According to the infiltration tests performed by EEI Geotechnical and Environmental Solutions in their Geotechnical Evaluation dated 11/06/2015, the infiltration rates varied considerably from the five bore locations ranging from 0.03 to 233.5 in/hr. Based on a weighted infiltration rate estimate (See attachment 8 in HMP), the infiltration rates are approximately 0.29 in/hr and 1.30 in/hr below the basin.

Criteria	Screening Question	Yes	No
6	**Can Infiltration in any appreciable quantity be allowed without increasing risk of geotechnical hazards (slope stability, groundwater mounding, utilities, or other factors) that cannot be mitigated to an acceptable level**? The response to this Screening Question shall be based on a comprehensive evaluation of the factors presented in Appendix C.2.	☑	

Provide basis:

According to the Geotechnical Evaluation, soils onsite range from conducive to not conducive for infiltrating stormwater depending on the specific location and depth. The Geotechnical study did not evaluate groundwater mounding however it noted that groundwater was encountered in several borings at depths ranging from 6-to-16 feet below existing grades. The project will incorporate 5-to-10 feet of fill which will improve groundwater separation; however the percolation rates of the incoming fill soils are unknown at this time, so full infiltration is not recommended. In its current condition, the site is 100% permeable and currently infiltrates portions of the stormwater that it conveys from ~3 sq-miles of contributing area (much of which is developed and impervious). Given these circumstances and the preliminary nature of this study it is assumed that the risk of geotechnical hazards associated with partial infiltration may be mitigated to an acceptable level by importing acceptable soils, using adequate compaction/tilling and placing an outlet near the bottom of the underground detention system.

For further details please refer to the Geotechnical Evaluation performed by EEI Geotechnical and Environmental Solutions (11/06/2015) included under Appendix E.4 of this SWQMP.

<table>
<tr><th colspan="2">Categorization of Infiltration Feasibility Condition</th><th colspan="2">Appendix E.2</th></tr>
<tr><th>Criteria</th><th>Screening Question</th><th>Yes</th><th>No</th></tr>
<tr><td>7</td><td>Can Infiltration in any appreciable quantity be allowed without posing significant risk for groundwater related concerns (shallow water table, stormwater pollutants or other factors)? The response to this Screening Question shall be based on a comprehensive evaluation of the factors presented in Appendix C.3.</td><td>☑</td><td></td></tr>
<tr><td colspan="4">Provide basis:

According to the Geotechnical Evaluation, soils onsite range from conducive to not conducive for infiltrating stormwater depending on the specific location and depth. The Geotechnical study did not evaluate groundwater mounding however it noted that groundwater was encountered in several borings at depths ranging from 6-to-16 feet below existing grades. The project will incorporate 5-to-10 feet of fill which will improve groundwater separation, however the percolation rates of the incoming fill soils are unknown at this time, so full infiltration is not recommended. In its current condition, the site is 100% permeable and currently infiltrates portions of the stormwater that it conveys from ~3 sq-miles of contributing area. Given these circumstances and the preliminary nature of this study it is assumed that the risk of geotechnical hazards associated with partial infiltration may be mitigated to an acceptable level.

Summarize findings of studies; provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability and why it was not feasible to mitigate low infiltration rates.

For further details please refer to the Geotechnical Evaluation performed by EEI Geotechnical and Environmental Solutions (11/06/2015) included under Appendix E.4 of this SWQMP.</td></tr>
<tr><td>8</td><td>Can infiltration be allowed without violating downstream water rights? The response to this Screening Question shall be based on a comprehensive evaluation of the factors presented in Appendix C.3.</td><td>☑</td><td></td></tr>
<tr><td colspan="4">Provide basis:

The subject property discharges directly into the Sweetwater River and it does not appear that onsite infiltration of stormwater would pose a significant threat to groundwater, increase the risk of geotechnical hazards or violate downstream water rights

Finding is based on project location and its proximity to the Sweetwater River.</td></tr>
</table>

Part 2 Result**	If all answers from row 1-4 are yes then partial infiltration design is potentially feasible. The feasibility screening category is **Partial Infiltration.** If any answer from row 5-8 is no, then infiltration of any volume is considered to be **infeasible** within the drainage area. The feasibility screening category is **No Infiltration.**	**Partial Infiltration**

***To be completed using gathered site information and best professional judgment considering the definition of MEP in the MS4 Permit. Additional testing and/or studies may be required by the City to substantiate findings.*

Intentionally Left Blank

Appendix E.3. Pollutant Control BMP Design Worksheets / Calculations

Intentionally Left Blank

Table F.1-2: Performance Standards for Technology Acceptance Protocol-Ecology Certification

Performance Goal	Influent Range	Criteria
Basic Treatment	20 – 100 mg/L TSS	Effluent goal ≤ 20 mg/L TSS
	100 – 200 mg/L TSS	≥ 80% TSS removal
	>200 mg/L TSS	> 80% TSS removal
Enhanced (Dissolved Metals) Treatment	Dissolved copper 0.005 – 0.02 mg/L	Must meet basic treatment goal and better than basic treatment currently defined as >30% dissolved copper removal
	Dissolved zinc 0.02 – 0.3 mg/L	Must meet basic treatment goal and better than basic treatment currently defined as >60% dissolved zinc removal
Phosphorous Treatment	Total phosphorous 0.1 – 0.5 mg/L	Must meet basic treatment goal and exhibit ≥50% total phosphorous removal
Oil Treatment	Total petroleum hydrocarbon > 10 mg/L	No ongoing or recurring visible sheen in effluent Daily average effluent Total petroleum hydrocarbon concentration < 10 mg/L Maximum effluent Total petroleum hydrocarbon concentration for a 15 mg/L for a discrete (grab) sample
Pretreatment	50 – 100 mg/L TSS	≤ 50 mg/L TSS
	≥ 200 mg/L TSS	≥ 50% TSS removal

F.2 Guidance on Sizing and Design of Non-Standard Biofiltration BMPs

This section explains the general process for design and sizing of non-standard biofiltration BMPs. This section assumes that the BMPs have been selected based on the criteria in Section F.1.

F.2.1 Guidance on Design per Conditions of Certification/Verification

The biofiltration standard and checklist in this appendix requires that "the BMP is used in a manner consistent with manufacturer guidelines and conditions of its third-party certification." Practically, what this means is that the BMP is used in the same way in which it was tested and certified. For example, it is not acceptable for a BMP of a given size to be certified/verified with a 100 gallon per minute treatment rate and be applied at a 150 gallon per minute treatment rate in a design.
Certifications or verifications issued by the Washington Technology Acceptance Protocol-Ecology

program and the Technology Acceptance Reciprocity Partnership or New Jersey Corporation for Advance Testing programs are typically accompanied by a set of guidelines regarding appropriate design and maintenance conditions that would be consistent with the certification/verification. It is common for these approvals to specify the specific model of BMP, design capacity for given unit sizes, type of media that is the basis for approval, and/or other parameter. The applicant must demonstrate conclusively that the proposed application of the BMP is consistent with these criteria.

For alternate non-proprietary systems that do not have a Technology Acceptance Protocol-Ecology / Technology Acceptance Reciprocity Partnership / New Jersey Corporation for Advance Testing certification (but which still must provide quantitative data per Appendix F.1), it must be demonstrate that the configuration and design proposed for the project is reasonably consistent with the configuration and design under which the BMP was tested to demonstrate compliance with Appendix F.1.

F.2.2 Sizing of Flow-Based Biofiltration BMP

This sizing method is only available when the BMP meets the pollutant treatment performance standard in Appendix F.1.

Proprietary biofiltration BMPs are typically designed as a flow-based BMPs (i.e., a constant treatment capacity with negligible storage volume). Additionally, proprietary biofiltration is only acceptable if no infiltration is feasible and where site-specific documentation demonstrates that the use of larger footprint biofiltration BMPs would be infeasible. The applicable sizing method for biofiltration is therefore reduced to: Treat 1.5 times the DCV.

The following steps should be followed to demonstrate that the system is sized to treat 1.5 times the DCV.

1. Calculate the flow rate required to meet the pollutant treatment performance standard without scaling for the 1.5 factor. Options include either:
    - Calculate the runoff flow rate from a 0.2 inch per hour uniform intensity precipitation event (See methodology Appendix B.6.3), or
    - Conduct a continuous simulation analysis to compute the size required to capture and treat 80 percent of average annual runoff; for small catchments, 5-minute precipitation data should be used to account for short time of concentration. Nearest rain gage with 5-minute precipitation data is allowed for this analysis.
2. Multiply the flow rate from Step 1 by 1.5 to compute the design flow rate for the biofiltration system.
3. Based on the conditions of certification/verification (discussed above), establish the design capacity, as a flow rate, of a given sized unit.
4. Demonstrates that an appropriate unit size and number of units is provided to provide a flow rate that meets the required flow rate from Step 2.

Modular Wetland System Proprietary Biofiltration (BF-3) Sizing

Water Quality Flowrate for DMA A				
1	Design Rainfall Intensity	i=	0.2	in/hr
2	Area tributary to BMP	A=	1.52	acres
3	Area weighted runoff factor	C=	0.85	unitless
4	Biofiltration Adjustment factor	F=	1.50	unitless
5	Water Quality Flowrate (C x I x A x F)	Q_{WQ}=	**0.388**	cfs

Water Quality Flowrate for DMA B				
1	Design Rainfall Intensity	i=	0.2	in/hr
2	Area tributary to BMP	A=	1.33	acres
3	Area weighted runoff factor	C=	0.89	unitless
4	Biofiltration Adjustment factor	F=	1.50	unitless
5	Water Quality Flowrate (C x I x A x F)	Q_{WQ}=	**0.353**	cfs

Water Quality Flowrate for DMA C				
1	Design Rainfall Intensity	i=	0.2	in/hr
2	Area tributary to BMP	A=	1.78	acres
3	Area weighted runoff factor	C=	0.89	unitless
4	Biofiltration Adjustment factor	F=	1.50	unitless
5	Water Quality Flowrate (C x I x A x F)	Q_{WQ}=	**0.476**	cfs

Water Quality Flowrate for DMA D				
1	Design Rainfall Intensity	i=	0.2	in/hr
2	Area tributary to BMP	A=	1.93	acres
3	Area weighted runoff factor	C=	0.88	unitless
4	Biofiltration Adjustment factor	F=	1.50	unitless
5	Water Quality Flowrate (C x I x A x F)	Q_{WQ}=	**0.508**	cfs

Bio Clean
A Forterra Company

Modular Wetlands® System Linear

A Stormwater Biofiltration Solution

SPECIFICATIONS

FLOW-BASED DESIGNS

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

MODEL #	DIMENSIONS	WETLANDMEDIA SURFACE AREA (sq. ft.)	TREATMENT FLOW RATE (cfs)
MWS-L-4-4	4' x 4'	23	0.052
MWS-L-4-6	4' x 6'	32	0.073
MWS-L-4-8	4' x 8'	50	0.115
MWS-L-4-13	4' x 13'	63	0.144
MWS-L-4-15	4' x 15'	76	0.175
MWS-L-4-17	4' x 17'	90	0.206
MWS-L-4-19	4' x 19'	103	0.237
MWS-L-4-21	4' x 21'	117	0.268
MWS-L-6-8	7' x 9'	64	0.147
MWS-L-8-8	8' x 8'	100	0.230
MWS-L-8-12	8' x 12'	151	0.346
MWS-L-8-16	8' x 16'	201	0.462
MWS-L-8-20	9' x 21'	252	0.577
MWS-L-8-24	9' x 25'	302	0.693
MWS-L-10-20	10' x 20'	302	0.693

BMP-A & BMP-B

BMP-C & BMP-D

Vegetated Swale (FT-1) Sizing

Water Quality Flowrate for DMA G				
1	Design Rainfall Intensity	i=	0.2	in/hr
2	Area tributary to BMP	A=	0.60	acres
3	Area weighted runoff factor	C=	0.65	unitless
4	Adjustment factor	F=	1.00	unitless
5	Water Quality Flowrate (C x I x A x F)	Q_{WQ}=	**0.078**	cfs

Note: This calculation assumes the entire DMA will flow into the vegetated swale at once, which is considered conservative. In actuality, there will be mulitple vegetated swales separated by the proposed driveways. See the next page to see the maximum capacity of the vegetated swale at a worst case scenario with 3" of freeboard (0 ft bottom width and 1% slope). As can be seen, the calculated water quality flowrate is less than the maximum capacity flowrate of the swale which demonstrates the vegetated swale is properly sized.

Channel Report

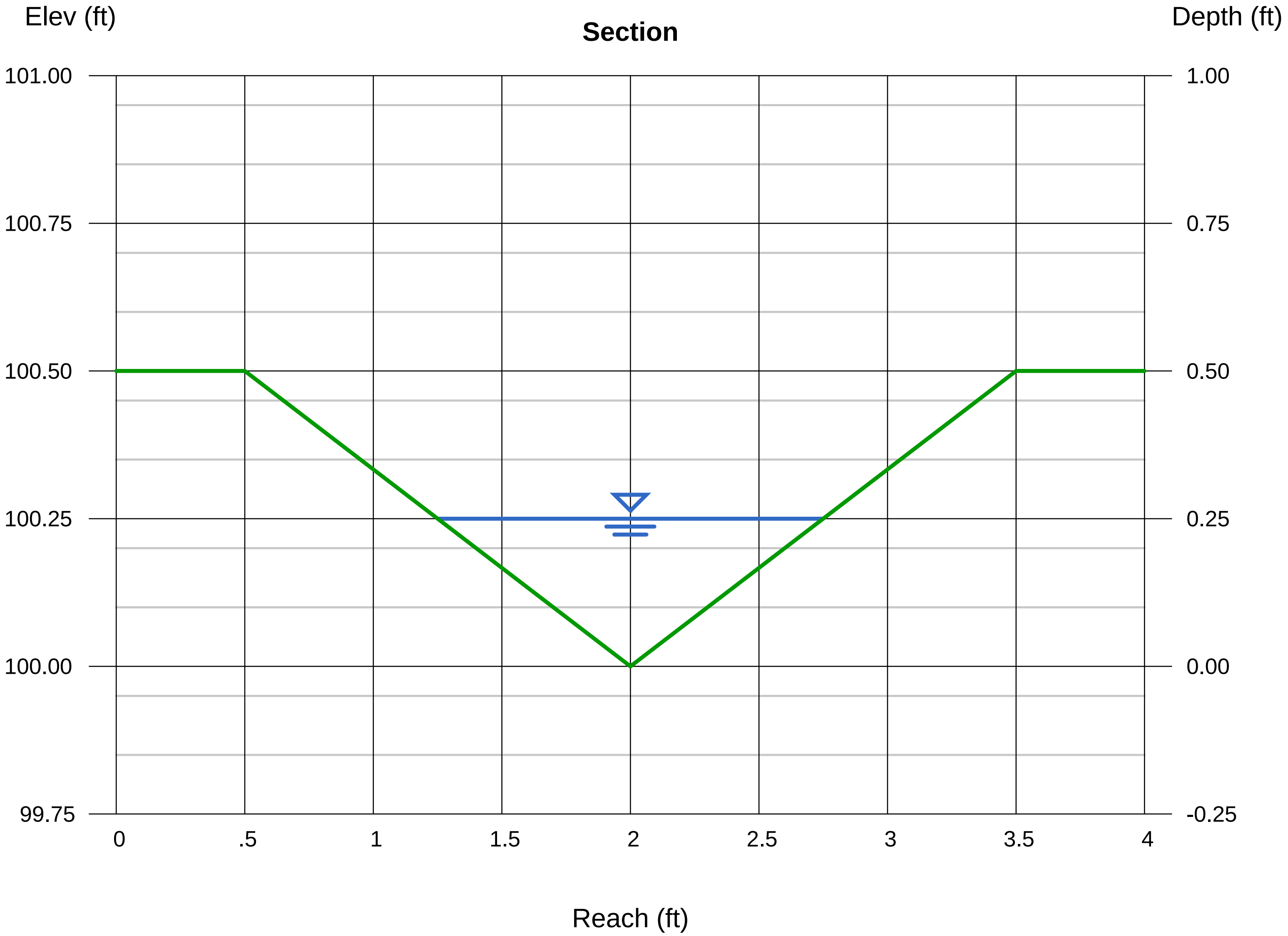
Max Capacity of the Vegetated Swale at a worst case scenario (0 ft bottom width and 1%

Triangular
Side Slopes (z:1) = 3.00, 3.00
Total Depth (ft) = 0.50

Invert Elev (ft) = 100.00
Slope (%) = 1.00
N-Value = 0.035

Calculations
Compute by: Known Depth
Known Depth (ft) = 0.25

Highlighted
Depth (ft) = 0.25
Q (cfs) = 0.192
Area (sqft) = 0.19
Velocity (ft/s) = 1.02
Wetted Perim (ft) = 1.58
Crit Depth, Yc (ft) = 0.20
Top Width (ft) = 1.50
EGL (ft) = 0.27



Intentionally Left Blank

Appendix E.4. Geotechnical Report

See standalone Geotechnical Report:

- "Geotechnical Evaluation Centerpoint Integrated Solutions Proposed CarMax Auto Superstore Development Southwest of Plaza Bonita and Sweetwater Road National City, County of San Diego, California 91950" Dated November 6, 2015 by EEI Geotechnical & Environmental Solutions

GEOTECHNICAL EVALUATION

Centerpoint Integrated Solutions
Proposed CarMax Auto Superstore Development
Southwest of Plaza Bonita and Sweetwater Road
National City, County of San Diego, California 91950

November 6, 2015

EEI Project No. CIS-72092.4

GEOTECHNICAL EVALUATION

Prepared for:

Mr. Heath Kennedy
Centerpoint Integrated Solutions
1240 Bergen Parkway, Suite A-250
Evergreen, Colorado 80439

Project Site Location:

Proposed CarMax Auto Superstore Development
Southwest of Plaza Bonita Road and Sweetwater Road
APN 564-471-11-00
National City, County of San Diego, California 91950

Prepared and Edited By:

Matt R. Love
PE 84154 (exp.9/30/17)
Senior Project Geologist

LICENSED PROFESSIONAL ENGINEER
MATTHEW R. LOVE
C 84154
EXP. 9-30-17
CIVIL
STATE OF CALIFORNIA

Craig C Chase

Craig C. Chase
CEG 2225 (exp. 6/30/17)
Senior Project Geologist

CERTIFIED ENGINEERING GEOLOGIST
CRAIG C. CHASE
No. EG2225
EXP. 6/30/17
STATE OF CALIFORNIA

Jerry L Michal

Jerry L. Michal
GE 2515 (exp. 3/31/16)
Senior Geotechnical Engineer

REGISTERED PROFESSIONAL ENGINEER
JERRY L. MICHAL
NO. 2515
Exp. 3-31-16
GEOTECHNICAL
STATE OF CALIFORNIA

EEI
2195 Faraday Avenue, Suite K
Carlsbad, California 92008-7207

EEI Project No. CIS-72092.4

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

FIGURES

APPENDICES

Distribution: (2) Addressee (one hard copy and one electronic copy)

1.0 INTRODUCTION

1.1 Purpose

The purpose of this Geotechnical Evaluation was to provide preliminary geotechnical information to Centerpoint Integrated Solutions ("Client") regarding the subject property in the City of National City, San Diego County, California. The information gathered in this evaluation is intended to provide the Client with an understanding of the physical conditions of site-specific subsurface soils, groundwater, and the regional geologic setting which could affect the cost or design of the proposed development at the property (Site Location Map-**Figure 1**, Aerial Site Map-**Figure 2**).

This Geotechnical Evaluation has been conducted in general accordance with the accepted geotechnical engineering principles and in general conformance with the approved proposal and cost estimate for the project by EEI, dated February 9, 2015, revised September 3, 2015. We understand that the Client is planning to develop the property for a CarMax Auto Superstore development.

EEI conducted an onsite field exploration on October 2, 5, 6, 7 and 8, 2015, which included drilling and sampling of twenty-one (21) hollow stem auger geotechnical borings and four (4) Cone Penetrometer Test (CPT) soundings for the proposed development at the subject property. This Geotechnical Evaluation has been prepared for the sole use of Centerpoint Integrated Solutions. Other parties, without the express written consent of EEI and Centerpoint Integrated Solutions should not rely upon this Geotechnical Evaluation.

1.2 Project Description

Based on our review of the preliminary site plan exhibit prepared by Charles J. O'Brien Architects (2013), the subject property comprises a total of 14.81-acres, including the proposed residual area. The planned area for development is approximately 9.43-acres. An approximately 19,285 square-foot CarMax Auto dealership building (assumed one- to two-stories) is planned for the central portion of the property, and will include a sales area, service area, and a presentation area. Additionally, a car wash building of approximately 936 square feet is also planned. The remainder of the property is to be developed with paved parking and drive areas and other related improvements. No detailed grading plans were available at the time of our preparation of this proposal; however, grading at the property is anticipated to include fill of up to 10 feet to raise the existing site elevations (exclusive of any remedial work).

1.3 Scope of Services

The scope of our services included:

- A review of readily available data pertinent to the subject property, including published and unpublished geologic reports/maps, and soils data for the area (**References**).

- Conducting a geotechnical reconnaissance of the subject property and nearby vicinity.

- Coordination with Underground Service Alert and property personnel to identify the presence of underground utilities for clearance of proposed boring locations.

- Drilling and logging of twenty-one (21) small diameter exploratory borings in readily accessible areas of the subject property to depths of approximately 5 feet to 51.5 feet below the ground surface (bgs). The approximate locations of each of our borings are presented on **Figure 3** (Boring Location Map).

- The advancement of four (4) Cone Penetrometer Tests soundings to a depth of approximately 50 feet below existing ground surface elevations. The locations of our cone penetration (CPT) soundings are presented on **Figure 3** (Boring Location Map).

- The performance of five (5) field percolation tests at an approximate depth of 5 feet below the ground surface to provide preliminary information for stormwater design purposes. Testing was performed in accordance with County of San Diego DEH guidelines for percolation test methods.

- An evaluation of seismicity and geologic hazards to include an evaluation of faulting and liquefaction potential.

- Completion of laboratory testing of representative earth materials encountered onsite to ascertain their pertinent soils engineering properties, including corrosion potential (**Appendix B**).

- The preparation of this report which presents our preliminary findings, conclusions, and recommendations.

2.0 BACKGROUND

2.1 Subject Property Description

The subject property is located at the southwest corner of the intersection of Sweetwater Road and Plaza Bonita Road, in National City, County of San Diego, California (**Figure 2**). The property consists of a single, irregular-shaped parcel, identified by Assessor’s Parcel Number (APN) 564-471-11-00, and encompasses approximately 15-acres of undeveloped land. According to a Client provided map, a CarMax Auto Superstore is proposed for future development of the property.

In general, the surrounding area and vicinity development includes a mix of residential, retail, and light commercial. The subject property is immediately bound by Highway 54 to the north, Sweetwater River to the south, Plaza Bonita Road and commercial-retail shopping center to the east, and Highway 805 to Highway 54 onramp to the west. Based on historical records such as aerial photographs, and topographic maps, the property was once used as a golf course which extended into adjacent properties.

The center of the subject property is approximately situated at 32.6587° north latitude and 117.0688° west longitude (GoogleEarth®, 2015).

2.2 Topography

The subject property is located on the United States Geological Survey (USGS), National City, 7.5-Minute Quadrangle (USGS, 2015). The property elevation ranges from approximately 25 feet above mean sea level (amsl) (southwestern portions) to approximately 40 feet amsl (northeastern portions). Based solely on topography, surface runoff generated on the property would flow towards the lower elevations in the southwestern portions of the property; eventually ending up in the Sweetwater River channel, located southwest of the property.

2.3 Geologic Setting

Regionally, the subject property lies within the Peninsular Ranges Geomorphic Province of southern California. This province consists of a series of ranges separated by northwest trending valleys; sub parallel to branches of the San Andreas Fault (CGS, 2002).

The Peninsular Ranges geomorphic province, one of the largest geomorphic units in western North America, extends from the Transverse Ranges geomorphic province and the Los Angeles Basin, south to Baja California. It is bound 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 (CGS, 2002). Major fault zones and subordinate fault zones found in the Peninsular Ranges Province typically trend in a northwest-southeast direction.

Regional geologic maps of the subject property and vicinity indicate the property is underlain by Quaternary-aged sedimentary deposits, consisting of Holocene and late Pleistocene-aged young alluvial flood-plain deposits. These alluvial deposits are described as consisting of poorly consolidated, poorly sorted, permeable flood-plain deposits of sandy, silty or clay-bearing alluvium.

3.0 FIELD EXPLORATION AND LABORATORY TESTING

3.1 Field Exploration

Fieldwork for our Geotechnical Evaluation was conducted on October 2, 5, 6, 7 and 8, 2015. A total of twenty-one (21) hollow stem auger borings were drilled in readily accessible areas within the subject property boundaries. Boring depths ranged from approximately 5 feet to approximately 51.5 feet below the existing ground surface (bgs), and were logged and sampled under the supervision of a Professional Engineer with EEI. The subsurface exploration also included the advancement of a total of four (4) cone penetration test (CPT) soundings. The CPT soundings were each advanced to approximate depth of 50 feet below the existing ground surface (bgs). Additionally, field percolation testing was performed in five of the exploratory borings (B-4, B-8, B-19, B-20 and B-21) at approximate depths of 5 feet below the ground surface. Testing was performed in accordance with County of San Diego DEH guidelines for percolation test methods.

Blow count (N) values were determined utilizing a 140 pound automatic hammer, falling 30-inches onto a Standard Penetration Test (SPT) split-spoon sampler and a Modified California split-tube sampler. A truck-mounted Mobile Diedrich D-50 and track-mounted Fraste PL-G Hollow Stem Auger drill rigs were used during fieldwork. The blows per foot (N value) required to advance the 18-inch long Modified California split-tube samplers a distance of 18-inches and were measured at 2½-foot intervals. The N values were recorded on the boring logs, which are presented in **Appendix A** - Soil Classification Chart and Boring Logs. Relatively "undisturbed" samples were collected in a 2.42-inch (inside diameter) California Modified split-tube sampler for visual examination and laboratory testing. The soils were classified in accordance with the Unified Soil Classification System (ASTM, 2015). Representative bulk samples were also collected for appropriate laboratory testing. Borings were backfilled with bentonite and drill cuttings following completion of drilling, logging, and sampling.

The CPT soundings were performed by Middle Earth Geo Testing Inc., under the supervision of a representative of EEI. Cone penetration testing was conducted in general accordance with ASTM Test Method D3441. The CPT procedure includes pushing an electronic cone penetrometer, which records data including tip resistance, sleeve friction and dynamic pore pressure as it is advanced. A 25 ton CPT rig equipped with a 15 square centimeter cone was used to conduct the in-situ testing. The CPT data, along with Middle Earth Geo Testing Inc.'s interpretation of the data, are presented in **Appendix A**.

3.2 Subsurface Conditions

Subsurface conditions encountered in our exploratory borings and CPT soundings consisted of artificial fill and Holocene to late Pleistocene-aged young alluvial flood-plain deposits.

Fill materials were encountered in nearly half of the exploratory borings, and extended to depths ranging from approximately 2 to 8 feet below the ground surface across the subject property where encountered. In general, the fill was composed of loose to medium dense and medium stiff to very stiff, mottled red, yellow and brown mixed sands, clays and silts. The young alluvial flood-plain deposits were encountered underlying the fill. In general, the alluvial deposits consisted primarily of very loose to dense sands, silty-sands and clayey-sands, with interbedded layers of very soft to very stiff mixed silts and clays. Fine grained materials were generally encountered within the upper 30 feet of soil during our subsurface investigation. Practical refusal due to heaving sands was encountered in the exploratory borings B-6 and B-13 at depths ranging from 46.5 to 50 feet below the ground surface, respectively, but refusal was not encountered in any of the CPT soundings. Data obtained from the CPT soundings are consistent with materials logged and sampled during the subsurface exploration. Detailed descriptions of the encountered soils are provided on the boring logs and on the CPT logs included as **Appendix A**.

3.3 Groundwater

At the time of our subsurface exploration, groundwater was encountered at depths ranging from 6 to 16 feet below the ground surface. Additionally, standing water was observed for a large portion of the southeastern corner of the subject property. In general, groundwater is expected to follow the direction of surface topography; therefore, local groundwater flow is expected to be in a general westerly direction. It should be noted that variations in groundwater may result from fluctuations in the ground surface topography, subsurface stratification, rainfall, irrigation, and other factors that may not have been evident at the time of our subsurface exploration.

3.4 Laboratory Testing and Classification

Representative samples were selected for laboratory testing to check their field classification(s) and to evaluate their pertinent engineering characteristics. Field descriptions and soil classifications were visually classified according to the American Society for Testing and Materials (ASTM D2488) which classifies soils under the USCS. Representative soil samples were tested in the lab for grain size distribution to determine actual classifications by ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes in accordance with the USCS. Final classifications of soils can be found on the boring logs in **Appendix A** and the laboratory test data in **Appendix B**.

3.4.1 Moisture Content and Dry Density

The in-situ moisture content and dry density of soils was determined for soil samples obtained from the borings. In-place moisture content and dry density of soils help in the evaluation of engineering design parameters for foundations, retaining walls, and other engineering structures. The moisture content determination of soil samples was conducted in general accordance with ASTM D2216, and was recorded as a percentage. The determination of dry density of soil samples was conducted in accordance with ASTM 2937, and recorded in pounds per cubic foot. Moisture content and dry density for soil samples retrieved from the field can be found on the boring logs located in **Appendix A**.

3.4.2 Expansion Index

A bulk sample of soils obtained from within 5 feet of the existing grade from Boring B-7 and Boring B-10 and tested for its expansion potential. Our expansion index testing was conducted in general accordance to ASTM D4829. The results of our expansion index testing are presented in **Appendix B.**

3.4.3 Maximum Dry Density and Optimum Moisture Content

The maximum dry density and optimum moisture content was determined from a bulk soil sample obtained from boring B-3 within the upper five feet of existing grade. Our testing was performed in general accordance with ASTM D1557, Method A. Results of our testing are presented in **Appendix B**.

3.4.4 Grain Size Distribution

To help check field classifications of soils, the grain size distribution of representative soil samples was determined. In order to find the percentages of fine grained particles in a particular soil stratum, soils were tested in general accordance with ASTM D422-Standard Test Method for Particle-Size Analysis of Soils. Gradation results are presented in **Appendix B**.

3.4.5 Direct Shear

Direct shear testing was conducted on three representative samples at varying depths. The samples were remolded to 90 percent of their maximum density (based on ASTM D1557) to measure their shear strength characteristics for engineering purposes. The samples were inundated for at least 18 hours. The samples were placed in a shear box and a normal load was applied (loads of approximately 1,000, 1,700 and 3,000 psf weights were used). The samples were then sheared at a controlled strain rate in a direct shear apparatus that measures horizontal displacement and shear resistance. Shear testing was run in general accordance with ASTM D3080. The results of our testing are presented in **Appendix B**.

3.4.6 Sulfate/Corrosion

A representative sample of the encountered onsite earth material was collected for analysis at Clarkson Laboratory and Supply, Inc. located in Chula Vista, California for corrosion/soluble sulfate potential.

This corrosion testing included soil minimum resistivity and pH by California Test 643 sulfate by California Test 417, and chloride by California Test 422. Results of these tests are presented in **Appendix B**.

3.4.7 R-Value

One representative bulk sample was collected to test for R-Value. One (1) bulk sample was collected from boring B-10 at a depth between 0 and 5 feet below existing grade for the proposed paved drive and parking areas. The sample was sent to a Geosoils laboratory in Carlsbad, California for R-Value testing. EEI reviewed test results from Geosoils and concurs with the results as presented. Test procedures were conducted in general accordance with the Department of Transportation, State of California, Materials & Research Test Method No. 301. Results are provided in **Appendix B**.

4.0 GEOLOGIC HAZARDS

4.1 Regional Faulting and Seismicity

The portion of Southern California that includes the subject property is considered to be seismically active. Due to the proximity of the property area to several nearby active faults, strong ground shaking could occur at the property as a result of an earthquake on any one of the faults.

Our review indicates that there are no known active faults crossing the property and the property is not located within an Alquist-Priolo Earthquake Fault Zone as defined by the State of California (Hart and Bryant, 1997, CDMG, 2000). The closest active fault to the property is the Rose Canyon fault, located approximately 5.6 miles northwest of the property. Other faults in the region include the Coronado Bank (approximately 15.7 miles northwest), and the offshore segment of the Newport-Inglewood fault (approximately 40.3 miles north) (Blake, 2000; Jennings, 1994).

While the potential risk of ground rupture cannot be completely ruled out, it is our opinion that the likelihood of surface fault rupture at the subject property is relatively low and the risk is considered similar to other sites in the vicinity.

4.2 Seismic Parameters and Peak-Ground Acceleration

Maximum considered ground motion maps provided in the California Building Code (CBC, 2013) were utilized with coordinates of 32.6587° north latitude and 117.0688° west longitude, to determine the site seismic parameters. EEI utilized seismic design criteria provided in the CBC (2013) and ASCE 7-10. Final selection of the appropriate seismic design coefficients should be made by the structural consultant based on the local laws and ordinances, expected building response, and desired level of conservatism. The site coefficients and adjusted maximum considered earthquake spectral response accelerations in accordance with the 2013 California Building Code are presented in **Table 2**.

TABLE 1
Seismic Hazard Response Parameters and Design Parameters CBC (2013)

Seismic Parameter	Period (Sec)		Value
Mapped Spectral Acceleration Value, Site Class B	0.2	S_s	0.953g
Mapped Spectral Acceleration Value, Site Class B	1.0	S_1	0.362g
Site Coefficient, Subject Site Class D per 2013 CBC Table 1613.3.3	--	F_a	1.119
Site Coefficient, Subject Site Class D per 2013 CBC Table 1613.3.3	--	F_v	1.675
Adjusted Maximum Considered Earthquake (MCE_R) Spectral Response Acceleration Site Class D	0.2	S_{MS}	1.066g
Adjusted Maximum Considered Earthquake (MCE_R) Spectral Response Acceleration Site Class D	1.0	S_{M1}	0.607g
Design Spectral Response Acceleration Occupancy Category I-III per 2013 CBC Table 1604.5	0.2	S_{DS}	0.711g
Design Spectral Response Acceleration Occupancy Category I-III per 2013 CBC Table 1604.5	1.0	S_{D1}	0.405g
Peak Ground Acceleration Adjusted For Site Class Effects		PGA_M	0.434g

4.3 Ground Lurching or Shallow Ground Rupture

Based on the geography, topography and site-specific geotechnical conditions encountered during our preliminary geotechnical evaluation at the subject property, we consider the potential for ground lurching or shallow ground rupture at the property to be low; however, due to the active seismicity of California, this possibility cannot be completely ruled out. In light of this, the unlikely hazard of lurching or ground-rupture should not preclude consideration of "flexible" design for onsite utility lines and connections.

4.4 Liquefaction

Liquefaction is a phenomenon in which the strength and stiffness of a soil is reduced by earthquake shaking or other rapid loading.

Liquefaction and related phenomena have been responsible for substantial structural damage in historical earthquakes, and are a design concern under certain conditions. Liquefaction occurs in saturated soils that are soils in which the space between individual particles is completely filled with water. This pore water exerts a pressure on the soil particles that influences how tightly the particles themselves are pressed together.

Prior to an earthquake, pore water pressure is typically low; however, earthquake motion can cause the pore water pressure to increase to the point where the soil particles can readily move with respect to each other. When liquefaction occurs; the strength of the soil decreases and the ability of a soil deposit to support structural loads are reduced.

Our evaluation of the subject property's susceptibility to liquefaction was performed in accordance with the procedure recommended by The National Center for Earthquake Engineering Research (Youd, et al., 2001). Our liquefaction evaluation utilizes the CLiq computer program developed by GeoLogismiki (2015) and incorporates the geotechnical data obtained from CPT soundings CPT-1 through CPT-4. It should be noted that the property is indicated to be within a storm water drainage basin (flood plain) that is considered susceptible to liquefaction based on a review of the Seismic Hazard Zones Map for the property vicinity (CDMG, 2001).

The liquefaction analyses were based on the adjusted peak-ground acceleration obtained from the USGS Seismic Design Maps and Equation 11.8-1 of ASCE 7-10. Based on this reference a peak-ground acceleration of 0.434g is obtained, which is the value used in our evaluation. Deaggregation of the probabilistic ground motion at the subject property was performed using the USGS interactive webpage which estimates the modal magnitude for a given probabilistic seismic ground motion. Results of our seismic hazard deaggregation (**Appendix C**) yielded a modal magnitude of 6.96, which is the magnitude used in our liquefaction analysis.

As previously discussed, our subsurface exploration encountered groundwater at depths ranging from 6 to 16 feet below the ground surface. Based on this information we assessed the liquefaction potential for the site utilizing a groundwater depth of 5 feet bgs for conservatism.

As noted in our exploratory borings, layers containing appreciable amounts of fine-grained soil were encountered at various depths. Our liquefaction evaluation included utilizing guidelines outlined by Robertson and Wride (1998) to determine whether these layers of fine-grained soil are susceptible to liquefaction.

Based on the results of our CLiq evaluation, we consider the subject property to be susceptible to considerable amounts of liquefaction. Generally, our evaluation indicates that potentially liquefiable soils consist of isolated and discontinuous thin lenses of saturated sands, silts and clays. The results of our liquefaction evaluation are included as **Appendix C**.

Cyclic mobility is a liquefaction phenomenon, triggered by cyclic loading, occurring in soil deposits with static shear stresses lower than the soil strength. Deformations due to cyclic mobility develop incrementally because of static and dynamic stresses that exist during an earthquake. Lateral spreading, a common result of cyclic mobility, can occur on gently sloping and on flat ground close to rivers and lakes. Due to the presence of a Sweetwater River channel located approximately 700 feet southwest of the proposed building locations, it appears that the subject property is susceptible to lateral spreading on the order of 1.68-inches in the event of the design earthquake.

4.5 Seismic Induced Settlement

Seismically induced settlement can occur due to reorientation of soil particles during strong shaking of unsaturated sands, as well as in response to liquefaction of saturated loose granular soils. The potential for seismically induced settlement within the upper alluvial deposit materials was estimated using the CLiq computer program (GeoLogismiki, 2015), which incorporates Robertson and Wrides's procedure (1998). Our evaluation was based on the aforementioned peak ground acceleration of 0.434g and a modal earthquake magnitude of 6.96. Our evaluation was performed on the CPT sounding data from CPT-1 through CPT-4. Based on our evaluation (**Appendix C**), we estimate the total maximum seismic-induced settlement to be on the order of 3.65-inches at isolated locations within the site. Differential earthquake induced settlements estimated to be on the order of 1.70-inches across a 50-foot span.

4.6 Tsunamis and Flooding

The subject property is not located within a mapped area on the State of California Tsunami Inundation Maps (Cal EMA, 2009); therefore, damage due to tsunamis is considered low.

EEI reviewed the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) online database to determine if the subject property was in a flood zone. According to FIRM Number FM06073C1912G, of Panel 1912 of 2375 (effective May 2012), the subject property is located within flood Zone AE and Zone X. FEMA defines Zone AE as an area subject to inundation by the 1-percent-annual-chance flood event with base flood elevations, while Zone X is described as area determined to be outside the 0.2 percent annual chance floodplain.

5.0 CONCLUSIONS

Based on our field exploration, laboratory testing and engineering and geologic analysis, it is our opinion that the subject property is suitable for the proposed retail development from a geotechnical engineering and geologic viewpoint.

However, there are existing geotechnical conditions associated with the subject property that will warrant mitigation and/or consideration during planning stages. The following conclusions take in consideration the assumption that the property is proposed for the construction of retail development and related improvements.

The CarMax building structure is proposed to have a footprint of approximately 19,285 square feet and is assumed to be one- to two-stories. Additionally, a car wash building of approximately 936 square feet is also planned. Furthermore, we understand that the existing site elevations are proposed to be raised on the order of 5 to 10 feet during grading operations for the proposed development. If site plans and/or the proposed building locations are revised, additional field studies may be warranted to address proposed site-specific conditions. As a result, EEI is providing the following conclusions:

- A total of twenty-one (21) exploratory hollow-stem auger borings were advanced within the subject property boundaries during this evaluation. Exploratory boring depths ranged from approximately 5 to 51 feet bgs. Additionally, field percolation testing was performed in five of the exploratory borings in accordance with County of San Diego DEH guidelines at depths of approximately 5 feet bgs. Overall, the property is underlain by artificial fill and Holocene to late Pleistocene-aged young alluvial flood-plain deposits. In general, the fill was encountered to a maximum depth of 8 feet bgs and was composed of loose to medium dense and medium stiff to very stiff, mottled red, yellow and brown mixed sands, clays and silts.

The young alluvial flood-plain deposits were encountered underlying the fill. In general, the alluvial deposits consisted primarily of very loose to dense sands, silty-sands and clayey-sands, with interbedded layers of very soft to very stiff mixed silts and clays.

- A total of four (4) exploratory Cone Penetrometer Test soundings (CPT), were advanced to an approximate depth of 50 feet below existing grade elevations. Data obtained from the CPT soundings are consistent with materials logged and sampled during the subsurface exploration.

- At the time of our subsurface exploration, groundwater was encountered at depths ranging from 6 to 16 feet below the ground surface.

- Laboratory test results performed on a sample of the upper soils obtained from the proposed building pad area indicate that the tested soils are slightly alkaline (tested pH value of 7.6) and are corrosive to extremely corrosive to ferrous metals with a tested minimum resistivity value of 300 ohm-cm. Laboratory testing also yielded soluble sulfate concentration of 0.105 percent within the tested sample, indicating a moderate potential for sulfate attack on concrete. A chloride concentration of 0.107 percent was detected within the sample of the upper soils, indicating that the upper soils possess a negligible potential for corrosion of steel reinforcement in concrete.

- The subject property is located within an area of southern California recognized as having a number of active and potentially-active faults located nearby. Our review indicates that there are no known active faults mapped as crossing the property and the property is not located within an Earthquake Fault Zone. The nearest active faults that could affect the property include the Rose Canyon fault located approximately 5.6 miles from the property. Other nearby seismic sources includes the Coronado Bank and the offshore segment of the Newport-Inglewood fault; each of these active faults is capable of generating severe ground shaking at the property.

- Based on EEI's evaluation, earth materials underlying the subject property are considered susceptible to considerable amounts of seismic induced liquefaction. Based on EEI's evaluation, the earth materials consisting of isolated and discontinuous lenses of saturated sands, silts and clays underlying the property of the proposed development appear to be susceptible to some seismically induced settlement on the order of 3.65-inches with differential settlements on the order of 1.70-inch over a 50-foot span. Additionally, it appears that the site is susceptible to lateral spreading on the order of 1.68-inches in the event of the design earthquake.

- There are several different methods that can be employed to mitigate the effects of liquefaction on proposed new structures or improvements (i.e., reduce the potential for structural collapse or risk of life and limb due to liquefaction at the subject property). Ground improvement and the use of deep foundations or other special foundation systems (stiff foundations, mat foundations etc.), and the utilization of geosynthetic fabric reinforcement, installed within fill soils that are placed in overexcavated areas within proposed new building areas. These methods can certainly mitigate or reduce the effects of liquefaction potential at the property.

- The results of our laboratory Expansion Index (EI) testing of a localized pocket of clayey materials sampled at a depth of 2 to 8 feet below the ground surface indicate an EI of 68, which represents a medium expansion potential for those soils. However, of the onsite soils encountered, the majority are anticipated to be very low to low expansive.

- EEI evaluated static settlement utilizing the CPT soundings data, results of laboratory testing and subsurface data to estimate settlement as a result of grading the pad(s) to a proposed finish slab grade.

Based upon our evaluation and our recommendations for remedial earthwork, the overburden loading from the proposed increase site grade, and a conventional or mat slab foundation system, EEI estimates total static settlement on the order of 4-inches within the building envelope. Differential settlement is estimated to be approximately 3-inches or less over a distance of 50 feet. Based on our experience in the immediate vicinity of the subject property, we consider the potential for these total static and differential settlements estimates to occur to be high. As such, we consider the installation of settlement monuments to be prudent after proposed building pad grades are achieved.

6.0 RECOMMENDATIONS

The recommendations presented herein should be incorporated into the planning and design phases of development. Guidelines for site preparation, earthwork, and onsite improvements are provided in the following sections.

As noted herein, our evaluation of the subject property reveals that the alluvial soils could experience seismic settlements on the order of 3.65-inches due to a design level earthquake, with differential settlements estimated to be approximately 1.70-inches and lateral spreading on the order of 1.68-inches in the event of the design earthquake.

There are several different methods that can be employed to mitigate the effects of seismic induced settlement and lateral spreading on the proposed improvements (i.e., reduce the potential for structural collapse or risk of life and limb due to seismic settlement at the subject property). While ground improvement and the use of deep foundations would certainly be expected to mitigate the seismic settlement at the property, these methods do not appear to be economically feasible, given the estimated magnitude of the settlement and the scope of the proposed project. As such, the recommendations provided in the following sections of this report are intended to be relatively economic measures to resist structural collapse as a result of seismic settlement at the property. It should be understood that the proposed improvements could experience some damage during a design seismic event.

We also recommend that the structural engineer evaluate whether the proposed building could tolerate the amount of seismic settlement estimated herein and whether the methods to reduce the potential for distress due to seismic settlement (described in the following sections of this report) are warranted.

6.1 General

Grading should conform to the guidelines presented in the 2013 California Building Code (CBC, 2013) and the requirements of the current edition of the County of San Diego Building Code and City of National City Grading Code. Additionally, general Earthwork and Grading Guidelines are provided herein as **Appendix D**.

During earthwork construction, removals and reprocessing of fill materials, as well as general grading procedures of the contractor should be observed and the fill placed selectively tested by representatives of the Geotechnical Engineer, EEI. If any unusual or unexpected conditions are exposed in the field, they should be reviewed by the Geotechnical Engineer and if warranted, modified and/or additional remedial recommendations will be offered. Specific guidelines and comments pertinent to the planned development are provided herein.

The recommendations presented herein have been completed using the information provided to us regarding site development.

If information concerning the proposed development is revised, or any changes in the design and location of the proposed property improvements are made, the conclusions and recommendations contained in this report should not be considered applicable unless the changes are reviewed and conclusions of this report modified or approved in writing by this office.

6.2 Site Preparation and Grading

Debris and other deleterious material, such as organic soils and/or environmentally impacted earth materials should be removed from the subject property prior to the start of grading. Areas to receive fill should be properly benched in accordance with current industry standards of practice and guidelines specified in the CBC (2013).

Existing utilities should be removed within the proposed building envelope. Abandoned trenches should be properly backfilled and tested. If unanticipated subsurface improvements (utility lines, septic systems, wells, utilities, etc.) are encountered during earthwork construction, the Geotechnical Engineer should be informed and appropriate remedial recommendations would then be provided.

6.3 Remedial Earthwork

The existing fill and upper alluvial materials appear to be relatively loose and are considered potentially compressible. As such, they are considered unsuitable for the support of settlement-sensitive structures or additional fill in their current condition. Additionally, our evaluation of the subject property (as described herein) indicates that liquefaction of the alluvial soils that underlie the property could result in settlements of approximately 3.65-inches and differential settlements on the orders of 1.70-inches. The estimated differential seismic settlements could adversely affect shallow foundations supporting the proposed building.

Therefore, where not already removed by the proposed subject property grading or disturbed during clearing and grubbing operations at the site, the existing fill materials should be completely removed in the area of the proposed building and other settlement-sensitive improvements. We anticipate that these removals will extend to depths of approximately 5-feet below the ground surface, or 36-inches below the bottoms of the proposed foundations, whichever is deeper. Reprocessing of the upper 12- inches of subgrade in pavement areas is also recommended.

Following removal of the upper soils, the bottom of the resulting excavation(s) should be observed by a representative of EEI to check that unsuitable materials have been sufficiently removed. It should be understood that based on the observations of our field representative, localized deeper removals may be recommended. The base of the removal area should be level to avoid differential fill thicknesses under proposed improvements. This remedial earthwork should extend at least 5 feet outside the proposed building limits and/or 5 feet beyond the area to receive fill. Note that vertical sides exceeding 5 feet in depth may be prone to sloughing and may require laying back to an inclination of 1:1 (horizontal to vertical) or flatter.

After removal of the upper soils and observation of the excavation bottoms, the over-excavated areas should be scarified to a minimum depth of 6-inches, moisture conditioned as needed to achieve at least optimum moisture content and re-compacted to at least 90 percent of the maximum dry density (based on ASTM D1557). The over-excavated areas should then be backfilled with suitable, approved onsite and/or imported soils that are placed and compacted as recommended herein until design finish grades are reached.

6.4 Fill Placement

Fill material should possess a low expansion potential (expansion index of less than 51 as determined by ASTM D4829), be free of organic matter (less than 3 percent organics by weight) and other deleterious material. Much of the onsite materials appear to be suitable for re-use as fill, provided they do not contain rocks greater than 6-inches in maximum dimension, organic debris and other deleterious materials. Rock fragments exceeding 6-inches in one dimension should be segregated and exported from the subject property, or utilized for landscaping.

If import soils are needed, the earthwork contractor should ensure that all proposed fill materials are approved by the geotechnical engineer prior to use. Representative soil samples should be made available for testing at least ten (10) working days prior to hauling to the subject property to allow for laboratory tests.

Fill materials should be placed in 6- to 8-inch loose lifts, moisture conditioned as necessary to at least optimum moisture and compacted to a minimum of 90 percent maximum dry density according to ASTM D1557. The upper 12-inches of pavement subgrade should be moisture conditioned to at least optimum moisture and compacted to at least 95 percent of the maximum dry density as determined by ASTM D1557. Suitable heavy grading equipment should be utilized to properly mix, spread, moisture condition or dry, and compact each fill lift.

Earthwork may be affected by the existing soil moisture content exceeding optimum. Moist to very moist earth materials may be difficult to mix and compact in their native condition, and drying or mixing with drier soils may be warranted to achieve the recommended relative compaction.

Those areas to receive fill (including over-excavated areas) or surface improvements should be scarified at least 12-inches, moisture conditioned to at least optimum moisture content and recompacted to at least 90 percent of the maximum dry density (based on ASTM D1557).

To help mitigate the effects of liquefaction and seismic-induced settlement within the proposed building area, we recommend that following the removals and the scarification of the removal bottom, that a geogrid layer, such as Tensar TriAx, be placed across the bottom prior to backfilling the excavation with fill soils. The geogrid should extend beyond the building pad area a minimum of 5 feet on all sides and up the sides of the excavation approximately 5 feet. After placing and compacting an additional 2.5 feet of fill material, an additional layer of Geogrid should be placed, and so on for every additional 2.5 feet of fill placed before completing the building pad grading. This should provide at least 5 feet of geogrid reinforced fill to support the structure and will limit, to the extent feasible, the loss of bearing capacity of the supporting bearing soils the design earthquake occur. Care should also be taken to make sure that the reinforcement is placed at depths sufficient so that it does not interfere with installation of buried utilities. It is our opinion that the reinforced fill, if properly placed within engineered fill materials, can be expected to provide a relatively rigid soil layer to support the proposed building and to span across voids that may develop under these improvements due to differential settlement that occurs in response to a design seismic event.

6.5 Yielding Subgrade Conditions

The soils encountered at the subject property can exhibit “pumping” or yielding once they become saturated. This can often occur in response to periods of significant precipitation, such as during the winter rainy season. If this occurs and in order to help stabilize the yielding subgrade soils within the bottom of the removal areas, the contractor can consider as an option, the placement of Mirafi 600X stabilization fabric (or approved equivalent) over the yielding subgrade, and placement of uniform sized, ¾- to 2-inch crushed rock over the stabilization fabric.

The crushed rock should be properly tracked into the underlying soils. We expect that a 6- to 12-inch thick section of the crushed rock will be required. If significant voids are present in the crushed gravel, a filter fabric should be placed over the crushed gravel to prevent migration of fines and subsequent settlement from the overlying fill. Fill soils, which should be placed and compacted in accordance with the recommendations presented herein, should then be placed upon the fabric until design finish grades are reached. The gravel and stabilization fabric should extend at least 5 feet laterally beyond the limits of the "pumping" areas. These operations should be performed under the observation and testing of a representative of EEI in order to evaluate the effectiveness of these measures and to provide additional recommendations for mitigative measures, as warranted.

6.6 Shrinkage and Bulking

Several factors will impact earthwork balancing on the subject property, including shrinkage, bulking, subsidence, trench spoils from utilities and footing excavations, and final pavement section thickness as well as the accuracy of topography. Shrinkage, bulking and subsidence are primarily dependent upon the degree of compactive effort achieved during construction. Shrinkage, bulking and subsidence should be considered by the project civil engineer relative to final site balancing. It is recommended that the site development be planned to include an area that could be raised or lowered to accommodate final site balancing.

6.7 Grading Considerations

As previously discussed, the existing site grades are proposed to be raised on the order of 5 to 10 feet during grading operations for the proposed development. In order to assess the potential settlement due to the overburden loads that will be added during grading, we recommend the installation of settlement monuments on that building pad after rough grades have been established. The elevations of the settlement monuments should be surveyed after installation and at weekly intervals (minimum) after. Survey data from the settlement monuments should be provided to EEI in order to determine the settlement of the building pad, if any, due to the overburden loading.

7.0 PRELIMINARY FOUNDATION RECOMMENDATIONS

7.1 General

In the event that plans concerning the proposed building structure are revised in the project design and/or location or loading conditions of the planned structure are made, conclusions and recommendations contained in this report should not be considered valid unless they are reviewed, revised and/or approved in writing by EEI. The foundation recommendations provided herein are based on the soil materials near finish grade possessing a low expansion potential (EI < 51).

7.2 Preliminary Foundation Design

In the event that plans concerning the proposed CarMax Auto Superstore building are revised in the project design and/or location or loading conditions of the planned structure are made, conclusions and recommendations contained in this report should not be considered valid unless they are reviewed, revised and/or approved in writing by EEI. The foundation recommendations provided herein are based on the soil materials near finish grade possessing a low expansion potential (EI < 51).

As discussed prior, we estimate that the subject property could experience seismic induced settlements on the order of 3.65-inches, with differential seismic settlements estimated to be approximately 1.70-inches.

We recommend that the structural engineer conduct an evaluation to see whether the proposed building can adequately tolerate the estimated seismic settlement without danger of collapse. We anticipate that an adequately designed and constructed mat foundation, together with the underlying reinforced fill layer (as recommended in **Section 6.4**) can provide sufficient rigidity to span over voids that may develop under the slab due to differential soil settlement resulting from a seismic event, thus further reducing the overall differential settlement across the proposed building. Based on the structural engineer's evaluation, additional geotechnical recommendations for the mitigation of the effects of liquefaction may be warranted.

7.2.1 Alternative 1 - Mat Foundations

A rigid mat foundation may be used for the support of the building at the subject property, provided the mat foundation is bearing within fill soils that are properly placed and compacted in accordance with the recommendations contained herein. When properly designed and constructed, a structural mat foundation system can be expected to support high structural loads and provide relatively uniform settlement across a structure, while being able to "bridge" over local areas of dynamic settlement. Mat foundations should be properly reinforced to form a relatively rigid structural unit in accordance with the structural engineers design. For designing a mat foundation, we recommend using an uncorrected modulus of subgrade reaction of 150 pounds per cubic inch (pci). For large foundations, the modulus is typically reduced by 75 percent. The mat foundation may also be designed for a maximum bearing pressure of 2,000 psf with a one third increase for transient loadings. Mat foundations should be reinforced in accordance with structural considerations.

7.2.2 Alternative 2 – Post-Tensioned Slab

A post-tensioned slab can be used for building support, provided it is bearing within reinforced fill soils that are placed and compacted in accordance with the recommendations contained in **Section 6.4** of this report. Perimeter thickened slab edges that are embedded at least 18-inches below finish grade can be designed for an allowable soil bearing value of 2,000 psf. This allowable soil bearing value can be increased by one-third for loads of short duration, including wind and seismic forces. Post-tensioned slabs should be designed by the structural engineer in accordance with the current guidelines of the post-tensioning institute. If this alternative foundation system is selected for building support, EEI would be pleased to provide additional geotechnical parameters for post-tensioned slab design.

7.2.3 Alternative 3 – Ground Improvement

Along with the two alternative foundation systems presented above, soil improvement can also be performed to mitigate the effects of liquefaction at the subject property. When performed properly, soil improvement can be expected to increase the property's resistance to liquefaction to the point where special foundation systems are not warranted. Those ground improvement methods that are often performed at sites, similar to the subject property, primarily involve in-place densification of soils. Based upon our analysis, ground improvement (such as rammed aggregate or stone columns) would need to be installed to a depth of at least 30 feet to minimize the potential seismic settlement to a tolerable level.

If the buildings experience seismically induced settlements that result in the structures being significantly out-of-plumb, the buildings could be subsequently re-leveled by pressure grouting or other methods in conjunction with other earthquake repairs.

Based on the information herein, we recommend that the project structural engineer evaluate whether a mat foundation system can be constructed to tolerate seismically induced ground shaking, liquefaction, and dynamic settlements estimated herein without structural collapse. If the structural engineer determines that mat foundations cannot be feasibly constructed for the seismic conditions at the property, then consideration should be given for the use of another foundation type for building support.

7.3 Foundation Design – Non Building Improvements

Non-building improvements can be supported on conventional continuous or isolated spread footings bearing upon at least 36-inches of properly compacted fill materials. In preparation for foundation construction, the earthwork contractor should ensure that the subject property has been prepared as recommended herein, and that field density tests have been performed to adequately document the relative compaction of the structural fill.

Conventional foundations can be designed to impose dead plus long term live load bearing pressures of 2,500 pounds per square foot (psf). The allowable foundation bearing pressure is for footings having a minimum width of 15-inches and a minimum depth of 18-inches embedment below the lowest adjacent finish grade. The allowable soil bearing pressure can be increased by one-third when considering transient loads of short duration, such as wind or earthquake loads. Based on the prevailing geotechnical conditions encountered during our subsurface exploration, we recommend that foundations be reinforced with at least two No. 4 bars, one placed at the top of the footing and one placed at the bottom.

7.4 Lateral Resistance of Foundations

Horizontal loads acting on foundations and stem walls cast in open excavations against undisturbed native soil or against properly placed and compacted fill will be resisted by friction acting along the base of the footing and by passive earth pressures against the side of the footing and stem wall. The frictional resistance acting along the base of footings founded on suitable foundation soils may be computed using a coefficient of friction equal to 0.25 with the normal dead load. Allowable passive earth pressures acting against the side of footings and stem walls may be assumed to be equivalent to a fluid weighing 250 pounds per cubic foot. Passive pressure in the upper 1-foot should be neglected unless confined by concrete slabs-on-grade or asphaltic pavement. The values given above may be increased by one-third for transient wind or seismic loads.

7.5 Footing Setbacks

All footings should maintain a minimum 7-foot horizontal setback from the base of the footing to any descending slope (if existing onsite). This distance is measured from the outside footing face at the bearing elevation. Footings should maintain a minimum horizontal setback of H/3 (H=slope height) from the base of the footing to the descending slope face and no less than 7 feet, or greater than 40 feet.

Footings adjacent to unlined drainage swales or underground utilities (if any) should be deepened to a minimum of 6-inches below the invert of the adjacent unlined swale or utilities. This distance is measured from the footing face at the bearing elevation. Footings for structures adjacent to retaining walls should be deepened so as to extend below a 1:1 projection from the heel of the wall. Alternatively, walls may be designed to accommodate structural loads from buildings or appurtenances.

7.6 Concrete Slabs on Grade

Interior slabs can be grade supported by native soil or structural fill whose placement/compaction is documented by the project soils engineer/engineer geologist as recommended herein.

The thickness of the slab should be in accordance with the structural engineer's design; however, based on geotechnical considerations, we recommend that concrete slabs be a minimum of 5-inches in thickness. Concrete slabs should be underlain by at least 2-inches of clean sand with a Sand Equivalent (SE) of at least 30.

Where moisture condensation is undesirable, concrete slabs should be underlain with a moisture/vapor retarder consisting of a minimum 10-mil, visqueen membrane, with all laps sealed. The membrane should be underlain by a 2-inch layer of clean sand. The visqueen moisture barrier should then be overlain by a 2-inch layer of clean sand to aid in concrete curing. To reduce the potential for buildup of hydrostatic pressures, the free draining material under the slabs should have positive drainage with no low lying areas (i.e., depressions) created.

Floor slabs should be suitably reinforced and jointed (in accordance with Structural Engineer's recommendations) so that a small amount of independent movement can occur without causing damage. Based on the encountered geotechnical conditions, we recommend that floor slabs be reinforced with minimum No. 4 bars spaced on 18-inch centers (each way). The contractor should take the appropriate precautions to make sure that the reinforcement is placed and maintained within the middle one-third of the slab.

Exterior slabs, such as walkways and driveways, can be adequately supported on documented structural fill that is at minimum 12-inches in thickness, and placed and compacted in accordance with the recommendations contained herein.

In preparation for slab or flatwork construction, the earthwork contractor should ensure that the onsite soils have been prepared as recommended and that field density tests have been performed to adequately document the relative compaction of the structural fill. Preparation of the native soils should be documented prior to placement of aggregate, structural components and/or fill.

Some minor cracking of slabs can be expected due to shrinkage. The potential for this slab cracking can be reduced by careful control of water/cement ratios in the concrete. The contractor should take appropriate curing precautions during the pouring of concrete in hot or windy weather to reduce the potential for cracking of slabs. We recommend that a slipsheet (or equivalent) be utilized if grouted fill, tile, or other crack-sensitive floor covering is planned directly on concrete slabs. All slabs should be designed in accordance with structural considerations.

All dedicated exterior flatwork should conform to standards provided by the governing agency including section composition, supporting material thickness and any requirements for reinforcing steel. Concrete mix proportions and construction techniques, including the addition of water and improper curing, can adversely affect the finished quality of the concrete and result in cracking and spalling of the slab. We recommend that all placement and curing be performed in accordance with procedures outlined by the American Concrete Institute and/or Portland Cement Association.

Special consideration should be given to concrete placed and cured during hot or cold weather conditions. Proper control joints should be provided to reduce the potential for damage resulting from shrinkage.

7.7 Corrosivity

Laboratory test results indicate that the upper materials contains a maximum soluble sulfate concentration of 0.105 percent, which indicate a moderate sulfate corrosion potential of concrete that will be in contact with the onsite soils. Our analysis also indicates maximum chloride concentrations of 0.107, which indicates a negligible corrosion potential to concrete due to chloride in the soils. As such, Type II cement can be used in concrete elements that will be in contact with the upper materials.

7.8 Retaining Walls (if proposed)

The design parameters provided herein assume that granular non-expansive soils (EI<21) are used to backfill any retaining walls. If expansive soils are used to backfill the proposed walls, increased active and at-rest earth pressures will need to be utilized for retaining wall design, and may be provided upon request. The foundation system for the retaining walls should be designed in accordance with the recommendations presented in the preceding sections of this report, as appropriate. Footings should be embedded at a minimum of 18-inches below adjacent grade (excluding 6-inch landscape layer). There should be no increase in bearing for footing width. Recommendations pertaining to "landscape" walls (i.e., Crib, Loffel, Earthstone, Geogrid, etc.) may vary from those provided herein, and should be provided upon request.

The design active earth pressure on a retaining wall may be considered equivalent to that produced by a fluid weighing 45 pounds per cubic foot (pcf). This design equivalent fluid pressure of 45 pcf is appropriate for cantilevered walls retaining non-expansive granular soils with a level ground surface, subject to lateral deflection at distances above grade due to lateral earth pressures. Restrained walls (i.e., basement walls and re-entrant corners within cantilevered walls) with a level granular backfill should be designed for an equivalent fluid pressure of 60 pcf for at-rest conditions. If backfill conditions (including the slope of the retained ground surface) differ from those assumed herein, EEI should be consulted to provide additional evaluation and/or recommendations as warranted. A safety factor for sliding and overturning of 1.5 is typically incorporated into the design of a cantilevered structure as described herein. All retaining structures should be fully free draining.

For resistance to lateral loads, an allowable coefficient of friction of 0.25 between the base of the foundation elements and underlying material is recommended. In addition, an allowable passive resistance equal to an equivalent fluid weighing 350 pcf acting against the foundation may be used to resist lateral forces. Passive pressure in the upper 1-foot should be neglected unless confined by concrete slabs-on-grade or asphaltic pavement. These values may be increased by $^1/_3$ for transient wind or seismic loads.

If required, the seismic earth pressures can be taken as equivalent to the pressure of a fluid weighing 5 pounds per cubic foot (pcf) for cantilever walls. This value is for level backfill conditions and does not include a factor of safety. Appropriate factors of safety should be incorporated into the design. This pressure is in addition to the un-factored static pressures. The allowable passive pressure and bearing capacity can be increased by one-third in determining the stability of the wall.

Adequate drainage should be provided behind all retaining walls. The drainage system should consist of a minimum of 4-inch diameter perforated PVC pipe (schedule 40 or approved equivalent) placed at the base of the retaining wall and surrounded by ¾-inch clean crushed rock wrapped in a Mirafi 140N filter fabric, or equivalent approved by the Geotechnical Engineer. The drain rock wrapped in fabric should be at least 12-inches wide and extend from the base of the wall to within 2 feet of the ground surface. The upper 2 feet of backfill should consist of compacted native soil. The retaining wall drainage system should be sloped to outfall to the storm drain system or other appropriate facility.

8.0 PRELIMINARY PAVEMENT DESIGN RECOMMENDATIONS

Deleterious material, excessively wet or dry pockets, concentrated zones of oversized rock fragments, and any other unsuitable yielding materials encountered during grading should be removed. Once compacted fill and/or native soils are brought to the proposed pavement subgrade elevations, the subgrade should be proof-rolled in order to check for a uniform firm and unyielding surface. Representatives of the project geotechnical engineer should observe all grading and fill placement.

The upper 12-inches of pavement subgrade soils should be scarified; moisture conditioned to at least optimum moisture content and compacted to at least 95 percent of the laboratory standard (ASTM D1557), where not already replaced with compacted fill materials during rough grading of the site. If loose or yielding materials are encountered during subgrade preparation, evaluation should be performed by EEI.

Aggregate base materials should be properly prepared (i.e., processed and moisture conditioned) and compacted to at least 95 percent of the maximum dry density as determined by ASTM D1557. Aggregate base materials should conform to Caltrans specifications for Class 2 aggregate base.

All pavement section changes should be properly transitioned. Although not anticipated, if adverse conditions are encountered during the preparation of subgrade materials, special construction methods may need to be employed. A representative of the project geotechnical engineer should be present for the preparation of subgrade and aggregate base.

For design purposes we have assumed a Traffic Index (TI) of 6.5 for the drive areas and 5.0 for the parking stalls at the subject property. This assumed TI should be verified as necessary by the Civil Engineer or Traffic Engineer. Based on the results of R-Value testing of the upper materials at the site, we have conservatively assumed a preliminary R-Value of 11 for the materials likely to be present at rough grades. The modulus of subgrade reaction (K-Value) was estimated at 70 pounds per square inch per inch (psi/in) for an R-Value of 11 (Caltrans, 1974). Pavement design was calculated for the parking lot structural section requirements for asphaltic concrete in accordance with the guidelines presented in the Caltrans Highway Design Manual. Rigid pavement sections were evaluated in general accordance with ACI 330R-08, based on an average daily truck traffic value of 10.

TABLE 2
Preliminary Pavement Design Recommendations

Traffic Index (TI)	**Pavement Surface**	**Aggregate Base Material** (1)
5.0 – Parking Stalls	4.0-inches Asphalt Concrete	7.0-inches
6.5 – Drive Areas	5.0-inches Asphalt Concrete	10.0-inches
Concrete Pavement - Entrance/Exit	5.5-inches Portland Cement Concrete (2)	4.0-inches
Concrete Pavement – Trash Apron	6.0-inches Portland Cement Concrete (2)	4.0-inches

(1) R-Value of 78 for Caltrans Class II aggregate base
(2) Reinforcement and control joints placed in accordance with the structural engineer's requirements

The recommended rigid pavement section provided herein is intended as a minimum guideline. If thinner or highly variable pavement sections are constructed, increased maintenance and repair could be expected. If the ADT (average daily traffic) or ADTT (average daily truck traffic) increases beyond that intended, as reflected by the assumed traffic index used for design, increased maintenance and repair could be required for the pavement section. Final pavement design should be verified by testing of soils exposed at subgrade after grading has been completed. Thicker pavement sections could result if R-Value testing indicates lower values.

9.0 DEVELOPMENT RECOMMENDATIONS

9.1 Landscape Maintenance and Planting

Water is known to decrease the physical strength of earth materials, significantly reducing stability by high moisture conditions. Surface drainage away from foundations and graded slopes should be maintained. Only the volume and frequency of irrigation necessary to sustain plant life should be applied.

Consideration should be given to selecting lightweight, deep-rooted types of landscape vegetation which require low irrigation that are capable of surviving the local climate. From a soils engineering viewpoint, "leaching" of the onsite soils is not recommended for establishing landscaping. If landscape soils are processed for the addition of amendments, the processed soils should be re-compacted to at least 90 percent relative compaction (based on ASTM D1557).

9.2 Site Drainage

Positive site drainage should be maintained at all times. Drainage should not flow uncontrolled over slopes or the subject property. Runoff should be channeled away from slopes and structures and should not be allowed to pond and/or seep uncontrolled into the ground. Pad drainage should be directed toward an acceptable outlet. Although not required, roof gutters and down spouts may be considered to control roof drainage, discharging a minimum of 10 feet from proposed structures, or into a subsurface drainage system. Consideration should be given to eliminating open-bottom planters directly adjacent to proposed structures for a minimum distance of 10 feet. As an alternative, closed-bottom type planters could be utilized, with a properly designed drain outlet placed in the bottom of the planter.

9.3 Site Runoff Considerations - Stormwater Disposal Systems

It is EEI understanding that the Client is considering that runoff generated from the facility be disposed of in engineered subsurface features onsite.

9.3.1 Percolation Testing

Following the drilling of exploratory borings B-4, B-8, B-19, B-20 and B-21, a 3-inch diameter perforated polyvinyl chloride (PVC) pipe was placed in the hole and gravel was placed around the pipe. The test holes were presoaked in general accordance with County of San Diego DEH Guidelines. The total duration and measurement intervals of the tests were adjusted per the observed percolation rates for each hole. The readings obtained from the final interval were used to calculate the pre-adjusted percolation rate for each test hole. Upon conclusion of testing, the perforated pipe was removed from the test holes and the test excavations were backfilled.

We note that a soil profile's percolation rate is not the same as its infiltration rate. Therefore, the measured/calculated percolation rate was converted to an estimated infiltration rate. Therefore, the measured/calculated field percolation rate was converted to an estimated infiltration rate utilizing a reduction factor known as the Porchet method. **Table 4** presents the measured percolation rate and corresponding infiltration rate calculated for the test hole.

TABLE 3
Summary of Percolation Testing

Location	Depth (ft.)	Soil Type	Pre-Adjusted Percolation Rate (in/hr.)	Infiltration Rate (in/hr.)
B-4 / P-1	~5	ML	0.53	0.03
B-8 / P-2	~5	CL (fill)	1.07	0.06
B-19 / P-3	~5	ML	3.36	0.45
B-20 / P-4	~5	SM	500+	233.5
B-21 / P-5	~5	SM	61.9	5.49

9.3.2 Summary of Findings

Based on the results of our field percolation testing, it appears that the percolation/infiltration rates presented herein range from conducive to not conductive to direct infiltration of surface stormwater for the preliminary design of subsurface storm water retention/disposal devices, based on the percolation tests performed at the specific locations and approximate depths at the subject property as listed in **Table 4**. It should be noted that groundwater was encountered within 6 feet (or 1-foot below test elevations) of the ground surface in numerous areas around the property.

9.3.3 Structural Setback from Retention Devices

It is recommended that retention/disposal devices be situated at least three times their depth, or a minimum of 15 feet (whichever is greater), from the outside bottom edge of structural foundations. Structural foundations include (but are not limited to) buildings, loading docks, retaining walls, and screen walls.

All stormwater disposal systems, including pervious pavement areas should be checked and maintained on regular intervals. Stormwater devices including bioswales that are located closer than 10 feet from any foundations/footings should be lined with an impermeable membrane to reduce the potential for saturation of foundation soils (also refer to **Section 7.6**).

9.4 Additional Site Improvements

Recommendations for additional grading, exterior concrete flatwork design and construction can be provided upon request. If in the future, additional property improvements were planned for the site, recommendations concerning the design and construction of improvements would be provided upon request.

9.5 Trenching

All temporary excavations for grading purposes and installation of underground utilities should be constructed in accordance with OSHA guidelines and local safety codes. Temporary excavations over 4 feet in height should be evaluated by the project engineer, and could require shoring, sloping, or a combination thereof. Temporary excavations within the onsite materials should be stable at 1.5:1 inclinations for cuts less than 20 feet in height.

Footing trench excavations for structures and walls should be observed and approved by a representative of the project soils engineer prior to placing reinforcement. Footing trench spoil and excess soils generated from utility trench excavations should be compacted to a minimum relative compaction of 90 percent (based on ASTM D1557) if not removed from the subject property. All excavations should conform to OSHA and local safety codes.

9.6 Utility Backfill

Fill around the pipe should be placed in accordance with details shown on the drawings, and should be placed in layers not to exceed 8-inches loose (unless otherwise approved by the Geotechnical Engineer) and compacted to at least 90 percent of the maximum dry density as determined in accordance with ASTM D1557 (Modified Proctor).

The Geotechnical Engineer should approve all backfill material. Select material should be used when called for on the drawings, or when recommended by the Geotechnical Engineer. Care should be taken during backfill and compaction operations to maintain alignment and prevent damage to the joints. The backfill should be kept free from stones, chunks of highly plastic clay, or other objectionable material. Backfill soils should be non-expansive, non-corrosive, and compatible with native earth materials. Backfill materials and testing should be in accordance with the CBC 2013 and City specifications.

All pipe backfill areas should be graded and maintained in such a condition that erosion or saturation will not damage the pipe bed or backfill. Flooding trench backfill is not recommended. Heavy equipment should not be operated over any pipe until it has been properly backfilled with a minimum 2 to 3 feet of cover. The utility trench should be systematically backfilled to allow maximum time for natural settlement. Backfill should not occur over porous, wet, or spongy subgrade surfaces. Should these conditions exist, the areas should be removed, replaced and recompacted.

10.0 PLAN REVIEW

Once the detailed and approved site and grading plans are available, they should be submitted to this office for review and comment, to reduce the potential for discrepancies between plans and recommendations presented herein. If conditions were found to differ substantially from those stated, appropriate recommendations would be provided. Additional field studies may be warranted once the final conceptual plans are produced.

11.0 LIMITATIONS

This Geotechnical Evaluation has been conducted in accordance with the generally accepted geotechnical engineering principles and practices. Findings provided herein have been derived in accordance with the current standards of practice, and no warranty is expressed or implied. Standards of practice are subject to change with time. This report has been prepared for the sole use of the Client, within a reasonable time from its authorization. Site conditions, land use (both onsite and offsite), or other factors may change as a result of manmade influences, and additional work may be required with the passage of time.

This Preliminary Geotechnical Evaluation should not be relied upon by other parties without the express written consent of EEI and the Client; therefore, any use or reliance upon this geotechnical evaluation by a party other than the Client should be solely at the risk of such third party and without legal recourse against EEI, its employees, officers, or directors, regardless of whether the action in which recovery of damages is brought or based upon contract, tort, statue, or otherwise.

The Client has the responsibility to see that all parties to the project, including the designer, contractor, subcontractor, and building official, etc. are aware of this report in its complete form. This report contains information that may be used in the preparation of contract specifications; however, the report is not designed as a specification document, and may not contain sufficient information for use without additional assessment. EEI assumes no responsibility or liability for work or testing performed by others. In addition, this report may be subject to review by the controlling authorities.

12.0 REFERENCES

American Society of Civil Engineers (ASCE), 2010, Minimum Design Loads for Buildings and Other Structures, ASCE Document ASCE/SEI 7-10.

American Society for Testing and Materials (ASTM), 2011, Annual Book of ASTM Standards, Volume 04.08, Construction: Soil and Rock (I), Standards D 420 - D 5876.

Blake T., 2000, EQFAULT, Version 3.0, a Computer Program for Probabilistic Estimation of Peak Acceleration from 3-D Fault Sources," Thomas F. Blake Computer Services and Software, Newbury Park, California.

Bray, J.D., and Sancio, R.B., 2006, Assessment of the Liquefaction Susceptibility of Fine-Grained Soils: American Society of Civil Engineers, Journal of the Geotechnical and Geoenvironmental Engineering, v. 132, n. 9, p. 1165-1177.

California Building Code (CBC), 2013, California Code of Regulations, Title 24, Part 2, Volume 2 of 2, California Building Standards Commission, Based on 2012 International Building Code; 2013 California Historical Building Code, Title 24, Part 8; and 2013 California Existing Building Code, Title 24, Part 10, effective January 1, 2014.

California Department of Transportation (Caltrans), 1974, Highway Design Manual, dated October 1, 1974.

California Division of Mines and Geology (CDMG), 2001, Seismic Hazard Zone Report for the National City 7.5-Minute Quadrangle, Orange County, California, dated 2001.

California Division of Mines and Geology (CDMG), 2000, California Department of Conservation, Digital Images of Official Maps of Alquist-Priolo Earthquake Fault Zones of California, Southern Region, DMG CD 2000-003.

California Department of Conservation Division of Mines and Geology (CDMG), 2002, Appendix A, 2002 California Fault Parameters, http://www.conservation.ca.gov/cgs/rghm/psha/Pages/Index.aspx

California Emergency Management Agency (Cal EMA), 2009, Tsunami Inundation Map for Emergency Planning, National City Quadrangle, dated June 1, 2009.

California Geological Survey (CGS), 2010, 2010 Fault Activity Map of California. http://www.quake.ca.gov/gmaps/GMC/stategeologicmap.html

California Geological Survey (CGS), 2002, California Geomorphic Provinces Note 36, Electronic Copy, Revised December 2002.

Charles J. O'Brien Architect, 2013, Preliminary Site Plan (Sheet SP-01), CarMax National City, California, dated November11, 2013.

Coduto, D. P., 2001, Foundation Design Principles and Practices, Second Edition.

Federal Emergency Management Agency (FEMA), 2012, Flood Insurance Rate Map, San Diego County, California, Panel 1912 of 2375, dated May 16, 2012.

Geologismiki Geotechnical Software, 2015, CLiq version 1.7 – Soil Liquefaction Software

Google Earth®, 2015, Version 7.1.3.22.3.

Hart, E.W., and Bryant, W.A. (Hart and Bryant), 1997, Fault-Rupture Hazard Zones in California: California Department of Conservation, Division of Mines and Geology, Special Publication 42.

Jennings, C.W., 1994, Fault Activity Map of California and Adjacent Areas: California Division of Mines and Geology (CDMG), Map Sheet No. 6, scale 1:750,000.

Robertson, P.K. and Wride, C.E., 1998, Cyclic Liquefaction and its Evaluation based on the CPT Canadian Geotechnical Journal, Vol. 35, dated August 1998.

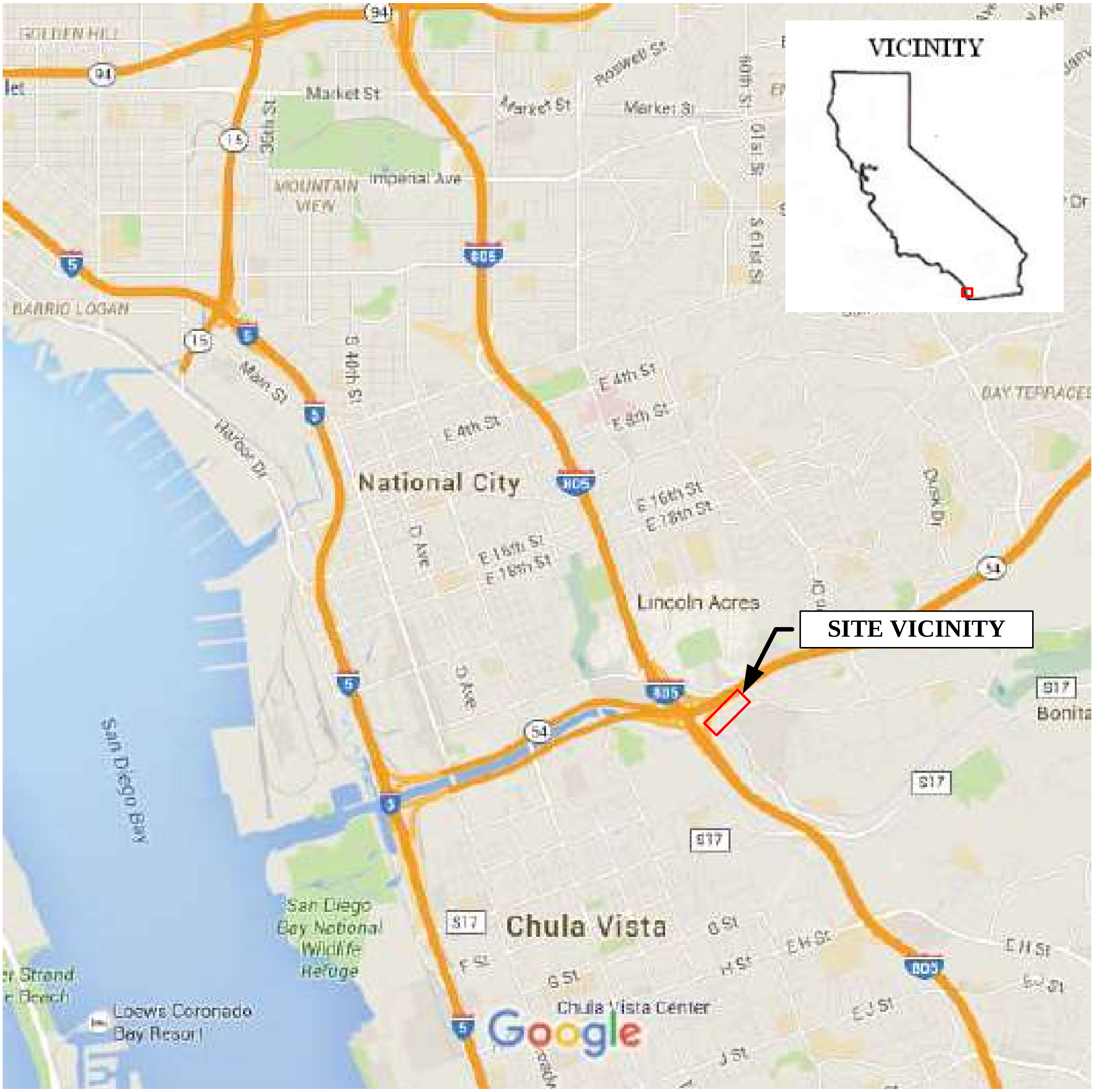
Tokimatsu, K. and Seed, H.B., 1987, "Evaluation of Settlements in Sands Due to Earthquake Shaking," American Society of Civil Engineers Journal of Geotechnical Engineering, Vol. 113, No. 8, pp. 861-878.

United States Geological Survey (USGS), 2015, 7.5 Minute Topographic Map, National City, California Quadrangle, scale 1:24,000.

United States Geological Survey (USGS), 2015, U.S. Seismic Design Maps, http://earthquake.usgs.gov/designmaps/us/application.php Last Modified: March 10, 2014.

Youd, et.al., 2001, "Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER/NSF Workshops on Evaluation of Liquefaction Resistance of Soils", American Society of Civil Engineers, Journal of Geotechnical and GeoEnvironmental Engineering, Vol. 127, No. 10, pp. 817-833.

FIGURES



Map Source: Google Maps®; Accessed 2015

LEGEND

N

Scale: 1" = 1mi

0 1mi 2mi

Note: All Locations Are Approximate

SITE VICINITY MAP

CENTERPOINT INTEGRATED SOLUTIONS, LLC
Proposed CARmax of National City
National City, California
EEI Project No. CIS-72092.4
Created October 2015

EEI
Geotechnical & Environmental Solutions

FIGURE 1

Source: Google Earth, 2015; Image Date: October 12, 2015

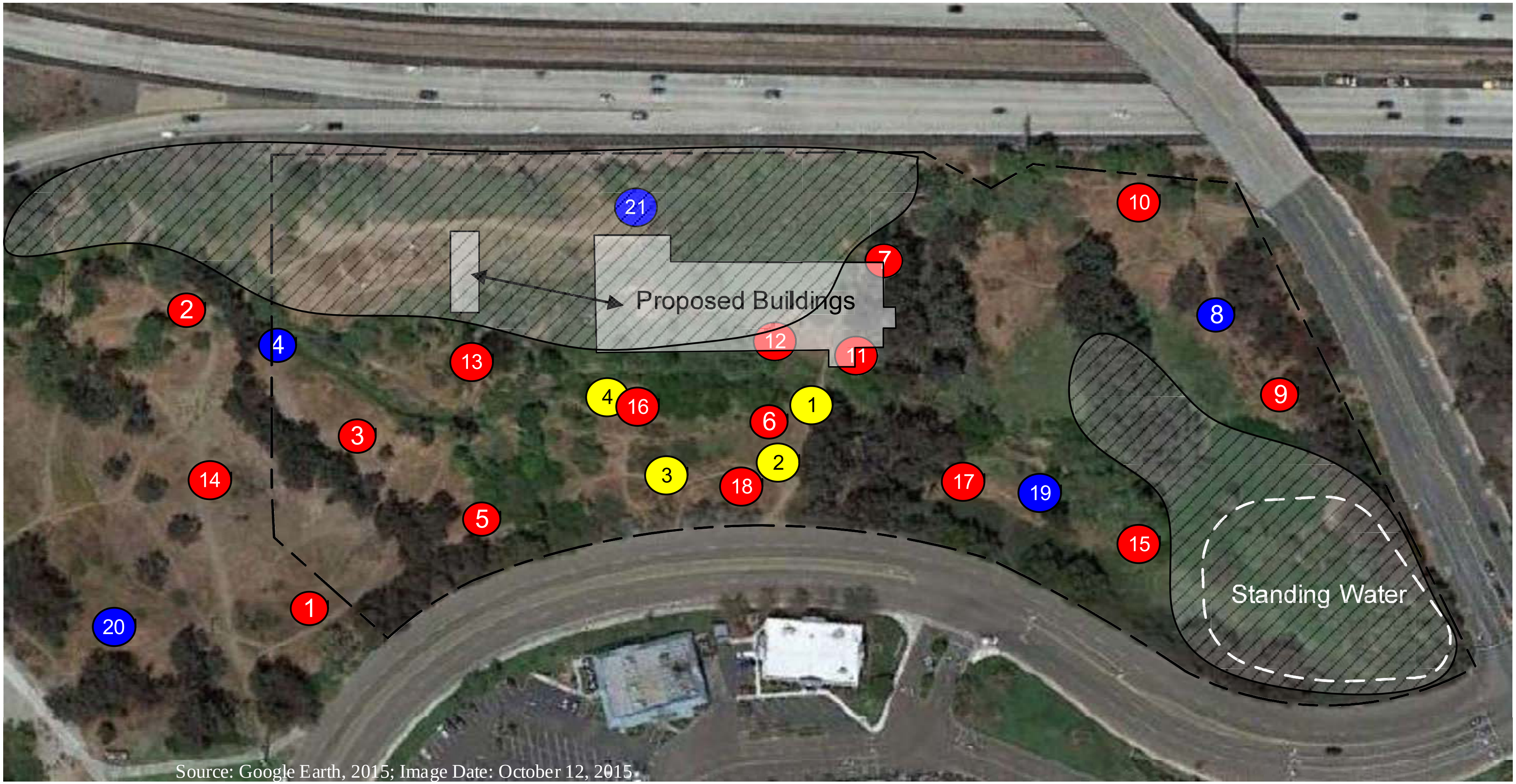
Scale: 1" = 300'

AERIAL SITE MAP

CENTERPOINT INTEGRATED SOLUTIONS, LLC
Proposed CARmax of National City
National City, California
EEI Project No. CIS-72092.4
Created October 2015

EEI
Geotechnical & Environmental Solutions

FIGURE 2



Source: Google Earth, 2015; Image Date: October 12, 2015

LEGEND

18 **Approximate Boring Locations**

21 **Approximate Boring/Percolation Locations**

4 **Approximate CPT Locations**

▨ **Area Inaccessible by Drill Rig**

Scale: 1" = 150'

0 FT 150FT 300FT

BORING LOCATION PLAN

CENTERPOINT INTEGRATED SOLUTIONS, LLC
Proposed CARmax of National City
National City, California
EEI Project No. CIS-72092.4
Created October 2015

EEI
Geotechnical & Environmental Solutions

FIGURE 3

APPENDIX A
SOIL CLASSIFICATION CHART AND BORING LOGS

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS
			GRAPH	LETTER	
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SEIVE	CLEAN GRAVELS (LITTLE OR NO FINES)	▨	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
			▨	GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)	▨	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
			▨	GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION REATINED ON NO. 4 SEIVE	CLEAN SANDS (LITTLE OR NO FINES)	▨	SW	WELL-GRADED SANDS,GRAVELLY SANDS, LITTLE OR NO FINES
			▨	SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)	▨	SM	SILTY-SANDS, SAND – SILT MIXTURES
			▨	SC	CLAYEY SANDS, SAND – CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50	▨	ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
			▨	CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			▨	OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50	▨	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
			▨	CH	INORGANIC CLAYS OF HIGH PLASTICITY
			▨	OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

BOREHOLE LOG

Number: B-1

Client: CenterPoint Intergrated Solutions, LLC

Sheet: 1 of 1

Location:
Proposed CarMax Auto Dealership
Sweetwater Road and Plaza Bonita Road, National City, California

Date Started: 10/2/2015

Date Finished: 10/2/2015

EEI Rep: ML

Project No.: CIS-72092.4

Drill Rig/Sampling Method: Truck-Mounted Diedrich D-50 / Hollow Stem Auger

Borehole Diameter: 8-inch

SAMPLE LOG								BOREHOLE LOG
Bulk	Sample Type	Blows Per 6"	Dry Unit Wt. (pcf)	Moisture (%)	Depth In Feet	USCS Symbol	Graphic Log	Geologic Description (SoilType, Color, Grain, Minor Soil Component, Moisture, Density, Odor, Etc.)
								ALLUVIUM
					1			SILTY-SAND, light brown, scattered gravels, damp to moist, loose; micaceous
					2			
	MC	5 3 6	105	10	3			
					4			
					5			
	MC	7 10 11	103	5	6			@ 5' Becomes moist to very moist, coarse grained, medium dense
					7		▽	
	MC	5 7 10	110	14	8			@ 7.5' Becomes saturated; heaving sands; groundwater encountered
					9			
					10			
	SPT	3 2 6			11	SM		@ 10' Becomes loose
					12			
					13			
					14			
					15			
	SPT	9 11 14			16			@ 15' Becomes gray-brown, fine to medium grained, saturated, medium dense
					17			
					18			
					19			
					20			
	SPT	3 2 3			21			@ 20' Becomes loose
					22			
					23			Total depth: 21.5-feet Groundwater encountered at 8-feet
					24			Boring backfilled on 10/2/2015 with drilled cuttings
					25			
					26			
					27			
					28			
					29			
					30			
					31			

Geotechnical & Environmental Solutions

BOREHOLE LOG

Number: B-2

Client: CenterPoint Intergrated Solutions, LLC

Sheet: 1 of 1

Location:
Proposed CarMax Auto Dealership
Sweetwater Road and Plaza Bonita Road, National City, California

Date Started: 10/2/2015

Date Finished: 10/2/2015

EEI Rep: ML

Project No.: CIS-72092.4

Drill Rig/Sampling Method Truck-Mounted Diedrich D-50 / Hollow Stem Auger

Borehole Diameter: 8-inch

SAMPLE LOG								BOREHOLE LOG
Bulk	Sample Type	Blows Per 6"	Dry Unit Wt. (pcf)	Moisture (%)	Depth In Feet	USCS Symbol	Graphic Log	Geologic Description (SoilType, Color, Grain, Minor Soil Component, Moisture, Density, Odor, Etc.)
								ALLUVIUM
					1			SILTY-SAND, light brown, scattered gravels, damp to moist, loose; micaceous
					2			
					3			
					4			
	MC	4 4 6			5			
			91	3	6			
					7			
					8			
					9		▽	@ 9' Groundwater encountered
	MC	9 7 5			10			@ 10' Becomes gray-brown, fine to medium grained, saturated; heaving sands
			106	15	11	SM		
					12			
					13			
					14			
	SPT	5 6 6			15			@ 15' Becomes medium dense
					16			
					17			
					18			
					19			
	SPT	0 0 0			20			@ 20' Push with SPT Sampler, very loose
					21			
					22			
					23			Total depth: 21.5-feet Groundwater encountered at 9-feet Boring backfilled on 10/2/2015 with drilled cuttings
					24			
					25			
					26			
					27			
					28			
					29			
					30			
					31			

EEI
Geotechnical & Environmental Solutions

BOREHOLE LOG

Number: B-3

Client: CenterPoint Intergrated Solutions, LLC

Sheet: 1 of 1

Location: Proposed CarMax Auto Dealership
Sweetwater Road and Plaza Bonita Road, National City, California

Date Started: 10/2/2015

Date Finished: 10/2/2015

EEI Rep: ML

Project No.: CIS-72092.4

Drill Rig/Sampling Method Truck-Mounted Diedrich D-50 / Hollow Stem Auger

Borehole Diameter: 8-inch

SAMPLE LOG						BOREHOLE LOG		
Bulk	Sample Type	Blows Per 6"	Dry Unit Wt. (pcf)	Moisture (%)	Depth In Feet	USCS Symbol	Graphic Log	Geologic Description (SoilType, Color, Grain, Minor Soil Component, Moisture, Density, Odor, Etc.)
☒					1 2 3 4	ML	⁘	**FILL** SANDY-SILT, orange-brown, scattered gravels, moist, medium dense
	MC ■	5 6 8	89	21	5 6 7	CL	▨	@ 5' SANDY-CLAY, red-brown and yellow mottled, fine to medium grained, moist, stiff
					8 9	CL	▨	**ALLUVIUM** @ 8' SANDY-CLAY, dark brown to brown, fine grained, moist, stiff
	MC ■	5 5 8			10 ▽			@ 10' Groundwater encountered; lost sample with Cal sampler; recovered with SPT
	SPT ☒	3 2 3			11 12 13 14			
	SPT ☒	8 10 12			15 16 17 18 19	SM	⁘	@ 15' SILTY-SAND, dark brown to gray, saturated, medium dense
	SPT ☒	6 10 14			20 21			
					22 23 24 25 26 27 28 29 30 31			Total depth: 21.5-feet Groundwater encountered at 8-feet Boring backfilled on 10/2/2015 with drilled cuttings

BOREHOLE LOG

Number: B-4/P-1

Client: CenterPoint Intergrated Solutions, LLC

Sheet: 1 of 1

Location:
Proposed CarMax Auto Dealership
Sweetwater Road and Plaza Bonita Road, National City, California

Date Started: 10/2/2015

Date Finished: 10/2/2015

EEI Rep: ML

Project No.: CIS-72092.4

Drill Rig/Sampling Method: Truck-Mounted Diedrich D-50 / Hollow Stem Auger

Borehole Diameter: 8-inch

SAMPLE LOG								BOREHOLE LOG
Bulk	Sample Type	Blows Per 6"	Dry Unit Wt. (pcf)	Moisture (%)	Depth In Feet	USCS Symbol	Graphic Log	Geologic Description (SoilType, Color, Grain, Minor Soil Component, Moisture, Density, Odor, Etc.)
					1			**ALLUVIUM** SANDY-SILT, light brown, scattered gravels, damp to moist, medium dense; micaceous
					2	ML		
					3			
					4			
					5			
					6			Total depth: 5-feet No groundwater encountered Percolation test performed Boring backfilled with drilled cuttings
					7			
					8			
					9			
					10			
					11			
					12			
					13			
					14			
					15			
					16			
					17			
					18			
					19			
					20			
					21			
					22			
					23			
					24			
					25			
					26			
					27			
					28			
					29			
					30			
					31			

EEI Geotechnical & Environmental Solutions

BOREHOLE LOG

Number: B-5

Client: CenterPoint Intergrated Solutions, LLC

Sheet: 1 of 1

Location:
Proposed CarMax Auto Dealership
Sweetwater Road and Plaza Bonita Road, National City, California

Date Started: 10/2/2015

Date Finished: 10/2/2015

EEI Rep: ML

Project No.: CIS-72092.4

Drill Rig/Sampling Method Truck-Mounted Diedrich D-50 / Hollow Stem Auger

Borehole Diameter: 8-inch

SAMPLE LOG								BOREHOLE LOG
Bulk	Sample Type	Blows Per 6"	Dry Unit Wt. (pcf)	Moisture (%)	Depth In Feet	USCS Symbol	Graphic Log	Geologic Description (SoilType, Color, Grain, Minor Soil Component, Moisture, Density, Odor, Etc.)
					1		▨	**FILL** SANDY-CLAY, red-yellow-brown mottled, fine to medium grained, damp, very stiff
					2		▨	
	MC	12 11 10	113	14	3		▨	
					4	CL	▨	
	SPT	3 2 3			5		▨	@ 5' Becomes wet, medium stiff
					6		▨ ▽	@ 6' Groundwater encountered
					7		▨	
					8			
					9		⁙	**ALLUVIUM** SILTY-SAND, dark gray, saturated, fine to medium grained, very loose; micaceous
	SPT	1 1 1			10		⁙	
					11		⁙	
					12		⁙	
					13		⁙	
					14		⁙	
	SPT	5 8 8			15	SM	⁙	@ 15' Becomes medium dense
					16		⁙	
					17		⁙	
					18		⁙	
					19		⁙	
	SPT	5 7 5			20		⁙	
					21		⁙	
					22			
					23			Total depth: 21.5-feet Groundwater encountered at 8-feet
					24			Boring backfilled on 10/2/2015 with drilled cuttings
					25			
					26			
					27			
					28			
					29			
					30			
					31			

BOREHOLE LOG

Number: B-6

Client: CenterPoint Intergrated Solutions, LLC

Sheet: 1 of 2

Location:
Proposed CarMax Auto Dealership
Sweetwater Road and Plaza Bonita Road, National City, California

Date Started: 10/2/2015

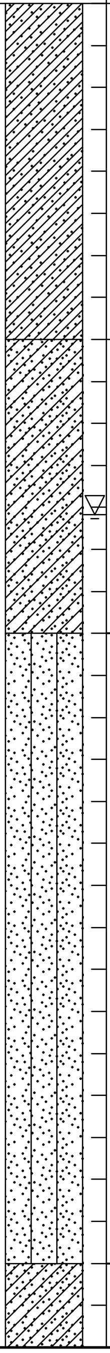
Date Finished: 10/2/2015

EEI Rep: ML

Project No.: CIS-72092.4

Drill Rig/Sampling Method Truck-Mounted Diedrich D-50 / Hollow Stem Auger

Borehole Diameter: 8-inch



SAMPLE LOG								BOREHOLE LOG
Bulk	Sample Type	Blows Per 6"	Dry Unit Wt. (pcf)	Moisture (%)	Depth In Feet	USCS Symbol	Graphic Log	Geologic Description (SoilType, Color, Grain, Minor Soil Component, Moisture, Density, Odor, Etc.)
					1 2 3 4	CL		**FILL** SANDY-CLAY with GRAVEL, red-yellow-brown mottled, fine to medium grained with scattered gravels, moist, very stiff
	MC	44 26 14			5 6			
	MC	12 11 13			7 8			@ 7.5' No sample recovered
					9			**ALLUVIUM** @ 10' CLAYEY-SAND, grayish-green, fine grained, very moist to wet, very loose
	MC	4 2 4	83	105	10 11	SC		
					12 13 14		∇	@ 12' Groundwater encountered
	SPT	2 1 1			15 16 17 18 19			@ 15' SILTY-SAND, dark gray, fine grained, saturated, very loose
	SPT	3 4 5			20 21 22 23 24	SM		@ 20' Becomes loose
	SPT	2 4 3			25 26 27 28 29			
	SPT	8 11 14			30 31	SC		@ 30' CLAYEY-SAND, dark gray, fine grained, saturated, medium dense

BOREHOLE LOG

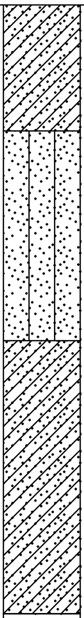
Number: B-6	**Client:** CenterPoint Intergrated Solutions, LLC	**Sheet:** 2 of 2

Location:
Proposed CarMax Auto Dealership
Sweetwater Road and Plaza Bonita Road, National City, California

Date Started:	**Date Finished:**
10/2/2015	10/2/2015

EEI Rep:	**Project No.:**	**Drill Rig/Sampling Method**	**Borehole Diameter:**
ML	CIS-72092.4	Truck-Mounted Diedrich D-50 / Hollow Stem Auger	8-inch

SAMPLE LOG / BOREHOLE LOG



Bulk	Sample Type	Blows Per 6"	Dry Unit Wt. (pcf)	Moisture (%)	Depth In Feet	USCS Symbol	Graphic Log	Geologic Description (SoilType, Color, Grain, Minor Soil Component, Moisture, Density, Odor, Etc.)
								Boring B-6 continued...
					33	SC		
					34			
	SPT	10 15 20			35			@ 35' SILTY-SAND, dark gray, fine to medium grained, saturated, dense
					36			
					37			
					38	SM		
					39			
	SPT	7 7 12			40			@ 40' CLAYEY-SAND, dark gray, fine grained, saturated, medium dense
					41			
					42			
					43	SC		
					44			
	SPT	9 14 22			45			@ 45' Becomes dense; refusal heaving
					46			
					47			
					48			Total depth: 46.5-feet Groundwater encountered at 12-feet Boring backfilled on 10/2/2015 with bentonite chips
					49			
					50			
					51			
					52			
					53			
					54			
					55			
					56			
					57			
					58			
					59			
					60			
					61			
					62			
					63			

	BOREHOLE LOG	**Number:** B-7
	Client: CenterPoint Intergrated Solutions, LLC	**Sheet:** 1 of 2
Date Started: 10/5/2015	**Date Finished:** 10/5/2015	**Location:** Proposed CarMax Auto Dealership Sweetwater Road and Plaza Bonita Road, National City, California
EEI Rep: ML	**Project No.:** CIS-72092.4	**Drill Rig/Sampling Method** Track-Mounted Fraste PL-G / Hollow Stem Auger
		Borehole Diameter: 8-inch

SAMPLE LOG						BOREHOLE LOG		
Bulk	Sample Type	Blows Per 6"	Dry Unit Wt. (pcf)	Moisture (%)	Depth In Feet	USCS Symbol	Graphic Log	Geologic Description (SoilType, Color, Grain, Minor Soil Component, Moisture, Density, Odor, Etc.)
								FILL SANDY-SILT, brown, damp, medium dense
▨					1	ML		
▨					2			
▨	MC	1 3 4		13	3			**ALLUVIUM** @ 3' CLAYEY-SAND, light brown, fine grained, moist, loose
▨					4			
	MC	4 6 7	94	16	5			
					6	SC		
					7			
	MC	3 6 6	92	25	8			@ 7.5' Becomes dark gray, fine to medium grained, wet
					9		▽	@ 9' Groundwater encountered
	SPT	2 3 4		25	10			@ 10' SAND, brown, fine to medium grained, saturated, loose
					11			
					12			
					13			
					14			
	SPT	3 6 9		27	15	SP		
					16			
					17			
					18			
					19			
	SPT	3 4 3		26	20			@ 20' CLAYEY-SAND, dark gray, saturated, loose
					21			
					22	SC		
					23			
					24			
	SPT	1 0 0		28	25			@ 25' SANDY-CLAY, dark gray, saturated, very soft
					26			
					27			
					28	CL		
					29			
	SPT	0 3 4		25	30			@ 30' Becomes medium stiff
					31			

BOREHOLE LOG

Number: B-7

Client: CenterPoint Intergrated Solutions, LLC

Sheet: 2 of 2

Location:
Proposed CarMax Auto Dealership
Sweetwater Road and Plaza Bonita Road, National City, California

Date Started: 10/5/2015

Date Finished: 10/5/2015

EEI Rep: ML

Project No.: CIS-72092.4

Drill Rig/Sampling Method Track-Mounted Fraste PL-G / Hollow Stem Auger

Borehole Diameter: 8-inch

SAMPLE LOG								BOREHOLE LOG
Bulk	Sample Type	Blows Per 6"	Dry Unit Wt. (pcf)	Moisture (%)	Depth In Feet	USCS Symbol	Graphic Log	Geologic Description (SoilType, Color, Grain, Minor Soil Component, Moisture, Density, Odor, Etc.)
							▨	*Boring B-7 continued...*
					33	CL	▨	
					34		▨	
	SPT ☒	6 8 9		24	35		░	@ 35' SILTY-SAND, gray, fine to medium grained, saturated, medium dense
					36		░	
					37		░	
					38		░	
					39		░	
	SPT ☒	7 12 13		24	40		░	
					41		░	
					42		░	
					43	SM	░	
					44		░	
	SPT ☒	8 14 11		26	45		░	
					46		░	
					47		░	
					48		░	
					49		░	
	SPT ☒	2 7 12		14	50		░	
					51		░	
					52			
					53			Total depth: 51.5-feet Groundwater encountered at 9-feet
					54			Boring backfilled on 10/5/2015 with bentonite chips
					55			
					56			
					57			
					58			
					59			
					60			
					61			
					62			
					63			

EEI
Geotechnical & Environmental Solutions

BOREHOLE LOG

Number: B-8/P-2

Client: CenterPoint Intergrated Solutions, LLC

Sheet: 1 of 1

Location:
Proposed CarMax Auto Dealership
Sweetwater Road and Plaza Bonita Road, National City, California

Date Started: 10/6/2015

Date Finished: 10/6/2015

EEI Rep: ML

Project No.: CIS-72092.4

Drill Rig/Sampling Method Truck-Mounted Diedrich D-50 / Hollow Stem Auger

Borehole Diameter: 8-inch

SAMPLE LOG								BOREHOLE LOG
Bulk	Sample Type	Blows Per 6"	Dry Unit Wt. (pcf)	Moisture (%)	Depth In Feet	USCS Symbol	Graphic Log	Geologic Description (SoilType, Color, Grain, Minor Soil Component, Moisture, Density, Odor, Etc.)
					1		▨	**FILL** SANDY-CLAY, dark brown to reddish brown, fine to medium grained, moist, medium stiff
					2	CL	▨	
					3		▨	
					4		▨	
					5			
					6			Total depth: 5-feet No groundwater encountered Percolation test performed Boring backfilled with drilled cuttings
					7			
					8			
					9			
					10			
					11			
					12			
					13			
					14			
					15			
					16			
					17			
					18			
					19			
					20			
					21			
					22			
					23			
					24			
					25			
					26			
					27			
					28			
					29			
					30			
					31			

BOREHOLE LOG

Number: B-9	**Sheet:** 1 of 1		
Client: CenterPoint Intergrated Solutions, LLC			
Location: Proposed CarMax Auto Dealership Sweetwater Road and Plaza Bonita Road, National City, California			
Date Started: 10/6/2015	**Date Finished:** 10/6/2015		
EEI Rep: ML	**Project No.:** CIS-72092.4	**Drill Rig/Sampling Method** Track-Mounted Fraste PL-G / Hollow Stem Auger	**Borehole Diameter:** 8-inch

SAMPLE LOG								BOREHOLE LOG
Bulk	Sample Type	Blows Per 6"	Dry Unit Wt. (pcf)	Moisture (%)	Depth In Feet	USCS Symbol	Graphic Log	Geologic Description (SoilType, Color, Grain, Minor Soil Component, Moisture, Density, Odor, Etc.)
					1			**ALLUVIUM** CLAYEY-SILT, dark borwn, damp, stiff; micaceous
					2			
	MC	2 6 7	88	14	3			
					4			
	MC	2 3 4			5	ML		@ 5' Becomes moist, medium stiff
					6			
					7			
	MC	1 1 3			8			@ 7.5' No sample recovered; blow counts indicate soft soil
					9		∇	@ 9' Groundwater encountered
	SPT	1 2 4			10			@ 10' SILTY-SAND, brown, fine grained, loose, saturated
					11			
					12			
					13			
					14			
	SPT	3 4 5			15			@ 15' Becomes fine to medium grained
					16	SM		
					17			
					18			
					19			
	SPT	2 3 3			20			
					21			
					22			
					23			Total depth: 21.5-feet Groundwater encountered at 9-feet
					24			Boring backfilled on 10/6/2015 with drilled cuttings
					25			
					26			
					27			
					28			
					29			
					30			
					31			

EEI
Geotechnical & Environmental Solutions

BOREHOLE LOG

Number: B-10

Client: CenterPoint Intergrated Solutions, LLC

Sheet: 1 of 1

Location:
Proposed CarMax Auto Dealership
Sweetwater Road and Plaza Bonita Road, National City, California

Date Started: 10/6/2015

Date Finished: 10/6/2015

EEI Rep: ML

Project No.: CIS-72092.4

Drill Rig/Sampling Method: Track-Mounted Fraste PL-G / Hollow Stem Auger

Borehole Diameter: 8-inch

SAMPLE LOG								BOREHOLE LOG
Bulk	Sample Type	Blows Per 6"	Dry Unit Wt. (pcf)	Moisture (%)	Depth In Feet	USCS Symbol	Graphic Log	Geologic Description (SoilType, Color, Grain, Minor Soil Component, Moisture, Density, Odor, Etc.)
							▨	**ALLUVIUM** CLAYEY-SAND, dark brown, fine grained, moist, loose
▩					1		▨	
▩					2		▨	
▩	MC ⧓	3 7 9	102	19	3		▨	
▩					4	SC	▨	
	MC ⧓	3 6 7	88	27	5		▨	
					6		▨	
					7		▨	
	MC ⧓	3 5 8	90	21	8		░	@ 7.5' SILTY-SAND, dark brown to gray, fine grained, some clay, moist to wet, loose
					9		░	
	SPT ☒	1 2 1			10		░ ▽	@ 10' Becomes very loose; groundwater encountered
					11		░	
					12		░	
					13		░	
					14	SM	░	
	SPT ☒	0 0 2			15		░	@ 15' Becomes fine to medium grained
					16		░	
					17		░	
					18		░	
					19		░	
	SPT ☒	2 3 3			20		░	@ 20' Becomes loose
					21		░	
					22			
					23			Total depth: 21.5-feet Groundwater encountered at 10-feet Boring backfilled on 10/6/2015 with drilled cuttings
					24			
					25			
					26			
					27			
					28			
					29			
					30			
					31			

BOREHOLE LOG

Number: B-11

Client: CenterPoint Intergrated Solutions, LLC

Sheet: 1 of 1

Location:
Proposed CarMax Auto Dealership
Sweetwater Road and Plaza Bonita Road, National City, California

Date Started: 10/6/2015

Date Finished: 10/6/2015

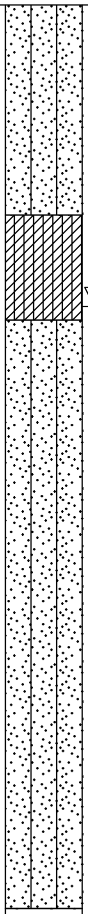
EEI Rep: ML

Project No.: CIS-72092.4

Drill Rig/Sampling Method: Track-Mounted Fraste PL-G / Hollow Stem Auger

Borehole Diameter: 8-inch

SAMPLE LOG								BOREHOLE LOG
Bulk	Sample Type	Blows Per 6"	Dry Unit Wt. (pcf)	Moisture (%)	Depth In Feet	USCS Symbol	Graphic Log	Geologic Description (SoilType, Color, Grain, Minor Soil Component, Moisture, Density, Odor, Etc.)
					1			**FILL** SILTY-SAND, dark brown, fine grained, moist, loose; micaceous
					2	SM		
	MC ⧗	3 6 3	85	12	3			
					4			
					5			
	MC ⧗	2 3 5	81	31	6	CL-ML		**ALLUVIUM** @ 2.5' SILTY-CLAY, dark brown, moist, medium stiff; micaceous
					7		▽	@ 7' Groundwater encountered
	MC ⧗	3 6 7	90	29	8			@ 7.5' SILTY-SAND, dark gray, fine to medium grained, saturated, loose
					9			
	SPT ⊠	2 4 5			10			
					11			
					12			
					13			
					14	SM		
	SPT ⊠	3 2 2			15			
					16			
					17			
					18			
					19			
	SPT ⊠	2 3 2			20			
					21			
					22			
					23			Total depth: 21.5-feet Groundwater encountered at 8-feet
					24			Boring backfilled on 10/6/2015 with drilled cuttings
					25			
					26			
					27			
					28			
					29			
					30			
					31			



BOREHOLE LOG

Number:	B-12
Client:	CenterPoint Intergrated Solutions, LLC
Sheet:	1 of 1
Location:	Proposed CarMax Auto Dealership Sweetwater Road and Plaza Bonita Road, National City, California
Date Started:	10/6/2015
Date Finished:	10/6/2015
EEI Rep:	ML
Project No.:	CIS-72092.4
Drill Rig/Sampling Method	Track-Mounted Fraste PL-G / Hollow Stem Auger
Borehole Diameter:	8-inch

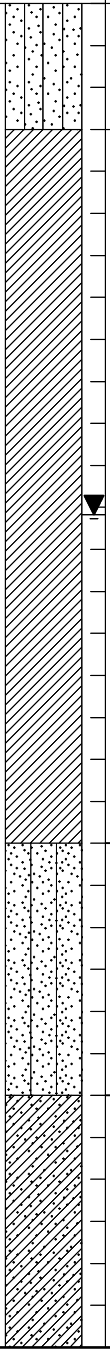
SAMPLE LOG | **BOREHOLE LOG**

Bulk	Sample Type	Blows Per 6"	Dry Unit Wt. (pcf)	Moisture (%)	Depth In Feet	USCS Symbol	Geologic Description (SoilType, Color, Grain, Minor Soil Component, Moisture, Density, Odor, Etc.)
					0		**ALLUVIUM** SILTY-SAND, light yellow-brown, scattered gravels, damp to moist, medium dense; micaceous
▨					1		
▨					2		
▨	MC	3 4 8	100	16	3		
▨					4		
▨	MC	4 5 6	109	14	5		@ 5' Becomes moist to very moist
					6		
					7		
	MC	6 6 6			8		▽ @ 8' Groundwater encountered
					9		
	SPT	2 2 3			10		@ 10' Becomes gray-brown, fine to medium grained, saturated, loose
					11	SM	
					12		
					13		
					14		
	SPT	1 1 2			15		
					16		
					17		
					18		
					19		
	SPT	3 2 2			20		@ 20' Becomes loose to medium dense
					21		
					22		
					23		Total depth: 21.5-feet Groundwater encountered at 8-feet
					24		Boring backfilled on 10/6/2015 with drilled cuttings
					25		
					26		
					27		
					28		
					29		
					30		
					31		

BOREHOLE LOG

Number: B-13	**Client:** CenterPoint Intergrated Solutions, LLC	**Sheet:** 1 of 2	
Date Started: 10/7/2015	**Date Finished:** 10/7/2015	**Location:** Proposed CarMax Auto Dealership Sweetwater Road and Plaza Bonita Road, National City, California	
EEI Rep: BM	**Project No.:** CIS-72092.4	**Drill Rig/Sampling Method** Track-Mounted Fraste PL-G / Hollow Stem Auger	**Borehole Diameter:** 8-inch

SAMPLE LOG								BOREHOLE LOG
Bulk	Sample Type	Blows Per 6"	Dry Unit Wt. (pcf)	Moisture (%)	Depth In Feet	USCS Symbol	Graphic Log	Geologic Description (SoilType, Color, Grain, Minor Soil Component, Moisture, Density, Odor, Etc.)
					1	ML		**FILL** SANDY-SILT, orange-brown, scattered gravels, moist, medium dense
					2			
	MC	9 11 14	114	12	3			**ALLUVIUM** @ 3' SANDY-CLAY, dark brown to brown, fine grained, moist, very stiff
					4			
					5			
	MC	10 13 20	112	10	6			
					7			
	MC	2 3 4	107	11	8			@ 7.5' Becomes medium stiff
					9			
	SPT	3 6 5			10			@ 10' Becomes moist to very moist, stiff
					11	CL		
					12		▼	@ 12' Groundwater encountered
					13			
					14			
	SPT	2 2 4			15			@ 15' Increase in silt content, becomes medium stiff
					16			
					17			
					18			
					19			
	SPT	3 9 15			20			@ 20' SILTY-SAND, gray, fine grained, saturated, medium dense
					21			
					22			
					23	SM		
					24			
	SPT	4 2 2			25			@ 25' Increase in clay content, becomes dark gray
					26			@ 26' SANDY-CLAY, dark gray, fine grained, saturated, stiff
					27			
					28			
					29	CL		
	SPT	2 6 5			30			
					31			



EEI
Geotechnical & Environmental Solutions

BOREHOLE LOG

Number:	B-13
Client:	CenterPoint Intergrated Solutions, LLC
Sheet:	2 of 2
Location:	Proposed CarMax Auto Dealership Sweetwater Road and Plaza Bonita Road, National City, California
Date Started:	10/7/2015
Date Finished:	10/7/2015
EEI Rep:	BM
Project No.:	CIS-72092.4
Drill Rig/Sampling Method	Track-Mounted Fraste PL-G / Hollow Stem Auger
Borehole Diameter:	8-inch

SAMPLE LOG								BOREHOLE LOG
Bulk	Sample Type	Blows Per 6"	Dry Unit Wt. (pcf)	Moisture (%)	Depth In Feet	USCS Symbol	Graphic Log	Geologic Description (SoilType, Color, Grain, Minor Soil Component, Moisture, Density, Odor, Etc.)
							▨	*Boring B-13 continued...*
					33		▨	
					34		▨	
	SPT ☒	3 8 9			35		▨	@ 35' Becomes very stiff
					36	CL	▨	
					37		▨	
					38		▨	
					39		▨	
	SPT ☒	4 8 10			40		⁚	@ 40' SILTY-SAND, dark gray, fine grained, saturated, medium dense
					41		⁚	
					42		⁚	
					43		⁚	
					44		⁚	
	SPT ☒	4 6 7			45		⁚	
					46	SM	⁚	
					47		⁚	
					48		⁚	
					49		⁚	
	SPT ☒	7 11 17			50		⁚	@ 50' No sample recovered; heaving sand
					51		⁚	
					52			
					53			Total depth: 51.5-feet Groundwater encountered at 12-feet Boring backfilled on 10/7/2015 with bentonite chips
					54			
					55			
					56			
					57			
					58			
					59			
					60			
					61			
					62			
					63			

BOREHOLE LOG

Number: B-14	**Client:** CenterPoint Intergrated Solutions, LLC	**Sheet:** 1 of 1	
Location: Proposed CarMax Auto Dealership Sweetwater Road and Plaza Bonita Road, National City, California			
Date Started: 10/7/2015	**Date Finished:** 10/7/2015		
EEI Rep: BM	**Project No.:** CIS-72092.4	**Drill Rig/Sampling Method** Track-Mounted Fraste PL-G / Hollow Stem Auger	**Borehole Diameter:** 8-inch

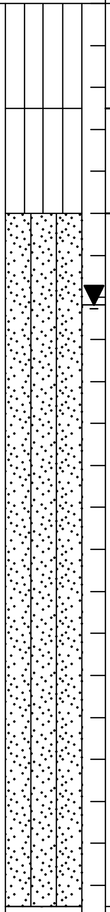
SAMPLE LOG / BOREHOLE LOG

Bulk	Sample Type	Blows Per 6"	Dry Unit Wt. (pcf)	Moisture (%)	Depth In Feet	USCS Symbol	Graphic Log	Geologic Description (SoilType, Color, Grain, Minor Soil Component, Moisture, Density, Odor, Etc.)
					1			**ALLUVIUM** SILTY-SAND, light brown, scattered gravels, damp to moist, loose; micaceous
					2			
	MC	4 6 7	99	3	3			
					4			
	MC	2 3 4	97	7	5			@ 5' Becomes moist to very moist, very loose
					6			
					7			
	MC	2 1 3			8		▼	@ 7.5' No sample recovery
					9			@ 8' Groundwater encountered
	SPT	4 1 2			10			@ 10' Becomes gray-brown, fine to medium grained, saturated
					11	SM		
					12			
					13			
					14			
	SPT	6 4 4			15			@ 15' Becomes loose
					16			
					17			
					18			
					19			
	SPT	4 4 7			20			@ 20' Becomes medium dense
					21			
					22			
					23			Total depth: 21.5-feet Groundwater encountered at 8-feet
					24			Boring backfilled on 10/7/2015 with drilled cuttings
					25			
					26			
					27			
					28			
					29			
					30			
					31			

BOREHOLE LOG

Number: B-15	**Client:** CenterPoint Intergrated Solutions, LLC	**Sheet:** 1 of 1	
Date Started: 10/7/2015	**Date Finished:** 10/7/2015	**Location:** Proposed CarMax Auto Dealership Sweetwater Road and Plaza Bonita Road, National City, California	
EEI Rep: BM	**Project No.:** CIS-72092.4	**Drill Rig/Sampling Method** Track-Mounted Fraste PL-G / Hollow Stem Auger	**Borehole Diameter:** 8-inch

SAMPLE LOG / BOREHOLE LOG



Bulk	Sample Type	Blows Per 6"	Dry Unit Wt. (pcf)	Moisture (%)	Depth In Feet	USCS Symbol	Geologic Description (SoilType, Color, Grain, Minor Soil Component, Moisture, Density, Odor, Etc.)
					0–2.5	ML	**ALLUVIUM** CLAYEY-SILT, dark brown, moist, medium stiff
	MC	3 4 5	96	13	2.5–5	ML	@ 2.5' SILT, brown, moist, medium stiff; micaeous
	MC	3 5 7	98	5	5–7	SM	@ 5' SILTY-SAND, dark brown, moist, loose
	SPT	2 4 4	100	20	7		@ 7' Groundwater encountered
	SPT	2 2 3			10		
	SPT	2 3 5			15		
	SPT	1 1 3			20–21.5		

Total depth: 21.5-feet
Groundwater encountered at 7-feet

Boring backfilled on 10/7/2015 with drilled cuttings

BOREHOLE LOG

Number: B-16

Client: CenterPoint Intergrated Solutions, LLC

Sheet: 1 of 2

Location:
Proposed CarMax Auto Dealership
Sweetwater Road and Plaza Bonita Road, National City, California

Date Started: 10/8/2015

Date Finished: 10/8/2015

EEI Rep: BM

Project No.: CIS-72092.4

Drill Rig/Sampling Method: Track-Mounted Fraste PL-G / Hollow Stem Auger

Borehole Diameter: 8-inch

SAMPLE LOG						BOREHOLE LOG	
Bulk	Sample Type	Blows Per 6"	Dry Unit Wt. (pcf)	Moisture (%)	Depth In Feet	USCS Symbol	Geologic Description (SoilType, Color, Grain, Minor Soil Component, Moisture, Density, Odor, Etc.)
					1		**FILL** SILTY-SAND, orange-brown, scattered gravels, moist, medium dense
					2	SM	
	MC	4 11 12	106	16	3		
					4		**ALLUVIUM**
	MC	5 6 9	88	20	5		@ 4' SANDY-CLAY, brown, gray and orange, scattered gravels, very moist, stiff
					6		
					7	CL	
	MC	2 3 3			8		@ 7.5' Becomes medium stiff
					9		
	SPT	2 2 3	99	21	10		@ 10' CLAYEY-SAND, grayish-green, fine grained, very moist to wet, loose
					11		
					12		
					13	SC	
					14		
	SPT	1 2 3			15		
					16		▼ @ 16' Groundwater encountered
					17		@ 17' SILTY-SAND, dark gray, fine grained, saturated, loose
					18		
					19		
	SPT	5 5 4			20		
					21		
					22		
					23	SM	
					24		
	SPT	3 2 2			25		
					26		
					27		
					28		
					29		
	SPT	1 4 6			30		@ 30' CLAYEY-SAND, dark gray, fine grained, saturated, medium dense
					31	SC	

BOREHOLE LOG

Number: B-16

Client: CenterPoint Intergrated Solutions, LLC

Sheet: 2 of 2

Location:
Proposed CarMax Auto Dealership
Sweetwater Road and Plaza Bonita Road, National City, California

Date Started: 10/8/2015

Date Finished: 10/8/2015

EEI Rep: BM

Project No.: CIS-72092.4

Drill Rig/Sampling Method Track-Mounted Fraste PL-G / Hollow Stem Auger

Borehole Diameter: 8-inch

SAMPLE LOG								BOREHOLE LOG
Bulk	Sample Type	Blows Per 6"	Dry Unit Wt. (pcf)	Moisture (%)	Depth In Feet	USCS Symbol	Graphic Log	Geologic Description (SoilType, Color, Grain, Minor Soil Component, Moisture, Density, Odor, Etc.)
					33 34	SC	▨	*Boring B-16 continued...*
	SPT ☒	3 7 12			35 36 37 38 39	SM	░	@ 35' SILTY-SAND, dark gray, fine to medium grained, saturated, medium dense
	SPT ☒	1 2 3			40 41 42 43 44	SC	▨	@ 40' CLAYEY-SAND, dark gray, fine grained, saturated, loose
	SPT ☒	2 4 7			45 46 47 48 49	SM	░	@ 45' SILTY-SAND, dark gray, fine to medium grained, saturated, medium dense
	SPT ☒	2 9 12			50 51		░	
					52 53 54 55 56 57 58 59 60 61 62 63			Total depth: 51.5-feet Groundwater encountered at 16-feet Boring backfilled on 10/8/2015 with bentonite chips

BOREHOLE LOG

Number:	B-17
Client:	CenterPoint Intergrated Solutions, LLC
Sheet:	1 of 1
Location:	Proposed CarMax Auto Dealership Sweetwater Road and Plaza Bonita Road, National City, California
Date Started:	10/8/2015
Date Finished:	10/8/2015
EEI Rep:	BM
Project No.:	CIS-72092.4
Drill Rig/Sampling Method	Track-Mounted Fraste PL-G / Hollow Stem Auger
Borehole Diameter:	8-inch

SAMPLE LOG								BOREHOLE LOG
Bulk	Sample Type	Blows Per 6"	Dry Unit Wt. (pcf)	Moisture (%)	Depth In Feet	USCS Symbol	Graphic Log	Geologic Description (SoilType, Color, Grain, Minor Soil Component, Moisture, Density, Odor, Etc.)
					1	ML		**FILL** SILT, dark brown, moist, loose; organic rich sediments; micaceous
					2			**ALLUVIUM**
	MC	3 4 5	83	14	3			@ 2.5' SILT, brown, moist, loose; micaceous
					4			
	MC	2 4 6	83	31	5	ML		@ 5' Becomes very moist
					6			
					7			
	MC	2 5 6	87	27	8			@ 7.5' SILTY-SAND, dark gray, fine grained, saturated, loose ▼ @ 8' Groundwater encountered at 8-feet
					9			
	MC	2 4 6	99	19	10			@ 10' Becomes fine to medium grained
					11			
					12			
					13			
					14			
	SPT	4 8 10			15	SM		@ 15' Becomes medium dense
					16			
					17			
					18			
					19			
	SPT	4 4 4			20			@ 20' Becomes loose
					21			
					22			
					23			Total depth: 21.5-feet Groundwater encountered at 8-feet Boring backfilled on 10/8/2015 with drilled cuttings
					24			
					25			
					26			
					27			
					28			
					29			
					30			
					31			

BOREHOLE LOG

Number: B-18

Client: CenterPoint Intergrated Solutions, LLC

Sheet: 1 of 1

Location:
Proposed CarMax Auto Dealership
Sweetwater Road and Plaza Bonita Road, National City, California

Date Started: 10/8/2015

Date Finished: 10/8/2015

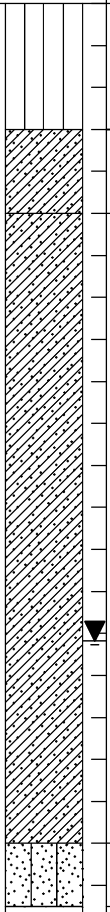
EEI Rep: BM

Project No.: CIS-72092.4

Drill Rig/Sampling Method: Track-Mounted Fraste PL-G / Hollow Stem Auger

Borehole Diameter: 8-inch

SAMPLE LOG / BOREHOLE LOG



Bulk	Sample Type	Blows Per 6"	Dry Unit Wt. (pcf)	Moisture (%)	Depth In Feet	USCS Symbol	Geologic Description (SoilType, Color, Grain, Minor Soil Component, Moisture, Density, Odor, Etc.)
					1	ML	**FILL** SILT, brown, abundant gravels, moist, loose; micaceous
					2		
	MC	2 7 7	78	10	3		@ 3' SANDY-CLAY, orange and brown mottled, abundant gravels, moist, stiff
					4	CL	
	MC	6 7 10	101	19	5		**ALLUVIUM** @ 5' SANDY-CLAY, brown, green and orange, scattered gravels, moist, stiff
					6		
					7		
	MC	2 6 6	95	20	8		
					9		
	MC	3 4 5	92	19	10		@ 10' Becomes medium stiff
					11		
					12	CL	
					13		
					14		
	SPT	1 2 3			15 ▼		@ 15' Groundwater encountered
					16		
					17		
					18		
					19		
	SPT	3 3 4			20		@ 20' SILTY-SAND, dark gray, saturated, loose
					21	SM	
					22		
					23		Total depth: 21.5-feet Groundwater encountered at 15-feet
					24		Boring backfilled on 10/8/2015 with drilled cuttings
					25		
					26		
					27		
					28		
					29		
					30		
					31		

BOREHOLE LOG

Number: B-19/P-3

Client: CenterPoint Intergrated Solutions, LLC

Sheet: 1 of 1

Location:
Proposed CarMax Auto Dealership
Sweetwater Road and Plaza Bonita Road, National City, California

Date Started: 10/8/2015

Date Finished: 10/8/2015

EEI Rep: BM

Project No.: CIS-72092.4

Drill Rig/Sampling Method Track-Mounted Fraste PL-G / Hollow Stem Auger

Borehole Diameter: 8-inch

SAMPLE LOG								BOREHOLE LOG
Bulk	Sample Type	Blows Per 6"	Dry Unit Wt. (pcf)	Moisture (%)	Depth In Feet	USCS Symbol	Graphic Log	Geologic Description (SoilType, Color, Grain, Minor Soil Component, Moisture, Density, Odor, Etc.)
					1	ML		**FILL** SILT, dark brown, moist, loose; organic rich sediments; micaceous
					2 3 4	ML	░	**ALLUVIUM** @ 2.5' SANDY-SILT, brown, moist, loose; micaceous
					5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31			Total depth: 5-feet No groundwater encountered Percolation test performed Boring backfilled on 10/8/2015 with drilled cuttings

EEI
Geotechnical & Environmental Solutions

BOREHOLE LOG

Number: B-20/P-4

Client: CenterPoint Intergrated Solutions, LLC

Sheet: 1 of 1

Location:
Proposed CarMax Auto Dealership
Sweetwater Road and Plaza Bonita Road, National City, California

Date Started: 10/7/2015

Date Finished: 10/7/2015

EEI Rep: ML

Project No.: CIS-72092.4

Drill Rig/Sampling Method Hand Auger

Borehole Diameter: 3-inch

SAMPLE LOG								BOREHOLE LOG
Bulk	Sample Type	Blows Per 6"	Dry Unit Wt. (pcf)	Moisture (%)	Depth In Feet	USCS Symbol	Graphic Log	Geologic Description (SoilType, Color, Grain, Minor Soil Component, Moisture, Density, Odor, Etc.)
					1			**ALLUVIUM** SILTY-SAND, light yellow-brown, fine grained, damp, medium dense
					2	SM		
					3			@ 3' Becomes fine to medium grained
					4			
					5			
					6			Total depth: 5-feet No groundwater encountered Percolation test performed
					7			
					8			Boring backfilled with drilled cuttings
					9			
					10			
					11			
					12			
					13			
					14			
					15			
					16			
					17			
					18			
					19			
					20			
					21			
					22			
					23			
					24			
					25			
					26			
					27			
					28			
					29			
					30			
					31			

EEI Geotechnical & Environmental Solutions

BOREHOLE LOG

Number: B-21/P-5

Client: CenterPoint Intergrated Solutions, LLC

Sheet: 1 of 1

Location:
Proposed CarMax Auto Dealership
Sweetwater Road and Plaza Bonita Road, National City, California

Date Started: 10/7/2015

Date Finished: 10/7/2015

EEI Rep: ML

Project No.: CIS-72092.4

Drill Rig/Sampling Method Hand Auger

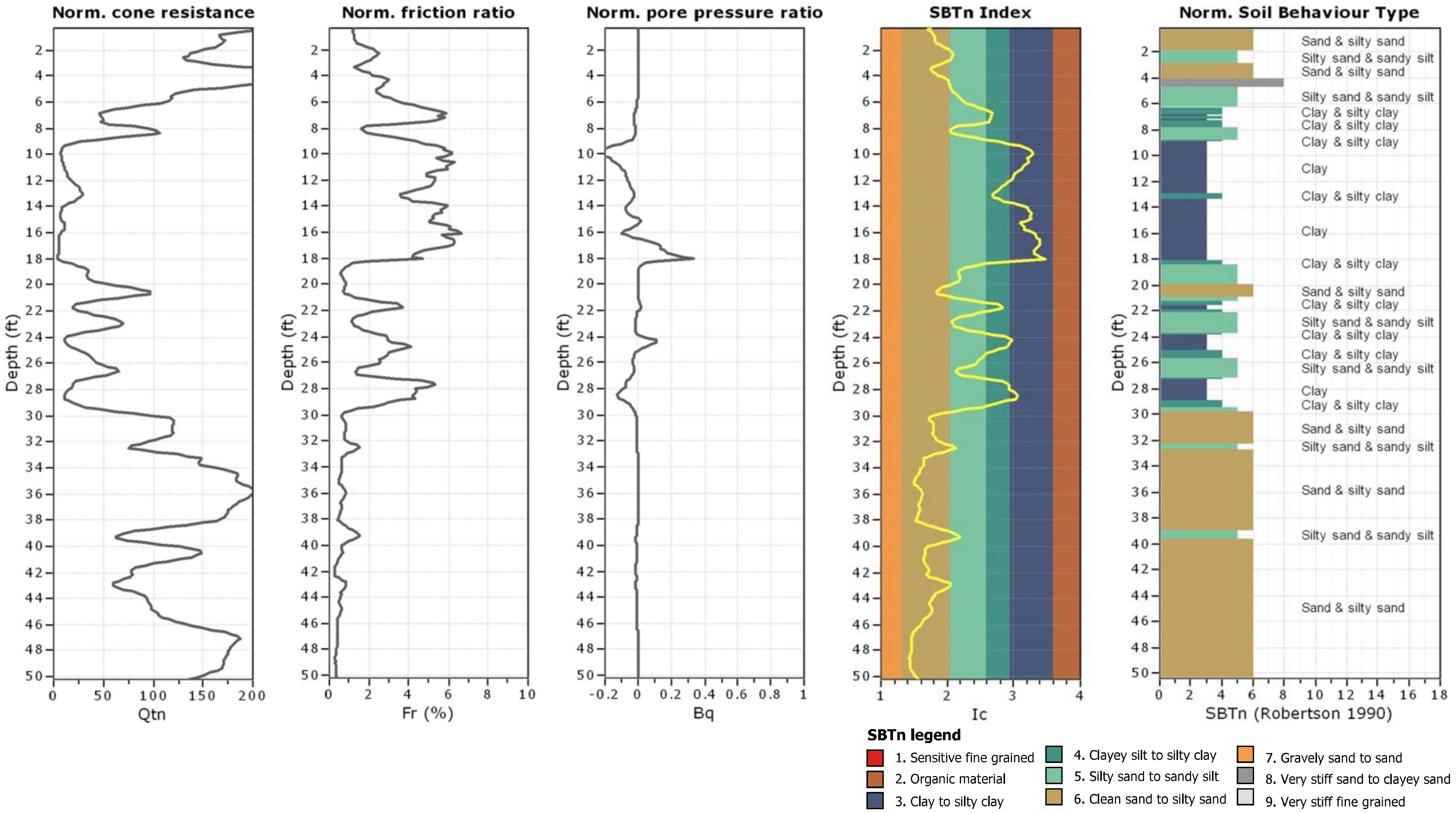
Borehole Diameter: 3-inch

SAMPLE LOG						BOREHOLE LOG		
Bulk	Sample Type	Blows Per 6"	Dry Unit Wt. (pcf)	Moisture (%)	Depth In Feet	USCS Symbol	Graphic Log	Geologic Description (SoilType, Color, Grain, Minor Soil Component, Moisture, Density, Odor, Etc.)
							▨	**ALLUVIUM**
					1		▨	SILTY-SAND, reddish-brown, fine grained, damp, medium dense
					2	SM	▨	
					3		▨	@ 2.5' Becomes brown, fine to medium grained
					4		▨	
					5			
					6			Total depth: 5-feet No groundwater encountered Percolation test performed
					7			
					8			Boring backfilled with drilled cuttings
					9			
					10			
					11			
					12			
					13			
					14			
					15			
					16			
					17			
					18			
					19			
					20			
					21			
					22			
					23			
					24			
					25			
					26			
					27			
					28			
					29			
					30			
					31			

EEI
Geotechnical & Environmental Solutions
2195 Faraday Avenue, Suite K, Carlsbad CA
www.EEItiger.com

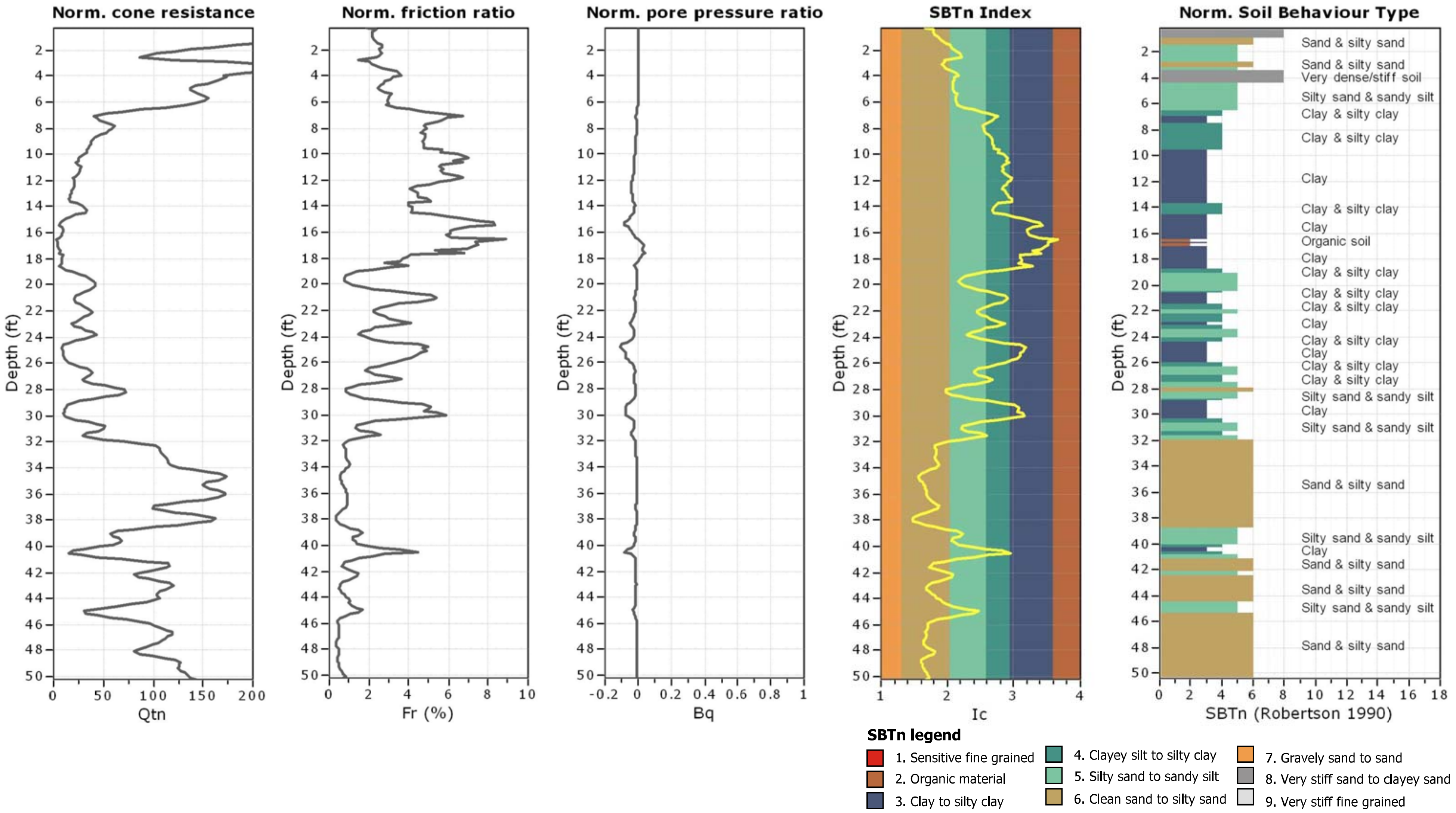
Project: **CIS-72092.4**
Location: **Proposed CarMax National City**

CPT: CPT-01
Total depth: 50.20 ft, Date: 10/29/2015



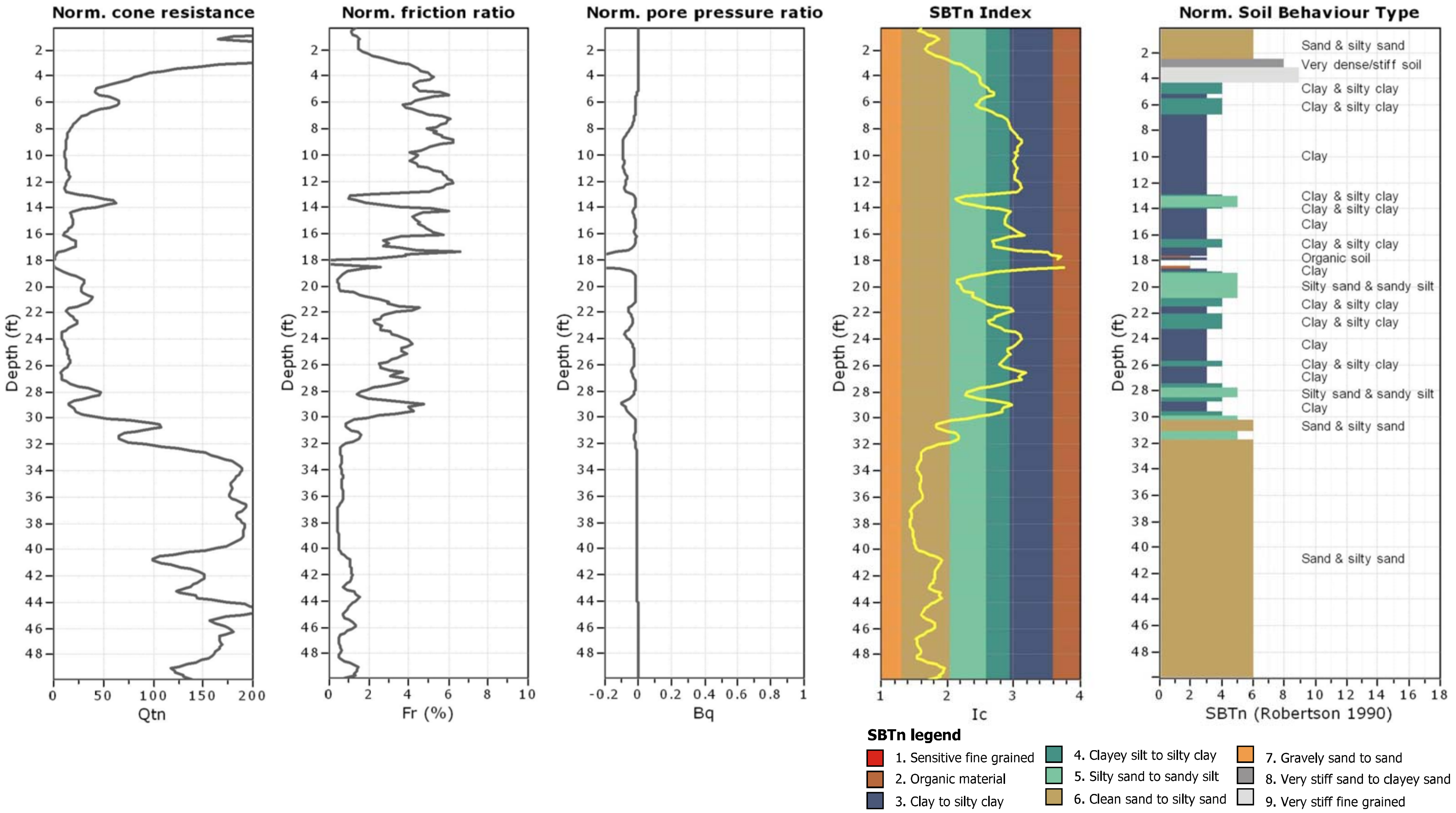
Project: **CIS-72092.4**
Location: **Proposed CarMax National City**

CPT: CPT-02
Total depth: 50.20 ft, Date: 10/29/2015



Project: **CIS-72092.4**
Location: **Proposed CarMax National City**

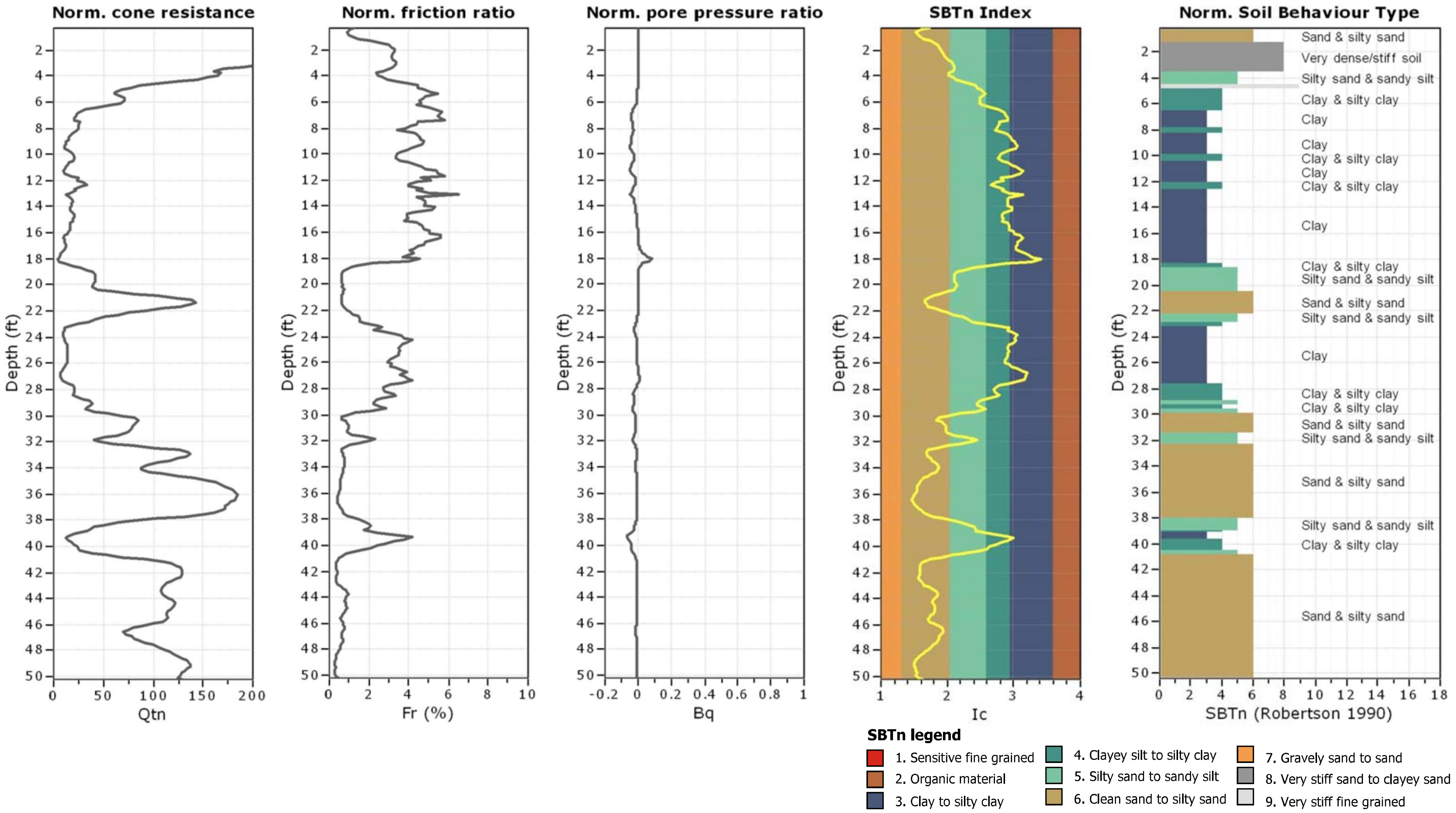
CPT: CPT-03
Total depth: 49.87 ft, Date: 10/29/2015



EEI
Geotechnical & Environmental Solutions
2195 Faraday Avenue, Suite K, Carlsbad CA
www.EEItiger.com

Project: **CIS-72092.4**
Location: **Proposed CarMax National City**

CPT: CPT-04
Total depth: 50.20 ft, Date: 10/29/2015



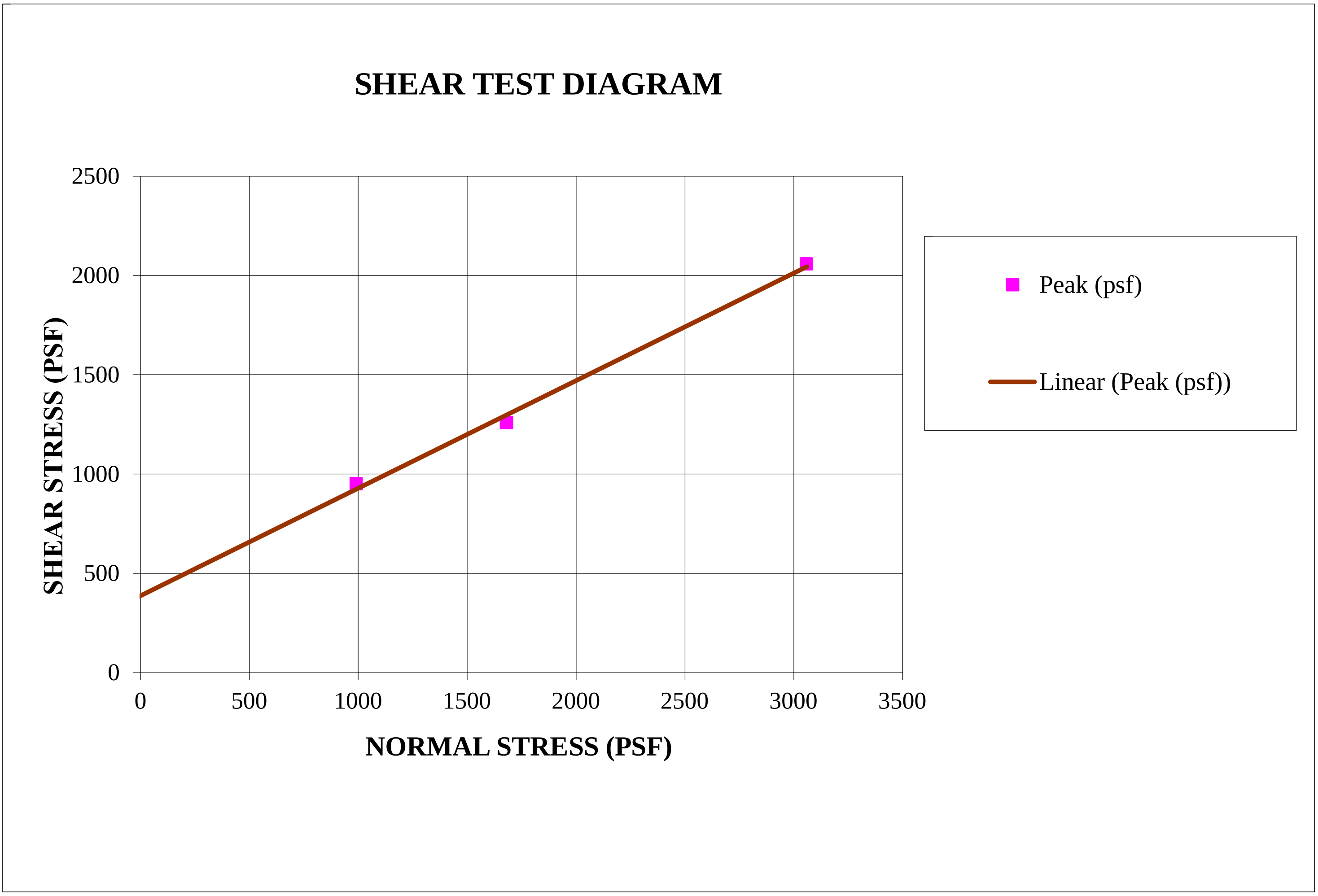
APPENDIX B
LABORATORY TEST DATA

DIRECT SHEAR TEST ASTM D 3080

Job Data	
Job No.:	CIS-72092.4
Client:	Centerpoint Integrated Solutions
Date:	10/14/15
Sample Data	
Sample:	B-7 @ 2-5 ft.
Remolded:	90%
Remarks:	Sample innundated prior to testing
Soil Description:	Light Brown Clayey Sand

EEI
Geotechnical & Environmental Solutions

2195 Faraday Avenue, Suite K, Carlsbad, CA 92008



Test Results

	Phi		Cohesion	
Ultimate (psf)	28	degrees	387	psf

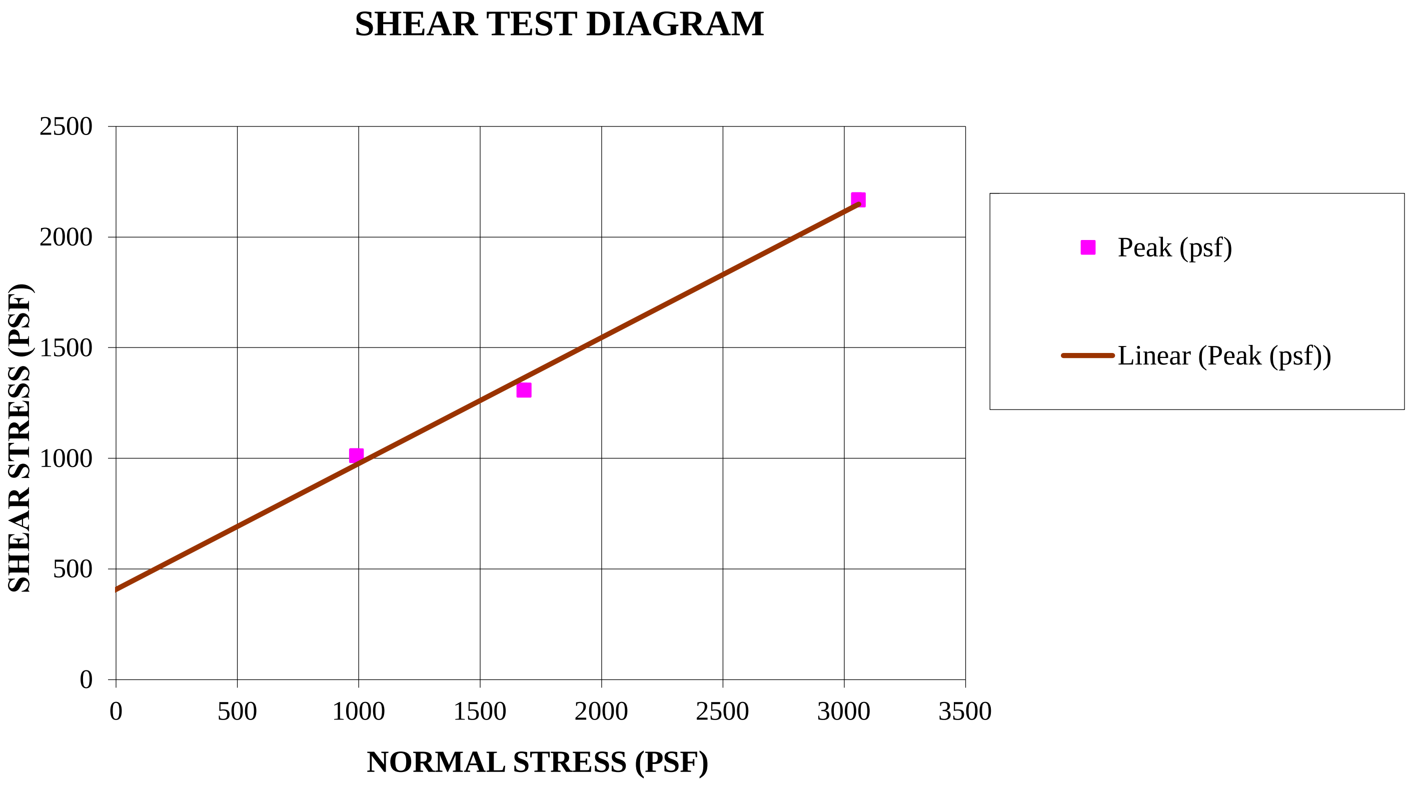
Average Initial Moisture	12.0%
Average Dry Density	108.5 pcf
Average Final Moisture	20.7%

DIRECT SHEAR TEST ASTM D 3080

Job Data	
Job No.:	CIS-72092.4
Client:	Centerpoint Integrated Solutions
Date:	10/15/15
Sample Data	
Sample:	B-10 @ 1-5 ft.
Remolded:	90%
Remarks:	Sample innundated prior to testing
Soil Description:	Brown Clayey Sand

EEI
Geotechnical & Environmental Solutions

2195 Faraday Avenue, Suite K, Carlsbad, CA 92008



Test Results

	Phi		Cohesion	
Ultimate (psf)	30	degrees	409	psf

Average Initial Moisture	9.5%
Average Dry Density	111.4 pcf
Average Final Moisture	16.4%

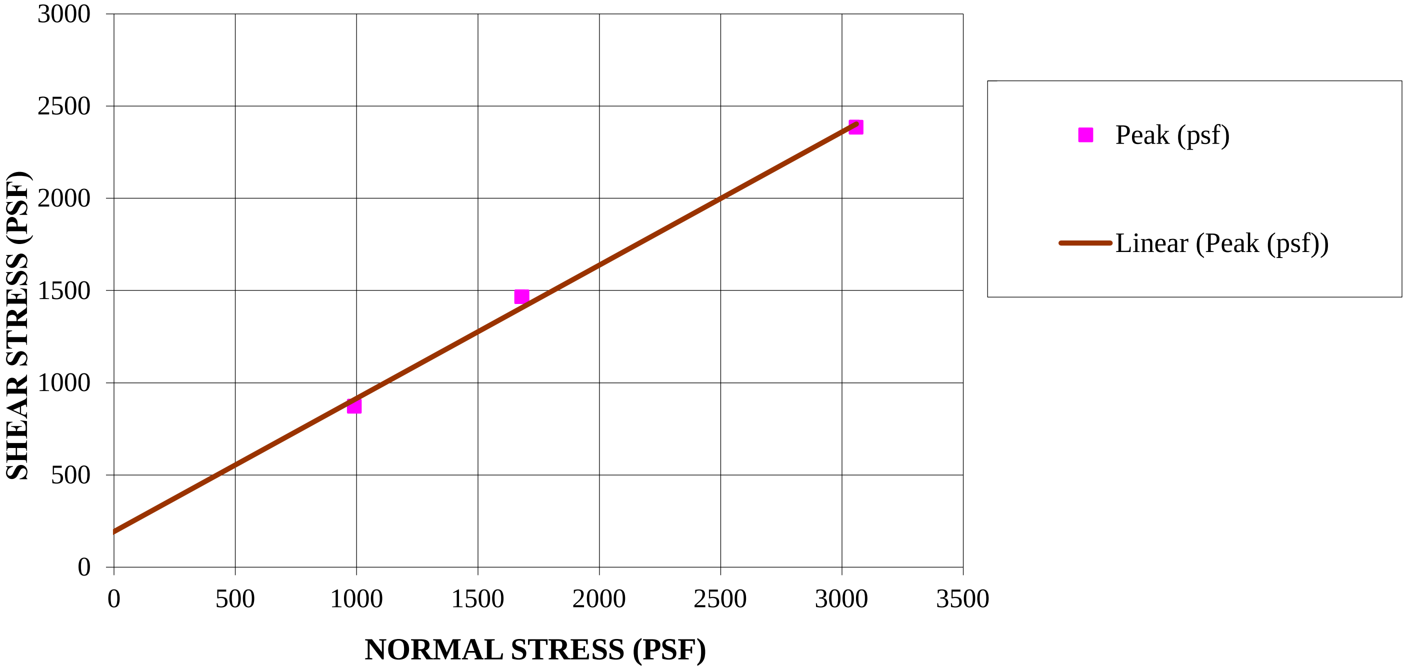
DIRECT SHEAR TEST ASTM D 3080

Job Data	
Job No.:	CIS-72092.4
Client:	Centerpoint Integrated Solutions
Date:	10/16/15
Sample Data	
Sample:	B-12 @ 1-6 ft.
Remolded:	90%
Remarks:	Sample innundated prior to testing
Soil Description:	Light Yellow Brown Silty Sand

EEI
Geotechnical & Environmental Solutions

2195 Faraday Avenue, Suite K, Carlsbad, CA 92008

SHEAR TEST DIAGRAM



Test Results

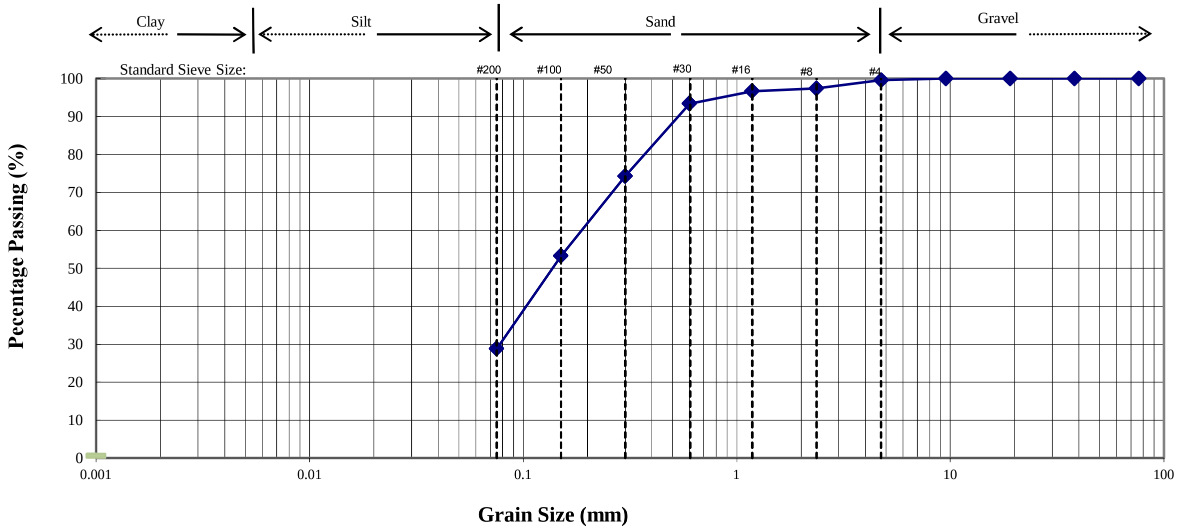
	Phi		Cohesion	
Ultimate (psf)	36	degrees	194	psf

Average Initial Moisture	9.5%
Average Dry Density	111.4 pcf
Average Final Moisture	16.4%

PARTICLE-SIZE ANALYSIS OF SOILS
ASTM METHOD D 422 (SIEVE ANALYSIS)

Sample :	B-7 @ 5 ft.	D10 (mm)	N/A
Total Weight (g)	112.9	D30 (mm)	0.08
Dry Weight (g)	100.3	D60 (mm)	0.20
Wet Sieve Weight (g)	71.4	Cu	N/A
Initial Moisture (%)	12.6	Cc	N/A

According to ASTM D 2487 Unified Soil Classification System (USCS) and ASTM D 422 (Standard Test Method for Particle-Size Analysis) test method results, soil sample B-7 at 5 feet is classified as Clayey Sand (SC)



Sieve Size (in)	Sieve Size (mm)	Cumulative Weight of dry soil (gm)	Percent Retained (%)	Percent Passing (%)
3"	76.2	0.0	0.0	100.0
1.5"	38.1	0.0	0.0	100.0
3/4"	19.05	0.0	0.0	100.0
3/8"	9.53	0.0	0.0	100.0
#4	4.75	0.4	0.4	99.6
#8	2.36	2.6	2.6	97.4
#16	1.18	3.3	3.3	96.7
#30	0.6	6.6	6.6	93.4
#50	0.3	25.8	25.7	74.3
#100	0.15	46.9	46.8	53.2
#200	0.075	71.4	71.2	28.8

Client: Centerpoint Integrated Solutions

Project Name: CarMax National City

Job Number: CIS-72092.4

Date: 10/15/15

Boring Number: B-7

Depth: 5 ft.

Soil Description: Light Brown Clayey Sand SC

Tested by: B D

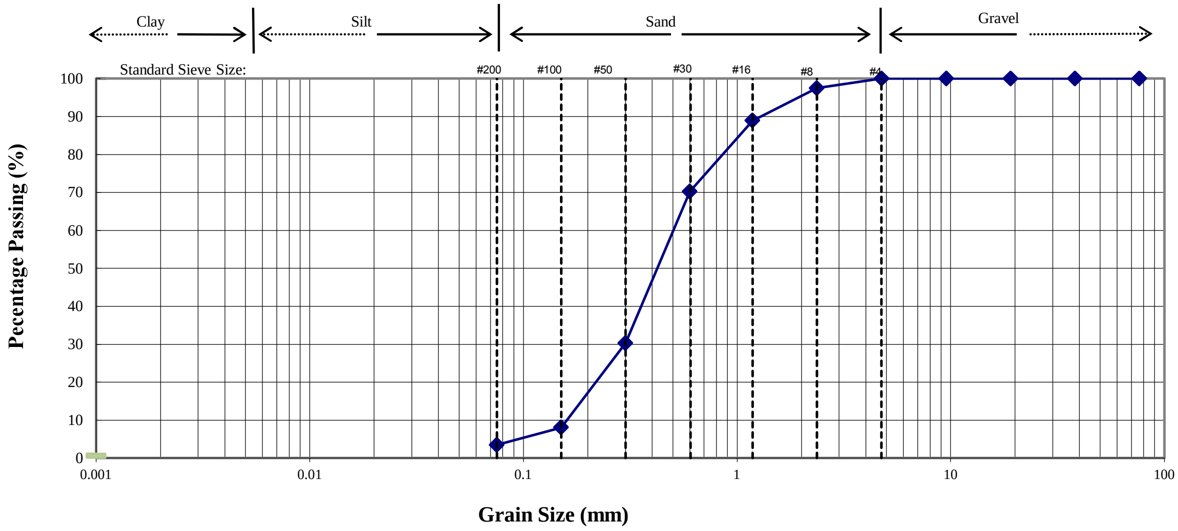
EEI
Geotechnical & Environmental Solutions

2195 Faraday Avenue, Suite K, Carlsbad CA 92008

PARTICLE-SIZE ANALYSIS OF SOILS
ASTM METHOD D 422 (SIEVE ANALYSIS)

Sample :	B-7 @ 10 ft.		D_{10} (mm)	0.163
Total Weight (g)	114.8		D_{30} (mm)	0.30
Dry Weight (g)	92.1		D_{60} (mm)	0.52
Wet Sieve Weight (g)	88.9		C_u	3.20
Initial Moisture (%)	24.6		C_c	1.04

According to ASTM D 2487 Unified Soil Classification System (USCS) and ASTM D 422 (Standard Test Method for Particle-Size Analysis) test method results, soil sample B-7 at 10 feet is classified as Poorly Graded Sand (SP)



Sieve Size (in)	Sieve Size (mm)	Cumulative Weight of dry soil (gm)	Percent Retained (%)	Percent Passing (%)
3"	76.2	0.0	0.0	100.0
1.5"	38.1	0.0	0.0	100.0
3/4"	19.05	0.0	0.0	100.0
3/8"	9.53	0.0	0.0	100.0
#4	4.75	0.0	0.0	100.0
#8	2.36	2.3	2.5	97.5
#16	1.18	10.2	11.1	88.9
#30	0.6	27.4	29.8	70.2
#50	0.3	64.2	69.7	30.3
#100	0.15	84.7	92.0	8.0
#200	0.075	88.9	96.5	3.5

Client: Centerpoint Integrated Solutions

Project Name: CarMax National City

Job Number: CIS-72092.4

Date: 10/15/15

Boring Number: B-7

Depth: 10 ft.

Soil Description: Brown Poorly Graded Sand SP

Tested by: B D

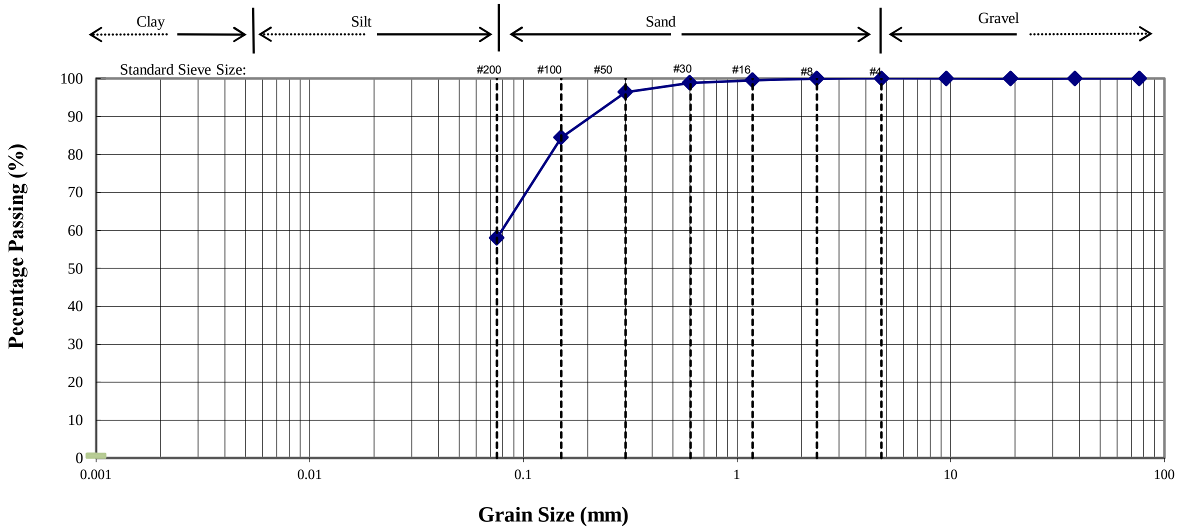
EEI
Geotechnical & Environmental Solutions

2195 Faraday Avenue, Suite K, Carlsbad CA 92008

PARTICLE-SIZE ANALYSIS OF SOILS
ASTM METHOD D 422 (SIEVE ANALYSIS)

Sample :	B-7 @ 25 ft.		D_{10} (mm)	N/A
Total Weight (g)	114.8		D_{30} (mm)	N/A
Dry Weight (g)	89.5		D_{60} (mm)	0.08
Wet Sieve Weight (g)	37.6		C_u	N/A
Initial Moisture (%)	28.3		C_c	N/A

According to ASTM D 2487 Unified Soil Classification System (USCS) and ASTM D 422 (Standard Test Method for Particle-Size Analysis) test method results, soil sample B-7 at 25 feet is classified as Sandy Clay (CL)



Sieve Size (in)	Sieve Size (mm)	Cumulative Weight of dry soil (gm)	Percent Retained (%)	Percent Passing (%)
3"	76.2	0.0	0.0	100.0
1.5"	38.1	0.0	0.0	100.0
3/4"	19.05	0.0	0.0	100.0
3/8"	9.53	0.0	0.0	100.0
#4	4.75	0.0	0.0	100.0
#8	2.36	0.0	0.0	100.0
#16	1.18	0.4	0.4	99.6
#30	0.6	1.0	1.1	98.9
#50	0.3	3.2	3.6	96.4
#100	0.15	13.9	15.5	84.5
#200	0.075	37.6	42.0	58.0

Client: Centerpoint Integrated Solutions

Project Name: Sweetwater Rd.

Job Number: CIS-72092.4

Date: 10/15/15

Boring Number: B-7

Depth: 25 ft.

Soil Description: Dark Gray Sandy Clay CL

Tested by: B D

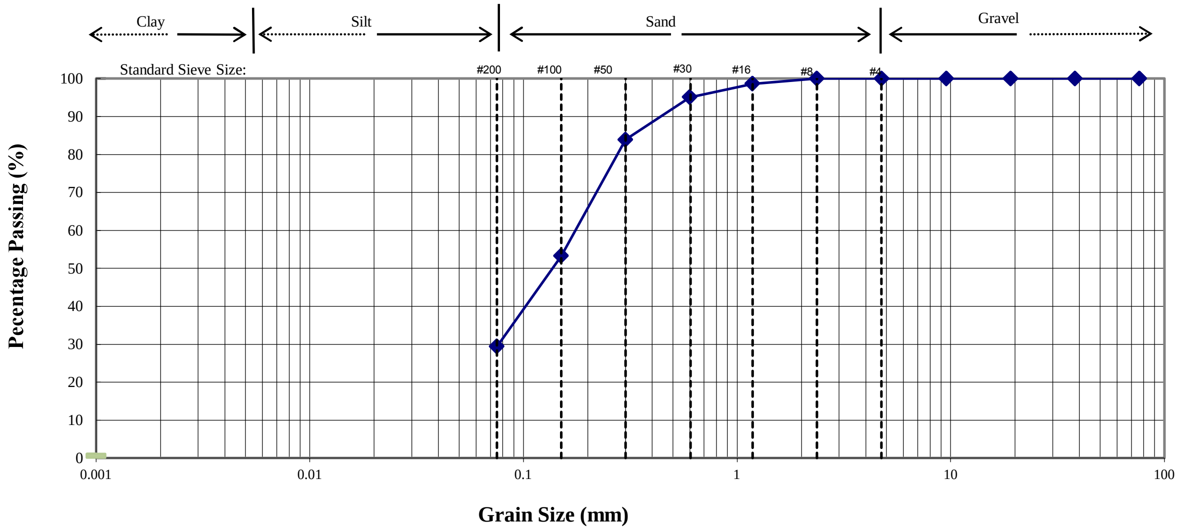
EEI
Geotechnical & Environmental Solutions

2195 Faraday Avenue, Suite K, Carlsbad CA 92008

PARTICLE-SIZE ANALYSIS OF SOILS
ASTM METHOD D 422 (SIEVE ANALYSIS)

Sample :	B-7 @ 40 ft.		D_{10} (mm)	N/A
Total Weight (g)	116.5		D_{30} (mm)	0.08
Dry Weight (g)	93.9		D_{60} (mm)	0.18
Wet Sieve Weight (g)	66.3		C_u	N/A
Initial Moisture (%)	24.1		C_c	N/A

According to ASTM D 2487 Unified Soil Classification System (USCS) and ASTM D 422 (Standard Test Method for Particle-Size Analysis) test method results, soil sample B-7 at 40 feet is classified as Silty Sand (SM)



Sieve Size (in)	Sieve Size (mm)	Cumulative Weight of dry soil (gm)	Percent Retained (%)	Percent Passing (%)
3"	76.2	0.0	0.0	100.0
1.5"	38.1	0.0	0.0	100.0
3/4"	19.05	0.0	0.0	100.0
3/8"	9.53	0.0	0.0	100.0
#4	4.75	0.0	0.0	100.0
#8	2.36	0.0	0.0	100.0
#16	1.18	1.3	1.4	98.6
#30	0.6	4.6	4.9	95.1
#50	0.3	15.1	16.1	83.9
#100	0.15	43.9	46.8	53.2
#200	0.075	66.3	70.6	29.4

EEI
Geotechnical & Environmental Solutions

2195 Faraday Avenue, Suite K, Carlsbad CA 92008

Client: Centerpoint Integrated Solutions

Project Name: CarMax

Job Number: CIS-72092.4

Date: 10/15/15

Boring Number: B-7

Depth: 40 ft.

Soil Description: Gray Silty Sand SM

Tested by: B D

EXPANSION INDEX TEST

ASTM METHOD D 4829

Sample B-7 @ 2-5 ft.

Moisture Content of Initial Sample		**% Saturation of Re-molded Sample**		**Moisture Content of Final Sample**	
Tare No. -	91	Wt. of Soil and Ring (g) -	579	Wt. of Soil and Ring (g) -	623.9
Wet Weight and Tare (g) -	142.4	Ring Weight (g) -	189.0	Ring Weight (g) -	189.0
Dry Weight and Tare (g) -	133.0	Wet Weight of Soil (g) -	390.0	Wet Weight of Soil (g) -	434.9
Tare Weight (g) -	49.9	Dry Weight of Soil (g) -	350.4	Dry Weight of Soil (g) -	350.4
Water Loss (g) -	9.4	Volume of Ring (ft^3) -	0.0073	Weight of Water (g) -	84.5
Dry Weight (g) -	83.1	Dry Density (pcf) -	105.8	*Final Moisture (%)*	*24.1*
Initial Moisture (%) -	*11.3*	*Initital Saturation (%) -*	*51.6*	*Final Saturation (%) -*	*110.0*

Expansion Test - UBC (144 PSF)

	Date	Time	Reading	
Add Weight	10/16/2015	7:15	0.000	
10 Minutes		7:25	0.000	Initial Reading
Add Water		9:00	0.055	
		10:30	0.064	
	10/19/2015	5:11	0.067	Final Reading

EImeasured	=	67
EI_{50}	**=**	**68**

Expansion Index, EI_{50}	**Potential Expansion**
0-20	Very Low
21-50	Low
51-90	Medium
91-130	High
>130	Very High

EEI Geotechnical & Environmental Solutions

2195 Faraday Avenue, Suite K, Carlsbad, CA 92008

Client: Centerpoint Integrated Solutions

Project Name: CarMax National City

Job Number: CIS-72092.4

Date: 10/16/15

Sample Number: B-7

Location: 2-5 ft.

Description: Light Brown Clayey-Sand

Tested by: BD

EXPANSION INDEX TEST

ASTM METHOD D 4829

Sample B-10 @ 1-5 ft.

Moisture Content of Initial Sample		**% Saturation of Re-molded Sample**		**Moisture Content of Final Sample**	
Tare No. -	52	Wt. of Soil and Ring (g) -	605	Wt. of Soil and Ring (g) -	639.7
Wet Weight and Tare (g) -	121.5	Ring Weight (g) -	198.9	Ring Weight (g) -	198.9
Dry Weight and Tare (g) -	115.6	Wet Weight of Soil (g) -	406.1	Wet Weight of Soil (g) -	440.8
Tare Weight (g) -	49.9	Dry Weight of Soil (g) -	372.6	Dry Weight of Soil (g) -	372.6
Water Loss (g) -	5.9	Volume of Ring (ft^3) -	0.0073	Weight of Water (g) -	68.2
Dry Weight (g) -	65.7	Dry Density (pcf) -	112.5	*Final Moisture (%)*	*18.3*
Initial Moisture (%) -	*9.0*	*Initital Saturation (%) -*	*48.8*	*Final Saturation (%) -*	*99.4*

Expansion Test - UBC (144 PSF)				
	Date	Time	Reading	
Add Weight	10/16/2015	6:20	0.000	
10 Minutes		6:30	0.000	Initial Reading
Add Water		7:40	0.026	
		10:30	0.027	
	10/19/2015	6:15	0.028	Final Reading

EImeasured = 28

EI_{50} = 27

Expansion Index, EI_{50}	**Potential Expansion**
0-20	Very Low
21-50	Low
51-90	Medium
91-130	High
>130	Very High

Client: Centerpoint Integrated Solutions

Project Name: CarMax National City

Job Number: CIS-72092.4

Date: 10/16/15

Sample Number: B-10

Location: 1-5 ft.

Description: Dark Brown Clayey Sand

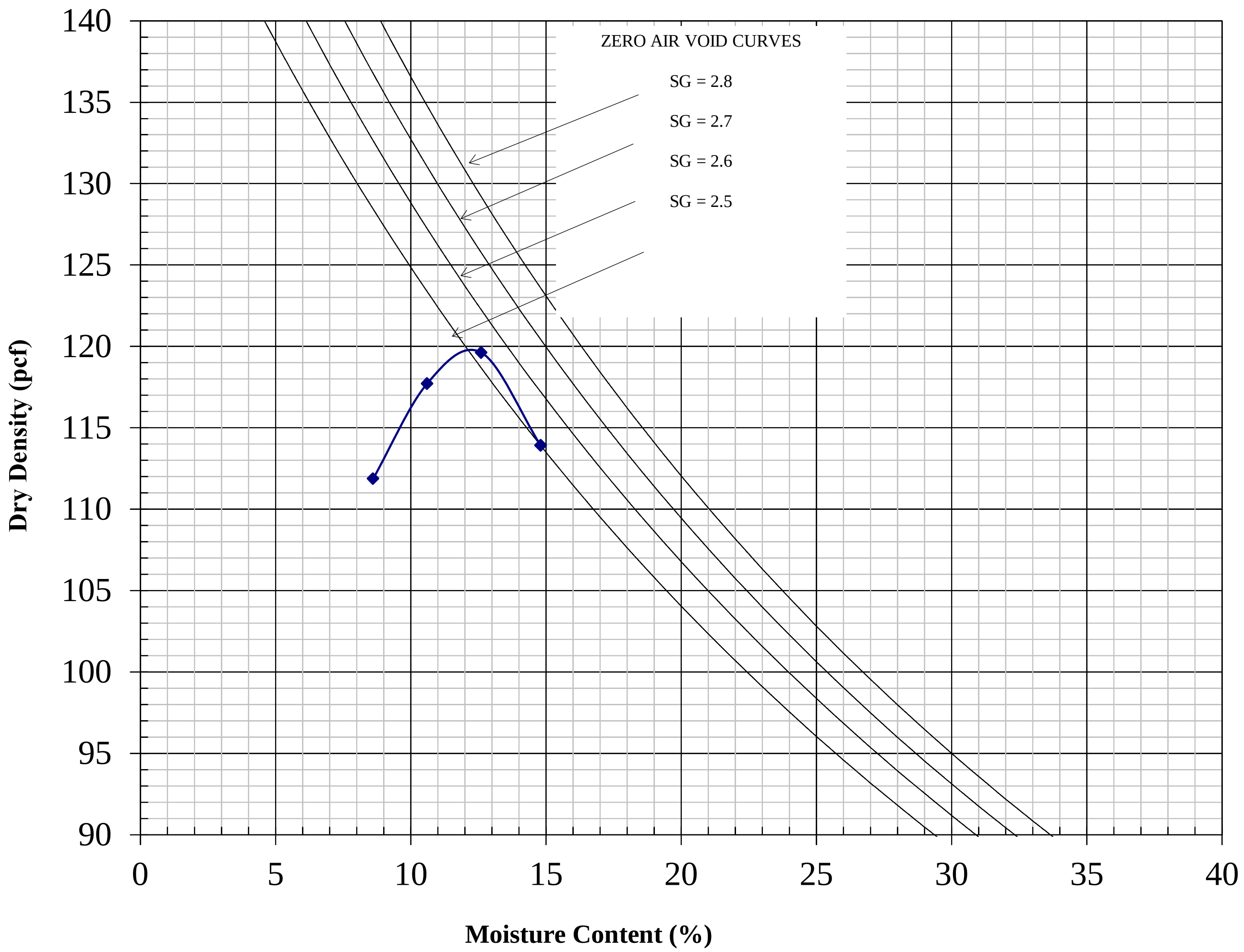
Tested by: BD

EEI
Geotechnical & Environmental Solutions

2195 Faraday Avenue, Suite K, Carlsbad, CA 92008

LABORATORY COMPACTION ASTM D 1557

Sample	1	2	3	4
Mold and wet soil (lbs.)	8.340	8.630	8.780	8.650
Mold (lbs.)	4.290	4.290	4.290	4.290
Wet Soil (lbs.)	4.050	4.340	4.490	4.360
Wet Density (pcf)	121.50	130.20	134.70	130.80
Moisture (%)	**8.6**	**10.6**	**12.6**	**14.8**
Dry Density (pcf)	**111.9**	**117.7**	**119.6**	**113.9**



Maximum density 120.5 pcf @ 12.0% moisture

EEI Geotechnical & Environmental Solutions

2195 Faraday, Suite K, Carlsbad, CA 92008

Client: Centerpoint Integrated Solutions

Project Name: CarMax National City

Procedure: Method A

Job Number: CIS-72092.4

Date: 10/14/15

Boring Number: B-7

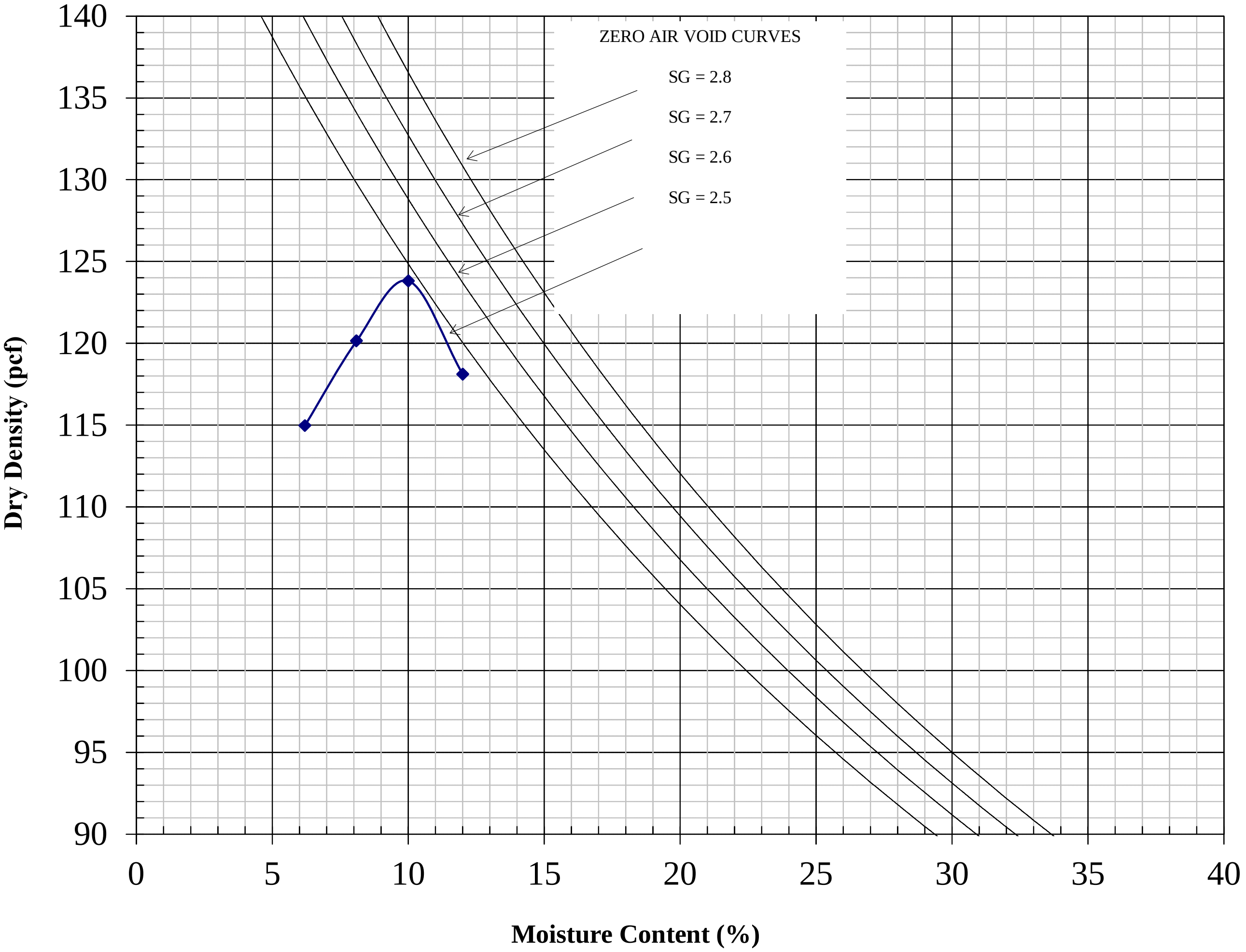
Location: 2-5 ft.

Soil Description: Light Brown Clayey Sand

Tested by: B D

LABORATORY COMPACTION ASTM D 1557

Sample	1	2	3	4
Mold and wet soil (lbs.)	8.360	8.620	8.830	8.700
Mold (lbs.)	4.290	4.290	4.290	4.290
Wet Soil (lbs.)	4.070	4.330	4.540	4.410
Wet Density (pcf)	122.10	129.90	136.20	132.30
Moisture (%)	**6.2**	**8.1**	**10.0**	**12.0**
Dry Density (pcf)	**115.0**	**120.2**	**123.8**	**118.1**



Maximum density 124.0 pcf @ 9.5% moisture

EEI
Geotechnical & Environmental Solutions

2195 Faraday, Suite K, Carlsbad, CA 92008

Client: Centerpoint Integrated Solutions

Project Name: CarMax National City

Procedure: Method A

Job Number: CIS-72092.4

Date: 10/14/15

Boring Number: B-10

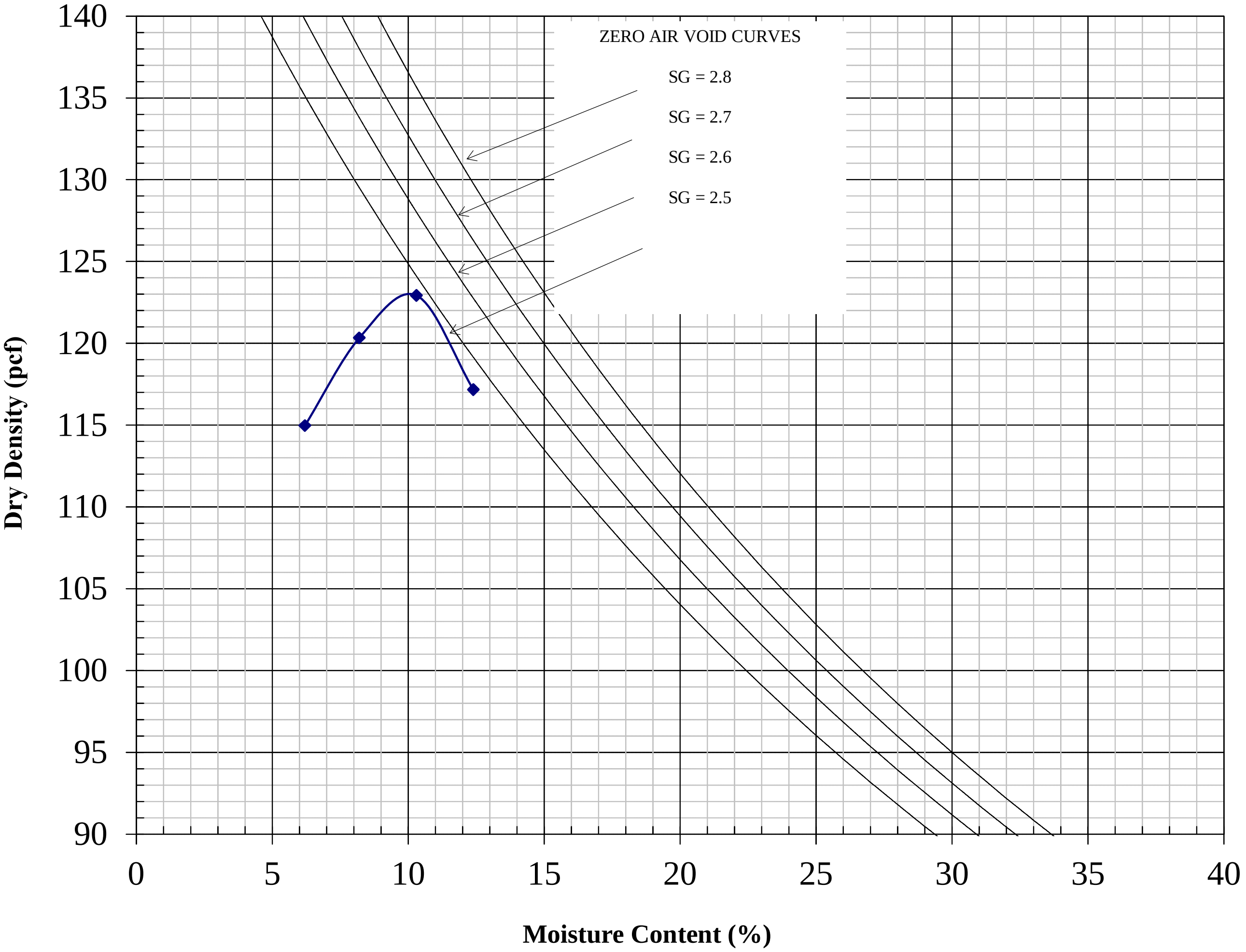
Location: 1-5 ft.

Soil Description: Dark Brown Clayey Sand

Tested by: B D

LABORATORY COMPACTION ASTM D 1557

Sample	**1**	**2**	**3**	**4**
Mold and wet soil (lbs.)	8.360	8.630	8.810	8.680
Mold (lbs.)	4.290	4.290	4.290	4.290
Wet Soil (lbs.)	4.070	4.340	4.520	4.390
Wet Density (pcf)	122.10	130.20	135.60	131.70
Moisture (%)	**6.2**	**8.2**	**10.3**	**12.4**
Dry Density (pcf)	**115.0**	**120.3**	**122.9**	**117.2**



Maximum density 124.0 pcf @ 9.5% moisture

Client: Centerpoint Integrated Solutions

Project Name: CarMax National City

Procedure: Method A

Job Number: CIS-72092.4

Date: 10/14/15

Boring Number: B-12

Location: 1-6 ft.

Soil Description: Light Yellow Brown Silty Sand

Tested by: B D

EEI
Geotechnical & Environmental Solutions

2195 Faraday, Suite K, Carlsbad, CA 92008

$$$$$$$$$$$$$$$$$$$$$PEFSVEXSV$]$$$VITSV$X$$

Xipitlsri$,:5=-$86915==7$$$$$$Je|$8691;=5;$$$$$$Iwxefpmwlih$5=6<$

GPEVOWS$R$$PEFSVEXSV$]$$ERH$$WYTTP$]$$MRG2$
794$Xvsywhepi$Hv2$Glype$Zmwxe0$Ge2$=5=54${{{2gpevowsrpef2gsq
EREP]XMGE$P$$ERH$$GSRWYPXMR$K$$GLIQMWXW

Hexi>$Sgxsfiv$640$6459$$$
Tyvglewi$Svhiv$Ryqfiv>$GMW1;64=618$$$$$$$$$$$$$$$$$$$$$$$$$$
Wepiw$Svhiv$Ryqfiv>$6<<<9
Eggsyrx$Ryqfiv>$IIM

Xs>$
.111111111111111111111111111111111111111111111111.$
IIM$Irzmvsrqirxep$Iuyepm~ivw$Mrg
65=9$Jevehe}$Eziryi$Wymxi$O
Gevpwfeh0GE=644<
Exxirxmsr>$Nijj$Fpeoi$

Pefsvexsv}$Ryqfiv>$WS9<67   Gywxsqivw$Tlsri>$;:4187517;8;$

Weqtpi$Hiwmkrexmsr>$
.111111111111111111111111111111111111111111111111.$
Sri$wsmp$weqtpi$vigimzih$sr54359359ex$5>89tq0$
xeoir$jvsq$W{iix{exiv$Vh2$Tvsnigx’GMW1;64=618
qevoihewF1;D6+19+$WQ2

Erep}wmw$F}$Gepmjsvrme$Xiwx$:870$5===0$HitevxqirxsjXverwtsvxexmsr
HmzmwmsrsjGsrwxvygxmsr0$Qixlsh$jsv$Iwxmqexmrk$xli$Wivzmgi$Pmji$sj
Wxiip$Gypzivxw2$

tL$;2:$$$$$$$$$$$$$$$

[exiv$Ehhih$,qp-$$$$$$$$$$$$$$$$$$$$$$$$$$$$$	Viwmwxmzmx}$,slq1gqq-$
54	5;44
9	=64
9	9<4
9	7=4
9	784
9	764
9	744
9	764
9	794

5=$}ievw$xs$tivjsvexmsr$jsv$e$5:$keyki$qixep$gypzivx2
68$}ievw$xs$tivjsvexmsr$jsv$e$58$keyki$qixep$gypzivx2
78$}ievw$xs$tivjsvexmsr$jsv$e$56$keyki$qixep$gypzivx2
87$}ievw$xs$tivjsvexmsr$jsv$e$54$keyki$qixep$gypzivx2
96$}ievw$xs$tivjsvexmsr$jsv$e$$<$keyki$qixep$gypzivx2

[exiv$Wspyfpi$Wypjexi$$Gepmj2$Xiwx$85;$ 42549)$,5494ttq-

[exiv$Wspyfpi$Glpsvmhi$Gepmj2$Xiwx$866   4254;)$,54;4ttq-

Laura Torres
cccccccccccccccccccccccccc
Peyve$Xsvviw
PX3mpz

APPENDIX C
LIQEUEFACTION ANALYSIS

EEI
Geotechnical & Environmental Solutions
2195 Faraday Avenue, Suite K, Carlsbad CA
www.EEItiger.com

LIQUEFACTION ANALYSIS REPORT

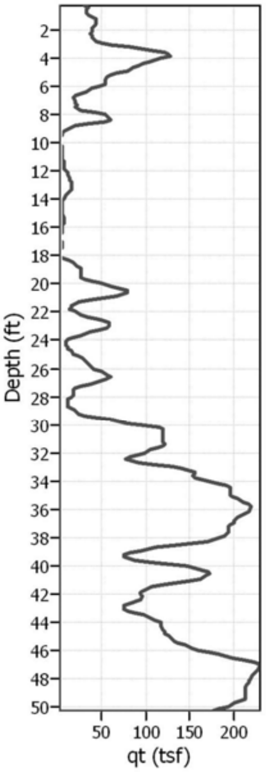
Project title : CIS-72092.4 **Location : Proposed CarMax National City**

CPT file : CPT-01

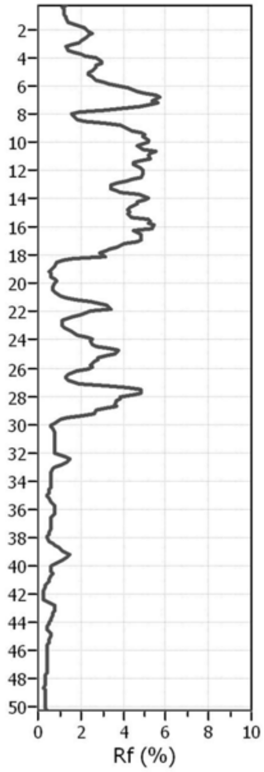
Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	5.00 ft	Use fill:	Yes	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	10.00 ft	Fill height:	5.00 ft	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	5	Fill weight:	120.00 lb/ft³	Limit depth:	N/A
Earthquake magnitude M_w:	6.76	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.43	Unit weight calculation:	Based on SBT	K_σ applied:	No		

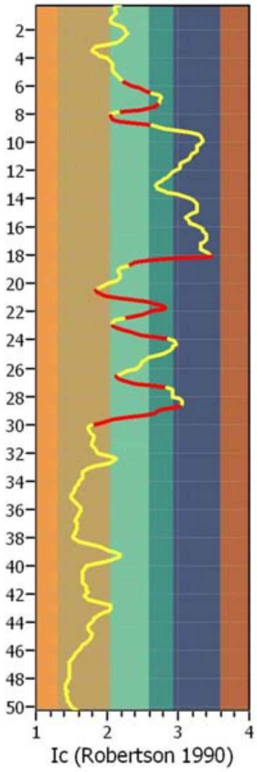
Cone resistance



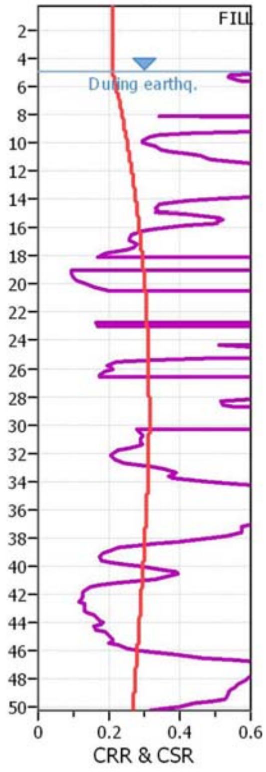
Friction Ratio



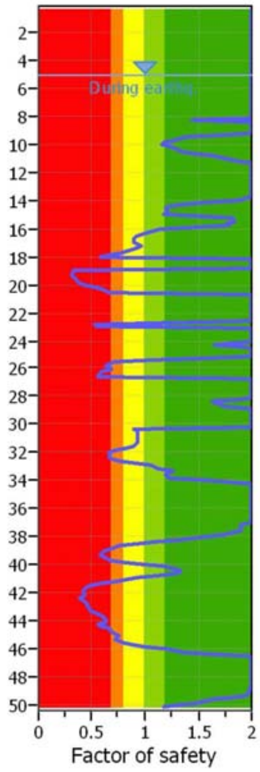
SBTn Plot



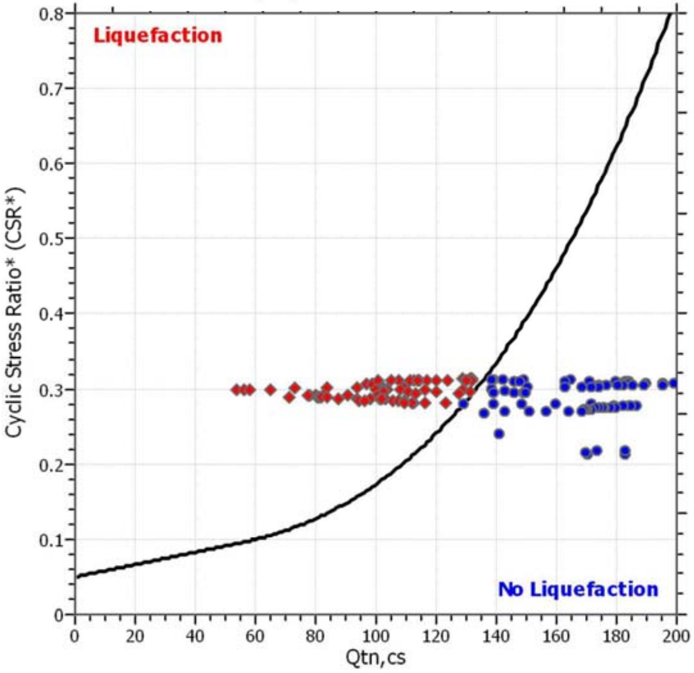
CRR plot



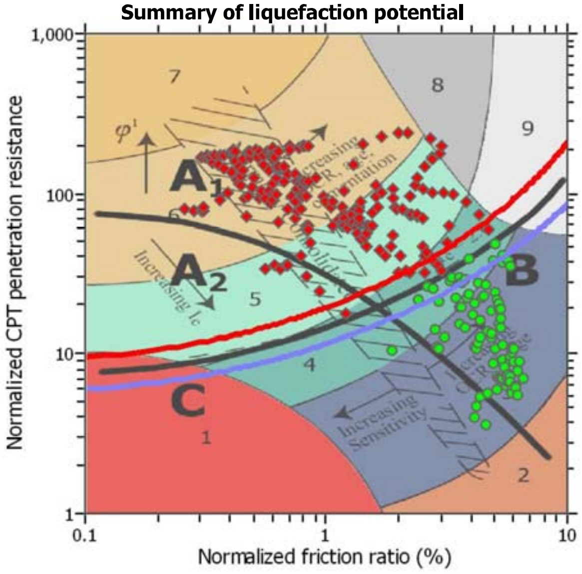
FS Plot



$M_w = 7^{1/2}$, sigma' = 1 atm base curve

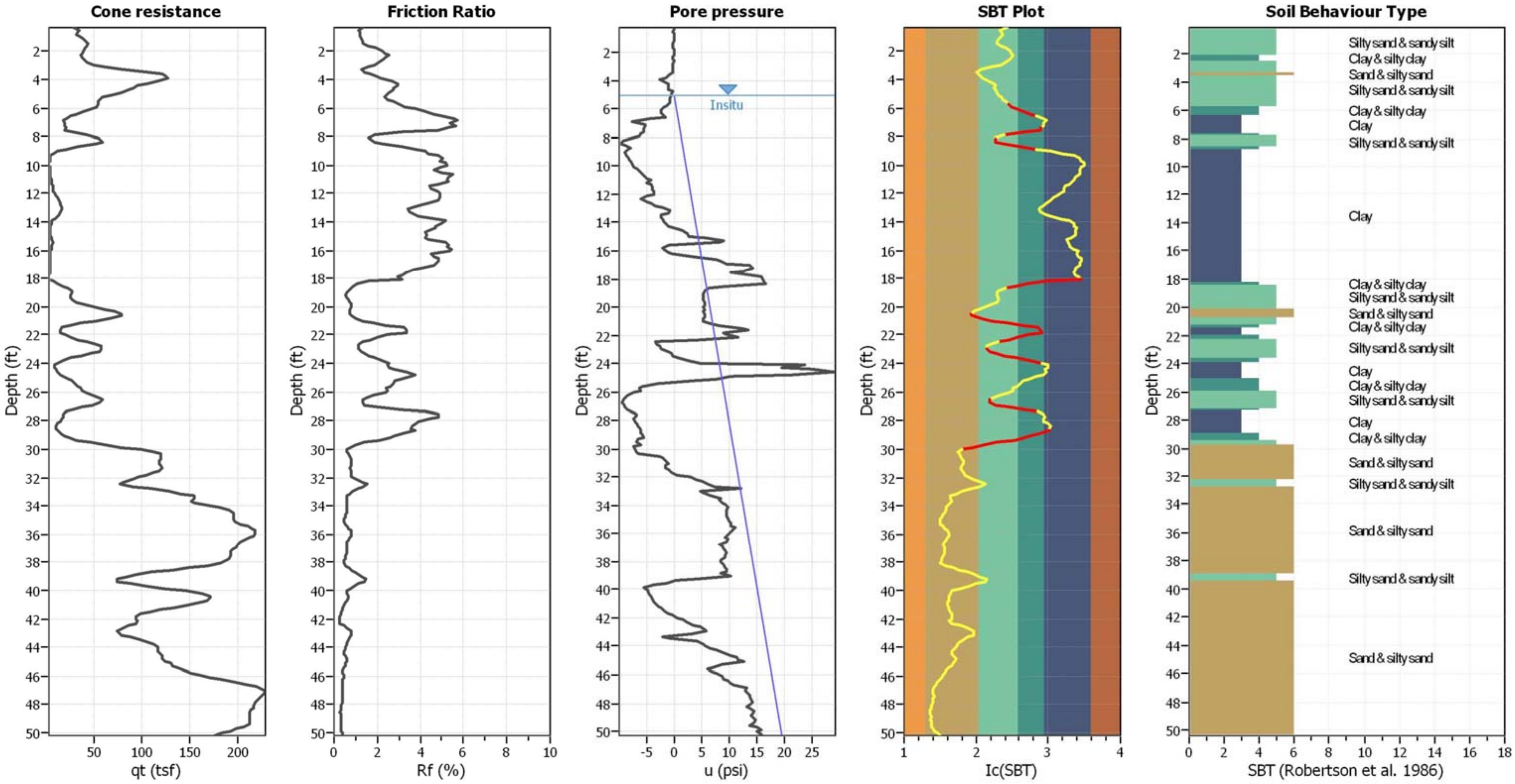


Summary of liquefaction potential



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



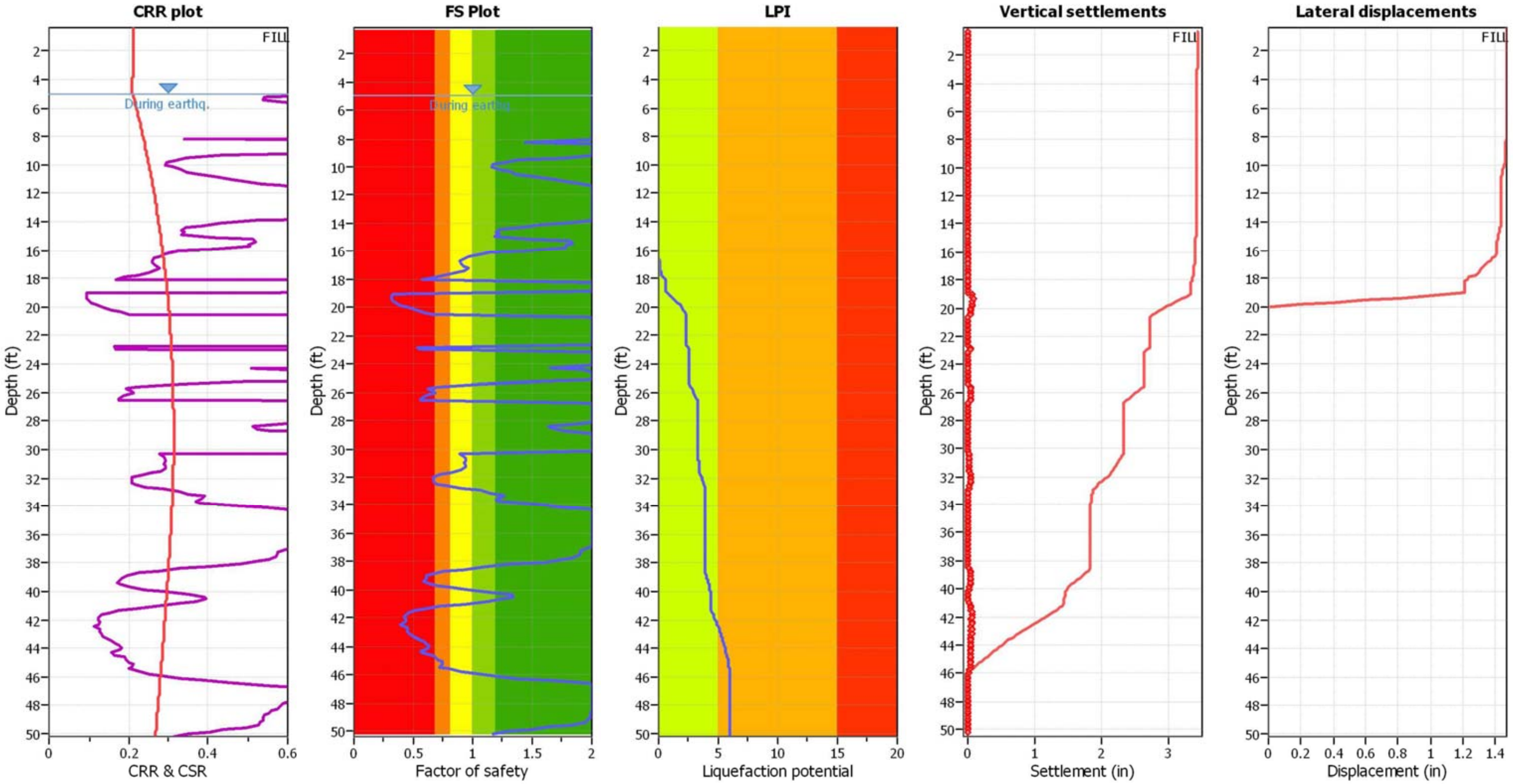
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	10.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	5	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	No
Earthquake magnitude M_w:	6.76	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.43	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	5.00 ft	Fill height:	5.00 ft	Limit depth:	N/A

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	10.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	5	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	No
Earthquake magnitude M_w:	6.76	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.43	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	5.00 ft	Fill height:	5.00 ft	Limit depth:	N/A

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

:: Post-earthquake settlement of dry sands ::

Depth (ft)	Ic	Kc	Qc1n	Qc1n,cs	N1,60 (blows)	Vs (ft/s)	Gmax (tsf)	CSR	Shear, γ (%)	Svol,15 (%)	Nc	ev (%)	Settle. (in)
5.33	2.19	1.64	56.03	91.75	21	477.7	396	0.21	0.034	0.03	9.05	0.03	0.001
5.49	2.09	1.44	65.46	94.41	20	486.6	413	0.21	0.033	0.03	9.05	0.03	0.001
5.66	2.11	1.48	63.36	93.69	20	484.7	409	0.21	0.035	0.03	9.05	0.03	0.001
5.82	2.13	1.51	61.76	93.18	20	483.2	407	0.21	0.037	0.04	9.05	0.03	0.001
5.98	2.11	1.46	66.92	97.99	21	495.8	431	0.21	0.033	0.03	9.05	0.02	0.001
6.15	2.08	1.42	73.90	104.86	23	512.9	466	0.21	0.029	0.03	9.05	0.02	0.001
6.31	2.06	1.39	80.15	111.36	24	528.2	499	0.21	0.027	0.02	9.05	0.02	0.001
6.48	2.06	1.39	83.05	115.10	25	537.0	519	0.21	0.026	0.02	9.05	0.02	0.001
6.64	2.12	1.49	81.25	120.86	26	551.1	551	0.21	0.024	0.02	9.05	0.01	0.001
6.80	2.18	1.62	79.00	128.26	29	565.9	587	0.21	0.022	0.01	9.05	0.01	0.000
6.97	2.24	1.77	74.56	131.76	30	569.8	597	0.21	0.022	0.01	9.05	0.01	0.000
7.13	2.27	1.85	71.86	133.01	31	569.9	597	0.21	0.023	0.01	9.05	0.01	0.000
7.30	2.30	1.93	70.25	135.89	32	573.2	606	0.21	0.023	0.01	9.05	0.01	0.000
7.46	2.27	1.85	72.88	134.48	31	573.2	605	0.21	0.024	0.01	9.05	0.01	0.000
7.62	2.25	1.79	73.35	131.66	30	568.7	594	0.21	0.025	0.02	9.05	0.01	0.000
7.79	2.19	1.64	80.59	132.57	30	574.9	608	0.21	0.025	0.02	9.05	0.01	0.000
7.95	2.12	1.49	93.46	139.49	30	592.3	650	0.21	0.023	0.01	9.05	0.01	0.000
8.12	2.01	1.31	113.10	148.46	31	607.7	688	0.21	0.021	0.01	9.05	0.01	0.000
8.28	1.85	1.14	152.77	174.89	34	638.8	769	0.21	0.018	0.01	9.05	0.01	0.000
8.45	1.80	1.10	203.14	224.36	43	712.7	984	0.21	0.013	0.01	9.05	0.00	0.000
8.61	1.83	1.13	228.89	257.91	50	771.2	1176	0.21	0.011	0.00	9.05	0.00	0.000
8.77	1.87	1.16	238.73	277.70	55	810.2	1314	0.21	0.010	0.00	9.05	0.00	0.000
8.94	1.90	1.19	240.29	285.65	57	827.6	1378	0.21	0.009	0.00	9.05	0.00	0.000
9.10	2.00	1.29	222.39	287.69	60	845.5	1447	0.21	0.009	0.00	9.05	0.00	0.000
9.27	2.06	1.39	198.52	275.72	59	833.0	1401	0.21	0.010	0.00	9.05	0.00	0.000
9.43	2.08	1.42	180.74	257.35	55	805.4	1300	0.21	0.011	0.00	9.05	0.00	0.000
9.59	2.07	1.40	171.62	239.75	51	776.8	1199	0.21	0.012	0.00	9.05	0.00	0.000
9.76	2.08	1.42	163.21	232.43	50	765.3	1160	0.21	0.013	0.00	9.05	0.00	0.000
9.92	2.08	1.42	148.26	210.87	45	728.7	1039	0.21	0.015	0.01	9.05	0.00	0.000

Total estimated settlement: 0.01

:: 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)
10.09	183.35	2.00	0.00	1.00	0.00	10.25	170.56	2.00	0.00	1.00	0.00
10.41	170.07	2.00	0.00	1.00	0.00	10.58	173.90	2.00	0.00	1.00	0.00
10.74	182.90	2.00	0.00	1.00	0.00	10.91	188.42	2.00	0.00	1.00	0.00
11.07	191.19	2.00	0.00	1.00	0.00	11.23	186.45	2.00	0.00	1.00	0.00
11.40	219.11	2.00	0.00	1.00	0.00	11.56	309.56	2.00	0.00	1.00	0.00
11.73	162.41	2.00	0.00	1.00	0.00	11.89	157.76	2.00	0.00	1.00	0.00
12.05	155.34	2.00	0.00	1.00	0.00	12.22	162.78	2.00	0.00	1.00	0.00
12.38	407.43	2.00	0.00	1.00	0.00	12.55	363.98	2.00	0.00	1.00	0.00
12.71	131.17	2.00	0.00	1.00	0.00	12.87	128.72	2.00	0.00	1.00	0.00
13.04	134.13	2.00	0.00	1.00	0.00	13.20	141.21	1.43	0.00	1.00	0.00
13.37	151.24	2.00	0.00	1.00	0.00	13.53	152.79	2.00	0.00	1.00	0.00
13.69	147.04	2.00	0.00	1.00	0.00	13.86	234.72	2.00	0.00	1.00	0.00
14.02	111.45	2.00	0.00	1.00	0.00	14.19	92.93	2.00	0.00	1.00	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)
14.35	81.75	1.76	0.01	1.00	0.00	14.51	74.83	1.38	0.05	1.00	0.00
14.68	71.46	1.26	0.08	1.00	0.00	14.84	70.80	1.18	0.11	1.00	0.00
15.01	70.73	1.16	0.11	1.00	0.00	15.17	71.32	1.23	0.09	1.00	0.00
15.34	71.96	1.31	0.06	1.00	0.00	15.50	74.93	1.36	0.05	1.00	0.00
15.66	80.56	1.45	0.04	1.00	0.00	15.83	83.99	1.63	0.02	1.00	0.00
15.99	87.05	1.78	0.01	1.00	0.00	16.16	89.73	1.87	0.00	1.00	0.00
16.32	90.18	2.00	0.00	1.00	0.00	16.48	90.42	2.00	0.00	1.00	0.00
16.65	92.93	2.00	0.00	1.00	0.00	16.81	100.02	2.00	0.00	1.00	0.00
16.98	106.58	2.00	0.00	1.00	0.00	17.14	112.58	2.00	0.00	1.00	0.00
17.30	118.12	2.00	0.00	1.00	0.00	17.47	123.24	2.00	0.00	1.00	0.00
17.63	122.17	2.00	0.00	1.00	0.00	17.80	119.79	2.00	0.00	1.00	0.00
17.96	291.96	2.00	0.00	1.00	0.00	18.12	257.61	2.00	0.00	1.00	0.00
18.29	109.36	2.00	0.00	1.00	0.00	18.45	107.48	2.00	0.00	1.00	0.00
18.62	104.67	2.00	0.00	1.00	0.00	18.78	102.25	2.00	0.00	1.00	0.00
18.94	92.42	1.89	0.00	1.00	0.00	19.11	84.03	1.56	0.02	1.00	0.00
19.27	78.05	1.39	0.04	1.00	0.00	19.44	74.39	1.24	0.07	1.00	0.00
19.60	71.34	1.20	0.08	1.00	0.00	19.76	71.32	1.21	0.07	1.00	0.00
19.93	70.97	1.18	0.08	1.00	0.00	20.09	77.61	1.48	0.03	1.00	0.00
20.26	85.84	1.82	0.01	1.00	0.00	20.42	92.56	1.84	0.00	1.00	0.00
20.58	92.13	1.78	0.01	1.00	0.00	20.75	91.90	1.78	0.01	1.00	0.00
20.91	86.03	1.47	0.03	1.00	0.00	21.08	76.87	1.14	0.09	1.00	0.00
21.24	68.57	1.02	0.14	1.00	0.00	21.40	67.92	0.97	0.17	1.00	0.00
21.57	67.13	0.91	0.22	1.00	0.00	21.73	66.85	0.90	0.23	1.00	0.00
21.90	66.80	0.90	0.22	1.00	0.00	22.06	67.03	0.93	0.20	1.00	0.00
22.23	64.76	0.96	0.17	1.00	0.00	22.39	61.70	0.92	0.20	1.00	0.00
22.55	58.29	0.87	0.25	1.00	0.00	22.72	54.12	0.76	0.50	1.00	0.01
22.88	49.50	0.64	0.50	1.00	0.01	23.05	48.32	0.57	0.50	1.00	0.01
23.21	56.24	2.00	0.00	1.00	0.00	23.37	81.73	2.00	0.00	1.00	0.00
23.54	56.60	2.00	0.00	1.00	0.00	23.70	58.39	2.00	0.00	1.00	0.00
23.87	58.70	2.00	0.00	1.00	0.00	24.03	56.52	0.32	3.73	1.00	0.07
24.19	54.02	0.32	3.87	1.00	0.07	24.36	56.08	0.32	3.75	1.00	0.08
24.52	58.43	0.33	3.63	1.00	0.07	24.69	65.06	0.35	3.32	1.00	0.07
24.85	73.42	0.39	3.01	1.00	0.06	25.01	83.46	0.45	2.71	1.00	0.05
25.18	93.93	0.52	2.46	1.00	0.05	25.34	102.60	0.60	2.29	1.00	0.04
25.51	109.14	0.66	2.18	1.00	0.04	25.67	111.10	2.00	0.00	1.00	0.00
25.83	105.69	2.00	0.00	1.00	0.00	26.00	98.98	2.00	0.00	1.00	0.00
26.16	96.98	2.00	0.00	1.00	0.00	26.33	128.17	2.00	0.00	1.00	0.00
26.49	97.94	2.00	0.00	1.00	0.00	26.65	95.52	2.00	0.00	1.00	0.00
26.82	95.50	2.00	0.00	1.00	0.00	26.98	176.64	2.00	0.00	1.00	0.00
27.15	90.45	2.00	0.00	1.00	0.00	27.31	89.27	2.00	0.00	1.00	0.00
27.47	89.74	2.00	0.00	1.00	0.00	27.64	92.90	2.00	0.00	1.00	0.00
27.80	96.60	0.53	2.40	1.00	0.05	27.97	98.66	0.55	2.36	1.00	0.05
28.13	98.50	2.00	0.00	1.00	0.00	28.30	95.49	2.00	0.00	1.00	0.00
28.46	90.25	2.00	0.00	1.00	0.00	28.62	85.60	2.00	0.00	1.00	0.00
28.79	187.66	2.00	0.00	1.00	0.00	28.95	74.67	2.00	0.00	1.00	0.00
29.12	68.50	2.00	0.00	1.00	0.00	29.28	68.39	1.64	0.01	1.00	0.00
29.44	74.75	1.93	0.00	1.00	0.00	29.61	86.16	2.00	0.00	1.00	0.00
29.77	97.18	2.00	0.00	1.00	0.00	29.94	104.12	2.00	0.00	1.00	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)
30.10	236.92	2.00	0.00	1.00	0.00	30.26	164.86	1.59	0.00	1.00	0.00
30.43	139.66	1.07	0.44	1.00	0.01	30.59	114.50	0.70	2.03	1.00	0.04
30.76	107.26	0.62	2.21	1.00	0.05	30.92	111.19	0.67	2.12	1.00	0.04
31.08	112.25	0.68	2.09	1.00	0.04	31.25	104.84	0.60	2.25	1.00	0.05
31.41	100.93	0.56	2.32	1.00	0.04	31.58	100.40	0.56	2.33	1.00	0.05
31.74	96.46	2.00	0.00	1.00	0.00	31.90	91.80	2.00	0.00	1.00	0.00
32.07	96.19	2.00	0.00	1.00	0.00	32.23	224.17	2.00	0.00	1.00	0.00
32.40	114.07	2.00	0.00	1.00	0.00	32.56	116.32	2.00	0.00	1.00	0.00
32.72	113.76	2.00	0.00	1.00	0.00	32.89	107.04	2.00	0.00	1.00	0.00
33.05	95.95	2.00	0.00	1.00	0.00	33.22	86.92	1.91	0.00	1.00	0.00
33.38	80.07	1.64	0.01	1.00	0.00	33.54	79.95	1.66	0.01	1.00	0.00
33.71	83.17	1.76	0.01	1.00	0.00	33.87	85.81	2.00	0.00	1.00	0.00
34.04	89.32	2.00	0.00	1.00	0.00	34.20	196.58	2.00	0.00	1.00	0.00
34.36	97.37	2.00	0.00	1.00	0.00	34.53	86.93	2.00	0.00	1.00	0.00
34.69	90.11	2.00	0.00	1.00	0.00	34.86	96.66	2.00	0.00	1.00	0.00
35.02	109.32	2.00	0.00	1.00	0.00	35.19	121.84	2.00	0.00	1.00	0.00
35.35	128.74	0.89	1.08	1.00	0.02	35.51	131.23	0.93	1.05	1.00	0.02
35.68	131.91	0.94	1.04	1.00	0.02	35.84	131.66	0.93	1.04	1.00	0.02
36.01	131.34	0.93	1.05	1.00	0.02	36.17	131.56	0.93	1.04	1.00	0.02
36.33	131.70	0.94	1.04	1.00	0.02	36.50	129.10	0.90	1.07	1.00	0.02
36.66	123.55	0.82	1.49	1.00	0.03	36.83	116.78	0.73	1.97	1.00	0.04
36.99	111.53	0.67	2.11	1.00	0.04	37.15	111.04	0.66	2.12	1.00	0.04
37.32	111.24	0.67	2.11	1.00	0.04	37.48	113.72	0.70	2.05	1.00	0.04
37.65	120.22	0.78	1.55	1.00	0.03	37.81	129.93	0.91	1.06	1.00	0.02
37.97	138.82	1.06	0.45	1.00	0.01	38.14	142.79	1.13	0.44	1.00	0.01
38.30	149.67	1.26	0.22	1.00	0.00	38.47	148.20	1.23	0.31	1.00	0.01
38.63	146.19	1.20	0.31	1.00	0.01	38.79	147.97	1.23	0.31	1.00	0.01
38.96	163.03	1.56	0.00	1.00	0.00	39.12	171.21	1.77	0.00	1.00	0.00
39.29	180.18	2.00	0.00	1.00	0.00	39.45	184.35	2.00	0.00	1.00	0.00
39.61	183.98	2.00	0.00	1.00	0.00	39.78	183.25	2.00	0.00	1.00	0.00
39.94	182.86	2.00	0.00	1.00	0.00	40.11	184.60	2.00	0.00	1.00	0.00
40.27	189.79	2.00	0.00	1.00	0.00	40.43	195.62	2.00	0.00	1.00	0.00
40.60	199.83	2.00	0.00	1.00	0.00	40.76	201.88	2.00	0.00	1.00	0.00
40.93	201.38	2.00	0.00	1.00	0.00	41.09	199.15	2.00	0.00	1.00	0.00
41.26	195.50	2.00	0.00	1.00	0.00	41.42	189.60	2.00	0.00	1.00	0.00
41.58	185.40	2.00	0.00	1.00	0.00	41.75	182.67	2.00	0.00	1.00	0.00
41.91	180.58	2.00	0.00	1.00	0.00	42.08	177.17	1.97	0.00	1.00	0.00
42.24	174.61	1.90	0.00	1.00	0.00	42.40	174.50	1.90	0.00	1.00	0.00
42.57	174.16	1.89	0.00	1.00	0.00	42.73	171.95	1.83	0.00	1.00	0.00
42.90	168.72	1.75	0.00	1.00	0.00	43.06	163.21	1.61	0.00	1.00	0.00
43.22	150.39	1.32	0.22	1.00	0.00	43.39	138.81	1.10	0.45	1.00	0.01
43.55	128.49	0.92	1.08	1.00	0.02	43.72	115.98	0.75	1.64	1.00	0.03
43.88	108.10	0.66	2.19	1.00	0.04	44.04	103.76	0.62	2.27	1.00	0.04
44.21	102.54	0.60	2.29	1.00	0.05	44.37	100.19	0.58	2.33	1.00	0.04
44.54	102.71	0.61	2.29	1.00	0.05	44.70	110.42	0.69	2.14	1.00	0.04
44.86	119.96	0.81	1.56	1.00	0.03	45.03	130.98	0.98	0.69	1.00	0.01
45.19	142.86	1.19	0.32	1.00	0.01	45.36	149.52	1.32	0.22	1.00	0.00
45.52	150.24	1.34	0.22	1.00	0.00	45.68	146.31	1.26	0.22	1.00	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)
45.85	139.25	1.13	0.44	1.00	0.01	46.01	127.64	0.93	1.09	1.00	0.02
46.18	113.16	0.73	2.06	1.00	0.04	46.34	100.70	0.60	2.32	1.00	0.04
46.50	90.46	0.51	2.54	1.00	0.05	46.67	82.56	0.45	2.73	1.00	0.06
46.83	78.03	0.43	2.86	1.00	0.05	47.00	78.41	0.43	2.85	1.00	0.06
47.16	79.71	0.44	2.81	1.00	0.05	47.32	77.37	0.42	2.88	1.00	0.06
47.49	71.28	0.39	3.08	1.00	0.06	47.65	80.81	0.45	2.78	1.00	0.05
47.82	81.02	0.45	2.78	1.00	0.06	47.98	81.76	0.45	2.76	1.00	0.05
48.15	83.51	0.47	2.71	1.00	0.06	48.31	87.77	0.50	2.60	1.00	0.05
48.47	93.62	0.54	2.47	1.00	0.05	48.64	97.92	0.58	2.38	1.00	0.05
48.80	101.00	0.61	2.32	1.00	0.04	48.97	103.05	0.64	2.28	1.00	0.05
49.13	102.18	0.63	2.30	1.00	0.04	49.29	94.60	0.56	2.45	1.00	0.05
49.46	96.51	0.57	2.41	1.00	0.05	49.62	105.63	0.67	2.23	1.00	0.04
49.79	107.24	0.69	2.21	1.00	0.05	49.95	109.39	0.71	2.17	1.00	0.04
50.11	112.21	0.75	2.09	1.00	0.04	50.28	111.80	0.74	2.10	1.00	0.04
50.44	109.31	0.72	2.17	1.00	0.04	50.61	116.56	0.81	1.62	1.00	0.03
50.77	123.03	0.90	1.15	1.00	0.02	50.93	129.50	1.01	0.69	1.00	0.01
51.10	139.40	1.19	0.32	1.00	0.01	51.26	148.50	1.38	0.00	1.00	0.00
51.43	160.05	1.65	0.00	1.00	0.00	51.59	171.79	1.98	0.00	1.00	0.00
51.75	179.49	2.00	0.00	1.00	0.00	51.92	184.62	2.00	0.00	1.00	0.00
52.08	186.80	2.00	0.00	1.00	0.00	52.25	184.82	2.00	0.00	1.00	0.00
52.41	182.21	2.00	0.00	1.00	0.00	52.57	180.27	2.00	0.00	1.00	0.00
52.74	177.92	2.00	0.00	1.00	0.00	52.90	176.26	2.00	0.00	1.00	0.00
53.07	175.49	2.00	0.00	1.00	0.00	53.23	174.42	2.00	0.00	1.00	0.00
53.39	172.89	2.00	0.00	1.00	0.00	53.56	171.76	2.00	0.00	1.00	0.00
53.72	170.58	1.99	0.00	1.00	0.00	53.89	170.17	1.98	0.00	1.00	0.00
54.05	170.17	1.99	0.00	1.00	0.00	54.22	169.30	1.96	0.00	1.00	0.00
54.38	168.63	1.95	0.00	1.00	0.00	54.54	164.32	1.83	0.00	1.00	0.00
54.71	156.96	1.63	0.00	1.00	0.00	54.87	151.34	1.50	0.00	1.00	0.00
55.04	142.90	1.31	0.22	1.00	0.00	55.20	136.11	1.18	0.33	1.00	0.01

Total estimated settlement: 3.43

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

:: Lateral displacement index calculation ::

Depth (ft)	q_t (tsf)	Q_{tn}	R_f (%)	$Q_{tn,cs}$	FS	D_r	$Gamma_{max}$ (%)	Lat. disp. (in)
10.09	66.25	124.65	2.38	183.35	2.00	74.27	0.00	0.00
10.25	59.85	112.53	2.34	170.56	2.00	70.90	0.00	0.00
10.41	56.63	106.42	2.51	170.07	2.00	69.05	0.00	0.00
10.58	54.86	103.07	2.73	173.90	2.00	68.00	0.00	0.00
10.74	54.82	102.96	3.03	182.90	2.00	67.96	0.00	0.00
10.91	53.04	99.57	3.32	188.42	2.00	66.86	0.00	0.00
11.07	48.01	90.06	3.75	191.19	2.00	63.54	0.00	0.00
11.23	39.71	74.35	4.23	186.45	2.00	57.22	0.00	0.00
11.40	31.84	59.46	4.65	219.11	2.00	49.84	0.00	0.00
11.56	25.71	47.84	4.98	309.56	2.00	42.67	0.00	0.00
11.73	20.90	38.74	5.55	162.41	2.00	35.70	0.03	0.00
11.89	18.85	34.85	5.73	157.76	2.00	32.20	0.03	0.00
12.05	19.76	36.55	5.36	155.34	2.00	33.77	0.03	0.00
12.22	20.52	37.96	5.65	162.78	2.00	35.03	0.03	0.00
12.38	21.92	40.59	5.29	407.43	2.00	37.24	0.00	0.00
12.55	20.64	38.15	4.85	363.98	2.00	35.19	0.00	0.00
12.71	26.75	49.69	3.14	131.17	2.00	43.92	0.00	0.00
12.87	43.42	81.18	1.89	128.72	2.00	60.12	0.00	0.00
13.04	53.59	96.59	1.60	134.13	2.00	65.86	0.00	0.00
13.20	57.02	101.97	1.68	141.21	1.43	67.64	1.13	0.00
13.37	59.86	106.93	1.87	151.24	2.00	69.21	0.00	0.00
13.53	53.39	97.37	2.21	152.79	2.00	66.12	0.00	0.00
13.69	33.95	63.19	3.18	147.04	2.00	51.85	0.00	0.00
13.86	20.78	38.26	3.85	234.72	2.00	35.29	0.00	0.00
14.02	12.26	22.15	4.24	111.45	2.00	17.24	0.05	0.00
14.19	7.74	13.58	4.39	92.93	2.00	1.11	0.08	0.00
14.35	5.38	9.11	4.83	81.75	1.76	0.00	0.17	0.00
14.51	4.36	7.17	5.04	74.83	1.38	0.00	0.55	0.00
14.68	4.07	6.60	4.92	71.46	1.26	0.00	0.84	0.00
14.84	3.85	6.18	5.19	70.80	1.18	0.00	1.18	0.00
15.01	3.84	6.13	5.21	70.73	1.16	0.00	1.25	0.01
15.17	4.04	6.50	4.95	71.32	1.23	0.00	0.96	0.00
15.34	4.31	6.99	4.64	71.96	1.31	0.00	0.69	0.00
15.50	4.45	7.25	4.94	74.93	1.36	0.00	0.59	0.00
15.66	4.74	7.78	5.48	80.56	1.45	0.00	0.43	0.00
15.83	5.29	8.79	5.30	83.99	1.63	0.00	0.24	0.00
15.99	5.75	9.65	5.22	87.05	1.78	0.00	0.15	0.00
16.16	6.04	10.17	5.30	89.73	1.87	0.00	0.12	0.00
16.32	6.58	11.19	4.86	90.18	2.00	0.00	0.09	0.00
16.48	7.20	12.34	4.44	90.42	2.00	0.00	0.08	0.00
16.65	7.60	13.09	4.47	92.93	2.00	0.00	0.08	0.00
16.81	8.24	14.28	4.85	100.02	2.00	2.76	0.07	0.00
16.98	9.38	16.41	4.91	106.58	2.00	7.34	0.07	0.00
17.14	10.61	18.73	4.90	112.58	2.00	11.71	0.06	0.00
17.30	11.91	21.16	4.87	118.12	2.00	15.74	0.06	0.00
17.47	13.27	23.72	4.82	123.24	2.00	19.50	0.05	0.00
17.63	14.64	26.29	4.37	122.17	2.00	22.90	0.05	0.00
17.80	15.06	27.04	4.12	119.79	2.00	23.84	0.05	0.00

:: Estimation of post-earthquake lateral Displacements :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	R_f (%)	$Q_{tn,cs}$	FS	D_r	$Gamma_{max}$ (%)	Lat. disp. (in)
17.96	16.45	28.96	3.65	291.96	2.00	26.10	0.00	0.00
18.12	16.89	29.38	3.43	257.61	2.00	26.57	0.00	0.00
18.29	15.62	27.06	3.46	109.36	2.00	23.86	0.05	0.00
18.45	13.42	23.33	3.73	107.48	2.00	18.97	0.05	0.00
18.62	11.79	20.49	3.90	104.67	2.00	14.68	0.06	0.00
18.78	8.87	15.26	4.73	102.25	2.00	4.95	0.07	0.00
18.94	6.56	10.87	5.19	92.42	1.89	0.00	0.11	0.00
19.11	5.60	9.01	5.00	84.03	1.56	0.00	0.29	0.00
19.27	5.14	8.06	4.67	78.05	1.39	0.00	0.50	0.00
19.44	4.71	7.20	4.67	74.39	1.24	0.00	0.88	0.00
19.60	4.62	6.98	4.33	71.34	1.20	0.00	1.04	0.00
19.76	4.72	7.11	4.24	71.32	1.21	0.00	0.97	0.00
19.93	4.66	6.95	4.29	70.97	1.18	0.00	1.10	0.00
20.09	5.66	8.70	4.24	77.61	1.48	0.00	0.37	0.00
20.26	6.83	10.74	4.39	85.84	1.82	0.00	0.13	0.00
20.42	6.98	10.91	5.16	92.56	1.84	0.00	0.12	0.00
20.58	6.82	10.54	5.28	92.13	1.78	0.00	0.15	0.00
20.75	6.91	10.61	5.21	91.90	1.78	0.00	0.15	0.00
20.91	5.90	8.77	5.42	86.03	1.47	0.00	0.38	0.00
21.08	4.83	6.83	5.38	76.87	1.14	0.00	1.29	0.01
21.24	4.46	6.14	4.48	68.57	1.02	0.00	2.20	0.01
21.40	4.31	5.83	4.64	67.92	0.97	0.00	2.85	0.01
21.57	4.14	5.49	4.83	67.13	0.91	0.00	3.84	0.02
21.73	4.12	5.41	4.85	66.85	0.90	0.00	4.16	0.02
21.90	4.17	5.45	4.79	66.80	0.90	0.00	4.06	0.02
22.06	4.31	5.64	4.64	67.03	0.93	0.00	3.50	0.01
22.23	4.45	5.84	4.04	64.76	0.96	0.00	2.99	0.01
22.39	4.37	5.65	3.66	61.70	0.92	0.00	3.54	0.01
22.55	4.19	5.32	3.34	58.29	0.87	0.00	4.78	0.02
22.72	3.82	4.66	3.14	54.12	0.76	0.00	9.12	0.04
22.88	3.41	3.95	2.93	49.50	0.64	0.00	4.00	0.02
23.05	3.17	3.52	3.16	48.32	0.57	0.00	4.00	0.02
23.21	7.39	10.25	1.62	56.24	2.00	0.00	0.09	0.00
23.37	12.71	17.56	1.10	81.73	2.00	9.59	0.00	0.00
23.54	17.98	24.46	0.89	56.60	2.00	20.52	0.00	0.00
23.70	22.94	30.76	0.78	58.39	2.00	28.09	0.00	0.00
23.87	26.91	35.52	0.67	58.70	2.00	32.84	0.00	0.00
24.03	27.06	35.41	0.59	56.52	0.32	32.73	51.20	0.20
24.19	26.22	34.09	0.53	54.02	0.32	31.48	51.20	0.20
24.36	26.00	33.85	0.62	56.08	0.32	31.25	51.20	0.21
24.52	27.42	35.59	0.66	58.43	0.33	32.90	51.20	0.20
24.69	31.58	40.87	0.76	65.06	0.35	37.46	51.20	0.21
24.85	38.24	49.15	0.84	73.42	0.39	43.55	51.20	0.20
25.01	49.62	62.77	0.81	83.46	0.45	51.63	34.10	0.00
25.18	62.38	77.53	0.74	93.93	0.52	58.60	22.70	0.00
25.34	71.62	88.09	0.73	102.60	0.60	62.81	22.70	0.00
25.51	79.02	96.28	0.71	109.14	0.66	65.75	10.43	0.00
25.67	78.80	96.10	0.79	111.10	2.00	65.69	0.00	0.00

:: Estimation of post-earthquake lateral Displacements :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	R_f (%)	$Q_{tn,cs}$	FS	D_r	Gamma$_{max}$ (%)	Lat. disp. (in)
25.83	66.64	82.45	1.02	105.69	2.00	60.63	0.00	0.00
26.00	51.05	64.23	1.33	98.98	2.00	52.39	0.00	0.00
26.16	36.97	47.33	1.79	96.98	2.00	42.31	0.00	0.00
26.33	24.53	31.87	2.45	128.17	2.00	29.26	0.00	0.00
26.49	16.86	21.99	3.20	97.94	2.00	17.01	0.06	0.00
26.65	15.01	19.45	3.33	95.52	2.00	12.96	0.06	0.00
26.82	14.78	19.04	3.38	95.50	2.00	12.25	0.06	0.00
26.98	20.04	25.51	2.50	176.64	2.00	21.91	0.00	0.00
27.15	26.39	33.18	2.05	90.45	2.00	30.59	0.00	0.00
27.31	33.18	41.12	1.69	89.27	2.00	37.67	0.00	0.00
27.47	42.58	51.90	1.36	89.74	2.00	45.35	0.00	0.00
27.64	52.84	63.37	1.14	92.90	2.00	51.94	0.00	0.00
27.80	57.74	68.76	1.11	96.60	0.53	54.64	34.10	0.00
27.97	58.47	69.43	1.16	98.66	0.55	54.96	34.10	0.00
28.13	55.64	66.07	1.26	98.50	2.00	53.32	0.00	0.00
28.30	47.77	56.91	1.42	95.49	2.00	48.39	0.00	0.00
28.46	37.20	44.48	1.61	90.25	2.00	40.26	0.00	0.00
28.62	26.56	31.82	1.88	85.60	2.00	29.20	0.00	0.00
28.79	17.83	21.23	2.24	187.66	2.00	15.85	0.00	0.00
28.95	11.87	13.82	2.53	74.67	2.00	1.68	0.08	0.00
29.12	9.62	10.88	2.50	68.50	2.00	0.00	0.09	0.00
29.28	9.51	10.68	2.52	68.39	1.64	0.00	0.21	0.00
29.44	11.00	12.56	2.73	74.75	1.93	0.00	0.09	0.00
29.61	12.48	14.41	3.36	86.16	2.00	3.05	0.07	0.00
29.77	15.01	17.50	3.73	97.18	2.00	9.47	0.07	0.00
29.94	19.01	22.25	3.58	104.12	2.00	17.40	0.05	0.00
30.10	23.74	27.70	3.12	236.92	2.00	24.63	0.00	0.00
30.26	28.12	32.66	2.85	164.86	1.59	30.06	0.00	0.00
30.43	31.05	35.89	2.77	139.66	1.07	33.18	0.00	0.00
30.59	33.61	38.62	2.62	114.50	0.70	35.60	51.20	0.00
30.76	36.04	41.14	2.44	107.26	0.62	37.69	51.20	0.00
30.92	38.32	43.59	2.51	111.19	0.67	39.59	51.20	0.00
31.08	41.49	46.94	2.41	112.25	0.68	42.04	51.20	0.00
31.25	48.90	54.66	1.84	104.84	0.60	47.06	34.10	0.00
31.41	56.76	62.73	1.44	100.93	0.56	51.61	34.10	0.00
31.58	59.73	65.59	1.34	100.40	0.56	53.08	34.10	0.00
31.74	56.51	61.81	1.31	96.46	2.00	51.12	0.00	0.00
31.90	49.03	53.51	1.39	91.80	2.00	46.36	0.00	0.00
32.07	37.73	41.29	1.96	96.19	2.00	37.80	0.00	0.00
32.23	26.80	29.32	3.13	224.17	2.00	26.51	0.00	0.00
32.40	20.75	22.51	4.24	114.07	2.00	17.79	0.05	0.00
32.56	18.61	20.03	4.84	116.32	2.00	13.93	0.06	0.00
32.72	17.76	18.92	4.84	113.76	2.00	12.05	0.06	0.00
32.89	17.18	18.14	4.42	107.04	2.00	10.66	0.06	0.00
33.05	15.38	15.96	3.90	95.95	2.00	6.44	0.07	0.00
33.22	12.50	12.56	3.84	86.92	1.91	0.00	0.10	0.00
33.38	10.99	10.76	3.64	80.07	1.64	0.00	0.21	0.00
33.54	11.19	10.94	3.57	79.95	1.66	0.00	0.20	0.00

:: Estimation of post-earthquake lateral Displacements :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	R_f (%)	$Q_{tn,cs}$	FS	D_r	$Gamma_{max}$ (%)	Lat. disp. (in)
33.71	11.81	11.58	3.72	83.17	1.76	0.00	0.15	0.00
33.87	15.02	15.13	3.20	85.81	2.00	4.67	0.07	0.00
34.04	20.51	21.00	2.73	89.32	2.00	15.50	0.06	0.00
34.20	24.47	25.16	2.62	196.58	2.00	21.46	0.00	0.00
34.36	31.29	32.23	2.11	97.37	2.00	29.63	0.00	0.00
34.53	45.55	46.83	1.41	86.93	2.00	41.96	0.00	0.00
34.69	61.70	63.13	1.04	90.11	2.00	51.82	0.00	0.00
34.86	78.60	79.86	0.76	96.66	2.00	59.58	0.00	0.00
35.02	98.80	99.76	0.61	109.32	2.00	66.92	0.00	0.00
35.19	114.75	115.43	0.59	121.84	2.00	71.74	0.00	0.00
35.35	120.45	120.98	0.66	128.74	0.89	73.29	4.50	0.00
35.51	120.50	120.88	0.75	131.23	0.93	73.26	3.99	0.00
35.68	119.60	119.72	0.80	131.91	0.94	72.94	3.86	0.00
35.84	118.87	118.68	0.82	131.66	0.93	72.65	3.90	0.00
36.01	118.88	118.31	0.82	131.34	0.93	72.55	3.96	0.00
36.17	120.48	119.51	0.80	131.56	0.93	72.88	3.91	0.00
36.33	121.94	120.57	0.77	131.70	0.94	73.17	3.88	0.00
36.50	119.19	117.49	0.77	129.10	0.90	72.32	4.39	0.00
36.66	112.60	110.67	0.78	123.55	0.82	70.35	5.72	0.00
36.83	104.94	102.79	0.78	116.78	0.73	67.91	7.92	0.00
36.99	97.82	95.53	0.82	111.53	0.67	65.49	10.18	0.00
37.15	90.11	87.85	1.04	111.04	0.66	62.73	21.74	0.00
37.32	80.69	78.45	1.34	111.24	0.67	58.99	21.37	0.00
37.48	77.90	75.51	1.51	113.72	0.70	57.73	17.76	0.00
37.65	91.26	88.26	1.36	120.22	0.78	62.88	10.97	0.00
37.81	109.36	105.52	1.17	129.93	0.91	68.77	4.16	0.00
37.97	129.50	124.56	0.90	138.82	1.06	74.25	2.72	0.00
38.14	140.81	134.97	0.74	142.79	1.13	76.90	2.50	0.00
38.30	155.76	148.89	0.63	149.67	1.26	80.14	1.98	0.00
38.47	154.71	147.47	0.62	148.20	1.23	79.82	2.08	0.00
38.63	152.62	145.10	0.62	146.19	1.20	79.29	2.22	0.00
38.79	155.31	147.31	0.62	147.97	1.23	79.79	2.09	0.00
38.96	172.21	163.03	0.59	163.03	1.56	83.13	1.28	0.00
39.12	181.21	171.21	0.61	171.21	1.77	84.75	0.98	0.00
39.29	191.12	180.18	0.61	180.18	2.00	86.43	0.00	0.00
39.45	195.98	184.35	0.59	184.35	2.00	87.19	0.00	0.00
39.61	196.06	183.98	0.56	183.98	2.00	87.12	0.00	0.00
39.78	195.76	183.25	0.52	183.25	2.00	86.99	0.00	0.00
39.94	195.78	182.86	0.48	182.86	2.00	86.92	0.00	0.00
40.11	198.08	184.60	0.47	184.60	2.00	87.23	0.00	0.00
40.27	204.05	189.79	0.51	189.79	2.00	88.15	0.00	0.00
40.43	210.77	195.62	0.60	195.62	2.00	89.15	0.00	0.00
40.60	215.87	199.83	0.69	199.83	2.00	89.85	0.00	0.00
40.76	218.67	201.88	0.79	201.88	2.00	90.19	0.00	0.00
40.93	218.77	201.38	0.83	201.38	2.00	90.10	0.00	0.00
41.09	216.90	199.15	0.81	199.15	2.00	89.74	0.00	0.00
41.26	213.48	195.50	0.76	195.50	2.00	89.13	0.00	0.00
41.42	207.55	189.60	0.70	189.60	2.00	88.12	0.00	0.00

:: Estimation of post-earthquake lateral Displacements :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	R_f (%)	$Q_{tn,cs}$	FS	D_r	$Gamma_{max}$ (%)	Lat. disp. (in)
41.58	203.39	185.40	0.63	185.40	2.00	87.38	0.00	0.00
41.75	200.85	182.67	0.59	182.67	2.00	86.89	0.00	0.00
41.91	199.05	180.58	0.59	180.58	2.00	86.51	0.00	0.00
42.08	195.85	177.17	0.60	177.17	1.97	85.88	0.96	0.00
42.24	193.51	174.61	0.60	174.61	1.90	85.40	1.03	0.00
42.40	193.77	174.50	0.58	174.50	1.90	85.38	1.03	0.00
42.57	193.77	174.16	0.55	174.16	1.89	85.31	1.04	0.00
42.73	191.67	171.95	0.51	171.95	1.83	84.89	0.91	0.00
42.90	188.47	168.72	0.48	168.72	1.75	84.27	1.01	0.00
43.06	182.73	163.21	0.45	163.21	1.61	83.17	1.20	0.00
43.22	169.37	150.39	0.54	150.39	1.32	80.47	1.81	0.00
43.39	150.59	132.67	0.68	138.81	1.10	76.33	2.67	0.00
43.55	132.47	115.77	0.80	128.49	0.92	71.83	4.01	0.00
43.72	111.53	96.47	0.95	115.98	0.75	65.81	7.30	0.00
43.88	95.08	81.35	1.14	108.10	0.66	60.19	22.41	0.00
44.04	82.03	69.41	1.34	103.76	0.62	54.95	34.10	0.00
44.21	74.74	62.68	1.50	102.54	0.60	51.58	34.10	0.00
44.37	74.71	62.50	1.42	100.19	0.58	51.49	34.10	0.00
44.54	88.12	74.25	1.16	102.71	0.61	57.17	22.70	0.00
44.70	105.44	89.48	0.97	110.42	0.69	63.33	18.35	0.00
44.86	125.74	107.55	0.75	119.96	0.81	69.40	5.86	0.00
45.03	146.09	125.66	0.62	130.98	0.98	74.54	3.44	0.00
45.19	162.73	140.14	0.63	142.86	1.19	78.14	2.25	0.00
45.36	171.20	147.23	0.65	149.52	1.32	79.77	1.80	0.00
45.52	172.16	147.71	0.66	150.24	1.34	79.88	1.75	0.00
45.68	168.80	144.53	0.63	146.31	1.26	79.16	1.99	0.00
45.85	162.47	138.81	0.57	139.25	1.13	77.82	2.51	0.00
46.01	149.81	127.61	0.49	127.64	0.93	75.05	3.73	0.00
46.18	133.52	113.16	0.43	113.16	0.73	71.08	7.86	0.00
46.34	119.45	100.70	0.39	100.70	0.60	67.23	14.16	0.00
46.50	107.92	90.46	0.35	90.46	0.51	63.69	22.70	0.00
46.67	98.95	82.56	0.30	82.56	0.45	60.68	22.70	0.00
46.83	93.94	78.03	0.30	78.03	0.43	58.81	22.70	0.00
47.00	94.47	78.41	0.28	78.41	0.43	58.97	22.70	0.00
47.16	96.02	79.71	0.25	79.71	0.44	59.52	22.70	0.00
47.32	93.72	77.37	0.30	77.37	0.42	58.53	22.70	0.00
47.49	87.43	71.28	0.46	71.28	0.39	55.83	22.70	0.00
47.65	81.32	65.53	0.61	80.81	0.45	53.05	34.10	0.00
47.82	75.11	59.77	0.80	81.02	0.45	50.01	34.10	0.00
47.98	75.53	59.94	0.82	81.76	0.45	50.11	34.10	0.00
48.15	78.49	62.29	0.82	83.51	0.47	51.37	34.10	0.00
48.31	88.03	70.34	0.73	87.77	0.50	55.39	22.70	0.00
48.47	98.39	79.07	0.67	93.62	0.54	59.25	22.70	0.00
48.64	107.86	87.20	0.57	97.92	0.58	62.48	22.70	0.00
48.80	111.86	90.37	0.59	101.00	0.61	63.66	22.70	0.00
48.97	116.41	94.16	0.55	103.05	0.64	65.01	11.84	0.00
49.13	116.72	94.36	0.51	102.18	0.63	65.08	12.29	0.00
49.29	116.91	94.60	0.44	94.60	0.56	65.17	14.50	0.00

:: Estimation of post-earthquake lateral Displacements :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	R_f (%)	$Q_{tn,cs}$	FS	D_r	Gamma$_{max}$ (%)	Lat. disp. (in)
49.46	119.51	96.51	0.47	96.51	0.57	65.83	14.50	0.00
49.62	121.96	98.16	0.52	105.63	0.67	66.39	10.29	0.00
49.79	122.14	97.82	0.59	107.24	0.69	66.27	9.49	0.00
49.95	125.42	100.37	0.59	109.39	0.71	67.12	8.52	0.00
50.11	130.57	104.60	0.57	112.21	0.75	68.48	7.41	0.00
50.28	131.65	105.44	0.53	111.80	0.74	68.75	7.52	0.00
50.44	136.20	109.31	0.48	109.31	0.72	69.94	8.43	0.00
50.61	144.62	116.56	0.43	116.56	0.81	72.06	5.92	0.00
50.77	152.42	123.03	0.42	123.03	0.90	73.84	4.31	0.00
50.93	160.43	129.50	0.44	129.50	1.01	75.53	3.18	0.00
51.10	172.40	139.40	0.44	139.40	1.19	77.96	2.26	0.00
51.26	183.23	148.50	0.43	148.50	1.38	80.05	1.66	0.00
51.43	196.98	160.05	0.42	160.05	1.65	82.52	1.13	0.00
51.59	210.93	171.79	0.41	171.79	1.98	84.86	0.78	0.00
51.75	220.28	179.49	0.41	179.49	2.00	86.31	0.00	0.00
51.92	226.63	184.62	0.41	184.62	2.00	87.24	0.00	0.00
52.08	229.62	186.80	0.41	186.80	2.00	87.63	0.00	0.00
52.25	227.77	184.82	0.41	184.82	2.00	87.27	0.00	0.00
52.41	225.05	182.21	0.41	182.21	2.00	86.80	0.00	0.00
52.57	223.08	180.27	0.40	180.27	2.00	86.45	0.00	0.00
52.74	220.52	177.92	0.39	177.92	2.00	86.02	0.00	0.00
52.90	218.70	176.26	0.37	176.26	2.00	85.71	0.00	0.00
53.07	217.90	175.49	0.36	175.49	2.00	85.56	0.00	0.00
53.23	216.72	174.42	0.34	174.42	2.00	85.36	0.00	0.00
53.39	214.84	172.89	0.32	172.89	2.00	85.07	0.00	0.00
53.56	213.56	171.76	0.30	171.76	2.00	84.85	0.00	0.00
53.72	212.70	170.58	0.31	170.58	1.99	84.63	0.77	0.00
53.89	212.75	170.17	0.32	170.17	1.98	84.55	0.78	0.00
54.05	212.91	170.17	0.31	170.17	1.99	84.55	0.77	0.00
54.22	212.43	169.30	0.32	169.30	1.96	84.38	0.79	0.00
54.38	212.15	168.63	0.33	168.63	1.95	84.25	0.80	0.00
54.54	207.35	164.32	0.33	164.32	1.83	83.39	0.92	0.00
54.71	199.03	156.96	0.33	156.96	1.63	81.88	1.16	0.00
54.87	193.00	151.34	0.35	151.34	1.50	80.68	1.39	0.00
55.04	183.50	142.90	0.37	142.90	1.31	78.78	1.83	0.00
55.20	176.01	136.11	0.40	136.11	1.18	77.17	2.30	0.00

Total estimated displacement: 1.47

Abbreviations

q_t:	Total cone resistance
Q_{tn}:	Adjusted cone resistance to an effective overburden stress of 1 atm
R_f:	Friction ration
$Q_{tn,cs}$:	Adjusted and corrected cone resistance due to fines
FS:	Calculated factor of safety against liquefaction
D_r:	Calculated relative density
Gamma$_{max}$:	Calculated maximum cyclic shear strain
Lat. disp.:	Lateral displacement

EEI
Geotechnical & Environmental Solutions
2195 Faraday Avenue, Suite K, Carlsbad CA
www.EEItiger.com

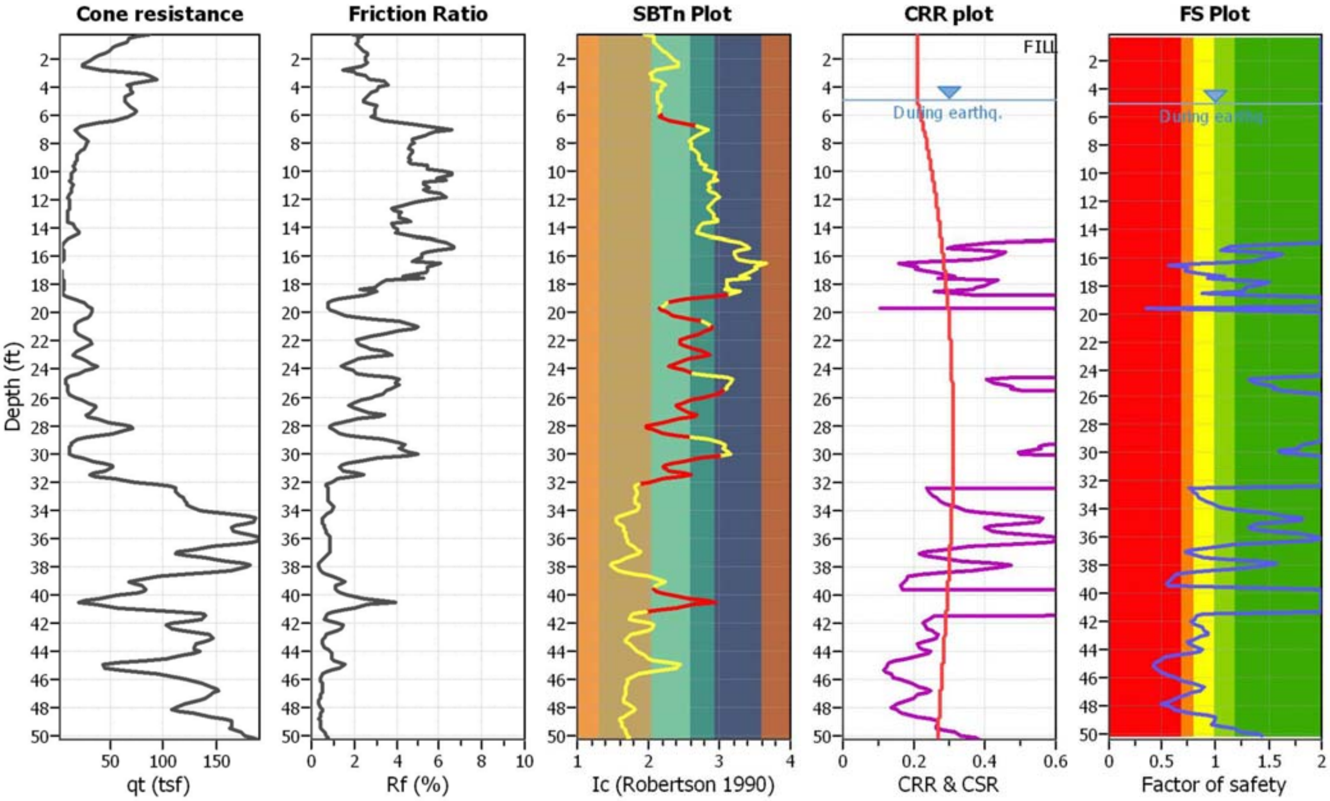
LIQUEFACTION ANALYSIS REPORT

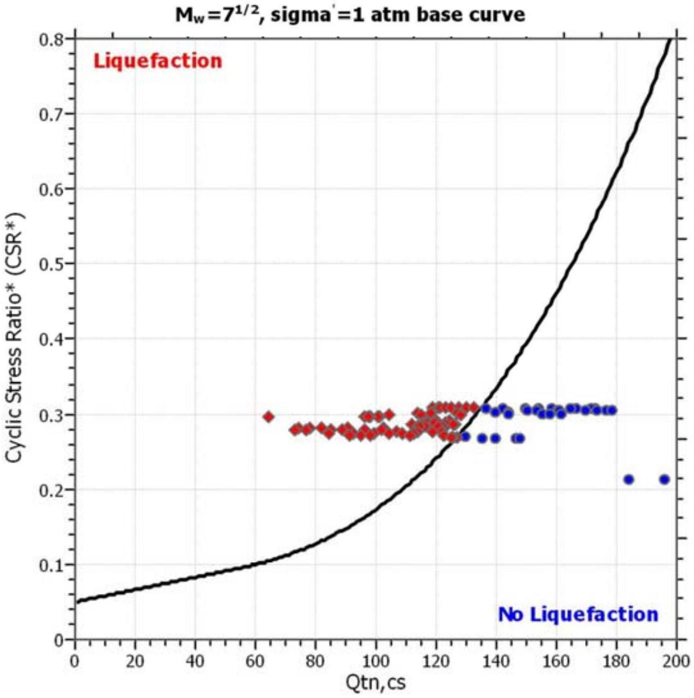
Project title : CIS-72092.4 **Location : Proposed CarMax National City**

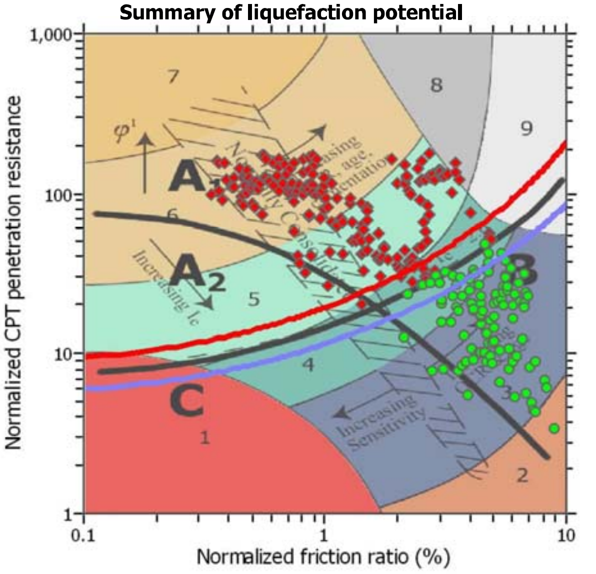
CPT file : CPT-02

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	5.00 ft	Use fill:	Yes	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	10.00 ft	Fill height:	5.00 ft	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	5	Fill weight:	120.00 lb/ft^3	Limit depth:	N/A
Earthquake magnitude M_w:	6.76	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.43	Unit weight calculation:	Based on SBT	K_σ applied:	No		

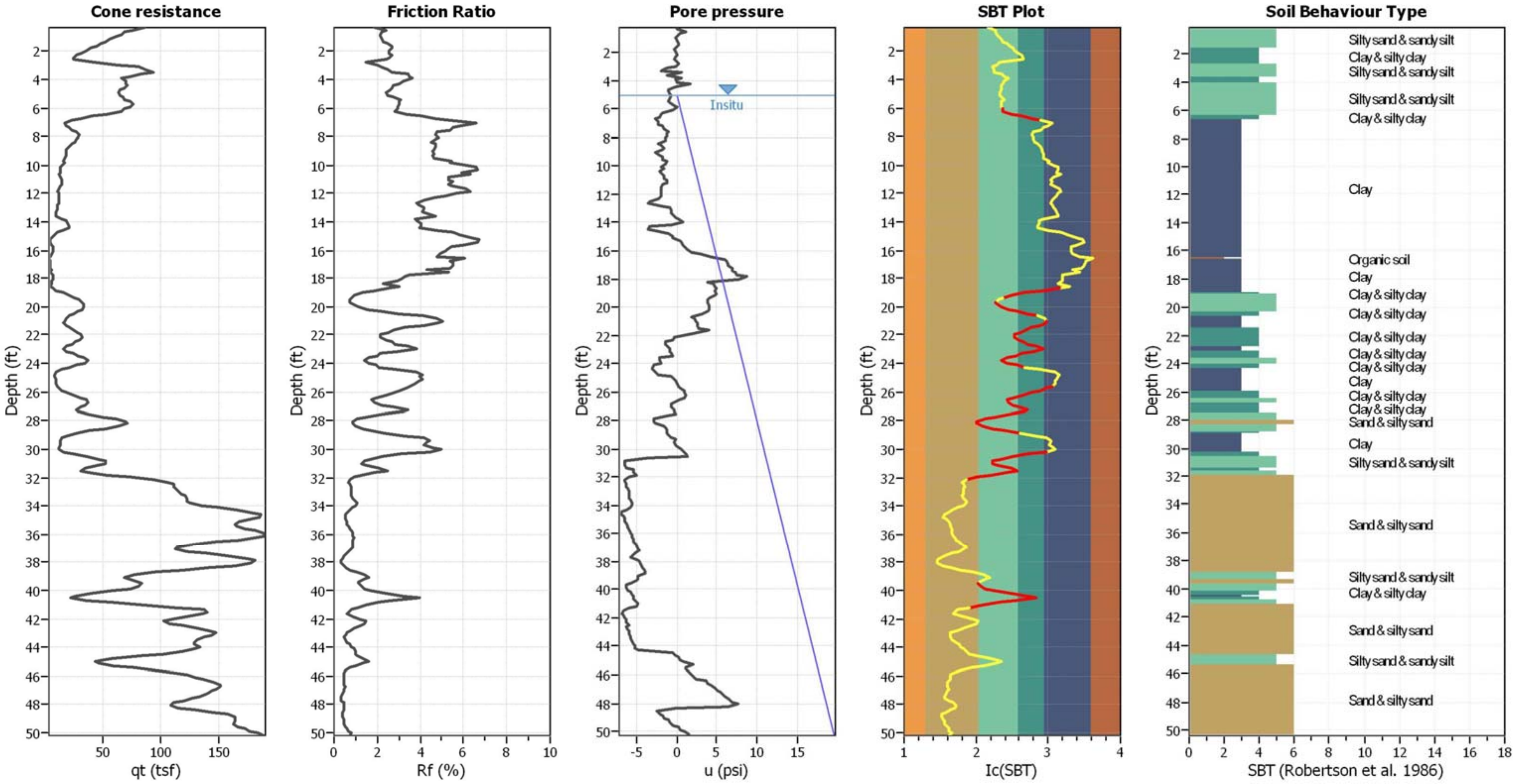






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



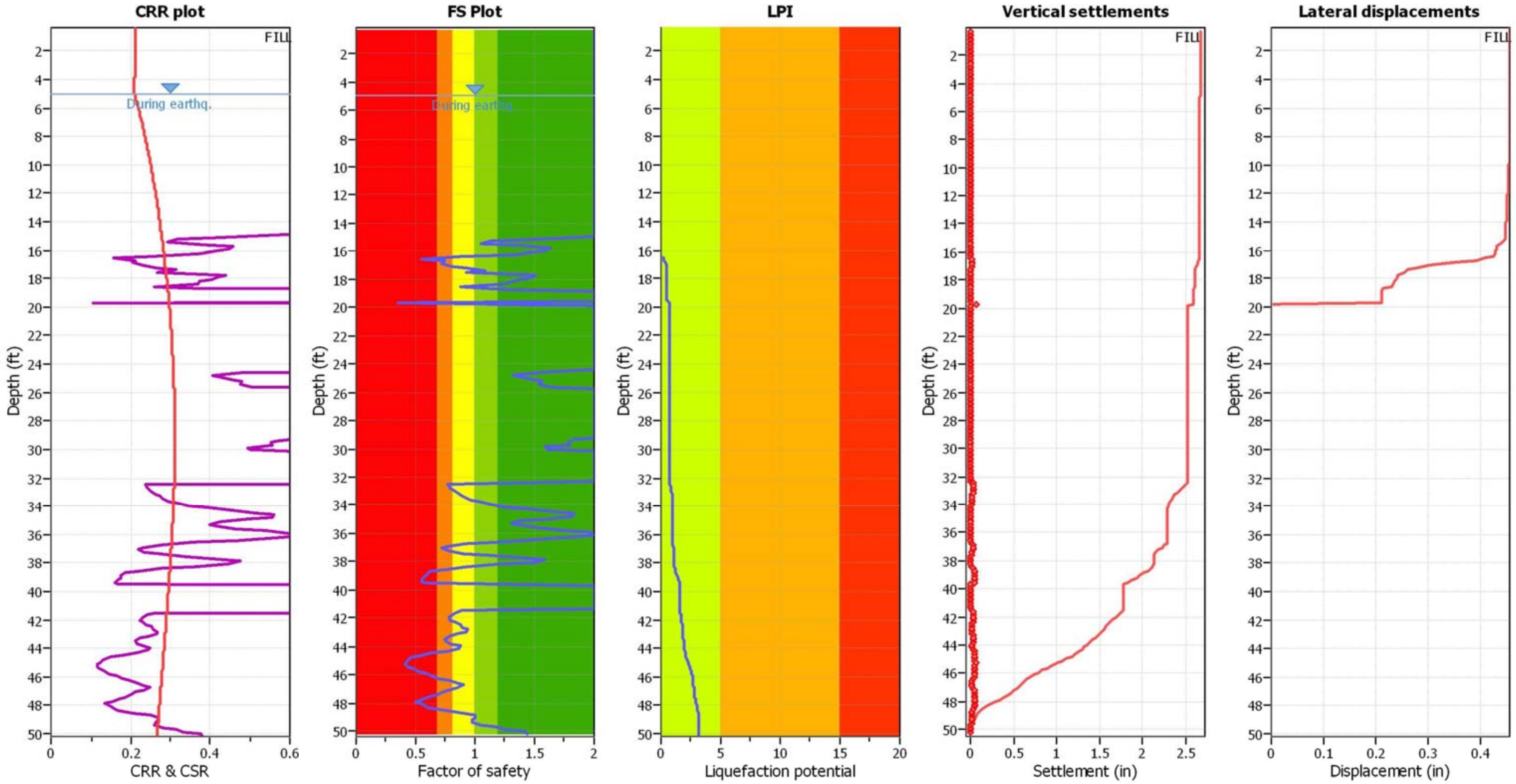
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	10.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	5	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	No
Earthquake magnitude M_w:	6.76	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.43	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	5.00 ft	Fill height:	5.00 ft	Limit depth:	N/A

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:	Robertson (2009)	Depth to water table (erthq.):	10.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	5	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	No
Earthquake magnitude M_w:	6.76	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.43	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	5.00 ft	Fill height:	5.00 ft	Limit depth:	N/A

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

:: Post-earthquake settlement of dry sands ::

Depth (ft)	Ic	Kc	Qc1n	Qc1n,cs	N1,60 (blows)	Vs (ft/s)	Gmax (tsf)	CSR	Shear, γ (%)	Svol,15 (%)	Nc	ev (%)	Settle. (in)
5.33	1.96	1.25	163.32	203.54	42	706.4	967	0.21	0.008	0.00	9.05	0.00	0.000
5.49	2.07	1.41	142.82	200.97	43	711.1	984	0.21	0.008	0.00	9.05	0.00	0.000
5.66	2.07	1.40	129.52	181.34	39	675.2	875	0.21	0.010	0.00	9.05	0.00	0.000
5.82	2.08	1.41	125.08	176.78	38	666.9	851	0.21	0.011	0.01	9.05	0.00	0.000
5.98	2.09	1.44	116.17	167.63	36	649.6	802	0.21	0.012	0.01	9.05	0.00	0.000
6.15	2.13	1.51	105.68	160.07	35	634.5	761	0.21	0.013	0.01	9.05	0.01	0.000
6.31	2.16	1.58	98.14	154.74	34	622.9	730	0.21	0.015	0.01	9.05	0.01	0.000
6.48	2.21	1.69	91.54	154.66	35	620.1	723	0.21	0.015	0.01	9.05	0.01	0.000
6.64	2.26	1.83	83.43	152.60	35	611.5	701	0.21	0.016	0.01	9.05	0.01	0.000
6.80	2.30	1.95	73.28	143.00	34	587.5	641	0.21	0.020	0.01	9.05	0.01	0.000
6.97	2.31	2.00	66.68	133.04	31	565.0	586	0.21	0.023	0.01	9.05	0.01	0.000
7.13	2.36	2.15	58.50	125.92	30	544.0	538	0.21	0.028	0.02	9.05	0.01	0.001
7.30	2.41	2.36	50.96	120.41	30	524.8	496	0.21	0.034	0.02	9.05	0.02	0.001
7.46	2.43	2.43	46.21	112.37	28	504.6	453	0.21	0.042	0.03	9.05	0.02	0.001
7.62	2.42	2.39	45.55	108.72	27	497.6	439	0.21	0.047	0.03	9.05	0.03	0.001
7.79	2.11	1.47	78.08	114.54	25	536.4	518	0.21	0.034	0.03	9.05	0.02	0.001
7.95	2.07	1.40	117.06	163.97	35	642.0	781	0.21	0.017	0.01	9.05	0.01	0.000
8.12	2.02	1.32	152.96	202.04	42	710.0	979	0.21	0.013	0.01	9.05	0.00	0.000
8.28	2.05	1.37	162.50	223.27	47	748.9	1104	0.21	0.011	0.00	9.05	0.00	0.000
8.45	2.06	1.38	176.92	244.28	52	783.7	1223	0.21	0.010	0.00	9.05	0.00	0.000
8.61	2.17	1.59	158.01	251.85	56	795.2	1265	0.21	0.010	0.00	9.05	0.00	0.000
8.77	2.21	1.69	138.45	233.51	53	762.8	1154	0.21	0.012	0.00	9.05	0.00	0.000
8.94	2.25	1.79	123.77	221.93	51	739.6	1077	0.21	0.013	0.00	9.05	0.00	0.000
9.10	2.19	1.65	131.77	217.11	49	736.7	1067	0.21	0.013	0.00	9.05	0.00	0.000
9.27	2.18	1.61	131.37	211.25	47	727.7	1038	0.21	0.014	0.01	9.05	0.00	0.000
9.43	2.14	1.54	132.89	204.00	45	716.5	1001	0.21	0.015	0.01	9.05	0.00	0.000
9.59	2.14	1.53	128.82	197.16	43	704.4	964	0.21	0.016	0.01	9.05	0.01	0.000
9.76	2.14	1.54	121.68	187.37	41	686.5	910	0.21	0.018	0.01	9.05	0.01	0.000
9.92	2.13	1.51	120.19	180.96	40	675.0	875	0.21	0.019	0.01	9.05	0.01	0.000

Total estimated settlement: 0.01

:: 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)
10.09	184.50	2.00	0.00	1.00	0.00	10.25	196.34	2.00	0.00	1.00	0.00
10.41	210.65	2.00	0.00	1.00	0.00	10.58	216.37	2.00	0.00	1.00	0.00
10.74	220.32	2.00	0.00	1.00	0.00	10.91	215.86	2.00	0.00	1.00	0.00
11.07	206.89	2.00	0.00	1.00	0.00	11.23	196.79	2.00	0.00	1.00	0.00
11.40	190.73	2.00	0.00	1.00	0.00	11.56	182.15	2.00	0.00	1.00	0.00
11.73	237.59	2.00	0.00	1.00	0.00	11.89	395.24	2.00	0.00	1.00	0.00
12.05	161.06	2.00	0.00	1.00	0.00	12.22	156.69	2.00	0.00	1.00	0.00
12.38	159.74	2.00	0.00	1.00	0.00	12.55	404.66	2.00	0.00	1.00	0.00
12.71	271.69	2.00	0.00	1.00	0.00	12.87	249.61	2.00	0.00	1.00	0.00
13.04	270.90	2.00	0.00	1.00	0.00	13.20	266.28	2.00	0.00	1.00	0.00
13.37	257.98	2.00	0.00	1.00	0.00	13.53	320.01	2.00	0.00	1.00	0.00
13.69	357.35	2.00	0.00	1.00	0.00	13.86	139.25	2.00	0.00	1.00	0.00
14.02	137.71	2.00	0.00	1.00	0.00	14.19	137.94	2.00	0.00	1.00	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)
14.35	136.40	2.00	0.00	1.00	0.00	14.51	135.05	2.00	0.00	1.00	0.00
14.68	143.29	2.00	0.00	1.00	0.00	14.84	144.58	2.00	0.00	1.00	0.00
15.01	147.65	2.00	0.00	1.00	0.00	15.17	143.54	2.00	0.00	1.00	0.00
15.34	142.01	2.00	0.00	1.00	0.00	15.50	134.81	2.00	0.00	1.00	0.00
15.66	131.82	2.00	0.00	1.00	0.00	15.83	129.07	2.00	0.00	1.00	0.00
15.99	133.87	2.00	0.00	1.00	0.00	16.16	135.85	2.00	0.00	1.00	0.00
16.32	133.91	2.00	0.00	1.00	0.00	16.48	132.60	2.00	0.00	1.00	0.00
16.65	131.71	2.00	0.00	1.00	0.00	16.81	128.31	2.00	0.00	1.00	0.00
16.98	124.42	2.00	0.00	1.00	0.00	17.14	118.48	2.00	0.00	1.00	0.00
17.30	114.27	2.00	0.00	1.00	0.00	17.47	107.70	2.00	0.00	1.00	0.00
17.63	102.60	2.00	0.00	1.00	0.00	17.80	100.91	2.00	0.00	1.00	0.00
17.96	103.41	2.00	0.00	1.00	0.00	18.12	101.19	2.00	0.00	1.00	0.00
18.29	98.94	2.00	0.00	1.00	0.00	18.45	101.36	2.00	0.00	1.00	0.00
18.62	105.31	2.00	0.00	1.00	0.00	18.78	110.26	2.00	0.00	1.00	0.00
18.94	118.47	2.00	0.00	1.00	0.00	19.11	125.70	2.00	0.00	1.00	0.00
19.27	300.23	2.00	0.00	1.00	0.00	19.44	305.37	2.00	0.00	1.00	0.00
19.60	121.60	2.00	0.00	1.00	0.00	19.76	112.75	2.00	0.00	1.00	0.00
19.93	102.10	2.00	0.00	1.00	0.00	20.09	91.54	1.50	0.03	1.00	0.00
20.26	82.20	1.14	0.10	1.00	0.00	20.42	78.97	1.04	0.14	1.00	0.00
20.58	86.16	1.38	0.04	1.00	0.00	20.75	89.44	1.63	0.01	1.00	0.00
20.91	86.96	1.58	0.02	1.00	0.00	21.08	84.13	1.47	0.03	1.00	0.00
21.24	78.84	1.33	0.05	1.00	0.00	21.40	65.81	0.89	0.24	1.00	0.00
21.57	57.09	0.55	0.50	1.00	0.01	21.73	63.30	0.74	0.50	1.00	0.01
21.90	62.80	0.72	0.50	1.00	0.01	22.06	66.39	0.81	0.50	1.00	0.01
22.23	70.05	0.92	0.21	1.00	0.00	22.39	69.45	1.09	0.11	1.00	0.00
22.55	69.84	0.92	0.20	1.00	0.00	22.72	73.57	1.51	0.02	1.00	0.00
22.88	70.78	1.45	0.03	1.00	0.00	23.05	67.85	1.38	0.04	1.00	0.00
23.21	64.75	1.28	0.05	1.00	0.00	23.37	58.70	1.26	0.06	1.00	0.00
23.54	56.89	0.88	0.23	1.00	0.00	23.70	61.57	1.27	0.05	1.00	0.00
23.87	63.71	2.00	0.00	1.00	0.00	24.03	86.24	2.00	0.00	1.00	0.00
24.19	60.15	2.00	0.00	1.00	0.00	24.36	59.59	2.00	0.00	1.00	0.00
24.52	61.93	2.00	0.00	1.00	0.00	24.69	64.28	0.35	3.36	1.00	0.07
24.85	67.79	2.00	0.00	1.00	0.00	25.01	76.04	2.00	0.00	1.00	0.00
25.18	85.83	2.00	0.00	1.00	0.00	25.34	96.55	2.00	0.00	1.00	0.00
25.51	186.88	2.00	0.00	1.00	0.00	25.67	119.69	2.00	0.00	1.00	0.00
25.83	121.88	2.00	0.00	1.00	0.00	26.00	120.99	2.00	0.00	1.00	0.00
26.16	117.74	2.00	0.00	1.00	0.00	26.33	112.97	2.00	0.00	1.00	0.00
26.49	106.80	2.00	0.00	1.00	0.00	26.65	169.07	2.00	0.00	1.00	0.00
26.82	118.63	2.00	0.00	1.00	0.00	26.98	96.73	2.00	0.00	1.00	0.00
27.15	99.07	2.00	0.00	1.00	0.00	27.31	107.98	2.00	0.00	1.00	0.00
27.47	154.87	2.00	0.00	1.00	0.00	27.64	203.30	2.00	0.00	1.00	0.00
27.80	102.24	2.00	0.00	1.00	0.00	27.97	99.36	2.00	0.00	1.00	0.00
28.13	91.89	2.00	0.00	1.00	0.00	28.30	122.53	2.00	0.00	1.00	0.00
28.46	88.99	2.00	0.00	1.00	0.00	28.62	85.45	2.00	0.00	1.00	0.00
28.79	83.27	2.00	0.00	1.00	0.00	28.95	85.06	2.00	0.00	1.00	0.00
29.12	90.51	2.00	0.00	1.00	0.00	29.28	147.24	2.00	0.00	1.00	0.00
29.44	80.43	2.00	0.00	1.00	0.00	29.61	79.18	1.56	0.02	1.00	0.00
29.77	76.51	1.32	0.04	1.00	0.00	29.94	76.60	1.38	0.03	1.00	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)
30.10	80.35	1.49	0.02	1.00	0.00	30.26	80.38	1.56	0.02	1.00	0.00
30.43	78.41	1.54	0.02	1.00	0.00	30.59	78.40	1.64	0.01	1.00	0.00
30.76	81.89	2.00	0.00	1.00	0.00	30.92	84.47	2.00	0.00	1.00	0.00
31.08	88.97	2.00	0.00	1.00	0.00	31.25	157.76	2.00	0.00	1.00	0.00
31.41	88.56	2.00	0.00	1.00	0.00	31.58	88.39	2.00	0.00	1.00	0.00
31.74	93.33	2.00	0.00	1.00	0.00	31.90	97.85	2.00	0.00	1.00	0.00
32.07	149.15	2.00	0.00	1.00	0.00	32.23	263.67	2.00	0.00	1.00	0.00
32.40	221.48	2.00	0.00	1.00	0.00	32.56	100.03	2.00	0.00	1.00	0.00
32.72	92.30	2.00	0.00	1.00	0.00	32.89	91.43	2.00	0.00	1.00	0.00
33.05	91.52	2.00	0.00	1.00	0.00	33.22	93.19	2.00	0.00	1.00	0.00
33.38	92.14	2.00	0.00	1.00	0.00	33.54	89.58	2.00	0.00	1.00	0.00
33.71	87.27	2.00	0.00	1.00	0.00	33.87	149.49	2.00	0.00	1.00	0.00
34.04	92.56	2.00	0.00	1.00	0.00	34.20	92.12	2.00	0.00	1.00	0.00
34.36	90.43	1.83	0.00	1.00	0.00	34.53	88.78	1.78	0.01	1.00	0.00
34.69	87.19	1.79	0.01	1.00	0.00	34.86	86.66	1.59	0.01	1.00	0.00
35.02	90.64	1.61	0.01	1.00	0.00	35.19	97.78	2.00	0.00	1.00	0.00
35.35	98.61	2.00	0.00	1.00	0.00	35.51	98.05	2.00	0.00	1.00	0.00
35.68	93.11	2.00	0.00	1.00	0.00	35.84	89.74	2.00	0.00	1.00	0.00
36.01	87.50	2.00	0.00	1.00	0.00	36.17	85.94	2.00	0.00	1.00	0.00
36.33	91.37	2.00	0.00	1.00	0.00	36.50	148.72	2.00	0.00	1.00	0.00
36.66	89.17	2.00	0.00	1.00	0.00	36.83	85.88	2.00	0.00	1.00	0.00
36.99	92.84	2.00	0.00	1.00	0.00	37.15	103.82	2.00	0.00	1.00	0.00
37.32	113.78	2.00	0.00	1.00	0.00	37.48	118.83	0.76	1.58	1.00	0.03
37.65	120.34	0.78	1.55	1.00	0.03	37.81	121.44	0.80	1.53	1.00	0.03
37.97	123.22	0.82	1.50	1.00	0.03	38.14	125.12	0.85	1.46	1.00	0.03
38.30	127.55	0.89	1.09	1.00	0.02	38.47	129.70	0.92	1.07	1.00	0.02
38.63	132.81	0.97	0.68	1.00	0.01	38.79	137.09	1.04	0.66	1.00	0.01
38.96	142.20	1.13	0.44	1.00	0.01	39.12	149.71	1.28	0.22	1.00	0.00
39.29	158.93	1.48	0.00	1.00	0.00	39.45	166.90	1.67	0.00	1.00	0.00
39.61	172.94	1.83	0.00	1.00	0.00	39.78	172.13	1.81	0.00	1.00	0.00
39.94	164.73	1.62	0.00	1.00	0.00	40.11	154.46	1.38	0.00	1.00	0.00
40.27	150.91	1.31	0.22	1.00	0.00	40.43	153.83	1.37	0.00	1.00	0.00
40.60	160.59	1.53	0.00	1.00	0.00	40.76	170.21	1.77	0.00	1.00	0.00
40.93	177.05	1.96	0.00	1.00	0.00	41.09	179.05	2.00	0.00	1.00	0.00
41.26	173.85	1.88	0.00	1.00	0.00	41.42	161.18	1.55	0.00	1.00	0.00
41.58	144.09	1.18	0.31	1.00	0.01	41.75	128.35	0.92	1.08	1.00	0.02
41.91	117.85	0.77	1.60	1.00	0.03	42.08	113.99	0.72	2.04	1.00	0.04
42.24	118.22	0.78	1.59	1.00	0.03	42.40	126.99	0.90	1.10	1.00	0.02
42.57	140.25	1.12	0.44	1.00	0.01	42.73	155.38	1.43	0.00	1.00	0.00
42.90	161.84	1.58	0.00	1.00	0.00	43.06	158.17	1.50	0.00	1.00	0.00
43.22	144.66	1.21	0.31	1.00	0.01	43.39	128.32	0.93	1.08	1.00	0.02
43.55	115.21	0.74	2.01	1.00	0.04	43.72	104.49	0.62	2.25	1.00	0.05
43.88	101.28	0.59	2.31	1.00	0.04	44.04	100.48	0.59	2.33	1.00	0.04
44.21	97.83	0.56	2.38	1.00	0.05	44.37	96.05	0.55	2.42	1.00	0.05
44.54	97.72	0.56	2.38	1.00	0.05	44.70	99.45	2.00	0.00	1.00	0.00
44.86	97.54	2.00	0.00	1.00	0.00	45.03	94.23	2.00	0.00	1.00	0.00
45.19	138.75	2.00	0.00	1.00	0.00	45.36	93.87	2.00	0.00	1.00	0.00
45.52	94.75	2.00	0.00	1.00	0.00	45.68	174.10	2.00	0.00	1.00	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)
45.85	101.46	2.00	0.00	1.00	0.00	46.01	106.36	2.00	0.00	1.00	0.00
46.18	116.95	2.00	0.00	1.00	0.00	46.34	126.28	2.00	0.00	1.00	0.00
46.50	124.63	0.89	1.13	1.00	0.02	46.67	120.18	0.83	1.55	1.00	0.03
46.83	117.69	0.80	1.60	1.00	0.03	47.00	115.89	0.78	1.64	1.00	0.03
47.16	117.10	0.79	1.61	1.00	0.03	47.32	119.31	0.82	1.57	1.00	0.03
47.49	122.95	0.88	1.15	1.00	0.02	47.65	124.02	0.89	1.14	1.00	0.02
47.82	126.54	0.93	1.11	1.00	0.02	47.98	125.89	0.93	1.12	1.00	0.02
48.15	121.31	0.86	1.18	1.00	0.02	48.31	115.71	0.78	1.64	1.00	0.03
48.47	112.18	0.74	2.09	1.00	0.04	48.64	113.62	0.76	1.69	1.00	0.03
48.80	115.99	0.79	1.64	1.00	0.03	48.97	121.83	0.87	1.17	1.00	0.02
49.13	120.93	0.86	1.18	1.00	0.02	49.29	114.23	0.77	1.67	1.00	0.03
49.46	102.26	0.64	2.29	1.00	0.05	49.62	90.94	0.53	2.53	1.00	0.05
49.79	82.11	0.47	2.75	1.00	0.06	49.95	78.01	0.44	2.86	1.00	0.05
50.11	74.52	0.42	2.97	1.00	0.06	50.28	73.09	0.41	3.02	1.00	0.06
50.44	76.62	0.44	2.91	1.00	0.06	50.61	84.73	0.49	2.68	1.00	0.05
50.77	88.62	0.52	2.58	1.00	0.05	50.93	96.48	0.59	2.41	1.00	0.05
51.10	101.59	0.64	2.31	1.00	0.05	51.26	106.73	0.70	2.22	1.00	0.04
51.43	113.66	0.78	1.69	1.00	0.03	51.59	118.62	0.85	1.22	1.00	0.02
51.75	121.89	0.90	1.17	1.00	0.02	51.92	118.54	0.85	1.22	1.00	0.02
52.08	112.49	0.77	1.71	1.00	0.03	52.25	108.93	0.73	2.18	1.00	0.04
52.41	104.60	0.68	2.25	1.00	0.04	52.57	99.18	0.62	2.35	1.00	0.05
52.74	92.38	0.56	2.49	1.00	0.05	52.90	84.41	0.50	2.68	1.00	0.05
53.07	91.25	0.55	2.52	1.00	0.05	53.23	95.15	0.59	2.43	1.00	0.05
53.39	97.82	0.62	2.38	1.00	0.05	53.56	111.44	0.77	1.73	1.00	0.04
53.72	122.24	0.92	1.16	1.00	0.02	53.89	126.65	1.00	0.71	1.00	0.01
54.05	126.62	1.00	0.71	1.00	0.01	54.22	125.44	0.98	0.72	1.00	0.01
54.38	124.86	0.97	0.72	1.00	0.01	54.54	129.71	1.05	0.47	1.00	0.01
54.71	135.87	1.17	0.33	1.00	0.01	54.87	139.78	1.25	0.32	1.00	0.01
55.04	147.13	1.41	0.00	1.00	0.00	55.20	148.13	1.44	0.00	1.00	0.00

Total estimated settlement: 2.67

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

:: Lateral displacement index calculation ::

Depth (ft)	q_t (tsf)	Q_{tn}	R_f (%)	$Q_{tn,cs}$	FS	D_r	$Gamma_{max}$ (%)	Lat. disp. (in)
10.09	64.89	122.06	2.50	184.50	2.00	73.58	0.00	0.00
10.25	66.85	125.74	2.75	196.34	2.00	74.56	0.00	0.00
10.41	68.27	128.41	3.11	210.65	2.00	75.25	0.00	0.00
10.58	72.91	137.17	3.02	216.37	2.00	77.43	0.00	0.00
10.74	75.39	141.84	3.00	220.32	2.00	78.54	0.00	0.00
10.91	73.81	138.83	2.95	215.86	2.00	77.83	0.00	0.00
11.07	68.67	129.09	2.97	206.89	2.00	75.43	0.00	0.00
11.23	65.72	123.50	2.83	196.79	2.00	73.97	0.00	0.00
11.40	53.71	100.78	3.35	190.73	2.00	67.26	0.00	0.00
11.56	40.53	75.84	4.00	182.15	2.00	57.87	0.00	0.00
11.73	30.17	56.24	4.71	237.59	2.00	48.00	0.00	0.00
11.89	22.91	42.50	5.33	395.24	2.00	38.76	0.00	0.00
12.05	16.79	30.92	6.55	161.06	2.00	28.25	0.04	0.00
12.22	18.21	33.59	5.82	156.69	2.00	30.99	0.04	0.00
12.38	20.34	37.58	5.51	159.74	2.00	34.70	0.03	0.00
12.55	22.76	42.15	5.36	404.66	2.00	38.48	0.00	0.00
12.71	27.22	50.56	4.78	271.69	2.00	44.49	0.00	0.00
12.87	28.88	53.68	4.71	249.61	2.00	46.47	0.00	0.00
13.04	27.84	51.69	4.81	270.90	2.00	45.22	0.00	0.00
13.20	26.86	49.81	4.69	266.28	2.00	44.00	0.00	0.00
13.37	25.68	47.56	4.52	257.98	2.00	42.47	0.00	0.00
13.53	22.49	41.53	4.71	320.01	2.00	38.00	0.00	0.00
13.69	20.01	36.82	4.70	357.35	2.00	34.02	0.00	0.00
13.86	18.67	34.27	4.61	139.25	2.00	31.65	0.03	0.00
14.02	18.39	33.72	4.57	137.71	2.00	31.12	0.04	0.00
14.19	18.15	33.25	4.63	137.94	2.00	30.65	0.04	0.00
14.35	17.85	32.67	4.59	136.40	2.00	30.07	0.04	0.00
14.51	17.32	31.63	4.62	135.05	2.00	29.01	0.04	0.00
14.68	16.10	29.31	5.47	143.29	2.00	26.49	0.04	0.00
14.84	16.68	30.39	5.40	144.58	2.00	27.69	0.04	0.00
15.01	14.92	27.04	6.17	147.65	2.00	23.84	0.05	0.00
15.17	13.13	23.66	6.55	143.54	2.00	19.42	0.05	0.00
15.34	12.69	22.81	6.62	142.01	2.00	18.21	0.05	0.00
15.50	12.91	23.21	5.88	134.81	2.00	18.79	0.05	0.00
15.66	11.42	20.36	6.31	131.82	2.00	14.46	0.06	0.00
15.83	13.20	23.71	5.30	129.07	2.00	19.49	0.05	0.00
15.99	14.38	25.92	5.29	133.87	2.00	22.44	0.05	0.00
16.16	14.20	25.56	5.49	135.85	2.00	21.98	0.05	0.00
16.32	14.34	25.81	5.30	133.91	2.00	22.29	0.05	0.00
16.48	13.57	24.35	5.45	132.60	2.00	20.37	0.05	0.00
16.65	11.81	21.00	6.10	131.71	2.00	15.49	0.06	0.00
16.81	10.79	19.05	6.30	128.31	2.00	12.28	0.06	0.00
16.98	11.23	19.87	5.70	124.42	2.00	13.66	0.06	0.00
17.14	11.27	19.92	5.15	118.48	2.00	13.74	0.06	0.00
17.30	11.44	20.23	4.72	114.27	2.00	14.26	0.06	0.00
17.47	11.56	20.44	4.15	107.70	2.00	14.59	0.06	0.00
17.63	11.59	20.21	3.80	102.60	2.00	14.22	0.06	0.00
17.80	10.79	18.74	3.89	100.91	2.00	11.73	0.06	0.00

:: Estimation of post-earthquake lateral Displacements :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	R_f (%)	$Q_{tn,cs}$	FS	D_r	$Gamma_{max}$ (%)	Lat. disp. (in)
17.96	10.54	18.26	4.18	103.41	2.00	10.88	0.06	0.00
18.12	10.15	17.46	4.14	101.19	2.00	9.39	0.07	0.00
18.29	9.73	16.62	4.11	98.94	2.00	7.76	0.07	0.00
18.45	9.40	15.97	4.47	101.36	2.00	6.45	0.07	0.00
18.62	9.84	16.65	4.68	105.31	2.00	7.83	0.07	0.00
18.78	14.80	24.45	3.78	110.26	2.00	20.50	0.05	0.00
18.94	17.81	29.08	3.82	118.47	2.00	26.23	0.04	0.00
19.11	19.36	31.41	4.03	125.70	2.00	28.78	0.04	0.00
19.27	20.53	33.00	3.99	300.23	2.00	30.41	0.00	0.00
19.44	20.15	32.16	3.97	305.37	2.00	29.56	0.00	0.00
19.60	14.15	22.90	4.81	121.60	2.00	18.35	0.05	0.00
19.76	10.20	16.30	5.49	112.75	2.00	7.13	0.07	0.00
19.93	7.87	12.13	5.85	102.10	2.00	0.00	0.08	0.00
20.09	5.98	8.77	6.36	91.54	1.50	0.00	0.34	0.00
20.26	4.78	6.65	6.69	82.20	1.14	0.00	1.33	0.01
20.42	4.51	6.13	6.66	78.97	1.04	0.00	2.00	0.01
20.58	5.71	8.12	5.95	86.16	1.38	0.00	0.52	0.00
20.75	6.64	9.61	5.43	89.44	1.63	0.00	0.23	0.00
20.91	6.52	9.35	5.21	86.96	1.58	0.00	0.27	0.00
21.08	6.19	8.73	5.17	84.13	1.47	0.00	0.38	0.00
21.24	5.73	7.89	4.89	78.84	1.33	0.00	0.62	0.00
21.40	4.20	5.33	4.76	65.81	0.89	0.00	4.22	0.02
21.57	2.99	3.31	6.01	57.09	0.55	0.00	4.00	0.02
21.73	3.70	4.43	5.40	63.30	0.74	0.00	10.37	0.04
21.90	3.65	4.31	5.48	62.80	0.72	0.00	11.99	0.05
22.06	4.01	4.86	5.48	66.39	0.81	0.00	6.84	0.03
22.23	4.48	5.56	5.36	70.05	0.92	0.00	3.62	0.01
22.39	5.14	6.58	4.28	69.45	1.09	0.00	1.63	0.01
22.55	4.55	5.59	5.28	69.84	0.92	0.00	3.61	0.01
22.72	6.85	9.17	3.50	73.57	1.51	0.00	0.33	0.00
22.88	6.68	8.85	3.29	70.78	1.45	0.00	0.40	0.00
23.05	6.43	8.40	3.11	67.85	1.38	0.00	0.52	0.00
23.21	6.09	7.81	2.96	64.75	1.28	0.00	0.75	0.00
23.37	6.05	7.71	2.31	58.70	1.26	0.00	0.80	0.00
23.54	4.61	5.43	3.04	56.89	0.88	0.00	4.39	0.02
23.70	6.21	7.85	2.58	61.57	1.27	0.00	0.75	0.00
23.87	9.49	12.55	1.90	63.71	2.00	0.00	0.08	0.00
24.03	15.25	20.05	1.31	86.24	2.00	13.95	0.00	0.00
24.19	20.62	26.66	0.97	60.15	2.00	23.37	0.00	0.00
24.36	25.24	32.15	0.79	59.59	2.00	29.54	0.00	0.00
24.52	29.16	36.80	0.75	61.93	2.00	34.01	0.00	0.00
24.69	32.18	40.33	0.75	64.28	0.35	37.03	51.20	0.21
24.85	32.96	41.31	0.85	67.79	2.00	37.82	0.00	0.00
25.01	33.02	41.69	1.15	76.04	2.00	38.12	0.00	0.00
25.18	31.75	40.45	1.57	85.83	2.00	37.12	0.00	0.00
25.34	28.65	36.86	2.16	96.55	2.00	34.06	0.00	0.00
25.51	24.56	31.93	3.01	186.88	2.00	29.32	0.00	0.00
25.67	20.48	26.82	4.10	119.69	2.00	23.56	0.05	0.00

:: Estimation of post-earthquake lateral Displacements :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	R_f (%)	$Q_{tn,cs}$	FS	D_r	Gamma_{max} (%)	Lat. disp. (in)
25.83	17.60	23.01	4.77	121.88	2.00	18.50	0.05	0.00
26.00	16.37	21.28	5.01	120.99	2.00	15.93	0.06	0.00
26.16	16.18	20.86	4.82	117.74	2.00	15.26	0.06	0.00
26.33	17.86	22.80	4.14	112.97	2.00	18.20	0.05	0.00
26.49	21.18	26.72	3.30	106.80	2.00	23.44	0.05	0.00
26.65	24.54	30.61	2.77	169.07	2.00	27.93	0.00	0.00
26.82	27.63	34.14	2.46	118.63	2.00	31.52	0.00	0.00
26.98	31.18	38.11	2.12	96.73	2.00	35.16	0.00	0.00
27.15	32.20	39.19	2.17	99.07	2.00	36.08	0.00	0.00
27.31	29.15	35.44	2.40	107.98	2.00	32.77	0.00	0.00
27.47	25.55	31.00	2.66	154.87	2.00	28.35	0.00	0.00
27.64	22.56	27.26	2.84	203.30	2.00	24.10	0.00	0.00
27.80	18.58	22.39	3.44	102.24	2.00	17.60	0.05	0.00
27.97	15.27	18.21	3.80	99.36	2.00	10.78	0.06	0.00
28.13	18.23	21.58	2.85	91.89	2.00	16.39	0.06	0.00
28.30	23.93	28.11	2.17	122.53	2.00	25.12	0.00	0.00
28.46	28.04	32.77	2.00	88.99	2.00	30.18	0.00	0.00
28.62	33.42	38.66	1.62	85.45	2.00	35.64	0.00	0.00
28.79	37.31	42.79	1.39	83.27	2.00	38.98	0.00	0.00
28.95	33.92	38.89	1.59	85.06	2.00	35.83	0.00	0.00
29.12	26.66	30.54	1.95	90.51	2.00	27.85	0.00	0.00
29.28	20.30	23.05	2.07	147.24	2.00	18.56	0.00	0.00
29.44	13.88	15.51	2.74	80.43	2.00	5.48	0.07	0.00
29.61	9.47	10.04	3.80	79.18	1.56	0.00	0.27	0.00
29.77	8.27	8.50	4.11	76.51	1.32	0.00	0.62	0.00
29.94	8.64	8.91	3.93	76.60	1.38	0.00	0.50	0.00
30.10	9.25	9.60	4.11	80.35	1.49	0.00	0.35	0.00
30.26	9.68	10.07	3.93	80.38	1.56	0.00	0.27	0.00
30.43	9.64	9.97	3.73	78.41	1.54	0.00	0.29	0.00
30.59	10.22	10.62	3.52	78.40	1.64	0.00	0.21	0.00
30.76	11.99	12.68	3.34	81.89	2.00	0.00	0.08	0.00
30.92	14.57	15.65	3.02	84.47	2.00	5.79	0.07	0.00
31.08	18.59	20.15	2.80	88.97	2.00	14.13	0.06	0.00
31.25	24.27	26.38	2.39	157.76	2.00	23.02	0.00	0.00
31.41	30.87	33.46	1.94	88.56	2.00	30.86	0.00	0.00
31.58	35.46	38.27	1.75	88.39	2.00	35.30	0.00	0.00
31.74	36.60	39.43	1.91	93.33	2.00	36.28	0.00	0.00
31.90	34.48	37.06	2.20	97.85	2.00	34.23	0.00	0.00
32.07	30.89	33.12	2.72	149.15	2.00	30.52	0.00	0.00
32.23	27.41	29.29	3.43	263.67	2.00	26.47	0.00	0.00
32.40	28.75	30.57	3.20	221.48	2.00	27.88	0.00	0.00
32.56	37.31	39.44	2.20	100.03	2.00	36.29	0.00	0.00
32.72	49.16	51.56	1.46	92.30	2.00	45.14	0.00	0.00
32.89	60.55	63.01	1.09	91.43	2.00	51.76	0.00	0.00
33.05	69.09	71.36	0.84	91.52	2.00	55.86	0.00	0.00
33.22	71.13	73.22	0.84	93.19	2.00	56.71	0.00	0.00
33.38	63.93	65.79	1.03	92.14	2.00	53.18	0.00	0.00
33.54	51.66	53.09	1.32	89.58	2.00	46.10	0.00	0.00

:: Estimation of post-earthquake lateral Displacements :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	R_f (%)	$Q_{tn,cs}$	FS	D_r	$Gamma_{max}$ (%)	Lat. disp. (in)
33.71	38.58	39.44	1.66	87.27	2.00	36.29	0.00	0.00
33.87	26.50	26.78	2.34	149.49	2.00	23.52	0.00	0.00
34.04	18.23	18.01	3.29	92.56	2.00	10.41	0.06	0.00
34.20	13.97	13.36	4.15	92.12	2.00	0.55	0.08	0.00
34.36	12.71	11.93	4.40	90.43	1.83	0.00	0.12	0.00
34.53	12.48	11.61	4.33	88.78	1.78	0.00	0.14	0.00
34.69	12.58	11.66	4.13	87.19	1.79	0.00	0.14	0.00
34.86	11.42	10.37	4.55	86.66	1.59	0.00	0.25	0.00
35.02	11.61	10.51	5.00	90.64	1.61	0.00	0.23	0.00
35.19	15.27	14.33	4.45	97.78	2.00	2.87	0.07	0.00
35.35	23.48	22.75	3.15	98.61	2.00	18.13	0.05	0.00
35.51	35.10	34.42	2.22	98.05	2.00	31.80	0.00	0.00
35.68	45.74	44.92	1.71	93.11	2.00	40.59	0.00	0.00
35.84	52.26	51.20	1.38	89.74	2.00	44.90	0.00	0.00
36.01	52.14	50.86	1.30	87.50	2.00	44.68	0.00	0.00
36.17	45.57	44.18	1.45	85.94	2.00	40.04	0.00	0.00
36.33	34.79	33.38	2.07	91.37	2.00	30.79	0.00	0.00
36.50	30.20	28.69	2.45	148.72	2.00	25.79	0.00	0.00
36.66	37.10	35.38	1.89	89.17	2.00	32.71	0.00	0.00
36.83	52.92	50.73	1.25	85.88	2.00	44.60	0.00	0.00
36.99	72.68	69.79	0.94	92.84	2.00	55.13	0.00	0.00
37.15	93.03	89.27	0.73	103.82	2.00	63.25	0.00	0.00
37.32	106.59	102.11	0.69	113.78	2.00	67.69	0.00	0.00
37.48	110.79	105.93	0.76	118.83	0.76	68.90	7.00	0.00
37.65	111.19	106.03	0.81	120.34	0.78	68.93	6.49	0.00
37.81	112.55	107.04	0.82	121.44	0.80	69.25	6.15	0.00
37.97	115.01	109.10	0.82	123.22	0.82	69.88	5.63	0.00
38.14	117.71	111.36	0.82	125.12	0.85	70.55	5.13	0.00
38.30	120.49	113.71	0.83	127.55	0.89	71.24	4.55	0.00
38.47	122.14	114.95	0.87	129.70	0.92	71.60	4.10	0.00
38.63	122.38	114.87	0.98	132.81	0.97	71.58	3.52	0.00
38.79	125.44	117.45	1.05	137.09	1.04	72.31	2.87	0.00
38.96	134.38	125.54	0.98	142.20	1.13	74.51	2.25	0.00
39.12	149.01	139.02	0.85	149.71	1.28	77.87	1.94	0.00
39.29	166.43	155.05	0.73	158.93	1.48	81.48	1.43	0.00
39.45	179.41	166.90	0.64	166.90	1.67	83.91	1.11	0.00
39.61	186.22	172.94	0.55	172.94	1.83	85.08	1.10	0.00
39.78	185.80	172.13	0.54	172.13	1.81	84.93	0.94	0.00
39.94	178.35	164.73	0.56	164.73	1.62	83.48	1.18	0.00
40.11	167.83	154.46	0.61	154.46	1.38	81.35	1.64	0.00
40.27	163.61	150.13	0.64	150.91	1.31	80.41	1.84	0.00
40.43	165.61	151.59	0.68	153.83	1.37	80.73	1.67	0.00
40.60	172.13	157.19	0.73	160.59	1.53	81.93	1.33	0.00
40.76	181.64	165.52	0.80	170.21	1.77	83.63	0.98	0.00
40.93	188.98	171.80	0.85	177.05	1.96	84.86	0.79	0.00
41.09	190.22	172.46	0.88	179.05	2.00	84.99	0.00	0.00
41.26	182.72	165.04	0.91	173.85	1.88	83.54	0.87	0.00
41.42	167.38	150.54	0.90	161.18	1.55	80.50	1.29	0.00

:: Estimation of post-earthquake lateral Displacements :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	R_f (%)	$Q_{tn,cs}$	FS	D_r	$Gamma_{max}$ (%)	Lat. disp. (in)
41.58	146.98	131.50	0.87	144.09	1.18	76.04	2.27	0.00
41.75	127.07	112.93	0.88	128.35	0.92	71.01	4.13	0.00
41.91	113.51	100.28	0.90	117.85	0.77	67.09	6.83	0.00
42.08	112.13	98.83	0.80	113.99	0.72	66.61	8.20	0.00
42.24	121.77	107.46	0.69	118.22	0.78	69.38	6.66	0.00
42.40	138.26	122.37	0.58	126.99	0.90	73.66	4.35	0.00
42.57	157.96	140.25	0.47	140.25	1.12	78.16	2.54	0.00
42.73	174.56	155.38	0.38	155.38	1.43	81.55	1.53	0.00
42.90	181.89	161.84	0.35	161.84	1.58	82.89	1.24	0.00
43.06	178.23	158.17	0.36	158.17	1.50	82.13	1.39	0.00
43.22	164.06	144.66	0.44	144.66	1.21	79.19	2.17	0.00
43.39	143.02	124.96	0.56	128.32	0.93	74.35	4.00	0.00
43.55	119.06	102.83	0.72	115.21	0.74	67.92	7.50	0.00
43.72	95.70	81.41	1.00	104.49	0.62	60.21	22.70	0.00
43.88	76.86	64.27	1.41	101.28	0.59	52.41	34.10	0.00
44.04	68.55	56.72	1.60	100.48	0.59	48.29	34.10	0.00
44.21	72.33	59.92	1.41	97.83	0.56	50.10	34.10	0.00
44.37	79.72	66.36	1.15	96.05	0.55	53.47	34.10	0.00
44.54	83.14	69.16	1.13	97.72	0.56	54.83	34.10	0.00
44.70	80.92	66.91	1.26	99.45	2.00	53.74	0.00	0.00
44.86	73.93	60.59	1.38	97.54	2.00	50.46	0.00	0.00
45.03	57.87	46.45	1.69	94.23	2.00	41.69	0.00	0.00
45.19	39.26	30.32	2.45	138.75	2.00	27.61	0.00	0.00
45.36	25.90	18.99	3.24	93.87	2.00	12.17	0.06	0.00
45.52	21.24	15.13	3.95	94.75	2.00	4.67	0.07	0.00
45.68	36.28	27.50	2.59	174.10	2.00	24.39	0.00	0.00
45.85	56.37	44.27	2.06	101.46	2.00	40.11	0.00	0.00
46.01	84.66	68.37	1.46	106.36	2.00	54.45	0.00	0.00
46.18	113.20	92.97	1.10	116.95	2.00	64.59	0.00	0.00
46.34	137.16	114.09	0.77	126.28	2.00	71.35	0.00	0.00
46.50	139.41	116.13	0.66	124.63	0.89	71.94	4.43	0.00
46.67	135.77	112.88	0.60	120.18	0.83	71.00	5.47	0.00
46.83	122.87	100.68	0.88	117.69	0.80	67.22	6.14	0.00
47.00	107.95	87.00	1.24	115.89	0.78	62.40	10.98	0.00
47.16	102.09	81.53	1.45	117.10	0.79	60.26	9.97	0.00
47.32	107.51	85.91	1.40	119.31	0.82	61.99	8.41	0.00
47.49	118.11	94.78	1.25	122.95	0.88	65.23	4.67	0.00
47.65	130.61	105.74	0.95	124.02	0.89	68.84	4.42	0.00
47.82	142.57	116.39	0.72	126.54	0.93	72.01	3.89	0.00
47.98	147.31	120.73	0.58	125.89	0.93	73.22	4.00	0.00
48.15	143.48	117.41	0.53	121.31	0.86	72.30	4.96	0.00
48.31	137.10	111.85	0.50	115.71	0.78	70.70	6.47	0.00
48.47	131.18	106.44	0.52	112.18	0.74	69.06	7.64	0.00
48.64	128.98	103.83	0.64	113.62	0.76	68.24	7.09	0.00
48.80	128.68	102.94	0.75	115.99	0.79	67.96	6.30	0.00
48.97	133.98	106.83	0.84	121.83	0.87	69.18	4.73	0.00
49.13	129.38	102.38	0.94	120.93	0.86	67.78	4.91	0.00
49.29	118.55	92.99	1.00	114.23	0.77	64.60	11.22	0.00

:: Estimation of post-earthquake lateral Displacements :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	R_f (%)	$Q_{tn,cs}$	FS	D_r	$Gamma_{max}$ (%)	Lat. disp. (in)
49.46	102.67	79.68	0.97	102.26	0.64	59.50	22.70	0.00
49.62	83.03	63.23	1.06	90.94	0.53	51.87	34.10	0.00
49.79	57.44	42.11	1.36	82.11	0.47	38.45	51.20	0.00
49.95	42.83	30.31	1.59	78.01	0.44	27.60	51.20	0.00
50.11	45.65	32.56	1.36	74.52	0.42	29.96	51.20	0.00
50.28	58.32	42.80	0.99	73.09	0.41	38.99	51.20	0.00
50.44	75.74	57.16	0.71	76.62	0.44	48.54	34.10	0.00
50.61	94.58	72.95	0.53	84.73	0.49	56.59	22.70	0.00
50.77	113.22	88.62	0.44	88.62	0.52	63.01	22.70	0.00
50.93	122.83	96.48	0.44	96.48	0.59	65.82	14.50	0.00
51.10	129.35	101.59	0.46	101.59	0.64	67.52	11.70	0.00
51.26	135.90	106.73	0.49	106.73	0.70	69.15	9.14	0.00
51.43	144.47	113.66	0.48	113.66	0.78	71.23	6.53	0.00
51.59	150.73	118.62	0.49	118.62	0.85	72.64	5.11	0.00
51.75	151.48	118.84	0.51	121.89	0.90	72.70	4.35	0.00
51.92	147.25	115.15	0.50	118.54	0.85	71.65	5.08	0.00
52.08	143.97	112.49	0.46	112.49	0.77	70.89	6.77	0.00
52.25	139.48	108.93	0.40	108.93	0.73	69.82	7.99	0.00
52.41	134.14	104.60	0.36	104.60	0.68	68.48	9.77	0.00
52.57	127.61	99.18	0.33	99.18	0.62	66.73	12.54	0.00
52.74	119.98	92.38	0.37	92.38	0.56	64.38	22.70	0.00
52.90	111.10	84.41	0.45	84.41	0.50	61.41	22.70	0.00
53.07	108.28	81.69	0.50	91.25	0.55	60.33	22.70	0.00
53.23	114.61	86.72	0.49	95.15	0.59	62.30	22.70	0.00
53.39	128.17	97.82	0.45	97.82	0.62	66.27	13.03	0.00
53.56	144.66	111.44	0.41	111.44	0.77	70.57	6.81	0.00
53.72	157.62	122.24	0.38	122.24	0.92	73.63	4.03	0.00
53.89	163.63	126.65	0.42	126.65	1.00	74.80	3.24	0.00
54.05	164.28	126.62	0.45	126.62	1.00	74.79	3.23	0.00
54.22	163.32	125.44	0.47	125.44	0.98	74.48	3.40	0.00
54.38	163.05	124.86	0.48	124.86	0.97	74.33	3.48	0.00
54.54	166.84	127.08	0.55	129.71	1.05	74.91	2.74	0.00
54.71	173.20	131.39	0.62	135.87	1.17	76.01	2.32	0.00
54.87	177.02	133.78	0.68	139.78	1.25	76.61	2.03	0.00
55.04	183.49	137.79	0.80	147.13	1.41	77.58	1.58	0.00
55.20	189.16	142.70	0.71	148.13	1.44	78.74	1.52	0.00

Total estimated displacement: 0.45

Abbreviations

q_t:	Total cone resistance
Q_{tn}:	Adjusted cone resistance to an effective overburden stress of 1 atm
R_f:	Friction ration
$Q_{tn,cs}$:	Adjusted and corrected cone resistance due to fines
FS:	Calculated factor of safety against liquefaction
D_r:	Calculated relative density
$Gamma_{max}$:	Calculated maximum cyclic shear strain
Lat. disp.:	Lateral displacement

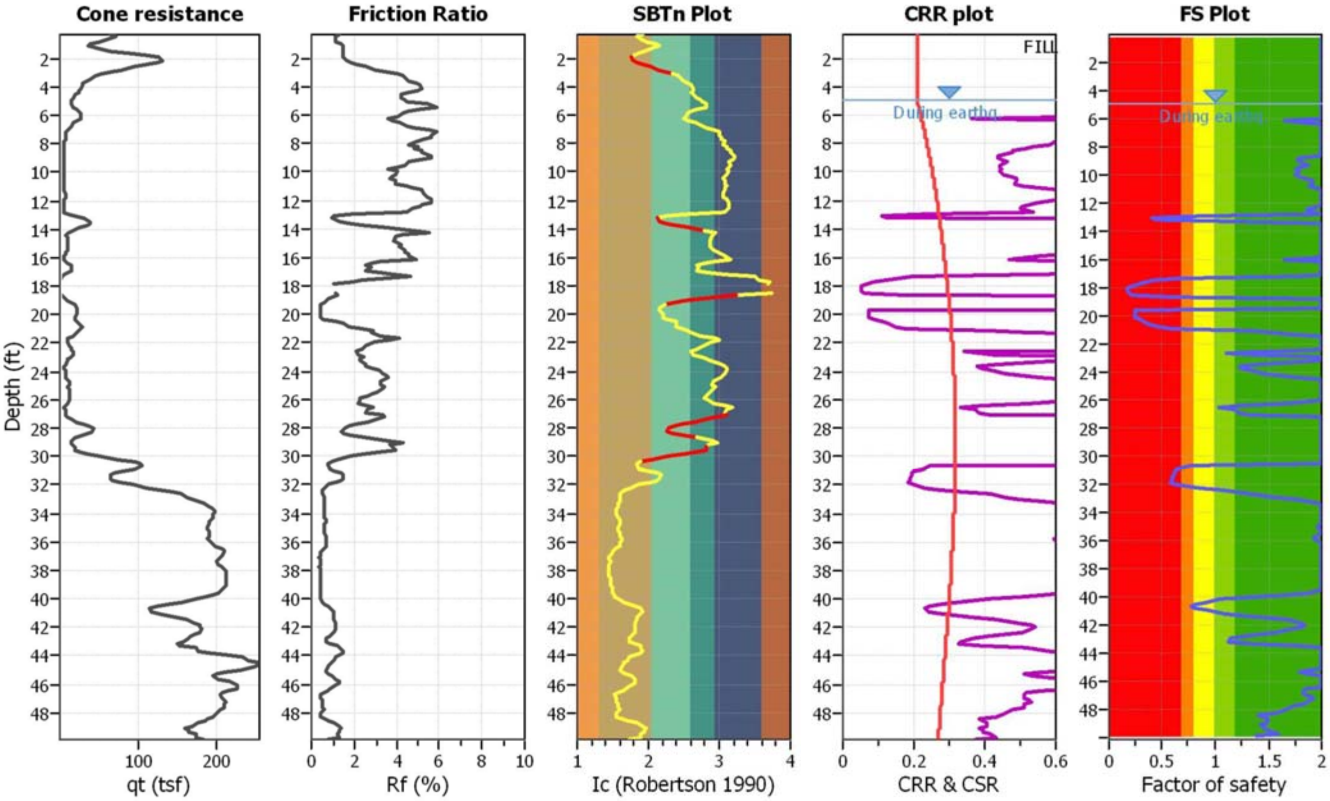
LIQUEFACTION ANALYSIS REPORT

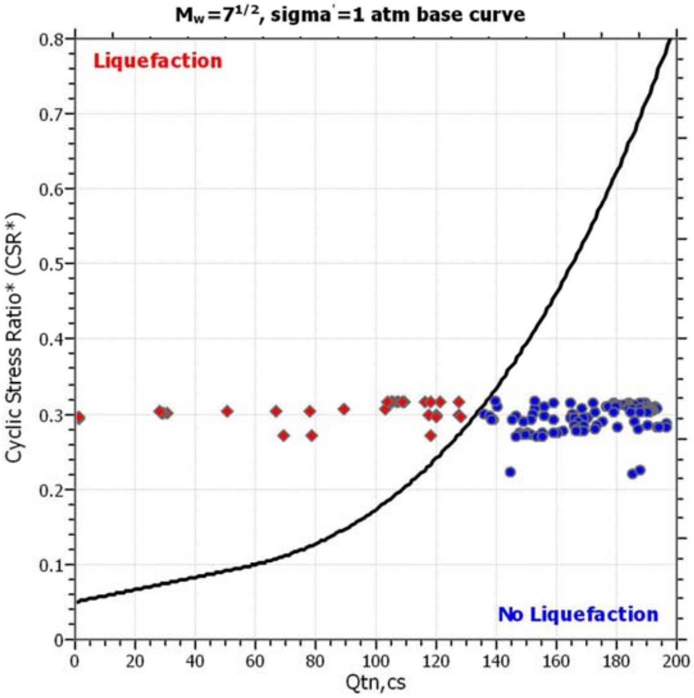
Project title : CIS-72092.4 **Location : Proposed CarMax National City**

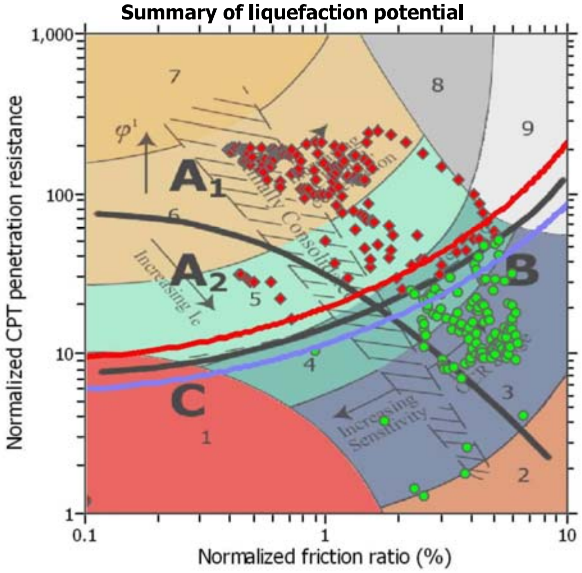
CPT file : CPT-03

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	5.00 ft	Use fill:	Yes	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	10.00 ft	Fill height:	5.00 ft	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	5	Fill weight:	120.00 lb/ft^3	Limit depth:	N/A
Earthquake magnitude M_w:	6.76	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.43	Unit weight calculation:	Based on SBT	K_σ applied:	No		

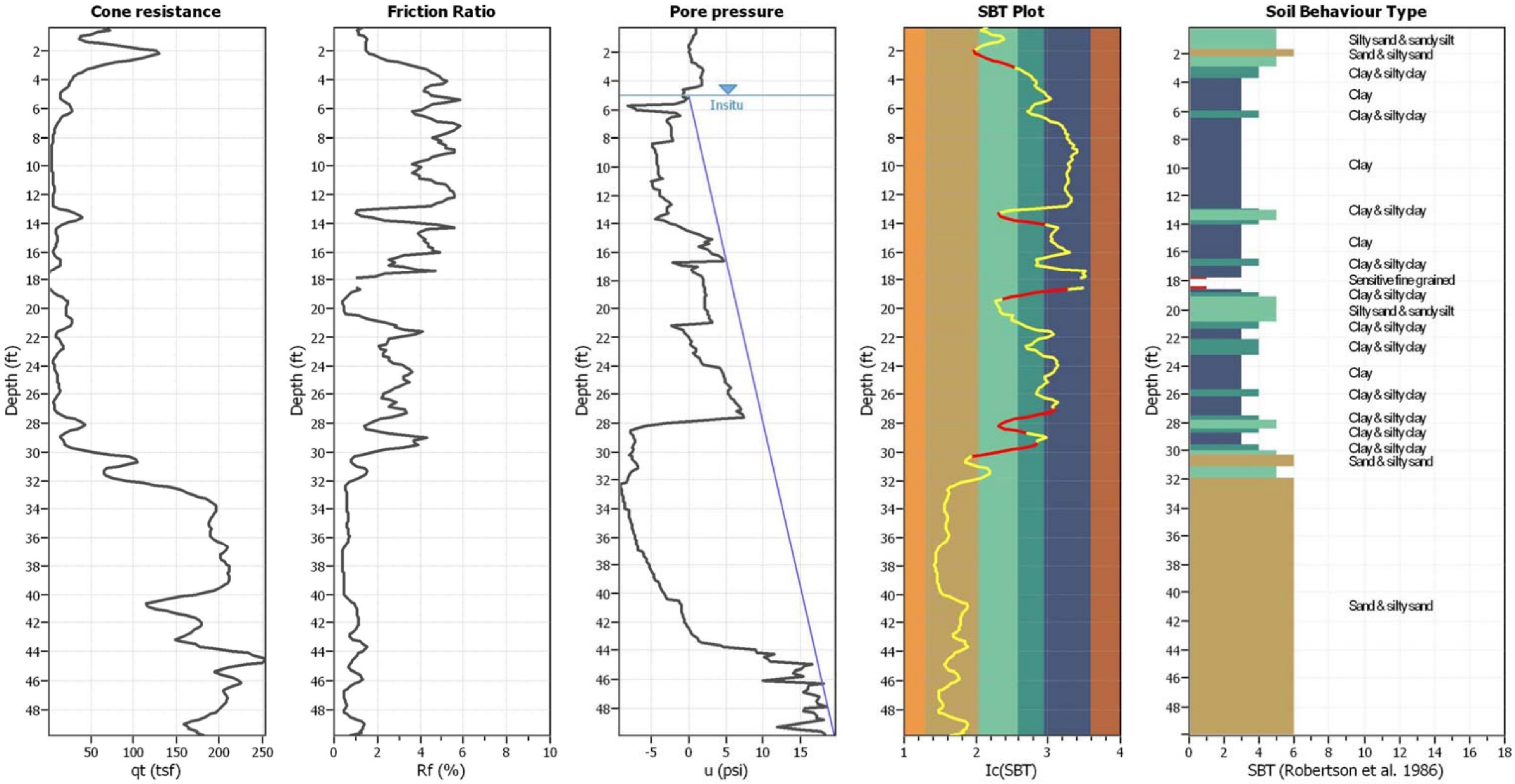






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



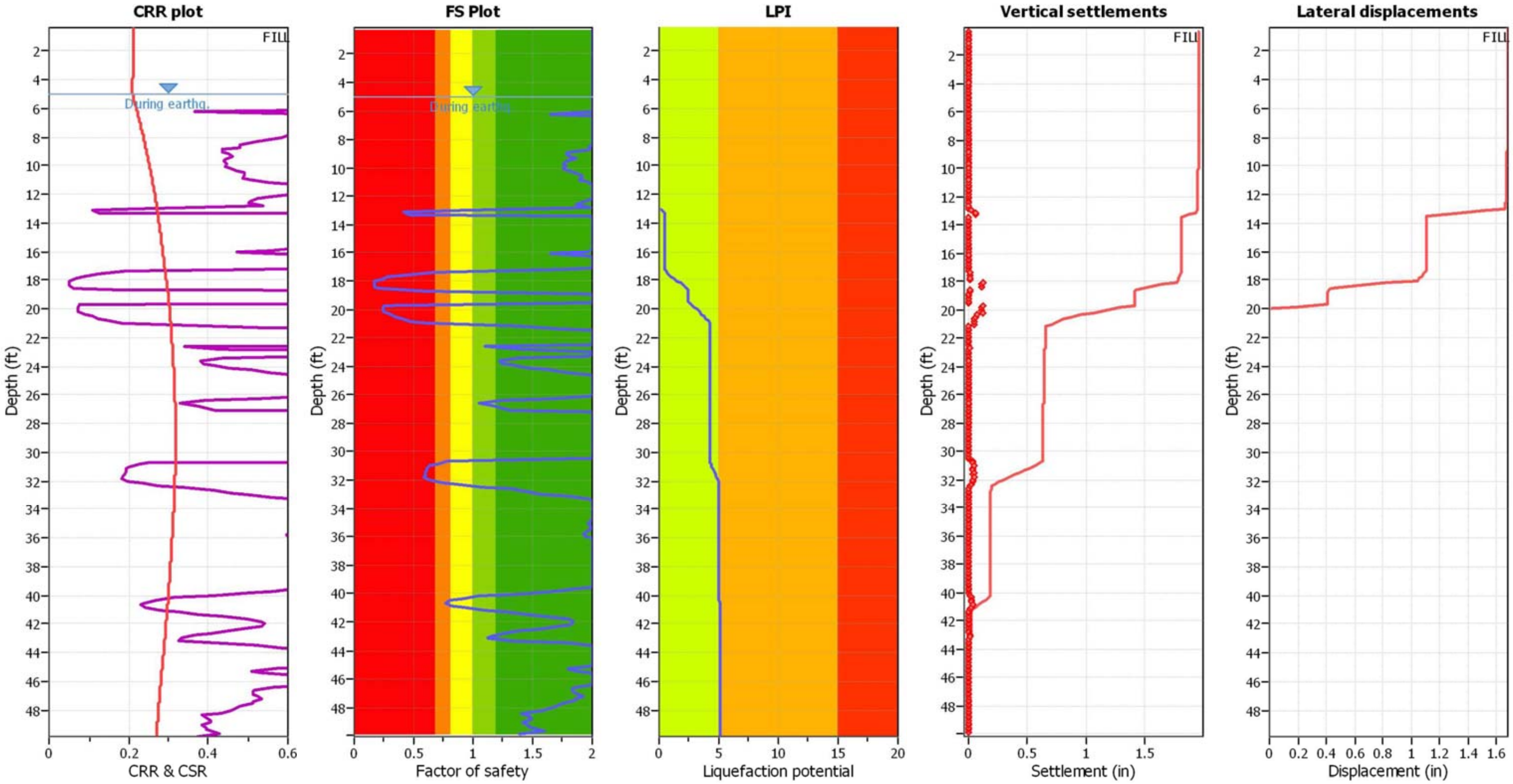
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	10.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	5	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	No
Earthquake magnitude M_w:	6.76	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.43	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	5.00 ft	Fill height:	5.00 ft	Limit depth:	N/A

SBT legend

🟥 1. Sensitive fine grained	🟦 4. Clayey silt to silty	🟧 7. Gravely sand to sand
🟫 2. Organic material	🟩 5. Silty sand to sandy silt	⬛ 8. Very stiff sand to
🟦 3. Clay to silty clay	🟨 6. Clean sand to silty sand	⬜ 9. Very stiff fine grained

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	10.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	5	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K$_\sigma$ applied:	No
Earthquake magnitude M$_w$:	6.76	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.43	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	5.00 ft	Fill height:	5.00 ft	Limit depth:	N/A

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

:: Post-earthquake settlement of dry sands ::

Depth (ft)	Ic	Kc	Qc1n	Qc1n,cs	N1,60 (blows)	Vs (ft/s)	Gmax (tsf)	CSR	Shear, γ (%)	Svol,15 (%)	Nc	ev (%)	Settle. (in)
5.33	1.93	1.22	121.75	148.43	30	600.0	667	0.21	0.014	0.01	9.05	0.01	0.000
5.49	1.83	1.13	137.35	155.61	30	599.9	666	0.21	0.014	0.01	9.05	0.01	0.000
5.66	1.91	1.20	111.17	133.02	27	565.0	581	0.21	0.018	0.01	9.05	0.01	0.000
5.82	1.96	1.26	96.93	121.80	25	546.7	539	0.21	0.021	0.02	9.05	0.01	0.000
5.98	2.10	1.46	73.51	107.52	23	519.6	481	0.21	0.027	0.02	9.05	0.02	0.001
6.15	2.15	1.56	68.84	107.60	24	519.0	480	0.21	0.028	0.02	9.05	0.02	0.001
6.31	2.07	1.41	86.05	121.27	26	551.7	552	0.21	0.022	0.02	9.05	0.01	0.001
6.48	1.96	1.25	122.17	152.25	31	610.6	695	0.21	0.016	0.01	9.05	0.01	0.000
6.64	1.86	1.16	166.31	192.29	38	672.4	864	0.21	0.012	0.01	9.05	0.00	0.000
6.80	1.80	1.11	208.32	230.96	45	724.4	1021	0.21	0.010	0.00	9.05	0.00	0.000
6.97	1.77	1.09	238.96	259.84	50	761.5	1142	0.21	0.009	0.00	9.05	0.00	0.000
7.13	1.80	1.10	245.79	271.42	0	0.0	0	0.21	0.000	0.00	9.05	0.00	0.000
7.30	1.85	1.15	233.64	268.04	0	0.0	0	0.21	0.000	0.00	9.05	0.00	0.000
7.46	1.93	1.22	209.12	255.23	0	0.0	0	0.21	0.000	0.00	9.05	0.00	0.000
7.62	2.03	1.34	178.91	239.13	0	0.0	0	0.21	0.000	0.00	9.05	0.00	0.000
7.79	2.14	1.53	148.31	226.59	0	0.0	0	0.21	0.000	0.00	9.05	0.00	0.000
7.95	2.24	1.78	122.10	217.73	0	0.0	0	0.21	0.000	0.00	9.05	0.00	0.000
8.12	2.35	2.10	99.97	210.12	0	0.0	0	0.21	0.000	0.00	9.05	0.00	0.000
8.28	2.41	2.36	85.56	201.60	0	0.0	0	0.21	0.000	0.00	9.05	0.00	0.000
8.45	2.46	2.58	74.80	192.85	49	656.9	828	0.21	0.017	0.01	9.05	0.00	0.000
8.61	2.51	2.80	66.09	184.89	48	634.9	767	0.21	0.020	0.01	9.05	0.01	0.000
8.77	2.56	3.10	58.24	180.82	48	617.5	721	0.21	0.022	0.01	9.05	0.01	0.000
8.94	2.59	3.29	54.10	178.22	48	607.2	694	0.21	0.024	0.01	9.05	0.01	0.000
9.10	2.62	3.48	50.38	175.45	0	0.0	0	0.21	0.000	0.00	0.00	0.00	0.000
9.27	2.62	3.47	48.61	168.74	0	0.0	0	0.21	0.000	0.00	0.00	0.00	0.000
9.43	2.61	3.37	46.27	155.73	0	0.0	0	0.21	0.000	0.00	0.00	0.00	0.000
9.59	2.63	3.54	39.66	140.28	0	0.0	0	0.21	0.000	0.00	9.05	0.00	0.000
9.76	2.69	3.91	32.98	128.82	0	0.0	0	0.21	0.000	0.00	0.00	0.00	0.000
9.92	2.74	4.30	29.02	124.89	0	0.0	0	0.21	0.000	0.00	0.00	0.00	0.000

Total estimated settlement: 0.00

:: 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)
10.09	125.26	2.00	0.00	1.00	0.00	10.25	138.60	2.00	0.00	1.00	0.00
10.41	152.60	2.00	0.00	1.00	0.00	10.58	379.68	2.00	0.00	1.00	0.00
10.74	257.38	2.00	0.00	1.00	0.00	10.91	211.96	2.00	0.00	1.00	0.00
11.07	185.63	2.00	0.00	1.00	0.00	11.23	145.24	1.64	0.00	1.00	0.00
11.40	188.15	2.00	0.00	1.00	0.00	11.56	280.91	2.00	0.00	1.00	0.00
11.73	126.97	2.00	0.00	1.00	0.00	11.89	122.94	2.00	0.00	1.00	0.00
12.05	122.31	2.00	0.00	1.00	0.00	12.22	118.86	2.00	0.00	1.00	0.00
12.38	112.93	2.00	0.00	1.00	0.00	12.55	108.80	2.00	0.00	1.00	0.00
12.71	102.28	2.00	0.00	1.00	0.00	12.87	95.28	2.00	0.00	1.00	0.00
13.04	90.42	2.00	0.00	1.00	0.00	13.20	90.21	2.00	0.00	1.00	0.00
13.37	87.61	2.00	0.00	1.00	0.00	13.53	87.26	1.98	0.00	1.00	0.00
13.69	87.28	1.98	0.00	1.00	0.00	13.86	86.67	1.79	0.01	1.00	0.00
14.02	86.65	1.78	0.01	1.00	0.00	14.19	84.46	1.82	0.01	1.00	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)
14.35	82.08	1.87	0.00	1.00	0.00	14.51	79.25	1.78	0.01	1.00	0.00
14.68	76.45	1.76	0.01	1.00	0.00	14.84	73.61	1.78	0.01	1.00	0.00
15.01	76.47	1.75	0.01	1.00	0.00	15.17	76.55	1.78	0.01	1.00	0.00
15.34	76.68	1.85	0.01	1.00	0.00	15.50	76.76	1.91	0.00	1.00	0.00
15.66	79.61	1.91	0.00	1.00	0.00	15.83	79.58	1.89	0.00	1.00	0.00
15.99	85.02	1.95	0.00	1.00	0.00	16.16	90.30	2.00	0.00	1.00	0.00
16.32	97.59	2.00	0.00	1.00	0.00	16.48	102.24	2.00	0.00	1.00	0.00
16.65	104.46	2.00	0.00	1.00	0.00	16.81	104.44	2.00	0.00	1.00	0.00
16.98	102.08	2.00	0.00	1.00	0.00	17.14	97.24	2.00	0.00	1.00	0.00
17.30	92.48	1.96	0.00	1.00	0.00	17.47	89.95	1.88	0.00	1.00	0.00
17.63	87.50	1.86	0.00	1.00	0.00	17.80	87.75	1.99	0.00	1.00	0.00
17.96	118.18	0.86	1.22	1.00	0.02	18.12	69.53	0.41	3.15	1.00	0.06
18.29	78.49	0.46	2.85	1.00	0.06	18.45	94.44	2.00	0.00	1.00	0.00
18.62	110.86	2.00	0.00	1.00	0.00	18.78	116.83	2.00	0.00	1.00	0.00
18.94	162.60	2.00	0.00	1.00	0.00	19.11	134.41	2.00	0.00	1.00	0.00
19.27	122.55	2.00	0.00	1.00	0.00	19.44	101.92	2.00	0.00	1.00	0.00
19.60	100.76	2.00	0.00	1.00	0.00	19.76	100.22	2.00	0.00	1.00	0.00
19.93	103.87	2.00	0.00	1.00	0.00	20.09	107.70	2.00	0.00	1.00	0.00
20.26	107.16	2.00	0.00	1.00	0.00	20.42	104.08	2.00	0.00	1.00	0.00
20.58	100.02	2.00	0.00	1.00	0.00	20.75	95.39	2.00	0.00	1.00	0.00
20.91	90.36	1.95	0.00	1.00	0.00	21.08	87.12	1.64	0.01	1.00	0.00
21.24	82.38	2.00	0.00	1.00	0.00	21.40	86.53	2.00	0.00	1.00	0.00
21.57	203.20	2.00	0.00	1.00	0.00	21.73	92.70	2.00	0.00	1.00	0.00
21.90	216.96	2.00	0.00	1.00	0.00	22.06	91.06	2.00	0.00	1.00	0.00
22.23	81.11	1.75	0.01	1.00	0.00	22.39	58.41	0.67	0.50	1.00	0.01
22.55	39.00	0.42	0.50	1.00	0.01	22.72	31.38	0.28	0.50	1.00	0.01
22.88	25.06	0.23	0.50	1.00	0.01	23.05	1.22	0.17	5.80	1.00	0.12
23.21	1.17	0.17	5.80	1.00	0.11	23.37	1.23	0.17	5.80	1.00	0.11
23.54	24.08	0.20	0.50	1.00	0.01	23.70	36.98	0.59	0.50	1.00	0.01
23.87	43.06	2.00	0.00	1.00	0.00	24.03	45.37	2.00	0.00	1.00	0.00
24.19	47.87	2.00	0.00	1.00	0.00	24.36	27.81	2.00	0.00	1.00	0.00
24.52	31.32	2.00	0.00	1.00	0.00	24.69	30.89	0.25	5.80	1.00	0.12
24.85	29.37	0.25	5.80	1.00	0.11	25.01	28.66	0.24	5.80	1.00	0.11
25.18	27.99	0.24	5.80	1.00	0.12	25.34	50.41	0.30	4.10	1.00	0.08
25.51	67.10	0.36	3.24	1.00	0.07	25.67	78.13	0.41	2.86	1.00	0.05
25.83	89.39	0.48	2.56	1.00	0.05	26.00	102.95	0.59	2.28	1.00	0.05
26.16	153.09	1.35	0.00	1.00	0.00	26.33	168.92	1.72	0.00	1.00	0.00
26.49	101.94	2.00	0.00	1.00	0.00	26.65	97.06	2.00	0.00	1.00	0.00
26.82	87.33	2.00	0.00	1.00	0.00	26.98	80.41	2.00	0.00	1.00	0.00
27.15	80.59	2.00	0.00	1.00	0.00	27.31	83.21	2.00	0.00	1.00	0.00
27.47	204.19	2.00	0.00	1.00	0.00	27.64	140.83	1.10	0.44	1.00	0.01
27.80	155.96	1.40	0.00	1.00	0.00	27.97	81.00	2.00	0.00	1.00	0.00
28.13	73.66	2.00	0.00	1.00	0.00	28.30	69.69	1.97	0.00	1.00	0.00
28.46	65.08	1.40	0.03	1.00	0.00	28.62	62.10	1.22	0.05	1.00	0.00
28.79	64.60	1.24	0.05	1.00	0.00	28.95	69.47	1.33	0.04	1.00	0.00
29.12	74.04	1.46	0.02	1.00	0.00	29.28	78.32	1.62	0.01	1.00	0.00
29.44	82.27	1.76	0.01	1.00	0.00	29.61	83.98	2.00	0.00	1.00	0.00
29.77	85.36	2.00	0.00	1.00	0.00	29.94	85.13	2.00	0.00	1.00	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)
30.10	87.04	2.00	0.00	1.00	0.00	30.26	86.61	2.00	0.00	1.00	0.00
30.43	85.84	2.00	0.00	1.00	0.00	30.59	83.51	2.00	0.00	1.00	0.00
30.76	81.14	2.00	0.00	1.00	0.00	30.92	74.97	2.00	0.00	1.00	0.00
31.08	71.44	2.00	0.00	1.00	0.00	31.25	65.33	1.65	0.01	1.00	0.00
31.41	62.69	1.25	0.05	1.00	0.00	31.58	61.93	1.04	0.10	1.00	0.00
31.74	62.33	1.18	0.06	1.00	0.00	31.90	62.34	1.22	0.05	1.00	0.00
32.07	71.23	1.32	0.04	1.00	0.00	32.23	81.29	2.00	0.00	1.00	0.00
32.40	90.21	2.00	0.00	1.00	0.00	32.56	196.87	2.00	0.00	1.00	0.00
32.72	95.05	2.00	0.00	1.00	0.00	32.89	93.93	2.00	0.00	1.00	0.00
33.05	92.02	2.00	0.00	1.00	0.00	33.22	85.64	2.00	0.00	1.00	0.00
33.38	81.92	2.00	0.00	1.00	0.00	33.54	87.06	2.00	0.00	1.00	0.00
33.71	212.79	2.00	0.00	1.00	0.00	33.87	92.43	2.00	0.00	1.00	0.00
34.04	99.79	2.00	0.00	1.00	0.00	34.20	99.82	2.00	0.00	1.00	0.00
34.36	104.50	2.00	0.00	1.00	0.00	34.53	109.22	2.00	0.00	1.00	0.00
34.69	223.60	2.00	0.00	1.00	0.00	34.86	104.42	2.00	0.00	1.00	0.00
35.02	105.39	2.00	0.00	1.00	0.00	35.19	108.70	2.00	0.00	1.00	0.00
35.35	117.49	2.00	0.00	1.00	0.00	35.51	121.64	2.00	0.00	1.00	0.00
35.68	121.54	0.78	1.53	1.00	0.03	35.84	116.01	0.71	1.99	1.00	0.04
36.01	109.63	0.64	2.17	1.00	0.04	36.17	107.33	0.62	2.20	1.00	0.04
36.33	106.82	0.61	2.21	1.00	0.04	36.50	105.73	0.60	2.23	1.00	0.05
36.66	105.21	0.60	2.24	1.00	0.04	36.83	103.85	0.58	2.27	1.00	0.05
36.99	108.65	0.63	2.18	1.00	0.04	37.15	118.15	0.74	1.94	1.00	0.04
37.32	127.80	0.87	1.09	1.00	0.02	37.48	140.30	1.07	0.44	1.00	0.01
37.65	153.33	1.32	0.21	1.00	0.00	37.81	159.26	1.45	0.00	1.00	0.00
37.97	164.75	1.57	0.00	1.00	0.00	38.14	172.63	1.77	0.00	1.00	0.00
38.30	179.55	1.97	0.00	1.00	0.00	38.47	184.67	2.00	0.00	1.00	0.00
38.63	188.76	2.00	0.00	1.00	0.00	38.79	189.97	2.00	0.00	1.00	0.00
38.96	189.29	2.00	0.00	1.00	0.00	39.12	188.39	2.00	0.00	1.00	0.00
39.29	186.41	2.00	0.00	1.00	0.00	39.45	184.08	2.00	0.00	1.00	0.00
39.61	182.59	2.00	0.00	1.00	0.00	39.78	180.68	2.00	0.00	1.00	0.00
39.94	179.01	1.97	0.00	1.00	0.00	40.11	178.60	1.96	0.00	1.00	0.00
40.27	179.41	1.99	0.00	1.00	0.00	40.43	179.60	1.99	0.00	1.00	0.00
40.60	178.37	1.96	0.00	1.00	0.00	40.76	177.17	1.93	0.00	1.00	0.00
40.93	177.34	1.93	0.00	1.00	0.00	41.09	179.84	2.00	0.00	1.00	0.00
41.26	184.16	2.00	0.00	1.00	0.00	41.42	189.41	2.00	0.00	1.00	0.00
41.58	193.10	2.00	0.00	1.00	0.00	41.75	193.85	2.00	0.00	1.00	0.00
41.91	192.01	2.00	0.00	1.00	0.00	42.08	188.97	2.00	0.00	1.00	0.00
42.24	185.66	2.00	0.00	1.00	0.00	42.40	184.16	2.00	0.00	1.00	0.00
42.57	185.79	2.00	0.00	1.00	0.00	42.73	188.14	2.00	0.00	1.00	0.00
42.90	189.89	2.00	0.00	1.00	0.00	43.06	192.10	2.00	0.00	1.00	0.00
43.22	192.62	2.00	0.00	1.00	0.00	43.39	191.77	2.00	0.00	1.00	0.00
43.55	190.58	2.00	0.00	1.00	0.00	43.72	190.98	2.00	0.00	1.00	0.00
43.88	191.00	2.00	0.00	1.00	0.00	44.04	190.52	2.00	0.00	1.00	0.00
44.21	188.27	2.00	0.00	1.00	0.00	44.37	184.90	2.00	0.00	1.00	0.00
44.54	179.41	2.00	0.00	1.00	0.00	44.70	173.39	1.88	0.00	1.00	0.00
44.86	165.38	1.67	0.00	1.00	0.00	45.03	152.69	1.37	0.00	1.00	0.00
45.19	136.04	1.05	0.66	1.00	0.01	45.36	127.33	0.91	1.10	1.00	0.02
45.52	120.22	0.81	1.55	1.00	0.03	45.68	117.37	0.77	1.61	1.00	0.03

:: 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)
45.85	120.21	0.81	1.55	1.00	0.03	46.01	128.41	0.93	1.08	1.00	0.02
46.18	138.11	1.10	0.45	1.00	0.01	46.34	147.07	1.27	0.22	1.00	0.00
46.50	155.98	1.47	0.00	1.00	0.00	46.67	164.73	1.68	0.00	1.00	0.00
46.83	169.52	1.81	0.00	1.00	0.00	47.00	170.54	1.84	0.00	1.00	0.00
47.16	169.65	1.82	0.00	1.00	0.00	47.32	165.94	1.72	0.00	1.00	0.00
47.49	159.14	1.56	0.00	1.00	0.00	47.65	152.11	1.40	0.00	1.00	0.00
47.82	145.69	1.26	0.22	1.00	0.00	47.98	139.59	1.14	0.44	1.00	0.01
48.15	138.52	1.13	0.45	1.00	0.01	48.31	149.59	1.35	0.22	1.00	0.00
48.47	167.63	1.79	0.00	1.00	0.00	48.64	175.71	2.00	0.00	1.00	0.00
48.80	186.16	2.00	0.00	1.00	0.00	48.97	197.10	2.00	0.00	1.00	0.00
49.13	206.04	2.00	0.00	1.00	0.00	49.29	207.71	2.00	0.00	1.00	0.00
49.46	212.55	2.00	0.00	1.00	0.00	49.62	209.96	2.00	0.00	1.00	0.00
49.79	206.66	2.00	0.00	1.00	0.00	49.95	190.74	2.00	0.00	1.00	0.00
50.11	173.93	2.00	0.00	1.00	0.00	50.28	166.50	1.80	0.00	1.00	0.00
50.44	169.60	1.89	0.00	1.00	0.00	50.61	180.83	2.00	0.00	1.00	0.00
50.77	193.60	2.00	0.00	1.00	0.00	50.93	196.74	2.00	0.00	1.00	0.00
51.10	194.12	2.00	0.00	1.00	0.00	51.26	187.59	2.00	0.00	1.00	0.00
51.43	173.38	2.00	0.00	1.00	0.00	51.59	167.38	1.85	0.00	1.00	0.00
51.75	166.71	1.83	0.00	1.00	0.00	51.92	166.83	1.84	0.00	1.00	0.00
52.08	168.42	1.89	0.00	1.00	0.00	52.25	169.58	1.92	0.00	1.00	0.00
52.41	166.89	1.85	0.00	1.00	0.00	52.57	166.67	1.85	0.00	1.00	0.00
52.74	162.58	1.74	0.00	1.00	0.00	52.90	160.74	1.69	0.00	1.00	0.00
53.07	159.32	1.66	0.00	1.00	0.00	53.23	155.55	1.57	0.00	1.00	0.00
53.39	148.26	1.40	0.00	1.00	0.00	53.56	150.45	1.45	0.00	1.00	0.00
53.72	151.82	1.49	0.00	1.00	0.00	53.89	151.72	1.49	0.00	1.00	0.00
54.05	148.68	1.42	0.00	1.00	0.00	54.22	150.22	1.46	0.00	1.00	0.00
54.38	150.28	1.46	0.00	1.00	0.00	54.54	153.57	1.54	0.00	1.00	0.00
54.71	155.42	1.59	0.00	1.00	0.00	54.87	146.59	1.39	0.00	1.00	0.00

Total estimated settlement: 1.95

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

:: Lateral displacement index calculation ::

Depth (ft)	q_t (tsf)	Q_{tn}	R_f (%)	$Q_{tn,cs}$	FS	D_r	$Gamma_{max}$ (%)	Lat. disp. (in)
10.09	15.23	28.21	4.46	125.26	2.00	25.23	0.04	0.00
10.25	15.01	27.77	5.46	138.60	2.00	24.71	0.04	0.00
10.41	17.05	31.60	5.87	152.60	2.00	28.98	0.04	0.00
10.58	21.83	40.62	5.13	379.68	2.00	37.27	0.00	0.00
10.74	25.53	47.60	4.54	257.38	2.00	42.50	0.00	0.00
10.91	27.55	51.39	4.28	211.96	2.00	45.03	0.00	0.00
11.07	28.11	52.43	4.06	185.63	2.00	45.69	0.00	0.00
11.23	28.14	52.49	3.62	145.24	1.64	45.72	0.18	0.00
11.40	23.96	44.55	3.76	188.15	2.00	40.31	0.00	0.00
11.56	19.11	35.37	4.08	280.91	2.00	32.70	0.00	0.00
11.73	15.61	28.73	4.49	126.97	2.00	25.84	0.04	0.00
11.89	13.36	24.48	4.79	122.94	2.00	20.54	0.05	0.00
12.05	11.30	20.56	5.49	122.31	2.00	14.80	0.06	0.00
12.22	9.92	17.94	5.84	118.86	2.00	10.29	0.06	0.00
12.38	9.21	16.57	5.65	112.93	2.00	7.66	0.07	0.00
12.55	8.59	15.38	5.59	108.80	2.00	5.21	0.07	0.00
12.71	8.01	14.27	5.25	102.28	2.00	2.73	0.07	0.00
12.87	7.15	12.63	5.04	95.28	2.00	0.00	0.08	0.00
13.04	6.98	12.29	4.58	90.42	2.00	0.00	0.08	0.00
13.20	6.45	11.28	4.96	90.21	2.00	0.00	0.09	0.00
13.37	6.21	10.80	4.83	87.61	2.00	0.00	0.09	0.00
13.53	5.80	10.01	5.17	87.26	1.98	0.00	0.10	0.00
13.69	5.83	10.06	5.14	87.28	1.98	0.00	0.10	0.00
13.86	5.35	9.14	5.60	86.67	1.79	0.00	0.16	0.00
14.02	5.36	9.12	5.60	86.65	1.78	0.00	0.16	0.00
14.19	5.52	9.41	5.07	84.46	1.82	0.00	0.14	0.00
14.35	5.68	9.70	4.58	82.08	1.87	0.00	0.12	0.00
14.51	5.48	9.31	4.38	79.25	1.78	0.00	0.16	0.00
14.68	5.44	9.22	4.04	76.45	1.76	0.00	0.17	0.00
14.84	5.54	9.39	3.61	73.61	1.78	0.00	0.16	0.00
15.01	5.48	9.26	4.01	76.47	1.75	0.00	0.17	0.00
15.17	5.60	9.47	3.93	76.55	1.78	0.00	0.16	0.00
15.34	5.82	9.88	3.78	76.68	1.85	0.00	0.13	0.00
15.50	6.02	10.24	3.65	76.76	1.91	0.00	0.11	0.00
15.66	6.06	10.30	3.96	79.61	1.91	0.00	0.11	0.00
15.83	6.02	10.20	3.99	79.58	1.89	0.00	0.12	0.00
15.99	6.24	10.60	4.49	85.02	1.95	0.00	0.10	0.00
16.16	6.77	11.59	4.72	90.30	2.00	0.00	0.08	0.00
16.32	7.35	12.67	5.17	97.59	2.00	0.00	0.08	0.00
16.48	7.96	13.80	5.28	102.24	2.00	1.62	0.08	0.00
16.65	8.16	14.16	5.39	104.46	2.00	2.48	0.08	0.00
16.81	8.04	13.93	5.47	104.44	2.00	1.93	0.08	0.00
16.98	7.51	12.90	5.59	102.08	2.00	0.00	0.08	0.00
17.14	6.79	11.53	5.60	97.24	2.00	0.00	0.08	0.00
17.30	6.52	10.99	5.22	92.48	1.96	0.00	0.09	0.00
17.47	6.32	10.60	5.06	89.95	1.88	0.00	0.11	0.00
17.63	6.28	10.51	4.78	87.50	1.86	0.00	0.12	0.00
17.80	6.70	11.29	4.48	87.75	1.99	0.00	0.09	0.00

:: Estimation of post-earthquake lateral Displacements :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	R_f (%)	$Q_{tn,cs}$	FS	D_r	$Gamma_{max}$ (%)	Lat. disp. (in)
17.96	14.32	24.87	1.96	118.18	0.86	21.07	38.11	0.15
18.12	23.06	37.13	1.04	69.53	0.41	34.30	51.20	0.20
18.29	32.83	51.07	0.97	78.49	0.46	44.82	51.20	0.21
18.45	38.55	60.10	1.30	94.44	2.00	50.20	0.00	0.00
18.62	40.13	63.49	1.79	110.86	2.00	52.01	0.00	0.00
18.78	33.51	54.37	2.33	116.83	2.00	46.89	0.00	0.00
18.94	25.50	42.94	3.37	162.60	2.00	39.10	0.00	0.00
19.11	16.49	28.90	4.85	134.41	2.00	26.02	0.04	0.00
19.27	11.15	19.53	5.56	122.55	2.00	13.10	0.06	0.00
19.44	9.80	16.94	4.29	101.92	2.00	8.41	0.07	0.00
19.60	10.55	18.02	3.98	100.76	2.00	10.44	0.06	0.00
19.76	10.78	18.26	3.90	100.22	2.00	10.87	0.06	0.00
19.93	11.47	19.31	4.01	103.87	2.00	12.71	0.06	0.00
20.09	11.85	19.87	4.22	107.70	2.00	13.67	0.06	0.00
20.26	12.05	20.03	4.15	107.16	2.00	13.93	0.06	0.00
20.42	10.57	17.52	4.35	104.08	2.00	9.50	0.07	0.00
20.58	9.63	15.79	4.36	100.02	2.00	6.08	0.07	0.00
20.75	8.36	13.38	4.55	95.39	2.00	0.60	0.08	0.00
20.91	7.46	11.68	4.56	90.36	1.95	0.00	0.09	0.00
21.08	6.49	9.87	4.93	87.12	1.64	0.00	0.22	0.00
21.24	8.65	13.56	3.24	82.38	2.00	1.06	0.08	0.00
21.40	12.16	18.86	2.80	86.53	2.00	11.94	0.06	0.00
21.57	15.05	23.01	2.53	203.20	2.00	18.50	0.00	0.00
21.73	15.02	22.96	2.80	92.70	2.00	18.44	0.05	0.00
21.90	14.79	22.36	2.57	216.96	2.00	17.56	0.00	0.00
22.06	11.80	17.97	3.22	91.06	2.00	10.34	0.06	0.00
22.23	7.29	10.67	3.84	81.11	1.75	0.00	0.16	0.00
22.39	3.41	4.09	4.69	58.41	0.67	0.00	4.00	0.02
22.55	2.54	2.59	2.37	39.00	0.42	0.00	4.00	0.02
22.72	2.04	1.74	1.96	31.38	0.28	0.00	4.00	0.02
22.88	1.86	1.43	1.07	25.06	0.23	0.00	4.00	0.02
23.05	1.75	1.22	0.00	1.22	0.17	0.00	51.20	0.21
23.21	1.73	1.17	0.00	1.17	0.17	0.00	51.20	0.20
23.37	1.77	1.23	0.00	1.23	0.17	0.00	51.20	0.20
23.54	1.81	1.28	1.10	24.08	0.20	0.00	4.00	0.02
23.70	3.31	3.71	1.21	36.98	0.59	0.00	4.00	0.02
23.87	7.63	10.25	0.79	43.06	2.00	0.00	0.09	0.00
24.03	12.15	16.41	0.66	45.37	2.00	7.35	0.00	0.00
24.19	16.63	22.28	0.60	47.87	2.00	17.45	0.00	0.00
24.36	21.11	27.81	0.47	27.81	2.00	24.76	0.00	0.00
24.52	24.05	31.32	0.42	31.32	2.00	28.68	0.00	0.00
24.69	23.79	30.89	0.42	30.89	0.25	28.22	51.20	0.21
24.85	22.63	29.37	0.44	29.37	0.25	26.56	51.20	0.20
25.01	22.13	28.66	0.45	28.66	0.24	25.75	51.20	0.00
25.18	21.68	27.99	0.46	27.99	0.24	24.98	51.20	0.00
25.34	21.52	27.86	0.56	50.41	0.30	24.82	51.20	0.00
25.51	22.38	29.64	1.16	67.10	0.36	26.86	51.20	0.00
25.67	26.22	34.79	1.45	78.13	0.41	32.15	51.20	0.00

:: Estimation of post-earthquake lateral Displacements :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	R_f (%)	$Q_{tn,cs}$	FS	D_r	$Gamma_{max}$ (%)	Lat. disp. (in)
25.83	29.57	39.28	1.76	89.39	0.48	36.16	51.20	0.00
26.00	28.45	38.18	2.39	102.95	0.59	35.22	51.20	0.00
26.16	26.28	35.45	2.89	153.09	1.35	32.77	0.00	0.00
26.33	23.43	31.42	2.82	168.92	1.72	28.79	0.00	0.00
26.49	17.68	23.74	3.28	101.94	2.00	19.53	0.05	0.00
26.65	11.73	15.59	4.09	97.06	2.00	5.65	0.07	0.00
26.82	10.20	13.23	3.73	87.33	2.00	0.23	0.08	0.00
26.98	10.80	13.96	2.96	80.41	2.00	2.02	0.08	0.00
27.15	13.40	17.30	2.54	80.59	2.00	9.08	0.07	0.00
27.31	15.46	19.91	2.46	83.21	2.00	13.73	0.06	0.00
27.47	16.77	21.49	2.39	204.19	2.00	16.25	0.00	0.00
27.64	19.07	24.24	2.10	140.83	1.10	20.22	0.00	0.00
27.80	18.47	23.38	2.17	155.96	1.40	19.03	0.00	0.00
27.97	14.81	18.63	2.43	81.00	2.00	11.53	0.06	0.00
28.13	12.21	15.12	2.29	73.66	2.00	4.64	0.07	0.00
28.30	10.52	12.82	2.28	69.69	1.97	0.00	0.09	0.00
28.46	7.84	9.12	2.55	65.08	1.40	0.00	0.47	0.00
28.62	7.06	7.99	2.55	62.10	1.22	0.00	0.89	0.00
28.79	7.19	8.12	2.78	64.60	1.24	0.00	0.83	0.00
28.95	7.64	8.69	3.14	69.47	1.33	0.00	0.60	0.00
29.12	8.31	9.55	3.37	74.04	1.46	0.00	0.38	0.00
29.28	9.16	10.64	3.50	78.32	1.62	0.00	0.22	0.00
29.44	9.90	11.59	3.64	82.27	1.76	0.00	0.15	0.00
29.61	11.13	13.16	3.42	83.98	2.00	0.07	0.08	0.00
29.77	12.37	14.71	3.23	85.36	2.00	3.75	0.07	0.00
29.94	12.47	14.75	3.21	85.13	2.00	3.84	0.07	0.00
30.10	12.13	14.26	3.46	87.04	2.00	2.70	0.07	0.00
30.26	12.75	14.96	3.29	86.61	2.00	4.30	0.07	0.00
30.43	13.76	16.09	3.05	85.84	2.00	6.70	0.07	0.00
30.59	14.10	16.39	2.84	83.51	2.00	7.31	0.07	0.00
30.76	14.44	16.68	2.63	81.14	2.00	7.89	0.07	0.00
30.92	14.10	16.12	2.27	74.97	2.00	6.75	0.07	0.00
31.08	12.40	13.97	2.26	71.44	2.00	2.04	0.08	0.00
31.25	9.98	10.94	2.20	65.33	1.65	0.00	0.20	0.00
31.41	7.95	8.28	2.52	62.69	1.25	0.00	0.80	0.00
31.58	6.91	6.92	2.89	61.93	1.04	0.00	1.92	0.00
31.74	7.65	7.82	2.61	62.33	1.18	0.00	1.06	0.00
31.90	7.92	8.11	2.53	62.34	1.22	0.00	0.89	0.00
32.07	8.48	8.77	3.30	71.23	1.32	0.00	0.61	0.00
32.23	11.22	12.14	3.39	81.29	2.00	0.00	0.08	0.00
32.40	15.75	17.55	3.17	90.21	2.00	9.56	0.07	0.00
32.56	22.71	25.49	2.64	196.87	2.00	21.88	0.00	0.00
32.72	31.73	35.52	2.14	95.05	2.00	32.84	0.00	0.00
32.89	39.31	43.69	1.78	93.93	2.00	39.67	0.00	0.00
33.05	43.45	47.96	1.57	92.02	2.00	42.75	0.00	0.00
33.22	42.03	46.05	1.38	85.64	2.00	41.41	0.00	0.00
33.38	35.57	38.82	1.46	81.92	2.00	35.77	0.00	0.00
33.54	27.10	29.45	1.85	87.06	2.00	26.65	0.00	0.00

:: Estimation of post-earthquake lateral Displacements :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	R_f (%)	$Q_{tn,cs}$	FS	D_r	$Gamma_{max}$ (%)	Lat. disp. (in)
33.71	20.29	21.85	2.46	212.79	2.00	16.79	0.00	0.00
33.87	14.85	15.71	3.64	92.43	2.00	5.92	0.07	0.00
34.04	14.97	15.77	4.27	99.79	2.00	6.03	0.07	0.00
34.20	18.04	19.17	3.66	99.82	2.00	12.47	0.06	0.00
34.36	19.77	21.04	3.74	104.50	2.00	15.55	0.06	0.00
34.53	20.91	22.22	3.92	109.22	2.00	17.36	0.05	0.00
34.69	27.53	29.33	3.12	223.60	2.00	26.52	0.00	0.00
34.86	36.27	38.55	2.43	104.42	2.00	35.54	0.00	0.00
35.02	52.09	55.11	1.84	105.39	2.00	47.33	0.00	0.00
35.19	74.53	78.03	1.26	108.70	2.00	58.81	0.00	0.00
35.35	94.79	98.31	0.95	117.49	2.00	66.44	0.00	0.00
35.51	103.71	106.91	0.83	121.64	2.00	69.20	0.00	0.00
35.68	104.90	107.70	0.80	121.54	0.78	69.45	6.60	0.00
35.84	96.68	99.13	0.87	116.01	0.71	66.71	8.60	0.00
36.01	82.58	84.71	1.09	109.63	0.64	61.52	22.70	0.00
36.17	69.94	71.75	1.40	107.33	0.62	56.04	22.70	0.00
36.33	65.27	66.78	1.53	106.82	0.61	53.67	34.10	0.00
36.50	65.25	66.48	1.50	105.73	0.60	53.52	34.10	0.00
36.66	67.59	68.57	1.42	105.21	0.60	54.55	34.10	0.00
36.83	75.78	76.43	1.13	103.85	0.58	58.13	22.70	0.00
36.99	92.62	92.78	0.80	108.65	0.63	64.53	22.70	0.00
37.15	109.60	109.19	0.64	118.15	0.74	69.90	7.67	0.00
37.32	125.41	124.39	0.56	127.80	0.87	74.20	4.81	0.00
37.48	141.95	140.30	0.52	140.30	1.07	78.18	2.81	0.00
37.65	155.53	153.33	0.54	153.33	1.32	81.11	1.82	0.00
37.81	161.85	159.26	0.58	159.26	1.45	82.36	1.50	0.00
37.97	167.79	164.75	0.61	164.75	1.57	83.48	1.25	0.00
38.14	176.27	172.63	0.62	172.63	1.77	85.02	1.16	0.00
38.30	183.79	179.55	0.63	179.55	1.97	86.32	0.96	0.00
38.47	189.64	184.67	0.60	184.67	2.00	87.25	0.00	0.00
38.63	194.36	188.76	0.59	188.76	2.00	87.97	0.00	0.00
38.79	196.10	189.97	0.58	189.97	2.00	88.18	0.00	0.00
38.96	195.88	189.29	0.59	189.29	2.00	88.06	0.00	0.00
39.12	195.40	188.39	0.60	188.39	2.00	87.90	0.00	0.00
39.29	193.78	186.41	0.65	186.41	2.00	87.56	0.00	0.00
39.45	191.83	184.08	0.67	184.08	2.00	87.14	0.00	0.00
39.61	190.75	182.59	0.67	182.59	2.00	86.87	0.00	0.00
39.78	189.29	180.68	0.66	180.68	2.00	86.52	0.00	0.00
39.94	188.05	179.01	0.63	179.01	1.97	86.22	0.96	0.00
40.11	188.13	178.60	0.61	178.60	1.96	86.14	0.97	0.00
40.27	189.43	179.41	0.61	179.41	1.99	86.29	0.95	0.00
40.43	190.07	179.60	0.64	179.60	1.99	86.33	0.94	0.00
40.60	189.25	178.37	0.68	178.37	1.96	86.10	0.97	0.00
40.76	188.45	177.17	0.70	177.17	1.93	85.88	1.00	0.00
40.93	189.14	177.34	0.71	177.34	1.93	85.91	0.99	0.00
41.09	192.26	179.84	0.70	179.84	2.00	86.37	0.00	0.00
41.26	197.34	184.16	0.67	184.16	2.00	87.16	0.00	0.00
41.42	203.36	189.41	0.59	189.41	2.00	88.08	0.00	0.00

:: Estimation of post-earthquake lateral Displacements :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	R_f (%)	$Q_{tn,cs}$	FS	D_r	$Gamma_{max}$ (%)	Lat. disp. (in)
41.58	207.72	193.10	0.53	193.10	2.00	88.72	0.00	0.00
41.75	208.96	193.85	0.48	193.85	2.00	88.85	0.00	0.00
41.91	207.41	192.01	0.43	192.01	2.00	88.53	0.00	0.00
42.08	204.55	188.97	0.39	188.97	2.00	88.01	0.00	0.00
42.24	201.43	185.66	0.40	185.66	2.00	87.42	0.00	0.00
42.40	200.24	184.16	0.40	184.16	2.00	87.15	0.00	0.00
42.57	202.40	185.79	0.40	185.79	2.00	87.44	0.00	0.00
42.73	205.32	188.14	0.39	188.14	2.00	87.86	0.00	0.00
42.90	207.64	189.89	0.39	189.89	2.00	88.17	0.00	0.00
43.06	210.44	192.10	0.40	192.10	2.00	88.55	0.00	0.00
43.22	211.45	192.62	0.41	192.62	2.00	88.64	0.00	0.00
43.39	211.01	191.77	0.42	191.77	2.00	88.49	0.00	0.00
43.55	210.21	190.58	0.44	190.58	2.00	88.29	0.00	0.00
43.72	211.11	190.98	0.45	190.98	2.00	88.35	0.00	0.00
43.88	211.59	191.00	0.45	191.00	2.00	88.36	0.00	0.00
44.04	211.54	190.52	0.46	190.52	2.00	88.28	0.00	0.00
44.21	209.56	188.27	0.47	188.27	2.00	87.88	0.00	0.00
44.37	206.30	184.90	0.47	184.90	2.00	87.29	0.00	0.00
44.54	200.77	179.41	0.47	179.41	2.00	86.29	0.00	0.00
44.70	194.57	173.39	0.46	173.39	1.88	85.17	1.05	0.00
44.86	186.13	165.38	0.45	165.38	1.67	83.60	1.11	0.00
45.03	172.67	152.69	0.47	152.69	1.37	80.97	1.67	0.00
45.19	154.80	135.96	0.54	136.04	1.05	77.14	2.91	0.00
45.36	138.01	120.26	0.64	127.33	0.91	73.09	4.20	0.00
45.52	123.75	106.93	0.78	120.22	0.81	69.21	5.89	0.00
45.68	115.52	99.10	0.92	117.37	0.77	66.70	6.73	0.00
45.85	116.18	99.27	1.02	120.21	0.81	66.76	5.84	0.00
46.01	126.03	107.65	1.05	128.41	0.93	69.43	3.92	0.00
46.18	138.73	118.55	1.05	138.11	1.10	72.62	2.45	0.00
46.34	150.17	128.30	1.07	147.07	1.27	75.22	1.96	0.00
46.50	161.07	137.50	1.09	155.98	1.47	77.51	1.46	0.00
46.67	171.91	146.59	1.12	164.73	1.68	79.62	1.09	0.00
46.83	177.83	151.34	1.14	169.52	1.81	80.68	0.94	0.00
47.00	179.11	152.00	1.15	170.54	1.84	80.82	0.90	0.00
47.16	179.30	151.81	1.13	169.65	1.82	80.78	0.93	0.00
47.32	176.90	149.45	1.07	165.94	1.72	80.26	1.04	0.00
47.49	171.00	144.08	1.01	159.14	1.56	79.05	1.28	0.00
47.65	167.12	140.72	0.87	152.11	1.40	78.28	1.61	0.00
47.82	164.19	138.24	0.74	145.69	1.26	77.69	1.99	0.00
47.98	157.47	132.16	0.71	139.59	1.14	76.20	2.43	0.00
48.15	149.24	124.07	0.90	138.52	1.13	74.12	2.27	0.00
48.31	153.09	126.25	1.21	149.59	1.35	74.69	1.35	0.00
48.47	172.98	142.65	1.33	167.63	1.79	78.72	0.96	0.00
48.64	176.74	144.94	1.53	175.71	2.00	79.25	0.00	0.00
48.80	192.78	158.30	1.47	186.16	2.00	82.16	0.00	0.00
48.97	213.65	176.10	1.31	197.10	2.00	85.68	0.00	0.00
49.13	232.91	192.75	1.14	206.04	2.00	88.66	0.00	0.00
49.29	239.00	197.83	1.07	207.71	2.00	89.52	0.00	0.00

:: Estimation of post-earthquake lateral Displacements :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	R_f (%)	$Q_{tn,cs}$	FS	D_r	Gamma$_{max}$ (%)	Lat. disp. (in)
49.46	253.27	210.22	0.95	212.55	2.00	91.52	0.00	0.00
49.62	253.19	209.94	0.90	209.96	2.00	91.48	0.00	0.00
49.79	249.40	206.66	0.83	206.66	2.00	90.96	0.00	0.00
49.95	230.50	190.74	0.71	190.74	2.00	88.31	0.00	0.00
50.11	211.33	173.93	0.70	173.93	2.00	85.27	0.00	0.00
50.28	198.78	162.33	0.77	166.50	1.80	82.99	0.95	0.00
50.44	194.89	157.67	0.96	169.60	1.89	82.03	0.86	0.00
50.61	202.51	162.72	1.18	180.83	2.00	83.07	0.00	0.00
50.77	215.91	173.02	1.29	193.60	2.00	85.09	0.00	0.00
50.93	219.80	175.71	1.31	196.74	2.00	85.60	0.00	0.00
51.10	224.65	180.20	1.11	194.12	2.00	86.44	0.00	0.00
51.26	225.01	181.20	0.92	187.59	2.00	86.62	0.00	0.00
51.43	213.98	172.58	0.75	173.38	2.00	85.01	0.00	0.00
51.59	206.76	167.38	0.58	167.38	1.85	84.00	0.90	0.00
51.75	205.05	166.71	0.46	166.71	1.83	83.87	0.91	0.00
51.92	205.80	166.83	0.48	166.83	1.84	83.89	0.91	0.00
52.08	208.20	168.42	0.49	168.42	1.89	84.21	0.86	0.00
52.25	209.92	169.58	0.49	169.58	1.92	84.43	0.82	0.00
52.41	207.65	166.89	0.53	166.89	1.85	83.90	0.89	0.00
52.57	207.99	166.67	0.55	166.67	1.85	83.86	0.90	0.00
52.74	203.99	162.58	0.59	162.58	1.74	83.04	1.02	0.00
52.90	201.62	160.74	0.54	160.74	1.69	82.66	1.08	0.00
53.07	199.34	159.32	0.45	159.32	1.66	82.37	1.12	0.00
53.23	195.22	155.55	0.45	155.55	1.57	81.58	1.26	0.00
53.39	188.36	148.26	0.58	148.26	1.40	80.00	1.60	0.00
53.56	184.28	143.26	0.76	150.45	1.45	78.87	1.48	0.00
53.72	175.60	134.25	1.05	151.82	1.49	76.72	1.41	0.00
53.89	167.77	126.63	1.28	151.72	1.49	74.79	1.02	0.00
54.05	158.28	118.22	1.43	148.68	1.42	72.53	1.16	0.00
54.22	163.49	122.25	1.36	150.22	1.46	73.63	1.08	0.00
54.38	164.19	122.51	1.35	150.28	1.46	73.70	1.07	0.00
54.54	174.15	130.61	1.22	153.57	1.54	75.82	1.31	0.00
54.71	174.37	130.10	1.30	155.42	1.59	75.69	1.22	0.00
54.87	181.83	138.62	0.76	146.59	1.39	77.78	1.63	0.00

Total estimated displacement: 1.68

Abbreviations

q_t:	Total cone resistance
Q_{tn}:	Adjusted cone resistance to an effective overburden stress of 1 atm
R_f:	Friction ration
$Q_{tn,cs}$:	Adjusted and corrected cone resistance due to fines
FS:	Calculated factor of safety against liquefaction
D_r:	Calculated relative density
Gamma$_{max}$:	Calculated maximum cyclic shear strain
Lat. disp.:	Lateral displacement

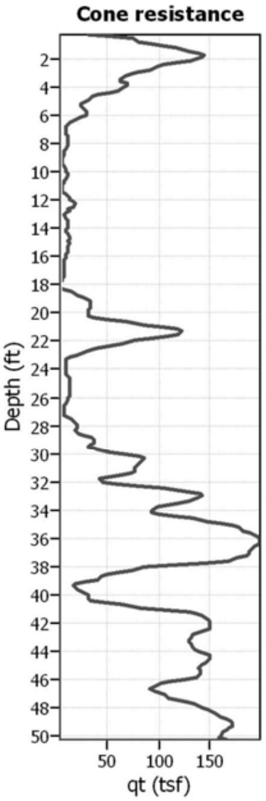
LIQUEFACTION ANALYSIS REPORT

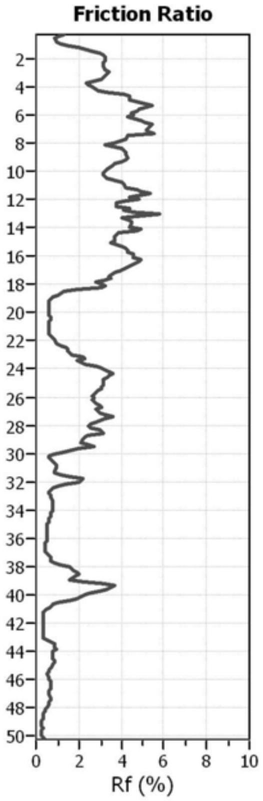
Project title : CIS-72092.4 **Location : Proposed CarMax National City**

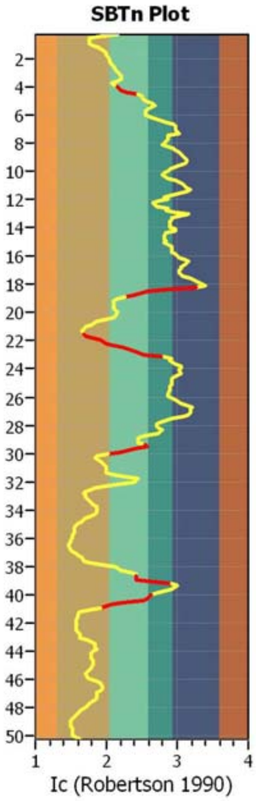
CPT file : CPT-04

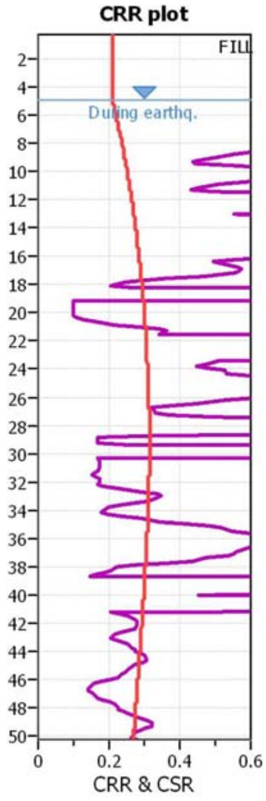
Input parameters and analysis data

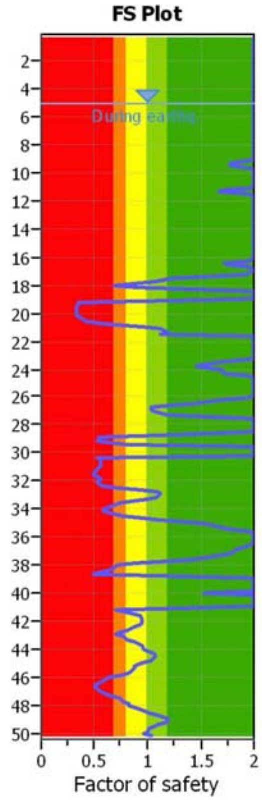
Analysis method:	Robertson (2009)	G.W.T. (in-situ):	5.00 ft	Use fill:	Yes	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	10.00 ft	Fill height:	5.00 ft	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	5	Fill weight:	120.00 lb/ft^3	Limit depth:	N/A
Earthquake magnitude M_w:	6.76	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.43	Unit weight calculation:	Based on SBT	K_σ applied:	No		

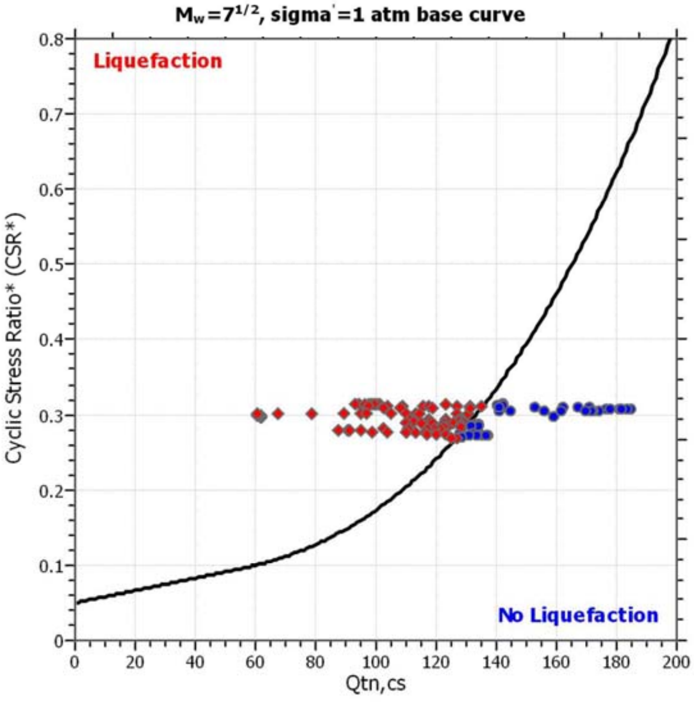


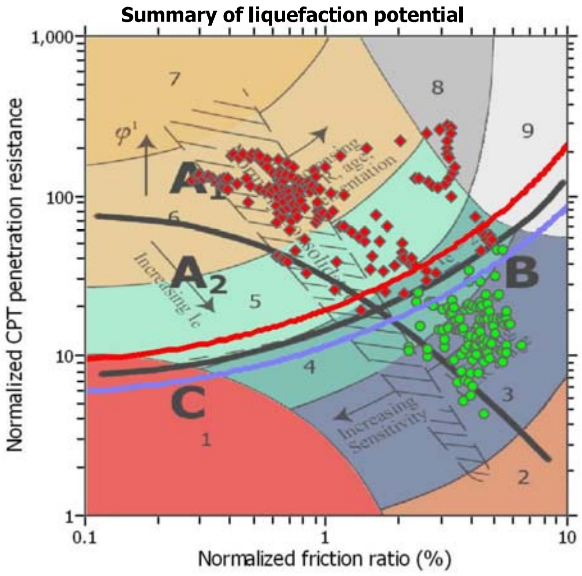






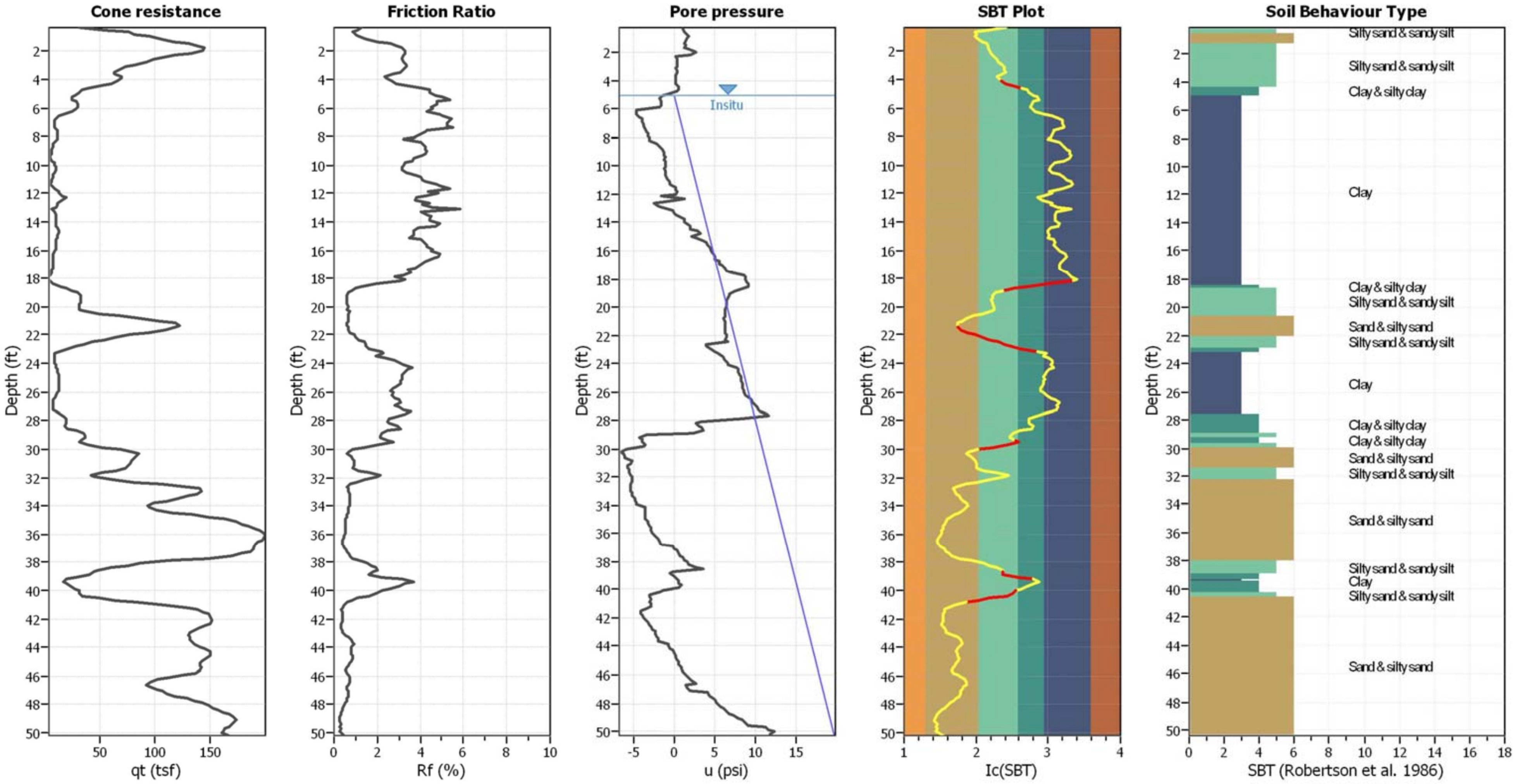






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



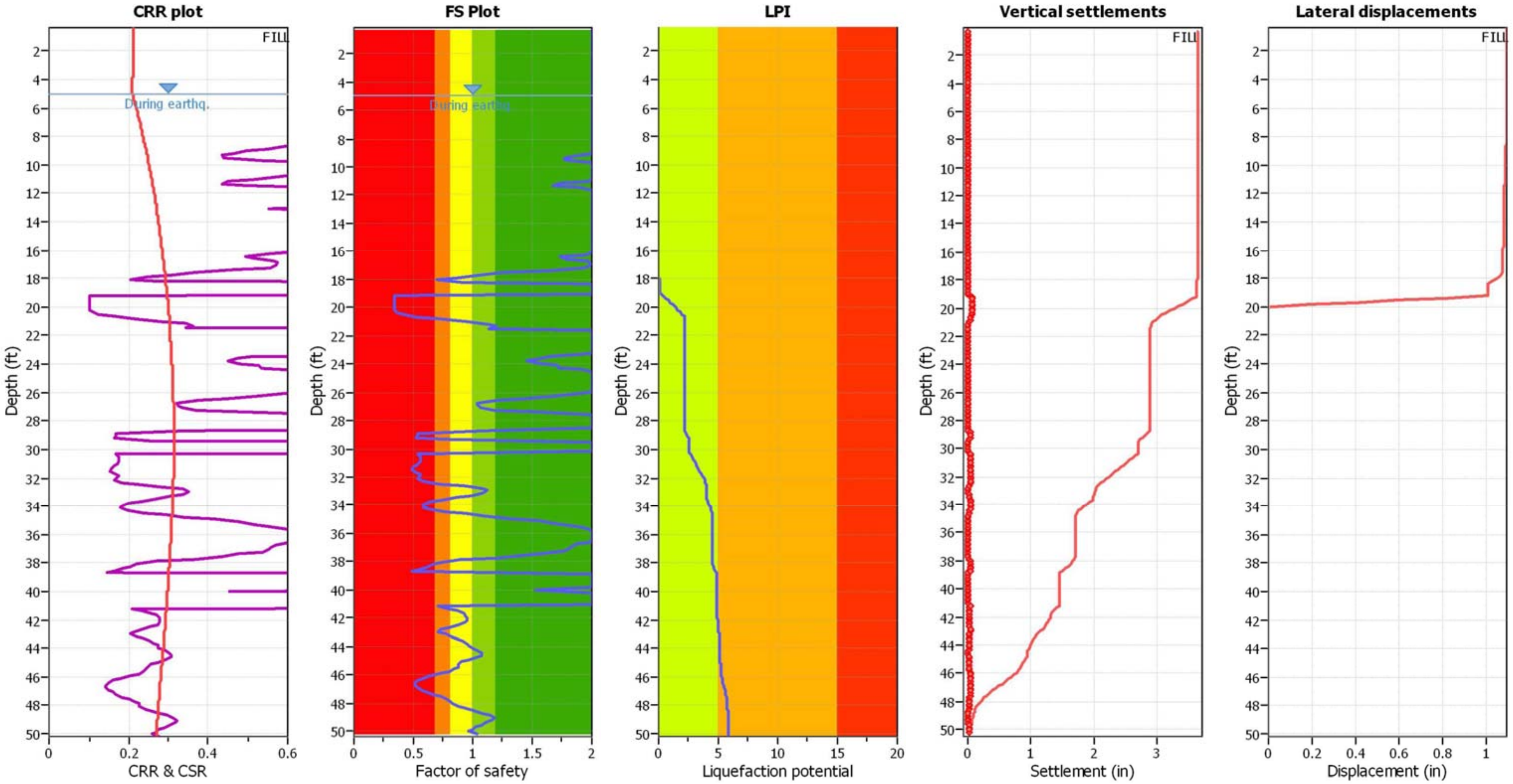
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	10.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	5	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	No
Earthquake magnitude M_w:	6.76	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.43	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	5.00 ft	Fill height:	5.00 ft	Limit depth:	N/A

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:	Robertson (2009)	Depth to water table (erthq.):	10.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	5	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	No
Earthquake magnitude M_w:	6.76	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.43	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	5.00 ft	Fill height:	5.00 ft	Limit depth:	N/A

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

:: Post-earthquake settlement of dry sands ::

Depth (ft)	Ic	Kc	Qc1n	Qc1n,cs	N1,60 (blows)	Vs (ft/s)	Gmax (tsf)	CSR	Shear, γ (%)	Svol,15 (%)	Nc	ev (%)	Settle. (in)
5.33	2.16	1.57	59.04	92.43	20	480.7	402	0.21	0.033	0.03	9.05	0.03	0.001
5.49	1.91	1.20	104.44	125.10	25	548.0	542	0.21	0.019	0.01	9.05	0.01	0.000
5.66	1.76	1.08	143.32	154.66	29	584.8	627	0.21	0.016	0.01	9.05	0.01	0.000
5.82	1.77	1.08	152.79	165.77	32	607.2	684	0.21	0.014	0.01	9.05	0.01	0.000
5.98	1.77	1.09	177.46	192.54	37	654.5	811	0.21	0.012	0.01	9.05	0.00	0.000
6.15	1.82	1.12	198.08	221.66	43	712.6	984	0.21	0.009	0.00	9.05	0.00	0.000
6.31	1.90	1.19	220.47	262.07	53	792.6	1251	0.21	0.007	0.00	9.05	0.00	0.000
6.48	1.96	1.25	244.91	307.35	63	869.7	1541	0.21	0.006	0.00	9.05	0.00	0.000
6.64	1.99	1.29	264.06	340.57	71	919.7	1745	0.21	0.005	0.00	9.05	0.00	0.000
6.80	2.00	1.31	273.61	357.45	75	943.9	1848	0.21	0.005	0.00	9.05	0.00	0.000
6.97	2.02	1.33	269.65	359.05	75	948.0	1866	0.21	0.005	0.00	9.05	0.00	0.000
7.13	2.04	1.36	249.40	338.84	72	922.4	1757	0.21	0.006	0.00	9.05	0.00	0.000
7.30	2.06	1.38	222.38	307.65	65	879.8	1583	0.21	0.007	0.00	9.05	0.00	0.000
7.46	2.08	1.42	198.80	282.38	61	843.7	1442	0.21	0.007	0.00	9.05	0.00	0.000
7.62	2.10	1.45	185.31	269.05	58	823.8	1368	0.21	0.008	0.00	9.05	0.00	0.000
7.79	2.12	1.50	173.50	259.51	57	808.9	1314	0.21	0.009	0.00	9.05	0.00	0.000
7.95	2.17	1.60	153.82	245.64	55	785.2	1230	0.21	0.010	0.00	9.05	0.00	0.000
8.12	2.20	1.65	138.87	229.82	52	757.8	1137	0.21	0.011	0.00	9.05	0.00	0.000
8.28	2.20	1.67	129.21	215.68	49	733.6	1057	0.21	0.012	0.00	9.05	0.00	0.000
8.45	2.21	1.69	119.05	201.00	45	707.5	974	0.21	0.014	0.01	9.05	0.00	0.000
8.61	2.17	1.60	117.98	188.48	42	687.4	913	0.21	0.016	0.01	9.05	0.01	0.000
8.77	2.09	1.44	131.19	188.46	41	688.9	916	0.21	0.016	0.01	9.05	0.01	0.000
8.94	2.10	1.46	130.41	190.05	41	691.9	925	0.21	0.016	0.01	9.05	0.01	0.000
9.10	2.15	1.55	122.83	190.66	42	692.3	927	0.21	0.016	0.01	9.05	0.01	0.000
9.27	2.20	1.66	114.01	189.79	0	0.0	0	0.21	0.000	0.00	0.00	0.00	0.000
9.43	2.28	1.89	98.30	186.08	0	0.0	0	0.21	0.000	0.00	0.00	0.00	0.000
9.59	2.44	2.46	74.09	182.56	0	0.0	0	0.21	0.000	0.00	9.05	0.00	0.000
9.76	2.50	2.78	63.74	177.38	0	0.0	0	0.21	0.000	0.00	9.05	0.00	0.000
9.92	2.53	2.95	57.54	169.54	44	602.8	682	0.21	0.029	0.01	9.05	0.01	0.000

Total estimated settlement: 0.00

:: 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)
10.09	260.32	2.00	0.00	1.00	0.00	10.25	337.10	2.00	0.00	1.00	0.00
10.41	384.20	2.00	0.00	1.00	0.00	10.58	259.60	2.00	0.00	1.00	0.00
10.74	240.07	2.00	0.00	1.00	0.00	10.91	216.53	2.00	0.00	1.00	0.00
11.07	230.77	2.00	0.00	1.00	0.00	11.23	240.91	2.00	0.00	1.00	0.00
11.40	138.76	2.00	0.00	1.00	0.00	11.56	125.15	2.00	0.00	1.00	0.00
11.73	116.72	2.00	0.00	1.00	0.00	11.89	110.81	2.00	0.00	1.00	0.00
12.05	108.72	2.00	0.00	1.00	0.00	12.22	106.65	2.00	0.00	1.00	0.00
12.38	108.79	2.00	0.00	1.00	0.00	12.55	107.80	2.00	0.00	1.00	0.00
12.71	105.72	2.00	0.00	1.00	0.00	12.87	103.26	2.00	0.00	1.00	0.00
13.04	100.79	2.00	0.00	1.00	0.00	13.20	93.68	2.00	0.00	1.00	0.00
13.37	92.77	2.00	0.00	1.00	0.00	13.53	90.41	2.00	0.00	1.00	0.00
13.69	87.90	2.00	0.00	1.00	0.00	13.86	85.23	2.00	0.00	1.00	0.00
14.02	82.35	2.00	0.00	1.00	0.00	14.19	79.42	1.88	0.00	1.00	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)
14.35	76.43	1.77	0.01	1.00	0.00	14.51	73.56	1.77	0.01	1.00	0.00
14.68	79.76	2.00	0.00	1.00	0.00	14.84	84.88	2.00	0.00	1.00	0.00
15.01	87.19	2.00	0.00	1.00	0.00	15.17	89.28	2.00	0.00	1.00	0.00
15.34	91.44	2.00	0.00	1.00	0.00	15.50	89.72	2.00	0.00	1.00	0.00
15.66	85.22	2.00	0.00	1.00	0.00	15.83	85.27	2.00	0.00	1.00	0.00
15.99	82.43	1.98	0.00	1.00	0.00	16.16	79.31	1.74	0.01	1.00	0.00
16.32	81.75	1.67	0.01	1.00	0.00	16.48	87.42	1.89	0.00	1.00	0.00
16.65	108.79	2.00	0.00	1.00	0.00	16.81	117.17	2.00	0.00	1.00	0.00
16.98	121.55	2.00	0.00	1.00	0.00	17.14	124.87	2.00	0.00	1.00	0.00
17.30	263.19	2.00	0.00	1.00	0.00	17.47	117.04	2.00	0.00	1.00	0.00
17.63	111.94	2.00	0.00	1.00	0.00	17.80	109.52	2.00	0.00	1.00	0.00
17.96	104.31	2.00	0.00	1.00	0.00	18.12	99.45	2.00	0.00	1.00	0.00
18.29	97.42	2.00	0.00	1.00	0.00	18.45	104.02	2.00	0.00	1.00	0.00
18.62	108.24	2.00	0.00	1.00	0.00	18.78	108.07	2.00	0.00	1.00	0.00
18.94	107.70	2.00	0.00	1.00	0.00	19.11	108.45	2.00	0.00	1.00	0.00
19.27	105.96	2.00	0.00	1.00	0.00	19.44	103.38	2.00	0.00	1.00	0.00
19.60	102.23	2.00	0.00	1.00	0.00	19.76	101.98	2.00	0.00	1.00	0.00
19.93	100.19	2.00	0.00	1.00	0.00	20.09	97.47	2.00	0.00	1.00	0.00
20.26	99.01	2.00	0.00	1.00	0.00	20.42	100.95	2.00	0.00	1.00	0.00
20.58	102.71	2.00	0.00	1.00	0.00	20.75	102.53	2.00	0.00	1.00	0.00
20.91	100.56	2.00	0.00	1.00	0.00	21.08	96.05	2.00	0.00	1.00	0.00
21.24	93.35	1.95	0.00	1.00	0.00	21.40	88.30	1.73	0.01	1.00	0.00
21.57	88.23	1.79	0.01	1.00	0.00	21.73	88.27	1.96	0.00	1.00	0.00
21.90	88.05	1.99	0.00	1.00	0.00	22.06	85.52	1.97	0.00	1.00	0.00
22.23	82.93	1.92	0.00	1.00	0.00	22.39	75.06	1.61	0.01	1.00	0.00
22.55	68.71	1.25	0.06	1.00	0.00	22.72	62.06	1.04	0.12	1.00	0.00
22.88	54.66	0.85	0.27	1.00	0.01	23.05	52.87	0.69	0.50	1.00	0.01
23.21	58.03	0.92	0.20	1.00	0.00	23.37	62.37	2.00	0.00	1.00	0.00
23.54	91.96	2.00	0.00	1.00	0.00	23.70	61.18	2.00	0.00	1.00	0.00
23.87	60.36	2.00	0.00	1.00	0.00	24.03	61.10	2.00	0.00	1.00	0.00
24.19	61.77	0.34	3.47	1.00	0.07	24.36	61.79	0.34	3.47	1.00	0.07
24.52	61.77	0.34	3.47	1.00	0.07	24.69	61.54	0.34	3.48	1.00	0.07
24.85	61.10	0.34	3.50	1.00	0.07	25.01	60.76	0.34	3.52	1.00	0.07
25.18	60.76	0.34	3.52	1.00	0.07	25.34	67.36	0.36	3.23	1.00	0.06
25.51	78.64	0.42	2.85	1.00	0.06	25.67	95.05	0.53	2.44	1.00	0.05
25.83	113.39	0.71	2.06	1.00	0.04	26.00	130.49	0.95	1.06	1.00	0.02
26.16	141.36	1.13	0.44	1.00	0.01	26.33	145.05	1.20	0.31	1.00	0.01
26.49	141.51	1.13	0.44	1.00	0.01	26.65	133.21	2.00	0.00	1.00	0.00
26.82	122.36	2.00	0.00	1.00	0.00	26.98	110.00	2.00	0.00	1.00	0.00
27.15	99.73	2.00	0.00	1.00	0.00	27.31	94.11	2.00	0.00	1.00	0.00
27.47	90.60	2.00	0.00	1.00	0.00	27.64	85.19	2.00	0.00	1.00	0.00
27.80	78.31	2.00	0.00	1.00	0.00	27.97	90.27	2.00	0.00	1.00	0.00
28.13	72.26	2.00	0.00	1.00	0.00	28.30	66.48	2.00	0.00	1.00	0.00
28.46	61.11	1.66	0.01	1.00	0.00	28.62	63.81	1.54	0.02	1.00	0.00
28.79	68.51	1.46	0.02	1.00	0.00	28.95	72.91	1.56	0.02	1.00	0.00
29.12	77.02	1.71	0.01	1.00	0.00	29.28	80.81	1.72	0.01	1.00	0.00
29.44	82.56	1.93	0.00	1.00	0.00	29.61	84.09	2.00	0.00	1.00	0.00
29.77	83.79	2.00	0.00	1.00	0.00	29.94	83.52	2.00	0.00	1.00	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)
30.10	83.46	2.00	0.00	1.00	0.00	30.26	83.15	2.00	0.00	1.00	0.00
30.43	82.97	2.00	0.00	1.00	0.00	30.59	80.79	2.00	0.00	1.00	0.00
30.76	78.67	2.00	0.00	1.00	0.00	30.92	76.61	2.00	0.00	1.00	0.00
31.08	74.98	1.93	0.00	1.00	0.00	31.25	70.90	1.70	0.01	1.00	0.00
31.41	68.60	1.43	0.03	1.00	0.00	31.58	65.89	1.21	0.06	1.00	0.00
31.74	62.93	1.03	0.11	1.00	0.00	31.90	60.69	1.04	0.11	1.00	0.00
32.07	62.89	1.06	0.10	1.00	0.00	32.23	67.46	1.18	0.06	1.00	0.00
32.40	77.72	1.55	0.02	1.00	0.00	32.56	86.05	2.00	0.00	1.00	0.00
32.72	87.33	2.00	0.00	1.00	0.00	32.89	86.07	2.00	0.00	1.00	0.00
33.05	85.78	2.00	0.00	1.00	0.00	33.22	85.95	2.00	0.00	1.00	0.00
33.38	91.14	2.00	0.00	1.00	0.00	33.54	97.31	2.00	0.00	1.00	0.00
33.71	142.27	1.11	0.44	1.00	0.01	33.87	98.36	0.54	2.37	1.00	0.05
34.04	98.63	0.54	2.36	1.00	0.05	34.20	97.45	0.53	2.39	1.00	0.05
34.36	123.19	0.81	1.50	1.00	0.03	34.53	152.64	2.00	0.00	1.00	0.00
34.69	96.19	2.00	0.00	1.00	0.00	34.86	90.78	2.00	0.00	1.00	0.00
35.02	90.76	2.00	0.00	1.00	0.00	35.19	94.76	2.00	0.00	1.00	0.00
35.35	97.77	0.53	2.38	1.00	0.05	35.51	100.88	0.56	2.32	1.00	0.04
35.68	101.14	0.56	2.32	1.00	0.05	35.84	100.92	0.56	2.32	1.00	0.04
36.01	99.97	0.55	2.34	1.00	0.05	36.17	97.50	0.53	2.39	1.00	0.05
36.33	94.21	0.50	2.45	1.00	0.05	36.50	92.84	0.49	2.48	1.00	0.05
36.66	96.19	0.52	2.41	1.00	0.05	36.83	100.71	0.56	2.32	1.00	0.05
36.99	99.65	0.55	2.34	1.00	0.04	37.15	97.54	0.53	2.38	1.00	0.05
37.32	103.51	0.59	2.27	1.00	0.05	37.48	115.56	0.72	2.00	1.00	0.04
37.65	131.28	0.93	1.05	1.00	0.02	37.81	140.34	1.08	0.44	1.00	0.01
37.97	142.65	1.12	0.44	1.00	0.01	38.14	140.49	1.08	0.44	1.00	0.01
38.30	135.06	0.99	0.67	1.00	0.01	38.47	126.66	0.86	1.11	1.00	0.02
38.63	117.53	0.74	1.95	1.00	0.04	38.79	108.88	0.64	2.18	1.00	0.04
38.96	103.59	0.59	2.27	1.00	0.05	39.12	102.61	0.58	2.29	1.00	0.04
39.29	108.17	0.64	2.19	1.00	0.04	39.45	118.93	0.76	1.58	1.00	0.03
39.61	131.45	0.94	1.05	1.00	0.02	39.78	141.11	1.10	0.44	1.00	0.01
39.94	153.32	1.34	0.21	1.00	0.00	40.11	162.43	1.55	0.00	1.00	0.00
40.27	167.57	1.68	0.00	1.00	0.00	40.43	171.12	1.77	0.00	1.00	0.00
40.60	177.17	1.94	0.00	1.00	0.00	40.76	181.07	2.00	0.00	1.00	0.00
40.93	183.97	2.00	0.00	1.00	0.00	41.09	184.74	2.00	0.00	1.00	0.00
41.26	183.66	2.00	0.00	1.00	0.00	41.42	181.76	2.00	0.00	1.00	0.00
41.58	178.13	1.98	0.00	1.00	0.00	41.75	174.23	1.87	0.00	1.00	0.00
41.91	172.49	1.83	0.00	1.00	0.00	42.08	171.93	1.81	0.00	1.00	0.00
42.24	169.94	1.76	0.00	1.00	0.00	42.40	161.84	1.56	0.00	1.00	0.00
42.57	156.24	1.43	0.00	1.00	0.00	42.73	145.22	1.20	0.31	1.00	0.01
42.90	127.05	0.89	1.10	1.00	0.02	43.06	114.48	0.73	2.03	1.00	0.04
43.22	109.89	0.67	2.16	1.00	0.04	43.39	105.18	0.62	2.24	1.00	0.05
43.55	97.11	0.55	2.39	1.00	0.05	43.72	89.68	0.49	2.55	1.00	0.05
43.88	81.51	2.00	0.00	1.00	0.00	44.04	177.46	2.00	0.00	1.00	0.00
44.21	83.64	2.00	0.00	1.00	0.00	44.37	86.19	2.00	0.00	1.00	0.00
44.54	86.92	2.00	0.00	1.00	0.00	44.70	88.32	2.00	0.00	1.00	0.00
44.86	86.95	2.00	0.00	1.00	0.00	45.03	159.11	1.53	0.00	1.00	0.00
45.19	124.82	2.00	0.00	1.00	0.00	45.36	83.32	2.00	0.00	1.00	0.00
45.52	71.40	2.00	0.00	1.00	0.00	45.68	75.01	2.00	0.00	1.00	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)
45.85	83.37	2.00	0.00	1.00	0.00	46.01	91.02	2.00	0.00	1.00	0.00
46.18	111.02	0.70	2.12	1.00	0.04	46.34	117.80	0.79	1.60	1.00	0.03
46.50	123.36	0.87	1.15	1.00	0.02	46.67	127.29	0.93	1.10	1.00	0.02
46.83	128.43	0.94	1.08	1.00	0.02	47.00	128.78	0.95	0.70	1.00	0.01
47.16	128.83	0.95	0.70	1.00	0.01	47.32	127.71	0.94	1.09	1.00	0.02
47.49	123.46	0.87	1.15	1.00	0.02	47.65	117.90	0.80	1.60	1.00	0.03
47.82	112.78	0.73	2.07	1.00	0.04	47.98	109.92	0.70	2.16	1.00	0.04
48.15	114.92	0.76	1.66	1.00	0.03	48.31	118.73	0.81	1.58	1.00	0.03
48.47	122.78	0.87	1.16	1.00	0.02	48.64	125.34	0.91	1.12	1.00	0.02
48.80	127.85	0.95	0.70	1.00	0.01	48.97	128.19	0.96	0.70	1.00	0.01
49.13	130.83	1.01	0.69	1.00	0.01	49.29	133.23	1.05	0.68	1.00	0.01
49.46	134.68	1.07	0.45	1.00	0.01	49.62	134.65	1.08	0.45	1.00	0.01
49.79	132.03	1.03	0.68	1.00	0.01	49.95	128.06	0.97	0.70	1.00	0.01
50.11	123.87	0.90	1.14	1.00	0.02	50.28	122.29	0.88	1.16	1.00	0.02
50.44	121.51	0.87	1.18	1.00	0.02	50.61	119.47	0.85	1.57	1.00	0.03
50.77	116.75	0.81	1.62	1.00	0.03	50.93	110.78	0.73	2.13	1.00	0.04
51.10	102.32	0.64	2.29	1.00	0.05	51.26	95.29	0.57	2.43	1.00	0.05
51.43	90.87	0.54	2.53	1.00	0.05	51.59	87.21	0.51	2.61	1.00	0.05
51.75	87.56	0.51	2.61	1.00	0.05	51.92	91.34	0.54	2.52	1.00	0.05
52.08	95.15	0.58	2.43	1.00	0.05	52.25	98.66	0.61	2.36	1.00	0.05
52.41	104.03	0.67	2.26	1.00	0.04	52.57	109.73	0.73	2.17	1.00	0.04
52.74	113.34	0.78	1.69	1.00	0.03	52.90	116.37	0.82	1.63	1.00	0.03
53.07	116.62	0.83	1.62	1.00	0.03	53.23	119.76	0.87	1.20	1.00	0.02
53.39	123.08	0.92	1.15	1.00	0.02	53.56	128.35	1.01	0.70	1.00	0.01
53.72	132.22	1.08	0.46	1.00	0.01	53.89	135.47	1.14	0.45	1.00	0.01
54.05	137.74	1.19	0.32	1.00	0.01	54.22	136.91	1.17	0.33	1.00	0.01
54.38	133.67	1.11	0.46	1.00	0.01	54.54	131.29	1.07	0.46	1.00	0.01
54.71	128.17	1.02	0.70	1.00	0.01	54.87	126.69	1.00	0.71	1.00	0.01
55.04	124.81	0.97	0.72	1.00	0.01	55.20	128.83	1.04	0.70	1.00	0.01

Total estimated settlement: 3.65

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

:: Lateral displacement index calculation ::

Depth (ft)	q_t (tsf)	Q_{tn}	R_f (%)	$Q_{tn,cs}$	FS	D_r	$Gamma_{max}$ (%)	Lat. disp. (in)
10.09	27.17	50.74	4.71	260.32	2.00	44.61	0.00	0.00
10.25	24.10	44.93	5.06	337.10	2.00	40.59	0.00	0.00
10.41	24.08	44.87	5.40	384.20	2.00	40.55	0.00	0.00
10.58	28.38	52.98	4.79	259.60	2.00	46.03	0.00	0.00
10.74	30.01	56.04	4.73	240.07	2.00	47.89	0.00	0.00
10.91	30.14	56.27	4.51	216.53	2.00	48.02	0.00	0.00
11.07	28.63	53.40	4.54	230.77	2.00	46.29	0.00	0.00
11.23	24.60	45.77	4.31	240.91	2.00	41.21	0.00	0.00
11.40	17.06	31.49	4.92	138.76	2.00	28.86	0.04	0.00
11.56	13.04	23.88	5.06	125.15	2.00	19.73	0.05	0.00
11.73	10.34	18.76	5.42	116.72	2.00	11.77	0.06	0.00
11.89	9.36	16.90	5.34	110.81	2.00	8.31	0.07	0.00
12.05	9.21	16.58	5.21	108.72	2.00	7.69	0.07	0.00
12.22	8.75	15.70	5.26	106.65	2.00	5.88	0.07	0.00
12.38	8.73	15.65	5.50	108.79	2.00	5.78	0.07	0.00
12.55	11.15	20.21	4.30	107.80	2.00	14.22	0.06	0.00
12.71	10.91	19.74	4.22	105.72	2.00	13.45	0.06	0.00
12.87	11.17	20.22	3.94	103.26	2.00	14.23	0.06	0.00
13.04	11.36	20.55	3.70	100.79	2.00	14.77	0.06	0.00
13.20	11.06	19.97	3.25	93.68	2.00	13.83	0.06	0.00
13.37	8.45	15.01	4.03	92.77	2.00	4.40	0.07	0.00
13.53	7.83	13.83	4.09	90.41	2.00	1.70	0.08	0.00
13.69	7.10	12.42	4.23	87.90	2.00	0.00	0.08	0.00
13.86	6.64	11.54	4.22	85.23	2.00	0.00	0.08	0.00
14.02	6.04	10.40	4.30	82.35	2.00	0.00	0.09	0.00
14.19	5.68	9.70	4.22	79.42	1.88	0.00	0.12	0.00
14.35	5.40	9.16	4.07	76.43	1.77	0.00	0.16	0.00
14.51	5.44	9.22	3.67	73.56	1.77	0.00	0.16	0.00
14.68	6.62	11.44	3.62	79.76	2.00	0.00	0.08	0.00
14.84	8.50	14.97	3.29	84.88	2.00	4.32	0.07	0.00
15.01	9.26	16.39	3.24	87.19	2.00	7.32	0.07	0.00
15.17	10.15	18.04	3.15	89.28	2.00	10.48	0.06	0.00
15.34	10.76	19.20	3.16	91.44	2.00	12.52	0.06	0.00
15.50	9.51	16.80	3.37	89.72	2.00	8.12	0.07	0.00
15.66	7.67	13.31	3.65	85.22	2.00	0.43	0.08	0.00
15.83	7.01	12.04	4.00	85.27	2.00	0.00	0.08	0.00
15.99	6.31	10.71	4.12	82.43	1.98	0.00	0.09	0.00
16.16	5.65	9.45	4.25	79.31	1.74	0.00	0.17	0.00
16.32	5.48	9.10	4.75	81.75	1.67	0.00	0.21	0.00
16.48	6.14	10.34	4.89	87.42	1.89	0.00	0.12	0.00
16.65	8.98	15.69	5.34	108.79	2.00	5.87	0.07	0.00
16.81	13.22	23.68	4.39	117.17	2.00	19.46	0.05	0.00
16.98	12.82	22.92	4.84	121.55	2.00	18.37	0.05	0.00
17.14	16.08	29.05	4.23	124.87	2.00	26.20	0.04	0.00
17.30	18.93	34.15	3.80	263.19	2.00	31.54	0.00	0.00
17.47	15.86	28.61	3.78	117.04	2.00	25.70	0.04	0.00
17.63	11.76	20.85	4.42	111.94	2.00	15.25	0.06	0.00
17.80	12.12	21.50	4.13	109.52	2.00	16.27	0.06	0.00

:: Estimation of post-earthquake lateral Displacements :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	R_f (%)	$Q_{tn,cs}$	FS	D_r	$Gamma_{max}$ (%)	Lat. disp. (in)
17.96	9.60	16.73	4.58	104.31	2.00	7.98	0.07	0.00
18.12	6.89	11.58	5.81	99.45	2.00	0.00	0.08	0.00
18.29	9.38	16.27	4.05	97.42	2.00	7.07	0.07	0.00
18.45	10.27	17.93	4.29	104.02	2.00	10.27	0.06	0.00
18.62	10.75	18.83	4.47	108.24	2.00	11.89	0.06	0.00
18.78	10.81	18.88	4.44	108.07	2.00	11.97	0.06	0.00
18.94	10.88	18.85	4.41	107.70	2.00	11.92	0.06	0.00
19.11	9.80	16.91	4.90	108.45	2.00	8.34	0.07	0.00
19.27	9.75	16.67	4.72	105.96	2.00	7.87	0.07	0.00
19.44	11.79	19.80	3.90	103.38	2.00	13.55	0.06	0.00
19.60	12.51	20.77	3.68	102.23	2.00	15.12	0.06	0.00
19.76	12.52	20.63	3.68	101.98	2.00	14.91	0.06	0.00
19.93	11.86	19.44	3.71	100.19	2.00	12.93	0.06	0.00
20.09	11.96	19.41	3.51	97.47	2.00	12.88	0.06	0.00
20.26	10.39	16.88	4.04	99.01	2.00	8.28	0.07	0.00
20.42	10.49	16.97	4.19	100.95	2.00	8.45	0.07	0.00
20.58	10.74	17.27	4.28	102.71	2.00	9.03	0.07	0.00
20.75	10.64	17.00	4.32	102.53	2.00	8.51	0.07	0.00
20.91	9.70	15.30	4.53	100.56	2.00	5.04	0.07	0.00
21.08	8.85	13.70	4.52	96.05	2.00	1.39	0.08	0.00
21.24	7.73	11.68	4.92	93.35	1.95	0.00	0.09	0.00
21.40	7.01	10.37	4.85	88.30	1.73	0.00	0.17	0.00
21.57	7.29	10.76	4.66	88.23	1.79	0.00	0.14	0.00
21.73	7.98	11.83	4.26	88.27	1.96	0.00	0.09	0.00
21.90	8.16	12.05	4.17	88.05	1.99	0.00	0.08	0.00
22.06	8.14	11.94	3.93	85.52	1.97	0.00	0.09	0.00
22.23	8.05	11.69	3.73	82.93	1.92	0.00	0.10	0.00
22.39	6.96	9.81	3.45	75.06	1.61	0.00	0.24	0.00
22.55	5.67	7.63	3.53	68.71	1.25	0.00	0.82	0.00
22.72	4.93	6.39	3.24	62.06	1.04	0.00	1.97	0.01
22.88	4.24	5.22	2.83	54.66	0.85	0.00	5.25	0.02
23.05	3.67	4.26	3.27	52.87	0.69	0.00	4.00	0.02
23.21	4.55	5.64	3.08	58.03	0.92	0.00	3.71	0.01
23.37	8.23	11.34	1.94	62.37	2.00	0.00	0.09	0.00
23.54	13.88	18.99	1.30	91.96	2.00	12.16	0.00	0.00
23.70	19.46	26.17	1.03	61.18	2.00	22.76	0.00	0.00
23.87	25.09	33.07	0.80	60.36	2.00	30.48	0.00	0.00
24.03	30.08	38.99	0.66	61.10	2.00	35.92	0.00	0.00
24.19	32.44	41.66	0.62	61.77	0.34	38.10	51.20	0.20
24.36	32.79	41.92	0.61	61.79	0.34	38.30	51.20	0.21
24.52	33.03	42.05	0.61	61.77	0.34	38.40	51.20	0.20
24.69	32.75	41.55	0.61	61.54	0.34	38.01	51.20	0.21
24.85	31.83	40.31	0.63	61.10	0.34	37.01	51.20	0.20
25.01	31.11	39.32	0.64	60.76	0.34	36.19	51.20	0.00
25.18	31.47	39.59	0.64	60.76	0.34	36.41	51.20	0.00
25.34	36.29	45.47	0.72	67.36	0.36	40.99	51.20	0.00
25.51	49.11	60.57	0.69	78.64	0.42	50.45	34.10	0.00
25.67	67.25	81.44	0.65	95.05	0.53	60.22	22.70	0.00

:: Estimation of post-earthquake lateral Displacements :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	R_f (%)	$Q_{tn,cs}$	FS	D_r	$Gamma_{max}$ (%)	Lat. disp. (in)
25.83	86.59	103.33	0.65	113.39	0.71	68.08	8.50	0.00
26.00	105.05	123.86	0.65	130.49	0.95	74.06	3.75	0.00
26.16	118.71	138.54	0.62	141.36	1.13	77.76	2.49	0.00
26.33	122.71	142.63	0.64	145.05	1.20	78.72	2.21	0.00
26.49	118.85	137.91	0.64	141.51	1.13	77.61	2.49	0.00
26.65	108.95	126.62	0.66	133.21	2.00	74.79	0.00	0.00
26.82	93.71	109.79	0.77	122.36	2.00	70.08	0.00	0.00
26.98	76.83	90.92	0.91	110.00	2.00	63.86	0.00	0.00
27.15	63.87	76.00	1.00	99.73	2.00	57.94	0.00	0.00
27.31	53.52	64.09	1.16	94.11	2.00	52.32	0.00	0.00
27.47	42.74	51.57	1.40	90.60	2.00	45.15	0.00	0.00
27.64	34.87	42.11	1.49	85.19	2.00	38.45	0.00	0.00
27.80	28.71	34.55	1.46	78.31	2.00	31.92	0.00	0.00
27.97	20.71	24.85	1.64	90.27	2.00	21.05	0.00	0.00
28.13	12.63	14.96	2.22	72.26	2.00	4.30	0.07	0.00
28.30	9.56	11.01	2.30	66.48	2.00	0.00	0.09	0.00
28.46	9.38	10.69	1.92	61.11	1.66	0.00	0.20	0.00
28.62	8.85	9.95	2.26	63.81	1.54	0.00	0.29	0.00
28.79	8.49	9.42	2.83	68.51	1.46	0.00	0.38	0.00
28.95	9.04	10.09	3.10	72.91	1.56	0.00	0.27	0.00
29.12	9.84	11.07	3.25	77.02	1.71	0.00	0.17	0.00
29.28	9.97	11.17	3.61	80.81	1.72	0.00	0.17	0.00
29.44	11.05	12.51	3.44	82.56	1.93	0.00	0.10	0.00
29.61	12.13	13.83	3.30	84.09	2.00	1.70	0.08	0.00
29.77	12.56	14.28	3.19	83.79	2.00	2.76	0.07	0.00
29.94	12.76	14.44	3.14	83.52	2.00	3.13	0.07	0.00
30.10	12.58	14.15	3.18	83.46	2.00	2.46	0.08	0.00
30.26	12.90	14.46	3.10	83.15	2.00	3.16	0.07	0.00
30.43	12.94	14.42	3.09	82.97	2.00	3.09	0.07	0.00
30.59	13.14	14.56	2.89	80.79	2.00	3.41	0.07	0.00
30.76	13.12	14.44	2.74	78.67	2.00	3.13	0.07	0.00
30.92	12.94	14.14	2.63	76.61	2.00	2.44	0.08	0.00
31.08	11.72	12.64	2.73	74.98	1.93	0.00	0.09	0.00
31.25	10.53	11.10	2.66	70.90	1.70	0.00	0.18	0.00
31.41	9.17	9.39	2.84	68.60	1.43	0.00	0.41	0.00
31.58	7.99	7.90	3.00	65.89	1.21	0.00	0.95	0.00
31.74	7.10	6.78	3.10	62.93	1.03	0.00	2.02	0.00
31.90	7.16	6.82	2.79	60.69	1.04	0.00	1.97	0.00
32.07	7.32	6.97	3.00	62.89	1.06	0.00	1.77	0.00
32.23	8.03	7.78	3.24	67.46	1.18	0.00	1.04	0.00
32.40	10.10	10.19	3.57	77.72	1.55	0.00	0.28	0.00
32.56	14.09	14.86	3.26	86.05	2.00	4.07	0.07	0.00
32.72	17.89	19.04	2.79	87.33	2.00	12.26	0.06	0.00
32.89	19.77	21.01	2.53	86.07	2.00	15.51	0.06	0.00
33.05	20.04	21.22	2.49	85.78	2.00	15.83	0.06	0.00
33.22	19.52	20.54	2.56	85.95	2.00	14.76	0.06	0.00
33.38	18.81	19.71	2.98	91.14	2.00	13.40	0.06	0.00
33.54	21.18	22.27	3.12	97.31	2.00	17.43	0.05	0.00

:: Estimation of post-earthquake lateral Displacements :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	R_f (%)	$Q_{tn,cs}$	FS	D_r	$Gamma_{max}$ (%)	Lat. disp. (in)
33.71	28.39	29.93	2.47	142.27	1.11	27.19	0.00	0.00
33.87	34.84	36.73	2.24	98.36	0.54	33.94	51.20	0.00
34.04	37.20	39.06	2.15	98.63	0.54	35.97	51.20	0.00
34.20	36.48	38.12	2.14	97.45	0.53	35.17	51.20	0.00
34.36	32.34	33.63	2.47	123.19	0.81	31.03	51.20	0.00
34.53	31.56	32.70	2.72	152.64	2.00	30.10	0.00	0.00
34.69	39.18	40.44	1.99	96.19	2.00	37.11	0.00	0.00
34.86	53.03	54.42	1.32	90.78	2.00	46.92	0.00	0.00
35.02	67.61	68.87	0.89	90.76	2.00	54.69	0.00	0.00
35.19	80.32	81.24	0.65	94.76	2.00	60.14	0.00	0.00
35.35	85.31	85.98	0.61	97.77	0.53	62.01	22.70	0.00
35.51	83.19	83.88	0.79	100.88	0.56	61.20	22.70	0.00
35.68	80.48	80.99	0.89	101.14	0.56	60.04	22.70	0.00
35.84	79.16	79.45	0.93	100.92	0.56	59.41	22.70	0.00
36.01	77.76	77.79	0.95	99.97	0.55	58.71	22.70	0.00
36.17	76.14	75.89	0.92	97.50	0.53	57.89	22.70	0.00
36.33	72.94	72.44	0.90	94.21	0.50	56.36	22.70	0.00
36.50	64.28	63.67	1.12	92.84	0.49	52.10	34.10	0.00
36.66	52.36	51.69	1.60	96.19	0.52	45.22	34.10	0.00
36.83	41.28	40.46	2.18	100.71	0.56	37.14	51.20	0.00
36.99	45.20	44.21	1.99	99.65	0.55	40.06	51.20	0.00
37.15	61.06	59.73	1.41	97.54	0.53	49.99	34.10	0.00
37.32	81.24	79.31	1.03	103.51	0.59	59.35	22.70	0.00
37.48	104.74	101.94	0.76	115.56	0.72	67.63	8.41	0.00
37.65	129.10	125.25	0.64	131.28	0.93	74.43	3.94	0.00
37.81	140.88	136.38	0.64	140.34	1.08	77.24	2.74	0.00
37.97	142.46	137.60	0.67	142.65	1.12	77.54	2.53	0.00
38.14	138.57	133.48	0.71	140.49	1.08	76.53	2.72	0.00
38.30	130.35	125.21	0.75	135.06	0.99	74.42	3.26	0.00
38.47	120.67	115.50	0.75	126.66	0.86	71.76	4.87	0.00
38.63	109.89	104.79	0.75	117.53	0.74	68.55	7.55	0.00
38.79	98.97	94.01	0.77	108.88	0.64	64.96	22.70	0.00
38.96	93.46	88.42	0.75	103.59	0.59	62.94	22.70	0.00
39.12	94.08	88.76	0.70	102.61	0.58	63.06	22.70	0.00
39.29	101.59	95.67	0.69	108.17	0.64	65.54	11.73	0.00
39.45	115.67	108.85	0.67	118.93	0.76	69.80	6.98	0.00
39.61	133.75	125.76	0.63	131.45	0.94	74.56	3.81	0.00
39.78	148.99	139.88	0.59	141.11	1.10	78.08	2.62	0.00
39.94	163.53	153.32	0.56	153.32	1.34	81.11	1.74	0.00
40.11	173.57	162.43	0.54	162.43	1.55	83.01	1.29	0.00
40.27	179.41	167.57	0.52	167.57	1.68	84.04	1.10	0.00
40.43	183.60	171.12	0.52	171.12	1.77	84.73	0.98	0.00
40.60	190.46	177.17	0.53	177.17	1.94	85.88	0.99	0.00
40.76	195.04	181.07	0.52	181.07	2.00	86.60	0.00	0.00
40.93	198.58	183.97	0.51	183.97	2.00	87.12	0.00	0.00
41.09	199.83	184.74	0.49	184.74	2.00	87.26	0.00	0.00
41.26	199.07	183.66	0.44	183.66	2.00	87.07	0.00	0.00
41.42	197.39	181.76	0.41	181.76	2.00	86.72	0.00	0.00

:: Estimation of post-earthquake lateral Displacements :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	R_f (%)	$Q_{tn,cs}$	FS	D_r	Gamma$_{max}$ (%)	Lat. disp. (in)
41.58	193.90	178.13	0.40	178.13	1.98	86.06	0.95	0.00
41.75	190.18	174.23	0.43	174.23	1.87	85.33	1.05	0.00
41.91	188.79	172.49	0.48	172.49	1.83	84.99	0.92	0.00
42.08	188.78	171.93	0.56	171.93	1.81	84.89	0.93	0.00
42.24	187.18	169.94	0.63	169.94	1.76	84.50	0.99	0.00
42.40	178.67	161.59	0.68	161.84	1.56	82.84	1.28	0.00
42.57	169.01	152.23	0.72	156.24	1.43	80.87	1.52	0.00
42.73	147.58	131.97	0.89	145.22	1.20	76.16	2.19	0.00
42.90	116.18	102.74	1.15	127.05	0.89	67.89	4.42	0.00
43.06	85.96	74.86	1.56	114.48	0.73	57.44	14.71	0.00
43.22	74.15	63.94	1.73	109.89	0.67	52.24	34.10	0.00
43.39	59.81	50.82	1.97	105.18	0.62	44.66	51.20	0.00
43.55	48.96	41.01	2.00	97.11	0.55	37.58	51.20	0.00
43.72	44.54	36.97	1.84	89.68	0.49	34.16	51.20	0.00
43.88	40.71	33.52	1.62	81.51	2.00	30.92	0.00	0.00
44.04	27.44	21.69	2.19	177.46	2.00	16.55	0.00	0.00
44.21	19.12	14.35	3.14	83.64	2.00	2.93	0.07	0.00
44.37	17.39	12.82	3.68	86.19	2.00	0.00	0.08	0.00
44.54	19.89	14.88	3.32	86.92	2.00	4.12	0.07	0.00
44.70	23.40	17.81	2.99	88.32	2.00	10.06	0.06	0.00
44.86	27.44	21.24	2.55	86.95	2.00	15.86	0.06	0.00
45.03	31.17	24.38	2.25	159.11	1.53	20.42	0.00	0.00
45.19	31.57	24.69	1.96	124.82	2.00	20.83	0.00	0.00
45.36	33.32	26.16	1.62	83.32	2.00	22.75	0.00	0.00
45.52	48.02	38.95	1.04	71.40	2.00	35.87	0.00	0.00
45.68	63.80	52.74	0.78	75.01	2.00	45.88	0.00	0.00
45.85	82.06	68.80	0.61	83.37	2.00	54.66	0.00	0.00
46.01	107.10	91.02	0.47	91.02	2.00	63.90	0.00	0.00
46.18	129.55	111.02	0.39	111.02	0.70	70.45	8.88	0.00
46.34	137.31	117.80	0.36	117.80	0.79	72.41	6.38	0.00
46.50	143.87	123.36	0.38	123.36	0.87	73.93	4.86	0.00
46.67	148.59	127.29	0.38	127.29	0.93	74.96	4.00	0.00
46.83	150.12	128.43	0.37	128.43	0.94	75.26	3.63	0.00
47.00	150.89	128.78	0.38	128.78	0.95	75.35	3.57	0.00
47.16	151.23	128.83	0.38	128.83	0.95	75.36	3.55	0.00
47.32	150.11	127.71	0.36	127.71	0.94	75.07	3.68	0.00
47.49	145.52	123.46	0.34	123.46	0.87	73.96	4.71	0.00
47.65	139.58	117.90	0.36	117.90	0.80	72.44	6.13	0.00
47.82	134.12	112.78	0.37	112.78	0.73	70.97	7.81	0.00
47.98	131.16	109.92	0.38	109.92	0.70	70.12	8.92	0.00
48.15	130.63	108.51	0.55	114.92	0.76	69.70	6.98	0.00
48.31	131.01	108.14	0.69	118.73	0.81	69.58	5.78	0.00
48.47	131.59	107.93	0.84	122.78	0.87	69.52	4.74	0.00
48.64	133.80	109.41	0.88	125.34	0.91	69.97	4.17	0.00
48.80	135.96	110.86	0.93	127.85	0.95	70.40	3.67	0.00
48.97	140.21	114.48	0.83	128.19	0.96	71.46	3.59	0.00
49.13	145.11	118.49	0.80	130.83	1.01	72.60	3.15	0.00
49.29	149.62	122.13	0.78	133.23	1.05	73.60	2.80	0.00

:: Estimation of post-earthquake lateral Displacements :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	R_f (%)	$Q_{tn,cs}$	FS	D_r	$Gamma_{max}$ (%)	Lat. disp. (in)
49.46	150.12	122.07	0.83	134.68	1.07	73.58	2.60	0.00
49.62	149.30	120.97	0.86	134.65	1.08	73.28	2.59	0.00
49.79	145.86	117.72	0.86	132.03	1.03	72.38	2.92	0.00
49.95	142.50	114.77	0.81	128.06	0.97	71.55	3.51	0.00
50.11	140.09	112.77	0.73	123.87	0.90	70.97	4.27	0.00
50.28	141.01	113.59	0.65	122.29	0.88	71.20	4.59	0.00
50.44	142.05	114.43	0.61	121.51	0.87	71.45	4.74	0.00
50.61	140.99	113.45	0.57	119.47	0.85	71.16	5.20	0.00
50.77	136.60	109.39	0.59	116.75	0.81	69.96	5.90	0.00
50.93	125.98	99.93	0.65	110.78	0.73	66.98	7.83	0.00
51.10	112.24	88.00	0.71	102.32	0.64	62.78	22.70	0.00
51.26	102.09	79.34	0.72	95.29	0.57	59.36	22.70	0.00
51.43	95.77	73.91	0.73	90.87	0.54	57.02	22.70	0.00
51.59	91.87	70.61	0.70	87.21	0.51	55.51	22.70	0.00
51.75	94.81	73.04	0.63	87.56	0.51	56.63	22.70	0.00
51.92	101.17	78.18	0.61	91.34	0.54	58.87	22.70	0.00
52.08	105.86	81.76	0.64	95.15	0.58	60.35	22.70	0.00
52.25	110.13	84.98	0.67	98.66	0.61	61.63	22.70	0.00
52.41	118.52	91.74	0.66	104.03	0.67	64.15	21.47	0.00
52.57	128.09	99.57	0.62	109.73	0.73	66.86	7.83	0.00
52.74	135.37	105.61	0.58	113.34	0.78	68.80	6.55	0.00
52.90	142.47	111.61	0.52	116.37	0.82	70.63	5.64	0.00
53.07	148.40	116.62	0.47	116.62	0.83	72.07	5.54	0.00
53.23	151.98	119.76	0.42	119.76	0.87	72.95	4.74	0.00
53.39	155.73	123.08	0.37	123.08	0.92	73.85	4.02	0.00
53.56	161.83	128.35	0.33	128.35	1.01	75.24	3.15	0.00
53.72	166.42	132.22	0.31	132.22	1.08	76.22	2.74	0.00
53.89	170.29	135.47	0.29	135.47	1.14	77.02	2.45	0.00
54.05	173.17	137.74	0.29	137.74	1.19	77.57	2.26	0.00
54.22	172.50	136.91	0.29	136.91	1.17	77.37	2.31	0.00
54.38	169.35	133.67	0.32	133.67	1.11	76.58	2.57	0.00
54.54	166.38	131.29	0.29	131.29	1.07	75.99	2.78	0.00
54.71	163.19	128.17	0.31	128.17	1.02	75.19	3.09	0.00
54.87	161.24	126.69	0.27	126.69	1.00	74.81	3.23	0.00
55.04	160.13	124.81	0.34	124.81	0.97	74.32	3.51	0.00
55.20	166.65	128.83	0.46	128.83	1.04	75.36	2.99	0.00

Total estimated displacement: 1.09

Abbreviations

q_t:	Total cone resistance
Q_{tn}:	Adjusted cone resistance to an effective overburden stress of 1 atm
R_f:	Friction ration
$Q_{tn,cs}$:	Adjusted and corrected cone resistance due to fines
FS:	Calculated factor of safety against liquefaction
D_r:	Calculated relative density
$Gamma_{max}$:	Calculated maximum cyclic shear strain
Lat. disp.:	Lateral displacement

APPENDIX D
EARTHWORK AND GRADING GUIDELINES

EARTHWORK AND GRADING GUIDELINES

GENERAL

These guidelines present general procedures and recommendations for earthwork and grading as required on the approved grading plans, including preparation of areas to be filled, placement of fill and installation of subdrains and excavations. The recommendations contained in the geotechnical report are applicable to each specific project, are part of the earthwork and grading guidelines and would supersede the provisions contained hereafter in the case of conflict. Observations and/or testing performed by the consultant during the course of grading may result in revised recommendations which could supersede these guidelines or the recommendations contained in the geotechnical report. Figures A through O are provided at the back of this appendix, exhibiting generalized cross sections relating to these guidelines.

The contractor is responsible for the satisfactory completion of all earthworks in accordance with provisions of the project plans and specifications. The project soil engineer and engineering geologist (geotechnical consultant) or their representatives should provide observation and testing services, and geotechnical consultation throughout the duration of the project.

EARTHWORK OBSERVATIONS AND TESTING

Geotechnical Consultant

Prior to the commencement of grading, a qualified geotechnical consultant (a soil engineer and engineering geologist) should be employed for the purpose of observing earthwork procedures and testing the fills for conformance with the recommendations of the geotechnical report, the approved grading plans, and applicable grading codes and ordinances.

The geotechnical consultant should provide testing and observation so that determination may be made that the work is being completed as specified. It is the responsibility of the contractor to assist the consultant and keep them aware of work schedules and predicted changes, so that the consultant may schedule their personnel accordingly.

All removals, prepared ground to receive fill, key excavations, and subdrains should be observed and documented by the project engineering geologist and/or soil engineer prior to placing any fill. It is the contractor’s responsibility to notify the engineering geologist and soil engineer when such areas are ready for observation.

Laboratory and Field Tests

Maximum dry density tests to determine the degree of compaction should be performed in accordance with American Standard Testing Materials test method ASTM designation D-1557-78. Random field compaction tests should be performed in accordance with test method ASTM designations D-1556-82, D-2937 or D-2922 & D-3017, at intervals of approximately two (2) feet of fill height per 10,000 sq. ft. or every one thousand cubic yards of fill placed. These criteria would vary depending on the soil conditions and the size of the project. The location and frequency of testing would be at the discretion of the geotechnical consultant

Contractor's Responsibility

All clearing, site preparation, and earthwork performed on the project should be conducted by the contractor, with observation by geotechnical consultants and staged approval by the appropriate governing agencies. It is the contractor's responsibility to prepare the ground surface to receive the fill to the satisfaction of the soil engineer, and to place, spread, moisture condition, mix and compact the fill in accordance with the recommendations of the soil engineer. The contractor should also remove all major deleterious material considered unsatisfactory by the soil engineer.

It is the sole responsibility of the contractor to provide adequate equipment and methods to accomplish the earthwork in accordance with applicable grading guidelines, codes or agency ordinances, and approved grading plans. Sufficient watering apparatus and compaction equipment should be provided by the contractor with due consideration for the fill material, rate of placement, and climatic conditions. If, in the opinion of the geotechnical consultant, unsatisfactory conditions such as questionable weather, excessive oversized rock, deleterious material or insufficient support equipment are resulting in a quality of work that is not acceptable, the consultant will inform the contractor, and the contractor is expected to rectify the conditions, and if necessary, stop work until conditions are satisfactory.

The contractor will properly grade all surfaces to maintain good drainage and prevent ponding of water. The contractor will take action to control surface water and to prevent erosion control measures that have been installed.

SITE PREPARATION

All vegetation including brush, trees, thick grasses, organic debris, and other deleterious material should be removed and disposed of offsite, and must be concluded prior to placing fill. Existing fill, soil, alluvium, colluvium, or rock materials determined by the soil engineer or engineering geologist as unsuitable for structural in-place support should be removed prior to fill placement. Depending upon the soil conditions, these materials may be reused as compacted fills. Any materials incorporated as part of the compacted fills should be approved by the soil engineer.

Any underground structures such as cesspools, cisterns, mining shafts, tunnels, septic tanks, wells, pipelines, or other structures not located prior to grading are to be removed or treated in a manner recommended by the soil engineer. Soft, dry, spongy, highly fractured, or otherwise unsuitable ground extending to such a depth that surface processing cannot adequately improve the condition should be over excavated down to firm ground and approved by the soil engineer before compaction and filling operations continue. Over excavated and processed soils which have been properly mixed and moisture-conditioned should be recompacted to the minimum relative compaction as specified in these guidelines.

Existing ground which is determined to be satisfactory for support of the fills should be scarified to a minimum depth of six (6) inches, or as directed by the soil engineer. After the scarified ground is brought to optimum moisture (or greater) and mixed, the materials should be compacted as specified herein. If the scarified zone is greater than 6 inches in depth, it may be necessary to remove the excess and place the material in lifts restricted to six (6) inches in compacted thickness.

Existing grind which is not satisfactory to support compacted fill should be over excavated as required in the geotechnical report or by the onsite soils engineer and/or engineering geologists. Scarification, discing, or other acceptable form of mixing should continue until the soils are broken down and free of large fragments or clods, until the working surface is reasonably uniform and free from ruts, hollows, hummocks, or other uneven features which would inhibit compaction as described above.

Where fills are to be placed on ground with slopes steeper than 5:1 (horizontal to vertical) gradient, the ground should be benched. The lowest bench, which will act as a key, should be a minimum of 12 feet wide and should be at least two (2) feet deep into competent material, approved by the soil engineer and/or engineering geologist. In fill over cut slope conditions, the recommended minimum width of the lowest bench or key is at least 15 feet with the key excavated on competent material, as designated by the Geotechnical Consultant. As a general rule, unless superseded by the Soil Engineer, the minimum width of fill keys should be approximately equal to one-half (½) the height of the slope.

Standard benching is typically four feet (minimum) vertically, exposing competent material. Benching may be used to remove unsuitable materials, although it is understood that the vertical height of the bench may exceed four feet. Pre stripping may be considered for removal of unsuitable materials in excess of four feet in thickness.

All areas to receive fill, including processed areas, removal areas, and toe of fill benches should be observed and approved by the soil engineer and/or engineering geologist prior to placement of fill. Fills may then be properly placed and compacted until design grades are attained.

COMPACTED FILLS

Earth materials imported or excavated on the property may be utilized as fill provided that each soil type has been accepted by the soil engineer. These materials should be free of roots, tree branches, other organic matter or other deleterious materials. All unsuitable materials should be removed from the fill as directed by the soil engineer. Soils of poor gradation, undesirable expansion potential, or substandard strength characteristics may be designated unsuitable by the consultant and may require mixing with other earth materials to serve as a satisfactory fill material.

Fill materials generated from benching operations should be dispersed throughout the fill area. Benching operations should not result in the benched material being placed only within a single equipment width away from the fill/bedrock contact.

Oversized materials, defined as rock or other irreducible materials with a maximum size exceeding 12 inches in one dimension, should not be buried or placed in fills unless the location of materials and disposal methods are specifically approved by the soil engineer. Oversized material should be taken offsite or placed in accordance with recommendations of the soil engineer in areas designated as suitable for rock disposal. Oversized material should not be placed vertically within 10 feet of finish grade or horizontally within 20 feet of slope faces.

To facilitate trenching, rock should not be placed within the range of foundation excavations or future utilities unless specifically approved by the soil engineer and/or the representative developers.

If import fill material is required for grading, representative samples of the material should be analyzed in the laboratory by the soil engineer to determine its physical properties. If any material other than that previously analyzed is imported to the fill or encountered during grading, analysis of this material should be conducted by the soil engineer as soon as practical.

Fill material should be placed in areas prepared to receive fill in near-horizontal layers that should not exceed six (6) inches compacted in thickness. The soil engineer may approve thicker lifts if testing indicates the grading procedures are such that adequate compaction is being achieved. Each layer should be spread evenly and mixed to attain uniformity of material and moisture suitable for compaction.

Fill materials at moisture content less than optimum should be watered and mixed, and “wet” fill materials should be aerated by scarification, or should be mixed with drier material. Moisture conditioning and mixing of fill materials should continue until the fill materials have uniform moisture content at or above optimum moisture.

After each layer has been evenly spread, moisture-conditioned and mixed, it should be uniformly compacted to a minimum of 90 percent of maximum density as determined by ASTM test designation, D 1557-78, or as otherwise recommended by the soil engineer. Compaction equipment should be adequately sized and should be reliable to efficiently achieve the required degree of compaction.

Where tests indicate that the density of any layer of fill, or portion thereof, is below the required relative compaction or improper moisture content, the particular layer or portion will be reworked until the required density and/or moisture content has been attained. No additional fill will be placed in an area until the last placed lift of fill has been tested and found to meet the density and moisture requirements, and is approved by the soil engineer.

Compaction of slopes should be accomplished by over-building the outside edge a minimum of three (3) feet horizontally, and subsequently trimming back to the finish design slope configuration. Testing will be performed as the fill is horizontally placed to evaluate compaction as the fill core is being developed. Special efforts may be necessary to attain the specified compaction in the fill slope zone. Final slope shaping should be performed by trimming and removing loose materials with appropriate equipment. A final determination of fill slope compaction should be based on observation and/or testing of the finished slope face.

If an alternative to over-building and cutting back the compacted fill slope is selected, then additional efforts should be made to achieve the required compaction in the outer 10 feet of each lift of fill by undertaking the following:

- Equipment consisting of a heavy short-shanked sheepsfoot should be used to roll (horizontal) parallel to the slopes continuously as fill is placed. The sheepsfoot roller should also be used to roll perpendicular to the slopes, and extend out over the slope to provide adequate compaction to the face slope.

- Loose fill should not be spilled out over the face of the slope as each lift is compacted. Any loose fill spilled over a previously completed slope face should be trimmed off or be subject to re-rolling.

- Field compaction tests will be made in the outer two (2) to five (5) feet of the slope at two (2) to three (3) foot vertical intervals, subsequent to compaction operations.

- After completion of the slope, the slope face should be shaped with a small dozer and then re-rolled with a sheepsfoot to achieve compaction to near the slope face. Subsequent to testing to verify compaction, the slopes should be grid-rolled to achieve adequate compaction to the slope face. Final testing should be used to confirm compaction after grid rolling.

- Where testing indicates less than adequate compaction, the contractor will be responsible to process, moisture condition, mix and recompact the slope materials as necessary to achieve compaction. Additional testing should be performed to verify compaction.

- Erosion control and drainage devices should be designed by the project civil engineer in compliance with the ordinances of the controlling governmental agencies, and/or in accordance with the recommendations of the soil engineer or engineering geologist.

EXCAVATIONS

Excavations and cut slopes should be observed and mapped during grading by the engineering geologist. If directed by the engineering geologist, further excavations or over-excavation and refilling of cut areas should be performed. When fills over cut slopes are to be graded, the cut portion of the slope should be observed by the engineering geologist prior to placement of the overlying fill portion of the slope. The engineering geologist should observe all cut slopes and should be notified by the contractor when cut slopes are started.

If, during the course of grading, unanticipated adverse or potentially adverse geologic conditions are encountered, the engineering geologist and soil engineer should investigate, evaluate and make recommendations to mitigate (or limit) these conditions. The need for cut slope buttressing or stabilizing should be based on as-grading evaluations by the engineering geologist, whether anticipated previously or not.

Unless otherwise specified in soil and geological reports, no cut slopes should be excavated higher or steeper than that allowed by the ordinances of controlling governmental agencies. Additionally, short-term stability of temporary cut slopes is the contractor's responsibility.

Erosion control and drainage devices should be designed by the project civil engineer and should be constructed in compliance with the ordinances of the controlling governmental agencies, and/or in accordance with the recommendations of the soil engineer or engineering geologist.

SUBDRAIN INSTALLATION

Subdrains should be installed in accordance with the approved embedment material, alignment and details indicated by the geotechnical consultant. Subdrain locations or construction materials should not be changed or modified without approval of the geotechnical consultant. The soil engineer and/or engineering geologist may recommend and direct changes in subdrain line, grade and drain material in the field, pending exposed conditions. The location of constructed subdrains should be recorded by the project civil engineer.

COMPLETION

Consultation, observation and testing by the geotechnical consultant should be completed during grading operations in order to state an opinion that all cut and filled areas are graded in accordance with the approved project specifications.

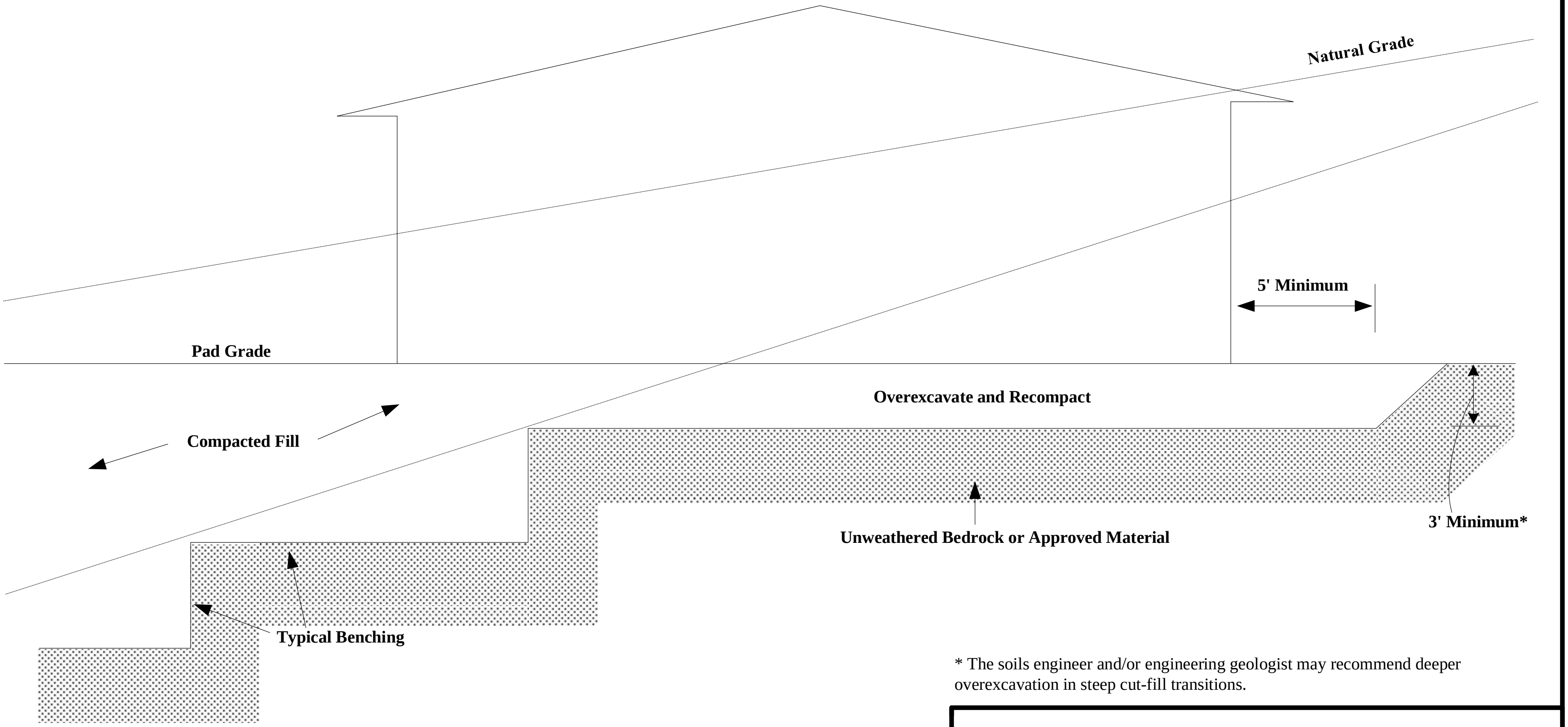
After completion of grading and after the soil engineer and engineering geologist have finished their observations, final reports should be submitted subject to review by the controlling governmental agencies. No additional grading should be undertaken without prior notification of the soil engineer and/or engineering geologist.

All finished cut and fill slopes should be protected from erosion, including but not limited to planting in accordance with the plan design specifications and/or as recommended by a landscape architect. Such protection and/or planning should be undertaken as soon as possible after completion of grading.

ATTACHMENTS

Figure A – Transition Lot Detail Cut Lot
Figure B – Transition Lot Detail Cut - Fill
Figure C – Rock Disposal Pits
Figure D – Detail for Fill Slope Toeing out on a Flat Alluviated Canyon
Figure E – Removal Adjacent to Existing Fill
Figure F – Daylight Cut Lot Detail
Figure G – Skin Fill of Natural Ground
Figure H – Typical Stabilization Buttress Fill Design
Figure I – Stabilization Fill for Unstable Material Exposed in Portion of Cut Slope
Figure J – Fill Over Cut Detail
Figure K – Fill Over Natural Detail
Figure L – Oversize Rock Disposal
Figure M – Canyon Subdrain Detail
Figure N – Canyon Subdrain Alternate Details
Figure O – Typical Stabilization Buttress Subdrain Detail
Figure P – Retaining Wall Backfill

TRANSITION LOT DETAIL
CUT LOT – MATERIAL TYPE
TRANSITION



* The soils engineer and/or engineering geologist may recommend deeper overexcavation in steep cut-fill transitions.

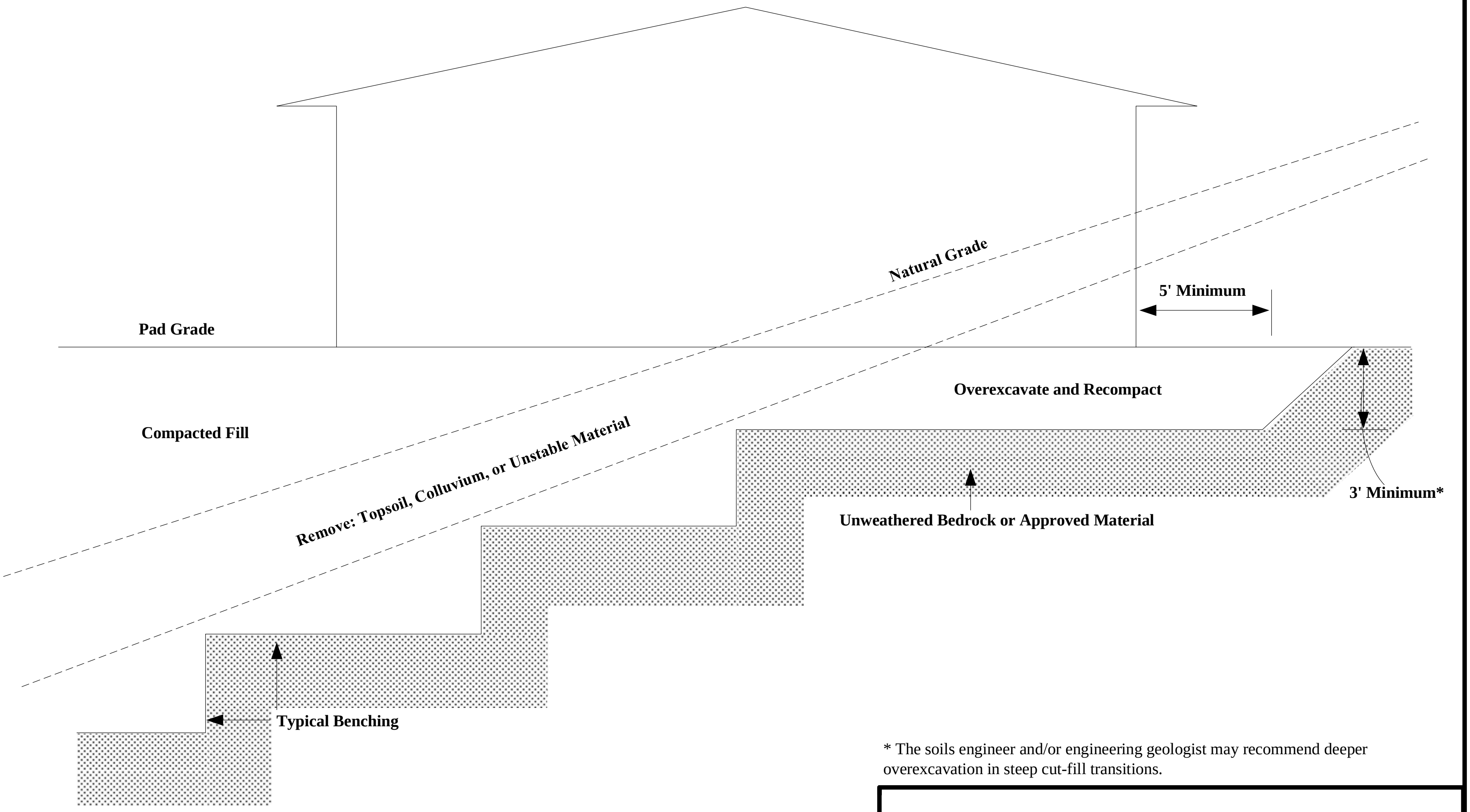
Note: Figure not to scale

EARTHWORK AND GRADING GUIDELINES
TRANSITION LOT DETAIL
CUT LOT – MATERIAL TYPE TRANSITION

EEI
Expertise . . Service . . *Solutions*

FIGURE A

TRANSITION LOT DETAIL
CUT – FILL – DAYLIGHT TRANSITION



* The soils engineer and/or engineering geologist may recommend deeper overexcavation in steep cut-fill transitions.

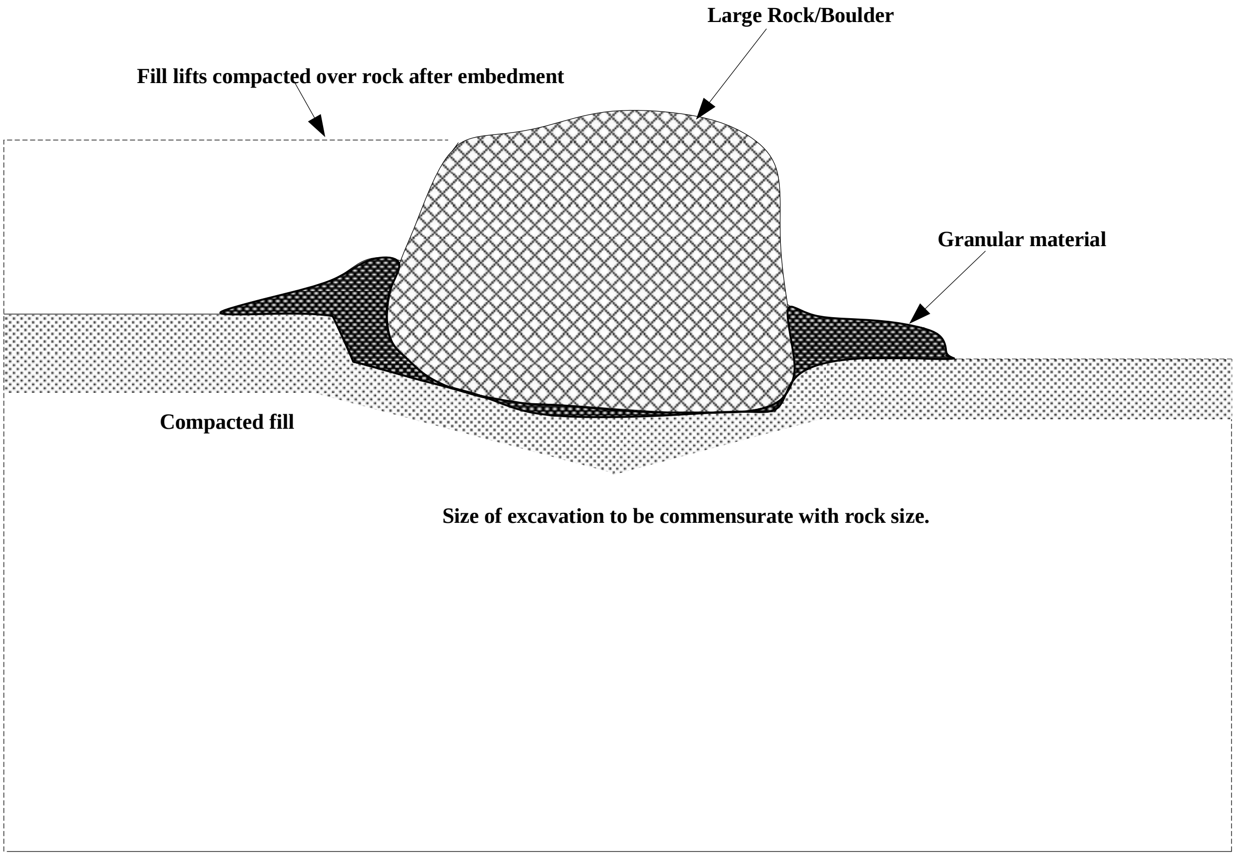
Note: Figure not to scale

EARTHWORK AND GRADING GUIDELINES
TRANSITION LOT DETAIL
CUT – FILL – DAYLIGHT TRANSITION

EEI
Expertise . . Service . . *Solutions*

FIGURE B

ROCK DISPOSAL PITS



Note:
(1) Large rock is defined as having a diameter larger than 3 feet in maximum size.
(2) Pit shall be excavated into compacted fill to a depth equal to half of the rock size.
(3) Granular soil shall be pushed into the pit and then flooded around the rock using a sheepsfoot to help with compaction.
(4) A minimum of 3 feet of compacted fill should be laid over each pit.
(5) Pits shall have at least 15 feet of separation between one another, horizontally.
(6) Pits shall be placed at least 20 feet from any fill slope.
(7) Pits shall be used only in deep fill areas.

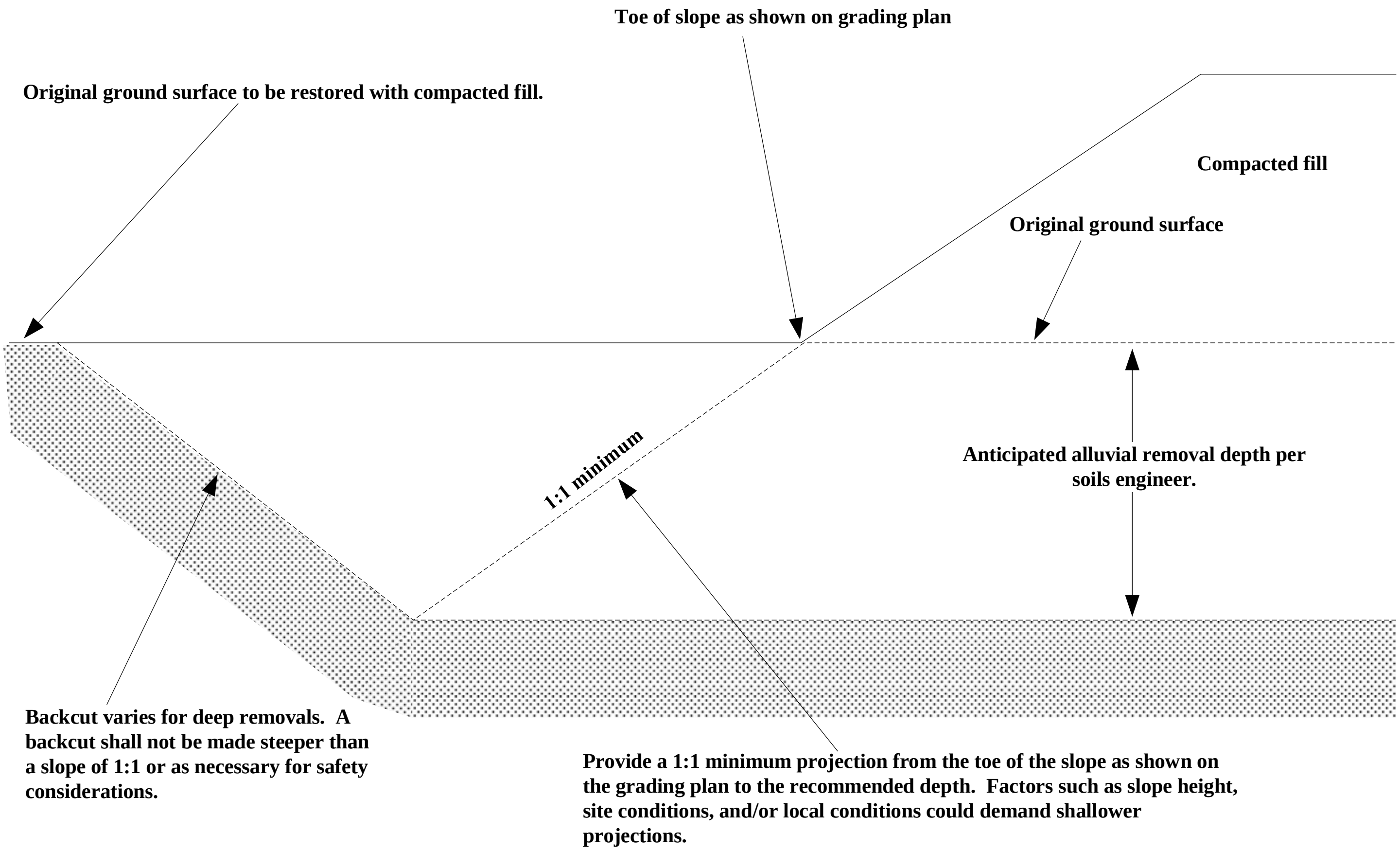
Note: Figure not to scale

EARTHWORK AND GRADING GUIDELINES
ROCK DISPOSAL PITS

EEI
Expertise . . Service . . *Solutions*

FIGURE C

DETAIL FOR FILL SLOPE TOEING OUT ON FLAT ALLUVIATED CANYON



Note: Figure not to scale

EARTHWORK AND GRADING GUIDELINES

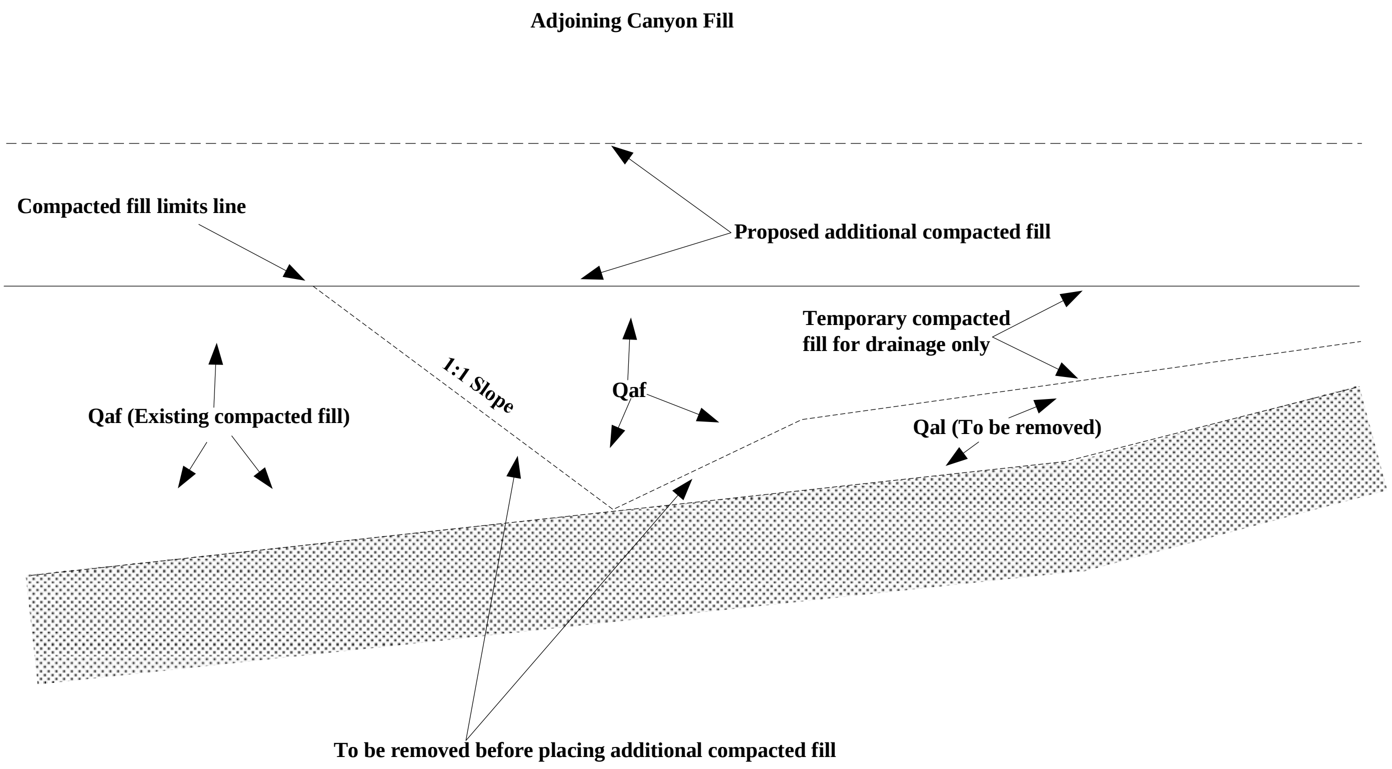
DETAIL FOR FILL SLOPE TOEING OUT ON A FLAT ALLUVIATED CANYON

EEI

Expertise . . Service . . *Solutions*

FIGURE D

REMOVAL ADJACENT TO EXISTING FILL



Legend

Qaf -	**Artificial Fill**
Qal -	**Alluvium**

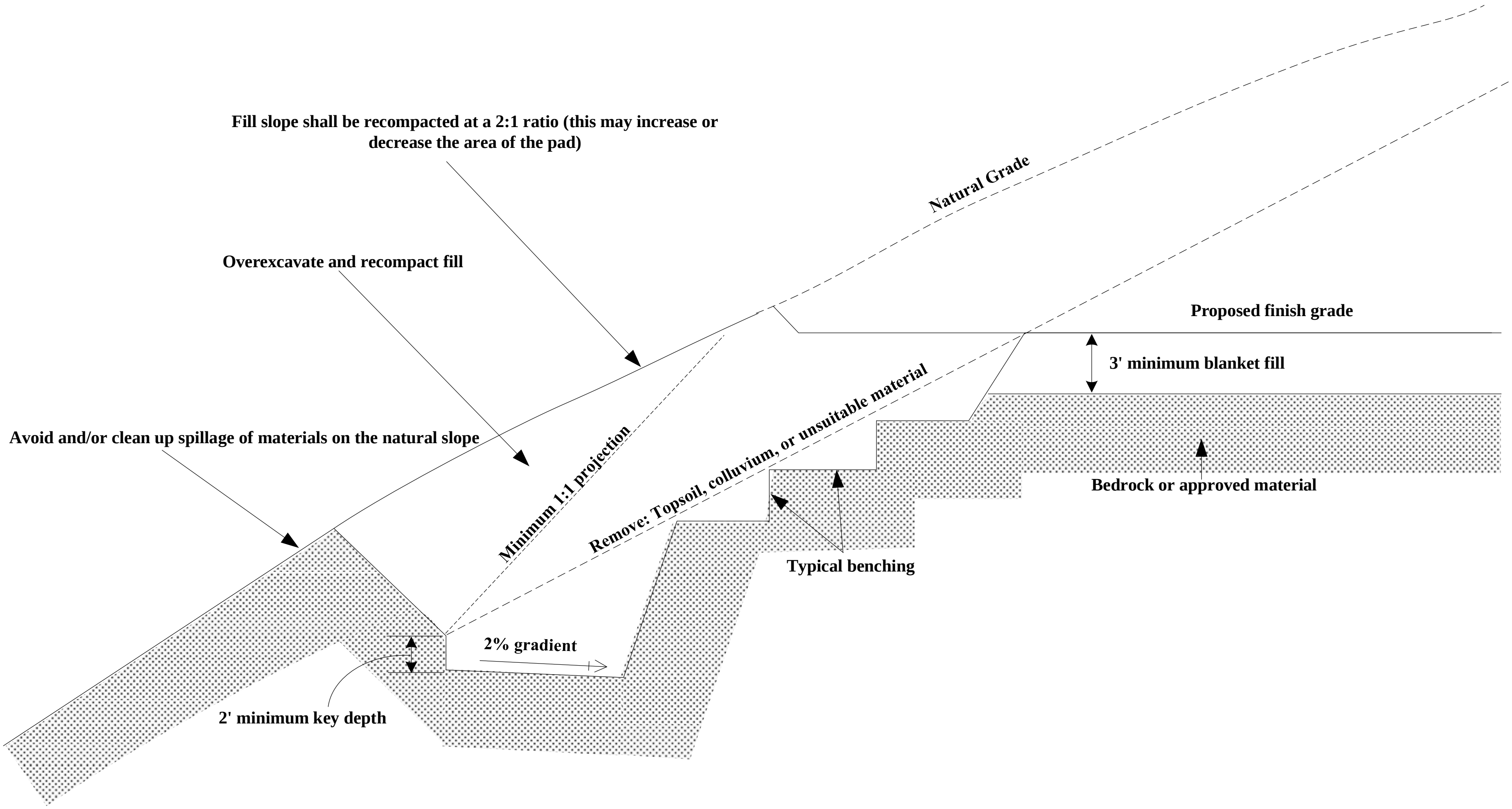
Note: Figure not to scale

EARTHWORK AND GRADING GUIDELINES
REMOVAL ADJACENT TO EXISTING FILL

EEI
Expertise . . Service . . ***Solutions***

FIGURE E

DAYLIGHT CUT LOT DETAIL



Note: (1) Subdrain and key width requirements shall be determined based on exposed subsurface conditions and the thickness of overburden.

(2) Pad overexcavation and recompaction shall be completed if determined as necessary by the soils engineer and/or engineering geologist.

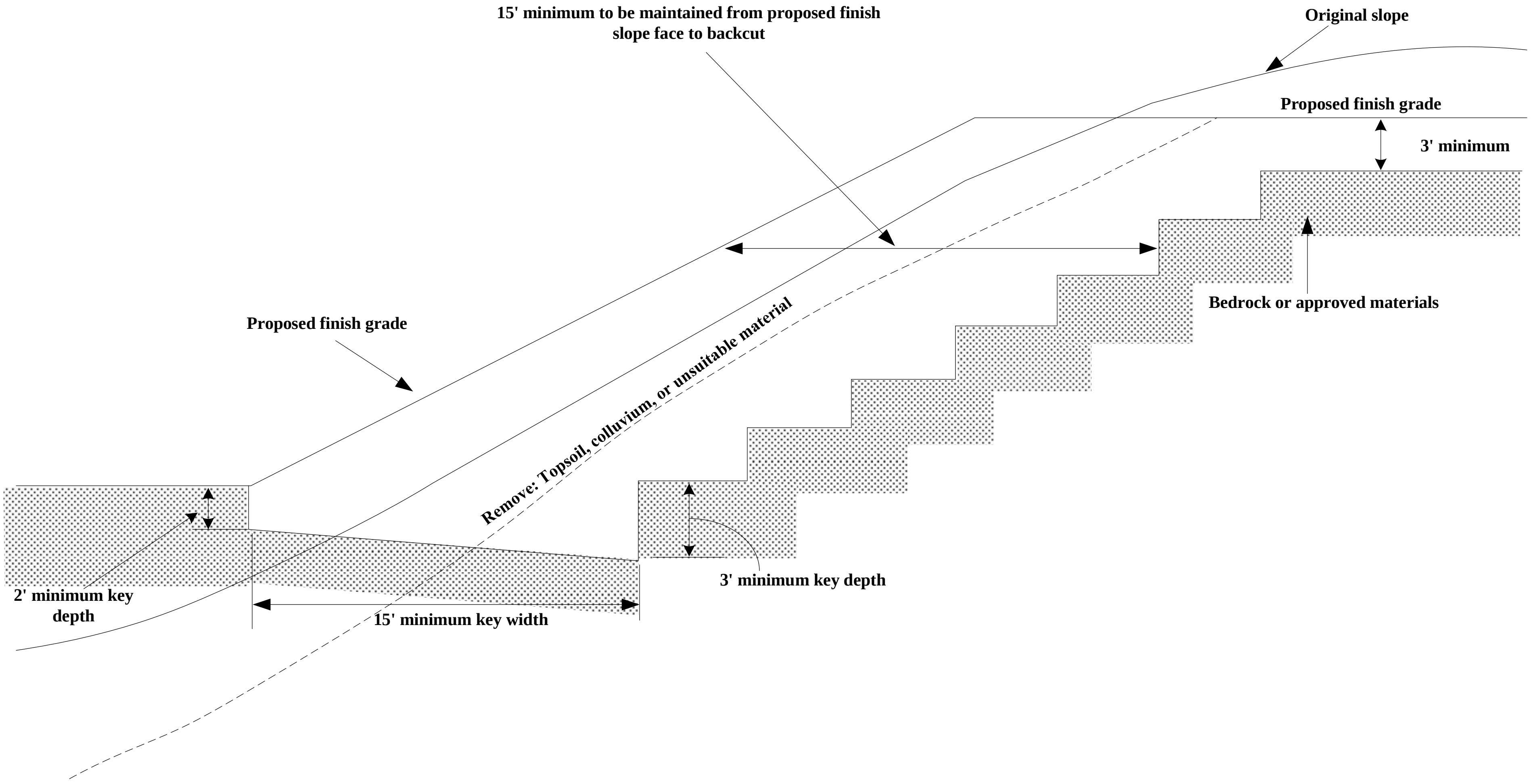
Note: Figure not to scale

EARTHWORK AND GRADING GUIDELINES
DAYLIGHT CUT LOT DETAIL

EEI
Expertise . . Service . . *Solutions*

FIGURE F

SKIN FILL OF NATURAL GROUND



Note: (1) The need and disposition of drains will be determined by the soils engineer and/or engineering geologist based on site conditions.

(2) Pad overexcavation and recompaction shall be completed if determined as necessary by the soils engineer and/or engineering geologist.

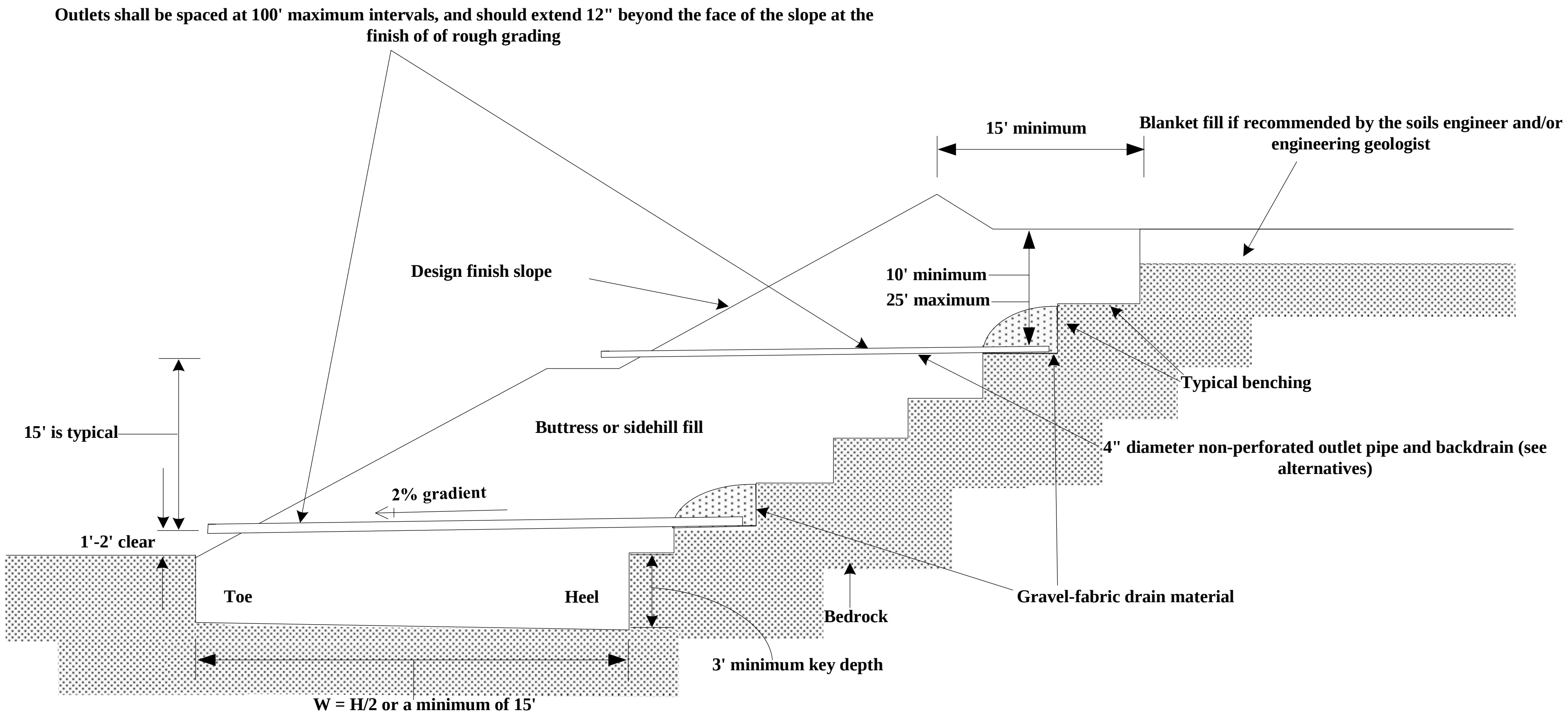
Note: Figure not to scale

EARTHWORK AND GRADING GUIDELINES
SKIN FILL OF NATURAL GROUND

EEI
Expertise . . Service . . *Solutions*

FIGURE G

TYPICAL STABILIZATION BUTTRESS FILL DESIGN



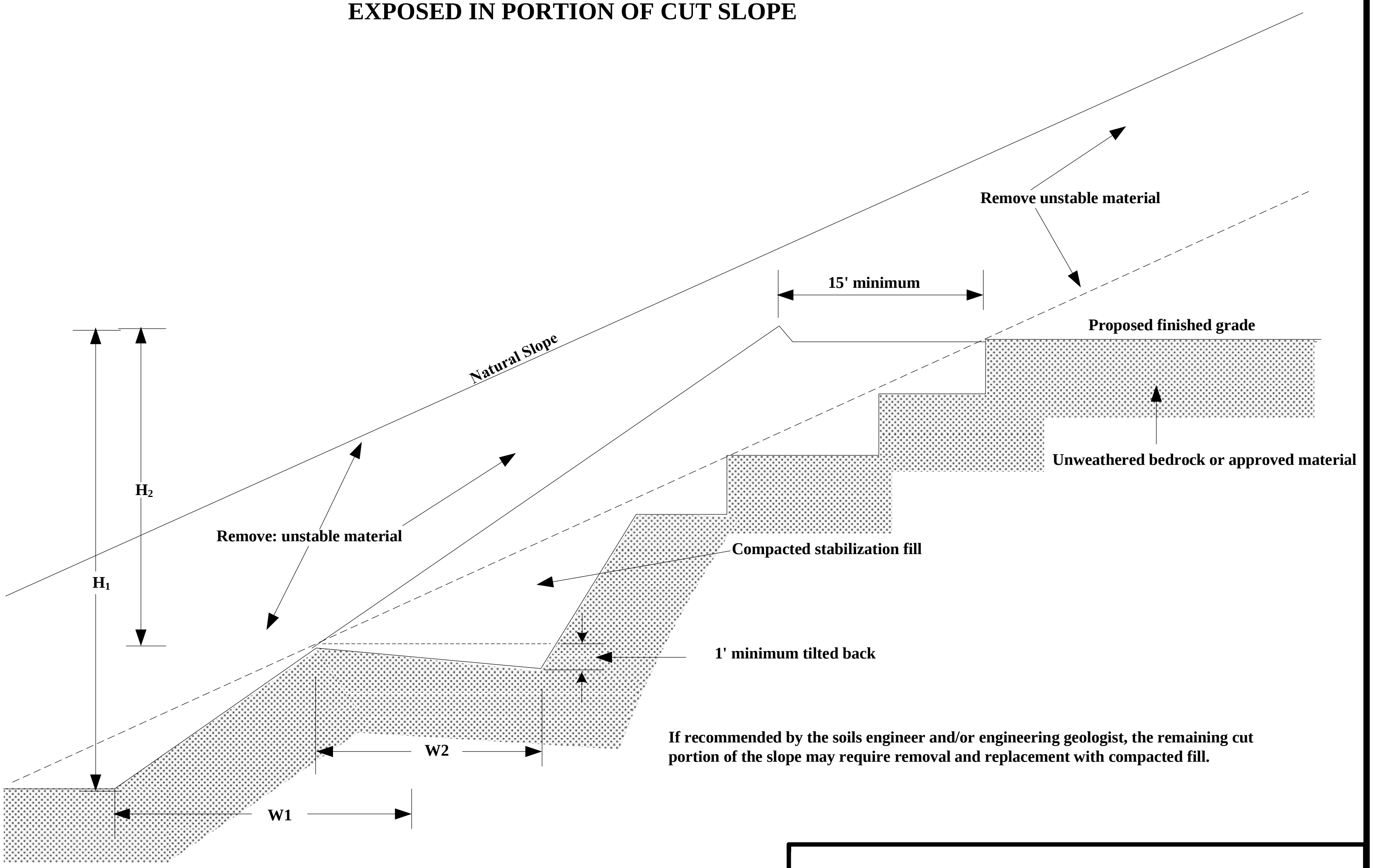
Note: Figure not to scale

EARTHWORK AND GRADING GUIDELINES
TYPICAL STABILIZATION BUTTRESS FILL DESIGN

EEI
Expertise . . Service . . *Solutions*

FIGURE H

STABILIZATION FILL FOR UNSTABLE MATERIAL EXPOSED IN PORTION OF CUT SLOPE



If recommended by the soils engineer and/or engineering geologist, the remaining cut portion of the slope may require removal and replacement with compacted fill.

Note:
(1) Subdrains are required only if specified by the soils engineer and/or engineering geologist.
(2) "W" shall be the equipment width (15') for slope heights less than 25 feet. For slopes greater than 25 feet "W" shall be determined by the project soils engineer and/or the engineering geologist. "W" shall never be less than H/2.

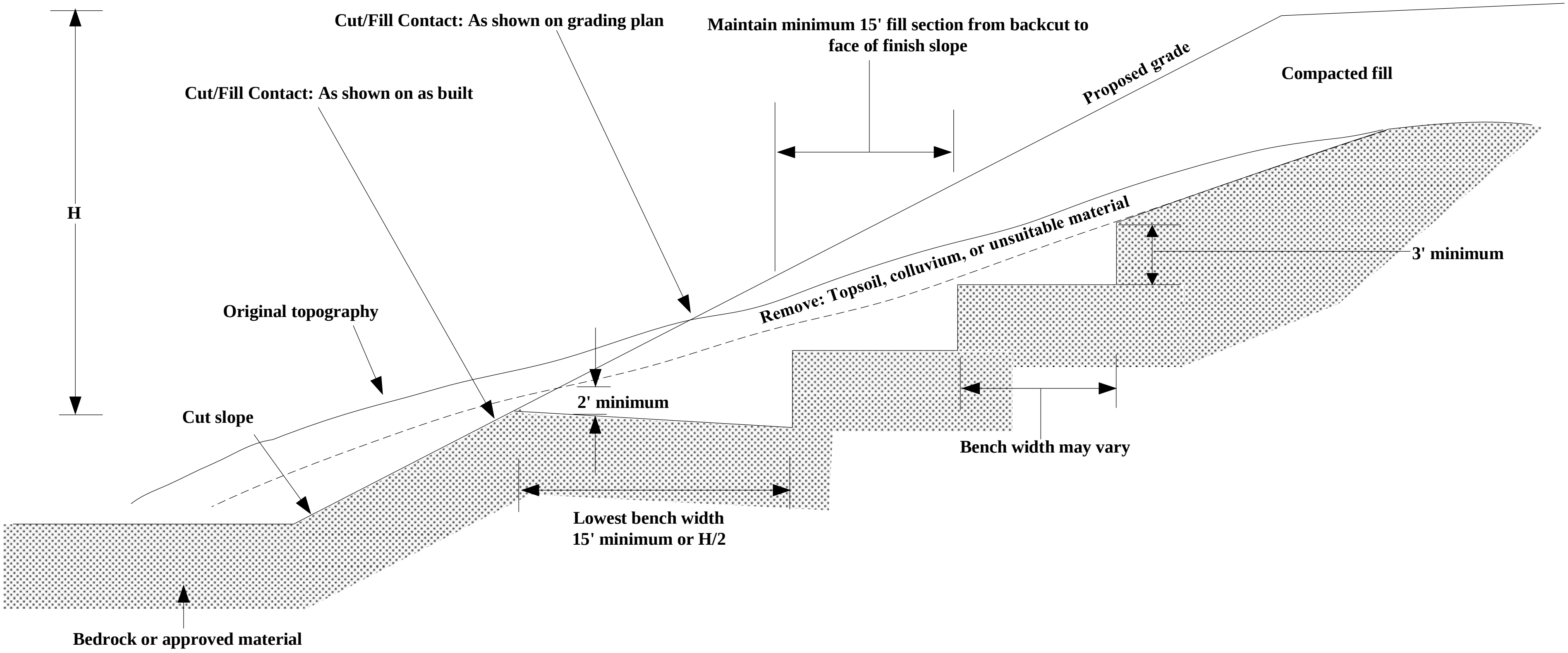
Note: Figure not to scale

EARTHWORK AND GRADING GUIDELINES
STABILIZATION FILL FOR UNSTABLE MATERIAL
EXPOSED IN PORTION OF CUT SLOPE

EEI
Expertise . . Service . . *Solutions*

FIGURE I

FILL OVER CUT DETAIL



Note: The cut sectioin shall be excavated and evaluated by the soils engineer/engineering geologist prior to constructing the fill portion.

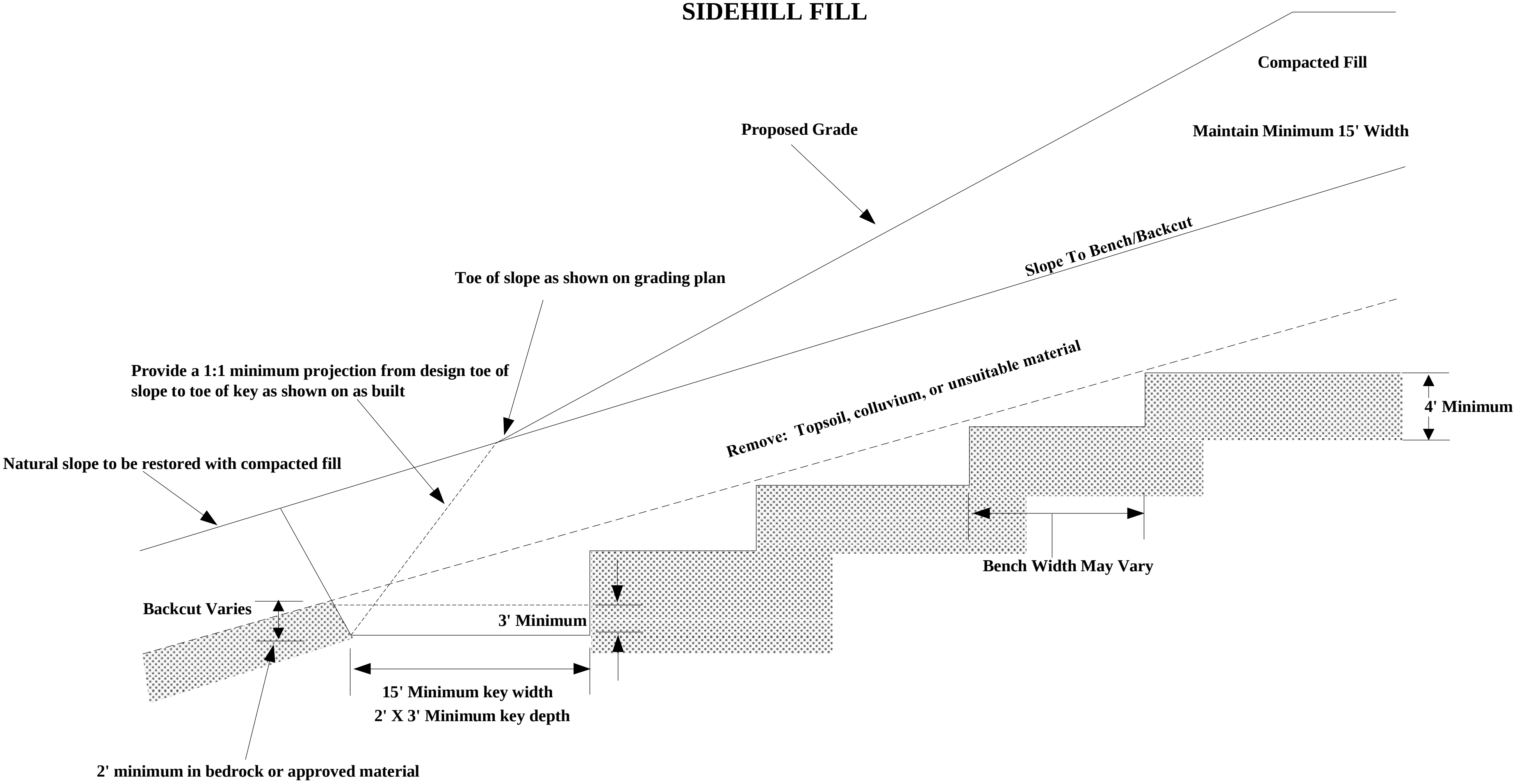
Note: Figure not to scale

EARTHWORK AND GRADING GUIDELINES
FILL OVER CUT DETAIL

EEI
Expertise . . Service . . *Solutions*

FIGURE J

FILL OVER NATURAL DETAIL
SIDEHILL FILL



Note: (1) Special recommendations shall be provided by the soils engineer/engineering geologist where the natural slope approaches or exceeds the design slope ratio.
(2) The need for and disposition of drains would be determined by the soils engineer/engineering geologist based upon exposed conditions.

Note: Figures not to scale

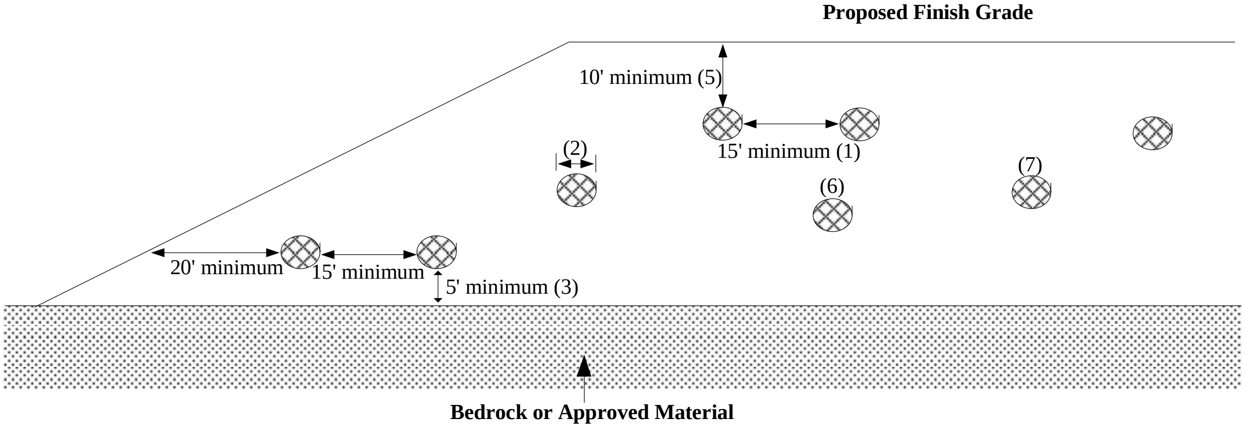
EARTHWORK AND GRADING GUIDELINES
FILL OVER NATURAL DETAIL
SIDEHILL FILL

EEI
Expertise . . Service . . *Solutions*

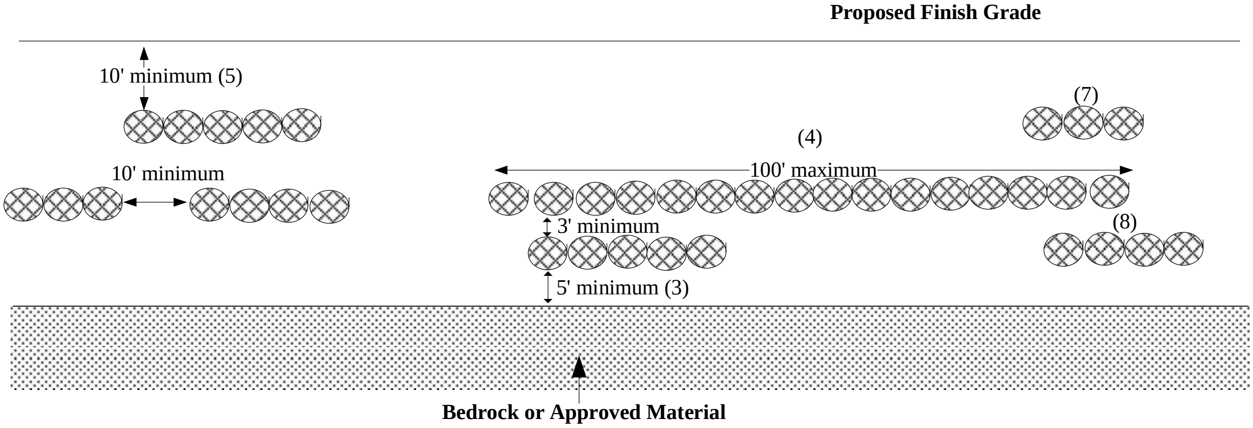
FIGURE K

OVERSIZE ROCK DISPOSAL

View Normal to Slope Face

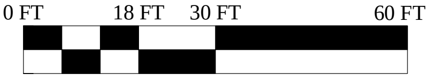


View Parallel to Slope Face



Note:
(1) One Equipment width or a minimum of 15 feet.
(2) Height and width may vary depending on rock size and type of equipment used. Length of windrow shall be no greater than 100 feet maximum.
(3) If approved by the soils engineer and/or engineering geologist.
(4) Orientation of windrows may vary but shall be as recommended by the soils engineer and/or engineering geologist. Unless recommended staggering of windrows is not necessary.
(5) Areas shall be cleared for utility trenches, foundations, and swimming pools.
(6) Voids in windrows shall be filled by flooding granular soil into place. Granular soil shall be any soil which has a unified soil classification system (Universal Building Code (UBC) 29-1). Designation of SM, SP, SW, GP, or GW.
(7) After fill between windrows is placed and compacted with the lift of fill covering windrow, windrow shall be proof rolled with a D-9 dozer or equivalent.
(8) Oversized rock is defined as larger than 12", and less than 4 feet in size.

Approximate Scale: 1" = 30'



Note: All distances are approximate

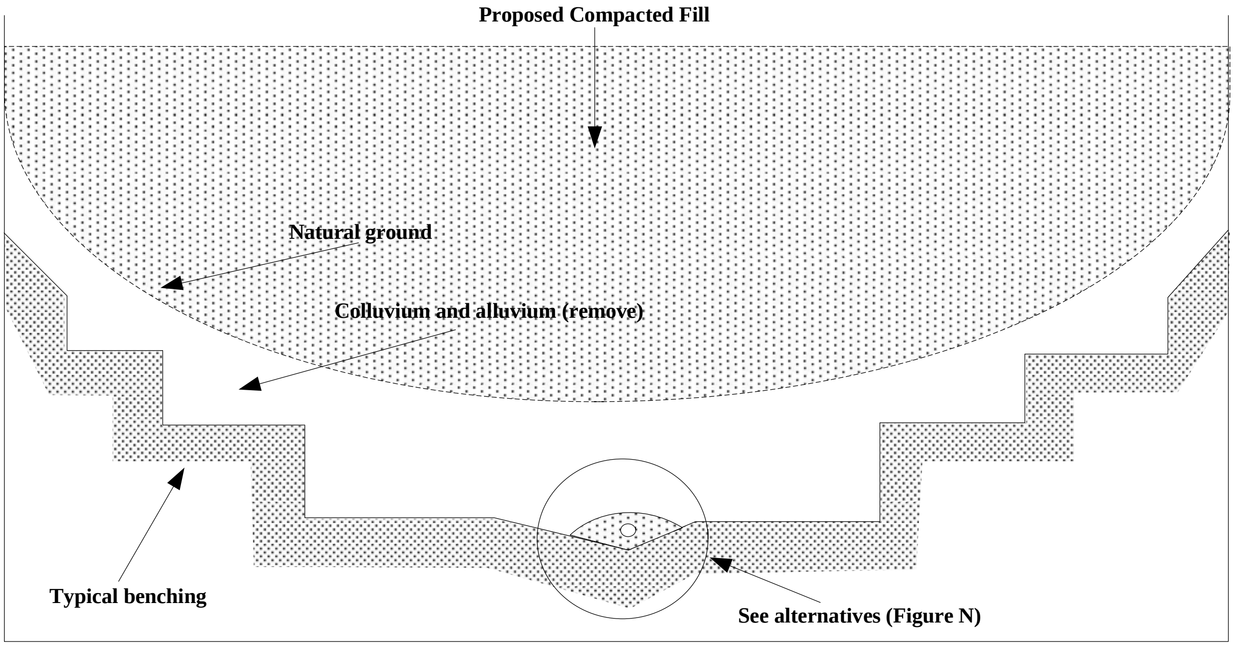
EARTHWORK AND GRADING GUIDELINES
OVERSIZE ROCK DISPOSAL

EEI
Expertise . . Service . . *Solutions*

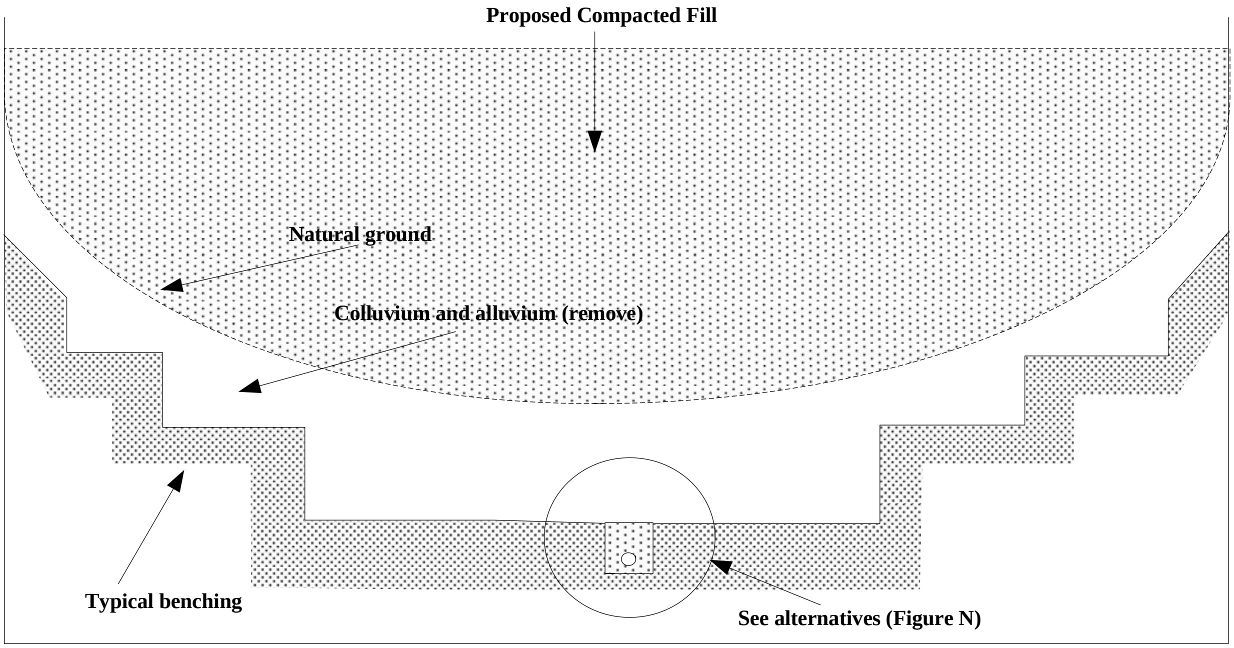
FIGURE L

CANYON SUBDRAIN DETAIL

Type A



Type B



Note: Alternatives, locations, and extent of subdrains should be determined by the soils engineer and/or engineering geologist during actual grading.

EARTHWORK AND GRADING GUIDELINES
CANYON SUBDRAIN DETAIL

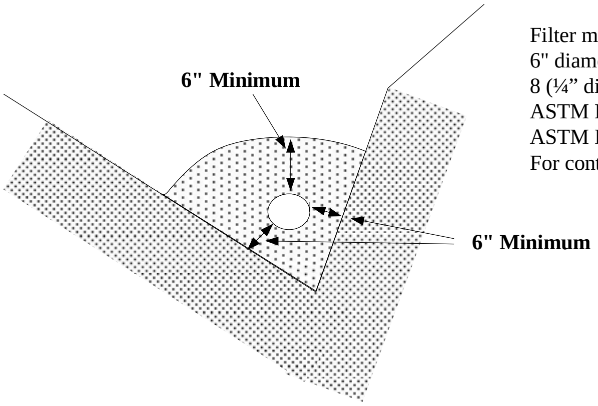
EEI
Expertise . . Service . . *Solutions*

FIGURE M

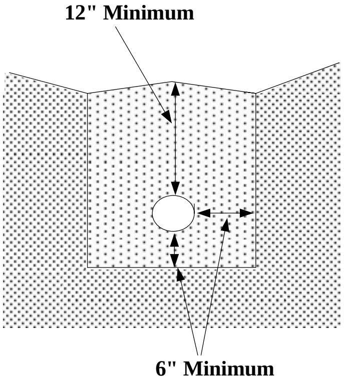
Note: Figures not to scale

CANYON SUBDRAIN ALTERNATE DETAILS

Alternate 1: Perforated Pipe and Filter Material



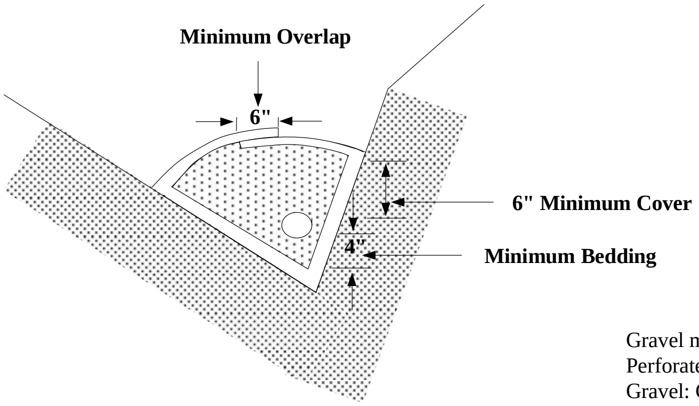
Filter material: Minimum volume of 9 feet^3/linear foot.
6" diameter ABS or PVC pipe or approved substitute with minimum 8 (¼" diameter) perforations per linear foot in bottom half of pipe.
ASTM D 2751, SDR 35 or ASTM D 1527, Schedule 40.
ASTM D 3034, SDR 35 or ASTM D 1785, Schedule 40.
For continuous run in excess of 500 feet use 8" diameter pipe.

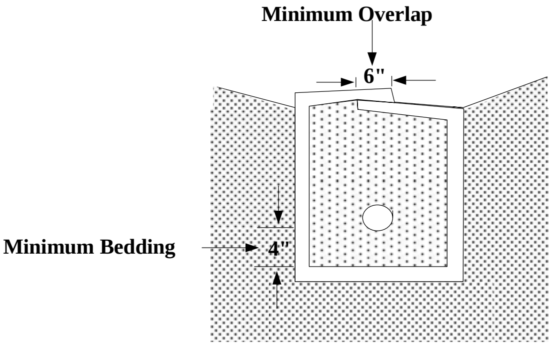


Filter Material

Sieve Size	Percent Passing
1"	100
¾"	90-100
3/8"	40-100
No. 4	25-40
No. 8	18-33
No. 30	5-15
No. 50	0-7
No. 200	0-3

Alternate 2: Perforated Pipe, Gravel and Filter Fabric





Gravel material 9 feet^3/linear foot.
Perforated pipe: see alternate 1.
Gravel: Clean ¾" rock or approved substitute.
Filter Fabric: Mirafi 140 or approved substitute.

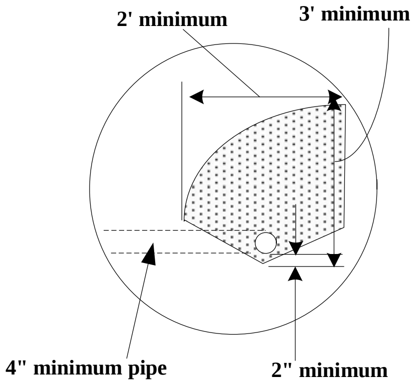
Note: Figures not to scale

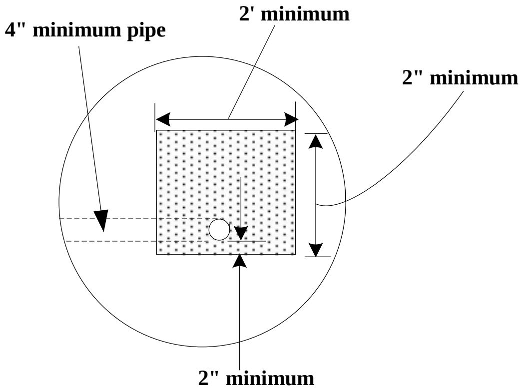
EARTHWORK AND GRADING GUIDELINES
CANYON SUBDRAIN ALTERNATE DETAILS

EEI
Expertise . . Service . . *Solutions*

FIGURE N

TYPICAL STABILIZATION BUTTRESS SUBDRAIN DETAIL





Filter Material: Minimum of 5 ft^3/linear foot of pipe or 4 ft^3/linear foot of pipe when placed in square cut trench.

Alternative In Lieu Of Filter Material: Gravel may be encased in approved filter fabric. Filter fabric shall be mirafi 140 or equivalent. Filter fabric shall be lapped a minimum of 12" on all joints.

Minimum 4" Diameter Pipe: ABS-ASTM D-2751, SDR 35 or ASTM D-1527 schedule 40 PVC-ASTM D-3034, SDR 35 or ASTM D-1785 schedule 40 with a crushing strength of 1,000 pounds minimum, and a minimum of 8 uniformly spaced perforations per foot of pipe installed with perforations at bottom of pipe. Provide cap at upstream end of pipe. Slope at 2% to outlet pipe. Outlet pipe shall be connected to the subdrain pipe with tee or elbow.

Note: (1) Trench for outlet pipes shall be backfilled with onsite soil.
(2) Backdrains and lateral drains shall be located at the elevation of every bench drain. First drain shall be located at the elevation just above the lower lot grade. Additional drains may be required at the discretion of the soils engineer and/or engineering geologist.

Filter Material – Shall be of the following specification or an approved equivalent:

Filter Material

Sieve Size	Percent Passing
1"	100
¾”	90-100
3/8"	40-100
No. 4	25-40
No. 8	18-33
No. 30	5-15
No. 50	0-7
No. 200	0-3

Gravel - Shall be of the following specification or an approved equivalent:

Filter Material

Sieve Size	Percent Passing
1½"	100
No. 4	50
No. 200	8

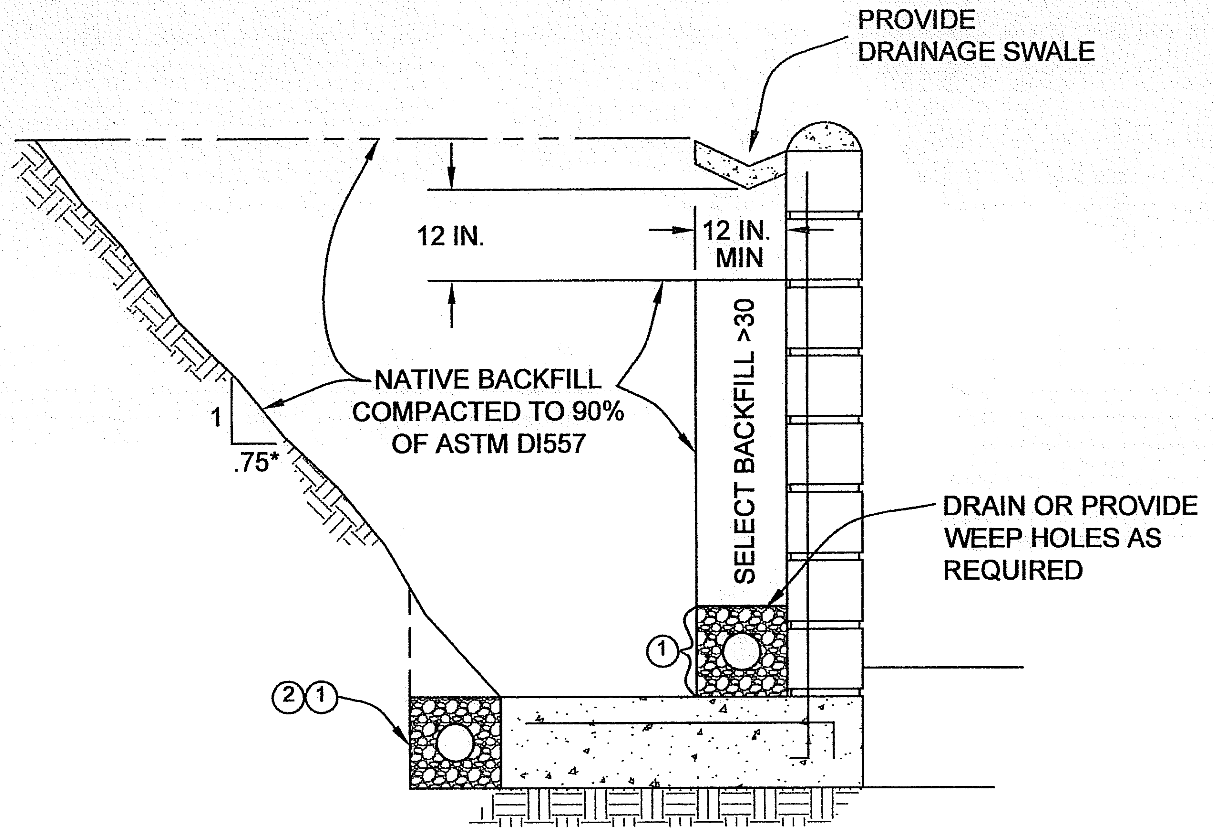
Sand equivalent: Minimum of 50

Note: Figures not to scale

EARTHWORK AND GRADING GUIDELINES
TYPICAL STABILIZATION BUTTRESS SUBDRAIN DETAIL

EEI
Expertise . . Service . . *Solutions*

FIGURE O



* OR AS REQUIRED FOR SAFETY

NOTES

① 4-INCH PERFORATED PVC SCHEDULE 40 OR APPROVED ALTERNATE. PLACE PERFORATION DOWN AND SURROUND WITH A MINIMUM OF 1 CUBIC FOOT PER LINEAL FOOT (1 FT. /FT.) OF 3/4 INCH ROCK OR APPROVED ALTERNATE AND WRAPPED IN FILTER FABRIC.

② PLACE DRAIN AS SHOWN WHERE MOISTURE MIGRATION THROUGH THE WALL IS UNDESIRABLE.

NOTE: FIGURE NOT TO SCALE

EARTHWORK & GRADING GUIDELINES
TYPICAL RETAINING WALL BACKFILL

EEI
Expertise...Service...*Solutions*

FIGURE P

Intentionally Left Blank

Appendix E.5. Impairments and Pollutants of Concern

Impairments and Pollutants of Concern	Appendix E.5

Identification of Receiving Water Pollutants of Concern

Describe path of storm water from the project site to the Pacific Ocean (or bay, lagoon, lake or reservoir, as applicable):

After treatment, stormwater from the development will discharge to the channel on the northern perimeter of the site. The channel is an unnamed tributary of the Sweetwater River that receives runoff from approximately 3 sq-miles of contributing area. The channel will be modified to incorporate conservation mitigation habitat as part of this project This unnamed channel discharges into the Sweetwater River at the western edge of the subject property. The Sweetwater River conveys flows into the San Diego Bay with ultimate discharge into the Pacific Ocean.

List any 303(d) impaired water bodies within the path of storm water from the project site to the Pacific Ocean (or bay, lagoon, lake or reservoir, as applicable), identify the pollutant(s)/stressor(s) causing impairment, and identify any TMDLs for the impaired water bodies:

303(d) Impaired Water Body	Pollutant(s)/Stressor(s)	TMDLs
Sweetwater River, Lower	Benthic Community Effects, chlorpyrifos, indicator bacteria, nitrogen, Phosphorus, selenium, TDS, toxicity	Bacteria, Dissolved Copper, Lead, Zinc
San Diego Bay	Mercury, PCBs, PAHs	Bacteria, Dissolved Copper, Lead, Zinc

Identification of Project Site Pollutants*

***Identification of project site pollutants is only required if flow-thru treatment BMPs are implemented onsite in lieu of retention or biofiltration BMPs (note the project must also participate in an alternative compliance program unless prior lawful approval to meet earlier PDP requirements is demonstrated)**

Identify pollutants expected from the project site based on all proposed use(s) of the site (see manual Appendix B.6):

Pollutant	Not Applicable to the Project Site	Expected from the Project Site	Also a Receiving Water Pollutant of Concern
Sediment			
Nutrients			
Heavy Metals			
Organic Compounds			
Trash & Debris			
Oxygen Demanding Substances			
Oil & Grease			
Bacteria & Viruses			
Pesticides			

Intentionally Left Blank

Appendix F

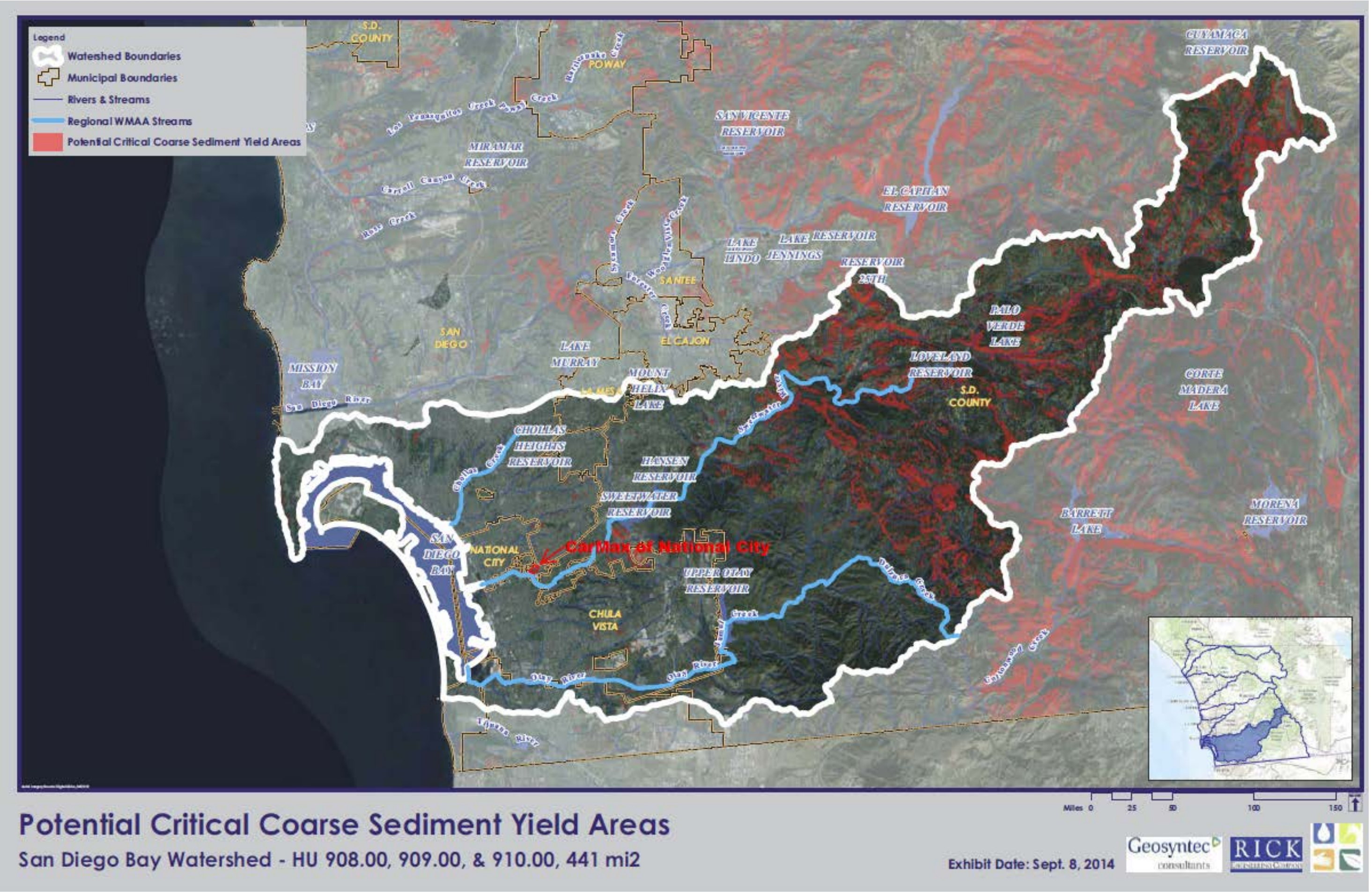
Hydromodification Flow Control Design Backup

Indicate which items are included behind this cover sheet

Contents	Included (Y/N)
F.1. Management of Critical Coarse Sediment Yield Areas F.1.1. Exhibit showing project drainage boundaries marked on WMAA Critical Coarse Sediment Yield Area Map *Optional analyses for Critical Coarse Sediment Yield Area Determination (when applicable; see Section 6.2 of the BMP Design Manual)*	Y
F.1.2 Verification of Geomorphic Landscape Units Onsite	N/A
F.1.3 Downstream Systems Sensitivity to Coarse Sediment	N/A
F.1.4 Optional Additional Analysis of Potential Critical Coarse Sediment Yield Areas Onsite	N/A
F.2. Geomorphic Assessment of Receiving Channels (when applicable) *Required if a low flow threshold other than 0.1Q2 is selected.*	N/A (0.1Q2 used as low flow threshold)
F.3. Flow Control Facility Design *Must include structural BMP drawdown calculations and overflow design summary. See Chapter 6 and Appendix G of the BMP Design Manual.*	Y
F.4. Copies of Electronic Files from Continuous Simulation Modeling (when applicable) *Required when a continuous simulation model is run using SDHM, SWMM, etc.* ***Model files must be provided electronically (on CD or DVD)****.*	Y
F.5. Vector Control Plan (when applicable) *Required when any structural BMP will not drain in 96 hours.*	N/A (BMP designed to drain in under 96 hours)

Intentionally Left Blank

Appendix F.1.1. Exhibit showing project drainage boundaries marked on WMAA Critical Coarse Sediment Yield Area Map



Source: San Diego Bay Watershed Management Area Analysis (WMAA) Attachment A.5, Geosyntec Consultants and Rick Engineering, October 3, 2014

According to the Potential Critical Coarse Sediment Yield Areas Map included under the San Diego Bay WMAA Attachment A.5 (recreated above) and the National City Map of Potential Critical Coarse Sediment Yield Areas (available online at http://www.ci.national-city.ca.us/index.aspx?page=164), the site is not considered a critical coarse sediment yield area.

Intentionally Left Blank

Appendix F.3. Flow Control Facility Design

Intentionally Left Blank

TECHNICAL MEMORANDUM:

SWMM Modeling for Hydromodification Compliance of:

CarMax National City

Prepared by:

Luis Parra, PhD, CPSWQ, ToR, D.WRE.
R.C.E. 66377

REGISTERED PROFESSIONAL ENGINEER
LUIS A PARRA-ROSALES
RCE ~ 66377
EXP 6/30/22
CIVIL
STATE OF CALIFORNIA

REC Consultants
2442 Second Avenue
San Diego, CA 92101
Telephone: (619) 232-9200

TECHNICAL MEMORANDUM

FROM:	Luis Parra, PhD, PE, CPSWQ, ToR, D.WRE, CFM. David Edwards, MS, PE, CFM.
DATE:	August 5, 2020
RE:	Summary of SWMM Modeling for Hydromodification Compliance for CarMax of National City, National City, CA.

INTRODUCTION

This memorandum summarizes the approach used to model the proposed commercial use site in the City of National City using the Environmental Protection Agency (EPA) Storm Water Management Model 5.0 (SWMM). SWMM models were prepared for the pre and post-developed conditions at the site in order to determine if the proposed HMP detention facilities have sufficient volume to meet Order R9-2013-001 requirements of the California Regional Water Quality Control Board San Diego Region (SDRWQCB), as explained in the Final Hydromodification Management Plan (HMP), dated March 2011, prepared for the County of San Diego by Brown and Caldwell.

SWMM MODEL DEVELOPMENT

The CarMax project site consists of a proposed development of a currently vegetated vacant lot, this improvement includes a car sales commercial area and also a natural stream restoration of an existing creek. Two (2) SWMM models were prepared for this study: the first for the pre-developed and the second for the post-developed conditions. The project site drains to one (1) Point of Compliance (POC) located downstream at the western point of discharge from the project site.

Per Section G1.2 in Appendix G of the 2018 City of National City BMP Design Manual, the EPA SWMM model was used to perform the continuous hydrologic simulation. For both SWMM models, flow duration curves were prepared to determine if the proposed HMP facilities are sufficient to meet the current HMP requirements.

The inputs required to develop SWMM models include rainfall, watershed characteristics, and BMP configurations. The Lindbergh gauge from the Project Clean Water website was used for this study since it is the most representative of the project site precipitation due to elevation and proximity to the project site.

Per the California Irrigation Management Information System "Reference Evaporation Zones" (CIMIS ETo Zone Map), the project site is located within the Zone 4 Evapotranspiration Area. Thus evapotranspiration vales for the site were modeled using Zone 4 average monthly values from Table G.1-1 from the 2018 BMP Design Manual. Per the NRCS web soil survey, the project site is situated upon Class C soils. Soils have been assumed to be uncompacted in the existing condition to represent the natural vegetated open space, while fully compacted in the post developed conditions (with the exception of the natural stream restoration areas). Other SWMM inputs for the subareas are discussed in the appendices to this document, where the selection of parameters is explained in detail.

HMP MODELING

PRE DEVELOPED CONDITIONS

In current existing conditions, the project site is a vegetated natural area comprising of sparse ground coverings and an existing stream which conveys flow in a westerly direction to the adjacent Sweetwater River. Table 1 below illustrates the pre-developed areas and impervious percentage accordingly.

TABLE 1 – SUMMARY OF PRE-DEVELOPED CONDITIONS

POC	DMA	Tributary Area, A (Ac)	Impervious Percentage, Ip[(1)]
POC-1-C	DMA-A	14.604	0%
TOTAL	--	14.604	N/A

Notes: (1) – Per the 2013 RWQCB permit, existing condition impervious surfaces are not to be accounted for in existing conditions analysis.

DEVELOPED CONDITIONS

The CarMax National City site proposes the construction of a commercial structure and a servicing parking lot in addition to a full stream restoration to the north of the proposed improvements. Runoff from the project area is drained to two (2) onsite underground detention basins. Once flows are routed via the proposed BMPs, flows are then discharged to the POC located at the existing stream discharge location to the west of the site. Two (2) small areas adjacent to the existing road to the south of the project discharge to proposed tree wells for water quality requirements, however for HMP compliance it is assumed that these flows are not detained and confluence directly at the POC.

Two (2) underground detention basins are located within the project site and are responsible for handling hydromodification requirements for the project site. In developed conditions, the basin will have a depth of 6.5 feet and a riser spillway structure (see dimensions in Table 5). Flows will then discharge from the basin via a riser structure located within the detention vaults. The riser structures will act as a spillway such that peak flows can be safely discharged to the receiving POC.

TABLE 2 – SUMMARY OF POST-DEVELOPED CONDITIONS

POC	DMA	Tributary Area, A (Ac)	Impervious Percentage, Ip[(1)]
POC-1	DMA-A/B	2.849	95.87%
	DMA-C/D	3.703	98.24%
	DMA-E	0.055	53.18%
	DMA-F	0.071	53.57%
	DMA-BYPASS (STREAM)	7.926	0.0%
TOTAL	--	14.604	N/A

The underground systems will comprise of MC-3500 StormTech storage vaults (or an approved equivalent) that incorporate a gravel layer beneath and above the system (and also between the vault rows) to provide water storage volume. The vaults will be unlined such that flows can infiltrate into the soil beneath the systems to aid in HMP compliance.

Water Quality BMP Sizing

It is assumed all storm water quality requirements for the project will be met by the BMPs detailed in the SWQMP and other BMPs included within the site design. However, detailed water quality requirements are not discussed within this technical memo. For further information in regards to storm water quality requirements for the project (including sizing and drawdown) please refer to the site specific Storm Water Quality Management Plan (SWQMP).

BMP MODELING FOR HMP PURPOSES

Modeling of HMP BMPs

Two (2) HMP underground detention basins are proposed for hydromodification conformance for the project site. Tables 4 & 5 illustrate the dimensions required for HMP compliance according to the SWMM model that was undertaken for the project.

TABLE 4 – SUMMARY OF DETENTION VAULT SYSTEMS

BMP	Tributary Area (Ac)	DIMENSIONS				
		BMP Area (ft^2)	Gravel Depth (Below chambers in)	Gravel Depth Above (in)	Number of Chambers	Total Storage Volume (ft^3)
Vault 1	2.849	3,750	12	21	70	14,511
Vault 2	3.703	4,950	12	21	90	19,076

TABLE 5 – SUMMARY OF RISER DETAILS:

BMP	Lower Orifice		Lower Slot		Main Weir	
	Dim (in)	Elev.(1) (ft)	B x h (in)	Elev.(1) (ft)	Length(2) (ft)	Elev.(1) (ft)
Vault 1	1.0625	0.75	N/A	N/A	4.0	5.00
Vault 2	1.25	0.75	N/A	N/A	4.0	5.00

Notes:
(1) Invert of base gravel is assumed to be 0.00 ft elevation;
(2) Overflow length

FLOW DURATION CURVE COMPARISON

The Flow Duration Curve (FDC) for the site was compared at the POC by exporting the hourly runoff time series results from SWMM to a spreadsheet.

Q_2 and Q_{10} were determined with a partial duration statistical analysis of the runoff time series in an Excel spreadsheet using the Cunnane plotting position method (which is the preferred plotting methodology in the HMP Permit). As the SWMM Model includes a statistical analysis based on the Weibull Plotting Position Method, the Weibull Method was also used within the spreadsheet to ensure that the results were similar to those obtained by the SWMM Model.

The range between 10% of Q_2 and Q_{10} was divided into 100 equal time intervals; the number of hours that each flow rate was exceeded was counted from the hourly series. Additionally, the intermediate peaks with a return period "i" were obtained (Q_i with i=3 to 9). For the purpose of the plot, the values were presented as percentage of time exceeded for each flow rate. FDC comparison at the POC is illustrated in Figure 1 in both normal and logarithmic scale. Attachment 5 provides a detailed drainage exhibit for the post-developed condition.

As can be seen in Figure 1, the FDC for the proposed condition with the HMP BMPs is within 110% of the curve for the existing condition in both peak flows and durations. The additional runoff volume generated from developing the site will be released to the existing point of discharge at a flow rate below the 10% Q_2 lower threshold for POC-1. Additionally, the project will also not increase peak flow rates between the Q_2 and the Q_{10}, as shown in the peak flow tables in Attachment 1.

Discussion of the Manning's coefficient (Pervious Areas) for Pre and Post-Development Conditions

Typically the Manning's coefficient is selected as n = 0.10 for pervious areas and n = 0.012 for impervious areas. Due to the complexity of the model carried out in pre and post-development conditions, a more accurate value of the Manning's coefficient for pervious areas has been chosen. Taken into consideration the "Handouts on Supplemental Guidance – Handout #2: Manning's "n" Values for Overland Flow Using EPA SWMM V.5" by the County of San Diego (Reference [6]) a more accurate value of n = 0.05 has been selected (see Table 1 of Reference [6] included in Attachment 7). An average n value between pasture and shrubs and bushes (which is also the value of dense grass) has been selected per the reference cited, for light rain (<0.8 in/hr) as more than 99% of the rainfall has been measured with this intensity.

SUMMARY

This study has demonstrated that the proposed HMP BMPs provided for the CarMax National City site is sufficient to meet the current HMP criteria for the Point of Compliance (POC), if the cross-section area and volume recommended within this technical memorandum, and the respective orifice and outlet structure are incorporated as specified within the proposed project site.

KEY ASSUMPTIONS

1. Type C Soils is representative of the existing condition site.

ATTACHMENTS

1. Q_2 to Q_{10} Comparison Tables
2. FDC Plots (log and natural "x" scale) and Flow Duration Table.
3. List of the "n" largest Peaks: Pre-Development and Post-Development Conditions
4. Elevations vs. Discharge Curves to be used in SWMM
5. Pre & Post Development Maps, Project plan and exhibits
6. SWMM Input Data in Input Format (Existing and Proposed Models)
7. SWMM Screens and Explanation of Significant Variables
8. Geotechnical Documentation
9. Summary files from the SWMM Model

REFERENCES

[1] – *"Review and Analysis of San Diego County Hydromodification Management Plan (HMP): Assumptions, Criteria, Methods, & Modeling Tools – Prepared for the Cities of San Marcos, Oceanside & Vista",* May 2012, TRW Engineering.

[2] – *"Final Hydromodification Management Plan (HMP) prepared for the County of San Diego",* March 2011, Brown and Caldwell.

[3] - Order R9-20013-001, California Regional Water Quality Control Board San Diego Region (SDRWQCB).

[4] – "*Handbook of Hydrology*", David R. Maidment, Editor in Chief. 1992, McGraw Hill.

[5] – "*City of National City BMP Design Manual*", October 2018.

[6] – "*Improving Accuracy in Continuous Hydrologic Modeling: Guidance for Selecting Pervious Overland Flow Manning's n Values in the San Diego Region*", 2016, TRW Engineering.

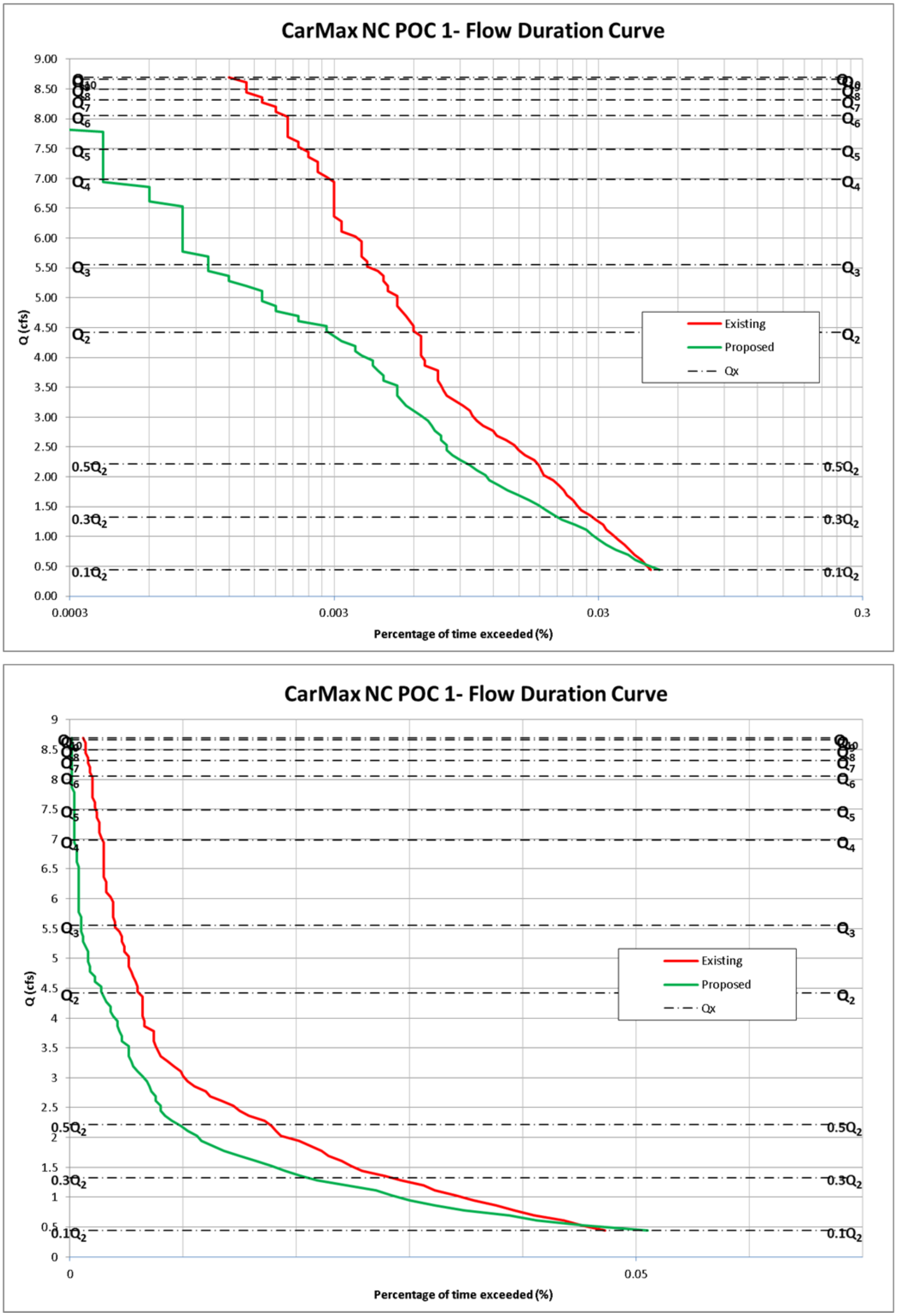


Figure 1a and 1b. Flow Duration Curve Comparison (logarithmic and normal “x” scale)

ATTACHMENT 1.

Q_2 to Q_{10} Comparison Table – POC 1

Return Period	Existing Condition (cfs)	Mitigated Condition (cfs)	Reduction, Exist - Mitigated (cfs)
2-year	4.424	2.700	1.724
3-year	5.552	3.783	1.769
4-year	6.984	4.313	2.672
5-year	7.491	4.580	2.911
6-year	8.051	4.726	3.326
7-year	8.311	4.818	3.494
8-year	8.497	5.013	3.484
9-year	8.661	5.195	3.466
10-year	8.696	5.337	3.358

ATTACHMENT 2

FLOW DURATION CURVE ANALYSIS

1) Flow duration curve shall not exceed the existing conditions by more than 10%, neither in peak flow nor duration.

The figures on the following pages illustrate that the flow duration curve in post-development conditions after the proposed BMP is below the existing flow duration curve. The flow duration curve table following the curve shows that if the interval $0.10Q_2 – Q_{10}$ is divided in 100 sub-intervals, then a) the post development divided by pre-development durations are never larger than 110% (the permit allows up to 110%); and b) there are no more than 10 intervals in the range 101%-110% which would imply an excess over 10% of the length of the curve (the permit allows less than 10% of excesses measured as 101-110%).

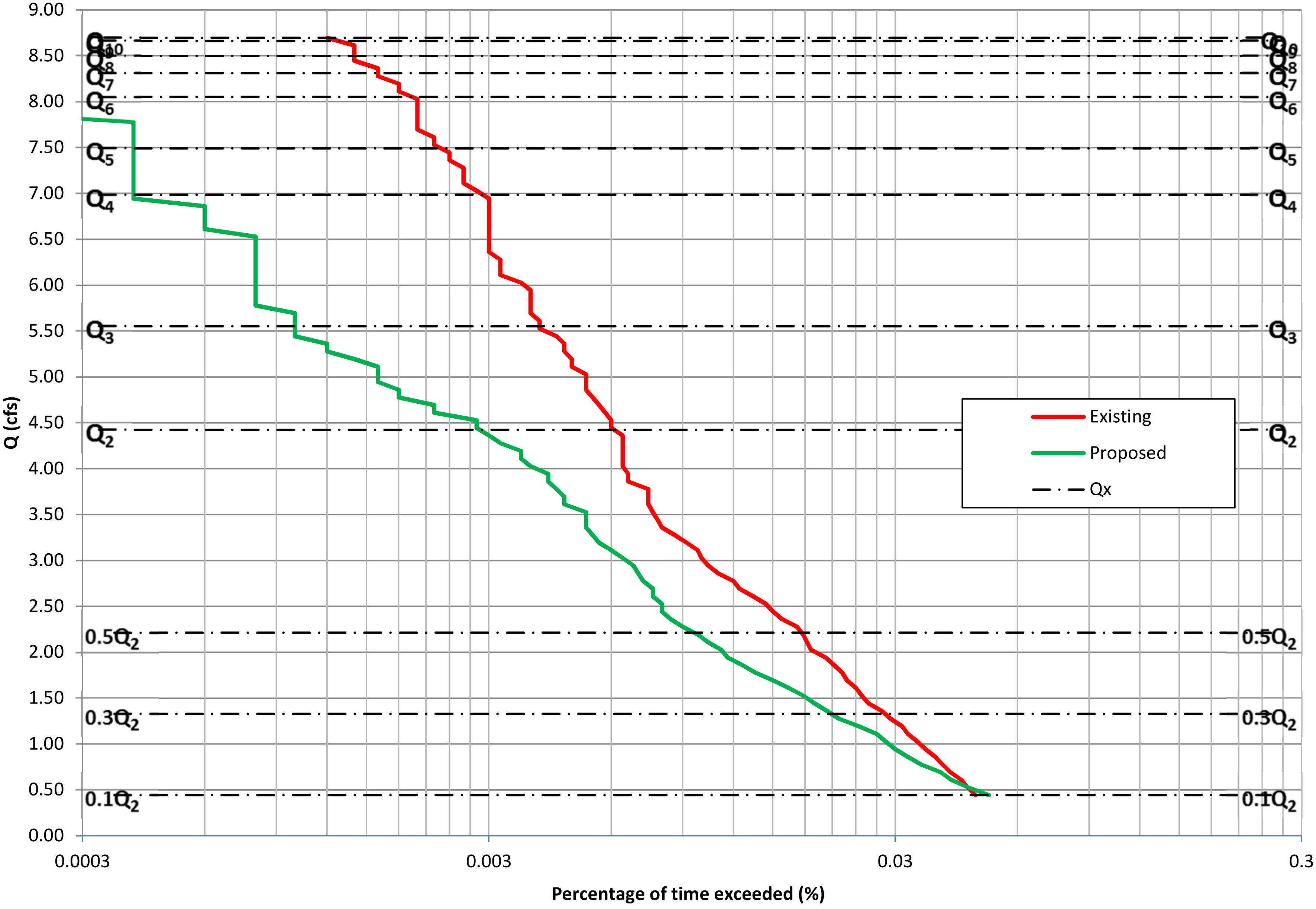
Consequently, the design passes the hydromodification test.

It is important to note that the flow duration curve can be expressed in the “x” axis as percentage of time, hours per year, total number of hours, or any other similar time variable. As those variables only differ by a multiplying constant, their plot in logarithmic scale is going to look exactly the same, and compliance can be observed regardless of the variable selected. However, in order to satisfy the City of National City HMP conditions, % of time exceeded is the variable of choice in the flow duration curve. The selection of a logarithmic scale in lieu of the normal scale is preferred, as differences between the pre-development and post-development curves can be seen more clearly in the entire range of analysis. Both graphics are presented just to prove the difference.

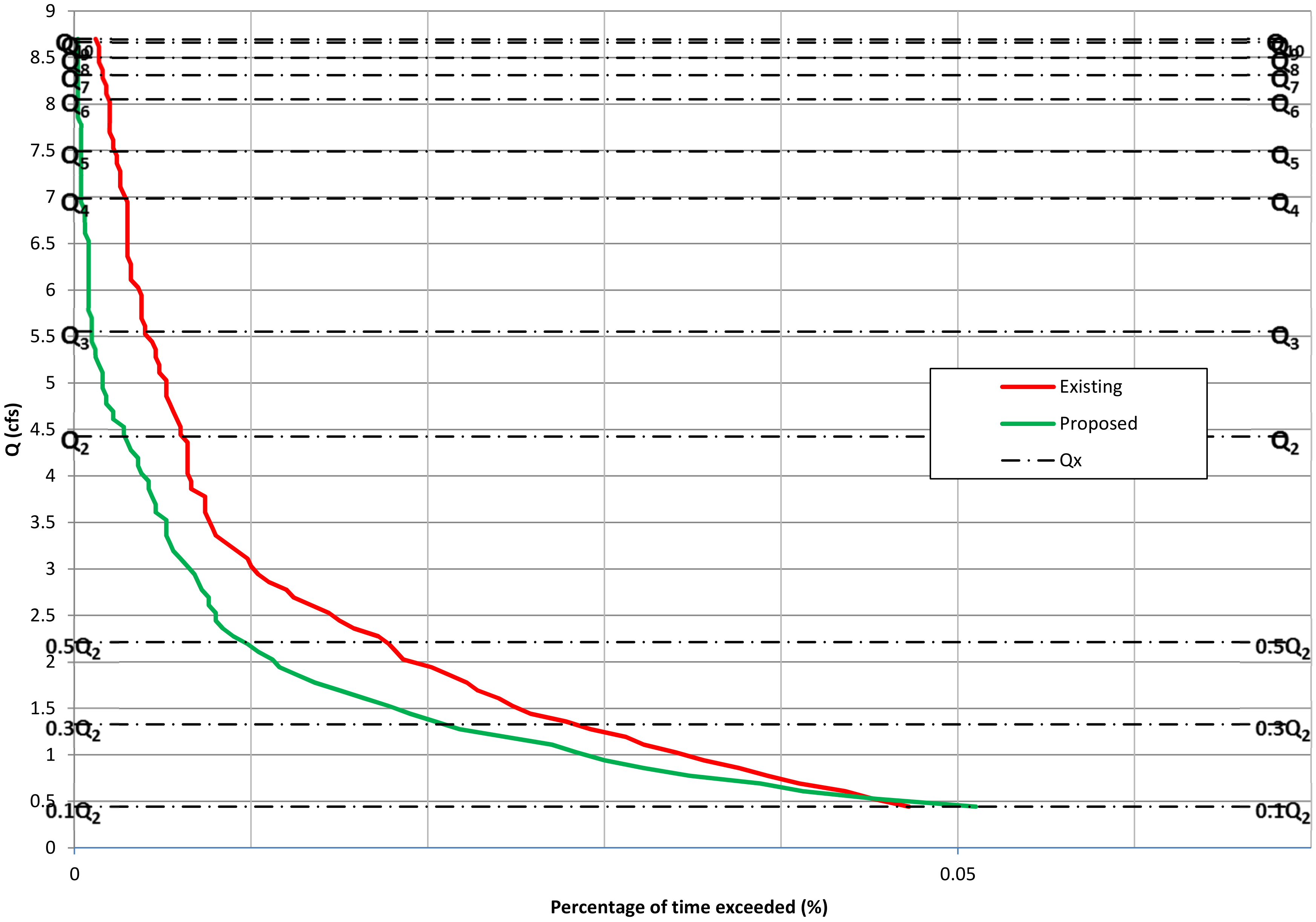
In terms of the “y” axis, the peak flow value is the variable of choice. As an additional analysis performed by REC, not only the range of analysis is clearly depicted (10% of Q_2 to Q_{10}) but also all intermediate flows are shown (Q_2, Q_3, Q_4, Q_5, Q_6, Q_7, Q_8 and Q_9) in order to demonstrate compliance at any range $Q_x – Q_{x+1}$. It must be pointed out that one of the limitations of both the SWMM and SDHM models is that the intermediate analysis is not performed (to obtain Q_i from i = 2 to 10). REC performed the analysis using the Cunnane Plotting position Method (the preferred method in the HMP permit) from the “n” largest independent peak flows obtained from the continuous time series.

The largest “n” peak flows are attached in this appendix, as well as the values of Q_i with a return period “i”, from i=2 to 10. The Q_i values are also added into the flow-duration plot.

CarMax NC POC 1- Flow Duration Curve



CarMax NC POC 1- Flow Duration Curve



Flow Duration Curve Data for Carmax National City - POC-1 , City of National City CA

Q2 = 4.42 cfs

Fraction 10 %

Q10 = 8.70 cfs

Step = 0.0834 cfs

Count = 499679 hours

57.00 years

Interval	Existing Condition			Detention Optimized			Pass or Fail?
	Q (cfs)	Hours > Q	% time	Hours>Q	% time	Post/Pre	
1	0.442	236	4.72E-02	255	5.10E-02	108%	Pass
2	0.526	226	4.52E-02	227	4.54E-02	100%	Pass
3	0.609	218	4.36E-02	206	4.12E-02	94%	Pass
4	0.692	205	4.10E-02	194	3.88E-02	95%	Pass
5	0.776	196	3.92E-02	174	3.48E-02	89%	Pass
6	0.859	188	3.76E-02	161	3.22E-02	86%	Pass
7	0.943	178	3.56E-02	150	3.00E-02	84%	Pass
8	1.026	170	3.40E-02	142	2.84E-02	84%	Pass
9	1.109	161	3.22E-02	135	2.70E-02	84%	Pass
10	1.193	156	3.12E-02	122	2.44E-02	78%	Pass
11	1.276	146	2.92E-02	109	2.18E-02	75%	Pass
12	1.359	139	2.78E-02	102	2.04E-02	73%	Pass
13	1.443	129	2.58E-02	95	1.90E-02	74%	Pass
14	1.526	124	2.48E-02	89	1.78E-02	72%	Pass
15	1.610	120	2.40E-02	82	1.64E-02	68%	Pass
16	1.693	114	2.28E-02	75	1.50E-02	66%	Pass
17	1.776	111	2.22E-02	68	1.36E-02	61%	Pass
18	1.860	106	2.12E-02	63	1.26E-02	59%	Pass
19	1.943	101	2.02E-02	58	1.16E-02	57%	Pass
20	2.026	93	1.86E-02	56	1.12E-02	60%	Pass
21	2.110	91	1.82E-02	52	1.04E-02	57%	Pass
22	2.193	89	1.78E-02	49	9.81E-03	55%	Pass
23	2.276	86	1.72E-02	45	9.01E-03	52%	Pass
24	2.360	79	1.58E-02	42	8.41E-03	53%	Pass
25	2.443	75	1.50E-02	40	8.01E-03	53%	Pass
26	2.527	72	1.44E-02	40	8.01E-03	56%	Pass
27	2.610	67	1.34E-02	38	7.60E-03	57%	Pass
28	2.693	62	1.24E-02	38	7.60E-03	61%	Pass
29	2.777	60	1.20E-02	36	7.20E-03	60%	Pass
30	2.860	55	1.10E-02	35	7.00E-03	64%	Pass
31	2.943	52	1.04E-02	34	6.80E-03	65%	Pass
32	3.027	50	1.00E-02	32	6.40E-03	64%	Pass
33	3.110	49	9.81E-03	30	6.00E-03	61%	Pass
34	3.193	46	9.21E-03	28	5.60E-03	61%	Pass
35	3.277	43	8.61E-03	27	5.40E-03	63%	Pass
36	3.360	40	8.01E-03	26	5.20E-03	65%	Pass

	Existing Condition			Detention Optimized			Pass or Fail?
Interval	Q (cfs)	Hours > Q	% time	Hours>Q	% time	Post/Pre	
37	3.444	39	7.81E-03	26	5.20E-03	67%	Pass
38	3.527	38	7.60E-03	26	5.20E-03	68%	Pass
39	3.610	37	7.40E-03	23	4.60E-03	62%	Pass
40	3.694	37	7.40E-03	23	4.60E-03	62%	Pass
41	3.777	37	7.40E-03	22	4.40E-03	59%	Pass
42	3.860	33	6.60E-03	21	4.20E-03	64%	Pass
43	3.944	33	6.60E-03	21	4.20E-03	64%	Pass
44	4.027	32	6.40E-03	19	3.80E-03	59%	Pass
45	4.110	32	6.40E-03	18	3.60E-03	56%	Pass
46	4.194	32	6.40E-03	18	3.60E-03	56%	Pass
47	4.277	32	6.40E-03	16	3.20E-03	50%	Pass
48	4.361	32	6.40E-03	15	3.00E-03	47%	Pass
49	4.444	30	6.00E-03	14	2.80E-03	47%	Pass
50	4.527	30	6.00E-03	14	2.80E-03	47%	Pass
51	4.611	29	5.80E-03	11	2.20E-03	38%	Pass
52	4.694	28	5.60E-03	11	2.20E-03	39%	Pass
53	4.777	27	5.40E-03	9	1.80E-03	33%	Pass
54	4.861	26	5.20E-03	9	1.80E-03	35%	Pass
55	4.944	26	5.20E-03	8	1.60E-03	31%	Pass
56	5.027	26	5.20E-03	8	1.60E-03	31%	Pass
57	5.111	24	4.80E-03	8	1.60E-03	33%	Pass
58	5.194	24	4.80E-03	7	1.40E-03	29%	Pass
59	5.278	23	4.60E-03	6	1.20E-03	26%	Pass
60	5.361	23	4.60E-03	6	1.20E-03	26%	Pass
61	5.444	22	4.40E-03	5	1.00E-03	23%	Pass
62	5.528	20	4.00E-03	5	1.00E-03	25%	Pass
63	5.611	20	4.00E-03	5	1.00E-03	25%	Pass
64	5.694	19	3.80E-03	5	1.00E-03	26%	Pass
65	5.778	19	3.80E-03	4	8.01E-04	21%	Pass
66	5.861	19	3.80E-03	4	8.01E-04	21%	Pass
67	5.944	19	3.80E-03	4	8.01E-04	21%	Pass
68	6.028	18	3.60E-03	4	8.01E-04	22%	Pass
69	6.111	16	3.20E-03	4	8.01E-04	25%	Pass
70	6.195	16	3.20E-03	4	8.01E-04	25%	Pass
71	6.278	16	3.20E-03	4	8.01E-04	25%	Pass
72	6.361	15	3.00E-03	4	8.01E-04	27%	Pass
73	6.445	15	3.00E-03	4	8.01E-04	27%	Pass
74	6.528	15	3.00E-03	4	8.01E-04	27%	Pass
75	6.611	15	3.00E-03	3	6.00E-04	20%	Pass
76	6.695	15	3.00E-03	3	6.00E-04	20%	Pass
77	6.778	15	3.00E-03	3	6.00E-04	20%	Pass
78	6.861	15	3.00E-03	3	6.00E-04	20%	Pass
79	6.945	15	3.00E-03	2	4.00E-04	13%	Pass
80	7.028	14	2.80E-03	2	4.00E-04	14%	Pass
81	7.112	13	2.60E-03	2	4.00E-04	15%	Pass

Interval	Existing Condition			Detention Optimized			Pass or Fail?
	Q (cfs)	Hours > Q	% time	Hours>Q	% time	Post/Pre	
82	7.195	13	2.60E-03	2	4.00E-04	15%	Pass
83	7.278	13	2.60E-03	2	4.00E-04	15%	Pass
84	7.362	12	2.40E-03	2	4.00E-04	17%	Pass
85	7.445	12	2.40E-03	2	4.00E-04	17%	Pass
86	7.528	11	2.20E-03	2	4.00E-04	18%	Pass
87	7.612	11	2.20E-03	2	4.00E-04	18%	Pass
88	7.695	10	2.00E-03	2	4.00E-04	20%	Pass
89	7.779	10	2.00E-03	2	4.00E-04	20%	Pass
90	7.862	10	2.00E-03	1	2.00E-04	10%	Pass
91	7.945	10	2.00E-03	1	2.00E-04	10%	Pass
92	8.029	10	2.00E-03	1	2.00E-04	10%	Pass
93	8.112	9	1.80E-03	1	2.00E-04	11%	Pass
94	8.195	9	1.80E-03	1	2.00E-04	11%	Pass
95	8.279	8	1.60E-03	1	2.00E-04	13%	Pass
96	8.362	8	1.60E-03	1	2.00E-04	13%	Pass
97	8.445	7	1.40E-03	1	2.00E-04	14%	Pass
98	8.529	7	1.40E-03	1	2.00E-04	14%	Pass
99	8.612	7	1.40E-03	1	2.00E-04	14%	Pass
100	8.696	6	1.20E-03	1	2.00E-04	17%	Pass

Peak Flows calculated with Cunnane Plotting Position

Return Period (years)	Pre-dev. Q (cfs)	Post-Dev. Q (cfs)	Reduction (cfs)
10	8.696	5.337	3.358
9	8.661	5.195	3.466
8	8.497	5.013	3.484
7	8.311	4.818	3.494
6	8.051	4.726	3.326
5	7.491	4.580	2.911
4	6.984	4.313	2.672
3	5.552	3.783	1.769
2	4.424	2.700	1.724

ATTACHMENT 3

List of the “n” Largest Peaks: Pre & Post-Developed Conditions

Basic Probabilistic Equation:

R = 1/P R: Return period (years).

P: Probability of a flow to be equaled or exceeded any given year (dimensionless).

Cunnane Equation:

$$P = \frac{i-0.4}{n+0.2}$$

Weibull Equation:

$$P = \frac{i}{n+1}$$

i: Position of the peak whose probability is desired (sorted from large to small)

n: number of years analyzed.

Explanation of Variables for the Tables in this Attachment

Peak: Refers to the peak flow at the date given, taken from the continuous simulation hourly results of the n year analyzed.

Posit: If all peaks are sorted from large to small, the position of the peak in a sorting analysis is included under the variable Posit.

Date: Date of the occurrence of the peak at the outlet from the continuous simulation

Note: all peaks are not annual maxima; instead they are defined as event maxima, with a threshold to separate peaks of at least 12 hours. In other words, any peak P in a time series is defined as a value where dP/dt = 0, and the peak is the largest value in 25 hours (12 hours before, the hour of occurrence and 12 hours after the occurrence, so it is in essence a daily peak).

List of Peak events and Determination of Q2 and Q10 (Pre-Development)
Carmax National City - POC-1

T (Year)	Cunnane (cfs)	Weibull (cfs)
10	**8.70**	**8.78**
9	**8.66**	**8.68**
8	**8.50**	**8.58**
7	**8.31**	**8.35**
6	**8.05**	**8.11**
5	**7.49**	**7.53**
4	**6.98**	**7.00**
3	**5.55**	**5.58**
2	**4.42**	**4.42**

Note:
Cunnane is the preferred
method by the HMP permit.

Peaks (cfs)			Period of Return (Years)	
	Date	Posit	Weibull	Cunnane
2.425	3/20/1991	57	1.02	1.01
2.503	1/12/2001	56	1.04	1.03
2.52	3/2/1983	55	1.05	1.05
2.587	3/12/1978	54	1.07	1.07
2.589	12/5/1966	53	1.09	1.09
2.631	10/10/1986	52	1.12	1.11
2.676	11/17/1972	51	1.14	1.13
2.681	2/8/1998	50	1.16	1.15
2.711	1/12/1993	49	1.18	1.18
2.724	1/29/1983	48	1.21	1.20
2.825	12/30/1951	47	1.23	1.23
2.857	2/23/2005	46	1.26	1.25
2.89	2/19/1993	45	1.29	1.28
2.904	3/6/1975	44	1.32	1.31
3.021	1/13/1993	43	1.35	1.34
3.066	3/16/1958	42	1.38	1.38
3.213	1/15/1993	41	1.41	1.41
3.276	1/18/1993	40	1.45	1.44
3.295	11/17/1986	39	1.49	1.48
3.305	11/16/1965	38	1.53	1.52
3.331	4/22/1988	37	1.57	1.56
3.458	2/17/1998	36	1.61	1.61
3.585	2/23/2000	35	1.66	1.65
3.789	12/21/2002	34	1.71	1.70
3.828	2/8/1976	33	1.76	1.75
3.851	3/24/1983	32	1.81	1.81
4.001	1/4/1995	31	1.87	1.87
4.38	3/17/1982	30	1.93	1.93
4.424	2/12/2003	29	2.00	2.00
4.595	2/14/1995	28	2.07	2.07
4.682	1/18/1952	27	2.15	2.15
4.837	2/21/2005	26	2.23	2.23
5.047	1/14/1969	25	2.32	2.33
5.057	4/21/1988	24	2.42	2.42
5.249	12/31/1976	23	2.52	2.53
5.435	3/1/1983	22	2.64	2.65
5.452	3/1/1981	21	2.76	2.78
5.461	2/3/1958	20	2.90	2.92
5.635	11/5/1987	19	3.05	3.08
5.963	1/6/1979	18	3.22	3.25
6.033	3/8/1968	17	3.41	3.45
6.054	12/4/1974	16	3.63	3.67
6.966	2/28/1970	15	3.87	3.92
7.03	1/12/1960	14	4.14	4.21
7.309	1/31/1979	13	4.46	4.54
7.465	3/16/1986	12	4.83	4.93
7.643	10/27/2004	11	5.27	5.40
8.038	1/10/1978	10	5.80	5.96
8.26	2/24/1998	9	6.44	6.65
8.389	1/10/1955	8	7.25	7.53
8.649	11/16/1972	7	8.29	8.67
8.703	1/25/1995	6	9.67	10.21
9.129	11/21/1967	5	11.60	12.43
9.426	12/29/2004	4	14.50	15.89
9.963	3/7/1952	3	19.33	22.00
11.716	2/20/1980	2	29.00	35.75
18.449	12/10/1965	1	58.00	95.33

List of Peak events and Determination of Q2 and Q10 (Post-Development)
Carmax National City - POC-1

T (Year)	Cunnane (cfs)	Weibull (cfs)
10	**5.34**	**5.43**
9	**5.19**	**5.26**
8	**5.01**	**5.08**
7	**4.82**	**4.87**
6	**4.73**	**4.73**
5	**4.58**	**4.59**
4	**4.31**	**4.34**
3	**3.78**	**3.84**
2	**2.70**	**2.70**

Note:
Cunnane is the preferred
method by the HMP permit.

Peaks (cfs)	Date	Posit	Period of Return (Years)	
			Weibull	Cunnane
1.588	11/17/1972	57	1.02	1.01
1.614	2/8/1998	56	1.04	1.03
1.67	10/10/1986	55	1.05	1.05
1.694	2/23/2005	54	1.07	1.07
1.697	1/12/1993	53	1.09	1.09
1.704	2/19/1993	52	1.12	1.11
1.741	1/16/1993	51	1.14	1.13
1.755	1/13/1993	50	1.16	1.15
1.8	3/16/1958	49	1.18	1.18
1.849	3/6/1975	48	1.21	1.20
1.918	11/16/1965	47	1.23	1.23
1.923	1/18/1993	46	1.26	1.25
1.933	11/25/1985	45	1.29	1.28
2.003	2/14/2003	44	1.32	1.31
2.044	2/17/1998	43	1.35	1.34
2.068	2/23/2000	42	1.38	1.38
2.082	1/14/1978	41	1.41	1.41
2.103	12/30/1951	40	1.45	1.44
2.152	1/15/1993	39	1.49	1.48
2.163	11/17/1986	38	1.53	1.52
2.176	12/21/2002	37	1.57	1.56
2.204	2/8/1976	36	1.61	1.61
2.262	3/24/1983	35	1.66	1.65
2.265	12/5/1966	34	1.71	1.70
2.268	3/2/1983	33	1.76	1.75
2.325	4/22/1988	32	1.81	1.81
2.544	2/12/2003	31	1.87	1.87
2.56	3/17/1982	30	1.93	1.93
2.7	1/18/1952	29	2.00	2.00
2.767	2/14/1995	28	2.07	2.07
2.912	1/14/1969	27	2.15	2.15
2.985	12/31/1976	26	2.23	2.23
3.093	3/1/1983	25	2.32	2.33
3.115	2/3/1958	24	2.42	2.42
3.128	3/1/1981	23	2.52	2.53
3.263	11/5/1987	22	2.64	2.65
3.533	12/4/1974	21	2.76	2.78
3.565	3/8/1968	20	2.90	2.92
3.984	1/12/1960	19	3.05	3.08
4.073	2/28/1970	18	3.22	3.25
4.229	3/16/1986	17	3.41	3.45
4.254	4/21/1988	16	3.63	3.67
4.279	1/31/1979	15	3.87	3.92
4.397	10/27/2004	14	4.14	4.21
4.539	1/10/1978	13	4.46	4.54
4.575	1/6/1979	12	4.83	4.93
4.608	1/4/1995	11	5.27	5.40
4.724	2/24/1998	10	5.80	5.96
4.752	1/10/1955	9	6.44	6.65
4.917	11/16/1972	8	7.25	7.53
5.147	11/21/1967	7	8.29	8.67
5.368	2/21/2005	6	9.67	10.21
5.707	3/7/1952	5	11.60	12.43
6.593	2/20/1980	4	14.50	15.89
6.926	1/25/1995	3	19.33	22.00
7.858	12/29/2004	2	29.00	35.75
16.337	12/10/1965	1	58.00	95.33

ATTACHMENT 4

AREA VS ELEVATION

The storage provided by the underground detention facilities is represented by the "basin" nodes within the SWMM model. These nodes incorporate the stage-storage values of each vault. Stage-storage calculations are provided on the following pages for verification purposes.

DISCHARGE VS ELEVATION

The orifices have been selected to maximize their size while still restricting flows to conform with the required 10% of the Q2 event flow as mandated in the Final Hydromodification Management Plan by Brown & Caldwell, dated March 2011. While REC acknowledges that these orifices are small, to increase the size of these outlets would impact the basin's ability to restrict flows beneath the HMP thresholds, thus preventing the BMP from conformance with HMP requirements.

In order to further reduce the risk of blockage of the orifices, regular maintenance of the riser and orifices must be performed to ensure potential blockages are minimized. A detail of the orifice and riser structure is provided in Attachment 5 of this memorandum.

The LID low flow orifice discharge relationship is addressed within the LID Module within SWMM – please refer to Attachment 7 for further information.

DISCHARGE EQUATIONS

1) Weir:

   $Q_W = C_W \cdot L \cdot H^{3/2}$ (1)

2) Slot:

   As an orifice: $Q_s = B_s \cdot h_s \cdot c_g \cdot \sqrt{2g\left(H - \frac{h_s}{2}\right)}$ (2.a)

   As a weir: $Q_s = C_W \cdot B_s \cdot H^{3/2}$ (2.b)

   For H > h_s slot works as weir until orifice equation provides a smaller discharge. The elevation such that equation (2.a) = equation (2.b) is the elevation at which the behavior changes from weir to orifice.

3) Vertical Orifices

   As an orifice: $Q_o = 0.25 \cdot \pi D^2 \cdot c_g \cdot \sqrt{2g\left(H - \frac{D}{2}\right)}$ (3.a)

   As a weir: Critical depth and geometric family of circular sector must be solved to determined Q as a function of H:

$$\frac{Q_O^2}{g} = \frac{A_{cr}^3}{T_{cr}}; \quad H = y_{cr} + \frac{A_{cr}}{2 \cdot T_{cr}}; \; T_{cr} = 2\sqrt{y_{cr}(D - y_{cr})}\,; \quad A_{cr} = \frac{D^2}{8}[\alpha_{cr} - sin(\alpha_{cr})]\,;$$

$$y_{cr} = \frac{D}{2}[1 - sin(0.5 \cdot \alpha_{cr})]$$ (3.b.1, 3.b.2, 3.b.3, 3.b.4 and 3.b.5)

   There is a value of H (approximately H = 110% D) from which orifices no longer work as weirs as critical depth is not possible at the entrance of the orifice. This value of H is obtained equaling the discharge using critical equations and equations (3.b).

A mathematical model is prepared with the previous equations depending on the type o discharge.

The following are the variables used above:

Q_W, Q_s, Q_O = Discharge of weir, slot or orifice (cfs)

C_W, c_g : Coefficients of discharge of weir (typically 3.1) and orifice (0.61 to 0.62)

L, B_s, D, h_s : Length of weir, width of slot, diameter of orifice and height of slot, respectively; (ft)

H: Level of water in the pond over the invert of slot, weir or orifice (ft)

A_{cr}, T_{cr}, y_{cr}, α_{cr}: Critical variables for circular sector: area (sq-ft), top width (ft), critical depth (ft), and angle to the center, respectively.

Outlet structure for Discharge of BASIN 1

Discharge vs Elevation Table

Low orifice: 1 "
Number: 0
Cg-low: 0.62
Middle orifice: 1.0625 "
number of orif: 1
Cg-middle: 0.62
invert elev: 0.75 ft

Lower slot
Invert: 0.00 ft
B 0.00 ft
h 0.000 ft
Upper slot
Invert: 0.000 ft
B: 0.00 ft
h 0.000 ft

Emergency Weir
Invert: **5.00** ft
B: **4** ft

h (ft)	H/D-low -	H/D-mid -	Qlow-orif (cfs)	Qlow-weir (cfs)	Qtot-low (cfs)	Qmid-orif (cfs)	Qmid-weir (cfs)	Qtot-med (cfs)	Qslot-low (cfs)	Qslot-upp (cfs)	Qemer (cfs)	Qtot (cfs)
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.100	1.200	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.200	2.400	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.300	3.600	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.400	4.800	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.500	6.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.600	7.200	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.700	8.400	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.800	9.600	0.564	0.000	0.000	0.000	0.002	0.002	0.002	0.000	0.000	0.000	0.002
0.900	10.800	1.693	0.000	0.000	0.000	0.010	0.013	0.010	0.000	0.000	0.000	0.010
1.000	12.000	2.822	0.000	0.000	0.000	0.014	0.016	0.014	0.000	0.000	0.000	0.014
1.100	13.200	3.952	0.000	0.000	0.000	0.017	0.026	0.017	0.000	0.000	0.000	0.017
1.200	14.400	5.081	0.000	0.000	0.000	0.020	0.124	0.020	0.000	0.000	0.000	0.020
1.300	15.600	6.211	0.000	0.000	0.000	0.022	0.218	0.022	0.000	0.000	0.000	0.022
1.400	16.800	7.340	0.000	0.000	0.000	0.024	0.238	0.024	0.000	0.000	0.000	0.024
1.500	18.000	8.469	0.000	0.000	0.000	0.026	0.257	0.026	0.000	0.000	0.000	0.026
1.600	19.200	9.599	0.000	0.000	0.000	0.027	0.275	0.027	0.000	0.000	0.000	0.027
1.700	20.400	10.728	0.000	0.000	0.000	0.029	0.292	0.029	0.000	0.000	0.000	0.029
1.800	21.600	11.858	0.000	0.000	0.000	0.031	0.307	0.031	0.000	0.000	0.000	0.031
1.900	22.800	12.987	0.000	0.000	0.000	0.032	0.322	0.032	0.000	0.000	0.000	0.032
2.000	24.000	14.117	0.000	0.000	0.000	0.034	0.336	0.034	0.000	0.000	0.000	0.034
2.100	25.200	15.246	0.000	0.000	0.000	0.035	0.350	0.035	0.000	0.000	0.000	0.035
2.200	26.400	16.375	0.000	0.000	0.000	0.036	0.363	0.036	0.000	0.000	0.000	0.036
2.300	27.600	17.505	0.000	0.000	0.000	0.038	0.376	0.038	0.000	0.000	0.000	0.038
2.400	28.800	18.634	0.000	0.000	0.000	0.039	0.388	0.039	0.000	0.000	0.000	0.039
2.500	30.000	19.764	0.000	0.000	0.000	0.040	0.400	0.040	0.000	0.000	0.000	0.040
2.600	31.200	20.893	0.000	0.000	0.000	0.041	0.412	0.041	0.000	0.000	0.000	0.041
2.700	32.400	22.022	0.000	0.000	0.000	0.042	0.423	0.042	0.000	0.000	0.000	0.042
2.800	33.600	23.152	0.000	0.000	0.000	0.043	0.434	0.043	0.000	0.000	0.000	0.043
2.900	34.800	24.281	0.000	0.000	0.000	0.044	0.445	0.044	0.000	0.000	0.000	0.044
3.000	36.000	25.411	0.000	0.000	0.000	0.045	0.455	0.045	0.000	0.000	0.000	0.045
3.100	37.200	26.540	0.000	0.000	0.000	0.047	0.465	0.047	0.000	0.000	0.000	0.047
3.200	38.400	27.669	0.000	0.000	0.000	0.048	0.475	0.048	0.000	0.000	0.000	0.048
3.300	39.600	28.799	0.000	0.000	0.000	0.048	0.485	0.048	0.000	0.000	0.000	0.048
3.400	40.800	29.928	0.000	0.000	0.000	0.049	0.495	0.049	0.000	0.000	0.000	0.049
3.500	42.000	31.058	0.000	0.000	0.000	0.050	0.504	0.050	0.000	0.000	0.000	0.050
3.600	43.200	32.187	0.000	0.000	0.000	0.051	0.513	0.051	0.000	0.000	0.000	0.051
3.700	44.400	33.317	0.000	0.000	0.000	0.052	0.522	0.052	0.000	0.000	0.000	0.052
3.800	45.600	34.446	0.000	0.000	0.000	0.053	0.531	0.053	0.000	0.000	0.000	0.053
3.900	46.800	35.575	0.000	0.000	0.000	0.054	0.540	0.054	0.000	0.000	0.000	0.054
4.000	48.000	36.705	0.000	0.000	0.000	0.055	0.548	0.055	0.000	0.000	0.000	0.055
4.100	49.200	37.834	0.000	0.000	0.000	0.056	0.557	0.056	0.000	0.000	0.000	0.056
4.200	50.400	38.964	0.000	0.000	0.000	0.057	0.565	0.057	0.000	0.000	0.000	0.057
4.300	51.600	40.093	0.000	0.000	0.000	0.057	0.574	0.057	0.000	0.000	0.000	0.057
4.400	52.800	41.222	0.000	0.000	0.000	0.058	0.582	0.058	0.000	0.000	0.000	0.058
4.500	54.000	42.352	0.000	0.000	0.000	0.059	0.590	0.059	0.000	0.000	0.000	0.059
4.600	55.200	43.481	0.000	0.000	0.000	0.060	0.598	0.060	0.000	0.000	0.000	0.060

4.700	56.400	44.611	0.000	0.000	0.000	0.061	0.605	0.061	0.000	0.000	0.000	0.061
4.800	57.600	45.740	0.000	0.000	0.000	0.061	0.613	0.061	0.000	0.000	0.000	0.061
4.900	58.800	46.869	0.000	0.000	0.000	0.062	0.621	0.062	0.000	0.000	0.000	0.062
5.000	60.000	47.999	0.000	0.000	0.000	0.063	0.628	0.063	0.000	0.000	0.000	0.063
5.100	61.200	49.128	0.000	0.000	0.000	0.064	0.636	0.064	0.000	0.000	0.386	0.450
5.200	62.400	50.258	0.000	0.000	0.000	0.064	0.643	0.064	0.000	0.000	1.101	1.165
5.300	63.600	51.387	0.000	0.000	0.000	0.065	0.650	0.065	0.000	0.000	2.027	2.092
5.400	64.800	52.517	0.000	0.000	0.000	0.066	0.657	0.066	0.000	0.000	3.125	3.191
5.500	66.000	53.646	0.000	0.000	0.000	0.066	0.665	0.066	0.000	0.000	4.371	4.437
5.600	67.200	54.775	0.000	0.000	0.000	0.067	0.672	0.067	0.000	0.000	5.749	5.816
5.700	68.400	55.905	0.000	0.000	0.000	0.068	0.679	0.068	0.000	0.000	7.247	7.315
5.800	69.600	57.034	0.000	0.000	0.000	0.069	0.685	0.069	0.000	0.000	8.856	8.925
5.900	70.800	58.164	0.000	0.000	0.000	0.069	0.692	0.069	0.000	0.000	10.57	10.64
6.000	72.000	59.293	0.000	0.000	0.000	0.070	0.699	0.070	0.000	0.000	12.38	12.45
6.100	73.200	60.422	0.000	0.000	0.000	0.071	0.706	0.071	0.000	0.000	14.29	14.36
6.200	74.400	61.552	0.000	0.000	0.000	0.071	0.712	0.071	0.000	0.000	16.28	16.35
6.300	75.600	62.681	0.000	0.000	0.000	0.072	0.719	0.072	0.000	0.000	18.36	18.43
6.400	76.800	63.811	0.000	0.000	0.000	0.073	0.725	0.073	0.000	0.000	20.52	20.59
6.500	78.000	64.940	0.000	0.000	0.000	0.073	0.732	0.073	0.000	0.000	22.76	22.83

Outlet structure for Discharge of BASIN 2

Discharge vs Elevation Table

Low orifice: 1 "
Number: 0
Cg-low: 0.62
Middle orifice: 1.25 "
number of orif: 1
Cg-middle: 0.62
invert elev: 0.75 ft

Lower slot
Invert: 0.00 ft
B 0.00 ft
h 0.000 ft
Upper slot
Invert: 0.000 ft
B: 0.00 ft
h 0.000 ft

Emergency Weir
Invert: **5.00** ft
B: **4** ft

h (ft)	H/D-low -	H/D-mid -	Qlow-orif (cfs)	Qlow-weir (cfs)	Qtot-low (cfs)	Qmid-orif (cfs)	Qmid-weir (cfs)	Qtot-med (cfs)	Qslot-low (cfs)	Qslot-upp (cfs)	Qemer (cfs)	Qtot (cfs)
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.100	1.200	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.200	2.400	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.300	3.600	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.400	4.800	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.500	6.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.600	7.200	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.700	8.400	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.800	9.600	0.480	0.000	0.000	0.000	0.000	0.002	0.002	0.000	0.000	0.000	0.002
0.900	10.800	1.440	0.000	0.000	0.000	0.013	0.016	0.013	0.000	0.000	0.000	0.013
1.000	12.000	2.400	0.000	0.000	0.000	0.019	0.024	0.019	0.000	0.000	0.000	0.019
1.100	13.200	3.360	0.000	0.000	0.000	0.023	0.026	0.023	0.000	0.000	0.000	0.023
1.200	14.400	4.320	0.000	0.000	0.000	0.027	0.062	0.027	0.000	0.000	0.000	0.027
1.300	15.600	5.280	0.000	0.000	0.000	0.030	0.245	0.030	0.000	0.000	0.000	0.030
1.400	16.800	6.240	0.000	0.000	0.000	0.033	0.328	0.033	0.000	0.000	0.000	0.033
1.500	18.000	7.200	0.000	0.000	0.000	0.035	0.354	0.035	0.000	0.000	0.000	0.035
1.600	19.200	8.160	0.000	0.000	0.000	0.038	0.379	0.038	0.000	0.000	0.000	0.038
1.700	20.400	9.120	0.000	0.000	0.000	0.040	0.402	0.040	0.000	0.000	0.000	0.040
1.800	21.600	10.080	0.000	0.000	0.000	0.042	0.424	0.042	0.000	0.000	0.000	0.042
1.900	22.800	11.040	0.000	0.000	0.000	0.044	0.444	0.044	0.000	0.000	0.000	0.044
2.000	24.000	12.000	0.000	0.000	0.000	0.046	0.464	0.046	0.000	0.000	0.000	0.046
2.100	25.200	12.960	0.000	0.000	0.000	0.048	0.483	0.048	0.000	0.000	0.000	0.048
2.200	26.400	13.920	0.000	0.000	0.000	0.050	0.501	0.050	0.000	0.000	0.000	0.050
2.300	27.600	14.880	0.000	0.000	0.000	0.052	0.519	0.052	0.000	0.000	0.000	0.052
2.400	28.800	15.840	0.000	0.000	0.000	0.054	0.536	0.054	0.000	0.000	0.000	0.054
2.500	30.000	16.800	0.000	0.000	0.000	0.055	0.553	0.055	0.000	0.000	0.000	0.055
2.600	31.200	17.760	0.000	0.000	0.000	0.057	0.569	0.057	0.000	0.000	0.000	0.057
2.700	32.400	18.720	0.000	0.000	0.000	0.058	0.584	0.058	0.000	0.000	0.000	0.058
2.800	33.600	19.680	0.000	0.000	0.000	0.060	0.599	0.060	0.000	0.000	0.000	0.060
2.900	34.800	20.640	0.000	0.000	0.000	0.061	0.614	0.061	0.000	0.000	0.000	0.061
3.000	36.000	21.600	0.000	0.000	0.000	0.063	0.629	0.063	0.000	0.000	0.000	0.063
3.100	37.200	22.560	0.000	0.000	0.000	0.064	0.643	0.064	0.000	0.000	0.000	0.064
3.200	38.400	23.520	0.000	0.000	0.000	0.066	0.657	0.066	0.000	0.000	0.000	0.066
3.300	39.600	24.480	0.000	0.000	0.000	0.067	0.670	0.067	0.000	0.000	0.000	0.067
3.400	40.800	25.440	0.000	0.000	0.000	0.068	0.683	0.068	0.000	0.000	0.000	0.068
3.500	42.000	26.400	0.000	0.000	0.000	0.070	0.696	0.070	0.000	0.000	0.000	0.070
3.600	43.200	27.360	0.000	0.000	0.000	0.071	0.709	0.071	0.000	0.000	0.000	0.071
3.700	44.400	28.320	0.000	0.000	0.000	0.072	0.722	0.072	0.000	0.000	0.000	0.072
3.800	45.600	29.280	0.000	0.000	0.000	0.073	0.734	0.073	0.000	0.000	0.000	0.073
3.900	46.800	30.240	0.000	0.000	0.000	0.075	0.746	0.075	0.000	0.000	0.000	0.075
4.000	48.000	31.200	0.000	0.000	0.000	0.076	0.758	0.076	0.000	0.000	0.000	0.076
4.100	49.200	32.160	0.000	0.000	0.000	0.077	0.770	0.077	0.000	0.000	0.000	0.077
4.200	50.400	33.120	0.000	0.000	0.000	0.078	0.782	0.078	0.000	0.000	0.000	0.078
4.300	51.600	34.080	0.000	0.000	0.000	0.079	0.793	0.079	0.000	0.000	0.000	0.079
4.400	52.800	35.040	0.000	0.000	0.000	0.080	0.804	0.080	0.000	0.000	0.000	0.080
4.500	54.000	36.000	0.000	0.000	0.000	0.082	0.815	0.082	0.000	0.000	0.000	0.082
4.600	55.200	36.960	0.000	0.000	0.000	0.083	0.826	0.083	0.000	0.000	0.000	0.083

4.700	56.400	37.920	0.000	0.000	0.000	0.084	0.837	0.084	0.000	0.000	0.000	0.084
4.800	57.600	38.880	0.000	0.000	0.000	0.085	0.848	0.085	0.000	0.000	0.000	0.085
4.900	58.800	39.840	0.000	0.000	0.000	0.086	0.858	0.086	0.000	0.000	0.000	0.086
5.000	60.000	40.800	0.000	0.000	0.000	0.087	0.869	0.087	0.000	0.000	0.000	0.087
5.100	61.200	41.760	0.000	0.000	0.000	0.088	0.879	0.088	0.000	0.000	0.386	0.474
5.200	62.400	42.720	0.000	0.000	0.000	0.089	0.889	0.089	0.000	0.000	1.101	1.190
5.300	63.600	43.680	0.000	0.000	0.000	0.090	0.899	0.090	0.000	0.000	2.027	2.117
5.400	64.800	44.640	0.000	0.000	0.000	0.091	0.909	0.091	0.000	0.000	3.125	3.216
5.500	66.000	45.600	0.000	0.000	0.000	0.092	0.919	0.092	0.000	0.000	4.371	4.463
5.600	67.200	46.560	0.000	0.000	0.000	0.093	0.929	0.093	0.000	0.000	5.749	5.841
5.700	68.400	47.520	0.000	0.000	0.000	0.094	0.938	0.094	0.000	0.000	7.247	7.340
5.800	69.600	48.480	0.000	0.000	0.000	0.095	0.948	0.095	0.000	0.000	8.856	8.951
5.900	70.800	49.440	0.000	0.000	0.000	0.096	0.957	0.096	0.000	0.000	10.57	10.67
6.000	72.000	50.400	0.000	0.000	0.000	0.097	0.967	0.097	0.000	0.000	12.38	12.48
6.100	73.200	51.360	0.000	0.000	0.000	0.098	0.976	0.098	0.000	0.000	14.29	14.38
6.200	74.400	52.320	0.000	0.000	0.000	0.099	0.985	0.099	0.000	0.000	16.28	16.38
6.300	75.600	53.280	0.000	0.000	0.000	0.099	0.994	0.099	0.000	0.000	18.36	18.46
6.400	76.800	54.240	0.000	0.000	0.000	0.100	1.003	0.100	0.000	0.000	20.52	20.62
6.500	78.000	55.200	0.000	0.000	0.000	0.101	1.012	0.101	0.000	0.000	22.76	22.86

Project:

StormTech
Detention • Retention • Water Quality
A division of ADS

Chamber Model - MC-3500
Units - **Imperial** Click Here for Metric
Number of Chambers - 70
Number of End Caps - 16
Voids in the stone (porosity) - 40 %
Base of Stone Elevation - 711.00 ft
Amount of Stone Above Chambers - 21 in
Amount of Stone Below Chambers - 12 in
Amount of Stone Between Chambers - 6 in
Area of system - 3750 sf Min. Area - 3730 sf min. area

☑ Include Perimeter Stone in Calculations

Height of System *(inches)*	Incremental Single Chamber *(cubic feet)*	Incremental Single End Cap *(cubic feet)*	Incremental Chambers *(cubic feet)*	Incremental End Cap *(cubic feet)*	Incremental Stone *(cubic feet)*	Incremental Ch, EC and Stone *(cubic feet)*	Cumulative System (cubic feet)	Elevation (feet)
78	0.00	0.00	0.00	0.00	125.00	125.00	14511.36	717.50
77	0.00	0.00	0.00	0.00	125.00	125.00	14386.36	717.42
76	0.00	0.00	0.00	0.00	125.00	125.00	14261.36	717.33
75	0.00	0.00	0.00	0.00	125.00	125.00	14136.36	717.25
74	0.00	0.00	0.00	0.00	125.00	125.00	14011.36	717.17
73	0.00	0.00	0.00	0.00	125.00	125.00	13886.36	717.08
72	0.00	0.00	0.00	0.00	125.00	125.00	13761.36	717.00
71	0.00	0.00	0.00	0.00	125.00	125.00	13636.36	716.92
70	0.00	0.00	0.00	0.00	125.00	125.00	13511.36	716.83
69	0.00	0.00	0.00	0.00	125.00	125.00	13386.36	716.75
68	0.00	0.00	0.00	0.00	125.00	125.00	13261.36	716.67
67	0.00	0.00	0.00	0.00	125.00	125.00	13136.36	716.58
66	0.00	0.00	0.00	0.00	125.00	125.00	13011.36	716.50
65	0.00	0.00	0.00	0.00	125.00	125.00	12886.36	716.42
64	0.00	0.00	0.00	0.00	125.00	125.00	12761.36	716.33
63	0.00	0.00	0.00	0.00	125.00	125.00	12636.36	716.25
62	0.00	0.00	0.00	0.00	125.00	125.00	12511.36	716.17
61	0.00	0.00	0.00	0.00	125.00	125.00	12386.36	716.08
60	0.00	0.00	0.00	0.00	125.00	125.00	12261.36	716.00
59	0.00	0.00	0.00	0.00	125.00	125.00	12136.36	715.92
58	0.00	0.00	0.00	0.00	125.00	125.00	12011.36	715.83
57	0.06	0.00	4.07	0.00	123.37	127.44	11886.36	715.75
56	0.19	0.02	13.59	0.38	119.41	133.38	11758.92	715.67
55	0.29	0.04	20.58	0.60	116.53	137.71	11625.54	715.58
54	0.40	0.05	28.26	0.82	113.37	142.45	11487.83	715.50
53	0.69	0.07	48.10	1.08	105.33	154.51	11345.38	715.42
52	1.03	0.09	71.98	1.41	95.64	169.04	11190.87	715.33
51	1.25	0.11	87.47	1.71	89.33	178.51	11021.84	715.25
50	1.42	0.13	99.56	2.02	84.37	185.95	10843.33	715.17
49	1.57	0.14	110.12	2.31	80.03	192.46	10657.38	715.08
48	1.71	0.16	119.50	2.61	76.16	198.26	10464.92	715.00
47	1.83	0.18	127.99	2.91	72.64	203.54	10266.66	714.92
46	1.94	0.20	135.64	3.21	69.46	208.31	10063.12	714.83
45	2.04	0.22	142.86	3.49	66.46	212.81	9854.81	714.75
44	2.13	0.23	149.43	3.76	63.72	216.91	9642.00	714.67
43	2.22	0.25	155.70	4.01	61.12	220.82	9425.09	714.58
42	2.31	0.27	161.48	4.25	58.71	224.43	9204.26	714.50
41	2.38	0.28	166.93	4.48	56.43	227.85	8979.83	714.42
40	2.46	0.29	172.14	4.70	54.26	231.10	8751.98	714.33
39	2.53	0.31	176.97	4.93	52.24	234.14	8520.88	714.25
38	2.59	0.32	181.56	5.14	50.32	237.02	8286.74	714.17
37	2.66	0.33	185.92	5.35	48.49	239.77	8049.72	714.08
36	2.72	0.35	190.06	5.55	46.76	242.37	7809.95	714.00
35	2.77	0.36	193.99	5.76	45.10	244.85	7567.59	713.92
34	2.82	0.37	197.73	5.96	43.53	247.21	7322.74	713.83

33	2.88	0.38	201.28	6.15	42.03	249.46	7075.53	713.75
32	2.92	0.40	204.69	6.34	40.59	251.62	6826.07	713.67
31	2.97	0.41	207.89	6.52	39.23	253.65	6574.45	713.58
30	3.01	0.42	210.87	6.70	37.97	255.54	6320.80	713.50
29	3.05	0.43	213.73	6.87	36.76	257.36	6065.26	713.42
28	3.09	0.44	216.60	7.05	35.54	259.19	5807.90	713.33
27	3.13	0.45	219.14	7.21	34.46	260.81	5548.71	713.25
26	3.17	0.46	221.60	7.37	33.41	262.38	5287.90	713.17
25	3.20	0.47	223.96	7.53	32.40	263.90	5025.52	713.08
24	3.23	0.48	226.18	7.68	31.46	265.32	4761.62	713.00
23	3.26	0.49	228.30	7.83	30.55	266.68	4496.31	712.92
22	3.29	0.50	230.32	7.97	29.69	267.97	4229.63	712.83
21	3.32	0.51	232.26	8.10	28.86	269.22	3961.66	712.75
20	3.34	0.51	234.09	8.23	28.07	270.39	3692.45	712.67
19	3.37	0.52	235.80	8.36	27.34	271.50	3422.05	712.58
18	3.39	0.53	237.48	8.47	26.62	272.57	3150.56	712.50
17	3.41	0.54	239.02	8.58	25.96	273.56	2877.99	712.42
16	3.44	0.54	240.59	8.69	25.29	274.57	2604.43	712.33
15	3.46	0.55	242.04	8.79	24.67	275.50	2329.86	712.25
14	3.48	0.56	243.51	8.88	24.04	276.44	2054.36	712.17
13	3.51	0.59	245.36	9.52	23.05	277.93	1777.93	712.08
12	0.00	0.00	0.00	0.00	125.00	125.00	1500.00	712.00
11	0.00	0.00	0.00	0.00	125.00	125.00	1375.00	711.92
10	0.00	0.00	0.00	0.00	125.00	125.00	1250.00	711.83
9	0.00	0.00	0.00	0.00	125.00	125.00	1125.00	711.75
8	0.00	0.00	0.00	0.00	125.00	125.00	1000.00	711.67
7	0.00	0.00	0.00	0.00	125.00	125.00	875.00	711.58
6	0.00	0.00	0.00	0.00	125.00	125.00	750.00	711.50
5	0.00	0.00	0.00	0.00	125.00	125.00	625.00	711.42
4	0.00	0.00	0.00	0.00	125.00	125.00	500.00	711.33
3	0.00	0.00	0.00	0.00	125.00	125.00	375.00	711.25
2	0.00	0.00	0.00	0.00	125.00	125.00	250.00	711.17
1	0.00	0.00	0.00	0.00	125.00	125.00	125.00	711.08

Project:

StormTech

Detention • Retention • Water Quality

A division of ADS

Chamber Model - MC-3500

Units - **Imperial** Click Here for Metric

Number of Chambers - 90

Number of End Caps - 30

Voids in the stone (porosity) - 40 %

Base of Stone Elevation - 711.00 ft

☑ Include Perimeter Stone in Calculations

Amount of Stone Above Chambers - 21 in

Amount of Stone Below Chambers - 12 in

Amount of Stone Between Chambers - 6 in

Area of system - 4950 sf Min. Area - 4949 sf min. area

Height of System *(inches)*	Incremental Single Chamber *(cubic feet)*	Incremental Single End Cap *(cubic feet)*	Incremental Chambers *(cubic feet)*	Incremental End Cap *(cubic feet)*	Incremental Stone *(cubic feet)*	Incremental Ch, EC and Stone *(cubic feet)*	Cumulative System (cubic feet)	Elevation (feet)
78	0.00	0.00	0.00	0.00	165.00	165.00	19076.36	717.50
77	0.00	0.00	0.00	0.00	165.00	165.00	18911.36	717.42
76	0.00	0.00	0.00	0.00	165.00	165.00	18746.36	717.33
75	0.00	0.00	0.00	0.00	165.00	165.00	18581.36	717.25
74	0.00	0.00	0.00	0.00	165.00	165.00	18416.36	717.17
73	0.00	0.00	0.00	0.00	165.00	165.00	18251.36	717.08
72	0.00	0.00	0.00	0.00	165.00	165.00	18086.36	717.00
71	0.00	0.00	0.00	0.00	165.00	165.00	17921.36	716.92
70	0.00	0.00	0.00	0.00	165.00	165.00	17756.36	716.83
69	0.00	0.00	0.00	0.00	165.00	165.00	17591.36	716.75
68	0.00	0.00	0.00	0.00	165.00	165.00	17426.36	716.67
67	0.00	0.00	0.00	0.00	165.00	165.00	17261.36	716.58
66	0.00	0.00	0.00	0.00	165.00	165.00	17096.36	716.50
65	0.00	0.00	0.00	0.00	165.00	165.00	16931.36	716.42
64	0.00	0.00	0.00	0.00	165.00	165.00	16766.36	716.33
63	0.00	0.00	0.00	0.00	165.00	165.00	16601.36	716.25
62	0.00	0.00	0.00	0.00	165.00	165.00	16436.36	716.17
61	0.00	0.00	0.00	0.00	165.00	165.00	16271.36	716.08
60	0.00	0.00	0.00	0.00	165.00	165.00	16106.36	716.00
59	0.00	0.00	0.00	0.00	165.00	165.00	15941.36	715.92
58	0.00	0.00	0.00	0.00	165.00	165.00	15776.36	715.83
57	0.06	0.00	5.23	0.00	162.91	168.14	15611.36	715.75
56	0.19	0.02	17.47	0.72	157.73	175.91	15443.22	715.67
55	0.29	0.04	26.46	1.13	153.97	181.55	15267.31	715.58
54	0.40	0.05	36.33	1.55	149.85	187.72	15085.76	715.50
53	0.69	0.07	61.85	2.03	139.45	203.32	14898.03	715.42
52	1.03	0.09	92.55	2.65	126.92	222.12	14694.71	715.33
51	1.25	0.11	112.46	3.22	118.73	234.40	14472.59	715.25
50	1.42	0.13	128.00	3.79	112.28	244.07	14238.19	715.17
49	1.57	0.14	141.58	4.33	106.63	252.55	13994.11	715.08
48	1.71	0.16	153.64	4.89	101.59	260.12	13741.57	715.00
47	1.83	0.18	164.56	5.45	96.99	267.01	13481.45	714.92
46	1.94	0.20	174.40	6.02	92.83	273.25	13214.44	714.83
45	2.04	0.22	183.67	6.55	88.91	279.13	12941.19	714.75
44	2.13	0.23	192.12	7.05	85.33	284.50	12662.06	714.67
43	2.22	0.25	200.18	7.52	81.92	289.62	12377.55	714.58
42	2.31	0.27	207.61	7.97	78.77	294.35	12087.94	714.50
41	2.38	0.28	214.63	8.40	75.79	298.82	11793.59	714.42
40	2.46	0.29	221.32	8.82	72.95	303.08	11494.77	714.33
39	2.53	0.31	227.54	9.24	70.29	307.06	11191.69	714.25
38	2.59	0.32	233.44	9.64	67.77	310.84	10884.63	714.17
37	2.66	0.33	239.05	10.03	65.37	314.45	10573.78	714.08
36	2.72	0.35	244.36	10.41	63.09	317.86	10259.34	714.00
35	2.77	0.36	249.42	10.80	60.91	321.13	9941.48	713.92
34	2.82	0.37	254.22	11.17	58.85	324.23	9620.35	713.83

33	2.88	0.38	258.79	11.53	56.87	327.19	9296.11	713.75
32	2.92	0.40	263.17	11.88	54.98	330.03	8968.92	713.67
31	2.97	0.41	267.29	12.23	53.19	332.71	8638.89	713.58
30	3.01	0.42	271.12	12.56	51.53	335.21	8306.18	713.50
29	3.05	0.43	274.79	12.89	49.93	337.61	7970.97	713.42
28	3.09	0.44	278.48	13.21	48.32	340.02	7633.36	713.33
27	3.13	0.45	281.75	13.52	46.89	342.16	7293.34	713.25
26	3.17	0.46	284.91	13.83	45.51	344.24	6951.18	713.17
25	3.20	0.47	287.95	14.12	44.17	346.24	6606.94	713.08
24	3.23	0.48	290.80	14.40	42.92	348.12	6260.69	713.00
23	3.26	0.49	293.53	14.68	41.72	349.92	5912.57	712.92
22	3.29	0.50	296.12	14.94	40.58	351.64	5562.65	712.83
21	3.32	0.51	298.62	15.19	39.48	353.29	5211.01	712.75
20	3.34	0.51	300.97	15.43	38.44	354.84	4857.73	712.67
19	3.37	0.52	303.18	15.67	37.46	356.31	4502.88	712.58
18	3.39	0.53	305.33	15.89	36.52	357.73	4146.58	712.50
17	3.41	0.54	307.31	16.10	35.64	359.04	3788.85	712.42
16	3.44	0.54	309.33	16.30	34.75	360.38	3429.81	712.33
15	3.46	0.55	311.19	16.48	33.93	361.61	3069.43	712.25
14	3.48	0.56	313.08	16.66	33.10	362.84	2707.83	712.17
13	3.51	0.59	315.46	17.85	31.68	364.98	2344.98	712.08
12	0.00	0.00	0.00	0.00	165.00	165.00	1980.00	712.00
11	0.00	0.00	0.00	0.00	165.00	165.00	1815.00	711.92
10	0.00	0.00	0.00	0.00	165.00	165.00	1650.00	711.83
9	0.00	0.00	0.00	0.00	165.00	165.00	1485.00	711.75
8	0.00	0.00	0.00	0.00	165.00	165.00	1320.00	711.67
7	0.00	0.00	0.00	0.00	165.00	165.00	1155.00	711.58
6	0.00	0.00	0.00	0.00	165.00	165.00	990.00	711.50
5	0.00	0.00	0.00	0.00	165.00	165.00	825.00	711.42
4	0.00	0.00	0.00	0.00	165.00	165.00	660.00	711.33
3	0.00	0.00	0.00	0.00	165.00	165.00	495.00	711.25
2	0.00	0.00	0.00	0.00	165.00	165.00	330.00	711.17
1	0.00	0.00	0.00	0.00	165.00	165.00	165.00	711.08

ATTACHMENT 5

Pre & Post-Developed Maps, Project Plan and Detention Section Sketches

LEGEND

- ═ ═ EX. STORM DRAIN
- ═ ═ PROP. STORM DRAIN
- ▣ ▣ EX. INLET/CATCHBASIN/CLEANOUT
- ▬ ▬ DRAINAGE MANAGEMENT AREA BOUNDARY
- ← DRAINAGE DIRECTION

SOURCE CONTROL BMPS

SC-1	PREVENTION OF ILLICIT DISCHARGES INTO THE MS4
SC-2	STORM DRAIN STENCILING OR SIGNAGE
SC-5	PROTECT TRASH STORAGE AREAS FROM RAINFALL, RUN-ON, RUNOFF, AND WIND DISPERSAL
SC-6A	ON-SITE STORM DRAIN INLETS
SC-6B	INTERIOR FLOOR DRAINS
SC-6D1	NEED FOR FUTURE INDOOR & STRUCTURAL PEST CONTROL
SC-6D2	LANDSCAPE DESIGN/OUTDOOR PESTICIDE USE
SC-6G	REFUSE AREAS
SC-6J	VEHICLE AND EQUIPMENT CLEANING
SC-6K	VEHICLE/EQUIPMENT REPAIR AND MAINTENANCE
SC-6L	FUEL DISPENSING AREA
SC-6N	FIRE SPRINKLER TEST WATER
SC-6O1	BOILER DRAIN LINES
SC-6O2	CONDENSATE LINES
SC-6O3	ROOFTOP EQUIPMENT
SC-6P	PLAZAS, SIDEWALKS, AND PARKING LOTS

SITE DESIGN BMPS

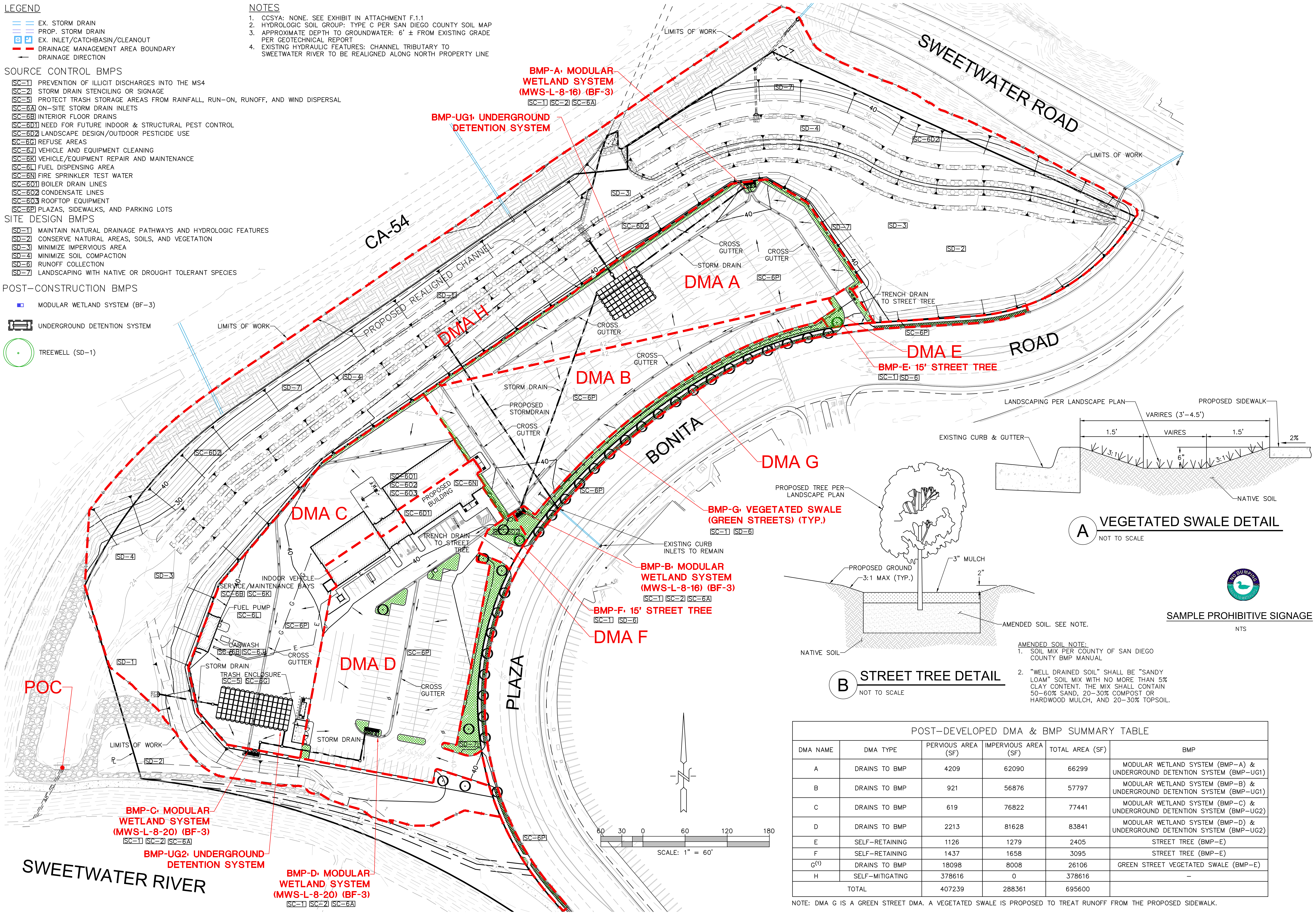
SD-1	MAINTAIN NATURAL DRAINAGE PATHWAYS AND HYDROLOGIC FEATURES
SD-2	CONSERVE NATURAL AREAS, SOILS, AND VEGETATION
SD-3	MINIMIZE IMPERVIOUS AREA
SD-4	MINIMIZE SOIL COMPACTION
SD-6	RUNOFF COLLECTION
SD-7	LANDSCAPING WITH NATIVE OR DROUGHT TOLERANT SPECIES

POST-CONSTRUCTION BMPS

- ▣ MODULAR WETLAND SYSTEM (BF-3)
- ▭ UNDERGROUND DETENTION SYSTEM
- ○ TREEWELL (SD-1)

NOTES

1. CCSYA: NONE. SEE EXHIBIT IN ATTACHMENT F.1.1
2. HYDROLOGIC SOIL GROUP: TYPE C PER SAN DIEGO COUNTY SOIL MAP
3. APPROXIMATE DEPTH TO GROUNDWATER: 6' ± FROM EXISTING GRADE PER GEOTECHNICAL REPORT
4. EXISTING HYDRAULIC FEATURES: CHANNEL TRIBUTARY TO SWEETWATER RIVER TO BE REALIGNED ALONG NORTH PROPERTY LINE



A VEGETATED SWALE DETAIL

NOT TO SCALE

B STREET TREE DETAIL

NOT TO SCALE

AMENDED SOIL NOTE:

1. SOIL MIX PER COUNTY OF SAN DIEGO COUNTY BMP MANUAL
2. "WELL DRAINED SOIL" SHALL BE "SANDY LOAM" SOIL MIX WITH NO MORE THAN 5% CLAY CONTENT. THE MIX SHALL CONTAIN 50-60% SAND, 20-30% COMPOST OR HARDWOOD MULCH, AND 20-30% TOPSOIL.

SAMPLE PROHIBITIVE SIGNAGE

NTS

POST-DEVELOPED DMA & BMP SUMMARY TABLE

DMA NAME	DMA TYPE	PERVIOUS AREA (SF)	IMPERVIOUS AREA (SF)	TOTAL AREA (SF)	BMP
A	DRAINS TO BMP	4209	62090	66299	MODULAR WETLAND SYSTEM (BMP-A) & UNDERGROUND DETENTION SYSTEM (BMP-UG1)
B	DRAINS TO BMP	921	56876	57797	MODULAR WETLAND SYSTEM (BMP-B) & UNDERGROUND DETENTION SYSTEM (BMP-UG1)
C	DRAINS TO BMP	619	76822	77441	MODULAR WETLAND SYSTEM (BMP-C) & UNDERGROUND DETENTION SYSTEM (BMP-UG2)
D	DRAINS TO BMP	2213	81628	83841	MODULAR WETLAND SYSTEM (BMP-D) & UNDERGROUND DETENTION SYSTEM (BMP-UG2)
E	SELF-RETAINING	1126	1279	2405	STREET TREE (BMP-E)
F	SELF-RETAINING	1437	1658	3095	STREET TREE (BMP-E)
G(1)	DRAINS TO BMP	18098	8008	26106	GREEN STREET VEGETATED SWALE (BMP-E)
H	SELF-MITIGATING	378616	0	378616	–
TOTAL		407239	288361	695600	

NOTE: DMA G IS A GREEN STREET DMA. A VEGETATED SWALE IS PROPOSED TO TREAT RUNOFF FROM THE PROPOSED SIDEWALK.

REVISIONS			
NO.	DESCRIPTION	DATE	APP'D

R·E·C Consultants, Inc.
Civil Engineering · Environmental
Land Surveying
2442 Second Avenue
San Diego, CA 92101
(619)232-9200 (619)232-9210 Fax

DATE: 7-1-20
SCALE: 1" = 60'
DRAWN: WOG
CHECKED: WOG

SHEET TITLE
DMA MAP

PROJECT
CARMAX NATIONAL CITY
PLAZA BONITA RD
NATIONAL CITY, CA 91950

SHEET
1
OF 1 SHEETS

SAVE DATE: 7/28/2020 ~ PLOT DATE: 8/5/2020 ~ FILE NAME: P:\Acad\1253 Carmax of National City\Civil\Exhibits\DMA Map for SWQMP.dwg

ATTACHMENT 6

SWMM Input Data in Input Format (Existing & Proposed Models)

PRE_DEV

```
[TITLE]

[OPTIONS]
FLOW_UNITS           CFS
INFILTRATION         GREEN_AMPT
FLOW_ROUTING         KINWAVE
START_DATE           10/17/1948
START_TIME           00:00:00
REPORT_START_DATE    10/17/1948
REPORT_START_TIME    00:00:00
END_DATE             10/17/2005
END_TIME             23:00:00
SWEEP_START          01/01
SWEEP_END            12/31
DRY_DAYS             0
REPORT_STEP          01:00:00
WET_STEP             00:15:00
DRY_STEP             04:00:00
ROUTING_STEP         0:01:00
ALLOW_PONDING        NO
INERTIAL_DAMPING     PARTIAL
VARIABLE_STEP        0.75
LENGTHENING_STEP     0
MIN_SURFAREA         0
NORMAL_FLOW_LIMITED  BOTH
SKIP_STEADY_STATE    NO
FORCE_MAIN_EQUATION  H-W
LINK_OFFSETS         DEPTH
MIN_SLOPE            0

[EVAPORATION]
;;Type       Parameters
;;---------- ----------
MONTHLY      0.041  0.076  0.118  0.192  0.237  0.318  0.308  0.286  0.217  0.14   0.067  0.041
DRY_ONLY     NO

[RAINGAGES]
;;               Rain      Time   Snow   Data
;;Name           Type      Intrvl Catch  Source
;;-------------- --------- ------ ------ ----------
LINDBERGH        INTENSITY 1:00   1.0    TIMESERIES LINDBERGH

[SUBCATCHMENTS]
;;                                                 Total    Pcnt.             Pcnt.    Curb     Snow
;;Name           Raingage         Outlet           Area     Imperv   Width    Slope    Length   Pack
;;-------------- ---------------- ---------------- -------- -------- -------- -------- -------- --------
DMA-1-C          LINDBERGH        POC-1            14.604   0        2892     1        0

[SUBAREAS]
;;Subcatchment   N-Imperv   N-Perv     S-Imperv   S-Perv     PctZero    RouteTo    PctRouted
;;-------------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
DMA-1-C          0.012      0.05       0.05       0.1        25         OUTLET

[INFILTRATION]
;;Subcatchment   Suction    HydCon     IMDmax
;;-------------- ---------- ---------- ----------
DMA-1-C          6          0.1        0.31

[OUTFALLS]
;;               Invert     Outfall    Stage/Table      Tide
;;Name           Elev.      Type       Time Series      Gate
;;-------------- ---------- ---------- ---------------- ----
POC-1            0          FREE                        NO

[TIMESERIES]
;;Name           Date       Time       Value
;;-------------- ---------- ---------- ----------
LINDBERGH        FILE "LbergRain.prn"

[REPORT]
INPUT      NO
```

```
CONTROLS   NO
SUBCATCHMENTS ALL
NODES ALL
LINKS ALL

[TAGS]

[MAP]
DIMENSIONS 0.000 0.000 10000.000 10000.000
Units      None

[COORDINATES]
;;Node           X-Coord            Y-Coord           
;;-------------- ------------------ ------------------
POC-1            2500.000           2700.000          

[VERTICES]
;;Link           X-Coord            Y-Coord           
;;-------------- ------------------ ------------------

[Polygons]
;;Subcatchment   X-Coord            Y-Coord           
;;-------------- ------------------ ------------------
DMA-1-C          2427.184           5983.010          
DMA-1-C          2427.184           5983.010          

[SYMBOLS]
;;Gage           X-Coord            Y-Coord           
;;-------------- ------------------ ------------------
LINDBERGH        1525.424           6864.407          
```

POST_DEV

```
[TITLE]

[OPTIONS]
FLOW_UNITS           CFS
INFILTRATION         GREEN_AMPT
FLOW_ROUTING         KINWAVE
START_DATE           10/17/1948
START_TIME           00:00:00
REPORT_START_DATE    10/17/1948
REPORT_START_TIME    00:00:00
END_DATE             10/17/2005
END_TIME             23:00:00
SWEEP_START          01/01
SWEEP_END            12/31
DRY_DAYS             0
REPORT_STEP          01:00:00
WET_STEP             00:15:00
DRY_STEP             04:00:00
ROUTING_STEP         0:01:00
ALLOW_PONDING        NO
INERTIAL_DAMPING     PARTIAL
VARIABLE_STEP        0.75
LENGTHENING_STEP     0
MIN_SURFAREA         0
NORMAL_FLOW_LIMITED  BOTH
SKIP_STEADY_STATE    NO
FORCE_MAIN_EQUATION  H-W
LINK_OFFSETS         DEPTH
MIN_SLOPE            0

[EVAPORATION]
;;Type       Parameters
;;---------- ----------
MONTHLY      0.06   0.08   0.11   0.15   0.17   0.19   0.19   0.18   0.15   0.11   0.08   0.06
DRY_ONLY     NO

[RAINGAGES]
;;               Rain      Time   Snow   Data
;;Name           Type      Intrvl Catch  Source
;;-------------- --------- ------ ------ ----------
LINDBERGH        INTENSITY 1:00   1.0    TIMESERIES LINDBERGH

[SUBCATCHMENTS]
;;                                                 Total    Pcnt.             Pcnt.    Curb     Snow
;;Name           Raingage         Outlet           Area     Imperv   Width    Slope    Length   Pack
;;-------------- ---------------- ---------------- -------- -------- -------- -------- -------- --------
DMA-A-B          LINDBERGH        BASIN-1          2.849    95.87    1241     1        0
DMA-F            LINDBERGH        POC-1            0.071    53.57    31       1        0
DMA-C-D          LINDBERGH        basin-2          3.703    98.24    1613     1        0
;Drains to vegetated self treatment area
DMA-E            LINDBERGH        POC-1            0.055    53.18    24       1        0
DMA-BYPASS       LINDBERGH        POC-1            7.926    0        1569     1        0

[SUBAREAS]
;;Subcatchment   N-Imperv   N-Perv     S-Imperv   S-Perv     PctZero    RouteTo    PctRouted
;;-------------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
DMA-A-B          0.012      0.05       0.05       0.1        25         OUTLET
DMA-F            0.012      0.05       0.05       0.1        25         PERVIOUS   100
DMA-C-D          0.012      0.05       0.05       0.1        25         OUTLET
DMA-E            0.012      0.05       0.05       0.1        25         PERVIOUS   100
DMA-BYPASS       0.012      0.05       0.05       0.1        25         PERVIOUS   100

[INFILTRATION]
;;Subcatchment   Suction    HydCon     IMDmax
```

POST_DEV

```
;;-------------- ---------- ---------- ----------
DMA-A-B          6          0.075      0.31
DMA-F            6          0.075      0.31
DMA-C-D          6          0.075      0.31
DMA-E            9          0.01875    0.3
DMA-BYPASS       6          0.1        0.3

[OUTFALLS]
;;               Invert     Outfall    Stage/Table      Tide
;;Name           Elev.      Type       Time Series      Gate
;;-------------- ---------- ---------- ---------------- ----
POC-1            0          FREE                        NO

[STORAGE]
;;               Invert   Max.     Init.    Storage    Curve                      Ponded   Evap.
;;Name           Elev.    Depth    Depth    Curve      Params                     Area     Frac.    Infiltration
Parameters
;;-------------- -------- -------- -------- ---------- -------- -------- -------- -------- -------- -----------------
------
BASIN-1          0        6.5      0        TABULAR    BASIN                      3750     0        6        0.29
0.31
BASIN-2          0        6.5      0        TABULAR    Basin2                     4950     0        6        1.3
0.31

[OUTLETS]
;;               Inlet            Outlet           Outflow    Outlet           Qcoeff/                     Flap
;;Name           Node             Node             Height     Type             QTable           Qexpon     Gate
;;-------------- ---------------- ---------------- ---------- ---------------- ---------------- ---------- ----
ORIFICE-1        BASIN-1          POC-1            0          TABULAR/DEPTH    SLOT                        NO
ORIFICE-2        BASIN-2          POC-1            0          TABULAR/HEAD     OUT2                        NO

[CURVES]
;;Name           Type       X-Value    Y-Value
;;-------------- ---------- ---------- ----------
SLOT             Rating     0.000      0.000
SLOT                        0.100      0.000
SLOT                        0.200      0.000
SLOT                        0.300      0.000
SLOT                        0.400      0.000
SLOT                        0.500      0.000
SLOT                        0.600      0.000
SLOT                        0.700      0.000
SLOT                        0.800      0.002
SLOT                        0.900      0.010
SLOT                        1.000      0.014
SLOT                        1.100      0.017
SLOT                        1.200      0.020
SLOT                        1.300      0.022
SLOT                        1.400      0.024
SLOT                        1.500      0.026
SLOT                        1.600      0.027
SLOT                        1.700      0.029
SLOT                        1.800      0.031
SLOT                        1.900      0.032
SLOT                        2.000      0.034
SLOT                        2.100      0.035
SLOT                        2.200      0.036
SLOT                        2.300      0.038
SLOT                        2.400      0.039
SLOT                        2.500      0.040
SLOT                        2.600      0.041
SLOT                        2.700      0.042
SLOT                        2.800      0.043
SLOT                        2.900      0.044
```

POST_DEV

```
SLOT                        3.000      0.045
SLOT                        3.100      0.047
SLOT                        3.200      0.048
SLOT                        3.300      0.048
SLOT                        3.400      0.049
SLOT                        3.500      0.050
SLOT                        3.600      0.051
SLOT                        3.700      0.052
SLOT                        3.800      0.053
SLOT                        3.900      0.054
SLOT                        4.000      0.055
SLOT                        4.100      0.056
SLOT                        4.200      0.057
SLOT                        4.300      0.057
SLOT                        4.400      0.058
SLOT                        4.500      0.059
SLOT                        4.600      0.060
SLOT                        4.700      0.061
SLOT                        4.800      0.061
SLOT                        4.900      0.062
SLOT                        5.000      0.063
SLOT                        5.100      0.450
SLOT                        5.200      1.165
SLOT                        5.300      2.092
SLOT                        5.400      3.191
SLOT                        5.500      4.437
SLOT                        5.600      5.816
SLOT                        5.700      7.315
SLOT                        5.800      8.925
SLOT                        5.900      10.639
SLOT                        6.000      12.451
SLOT                        6.100      14.357
SLOT                        6.200      16.351
SLOT                        6.300      18.430
SLOT                        6.400      20.591
SLOT                        6.500      22.831

OUT2             Rating     0.000      0.000
OUT2                        0.100      0.000
OUT2                        0.200      0.000
OUT2                        0.300      0.000
OUT2                        0.400      0.000
OUT2                        0.500      0.000
OUT2                        0.600      0.000
OUT2                        0.700      0.000
OUT2                        0.800      0.002
OUT2                        0.900      0.013
OUT2                        1.000      0.019
OUT2                        1.100      0.023
OUT2                        1.200      0.027
OUT2                        1.300      0.030
OUT2                        1.400      0.033
OUT2                        1.500      0.035
OUT2                        1.600      0.038
OUT2                        1.700      0.040
OUT2                        1.800      0.042
OUT2                        1.900      0.044
OUT2                        2.000      0.046
OUT2                        2.100      0.048
OUT2                        2.200      0.050
OUT2                        2.300      0.052
OUT2                        2.400      0.054
OUT2                        2.500      0.055
OUT2                        2.600      0.057
```

POST_DEV

```
OUT2                        2.700      0.058
OUT2                        2.800      0.060
OUT2                        2.900      0.061
OUT2                        3.000      0.063
OUT2                        3.100      0.064
OUT2                        3.200      0.066
OUT2                        3.300      0.067
OUT2                        3.400      0.068
OUT2                        3.500      0.070
OUT2                        3.600      0.071
OUT2                        3.700      0.072
OUT2                        3.800      0.073
OUT2                        3.900      0.075
OUT2                        4.000      0.076
OUT2                        4.100      0.077
OUT2                        4.200      0.078
OUT2                        4.300      0.079
OUT2                        4.400      0.080
OUT2                        4.500      0.082
OUT2                        4.600      0.083
OUT2                        4.700      0.084
OUT2                        4.800      0.085
OUT2                        4.900      0.086
OUT2                        5.000      0.087
OUT2                        5.100      0.474
OUT2                        5.200      1.190
OUT2                        5.300      2.117
OUT2                        5.400      3.216
OUT2                        5.500      4.463
OUT2                        5.600      5.841
OUT2                        5.700      7.340
OUT2                        5.800      8.951
OUT2                        5.900      10.665
OUT2                        6.000      12.478
OUT2                        6.100      14.384
OUT2                        6.200      16.378
OUT2                        6.300      18.458
OUT2                        6.400      20.619
OUT2                        6.500      22.859

BASIN            Storage    0          1500
BASIN                       0.083333333 1500
BASIN                       0.166666667 1500
BASIN                       0.25       1500
BASIN                       0.333333333 1500
BASIN                       0.416666667 1500
BASIN                       0.5        1500
BASIN                       0.583333333 1500
BASIN                       0.666666667 1500
BASIN                       0.75       1500
BASIN                       0.833333333 1500
BASIN                       0.916666667 1500
BASIN                       1          3335.101726
BASIN                       1.083333333 3317.223567
BASIN                       1.166666667 3305.97708
BASIN                       1.25       3294.830334
BASIN                       1.333333333 3282.740285
BASIN                       1.416666667 3270.827686
BASIN                       1.5        3257.941123
BASIN                       1.583333333 3244.708151
BASIN                       1.666666667 3230.592748
BASIN                       1.75       3215.656293
BASIN                       1.833333333 3200.105971
BASIN                       1.916666667 3183.788964
```

POST_DEV

```
BASIN                       2          3166.741656
BASIN                       2.083333333 3148.584998
BASIN                       2.166666667 3129.734837
BASIN                       2.25       3110.249301
BASIN                       2.333333333 3088.338502
BASIN                       2.416666667 3066.508525
BASIN                       2.5        3043.7768
BASIN                       2.583333333 3019.390235
BASIN                       2.666666667 2993.503265
BASIN                       2.75       2966.5126
BASIN                       2.833333333 2938.200541
BASIN                       2.916666667 2908.387061
BASIN                       3          2877.181172
BASIN                       3.083333333 2844.246459
BASIN                       3.166666667 2809.664416
BASIN                       3.25       2773.245397
BASIN                       3.333333333 2734.176176
BASIN                       3.416666667 2693.217474
BASIN                       3.5        2649.867208
BASIN                       3.583333333 2602.952529
BASIN                       3.666666667 2553.718296
BASIN                       3.75       2499.735769
BASIN                       3.833333333 2442.494174
BASIN                       3.916666667 2379.164389
BASIN                       4          2309.496977
BASIN                       4.083333333 2231.360778
BASIN                       4.166666667 2142.107663
BASIN                       4.25       2028.424431
BASIN                       4.333333333 1854.123694
BASIN                       4.416666667 1709.375824
BASIN                       4.5        1652.48489
BASIN                       4.583333333 1600.582557
BASIN                       4.666666667 1529.275193
BASIN                       4.75       1500
BASIN                       4.833333333 1500
BASIN                       4.916666667 1500
BASIN                       5          1500
BASIN                       5.083333333 1500
BASIN                       5.166666667 1500
BASIN                       5.25       1500
BASIN                       5.333333333 1500
BASIN                       5.416666667 1500
BASIN                       5.5        1500
BASIN                       5.583333333 1500
BASIN                       5.666666667 1500
BASIN                       5.75       1500
BASIN                       5.833333333 1500
BASIN                       5.916666667 1500
BASIN                       6          1500
BASIN                       6.083333333 1500
BASIN                       6.166666667 1500
BASIN                       6.25       1500
BASIN                       6.333333333 1500
BASIN                       6.416666667 1500
BASIN                       6.5        1500

Basin2           Storage    0          1980
Basin2                      0.083333333 1980
Basin2                      0.166666667 1980
Basin2                      0.25       1980
Basin2                      0.333333333 1980
Basin2                      0.416666667 1980
Basin2                      0.5        1980
Basin2                      0.583333333 1980
```

POST_DEV

```
Basin2                      0.666666667 1980
Basin2                      0.75       1980
Basin2                      0.833333333 1980
Basin2                      0.916666667 1980
Basin2                      1          1980
Basin2                      1.083333333 1980
Basin2                      1.166666667 4379.803262
Basin2                      1.25       4354.122088
Basin2                      1.333333333 4339.266324
Basin2                      1.416666667 4324.512399
Basin2                      1.5        4308.519506
Basin2                      1.583333333 4292.728959
Basin2                      1.666666667 4275.660318
Basin2                      1.75       4258.123213
Basin2                      1.833333333 4239.426226
Basin2                      1.916666667 4219.648219
Basin2                      2          4199.060493
Basin2                      2.083333333 4177.462757
Basin2                      2.166666667 4154.90299
Basin2                      2.25       4130.895183
Basin2                      2.333333333 4105.977476
Basin2                      2.416666667 4080.217886
Basin2                      2.5        4051.317005
Basin2                      2.583333333 4022.505803
Basin2                      2.666666667 3992.524702
Basin2                      2.75       3960.38813
Basin2                      2.833333333 3926.307686
Basin2                      2.916666667 3890.789579
Basin2                      3          3853.55304
Basin2                      3.083333333 3814.33967
Basin2                      3.166666667 3773.365658
Basin2                      3.25       3730.120154
Basin2                      3.333333333 3684.753714
Basin2                      3.416666667 3636.984113
Basin2                      3.5        3585.803658
Basin2                      3.583333333 3532.165699
Basin2                      3.666666667 3475.407108
Basin2                      3.75       3414.033637
Basin2                      3.833333333 3349.597367
Basin2                      3.916666667 3278.987227
Basin2                      4          3204.112522
Basin2                      4.083333333 3121.409052
Basin2                      4.166666667 3030.586028
Basin2                      4.25       2928.89999
Basin2                      4.333333333 2812.842467
Basin2                      4.416666667 2665.391671
Basin2                      4.5        2439.889225
Basin2                      4.583333333 2252.696677
Basin2                      4.666666667 2178.602898
Basin2                      4.75       2110.94442
Basin2                      4.833333333 2017.639534
Basin2                      4.916666667 1980
Basin2                      5          1980
Basin2                      5.083333333 1980
Basin2                      5.166666667 1980
Basin2                      5.25       1980
Basin2                      5.333333333 1980
Basin2                      5.416666667 1980
Basin2                      5.5        1980
Basin2                      5.583333333 1980
Basin2                      5.666666667 1980
Basin2                      5.75       1980
Basin2                      5.833333333 1980
Basin2                      5.916666667 1980
```

POST_DEV

```
Basin2                      6          1980
Basin2                      6.083333333 1980
Basin2                      6.166666667 1980
Basin2                      6.25       1980
Basin2                      6.333333333 1980
Basin2                      6.416666667 1980
Basin2                      6.5        1980

[TIMESERIES]
;;Name           Date       Time       Value
;;-------------- ---------- ---------- ----------
LINDBERGH        FILE "LbergRain.prn"

[REPORT]
INPUT      NO
CONTROLS   NO
SUBCATCHMENTS ALL
NODES ALL
LINKS ALL

[TAGS]

[MAP]
DIMENSIONS 0.000 0.000 10000.000 10000.000
Units      None

[COORDINATES]
;;Node           X-Coord            Y-Coord
;;-------------- ------------------ ------------------
POC-1            3400.000           1687.170
BASIN-1          3379.765           4002.933
BASIN-2          4845.000           4076.246

[VERTICES]
;;Link           X-Coord            Y-Coord
;;-------------- ------------------ ------------------

[Polygons]
;;Subcatchment   X-Coord            Y-Coord
;;-------------- ------------------ ------------------
DMA-A-B          3379.791           6620.209
DMA-A-B          3379.791           6620.209
DMA-F            8086.510           2741.935
DMA-C-D          4845.000           6612.903
DMA-E            7368.035           4912.023
DMA-BYPASS       784.457            3724.340

[SYMBOLS]
;;Gage           X-Coord            Y-Coord
;;-------------- ------------------ ------------------
LINDBERGH        1525.424           6864.407
```

ATTACHMENT 7

EPA SWMM FIGURES AND EXPLANATIONS

Per the attached, the reader can see the screens associated with the EPA-SWMM Model in both pre-development and post-development conditions. Each portion, i.e., sub-catchments, outfalls, storage units, weir as a discharge, and outfalls (point of compliance), are also shown.

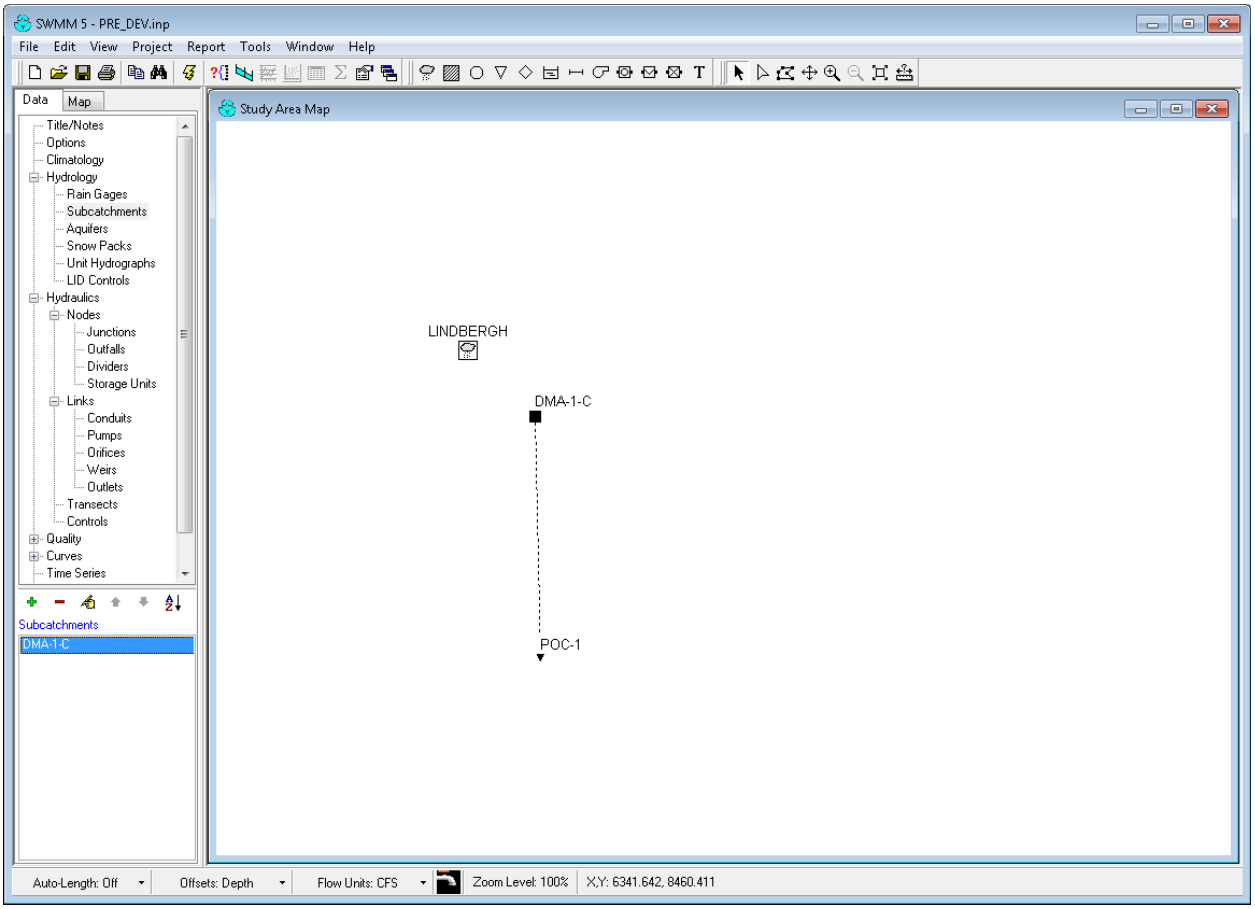
Variables for modeling are associated with typical recommended values by the EPA-SWMM model, typical values found in technical literature (such as Maidment's Handbook of Hydrology). Recommended values for the SWMM model have been attained from Appendix G of the 2016 City of National City BMP Design Manual.

Soil characteristics of the existing soils were determined from the NRCS Web Soil Survey (located in Attachment 8 of this report).

A Technical document prepared by Tory R Walker Engineering for the Cities of San Marcos, Oceanside and Vista (Reference [1]) can also be consulted for additional information regarding typical values for SWMM parameters.

Manning's roughness coefficients have been based upon the findings of the "*Improving Accuracy in Continuous Hydrologic Modeling: Guidance for Selecting Pervious Overland Flow Manning's n Values in the San Diego Region*" date 2016 by TRW Engineering (Reference [6]).

PRE-DEVELOPED CONDITIONS



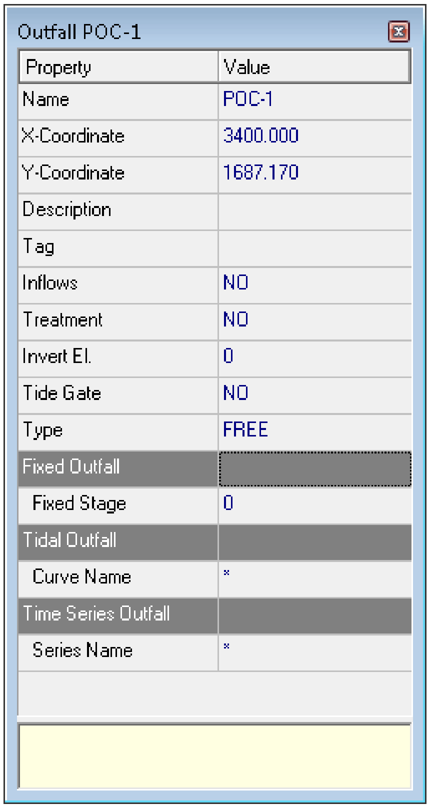
Auto-Length: Off

Offsets: Depth

Flow Units: CFS

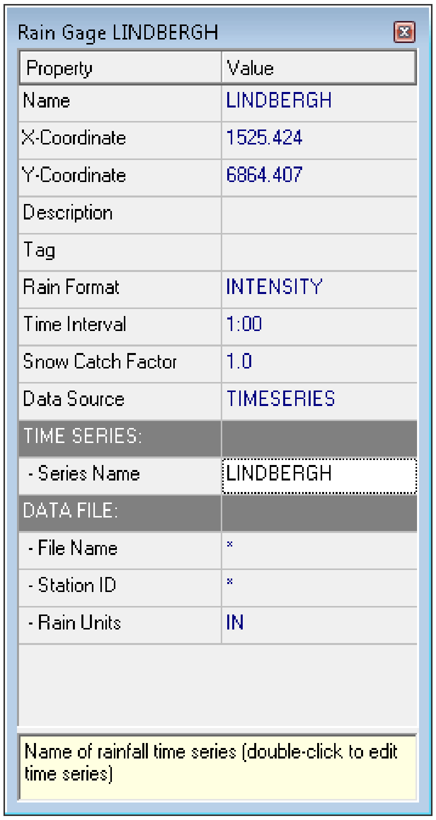
Zoom Level: 100%

X,Y: 6341.642, 8460.411



Outfall POC-1

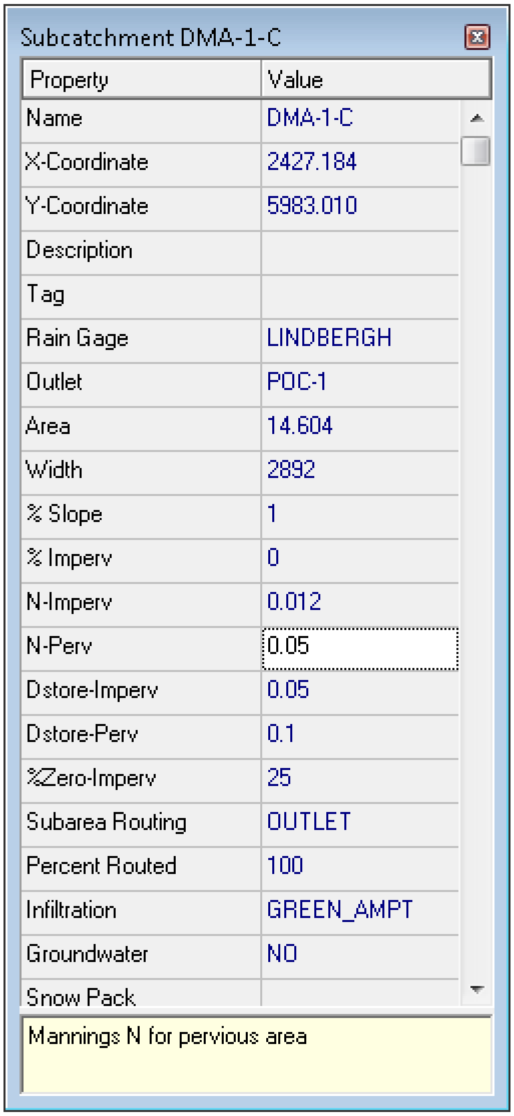
Property	Value
Name	POC-1
X-Coordinate	3400.000
Y-Coordinate	1687.170
Description	
Tag	
Inflows	NO
Treatment	NO
Invert El.	0
Tide Gate	NO
Type	FREE
Fixed Outfall	
Fixed Stage	0
Tidal Outfall	
Curve Name	*
Time Series Outfall	
Series Name	*



Rain Gage LINDBERGH

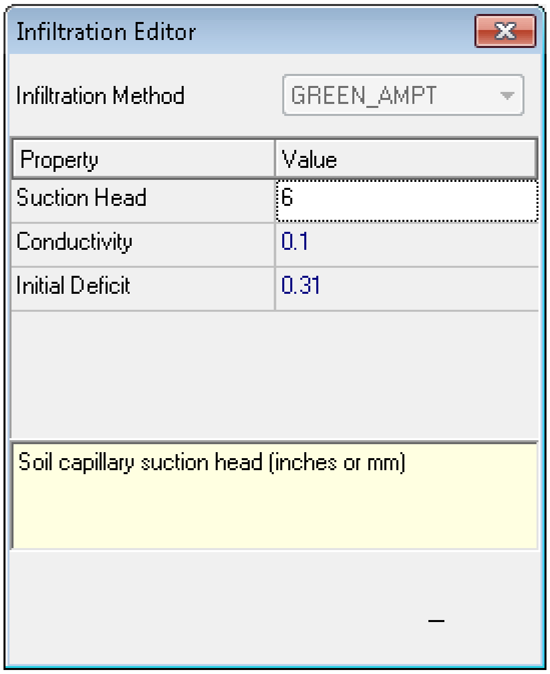
Property	Value
Name	LINDBERGH
X-Coordinate	1525.424
Y-Coordinate	6864.407
Description	
Tag	
Rain Format	INTENSITY
Time Interval	1:00
Snow Catch Factor	1.0
Data Source	TIMESERIES
TIME SERIES:	
- Series Name	LINDBERGH
DATA FILE:	
- File Name	*
- Station ID	*
- Rain Units	IN

Name of rainfall time series (double-click to edit time series)


Subcatchment DMA-1-C

Property	Value
Name	DMA-1-C
X-Coordinate	2427.184
Y-Coordinate	5983.010
Description	
Tag	
Rain Gage	LINDBERGH
Outlet	POC-1
Area	14.604
Width	2892
% Slope	1
% Imperv	0
N-Imperv	0.012
N-Perv	0.05
Dstore-Imperv	0.05
Dstore-Perv	0.1
%Zero-Imperv	25
Subarea Routing	OUTLET
Percent Routed	100
Infiltration	GREEN_AMPT
Groundwater	NO
Snow Pack	

Mannings N for pervious area

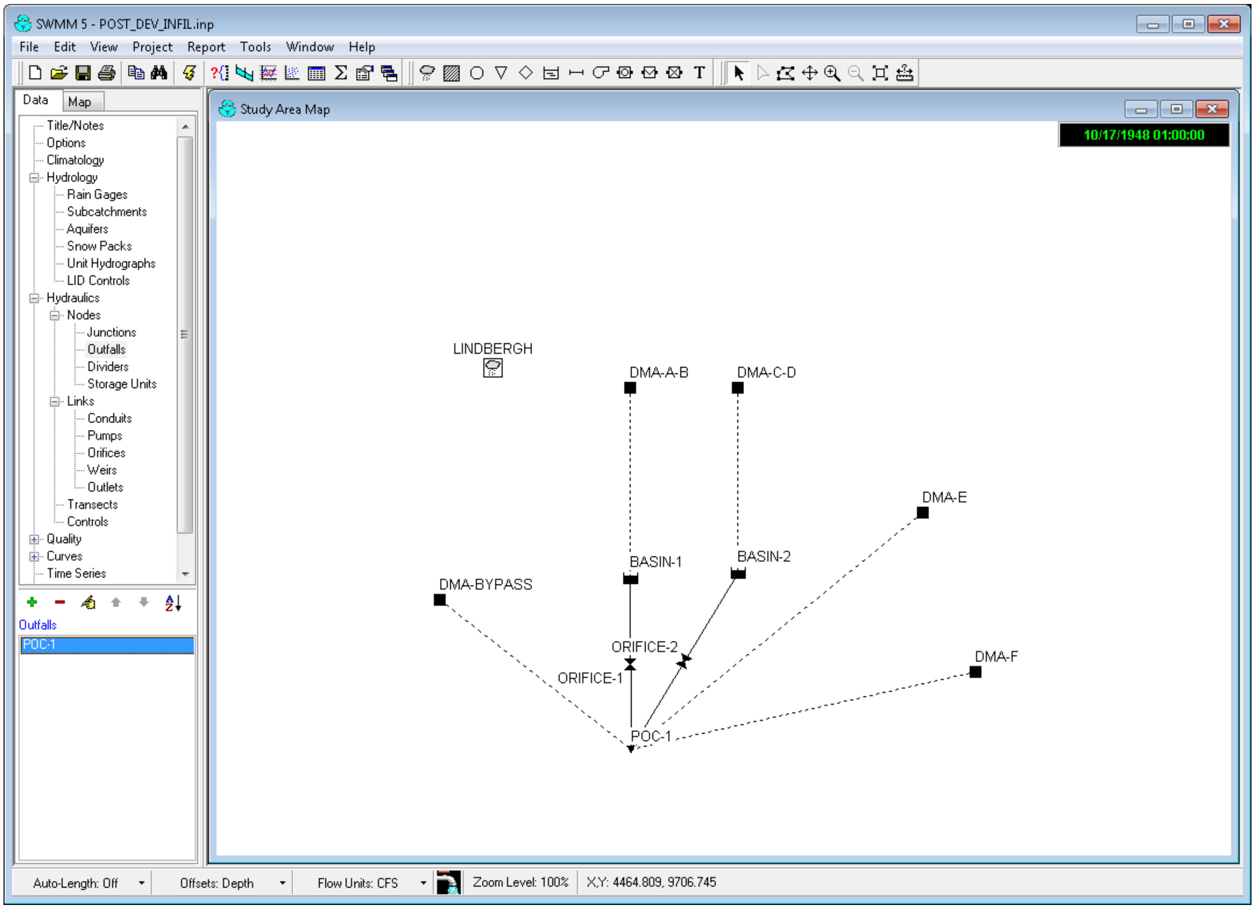

Infiltration Editor

Infiltration Method: GREEN_AMPT

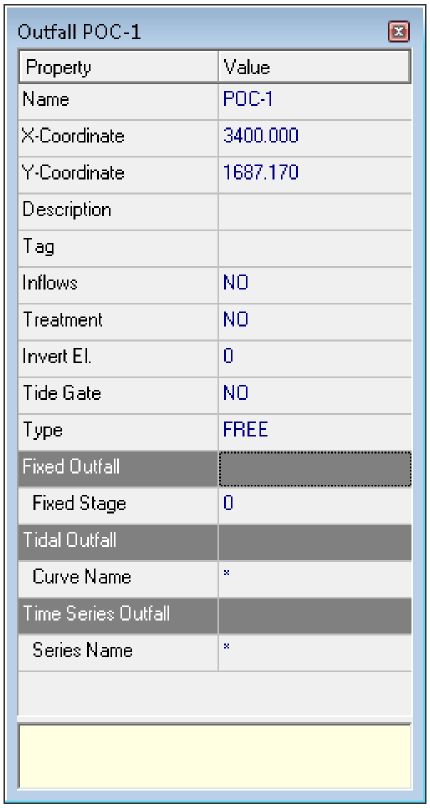
Property	Value
Suction Head	6
Conductivity	0.1
Initial Deficit	0.31

Soil capillary suction head (inches or mm)

POST-DEVELOPED CONDITIONS

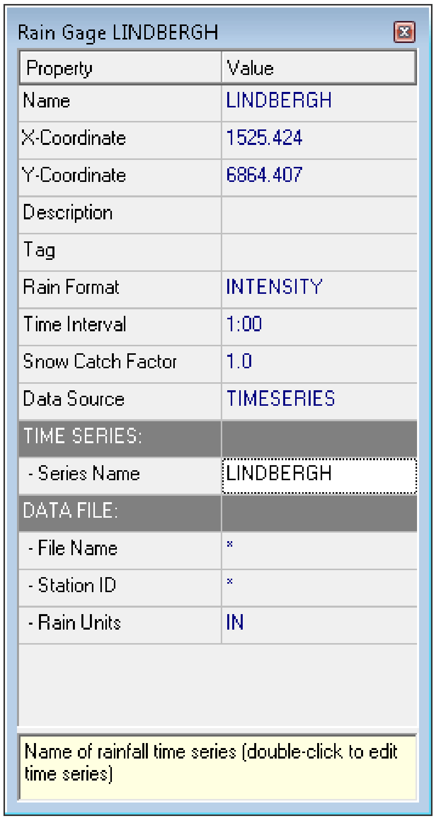


Auto-Length: Off | Offsets: Depth | Flow Units: CFS | Zoom Level: 100% | X,Y: 4464.809, 9706.745



Outfall POC-1

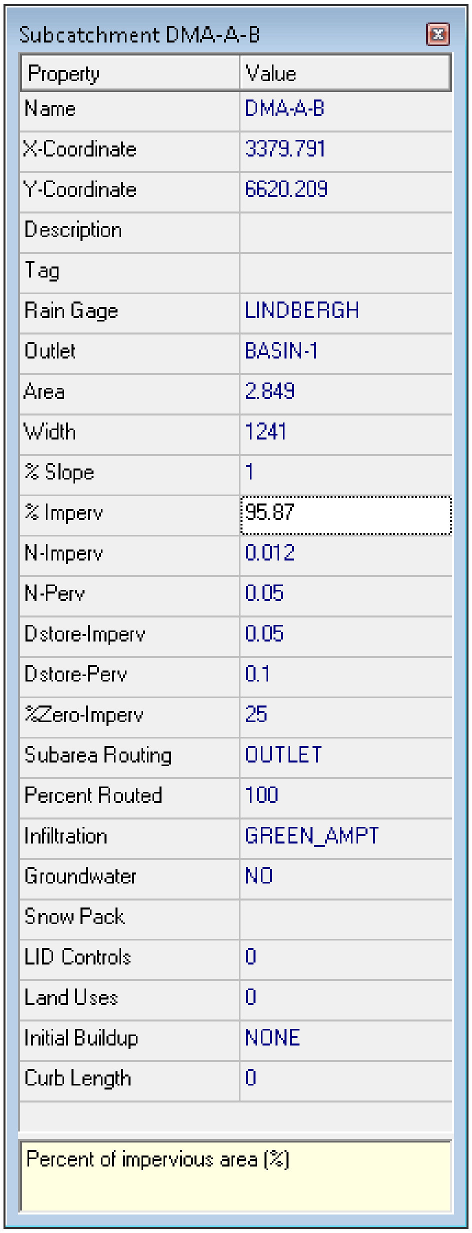
Property	Value
Name	POC-1
X-Coordinate	3400.000
Y-Coordinate	1687.170
Description	
Tag	
Inflows	NO
Treatment	NO
Invert El.	0
Tide Gate	NO
Type	FREE
Fixed Outfall	
Fixed Stage	0
Tidal Outfall	
Curve Name	*
Time Series Outfall	
Series Name	*



Rain Gage LINDBERGH

Property	Value
Name	LINDBERGH
X-Coordinate	1525.424
Y-Coordinate	6864.407
Description	
Tag	
Rain Format	INTENSITY
Time Interval	1:00
Snow Catch Factor	1.0
Data Source	TIMESERIES
TIME SERIES:	
- Series Name	LINDBERGH
DATA FILE:	
- File Name	*
- Station ID	*
- Rain Units	IN

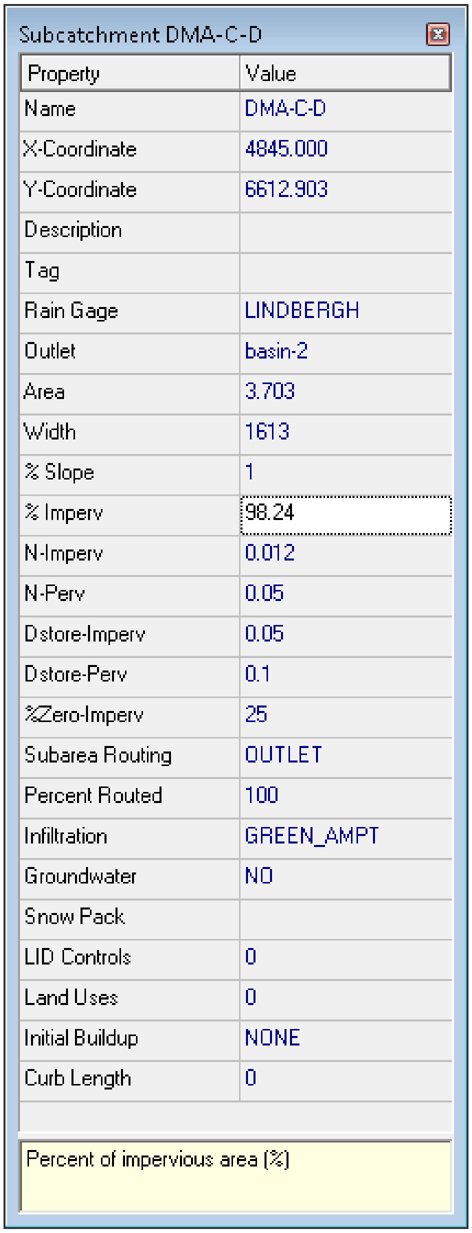
Name of rainfall time series (double-click to edit time series)



Subcatchment DMA-A-B

Property	Value
Name	DMA-A-B
X-Coordinate	3379.791
Y-Coordinate	6620.209
Description	
Tag	
Rain Gage	LINDBERGH
Outlet	BASIN-1
Area	2.849
Width	1241
% Slope	1
% Imperv	95.87
N-Imperv	0.012
N-Perv	0.05
Dstore-Imperv	0.05
Dstore-Perv	0.1
%Zero-Imperv	25
Subarea Routing	OUTLET
Percent Routed	100
Infiltration	GREEN_AMPT
Groundwater	NO
Snow Pack	
LID Controls	0
Land Uses	0
Initial Buildup	NONE
Curb Length	0

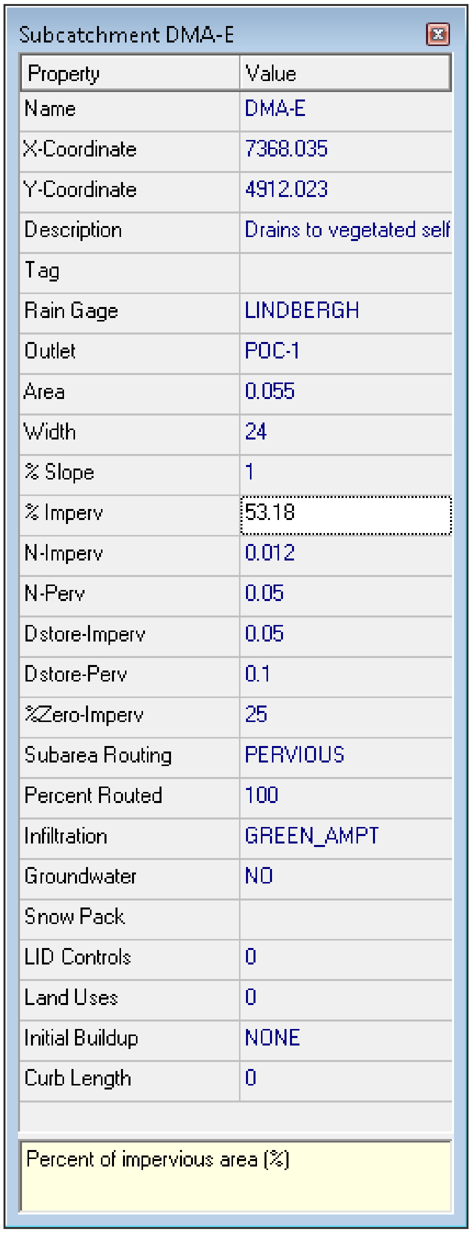
Percent of impervious area (%)



Subcatchment DMA-C-D

Property	Value
Name	DMA-C-D
X-Coordinate	4845.000
Y-Coordinate	6612.903
Description	
Tag	
Rain Gage	LINDBERGH
Outlet	basin-2
Area	3.703
Width	1613
% Slope	1
% Imperv	98.24
N-Imperv	0.012
N-Perv	0.05
Dstore-Imperv	0.05
Dstore-Perv	0.1
%Zero-Imperv	25
Subarea Routing	OUTLET
Percent Routed	100
Infiltration	GREEN_AMPT
Groundwater	NO
Snow Pack	
LID Controls	0
Land Uses	0
Initial Buildup	NONE
Curb Length	0

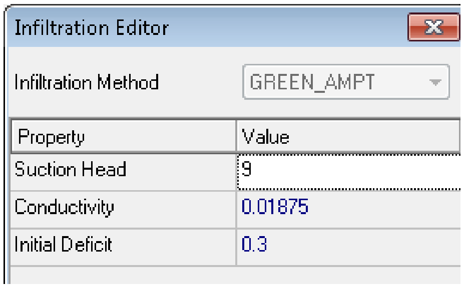
Percent of impervious area (%)



Subcatchment DMA-E

Property	Value
Name	DMA-E
X-Coordinate	7368.035
Y-Coordinate	4912.023
Description	Drains to vegetated self
Tag	
Rain Gage	LINDBERGH
Outlet	POC-1
Area	0.055
Width	24
% Slope	1
% Imperv	53.18
N-Imperv	0.012
N-Perv	0.05
Dstore-Imperv	0.05
Dstore-Perv	0.1
%Zero-Imperv	25
Subarea Routing	PERVIOUS
Percent Routed	100
Infiltration	GREEN_AMPT
Groundwater	NO
Snow Pack	
LID Controls	0
Land Uses	0
Initial Buildup	NONE
Curb Length	0

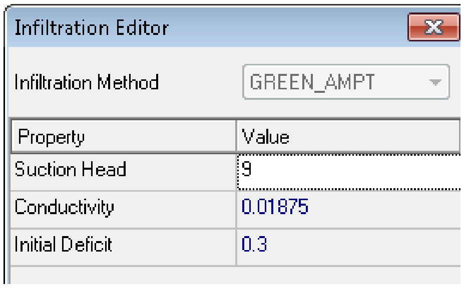
Percent of impervious area (%)



Infiltration Editor

Infiltration Method: GREEN_AMPT

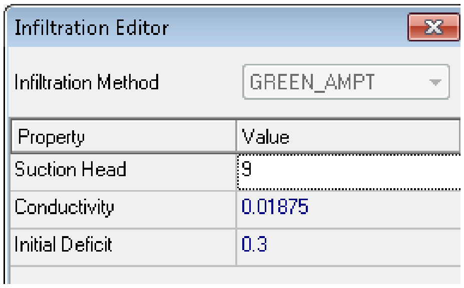
Property	Value
Suction Head	9
Conductivity	0.01875
Initial Deficit	0.3



Infiltration Editor

Infiltration Method: GREEN_AMPT

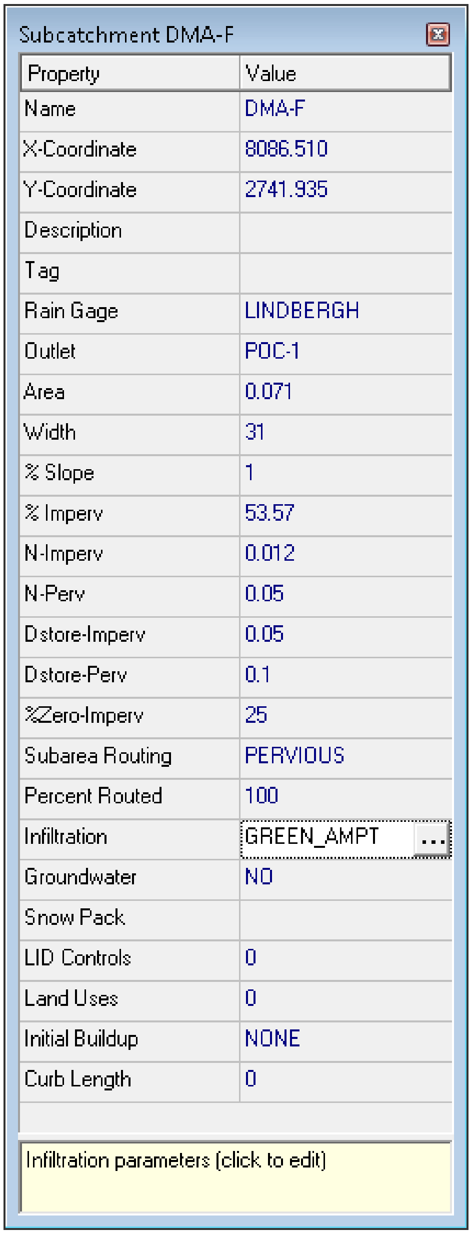
Property	Value
Suction Head	9
Conductivity	0.01875
Initial Deficit	0.3



Infiltration Editor

Infiltration Method: GREEN_AMPT

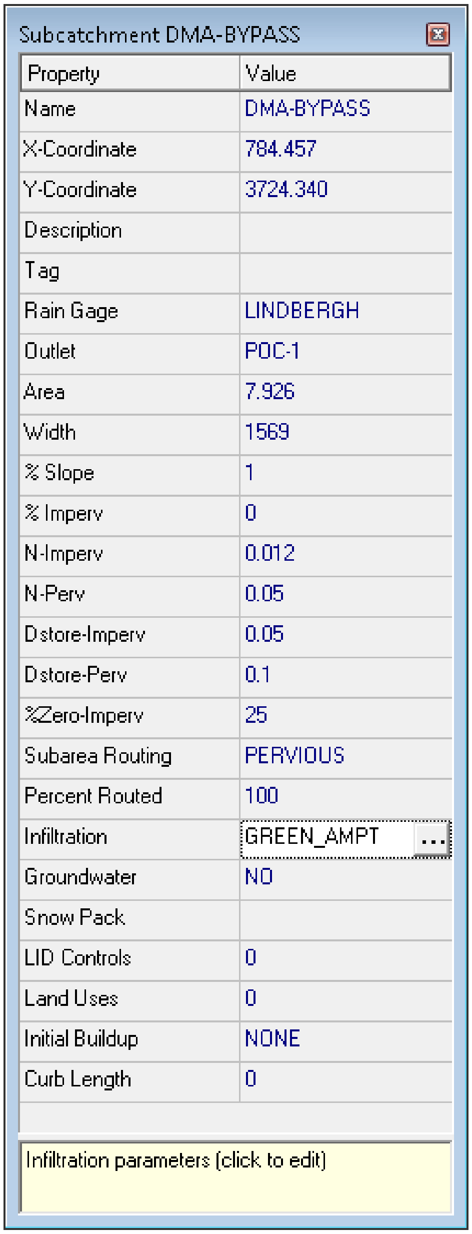
Property	Value
Suction Head	9
Conductivity	0.01875
Initial Deficit	0.3



Subcatchment DMA-F

Property	Value
Name	DMA-F
X-Coordinate	8086.510
Y-Coordinate	2741.935
Description	
Tag	
Rain Gage	LINDBERGH
Outlet	POC-1
Area	0.071
Width	31
% Slope	1
% Imperv	53.57
N-Imperv	0.012
N-Perv	0.05
Dstore-Imperv	0.05
Dstore-Perv	0.1
%Zero-Imperv	25
Subarea Routing	PERVIOUS
Percent Routed	100
Infiltration	GREEN_AMPT
Groundwater	NO
Snow Pack	
LID Controls	0
Land Uses	0
Initial Buildup	NONE
Curb Length	0

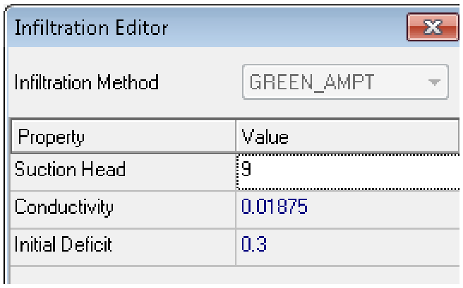
Infiltration parameters (click to edit)



Subcatchment DMA-BYPASS

Property	Value
Name	DMA-BYPASS
X-Coordinate	784.457
Y-Coordinate	3724.340
Description	
Tag	
Rain Gage	LINDBERGH
Outlet	POC-1
Area	7.926
Width	1569
% Slope	1
% Imperv	0
N-Imperv	0.012
N-Perv	0.05
Dstore-Imperv	0.05
Dstore-Perv	0.1
%Zero-Imperv	25
Subarea Routing	PERVIOUS
Percent Routed	100
Infiltration	GREEN_AMPT
Groundwater	NO
Snow Pack	
LID Controls	0
Land Uses	0
Initial Buildup	NONE
Curb Length	0

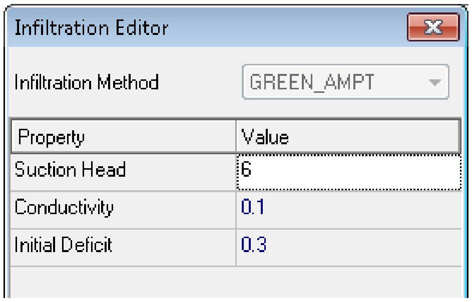
Infiltration parameters (click to edit)



Infiltration Editor

Infiltration Method: GREEN_AMPT

Property	Value
Suction Head	9
Conductivity	0.01875
Initial Deficit	0.3

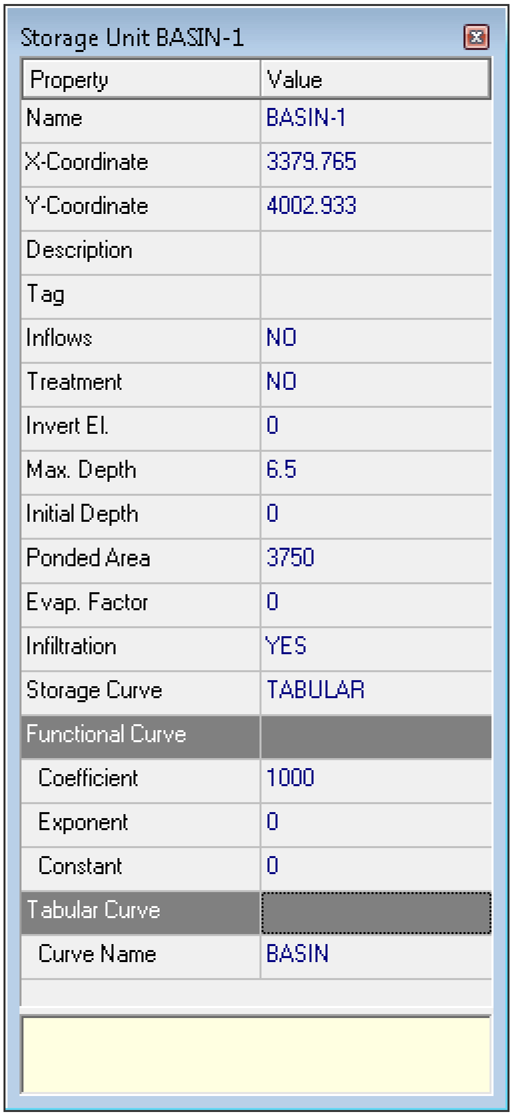


Infiltration Editor

Infiltration Method: GREEN_AMPT

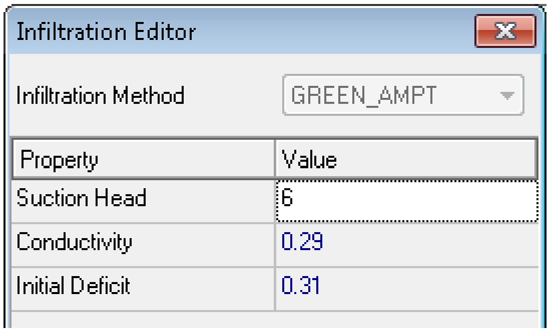
Property	Value
Suction Head	6
Conductivity	0.1
Initial Deficit	0.3

Underground HMP Basin 1



Storage Unit BASIN-1

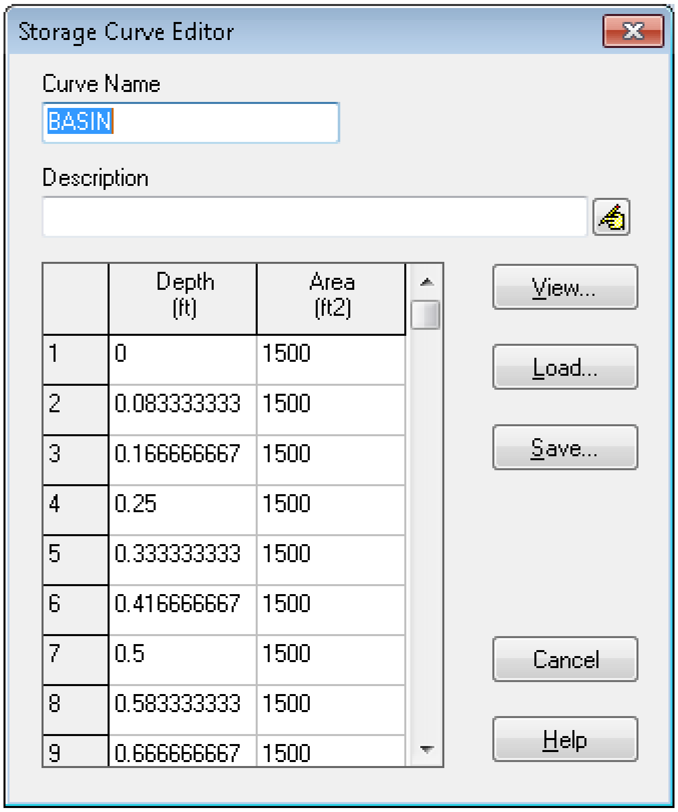
Property	Value
Name	BASIN-1
X-Coordinate	3379.765
Y-Coordinate	4002.933
Description	
Tag	
Inflows	NO
Treatment	NO
Invert El.	0
Max. Depth	6.5
Initial Depth	0
Ponded Area	3750
Evap. Factor	0
Infiltration	YES
Storage Curve	TABULAR
Functional Curve	
Coefficient	1000
Exponent	0
Constant	0
Tabular Curve	
Curve Name	BASIN



Infiltration Editor

Infiltration Method: GREEN_AMPT

Property	Value
Suction Head	6
Conductivity	0.29
Initial Deficit	0.31

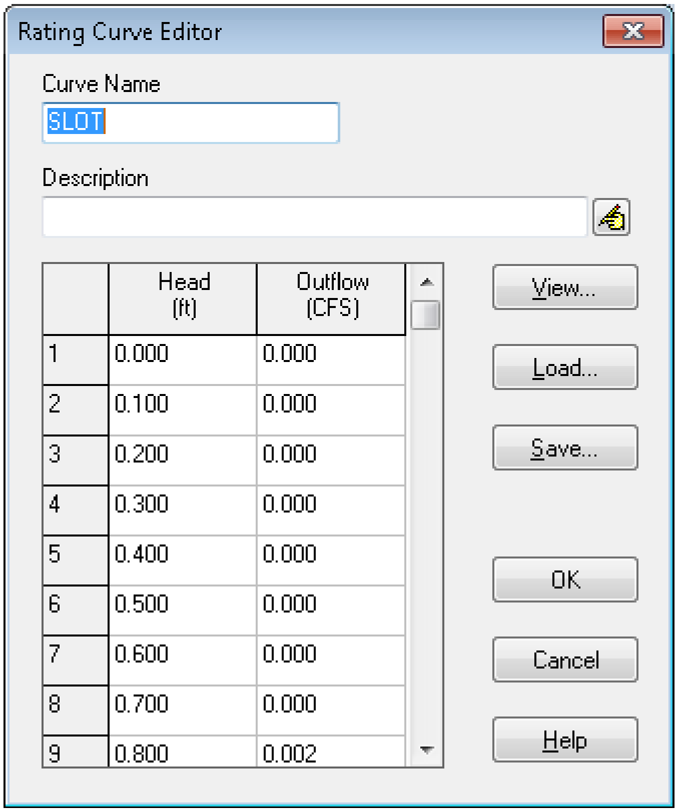


Storage Curve Editor

Curve Name: BASIN

Description:

	Depth (ft)	Area (ft2)
1	0	1500
2	0.083333333	1500
3	0.166666667	1500
4	0.25	1500
5	0.333333333	1500
6	0.416666667	1500
7	0.5	1500
8	0.583333333	1500
9	0.666666667	1500



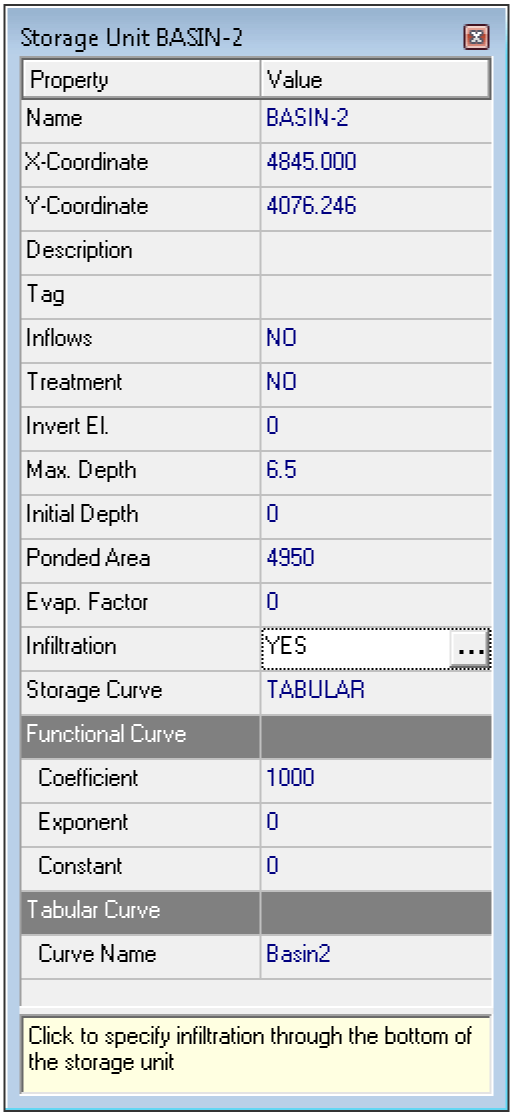
Rating Curve Editor

Curve Name: SLOT

Description:

	Head (ft)	Outflow (CFS)
1	0.000	0.000
2	0.100	0.000
3	0.200	0.000
4	0.300	0.000
5	0.400	0.000
6	0.500	0.000
7	0.600	0.000
8	0.700	0.000
9	0.800	0.002

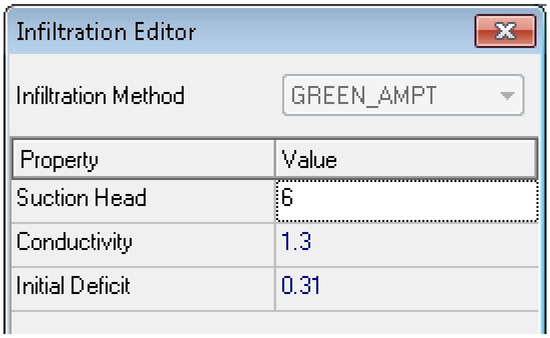
Underground HMP Basin 2



Storage Unit BASIN-2

Property	Value
Name	BASIN-2
X-Coordinate	4845.000
Y-Coordinate	4076.246
Description	
Tag	
Inflows	NO
Treatment	NO
Invert El.	0
Max. Depth	6.5
Initial Depth	0
Ponded Area	4950
Evap. Factor	0
Infiltration	YES
Storage Curve	TABULAR
Functional Curve	
Coefficient	1000
Exponent	0
Constant	0
Tabular Curve	
Curve Name	Basin2

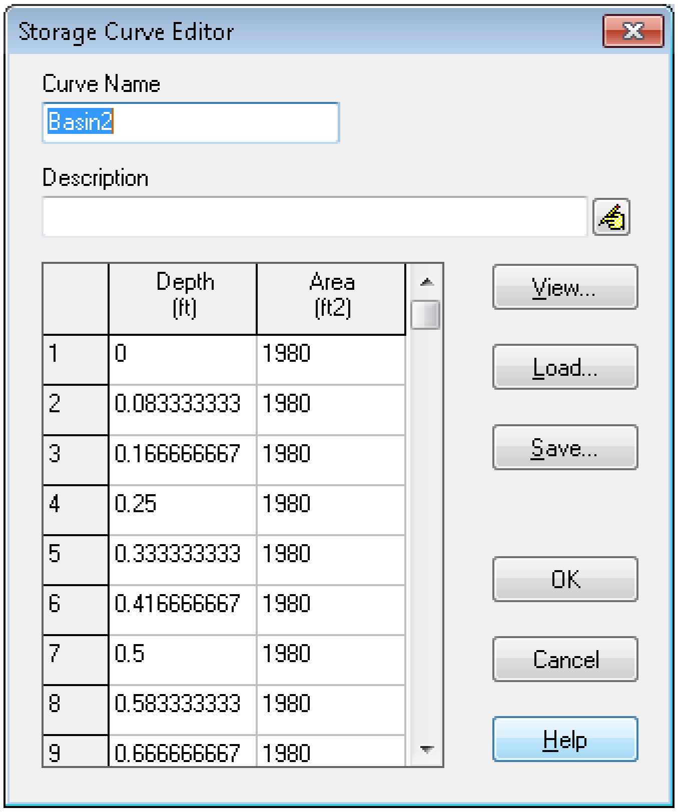
Click to specify infiltration through the bottom of the storage unit



Infiltration Editor

Infiltration Method: GREEN_AMPT

Property	Value
Suction Head	6
Conductivity	1.3
Initial Deficit	0.31

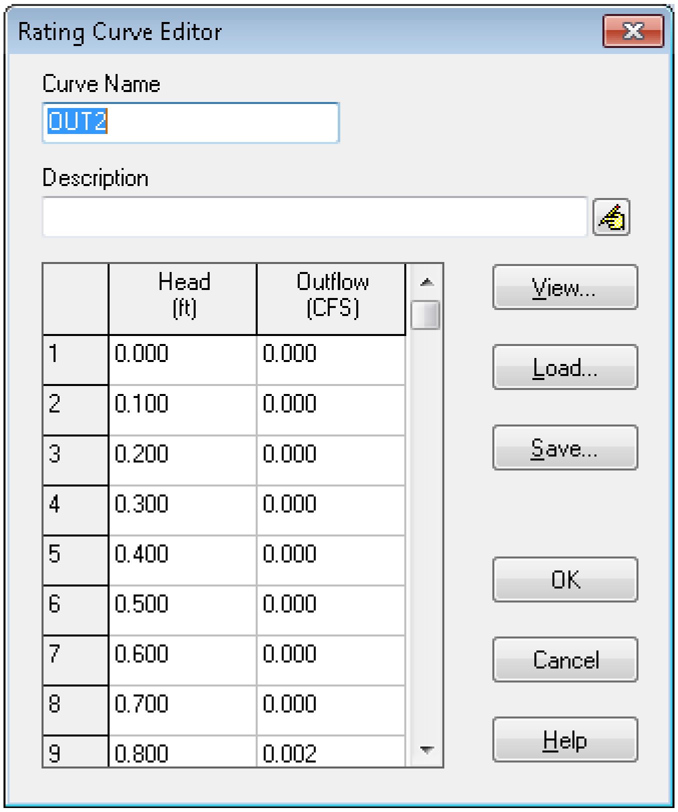


Storage Curve Editor

Curve Name: Basin2

Description:

	Depth (ft)	Area (ft2)
1	0	1980
2	0.083333333	1980
3	0.166666667	1980
4	0.25	1980
5	0.333333333	1980
6	0.416666667	1980
7	0.5	1980
8	0.583333333	1980
9	0.666666667	1980



Rating Curve Editor

Curve Name: OUT2

Description:

	Head (ft)	Outflow (CFS)
1	0.000	0.000
2	0.100	0.000
3	0.200	0.000
4	0.300	0.000
5	0.400	0.000
6	0.500	0.000
7	0.600	0.000
8	0.700	0.000
9	0.800	0.002

EXPLANATION OF SELECTED VARIABLES

Sub Catchment Areas:

Please refer to the attached diagrams that indicate the DMA and Bio-Retention BMPs (BMP) sub areas modeled within the project site at both the pre and post developed conditions draining to the POC.

Parameters for the pre- and post-developed models include soil type C as determined from the NRCS websoil survey review (attached at the end of this appendix). Suction head, conductivity and initial deficit corresponds to average values expected for these soils types, according to sources consulted, professional experience, and approximate values obtained by the interim Orange County modeling approach. REC selected infiltration values, such that the percentage of total precipitation that becomes runoff, is realistic for the soil types and slightly smaller than measured values for Southern California watersheds.

Selection of a Kinematic Approach: As the continuous model is based on hourly rainfall, and the time of concentration for the pre-development and post-development conditions is significantly smaller than 60 minutes, precise routing of the flows through the impervious surfaces, the underdrain pipe system, and the discharge pipe was considered unnecessary. The truncation error of the precipitation into hourly steps is much more significant than the precise routing in a system where the time of concentration is much smaller than 1 hour.

Overland Flow Manning’s Coefficient per TRWE (Reference [6])

appeal of a de facto value, we anticipate that jurisdictions will not be inclined to approve land surfaces other than short prairie grass. Therefore, in order to provide SWMM users with a wider range of land surfaces suitable for local application and to provide Copermittees with confidence in the design parameters, we recommend using the values published by Yen and Chow in Table 3-5 of the EPA SWMM Reference Manual Volume I – Hydrology.

SWMM-Endorsed Values Will Improve Model Quality

In January 2016, the EPA released the SWMM Reference Manual Volume I – Hydrology (SWMM Hydrology Reference Manual). The SWMM Hydrology Reference Manual complements the SWMM 5 User's Manual and SWMM 5 Applications Manual by providing an in-depth description of the program's hydrologic components (EPA 2016). Table 3-5 of the SWMM Hydrology Reference Manual expounds upon SWMM 5 User's Manual Table A.6 by providing Manning's *n* values for additional overland flow surfaces[3]. The values are provided in Table 1:

Table 1: Manning's *n* Values for Overland Flow (EPA, 2016; Yen 2001; Yen and Chow, 1983).

Overland Surface	Light Rain (< 0.8 in/hr)	Moderate Rain (0.8-1.2 in/hr)	Heavy Rain (> 1.2 in/hr)
Smooth asphalt pavement	0.010	0.012	0.015
Smooth impervious surface	0.011	0.013	0.015
Tar and sand pavement	0.012	0.014	0.016
Concrete pavement	0.014	0.017	0.020
Rough impervious surface	0.015	0.019	0.023
Smooth bare packed soil	0.017	0.021	0.025
Moderate bare packed soil	0.025	0.030	0.035
Rough bare packed soil	0.032	0.038	0.045
Gravel soil	0.025	0.032	0.045
Mowed poor grass	0.030	0.038	0.045
Average grass, closely clipped sod	0.040	0.050	0.060
Pasture	0.040	0.055	0.070
Timberland	0.060	0.090	0.120
Dense grass	0.060	0.090	0.120
Shrubs and bushes	0.080	0.120	0.180
Land Use			
Business	0.014	0.022	0.035
Semibusiness	0.022	0.035	0.050
Industrial	0.020	0.035	0.050
Dense residential	0.025	0.040	0.060
Suburban residential	0.030	0.055	0.080
Parks and lawns	0.040	0.075	0.120

For purposes of local hydromodification management BMP design, these Manning's *n* values are an improvement upon the values presented by Engman (1986) in SWMM 5 User's Manual Table A.6. Values from SWMM 5 User's Manual Table A.6, while completely suitable for the intended application to certain agricultural land covers, comes with the disclaimer that the provided Manning's *n* values are valid for shallow-depth overland flow that match the conditions in the experimental plots (Engman,

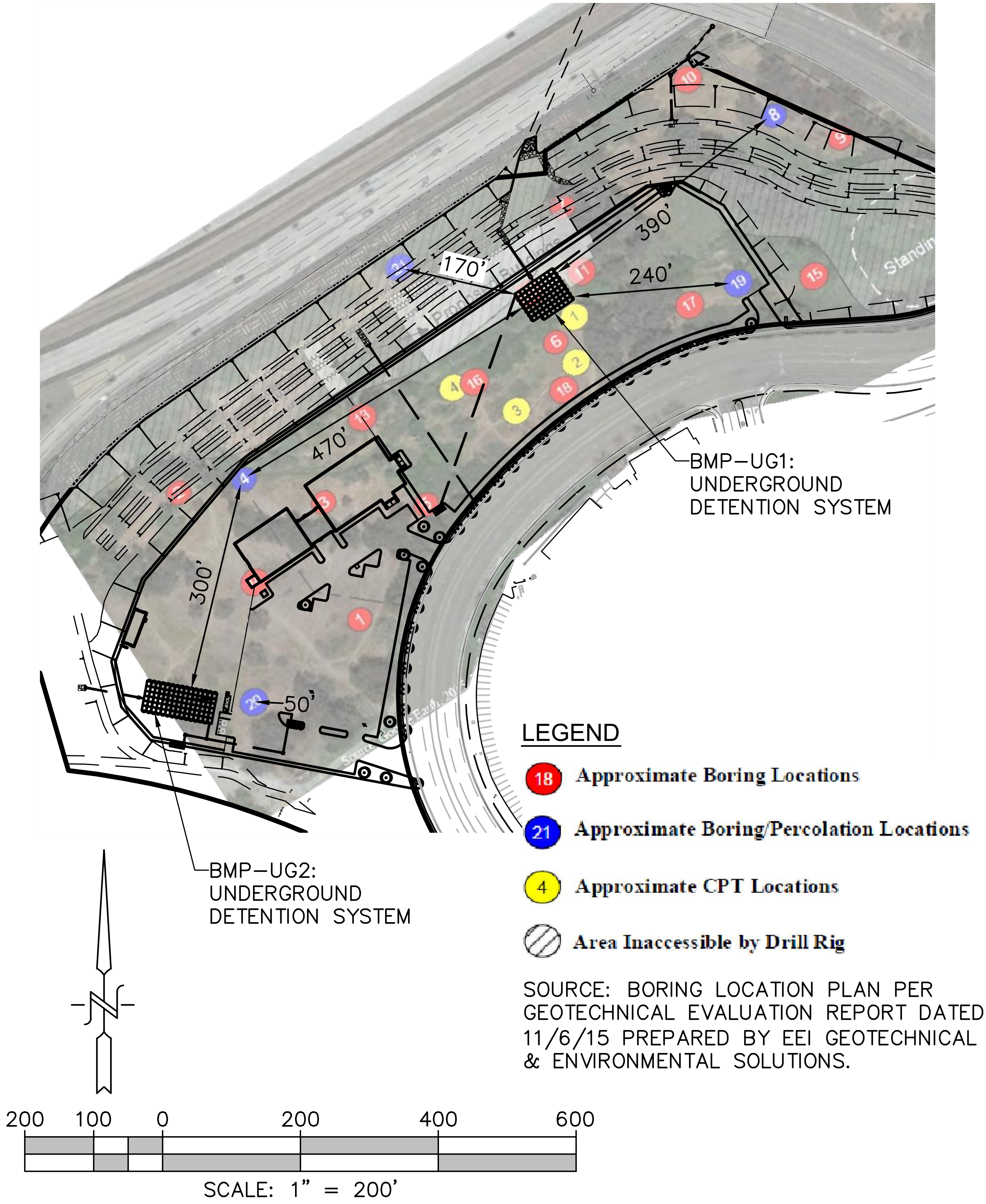
---

[3] Further discussion is provided on page 6 under "Discussion of Differences Between Manning's *n* Values"

ATTACHMENT 8

Geotechnical Documentation: Soil Type

INFILTRATION RATE CALCULATION EXHIBIT



SOURCE: BORING LOCATION PLAN PER GEOTECHNICAL EVALUATION REPORT DATED 11/6/15 PREPARED BY EEI GEOTECHNICAL & ENVIRONMENTAL SOLUTIONS.

Infiltration Rate Estimates

BMP - UG1:

Infiltration: 5.49 in/hr
Distance: 170 ft
Exponent: 0.399

Infiltration: 0.45 in/hr
Distance: 240 ft
Exponent: 0.283

Infiltration: 0.06 in/hr
Distance: 390 ft
Exponent: 0.174

Infiltration: 0.03 in/hr
Distance: 470 ft
Exponent: 0.144

SF: 2

$F_{average}$: 0.58 in/hr
F_{design} : **0.29** in/hr

BMP - UG2:

Infiltration: 5.49 in/hr
Distance: 50 ft
Exponent: 0.857

Note: Value measured is unreliable (233.5 in/hr)
Largest value for soil Type (SM) used instead (over 40 times smaller).

Infiltration: 0.03 in/hr
Distance: 300 ft
Exponent: 0.143

SF: 2

$F_{average}$: 2.61 in/hr
F_{design} : **1.30** in/hr

Formulas:

$$F_{design} = F_{average} / SF$$

$$F_{design} = \prod_{i=1}^{n} F_i^{mi}$$

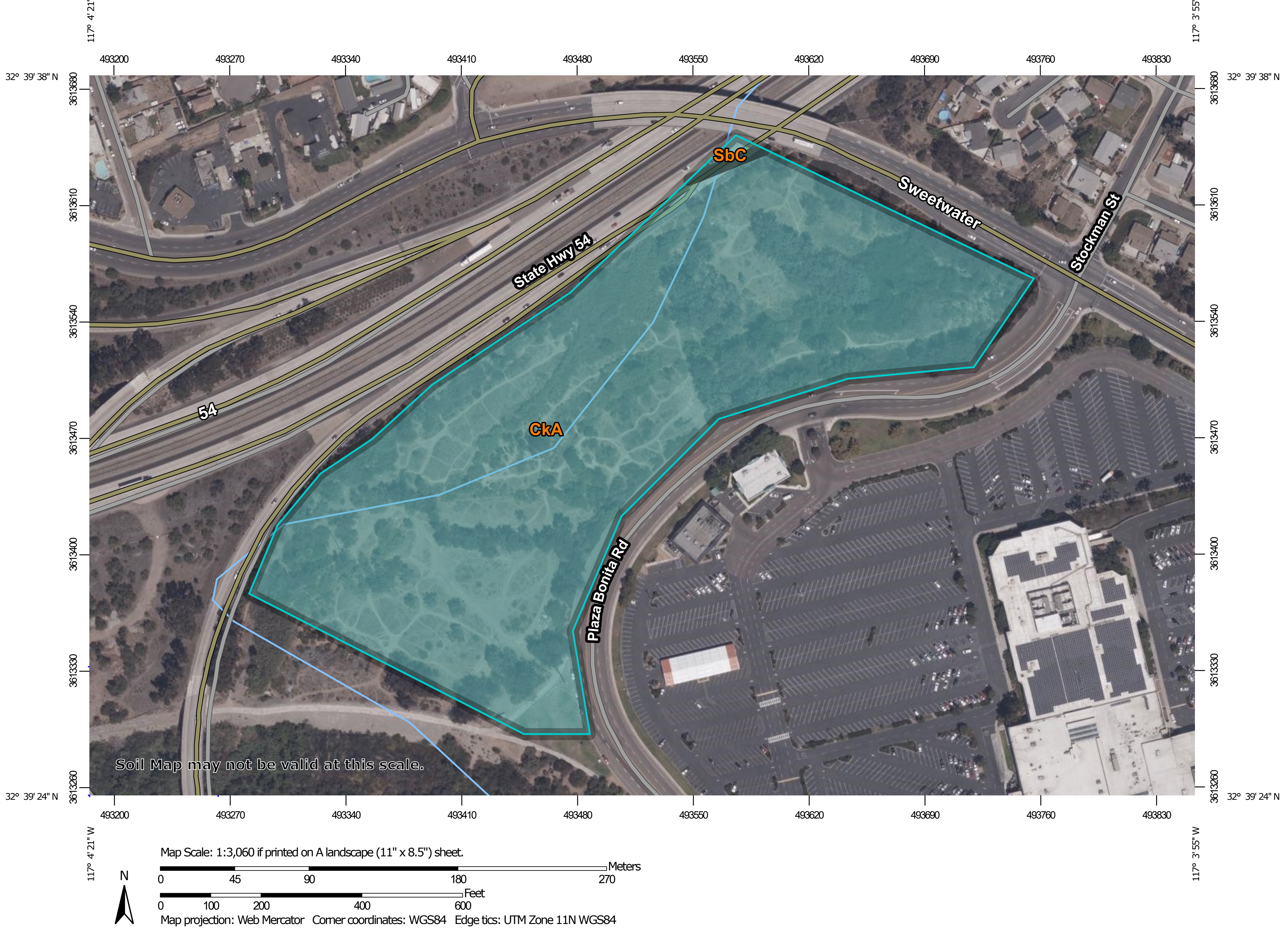
F_i : measured infiltration at one of the "i" points used to obtain the average infiltration

m_i : exponent for the geometric mean calculation, such that $\Sigma m_i = 1$

$$m_i = [1/d_i]/\sum_{i=1}^{n}[1/d_i]$$

d_i: distance from each measured infiltration to the corresponding BMP.

Hydrologic Soil Group—San Diego County Area, California



Map Scale: 1:3,060 if printed on A landscape (11" x 8.5") sheet.

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

MAP LEGEND

Area of Interest (AOI)

- ▭ Area of Interest (AOI)

Soils

Soil Rating Polygons

- ■ A
- ■ A/D
- ■ B
- ■ B/D
- ■ C
- ■ C/D
- ■ D
- □ Not rated or not available

Soil Rating Lines

- 〰 A
- 〰 A/D
- 〰 B
- 〰 B/D
- 〰 C
- 〰 C/D
- 〰 D
- 〰 Not rated or not available

Soil Rating Points

- ■ A
- ■ A/D
- ■ B
- ■ B/D
- ■ C
- ■ C/D
- ■ D
- ▣ Not rated or not available

Water Features

- 〰 Streams and Canals

Transportation

- ┼┼┼ Rails
- 〰 Interstate Highways
- 〰 US Routes
- 〰 Major Roads
- 〰 Local Roads

Background

- ■ Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: San Diego County Area, California
Survey Area Data: Version 15, May 27, 2020

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

Date(s) aerial images were photographed: Aug 22, 2018—Aug 31, 2018

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
CkA	Chino silt loam, saline, 0 to 2 percent slopes	C	16.2	99.5%
SbC	Salinas clay loam, 2 to 9 percent slopes	C	0.1	0.5%
Totals for Area of Interest			**16.3**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

ATTACHMENT 9

Summary Files from the SWMM Model

PRE_DEV

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.0 (Build 5.0.022)
--------------------------------------------------------------


*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ YES
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... NO
  Water Quality .......... NO
Infiltration Method ...... GREEN_AMPT
Starting Date ............ OCT-17-1948 00:00:00
Ending Date .............. OCT-17-2005 23:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 01:00:00
Wet Time Step ............ 00:15:00
Dry Time Step ............ 04:00:00


**************************        Volume         Depth
Runoff Quantity Continuity     acre-feet        inches
**************************     ---------       -------
Total Precipitation ......       685.624       563.373
Evaporation Loss .........         5.305         4.359
Infiltration Loss ........       646.755       531.434
Surface Runoff ...........        36.555        30.037
Final Surface Storage ....         0.000         0.000
Continuity Error (%) .....        -0.436


**************************        Volume        Volume
Flow Routing Continuity        acre-feet      10^6 gal
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......        36.555        11.912
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.000
External Outflow .........        36.555        11.912
Internal Outflow .........         0.000         0.000
Storage Losses ...........         0.000         0.000
Initial Stored Volume ....         0.000         0.000
Final Stored Volume ......         0.000         0.000
Continuity Error (%) .....         0.000


***************************
Subcatchment Runoff Summary
***************************

---------------------------------------------------------------------------------------------------------
                            Total      Total      Total      Total      Total        Total     Peak  Runoff
                           Precip      Runon       Evap      Infil     Runoff       Runoff   Runoff   Coeff
Subcatchment                   in         in         in         in         in     10^6 gal      CFS
---------------------------------------------------------------------------------------------------------
DMA-1-C                    563.37       0.00       4.36     531.43      30.04        11.91    18.45   0.053

Analysis begun on:  Wed Aug 05 14:53:05 2020
Analysis ended on:  Wed Aug 05 14:53:22 2020
Total elapsed time: 00:00:17
```

POST_DEV

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.0 (Build 5.0.022)
--------------------------------------------------------------


*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ YES
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Infiltration Method ...... GREEN_AMPT
Flow Routing Method ...... KINWAVE
Starting Date ............ OCT-17-1948 00:00:00
Ending Date .............. OCT-17-2005 23:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 01:00:00
Wet Time Step ............ 00:15:00
Dry Time Step ............ 04:00:00
Routing Time Step ........ 60.00 sec


**************************        Volume         Depth
Runoff Quantity Continuity     acre-feet        inches
**************************     ---------       -------
Total Precipitation ......       685.624       563.373
Evaporation Loss .........        60.333        49.575
Infiltration Loss ........       361.456       297.006
Surface Runoff ...........       268.903       220.955
Final Surface Storage ....         0.012         0.010
Continuity Error (%) .....        -0.741


**************************        Volume        Volume
Flow Routing Continuity        acre-feet      10^6 gal
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......       268.902        87.626
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.000
External Outflow .........        86.814        28.290
Internal Outflow .........         0.000         0.000
Storage Losses ...........       182.035        59.319
Initial Stored Volume ....         0.000         0.000
Final Stored Volume ......         0.025         0.008
Continuity Error (%) .....         0.011


********************************
Highest Flow Instability Indexes
********************************
All links are stable.
```

POST_DEV

```
*************************
Routing Time Step Summary
*************************
Minimum Time Step           :    60.00 sec
Average Time Step           :    60.00 sec
Maximum Time Step           :    60.00 sec
Percent in Steady State     :     0.00
Average Iterations per Step :     1.00


***************************
Subcatchment Runoff Summary
***************************

--------------------------------------------------------------------------------------------------------
                          Total      Total      Total      Total      Total       Total     Peak  Runoff
                         Precip      Runon       Evap      Infil     Runoff      Runoff   Runoff   Coeff
Subcatchment                 in         in         in         in         in    10^6 gal      CFS
--------------------------------------------------------------------------------------------------------
DMA-A-B                  563.37       0.00     103.32      21.09     446.37       34.53     3.88   0.792
DMA-F                    563.37       0.00      63.17     369.38     141.36        0.27     0.09   0.251
DMA-C-D                  563.37       0.00     105.81       8.98     455.95       45.85     5.06   0.809
DMA-E                    563.37       0.00      72.42     257.84     247.99        0.37     0.07   0.440
DMA-BYPASS               563.37       0.00       3.70     530.37      30.67        6.60    10.01   0.054


******************
Node Depth Summary
******************

---------------------------------------------------------------------
                               Average  Maximum  Maximum  Time of Max
                                 Depth    Depth      HGL   Occurrence
Node                 Type         Feet     Feet     Feet  days hr:min
---------------------------------------------------------------------
POC-1                OUTFALL      0.00     0.00     0.00     0  00:00
BASIN-1              STORAGE      0.08     5.45     5.45  6263  08:49
BASIN-2              STORAGE      0.03     5.45     5.45  6263  09:04


*******************
Node Inflow Summary
*******************

-------------------------------------------------------------------------------------
                                Maximum  Maximum                  Lateral       Total
                                Lateral    Total  Time of Max      Inflow      Inflow
                                 Inflow   Inflow   Occurrence      Volume      Volume
Node                 Type           CFS      CFS  days hr:min    10^6 gal    10^6 gal
-------------------------------------------------------------------------------------
POC-1                OUTFALL      10.17    16.63  6263  09:01       7.243      28.287
BASIN-1              STORAGE       3.88     3.88  6263  09:00      34.531      34.531
BASIN-2              STORAGE       5.06     5.06  6263  09:00      45.845      45.845


**********************
Node Surcharge Summary
**********************

Surcharging occurs when water rises above the top of the highest conduit.
---------------------------------------------------------------------
                                             Max. Height   Min. Depth
```

POST_DEV

```
                                 Hours     Above Crown    Below Rim
Node                 Type      Surcharged           Feet         Feet
---------------------------------------------------------------------
BASIN-1              STORAGE    499679.02          5.455        1.045
BASIN-2              STORAGE    499679.02          5.454        1.046


*********************
Node Flooding Summary
*********************

No nodes were flooded.


**********************
Storage Volume Summary
**********************

--------------------------------------------------------------------------------------------
                       Average     Avg   E&I       Maximum     Max    Time of Max    Maximum
                        Volume    Pcnt  Pcnt        Volume    Pcnt     Occurrence    Outflow
Storage Unit          1000 ft3    Full  Loss      1000 ft3    Full    days hr:min        CFS
--------------------------------------------------------------------------------------------
BASIN-1                  0.170       1    59        12.945      89    6263  08:48       3.87
BASIN-2                  0.075       0    85        17.008      89    6263  09:04       3.89


***********************
Outfall Loading Summary
***********************

-----------------------------------------------------------
                      Flow       Avg.      Max.       Total
                      Freq.      Flow      Flow      Volume
Outfall Node          Pcnt.       CFS       CFS    10^6 gal
-----------------------------------------------------------
POC-1                  3.91      0.05     16.63      28.287
-----------------------------------------------------------
System                 3.91      0.05     16.63      28.287


********************
Link Flow Summary
********************

-----------------------------------------------------------------------------
                               Maximum  Time of Max   Maximum    Max/    Max/
                                |Flow|   Occurrence   |Veloc|    Full    Full
Link                 Type          CFS  days hr:min    ft/sec    Flow   Depth
-----------------------------------------------------------------------------
ORIFICE-1            DUMMY        3.87  6263  08:49
ORIFICE-2            DUMMY        3.89  6263  09:04


*************************
Conduit Surcharge Summary
*************************

No conduits were surcharged.


Analysis begun on:  Wed Aug 05 12:43:38 2020
Analysis ended on:  Wed Aug 05 12:44:11 2020
Total elapsed time: 00:00:33
```

Appendix F.4. Copies of Electronic Files from Continuous Simulation Modeling

Intentionally Left Blank

Appendix G

Source Control BMP Checklist

Intentionally Left Blank

Source Control BMP Checklist		**Appendix G**
If These Sources Will Be on the Project Site	**… Then Your SWQMP Shall Implement These Source Control BMPs, as Applicable and Feasible**	
Potential Sources of Pollutants	**Permanent BMPs—Show on Plans** *(BMPs shown only on building or landscape plans can be described narratively if the applicable plan set has not yet been prepared at the time of SWQMP submittal)*	**Additional BMPs and Narrative Description**
☑ **A.** Onsite storm drain inlets ☐ Not Applicable	☑ Locations of inlets and catch basins. ☑ Note associated with each inlet and catch basin: Mark all inlets with prohibitive language (such as “No Dumping! Flows to Bay” or similar). ☑ Note associated with each public access point along channels and creeks within the project area: Post signs with prohibitive language and/or graphical icons, which prohibit illegal dumping.	☑ Maintain legibility of stencils and signs (periodically repaint or replace inlet markings/signage). ☑ Provide stormwater pollution prevention information to new site owners, lessees, or operators. <u>Narrative Description</u>: All of the proposed storm drain inlets are to be marked with prohibitive language and legibility maintained. Signage that prohibits illegal dumping will also be posted near the channel.
☑ **B.** Interior floor drains and elevator shaft sump pumps ☐ Not Applicable	👍 Show that interior floor drains and elevator shaft sump pumps will be plumbed to the sanitary sewer system. *(typically on building plans)*	☑ Inspect and maintain drains to prevent blockages and overflow. <u>Narrative Description</u>: The indoor vehicle service/maintenance bays and carwash will have interior floor drains that we be plumbed to the sanitary sewer. See architect/plumbing plans.
☐ **C.** Drains within interior parking garages ☑ Not Applicable	☐ Show that parking garage floor drains, except for drains that receive runoff from areas exposed to precipitation, will be plumbed to the sanitary sewer system. *(typically on building plans)*	☐ Inspect and maintain drains to prevent blockages and overflow. <u>Narrative Description</u>:

Source Control BMP Checklist		Appendix G
If These Sources Will Be on the Project Site	… Then Your SWQMP Shall Implement These Source Control BMPs, as Applicable and Feasible	
Potential Sources of Pollutants	**Permanent BMPs—Show on Plans** *(BMPs shown only on building or landscape plans can be described narratively if the applicable plan set has not yet been prepared at the time of SWQMP submittal)*	**Additional BMPs and Narrative Description**
☑ **D1.** Need for future indoor & structural pest control ☐ Not Applicable		☑ Provide Integrated Pest Management information to owners, lessees, and operators. ☑ Note building design features that discourage entry of pests. Narrative Description: CarMax designed with automatic closing doors and sealed windows to discourage pest entry. Integrated pest management information to be provided to Owners, Lessees and Operators

Source Control BMP Checklist		Appendix G
If These Sources Will Be on the Project Site	**... Then Your SWQMP Shall Implement These Source Control BMPs, as Applicable and Feasible**	
Potential Sources of Pollutants	**Permanent BMPs—Show on Plans** *(BMPs shown only on building or landscape plans can be described narratively if the applicable plan set has not yet been prepared at the time of SWQMP submittal)*	**Additional BMPs and Narrative Description**
☑ **D2.** Landscape Design/ Outdoor Pesticide Use ☐ Not Applicable	☑ Show self-retaining landscape areas, if any. ☑ Show stormwater treatment facilities, if any. ☐ For nurseries, garden centers, and similar facilities, show how irrigation water in the nursery/garden center will be prevented from reaching the storm drain system. *Show the following on the landscape or irrigation plans:* ☑ Existing trees, shrubs, and ground cover to be undisturbed and retained. ☑ Landscape and irrigation designed to prevent irrigation runoff to the storm drain system, to promote surface infiltration where appropriate, and to minimize the use of fertilizers and pesticides that can contribute to stormwater pollution. ☑ Where landscaped areas are used to retain or detain stormwater, specify plants that are tolerant of periodic saturated soil conditions. ☑ Use of native or pest-resistant plant species. ☑ Use of plants appropriate to site soils, slopes, climate, sun, wind, rain, land use, air movement, ecological consistency, and plant interactions	☑ Provide IPM information to new owners, lessees and operators. Narrative Description: Site designed to preserve portions of the stream/riparian habitat, including some existing trees, shrubs and ground vegetation – these areas will be protected during construction. The proposed landscaping will be designed with native and/or drought tolerant species, limited fertilizer needs water efficient irrigation designed to prevent runoff. Integrated pest management information to be provided to Owners, Lessees and Operators. See Landscape plan.
☐ **E.** Pools, spas, ponds, decorative fountains, and other water features. ☑ Not Applicable	☐ Show location of water feature.	Narrative Description:

Source Control BMP Checklist

If These Sources Will Be on the Project Site	… Then Your SWQMP Shall Implement These Source Control BMPs, as Applicable and Feasible	
Potential Sources of Pollutants	**Permanent BMPs—Show on Plans** *(BMPs shown only on building or landscape plans can be described narratively if the applicable plan set has not yet been prepared at the time of SWQMP submittal)*	**Additional BMPs and Narrative Description**
☐ **F.** Food service ☑ Not Applicable	☐ For restaurants, grocery stores, and other food service operations, show location (indoors or in a covered area outdoors) of a floor sink or other area for cleaning floor mats, containers, and equipment. *(typically on building plans)* ☐ On the drawing, show a note that this drain will be connected to a grease interceptor before discharging to the sanitary sewer system. *(typically on building plans)* ☐ Show a note indicating that waste containers for oils, grease, and fats will be stored indoors. Alternatively, if it is not feasible to store these containers indoors, show a designated storage structure that provides coverage for these waste containers.	☐ Include the following in lease agreements: “Tenant shall maintain grease interceptor to prevent blockages and overflow.” Narrative Description:
☑ **G.** Refuse areas ☐ Not Applicable	☑ Show where site refuse and recycled materials will be handled and stored for pickup. See local municipal requirements for sizes and other details of refuse areas. ☑ For designated refuse areas located outdoors, show all of the following: 1. Permanent structural overhead coverage (e.g. roof) 2. Grading and structures (e.g. berms) to prevent run-on from surrounding areas and to prevent runoff from the refuse area. 3. Structures (e.g. walls, screens) to protect against wind dispersal. ☐ Any drains from dumpsters or compactors shall be connected to a grease removal device before discharge to sanitary sewer.	Narrative Description: A refuse storage area has been incorporated into the CarMax site plan that includes a permanent structural overhang, berms and screen walls to prevent direct contact with rainfall, run-on and to protect against wind dispersal. All trash and recycled materials will be stored and properly disposed of in accordance with all applicable Local, State and Federal regulations.

Source Control BMP Checklist		Appendix G
If These Sources Will Be on the Project Site	… Then Your SWQMP Shall Implement These Source Control BMPs, as Applicable and Feasible	
Potential Sources of Pollutants	**Permanent BMPs—Show on Plans** *(BMPs shown only on building or landscape plans can be described narratively if the applicable plan set has not yet been prepared at the time of SWQMP submittal)*	**Additional BMPs and Narrative Description**
☐ **H.** Industrial processes. ☑ Not Applicable	☐ Show outdoor process area, if applicable. If all industrial processes will take place in building, note that in the source control BMP in the SWQMP, but nothing needs to be shown on the plans.	Narrative Description:

Source Control BMP Checklist

If These Sources Will Be on the Project Site	… Then Your SWQMP Shall Implement These Source Control BMPs, as Applicable and Feasible	
Potential Sources of Pollutants	**Permanent BMPs—Show on Plans** *(BMPs shown only on building or landscape plans can be described narratively if the applicable plan set has not yet been prepared at the time of SWQMP submittal)*	**Additional BMPs and Narrative Description**
☐ **I.** Outdoor storage of equipment or materials. (See rows J and K for source control measures for vehicle cleaning, repair, and maintenance.) ☑ Not Applicable	☐ Show any outdoor storage areas. For all outdoor storage areas show all structures used to meet the following requirements: ▪ Materials stored outdoors shall be covered, contained, and/or elevated to prevent stormwater and non-stormwater from contacting and/or transporting materials and pollutants to the storm drain system. Some examples of cover are roofs, awnings, and tarps. Where coverage is not feasible or is cost prohibitive, alternative approaches such as installing berms around the stored materials, directing runoff to pervious areas, or installing treatment devices may be allowed. ▪ Hazardous materials and wastes shall be stored, managed, and disposed in accordance with federal, state, and local laws and regulations. Hazardous materials and wastes and their primary storage containers shall also be stored such that they will not come into contact with stormwater, even if leaks or spills occur. Hazardous materials and wastes generated by business activities are additionally regulated by the County of San Diego Department of Environmental Health. Disposal of hazardous wastes using an authorized hazardous waste collection service is required. Store hazardous materials and wastes, and their primary storage containers, with sufficient cover and/or containment to prevent contact with stormwater. ▪ Runoff from roofs and downspouts shall be directed away from storage areas.	☐ Where appropriate, reference documentation of compliance with the requirements of local Hazardous Materials Programs for: ▪ Hazardous Waste Generation ▪ Hazardous Materials Release Response and Inventory ▪ California Accidental Release Prevention Program ▪ Aboveground Storage Tank ▪ Uniform Fire Code Article 80 Section 103(b) & (c) 1991 ▪ Underground Storage Tank Narrative Description:

Source Control BMP Checklist		Appendix G
If These Sources Will Be on the Project Site	... Then Your SWQMP Shall Implement These Source Control BMPs, as Applicable and Feasible	
Potential Sources of Pollutants	**Permanent BMPs—Show on Plans** *(BMPs shown only on building or landscape plans can be described narratively if the applicable plan set has not yet been prepared at the time of SWQMP submittal)*	**Additional BMPs and Narrative Description**
☑ **J.** Vehicle and Equipment Cleaning ☐ Not Applicable	☑ Show on drawings as appropriate: Development projects that include areas for washing, steam cleaning, or other cleaning of vehicles or equipment shall incorporate the following features into the design of such areas, as applicable. 1. Self-contained, and covered with a roof or overhang; 2. Have a grade or berm area to prevent run-on from surrounding areas; 3. Equipped with a clarifier, grease interceptor, or other pretreatment facility, as appropriate; 4. Properly connected to a sanitary sewer; and 5. No storm drains are located in wash areas; or 6. Other features that are comparable and equally effective	☑ All connections to the sanitary sewer system shall obtain appropriate permits. ☐ If a car wash area is not provided, describe measures taken to discourage onsite car washing and explain how these will be enforced. <u>Narrative Description</u>: The CarMax site includes a private car wash facility that will be self-contained covered and plumbed to the sanitary sewer. The grading and drainage has been designed to prevent run-on to the carwash area.

Source Control BMP Checklist		Appendix G
If These Sources Will Be on the Project Site	**… Then Your SWQMP Shall Implement These Source Control BMPs, as Applicable and Feasible**	
Potential Sources of Pollutants	**Permanent BMPs—Show on Plans** *(BMPs shown only on building or landscape plans can be described narratively if the applicable plan set has not yet been prepared at the time of SWQMP submittal)*	**Additional BMPs and Narrative Description**
☑ **K.** Vehicle/ Equipment Repair and Maintenance ☐ Not Applicable	☑ Accommodate all vehicle equipment repair and maintenance indoors. Or designate an outdoor work area and show all structures needed to meet the following requirements for outdoor work areas: 1. Area is covered (e.g. with roof or canopy) 2. Area is protected from runoff from upstream areas (e.g. with berms) 3. Spills or by-products are prevented from escaping the contained work area ☑ Add a note on the plans that states either (1) there are no floor drains, or (2) floor drains are connected to a sump for collection and disposal or to wastewater pretreatment systems prior to discharge to the sanitary sewer.	☐ Applicable permits must be obtained for connections to the sanitary sewer system. Narrative Description: The CarMax site includes covered, indoor maintenance bays designed to contain spills within the work area. The grading and drainage has been designed to prevent run-on to the maintenance bay area.

Source Control BMP Checklist		Appendix G
If These Sources Will Be on the Project Site	**… Then Your SWQMP Shall Implement These Source Control BMPs, as Applicable and Feasible**	
Potential Sources of Pollutants	**Permanent BMPs—Show on Plans** *(BMPs shown only on building or landscape plans can be described narratively if the applicable plan set has not yet been prepared at the time of SWQMP submittal)*	**Additional BMPs and Narrative Description**
☑ **L.** Fuel Dispensing Areas ☐ Not Applicable	☑ Fueling areas shall have impermeable floors (i.e., Portland cement concrete or equivalent smooth impervious surface) that are (1) graded at the minimum slope necessary to prevent ponding; and (2) separated from the rest of the site by a grade break that prevents run-on of stormwater to the MEP. The fueling area shall be defined as the area extending a minimum of 6.5 feet from the corner of each fuel dispenser or the length at which the hose and nozzle assembly may be operated plus a minimum of one foot, whichever is greater. ☑ Fueling areas shall be covered by a canopy that extends a minimum of ten feet in each direction from each pump. [Alternative: The fueling area must be covered and the cover’s minimum dimensions must be equal to or greater than the area within the grade break or fuel dispensing area.] The canopy [or cover] shall not drain onto the fueling area.	Narrative Description: The CarMax site includes a Fuel Dispensing Area which shall be impermeable with a grade break to prevent run-on and covered with a canopy.

If These Sources Will Be on the Project Site	… Then Your SWQMP Shall Implement These Source Control BMPs, as Applicable and Feasible	
Potential Sources of Pollutants	**Permanent BMPs—Show on Plans** *(BMPs shown only on building or landscape plans can be described narratively if the applicable plan set has not yet been prepared at the time of SWQMP submittal)*	**Additional BMPs and Narrative Description**
M. Loading Docks ☑ Not Applicable	☐ Show a preliminary design for the loading dock area, including roofing and drainage. Loading docks shall be covered and/or graded to minimize run-on to and runoff from the loading area. Roof downspouts shall be positioned to direct stormwater away from the loading area. Water from loading dock areas should be drained to the sanitary sewer system where feasible. Direct connections to storm drains from depressed loading docks are prohibited. ☐ Loading dock areas draining directly to the sanitary sewer shall be equipped with a spill control valve or equivalent device, which shall be kept closed during periods of operation. ☐ Provide a roof overhang over the loading area or install door skirts (cowling) at each bay that enclose the end of the trailer.	Narrative Description:
☑ **N.** Fire Sprinkler Test Water ☐ Not Applicable	☑ Show how fire sprinkler test water will be drained to the sanitary sewer system.	Narrative Description: Fire sprinkler test water will be collected by the interior floor drains and piped to the sanitary sewer system.
☑ **O.1** Boiler drain lines ☐ Not Applicable	☑ Show how boiler drain lines will be directly or indirectly connected to the sanitary sewer system or otherwise will not discharge to the storm drain system.	Narrative Description: Water from boiler drain lines will either be collected by interior floor drains or piped directly into the sanitary sewer system.
☑ **O.2** Condensate drain lines ☐ Not Applicable	☐ Show how condensate drain lines, including air conditioning condensate, will, if not directed to the sanitary sewer, discharge to landscaped areas (if the flow is small enough that runoff will not occur) or will otherwise not discharge to the storm drain system.	Narrative Description: Runoff from all impervious surfaces, including condensate drain lines will discharge to pervious landscaped areas.

Source Control BMP Checklist		**Appendix G**
If These Sources Will Be on the Project Site	**… Then Your SWQMP Shall Implement These Source Control BMPs, as Applicable and Feasible**	
Potential Sources of Pollutants	**Permanent BMPs—Show on Plans** *(BMPs shown only on building or landscape plans can be described narratively if the applicable plan set has not yet been prepared at the time of SWQMP submittal)*	**Additional BMPs and Narrative Description**
☑ **O.3** Rooftop equipment ☐ Not Applicable	☑ Show how rooftop mounted equipment with potential to produce pollutants will have overhead coverage and/or have secondary containment.	Narrative Description: Rooftop equipment has been designed with overhead coverage and secondary containment.
☐ **O.4** Drainage sumps ☑ Not Applicable	☐ Show how any drainage sumps onsite will feature a sediment sump to reduce the quantity of sediment in pumped water.	Narrative Description:
☐ **O.5** Roofing, gutters, and trim ☑ Not Applicable	☐ Show that roofing, gutters, and trim made of copper or other unprotected metals that may leach into runoff will be avoided.	Narrative Description:
☑ **P.** Plazas, sidewalks, and parking lots. ☐ Not Applicable		☑ Plazas, sidewalks, and parking lots shall be swept regularly, or cleaned using an equally effective method, to prevent the accumulation of litter and debris. Narrative Description: Runoff from all impervious surfaces, including plazas, sidewalks and parking lots will discharge to pervious landscaped areas.

Intentionally Left Blank

Appendix H

Operation and Maintenance

Indicate which items are included behind this cover sheet

Contents	Included (Y/N)
H.1. Operation and Maintenance Plan *Note: all pages of the O&M Plan must be on 8.5" x 11" paper (either portrait or landscape orientation is acceptable).*	Y
H.2. Draft Stormwater Facilities Maintenance Agreement (where applicable) *The maintenance agreement must be completed with project-specific information and submitted as a draft. The maintenance agreement will be recorded at the end of the project rather than at the time of SWQMP approval. Maintenance agreements are not required for projects when the City will be responsible for all BMP operation and maintenance.*	Y

Intentionally Left Blank

Appendix H.1. Operation and Maintenance Plan

Intentionally Left Blank

Appendix H.2. Draft Stormwater Facilities Maintenance Agreement

Intentionally Left Blank

Recording Requested By:)
)
City Engineer)
)
When Recorded Mail to:)
City Clerk)
City of National City)
1243 National City Blvd.)
National City, CA 91950) SPACE ABOVE FOR RECORDER'S USE ONLY

PRIVATE STORM WATER BEST MANANGEMENT PRACTICES (BMPs) MAINTENANCE AGREEMENT

Assessor's Parcel No.: ___________________________ Project No.: _______________
W.O. No.: ________________

THIS AGREEMENT for the periodic maintenance and repair of Private Permanent Storm Water Best Management Practices (Private Permanent Storm Water BMPs) (hereinafter referred to as the “BMPs”), is made by and between the City Of National City, a municipality and ________________ CarMax, Inc. ________________ (hereinafter referred to as the "Owner").

WHEREAS, this Agreement is required as a condition of approval by the City of National City Municipal Code Chapter 14.22 and the City of National City BMP Manual; and

WHEREAS, “Owner” who is the owner of certain real property (the “Property”) described on the site map, Exhibit “A”, attached hereto, will use and enjoy the benefit of said BMPs incidental to its development; and

WHEREAS, establishment of the BMPs is a condition of developing the property; and

WHEREAS, there exists a benefit to the public when the BMPs are adequately maintained on a regular and periodic basis; and

WHEREAS, it is the desire of the Owner that said BMPs shall be maintained in a safe and usable condition by the Owner; and

WHEREAS, it is the desire of the Owner to conduct the periodic maintenance and repair of said BMPs and owner is responsible for the expense of such maintenance and repair; and

WHEREAS, BMPs have been separately described in the Operation and Maintenance (O&M) Plan, Exhibit "B", attached hereto and made a part hereof (hereinafter referred to as the "Plan"), consistent with Drawing Number(s) ________________, copies of which are on file in the office of the City Engineer; and

WHEREAS, it is the intention of the Owner that this Agreement shall constitute a covenant running with the land, and shall be binding upon each successive owner of all or any portion of the property.

NOW THEREFORE, IT IS HEREBY AGREED AS FOLLOWS:

1. The Owner will submit to the City an annual maintenance report verifying the maintenance and efficient operation of said BMPs.

2. The Owner will maintain operation and maintenance records for at least five (5) years. These records shall be made available to the City for inspection upon request at any time.

3. The Property is benefited by this Agreement, and present and successive owners of all or any portion of the property are now and shall be hereafter expressly bound by the maintenance agreement for the benefit of the land.

4. The cost of maintaining the installed BMPs shall be paid by the owner or the heirs, assigns and successors in interest of each such owner, proportional to their respective interest.

5. In the event any of the herein described parcels of land on the property are further subdivided, the owners, heirs, assigns and successors in interest of each newly created parcel shall be liable under this Agreement for their then pro rata share of expenses and such pro rata shares of expenses shall be computed to reflect their proportionate interest in such newly created parcels.

6. The maintenance to be performed upon the BMPs under this Agreement on the property shall be as set forth in the Plan, Exhibit "B". The Owner shall conduct any repair that is necessary to adequately maintain said BMPS in a functional condition in accordance with their intended purpose. Repairs under this Agreement shall include, but is not limited to, repairing access roadbeds, repairing and maintaining drainage structures, removing debris, and other work reasonably necessary and proper to repair and preserve the BMPs for their intended purposes.

7. If there is a covenant, agreement, or other obligation imposed as a condition of the development on the property, the obligation to repair and maintain the BMPs, as herein set forth shall commence when the improvements have been completed and approved by the City.

8. Any extraordinary repair required to correct damage to said BMPs that results from action taken or contracted for by the owners or their successors in interest shall be paid for by the party taking action or party contracting for work which caused the necessity for the extraordinary repair. The repair shall restore the BMPs to the condition and proper storm water functioning existing prior to said damage.

9. Any liability of the owners for personal injury as a result of or arising out of repairs and maintenance under this Agreement shall be borne by the Owner in proportion to their respective interest in the property. The Owner shall be responsible for maintaining their own insurance. This Agreement is not intended to provide for any sharing or assumption of liability with respect to personal injury or property damage other than that attributable to the repairs and maintenance undertaken under this Agreement.

10. The Owner shall jointly and severally defend, indemnify and hold harmless the City and each of its officials, directors, officers, agents and employees from and against all liability, claims, damages, losses, expenses, personal injury and other costs, including costs of defense and attorney's fees arising out of or in any way related to the use of, repair or maintenance of, or the failure to repair or maintain the BMPs, or its failure to comply with the terms of this Agreement.

11. Nothing in this Agreement, the specifications or other contract documents or the City's review and approval of the plans and specifications or inspection of the work or maintenance related to the BMPs is intended to constitute an acknowledgement of a responsibility or liability for any such matter, and the City and each of its officials, directors, officers, employees and agents, shall have no responsibility or liability in connection with their reviews or approvals.

12. This instrument shall be recorded and the obligation hereby created shall constitute a covenant running with the land, and each subsequent purchaser of all or any portion thereof, by acceptance of delivery of a deed and/or conveyance regardless of form, shall be deemed to have consented to and become bound by this agreement, including without limitation, the right of any person entitled to enforce the terms of this Agreement to institute legal action as provided in Paragraph 8 hereof, such remedy to be cumulative and in addition to other remedies provided in this Agreement and to all other remedies at law or in equity.

13. The terms of this Agreement may be amended in writing upon the request of the Owner of the land described in Exhibit “A” and with the consent of the City Council.

14. This Agreement shall be governed by the laws of the State of California. In the event that any of the provisions of this Agreement are held to be unenforceable or invalid by any court of competent jurisdiction, the validity and enforceability of the remaining provisions shall not be affected thereby.

15. Should the Developer, the Owner, an Association, or any of their successors, heirs or assigns fail to comply with their repair and maintenance obligation under this Agreement, the City of National City shall have the right, but not the duty, to perform such repair and maintenance, and shall be entitled to recover the full cost of such repair from the party having such repair and maintenance obligation.

IN WITNESS WHEREOF, the parties have executed this Agreement

This________________day of______________________, 20____.

Owner(s):

____

(Print name:)

____

(Print name:)

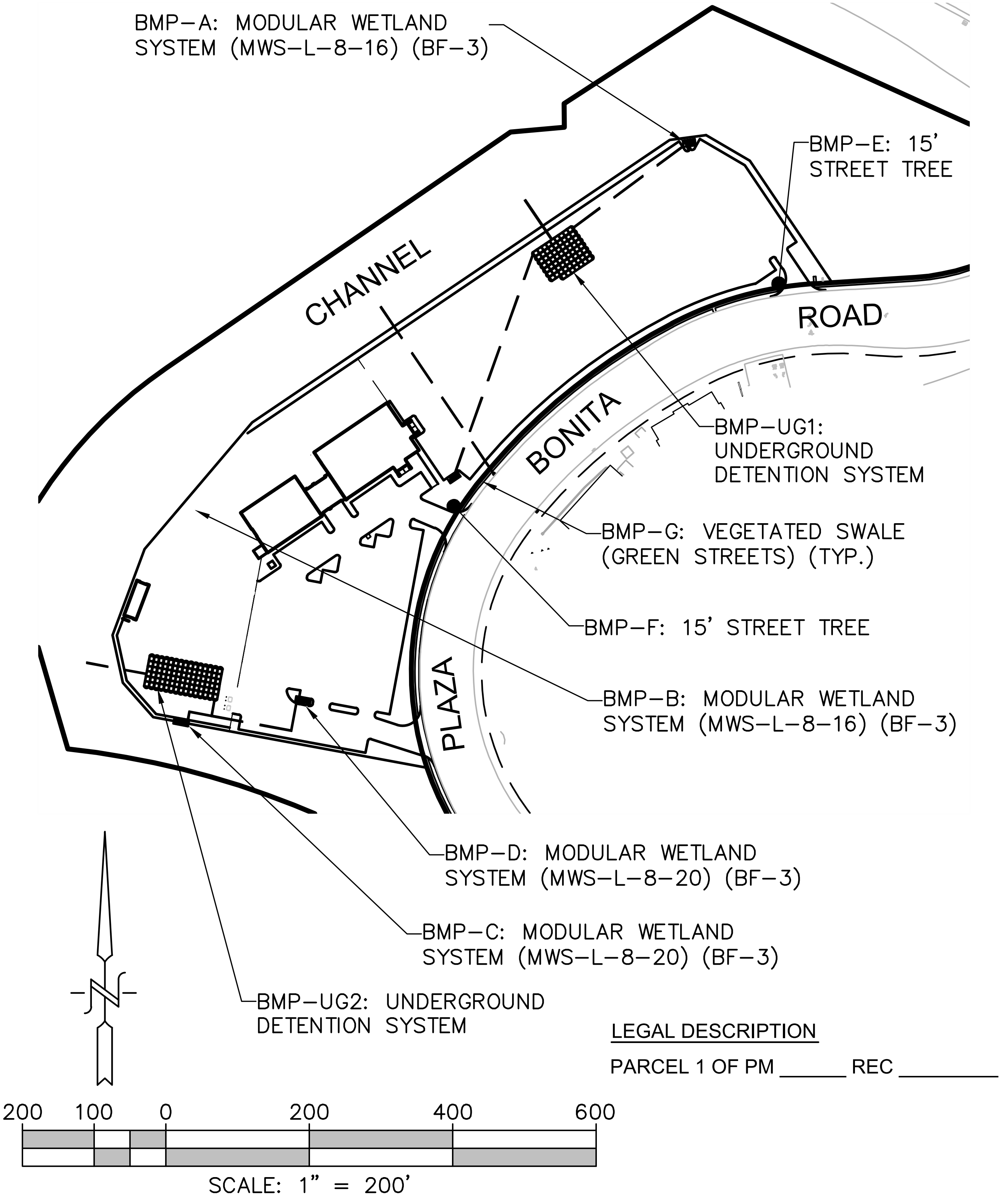
Signature of OWNER must be notarized. Attach the appropriate acknowledgement.

____   _______________

Signature   Date

EXHIBIT 'A'

SITE MAP



LEGAL DESCRIPTION

PARCEL 1 OF PM ______ REC _________

EXHIBIT “B”

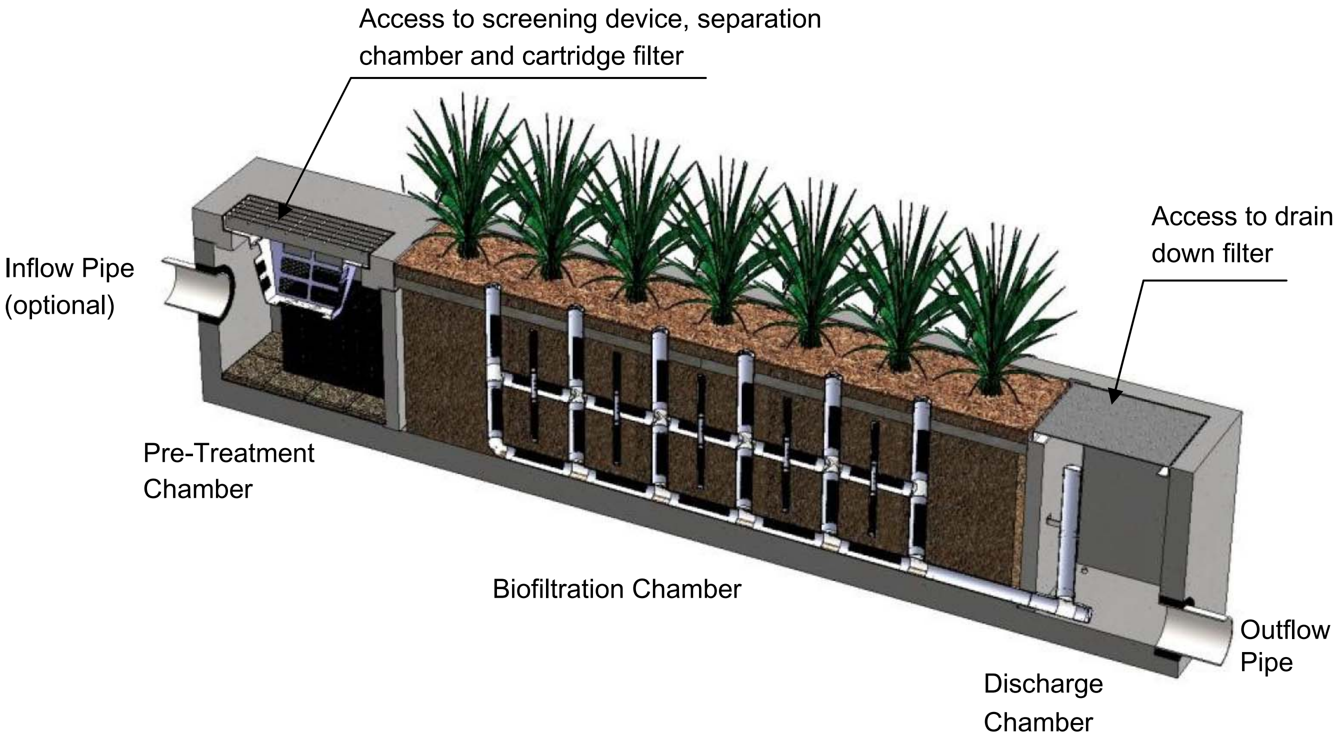
Operation & Maintenance Plan

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.

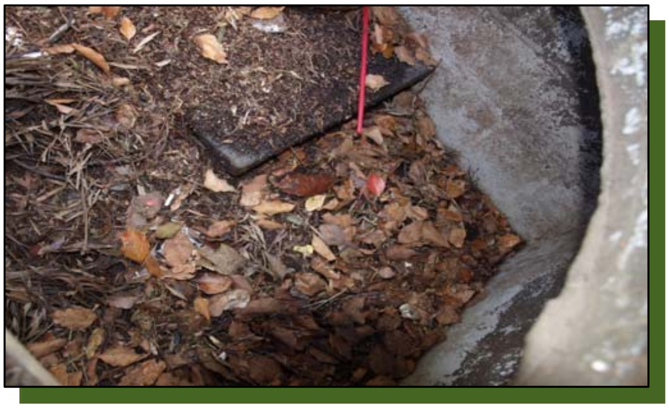
Maintenance Procedure Illustration

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.

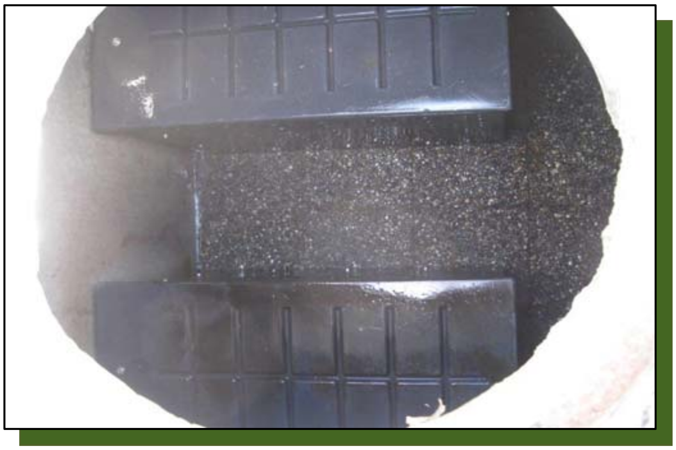
Separation Chamber

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

For Office Use Only

(Reviewed By)

(Date)
Office personnel to complete section to the left.

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 ____________________

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: ____________________

Maintenance Report

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

www.modularwetlands.com

BIO CLEAN
ENVIRONMENTAL SERVICES, INC.

Cleaning and Maintenance Report
Modular Wetlands System

MODULAR WETLANDS

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

StormTech®
Detention • Retention • Water Quality
An ADS company

Isolator® Row O&M Manual

THE MOST **ADVANCED** NAME IN WATER MANAGEMENT SOLUTIONS™

THE ISOLATOR® ROW

INTRODUCTION

An important component of any Stormwater Pollution Prevention Plan is inspection and maintenance. The StormTech Isolator Row is a technique to inexpensively enhance Total Suspended Solids (TSS) removal and provide easy access for inspection and maintenance.

THE ISOLATOR ROW

The Isolator Row is a row of StormTech chambers, either SC-160LP, SC-310, SC-310-3, SC-740, DC-780, MC-3500 or MC-4500 models, that is surrounded with filter fabric and connected to a closely located manhole for easy access. The fabric-wrapped chambers provide for settling and filtration of sediment as storm water rises in the Isolator Row and ultimately passes through the filter fabric. The open bottom chambers and perforated sidewalls (SC-310, SC- 310-3 and SC-740 models) allow storm water to flow both vertically and horizontally out of the chambers. Sediments are captured in the Isolator Row protecting the storage areas of the adjacent stone and chambers from sediment accumulation.

Two different fabrics are used for the Isolator Row. A woven geotextile fabric is placed between the stone and the Isolator Row chambers. The tough geotextile provides a media for storm water filtration and provides a durable surface for maintenance operations. It is also designed to prevent scour of the underlying stone and remain intact during high pressure jetting. A non-woven fabric is placed over the chambers to provide a filter media for flows passing through the perforations in the sidewall of the chamber. The non-woven fabric is not required over the SC-160LP, DC-780, MC-3500 or MC-4500 models as these chambers do not have perforated side walls.

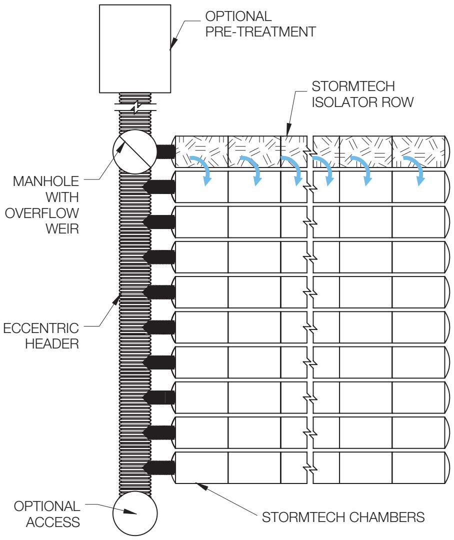
The Isolator Row is typically designed to capture the “first flush” and offers the versatility to be sized on a volume basis or flow rate basis. An upstream manhole not only provides access to the Isolator Row but typically includes a high flow weir such that storm water flowrates or volumes that exceed the capacity of the Isolator Row overtop the over flow weir and discharge through a manifold to the other chambers.

The Isolator Row may also be part of a treatment train. By treating storm water prior to entry into the chamber system, the service life can be extended and pollutants such as hydrocarbons can be captured. Pre-treatment best management practices can be as simple as deep sump catch basins, oil-water separators or can be innovative storm water treatment devices. The design of the treatment train and selection of pretreatment devices by the design engineer is often driven by regulatory requirements. Whether pretreatment is used or not, the Isolator Row is recommended by StormTech as an effective means to minimize maintenance requirements and maintenance costs.

Note: See the StormTech Design Manual for detailed information on designing inlets for a StormTech system, including the Isolator Row.

Looking down the Isolator Row from the manhole opening, woven geotextile is shown between the chamber and stone base.

StormTech Isolator Row with Overflow Spillway (not to scale)



ISOLATOR ROW INSPECTION/MAINTENANCE

INSPECTION

The frequency of inspection and maintenance varies by location. A routine inspection schedule needs to be established for each individual location based upon site specific variables. The type of land use (i.e. industrial, commercial, residential), anticipated pollutant load, percent imperviousness, climate, etc. all play a critical role in determining the actual frequency of inspection and maintenance practices.

At a minimum, StormTech recommends annual inspections. Initially, the Isolator Row should be inspected every 6 months for the first year of operation. For subsequent years, the inspection should be adjusted based upon previous observation of sediment deposition.

The Isolator Row incorporates a combination of standard manhole(s) and strategically located inspection ports (as needed). The inspection ports allow for easy access to the system from the surface, eliminating the need to perform a confined space entry for inspection purposes.

If upon visual inspection it is found that sediment has accumulated, a stadia rod should be inserted to determine the depth of sediment. When the average depth of sediment exceeds 3 inches throughout the length of the Isolator Row, clean-out should be performed.

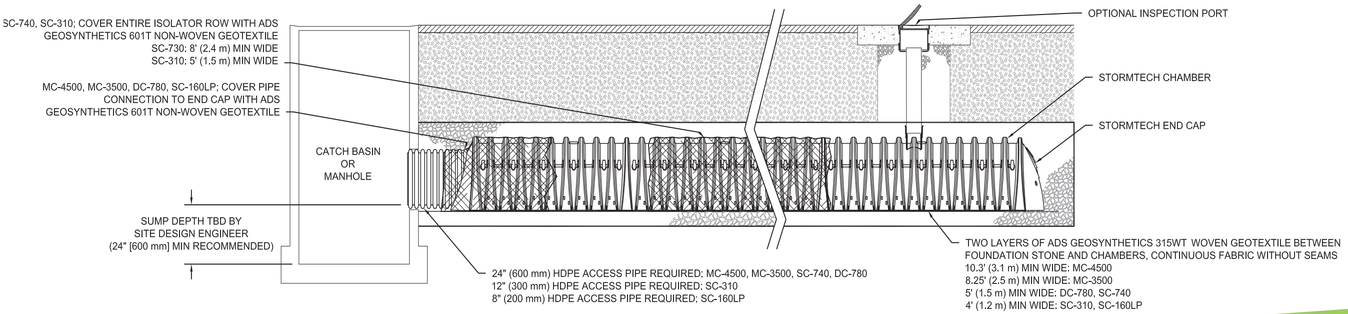
MAINTENANCE

The Isolator Row was designed to reduce the cost of periodic maintenance. By “isolating” sediments to just one row, costs are dramatically reduced by eliminating the need to clean out each row of the entire storage bed. If inspection indicates the potential need for maintenance, access is provided via a manhole(s) located on the end(s) of the row for cleanout. If entry into the manhole is required, please follow local and OSHA rules for a confined space entries.

Maintenance is accomplished with the JetVac process. The JetVac process utilizes a high pressure water nozzle to propel itself down the Isolator Row while scouring and suspending sediments. As the nozzle is retrieved, the captured pollutants are flushed back into the manhole for vacuuming. Most sewer and pipe maintenance companies have vacuum/JetVac combination vehicles. Selection of an appropriate JetVac nozzle will improve maintenance efficiency. Fixed nozzles designed for culverts or large diameter pipe cleaning are preferable. Rear facing jets with an effective spread of at least 45” are best. Most JetVac reels have 400 feet of hose allowing maintenance of an Isolator Row up to 50 chambers long. **The JetVac process shall only be performed on StormTech Isolator Rows that have AASHTO class 1 woven geotextile (as specified by StormTech) over their angular base stone.**

StormTech Isolator Row (not to scale)

Note: Non-woven fabric is only required over the inlet pipe connection into the end cap for SC-160LP, DC-780, MC-3500 and MC-4500 chamber models and is not required over the entire Isolator Row.



ISOLATOR ROW STEP BY STEP MAINTENANCE PROCEDURES

STEP 1

Inspect Isolator Row for sediment.

- A) Inspection ports (if present)
  - i. Remove lid from floor box frame
  - ii. Remove cap from inspection riser
  - iii. Using a flashlight and stadia rod,measure depth of sediment and record results on maintenance log.
  - iv. If sediment is at or above 3 inch depth, proceed to Step 2. If not, proceed to Step 3.
- B) All Isolator Rows
  - i. Remove cover from manhole at upstream end of Isolator Row
  - ii. Using a flashlight, inspect down Isolator Row through outlet pipe
    1. Mirrors on poles or cameras may be used to avoid a confined space entry
    2. Follow OSHA regulations for confined space entry if entering manhole
  - iii. If sediment is at or above the lower row of sidewall holes (approximately 3 inches), proceed to Step 2. If not, proceed to Step 3.

STEP 2

Clean out Isolator Row using the JetVac process.

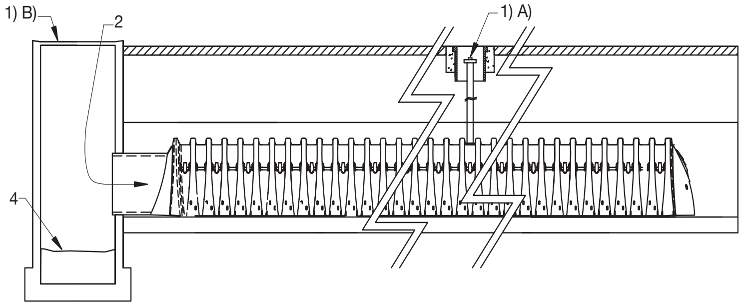
- A) A fixed floor cleaning nozzle with rear facing nozzle spread of 45 inches or more is preferable
- B) Apply multiple passes of JetVac until backflush water is clean
- C) Vacuum manhole sump as required

STEP 3

Replace all caps, lids and covers, record observations and actions.

STEP 4

Inspect & clean catch basins and manholes upstream of the StormTech system.



SAMPLE MAINTENANCE LOG

Date	Stadia Rod Readings		Sediment Depth (1)–(2)	Observations/Actions	Inspector
	Fixed point to chamber bottom (1)	Fixed point to top of sediment (2)			
3/15/11	6.3 ft	none		New installation. Fixed point is CI frame at grade	DJM
9/24/11		6.2	0.1 ft	Some grit felt	SM
6/20/13		5.8	0.5 ft	Mucky feel, debris visible in manhole and in Isolator Row, maintenance due	NV
7/7/13	6.3 ft		0	System jetted and vacuumed	DJM

ADS “Terms and Conditions of Sale” are available on the ADS website, www.ads-pipe.com
The ADS logo and the Green Stripe are registered trademarks of Advanced Drainage Systems, Inc.
Stormtech® and the Isolator® Row are registered trademarks of StormTech, Inc.
© 2017 Advanced Drainage Systems, Inc. #11011 03/17 CS

StormTech®
Detention • Retention • Water Quality
A division of ADS

Advanced Drainage Systems, Inc.
4640 Trueman Blvd., Hilliard, OH 43026
1-800-821-6710 www.ads-pipe.com

StormTech Maintenance Log

Project Name:
Location:

StormTech®
www.stormtech.com

	Stadia Rod Readings				
Date	**Fixed point to chamber bottom (1)**	**Fixed point to top of sediment (2)**	**Sediment Depth (1) - (2)**	**Observations / Actions**	**Inspector**

SD-1

Tree Wells

BMP MAINTENANCE FACT SHEET
FOR
SITE DESIGN BMP SD-1 TREE WELLS

Tree wells as site design BMPs are trees planted in configurations that allow storm water runoff to be directed into the soil immediately surrounding the tree. The tree may be contained within a planter box or structural cells. The surrounding area will be graded to direct runoff to the tree well. There may be features such as tree grates, suspended pavement design, or shallow surface depressions designed to allow runoff into the tree well. Typical tree well components include:

- Trees of the appropriate species for site conditions and constraints
- Available growing space based on tree species, soil type, water availability, surrounding land uses, and project goals
- Entrance/opening that allows storm water runoff to flow into the tree well (e.g., a curb opening, tree grate, or surface depression)
- Optional suspended pavement design to provide structural support for adjacent pavement without requiring compaction of underlying layers
- Optional root barrier devices as needed; a root barrier is a device installed in the ground, between a tree and the sidewalk, intended to guide roots down and away from the sidewalk in order to prevent sidewalk lifting from tree roots
- Optional tree grates; to be considered to maximize available space for pedestrian circulation and to protect tree roots from compaction related to pedestrian circulation; tree grates are typically made up of porous material that will allow the runoff to soak through
- Optional shallow surface depression for ponding of excess runoff
- Optional planter box drain

Normal Expected Maintenance

Tree health shall be maintained as part of normal landscape maintenance. Additionally, ensure that storm water runoff can be conveyed into the tree well as designed. That is, the opening that allows storm water runoff to flow into the tree well (e.g., a curb opening, tree grate, or surface depression) shall not be blocked, filled, re-graded, or otherwise changed in a manner that prevents storm water from draining into the tree well. A summary table of standard inspection and maintenance indicators is provided within this Fact Sheet.

Non-Standard Maintenance or BMP Failure

Tree wells are site design BMPs that normally do not require maintenance actions beyond routine landscape maintenance. The normal expected maintenance described above ensures the BMP functionality. If changes have been made to the tree well entrance / opening such that runoff is prevented from draining into the tree well (e.g., a curb inlet opening is blocked by debris or a grate is clogged causing runoff to flow around instead of into the tree well, or a surface depression has been filled so runoff flows away from the tree well), the BMP is not performing as intended to protect downstream waterways from pollution and/or erosion. Corrective maintenance will be required to restore drainage into the tree well as designed.

Surface ponding of runoff directed into tree wells is expected to infiltrate/evapotranspirate within 24-96 hours following a storm event. Surface ponding longer than approximately 24 hours following a storm event may be detrimental to vegetation health, and surface ponding longer than approximately 96 hours following a storm event poses a risk of vector (mosquito) breeding. Poor drainage can result from clogging or compaction of the soils surrounding the tree. Loosen or replace the soils to restore drainage.

Other Special Considerations

Site design BMPs, such as tree wells, installed within a new development or redevelopment project are components of an overall storm water management strategy for the project. The presence of site design BMPs within a project is usually a factor in the determination of the amount of runoff to be managed with structural BMPs (i.e., the amount of runoff expected to reach downstream retention or biofiltration basins that process storm water runoff from the project as a whole). When site design BMPs are not maintained or are removed, this can lead to clogging or failure of downstream structural BMPs due to greater delivery of runoff and pollutants than intended for the structural BMP. Therefore, the [City Engineer] may require confirmation of maintenance of site design BMPs as part of their structural BMP maintenance documentation requirements. Site design BMPs that have been installed as part of the project should not be removed, nor should they be bypassed by re-routing roof drains or re-grading surfaces within the project. If changes are necessary, consult the [City Engineer] to determine requirements.

SUMMARY OF STANDARD INSPECTION AND MAINTENANCE FOR SD-1 TREE WELLS

The property owner is responsible to ensure inspection, operation and maintenance of permanent BMPs on their property unless responsibility has been formally transferred to an agency, community facilities district, homeowners association, property owners association, or other special district.

Maintenance frequencies listed in this table are average/typical frequencies. Actual maintenance needs are site-specific, and maintenance may be required more frequently. Maintenance must be performed whenever needed, based on maintenance indicators presented in this table. The BMP owner is responsible for conducting regular inspections to see when maintenance is needed based on the maintenance indicators. During the first year of operation of a structural BMP, inspection is recommended at least once prior to August 31 and then monthly from September through May. Inspection during a storm event is also recommended. After the initial period of frequent inspections, the minimum inspection and maintenance frequency can be determined based on the results of the first year inspections.

Threshold/Indicator	Maintenance Action	Typical Maintenance Frequency
Tree health	Routine actions as necessary to maintain tree health.	• Inspect monthly. • Maintenance when needed.
Dead or diseased tree	Remove dead or diseased tree. Replace per original plans.	• Inspect monthly. • Maintenance when needed.
Standing water in tree well for longer than 24 hours following a storm event Surface ponding longer than approximately 24 hours following a storm event may be detrimental to tree health	Loosen or replace soils surrounding the tree to restore drainage.	• Inspect monthly and after every 0.5-inch or larger storm event. If standing water is observed, increase inspection frequency to after every 0.1-inch or larger storm event. • Maintenance when needed.
Presence of mosquitos/larvae For images of egg rafts, larva, pupa, and adult mosquitos, see http://www.mosquito.org/biology	Disperse any standing water from the tree well to nearby landscaping. Loosen or replace soils surrounding the tree to restore drainage (and prevent standing water).	• Inspect monthly and after every 0.5-inch or larger storm event. If mosquitos are observed, increase inspection frequency to after every 0.1-inch or larger storm event. • Maintenance when needed
Entrance / opening to the tree well is blocked such that storm water will not drain into the tree well (e.g., a curb inlet opening is blocked by debris or a grate is clogged causing runoff to flow around instead of into the tree well; or a surface depression is filled such that runoff drains away from the tree well)	Make repairs as appropriate to restore drainage into the tree well.	• Inspect monthly. • Maintenance when needed.

References

American Mosquito Control Association.
http://www.mosquito.org/
County of San Diego. 2014. Low Impact Development Handbook.
http://www.sandiegocounty.gov/content/sdc/dpw/watersheds/susmp/lid.html
San Diego County Copermittees. 2016. Model BMP Design Manual, Appendix E, Fact Sheet SD-1.
http://www.projectcleanwater.org/index.php?option=com_content&view=article&id=250&Itemid=220

SD-1

Tree Wells

Date:

Inspector:

BMP ID No.:

Permit No.:

APN(s):

Property / Development Name:

Responsible Party Name and Phone Number:

Property Address of BMP:

Responsible Party Address:

INSPECTION AND MAINTENANCE CHECKLIST FOR SD-1 TREE WELLS PAGE 1 of 2

Threshold/Indicator	Maintenance Recommendation	Date	Description of Maintenance Conducted
Dead or diseased tree Maintenance Needed? ☐ YES ☐ NO ☐ N/A	☐ Remove dead or diseased tree ☐ Replace per original plans ☐ Other / Comments:		
Standing water in tree well for longer than 24 hours following a storm event Surface ponding longer than approximately 24 hours following a storm event may be detrimental to tree health Maintenance Needed? ☐ YES ☐ NO ☐ N/A	☐ Loosen or replace soils surrounding the tree to restore drainage ☐ Other / Comments:		

SD-1

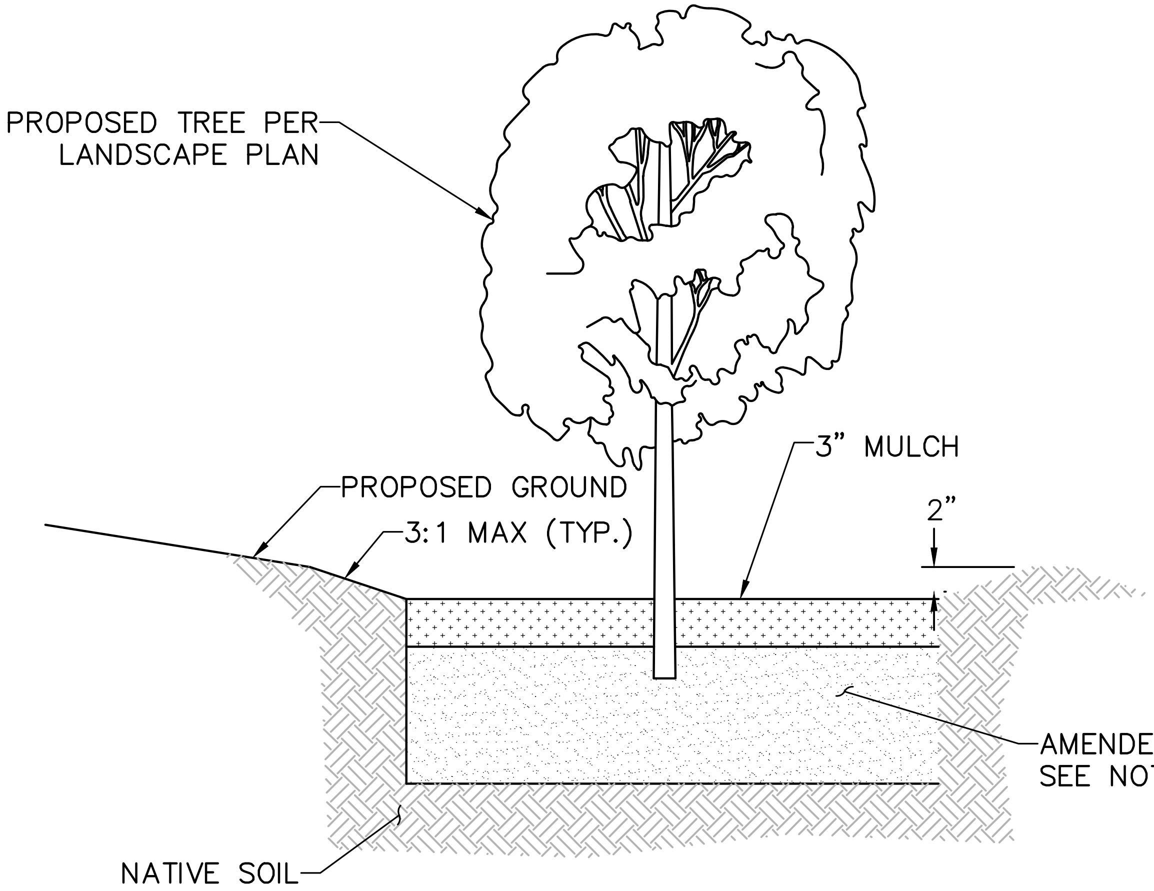
Tree Wells

Date:	Inspector:	BMP ID No.:
Permit No.:	APN(s):	

INSPECTION AND MAINTENANCE CHECKLIST FOR SD-1 TREE WELLS PAGE 2 of 2			
Threshold/Indicator	**Maintenance Recommendation**	**Date**	**Description of Maintenance Conducted**
Presence of mosquitos/larvae For images of egg rafts, larva, pupa, and adult mosquitos, see http://www.mosquito.org/biology Maintenance Needed? ☐ YES ☐ NO ☐ N/A	☐ Disperse any standing water from the tree well to nearby landscaping ☐ Loosen or replace soils surrounding the tree to restore drainage (and prevent standing water) ☐ Other / Comments:		
Entrance / opening to the tree well is blocked such that storm water will not drain into the tree well (e.g., a curb inlet opening is blocked by debris or a grate is clogged causing runoff to flow around instead of into the tree well; or a surface depression is filled such that runoff drains away from the tree well) Maintenance Needed? ☐ YES ☐ NO ☐ N/A	☐ Make repairs as appropriate to restore drainage into the tree well ☐ Other / Comments:		

Intentionally Left Blank

DETAILS



A STREET TREE DETAIL

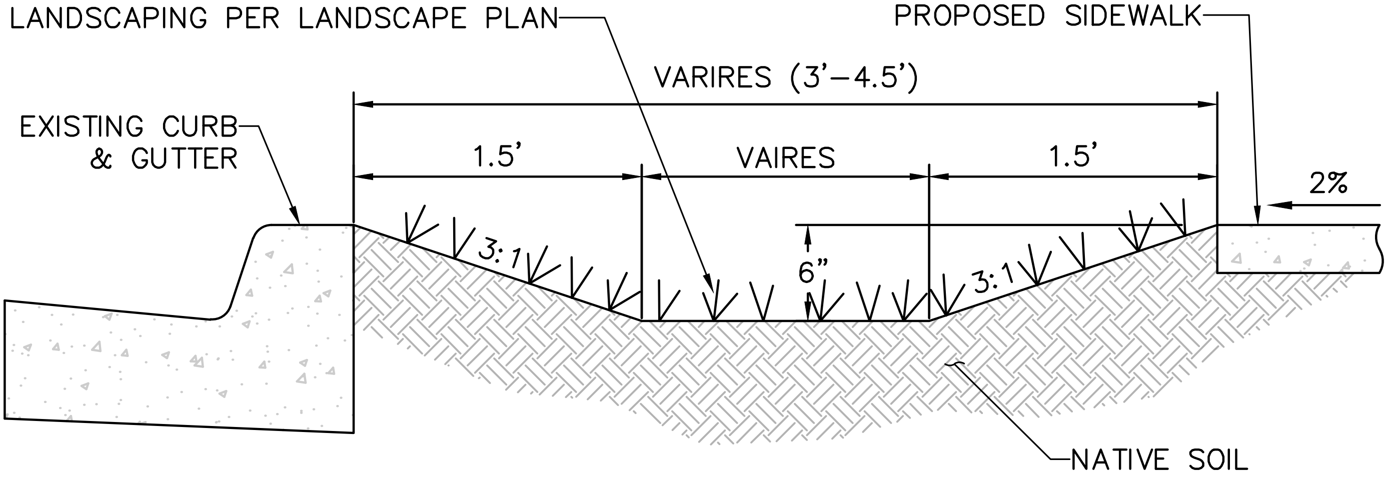
NOT TO SCALE

AMENDED SOIL NOTE:

1. SOIL MIX PER COUNTY OF SAN DIEGO COUNTY BMP MANUAL

2. "WELL DRAINED SOIL" SHALL BE "SANDY LOAM" SOIL MIX WITH NO MORE THAN 5% CLAY CONTENT. THE MIX SHALL CONTAIN 50–60% SAND, 20–30% COMPOST OR HARDWOOD MULCH, AND 20–30% TOPSOIL.

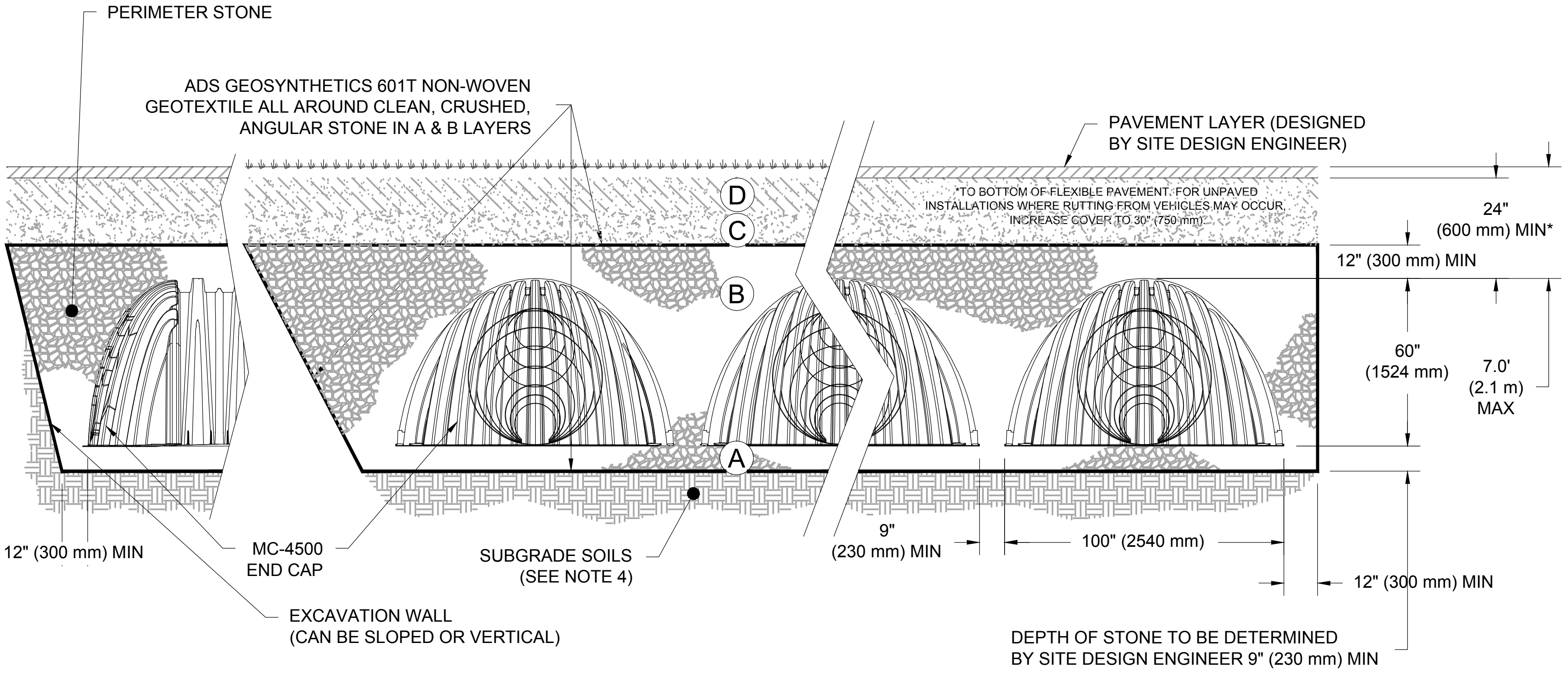
DETAILS



B VEGETATED SWALE DETAIL

NOT TO SCALE

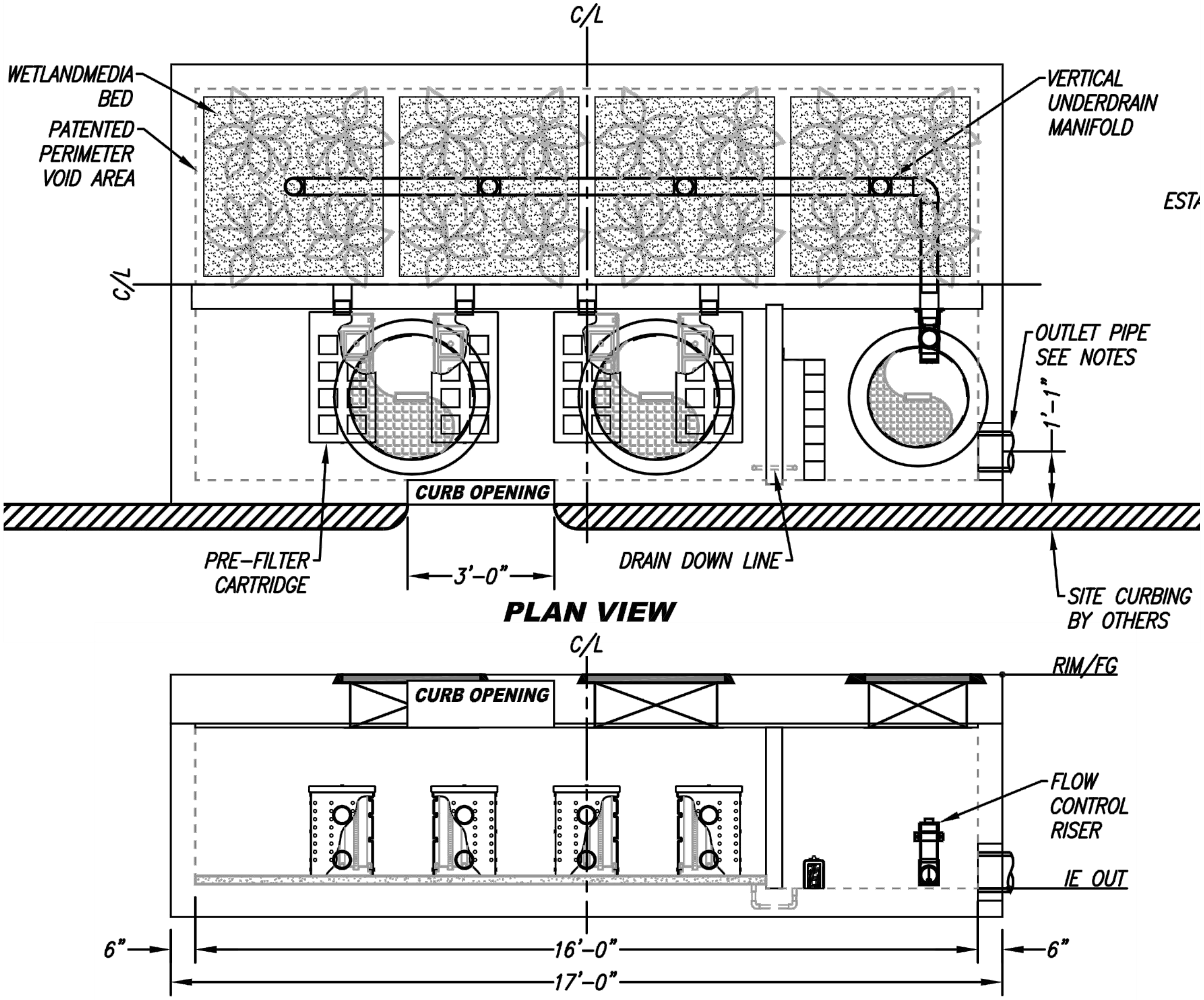
DETAILS



Ⓒ UNDERGROUND DETENTION SYSTEM

NOT TO SCALE

DETAILS

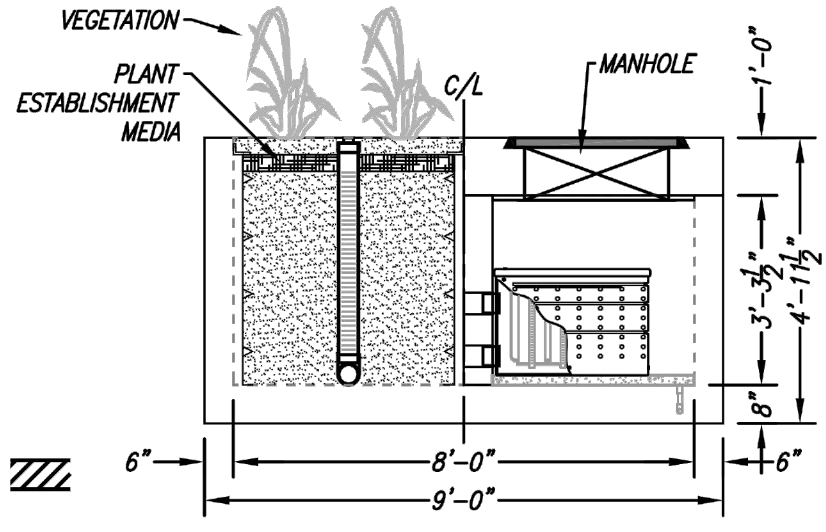


ELEVATION VIEW

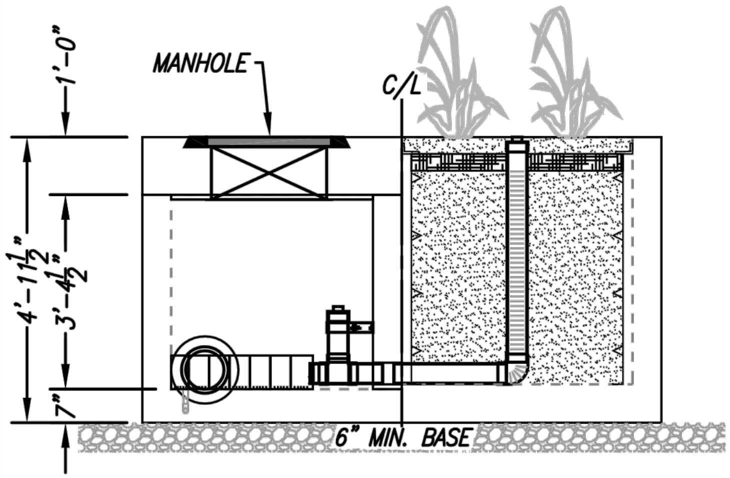
D MODULAR WETLAND

NOT TO SCALE

DETAILS



LEFT END VIEW



RIGHT END VIEW

E

MODULAR WETLAND

NOT TO SCALE