Appendix F2
Preliminary Low Impact Development Plan

Preliminary Low Impact Development (LID) Plan

Prepared for:
Melia Homes
8951 Research Drive, Suite 100
Irvine, CA 92618-4237
(949) 759-4367

Property:
APN 6106-013-040
TTM 82390
1515 West 178th Street
Gardena, California 90248

Prepared by:
C&V Consulting, Inc.
6 Orchard, Suite 200
Lake Forest, CA 92630
(949) 916-3800
Dane McDougall, P.E

Preparation Date:
November 2018
Revised April 2019

Receipt of WDID

REPLACE THIS SHEET

To be provided during Final Engineering

Notice of Intent

REPLACE THIS SHEET

To be provided during Final Engineering

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Owner/Developer
Approval and Certification
of the
Preliminary Low Impact Development (LID) Plan

Project Name: ***Gardena***

Project Number: **Tentative Tract 82390**
APN 6106-013-040

Project Address: **1515 West 178TH Street**
Gardena, CA 90248

This Low Impact Development (LID) Plan for the ***TTM 82390 Gardena*** project has been prepared for Melia Homes by C&V Consulting, Inc. It is intended to comply with the requirements of the City of Gardena and County of Los Angeles's Conditions of Approval.

The undersigned is authorized to approve implementation of provisions of this plan as appropriate, and will strive to have the plan carried out by successors consistent with the County of Los Angeles LID Manual and the intent of the NPDES storm water requirements.

"I certify under penalty of law that this document and all attachments were prepared under my jurisdiction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathered the information, to the best of my knowledge and belief, the information submitted is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

Owner/Developer Signature	Date
Chad Brown, Vice President	**(949) 759-4367**
Owner/Developer's Name and Title	Telephone Number

Section 200

A. Contact Information/List of Responsible Parties

The property contact information is:

Chad Brown
Tel: (949) 759-4367
Melia Homes
8951 Research Drive, Suite 100
Irvine, CA 92618-4237

The property owner shall have primary responsibility and significant authority for the implementation, maintenance, and inspection of the property BMPs. Duties of the Owner include but are not limited to:

- Implementing all elements of the LID, including but not limited to:
  - Implementation of prompt and effective erosion and sediment control measures
  - Implementing all non-storm water management, and materials and waste management activities, such as: monitoring, discharges, general site clean-up; vehicle and equipment cleaning, spill control; good construction housekeeping to ensure that no materials other than storm water are discharged which may have an adverse effect on receiving waters or storm drain systems, etc.
- Pre-storm inspections
- Storm event inspections
- Post-storm inspections
- Routine inspections as described in the LID
- Ensuring elimination of all unauthorized discharges
- The Owner shall be assigned authority to mobilize crews in order to make immediate repairs to the control measures.
- Coordinate all of the necessary corrections/repairs are made immediately, and that the project complies with the LID at all times.
- Managing and report any Illicit Connections or Illegal Discharges.

Section 300

A. References

The following documents are made a part of this SUSMP by reference:

- Project plans and specifications for the City of Gardena to support the ***TTM 82390 Gardena*** project, prepared by C&V Consulting, Inc., 6 Orchard, Suite 200, Lake Forest, CA 92630.

- County of Los Angeles Department of Public Works, Low Impact Development Standards Manual dated February 2014

- State Water Resources Control Board (SWRCB) National Pollutant Discharge Elimination System (NPDES) General Permit for Storm Water Discharges Associated with Construction and Land Disturbance Activities, Order No. 2009-0009-DWQ, NPDES No. CAS000002 dated July 1, 2010

- California Stormwater BMP Handbook – Construction, January 2009.

- California Stormwater BMP Handbook – New Development and Redevelopment, January 2003.

- Los Angeles County Municipal Stormwater/ NPDES Permit Order R4-2012-0175

Section 400 – Body of SUSMP

A. Objectives

This Low Impact Development (LID) Plan has four main objectives:

1) Identify all pollutant sources, including sources of sediment that may affect the quality of storm water discharges associated with daily use / activity (storm water discharges) from the property site.
2) Identify non-storm water discharges.
3) Identify, construct, implement and maintain Best Management Practices (BMPs) to reduce or eliminate pollutants in storm water discharges and authorized non-storm water discharges from the property site.
4) Develop a maintenance schedule for BMPs designed to reduce or eliminate pollutants.

B. Project Background and Description

The proposed project is located at 1515 West 178TH Street, in the City of Gardena, County of Los Angeles. The site is bordered by West 178TH Street to the south, existing commercial facility to east, existing mobile home facility to the west, and existing vacant dirt lot & horse stables to the north. The subject project site proposes 120 townhome units and a recreational area over approximately 5.63 acres. The proposed development will include drive aisles, parking, landscaping, walkways and common open space areas.

The entire project site is currently being utilized as a commercial facility that provides freight shipping services. Associated improvement within the site include one large warehouse. Other site improvements consist of chain link, wood, masonry and rod-iron fencing along most of the property lines. The elevations within the site generally vary from approximately 32 to 41 feet above mean sea level (MSL).

C. Vicinity Map

Please refer to Figures 1 & 2 for Vicinity and Location maps.

D. Existing Site Drainage Condition

In the current condition, half of the site generally sheet flows over land towards the northwest corner of the site where there is an existing onsite storm drain inlet. Stormwater runoff entering this existing onsite storm drain inlet presumably continues to travel to the subsequent storm drain system and finally discharges into the Dominguez Channel. The other half of the site generally sheet flows over land towards southwest corner of the site and discharges to West 178th Street. On West 178th Street, stormwater runoff is conveyed via street flow within the existing curb/gutter in the westerly direction and enters an existing catch basin located about 120 feet west of the site. Stormwater runoff enters this existing catch basin, continues within an existing LACFCD 48” Reinforced Concrete Pipe BI 0432 – Line C in the northerly direction, and discharges into the Dominguez Channel.

E. Proposed Site Drainage Condition

The proposed project site will be graded to collect runoff at various low points throughout the site in order to control amount of imported fill during grading and the overall height of existing perimeter retaining walls. Stormwater runoff generated by the entire site will be conveyed to various low points equipped with catch basins on site. Each catch basin inlet will be equipped with Dvert System to divert low flows during smaller storm events or the first flush portion of the larger storm events to proposed Modular Wetlands System (MWS) Biofiltration Vaults for water quality treatment. The proposed development will utilize catch basins and an onsite area drain system to collect and convey stormwater runoff to a proposed underground storm drain system. The stormwater runoff will be conveyed offsite via a proposed LACFCD connection to the existing 48" RCP storm drain system within West 178th Street and discharges into the existing Dominguez Channel.

During larger storm events when treatment systems are at capacity, overflow runoff will be facilitated by the proposed grading by draining half of the project site to the northwest corner, matching the historic drainage condition. Wall knockouts will be provided for emergency overflow. The proposed catch basins will also be equipped with internal bypass systems to convey larger storm event overflow conditions.

Refer to the separately prepared Vesting Tentative Tract Map No. 82390 Plans by C&V Consulting, Inc. for additional information.

F. SUSMP Project Types, Characteristics, & Activities

This proposed development of 120 units of townhomes is subject to the County of Los Angeles's requirement for the LID under the "Designated Project" category. According to the County's LID Standards Manual 2014 – Section 2, Designated Projects are identified as "Redevelopment projects, which are developments that result in creation or addition or replacement of either: (1) 5,000 square feet or more of impervious surface on a site that was previously developed as described in the above bullets; or (2) 10,000 square feet or more of impervious surface area on a site that was previously developed as a single family home".

G. Pollutant Source Identification and BMP Selection

The following is a list of materials to be used in the daily construction activities at the project site, which will potentially contribute to pollutants, other than sediment, to storm water runoff. Control Practices for each activity are identified below:

- Vehicle fluids, including oil, grease, petroleum, and coolants from personal vehicles
- Landscaping materials and wastes (topsoil, plant materials, herbicides, fertilizers, mulch, pesticides)
- General trash debris and litter
- Pet waste (bacteria/ fecal coliforms)

The Best Management Practices (BMPs) that have been selected for implementation on this project are detailed in the following sections.

H. Source Control BMPs

Project proponents shall implement Site Design concepts that achieve each of the following:

- Minimize Urban Runoff
- Minimize Impervious Footprint
- Conserve Natural Areas
- Minimize Directly Connected Impervious Areas (DCIAs)

The following tables identify the source control and treatment BMPs and how each implemented to achieve each Site Design concept.

Table-1: Source Control BMPs

BMP	BMP DESCRIPTION	CHECK ONE		IF NOT APPLICABLE, STATE BRIEF REASON
		INCLUDED?	NOT APPLICABLE	
	Non-Structural Source Control BMPs:			
	Education for Leasers', Operators, Occupants, or Employees	X		
	Activity Restrictions (CC&Rs)	X		
SD-12	Efficient Irrigation System and Landscape Maintenance	X		
	Common Area Litter Control	X		
SE-7	Street Sweeping Private Streets and Parking Lots	X		
	Drainage Facility Inspection and Maintenance	X		
	Structural Source Control BMPs:			
SD-13	MS4 Stenciling and Signage	X		
SD-10	Landscape and Irrigation System Design	X		

BMP	BMP DESCRIPTION	CHECK ONE		IF NOT APPLICABLE, STATE BRIEF REASON
		INCLUDED?	NOT APPLICABLE	
SD-11	Roof Runoff Controls	X		
	Protect Slopes and Channels		X	No proposed slopes and channels.
SD-30	Provide Community Car Wash Racks		X	Car Wash Racks are not permitted within the proposed development – Not Applicable.
	Proper Site Design:			
SD-30	Fueling Areas		X	No Fueling Areas
SD-33	Air/Water Supply Area Drainage		X	No Air/Water Supply
SD-32	Trash Storage Areas		X	No proposed trash enclosures, individual unit trash bins will be provided.
SD-31	Loading Docks		X	Not Applicable
SD-31	Maintenance Bays		X	No Maintenance Bays
SD-33	Vehicle and Equipment Wash Areas		X	No Wash Areas
SD-35	Outdoor Material Storage Areas		X	No Material Storage
SD-36	Outdoor Work Areas or Processing Areas		X	No Work Areas
	Provide Wash Water Controls for Food Preparation Areas		X	No Food Prep Areas
	Pool Water Draining	X		

Non-Structural Measures

Non-structural BMPs are generally managerial, educational, inspection and/ or maintenance oriented. These items consist of educating employees and occupants, developing and implementing HOA guidelines, implementing BMPs and enforcing Code requirements. Non-structural BMPs used for this project are summarized below:

Education for Employees and Occupants

Practical informational materials will be provided to homeowners, HOA and employees on general good housekeeping practices that contribute to protection of storm water quality. Among other things, these materials will describe the use of chemicals (including household type) that should be limited to the property, with no discharge of specified wastes via hosing or other direct discharge to gutters, catch basins and storm

drains. Initially, the Owner will provide these materials. Thereafter, such materials will be available through the HOA education program.

This program must be maintained, enforced, and updated periodically by the HOA. Educational materials including, but not limited to, the materials included in the Appendix F of this plan will be made available to the employees and contractors of the HOA.

Activity Restrictions
Activities on this site will be limited to activities related to residential living. The project's Conditions, Covenants, and Restrictions (CC&Rs) will outline the activities that are restricted on the property. Such activities related to the SUSMP include car washing, car maintenance and disposal of used motor fluids, pet waste cleanup, and trash container areas.

Efficient Landscape System & Landscape Maintenance
Management programs will be designed and established by the HOA, who will maintain the common areas within the project site. These programs will include how to mitigate the potential dangers of fertilizer and pesticide usage (refer to the Maintenance and Frequency Table). Ongoing maintenance will be consistent with the State of California Model- Water Efficient Landscape Ordinance. Fertilizer and pesticide usage shall be consistent with County Management Guidelines for use of Fertilizers and Pesticides.

Common Area Litter Control
The HOA will be required to implement trash management and litter control procedures in the common areas aimed at reducing pollution of drainage water. The HOA may also contract with their landscape maintenance firm to provide this service during regularly scheduled maintenance, which should consist of litter patrol, emptying of trash receptacles in common areas, and noting trash disposal violations and reporting the violations to the HOA for remediation.

Trash Enclosures
Proposed trash enclosures will not be included in this development. Instead, individual unit trash bins will be provided

Street Sweeping in Private Streets and Parking Lots
The HOA shall have all streets and parking lots swept on a weekly basis. This procedure will be intensified around October 15th of each year prior to and throughout rain storm period.

Drainage Facility Inspection & Maintenance
The HOA will be responsible for implementing each of the BMPs detailed in this plan. The HOA will also be responsible for cleaning and maintaining the BMPs on a regular basis. Maintenance operations should be logged in Appendix G. Refer to Appendix C for site specific drainage BMP information.

Storm Drain Stenciling/ Signage
Phrase "No Dumping – Drains to Ocean" or equally effective phrase to be stenciled on catch basins to alert the public to the destination of pollutants discharged into storm water. This stenciling will be inspected and re-stenciled on a periodic basis by the HOA. Refer to Table 4 for maintenance frequency.

Landscape & Irrigation System Design
As part of the design of all common area landscape irrigation shall employ water conservation principals, including, but not limited to, such provisions as water sensors, programmable irrigation times (for short cycles), etc. will be used. Such common areas will be maintained by the HOA.

Title 22 CC&R Compliance
The HOA will comply with this Regulation as part of the development's CC&Rs. CC&Rs will be prepared as a separate document and reviewed by the City's Attorney.

Los Angeles County Fire Department Code Implementation
The HOA will comply with this Code as part of the development's CC&Rs. CC&Rs will be prepared as a separate document and reviewed by the City's Attorney.

Employee Training
A training program will be established as it would apply to future employees, contractors, and homeowners of the HOA to inform and train in maintenance activities regarding the impact of dumping oil, paints, solvents, or other potentially harmful chemicals into storm drains; the proper use of fertilizers and pesticides in landscaping maintenance practices; and the impacts of littering and improper water disposal.

The HOA (or a hired firm) will conduct the training program which will include targeted training sessions with specific construction disciplines (landscaping, concrete finishers, painters, etc.). See Appendix F for examples of educational materials that will be provided to the Employees.

The project's CC&Rs will include provisions for future employee training programs conducted on a yearly based prior to the rainy season.

Pool Water Draining
Pool drain shall be connected to separate sanitary sewer system. HOA responsible for discharging any pool draining activities to sanitary sewer system. Pool water discharge to the storm drain system is prohibited.

I. Structural BMPs

Structural BMPs shall be installed by the developer, through the construction and development of the project, for instance; landscaping and irrigation systems shall be designed by licensed landscape architects and installed by qualified contractors to specifications and standards of the City of Gardena. The structural BMPs used for this project are summarized below:

With this project we anticipate sediment runoff during construction, on-site trash, and the potential of on-site automobile oil. To mitigate these pollutants, we propose the structural best management practices listed.

Table-2: Design BMPs

BMP	TECHNIQUE	INCLUDED? YES	INCLUDED? NO	BRIEF DESCRIPTION OF METHOD
SD-10	Minimize Impervious Area/Maximize Permeability (C-Factor Reduction)	X		We have incorporated landscape areas wherever possible within the project site. See Appendix B for details.
	Minimize Directly Connected Impervious Areas (DCIAs) (C-Factor Reduction)	X		We minimize DCIAs by limiting sidewalks and parking areas to the minimum necessary for proper use. Stepping stones are used in areas with minimal foot traffic.
	Create Reduced or "Zero Discharge" Areas (Runoff Volume Reduction)	X		The site runoff will be treated prior to discharge from the site.

Table-3: Treatment BMPs

BMP	NAME	INCLUDED? YES	INCLUDED? NO	IF NOT APPLICABLE, STATE BRIEF REASON
BIO-1	Biofiltration	X		
TC-31	Vegetated (Grass) Strips		X	Alternative BMP selected.
TC-30	Vegetated (Grass) Swales		X	Alternative BMP selected.
MP-40	Media Filter		X	Alternative BMP selected
MP-52	Drain Inserts	X		
TC-22	Dry Detention Basin (Extended Detention Basin)		X	Alternative BMP selected.
TC-20	Wet Detention Basin		X	Alternative BMP selected.
TC-21	Constructed Wetland		X	Alternative BMP selected.
TC-12	Retention/Irrigation		X	Alternative BMP selected.
TC-11	Infiltration Basin		X	Alternative BMP selected.

BMP	NAME	INCLUDED? YES	INCLUDED? NO	IF NOT APPLICABLE, STATE BRIEF REASON
TC-10	Infiltration Trench		X	Alternative BMP selected.
TC-40	Media Filter		X	Alternative BMP selected.
TC-32	Bioretention		X	Alternative BMP selected.

Drainage Management Area (DMA)	Area Size (ac)	Treatment Flow Rate = 1.5 x $Q_{85th\ peak}$ (cfs)	Treatment Capacity (cfs)	MWS Model
A1	0.44	0.172	0.231	MWS-L-8-8
A2	0.86	0.316	0.346	MWS-L-8-12
A3	1.19	0.414	0.462	MWS-L-8-16
A4	0.51	0.193	0.231	MWS-L-8-8
A5	1.06	0.322	0.346	MWS-L-8-12
A6	1.57	0.451	0.462	MWS-L-8-16
Total	5.63	1.868	2.078	--

The proposed site of 5.63 acre will generate approximately 1.868 cfs based on the 85TH percentile 24-hr rain event. Stormwater runoff will be collected and treated by going through these proposed Modular Wetlands Systems (MWS) Biofiltration Vaults that have a total treatment capacity of approximately 2.078 cfs. Therefore, the proposed units will be able to provide more than enough treatment capacity for the project site.

The MWS Biofiltration system will address the Pollutants of Concern as water entering from proposed catch basins (Nutrients, Bacteria/ Viruses, Total Suspended Solids) and will treat the required water quality volume according to the Flow-Based Standard (Refer to Appendix C for matrix of MWS Flow-Based Model Specification).

The MWS Biofiltration Units will be installed near each proposed catch basin (Refer to Figure-3 for Preliminary LID Exhibit). Drainage from roof tops and landscape areas will be collected through area drains and entered the proposed catch basins. All curb inlet catch basins will be equipped with trash racks for pretreatment and Dvert System to divert low flows to proposed MWS Biofiltration Vaults for water quality treatment.

Biofiltration

Much of the site will be swept to remove litter. Stormwater runoff in the street and parking areas will flow to the proposed catch basin through a biofiltration system and stormwater runoff in the landscape areas will flow over land to area drains which will connect to the catch basins and be treated.

Catch Basin Inspection
The HOA will maintain the drainage systems, including catch basins and culverts. The HOA is required to have catch basins inspected and, if necessary, cleaned prior to the storm season, no later than October 15th each year or prior to the first 24-hour storm event, whichever occurs first. These duties may be contracted out to the landscape maintenance firm hired by the HOA. Please see Appendix E for maintenance program. Maintenance operations should be logged in Appendix G.

Runoff-Minimizing Landscape Design
As part of the design of all common landscape areas with similar planting material with similar water requirements will be used in order to reduce excess irrigation runoff and promote surface filtration. Such common landscape areas will be maintained by the HOA.

Community Car Wash Racks
No community car wash rack or area will be provided, therefore, washing of vehicles by residents on the property will not be allowed per the CC&Rs.

Wash Water Controls for Food Preparation Areas
A sign will be posted indicating that discharge of wash water to the municipal storm drain system is prohibited. All wash water should be disposed of to the sanitary sewer system. Restrictions will be enforced per the CC&Rs.

Self Contained Washing
Self-contained washing of vehicles by residents or owners on the property will not be allowed per the CC&Rs.

Outdoor Material Storage Areas
Outdoor material storage areas refer to storage areas or storage facilities solely for the storage of materials. Improper storage of materials outdoors may provide an opportunity for toxic compounds, oil and grease, heavy metals, nutrients, suspended solids, and other pollutants to enter the storm water conveyance system. Outdoor Storage by residents or owners on the property will not be allowed per the CC&Rs.

J. BMP Maintenance, Inspection, and Repair

Inspections will be conducted as follows:

- Annually prior to the start of the rainy season
- Every (1) month during rainy season
- At any other time(s) or intervals of time specified in the contract documents

An inspection form shall be completed at least once per year prior to the start of the rainy season. This inspection check sheet (Refer to Appendix G) shall be included in this report and kept onsite at all times. The check sheet should be filled out completely and clearly indicate any BMPs that are in need of repair or maintenance. These repairs and/ or maintenance procedures shall be carried out at the soonest possible time.

A legible log shall be kept on site to record the inspection of the stormwater pollution abatement control measures. The record must contain the following information: (i) type of maintenance activities or source-control practices; (ii) date the activities are completed; and (iii) the name of the operator performing the activities. During transfer of ownership/operation of the facility, the current owner must notify the new owner/operator of the BMPs and the associated maintenance activities that also transfer to the new owner/operator of the property. Refer to Appendix G.

K. Inspection, Maintenance, and Responsibility for BMPs

The following tables show the lists of the post-construction BMPs (routine non-structural and structural), the required ongoing maintenance, the inspection and maintenance frequency, the inspection criteria, and the entity or party responsible for implementation, maintenance, and/or inspection.

Table-4: Non-Structural BMP Maintenance Responsibility/Frequency Matrix

BMP	RESPONSIBILITY	FREQUENCY
Homeowner/ Business owner Education, Activity Restrictions	HOA will provide educational materials. Those materials and responsibilities must be passed onto subsequent property owners.	Continuous. CC&Rs to be provided to homeowners at the time they purchase the property and updates provided by the HOA as they occur.
Common Area Landscape Management	HOA will appoint a landscape maintenance contractor	Monthly during regular maintenance and use with management guidelines for use of fertilizers and pesticides. Landscape Contractor shall remove all landscaping “cuttings” from the site and recycle. No proposed separate green waste receptables onsite.

BMP	RESPONSIBILITY	FREQUENCY
Parking Areas and Drives Management	HOA will appoint a landscape maintenance contractor	The Drives Aisles are to be swept on a routine scheduled basis to facilitate the pickup of trash and debris (plant or otherwise) and to remove excessive oil, grease and build-up. During sweeping, debris is to be removed from the parking areas and drives and then scrubbed and rinsed. This sweeping schedule will be at a minimum occurrence of once a week and as necessary to rid / reduce active pollutants from the pavement areas. This maintenance requirement will be listed in the Convent, Conditions and Restrictions (CC&Rs) of this project. These CC&Rs will be recorded to the property at the County Recorder's Office and be included on the final Title report of these properties.
Litter Control by Sweeping	HOA will appoint a landscape maintenance contractor.	Weekly inspection of trash receptacles to ensure that lids are closed and pick up any excess trash on the ground, noting trash disposal violations to the HOA for remediation.
Employee Training	HOA will appoint a landscape contractor after construction.	Monthly for maintenance personnel and employees to include the educational materials contained in the approved SUSMP.
Common Area Catch Basin Inspection & Cleaning	HOA will appoint a landscape maintenance contractor for common areas and storm drain facilities.	Inspect basins once a month. Clean debris and silt in bottom of catch basins as needed. Intensify on or about October 15th each year or prior to the first 24-hour storm event, whichever occurs first. Refer to Appendix E.

Table-5: Structural BMP Maintenance Responsibility/ Frequency Matrix

BMP	RESPONSIBILITY	FREQUENCY
Common Area Efficient Irrigation	HOA will appoint a landscape contractor after construction	Once a week, in conjunction with maintenance activities. Verify that runoff minimizing landscape design continues to function by checking that water sensors are functioning properly, that irrigation heads are adjusted properly to eliminate overspray

BMP	RESPONSIBILITY	FREQUENCY
		to hardscape areas, and to verify that irrigation timing and cycle lengths are adjusted in accordance with water demands, given time of year, weather and day or night time temperatures.
Common Area Runoff Efficient Landscape Design	HOA will appoint a landscape maintenance contractor	Once a week in conjunction with maintenance activities and prior to finalizing any replanting schemes. Verify that plants continue to be grouped according to similar water requirements in order to reduce excess irrigation runoff.
Curb Inlet Catch Basin Trash Rack	HOA	Inspection three times per year, at minimum or per manufacturer's specifications. Replacement of trash rack once per year, prior to start of rainy season (October 15TH). Repair and/or replacement of components as needed. Clean and remove all debris at least once per month.
Modular Wetlands System, Biofiltration Unit	HOA after construction.	Modular Wetlands System Biofiltration Unit maintenance will conform to manufacturer's specifications. Please see additional information in Appendix C.

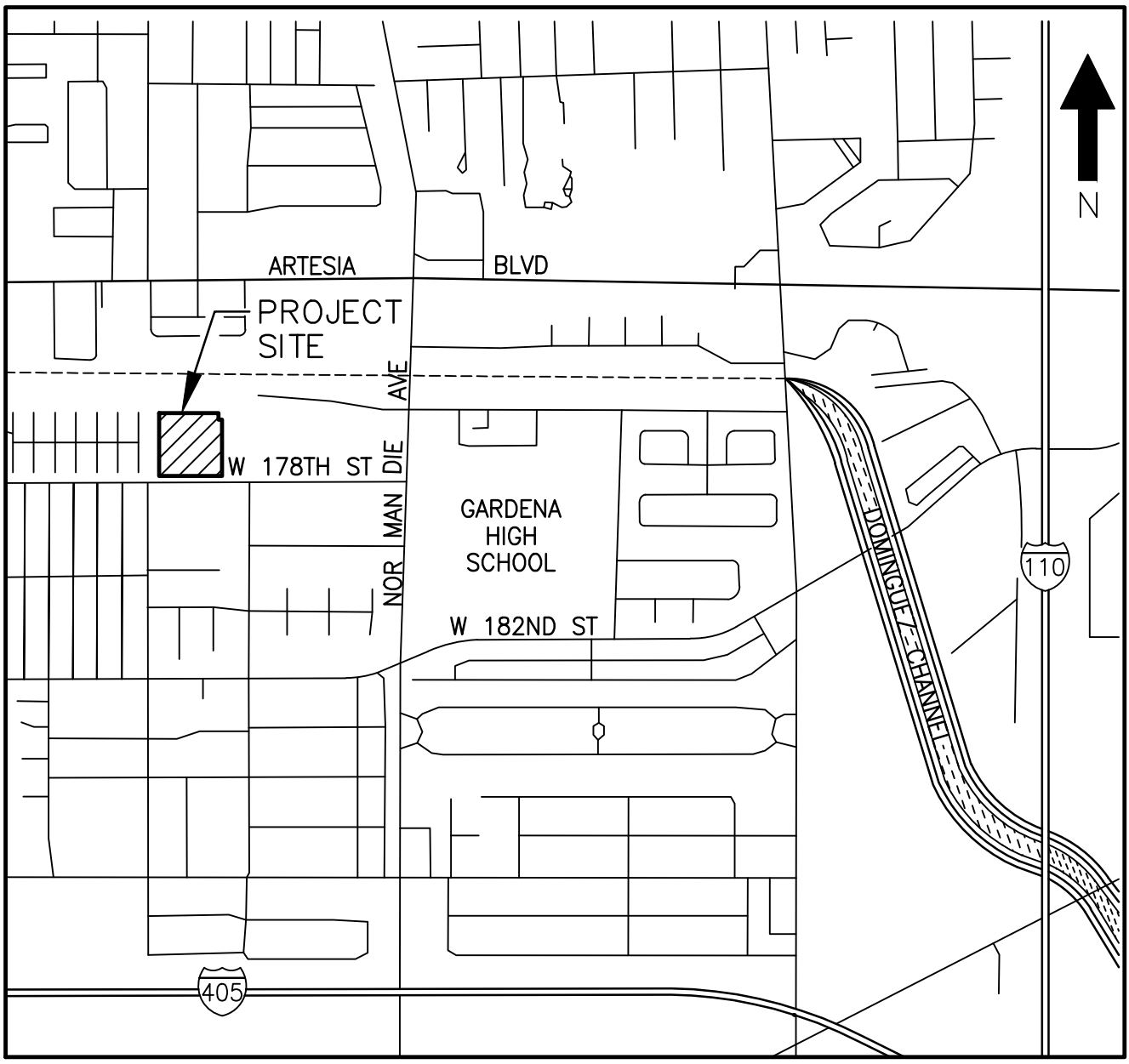
L. Operation/Maintenance Funding after Project Completion

The post-construction BMPs as described above will be funded and maintained by:

Chad Brown
Tel: (949) 759-4367
Melia Homes
8951 Research Drive, Suite 100
Irvine, CA 92618-4237

- Maintenance and requirements of the maintenance for the properties will be listed in the Convent, Conditions and Restrictions (CC&Rs) of this project and will be the responsibility of the property owner at all times. These CC&Rs will be recorded to the property at the County Recorder's Office and be included on the Title report of these properties.

Figure -1:
Project Vicinity Map



VICINITY MAP

NOT TO SCALE

Figure -2:
Project Location Map

MELA-002
West 178th Street
In the City of Gardena
Tentative Tract No. 82390

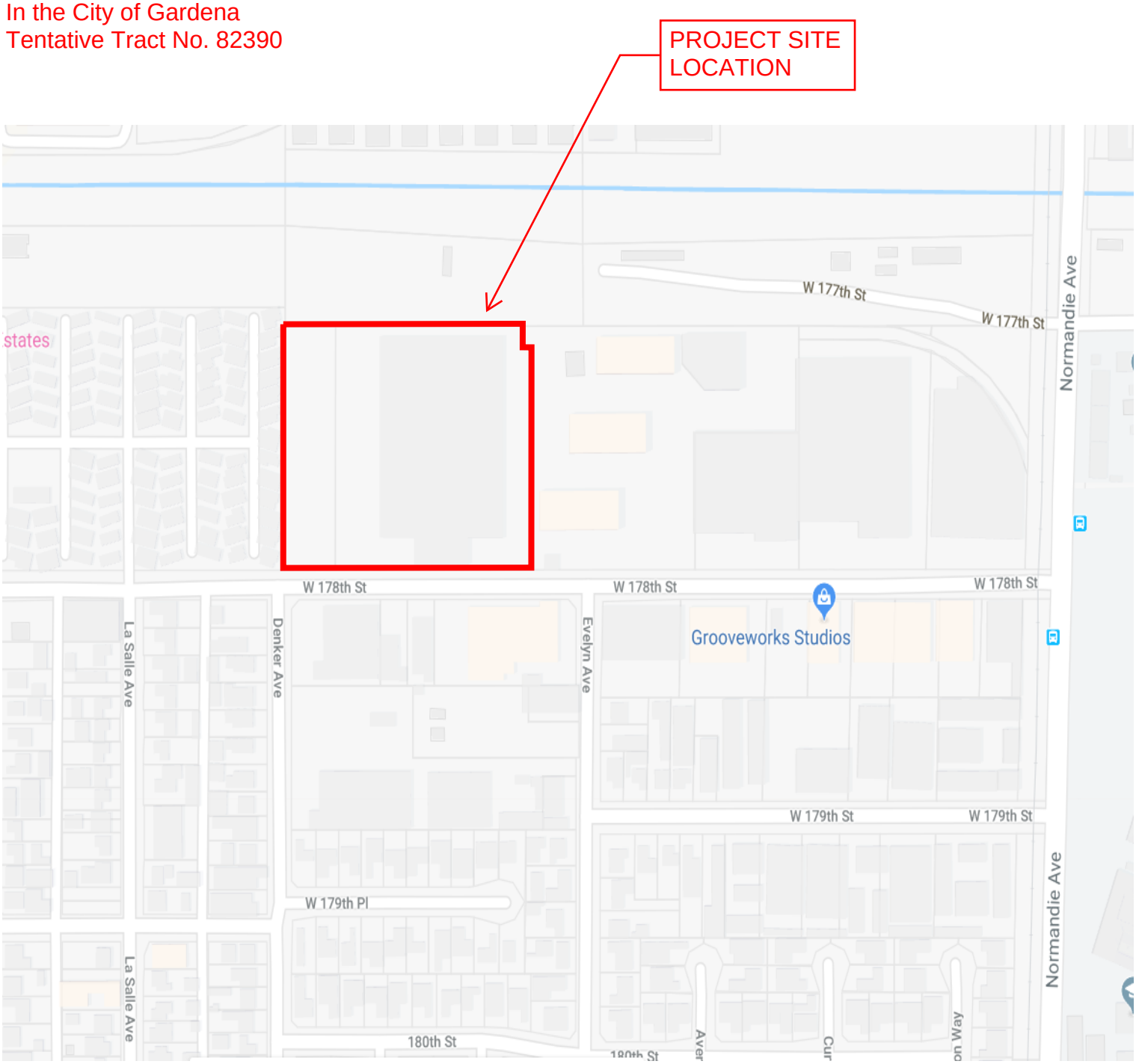
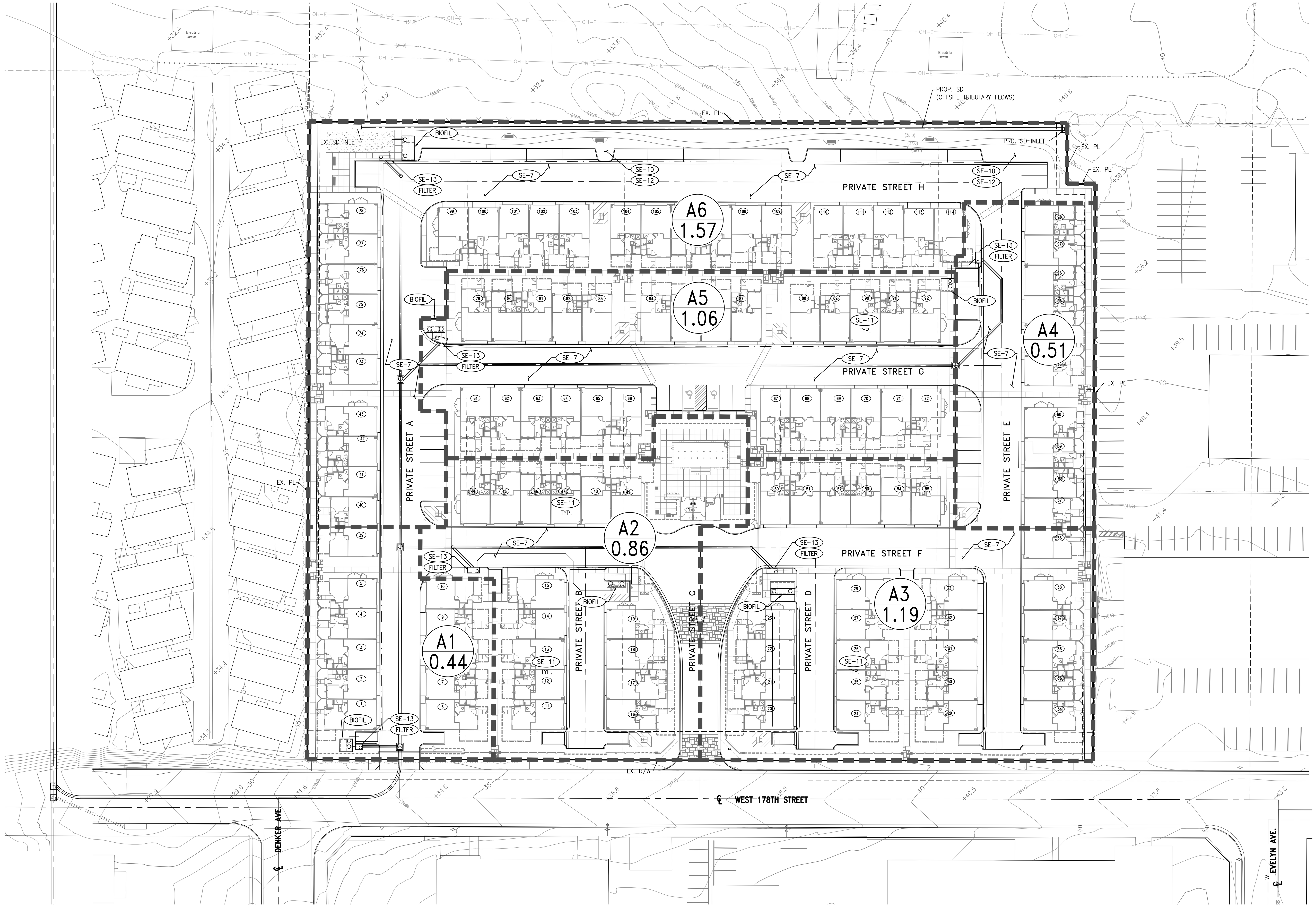


Figure -3:
Preliminary LID Exhibit

PRELIMINARY LID EXHIBIT
FOR TENTATIVE TRACT NO. 82390
CITY OF GARDENA COUNTY OF LOS ANGELES, STATE OF CALIFORNIA



LEGEND

- DRAINAGE AREA BOUNDARY
- XX / X.XX — DRAINAGE MANAGEMENT AREA (DMA) NUMBER; DMA AREA IN ACRE
- PROPOSED PRIVATE STORM DRAIN PIPE
- RIGHT-OF-WAY/ BOUNDARY
- PROPOSED CATCH BASIN
- PROPOSED BIOFILTRATION VAULT

BEST MANAGEMENT PRACTICES:

- SE-7 — PRIVATE STREET/ PARKING LOT SWEEPING & VACUUMING
- SD-10 — SITE DESIGN & LANDSCAPE PLANNING
- SD-11 — ROOF RUNOFF CONTROLS
- SD-12 — EFFICIENT IRRIGATION
- SD-13 — STORM DRAIN SYSTEM SIGNAGE
- BIOFIL — MODULAR WETLANDS SYSTEM (MWS) BIOFILTRATION UNIT (SEE REPORT FOR ADDITIONAL INFORMATION)
- FILTER — CATCH BASIN FILTER INSERT/ TRASH RACK OLDCASTLE (OR APPROVED EQUAL)

BMP SUMMARY

DMA	AREA (AC)	PERVIOUS AREA (AC)	% PERVIOUS	IMPERVIOUS AREA (AC)	% IMPERVIOUS	TREATMENT FLOW RATE (CFS)	TREATMENT CAPACITY (CFS)	MWS MODEL
1	0.44	0.06	14%	0.38	86%*	0.172	0.231	MWS-L-8-8
2	0.86	0.12	14%	0.74	86%*	0.316	0.346	MWS-L-8-12
3	1.19	0.17	14%	1.02	86%*	0.414	0.462	MWS-L-8-16
4	0.51	0.07	14%	0.43	86%*	0.193	0.231	MWS-L-8-8
5	1.06	0.15	14%	0.91	86%*	0.322	0.346	MWS-L-8-12
5	1.57	0.22	14%	1.35	86%*	0.451	0.462	MWS-L-8-16
TOTAL	5.63	0.79	14%	4.84	86%*	1.868	2.078	--

* 86% IMPERVIOUS AREA WAS ASSUMED FOR PROPOSED DEVELOPMENT IN THIS PRELIMINARY LID REPORT.

REVISIONS

NO	DATE	INITIAL	DESCRIPTION	APP	DATE

OWNER/DEVELOPER

MELIA HOMES
MELIA HOMES
8951 RESEARCH DR. #100
IRVINE, CA 92618
(949) 759-4367

PREPARED BY :

C&V CONSULTING, INC.
CIVIL ENGINEERING
LAND PLANNING & SURVEYING
6 ORCHARD, SUITE 200
LAKE FOREST, CA 92630
T. 949.916.3800
F. 949.916.3805
CVC-INC.NET

REGISTERED PROFESSIONAL ENGINEER
DANE P. MCDOUGALL
C 80705
CIVIL
STATE OF CALIFORNIA

TTM - 82390
1515 WEST 178TH STREET
GARDENA, CALIFORNIA

SHEET 1 OF 1

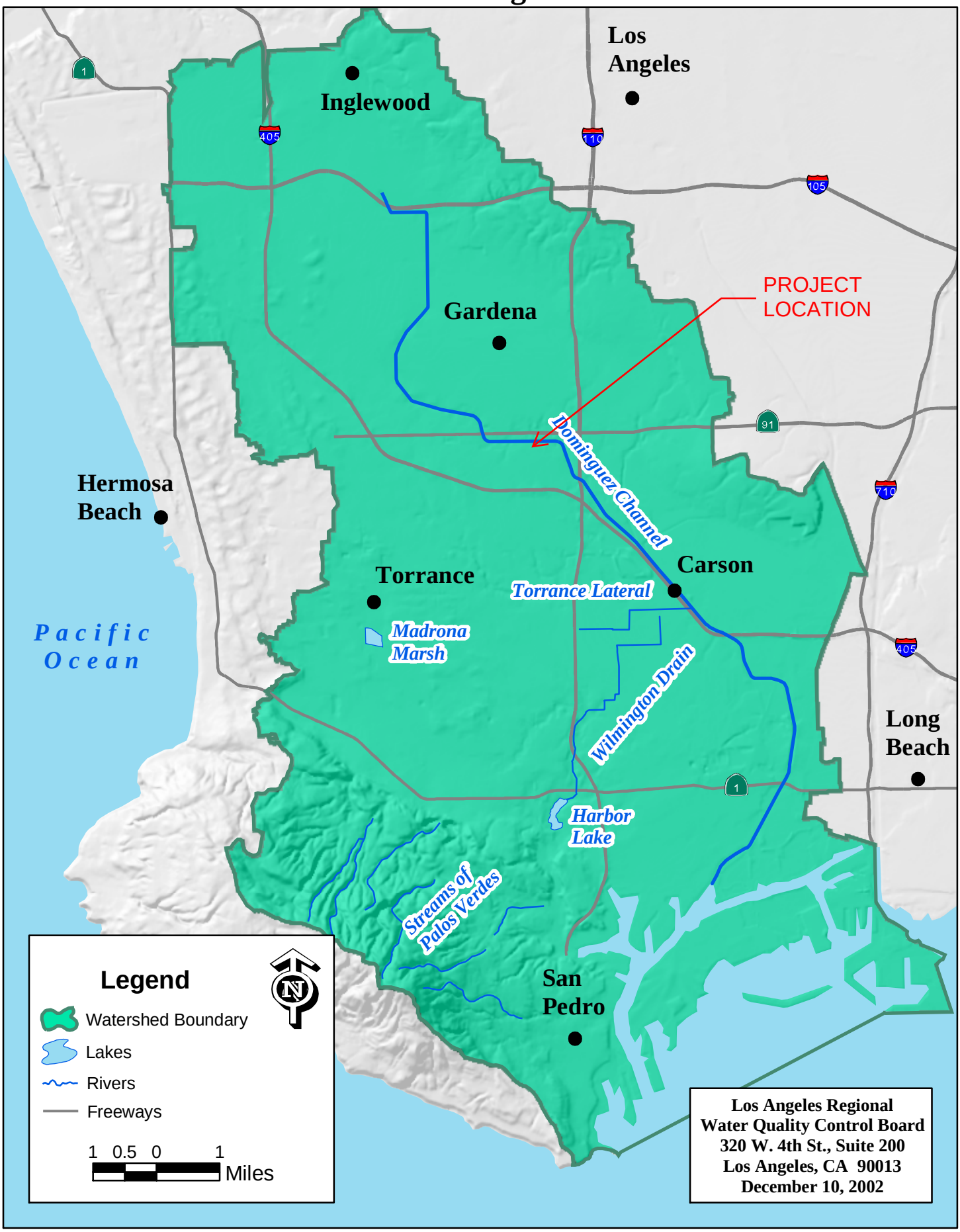
SCALE: AS SHOWN | DRAWN BY: LB | CHECKED BY: JH

CITY OF GARDENA

PLAN SET: PS02 DATE: 4/12/19 PROJ: MELA-002

Figure -4:
Impaired Waters

Dominguez Channel and Los Angeles/Long Beach Harbors Watershed Management Area



Appendix A:
Flow Rate Calculations & Hydrology Report

Refer to Tc & Flow rate calculations hereon for Post-Development 0.75” 24 hr storm event and 85 percentile 24 hr storm event.

Note: 85 percentile 24 hr governed for the design storm.

Refer separately prepared Preliminary Hydrology Report by C&V Consulting, Inc. dated November 2018 for additional information.

Peak Flow Hydrologic Analysis

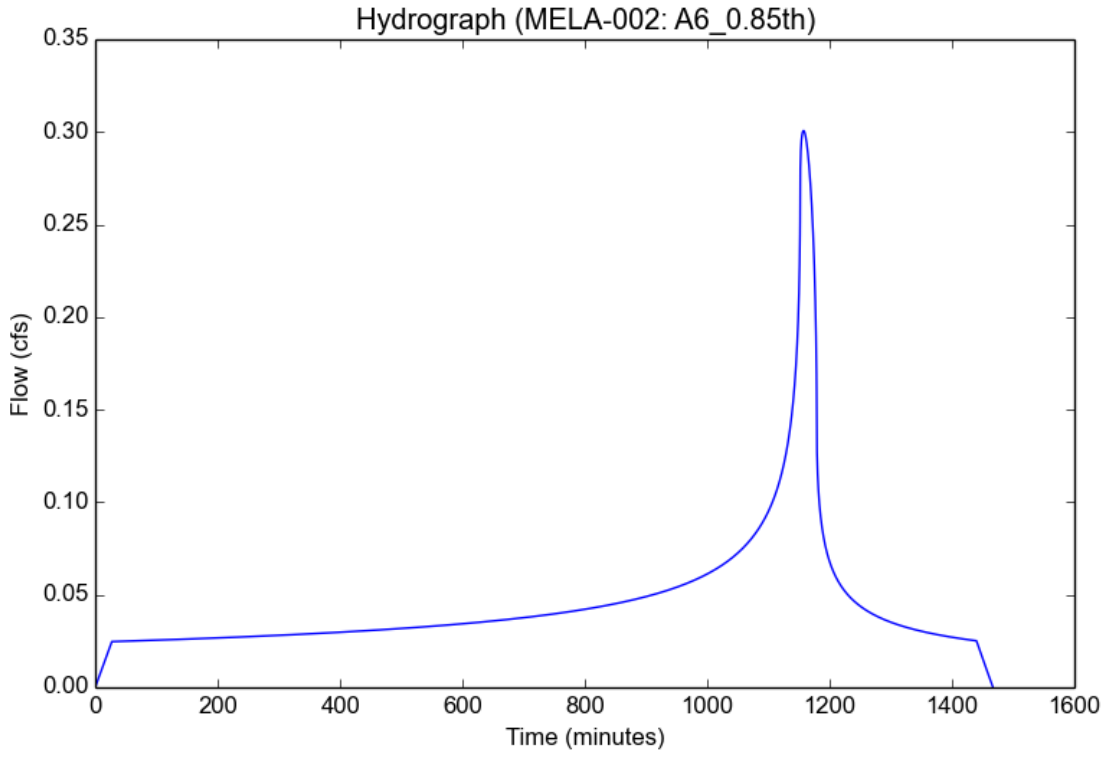
File location: P:/M/MELA-002/Admin/Reports/LID/Preliminary/Appendix A - Calcs/MELA-002 - A6_0.85th.pdf
Version: HydroCalc 1.0.3

Input Parameters

Project Name	MELA-002
Subarea ID	A6_0.85th
Area (ac)	1.57
Flow Path Length (ft)	456.2
Flow Path Slope (vft/hft)	0.008
85th Percentile Rainfall Depth (in)	0.9
Percent Impervious	0.86
Soil Type	13
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	0.9
Peak Intensity (in/hr)	0.2431
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.788
Time of Concentration (min)	27.0
Clear Peak Flow Rate (cfs)	0.3007
Burned Peak Flow Rate (cfs)	0.3007
24-Hr Clear Runoff Volume (ac-ft)	0.092
24-Hr Clear Runoff Volume (cu-ft)	4008.4356



Peak Flow Hydrologic Analysis

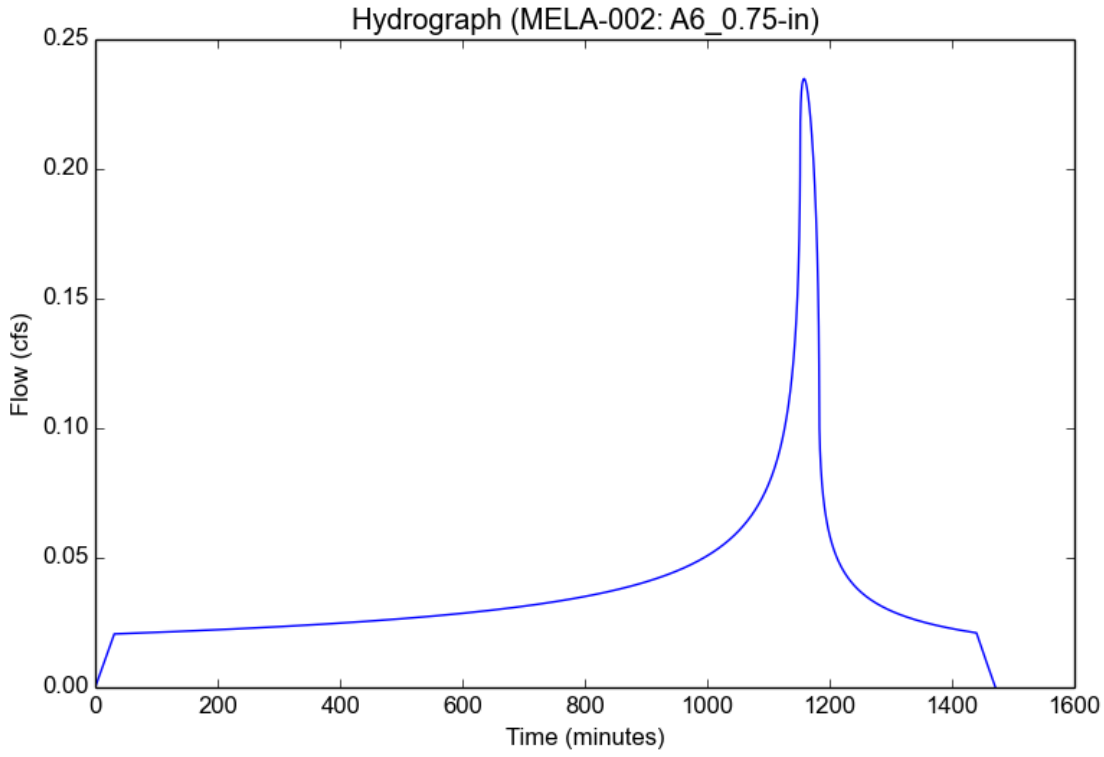
File location: P:/M/MELA-002/Admin/Reports/LID/Preliminary/Appendix A - Calcs/MELA-002 - A6_0.75-in.pdf
Version: HydroCalc 1.0.3

Input Parameters

Project Name	MELA-002
Subarea ID	A6_0.75-in
Area (ac)	1.57
Flow Path Length (ft)	456.2
Flow Path Slope (vft/hft)	0.008
0.75-inch Rainfall Depth (in)	0.75
Percent Impervious	0.86
Soil Type	13
Design Storm Frequency	0.75 inch storm
Fire Factor	0
LID	True

Output Results

Modeled (0.75 inch storm) Rainfall Depth (in)	0.75
Peak Intensity (in/hr)	0.1898
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.788
Time of Concentration (min)	31.0
Clear Peak Flow Rate (cfs)	0.2348
Burned Peak Flow Rate (cfs)	0.2348
24-Hr Clear Runoff Volume (ac-ft)	0.0767
24-Hr Clear Runoff Volume (cu-ft)	3340.373



Peak Flow Hydrologic Analysis

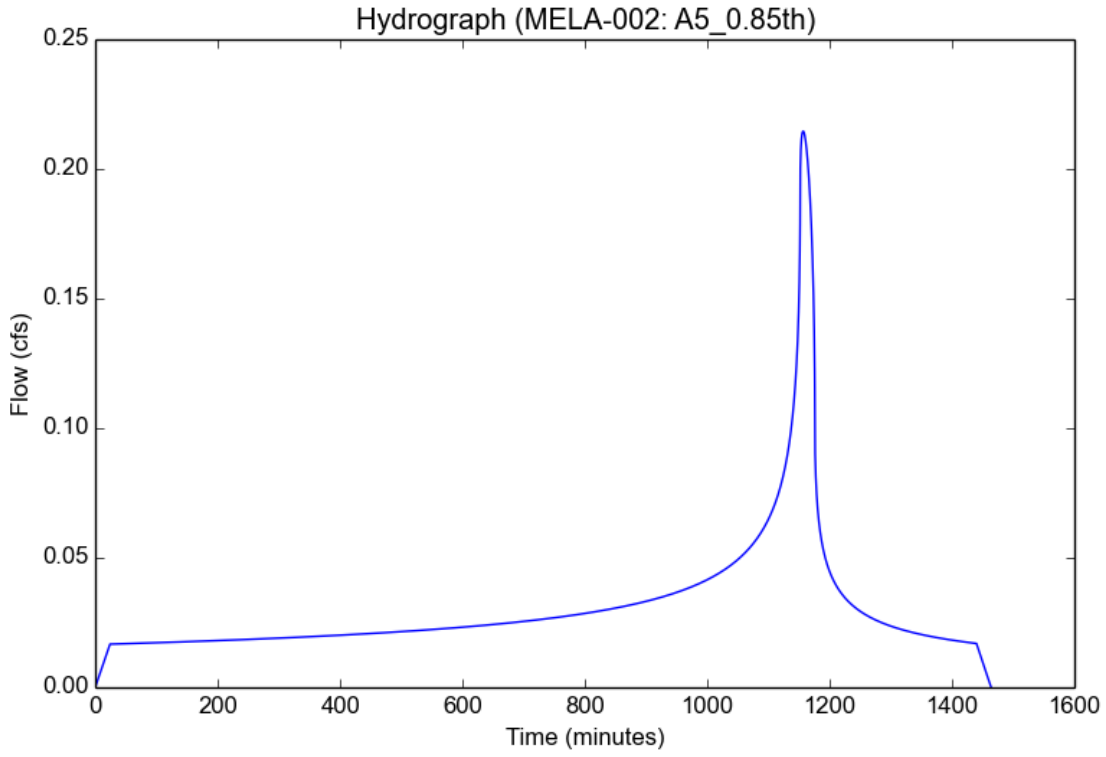
File location: P:/M/MELA-002/Admin/Reports/LID/Preliminary/Appendix A - Calcs/MELA-002 - A5_0.85th.pdf
Version: HydroCalc 1.0.3

Input Parameters

Project Name	MELA-002
Subarea ID	A5_0.85th
Area (ac)	1.06
Flow Path Length (ft)	368.1
Flow Path Slope (vft/hft)	0.008
85th Percentile Rainfall Depth (in)	0.9
Percent Impervious	0.86
Soil Type	13
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	0.9
Peak Intensity (in/hr)	0.2569
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.788
Time of Concentration (min)	24.0
Clear Peak Flow Rate (cfs)	0.2146
Burned Peak Flow Rate (cfs)	0.2146
24-Hr Clear Runoff Volume (ac-ft)	0.0621
24-Hr Clear Runoff Volume (cu-ft)	2706.327



Peak Flow Hydrologic Analysis

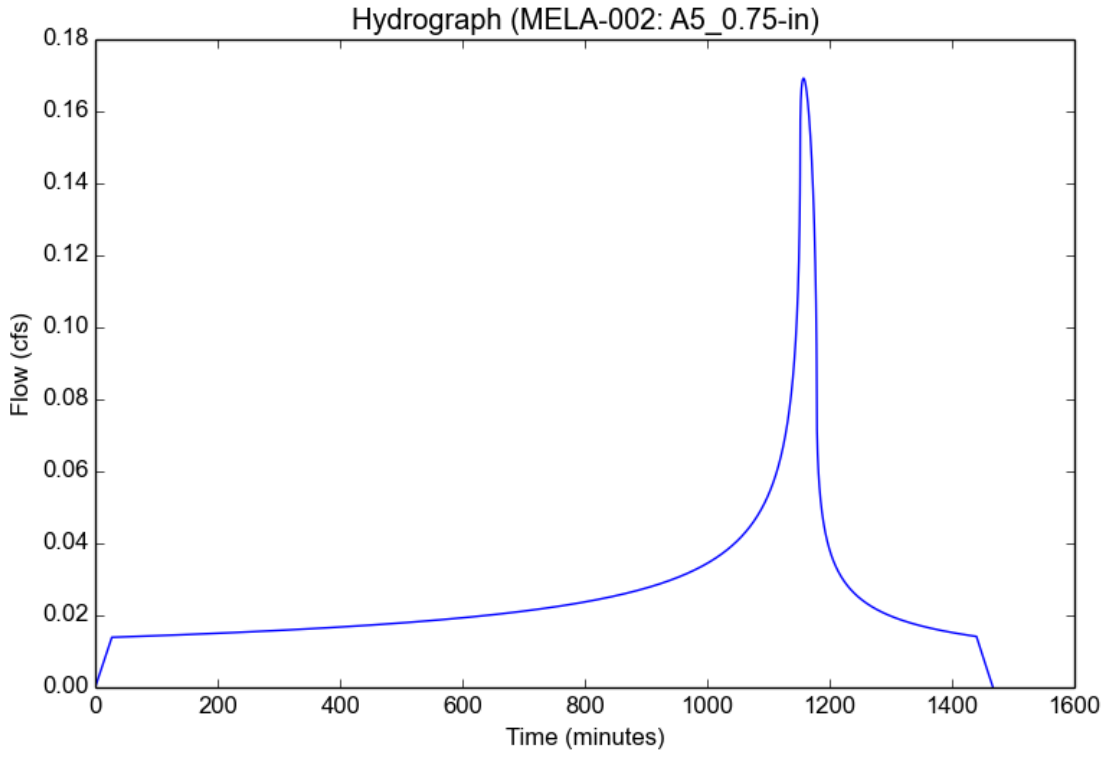
File location: P:/M/MELA-002/Admin/Reports/LID/Preliminary/Appendix A - Calcs/MELA-002 - A5_0.75-in.pdf
Version: HydroCalc 1.0.3

Input Parameters

Project Name	MELA-002
Subarea ID	A5_0.75-in
Area (ac)	1.06
Flow Path Length (ft)	368.1
Flow Path Slope (vft/hft)	0.008
0.75-inch Rainfall Depth (in)	0.75
Percent Impervious	0.86
Soil Type	13
Design Storm Frequency	0.75 inch storm
Fire Factor	0
LID	True

Output Results

Modeled (0.75 inch storm) Rainfall Depth (in)	0.75
Peak Intensity (in/hr)	0.2026
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.788
Time of Concentration (min)	27.0
Clear Peak Flow Rate (cfs)	0.1692
Burned Peak Flow Rate (cfs)	0.1692
24-Hr Clear Runoff Volume (ac-ft)	0.0518
24-Hr Clear Runoff Volume (cu-ft)	2255.2769



Peak Flow Hydrologic Analysis

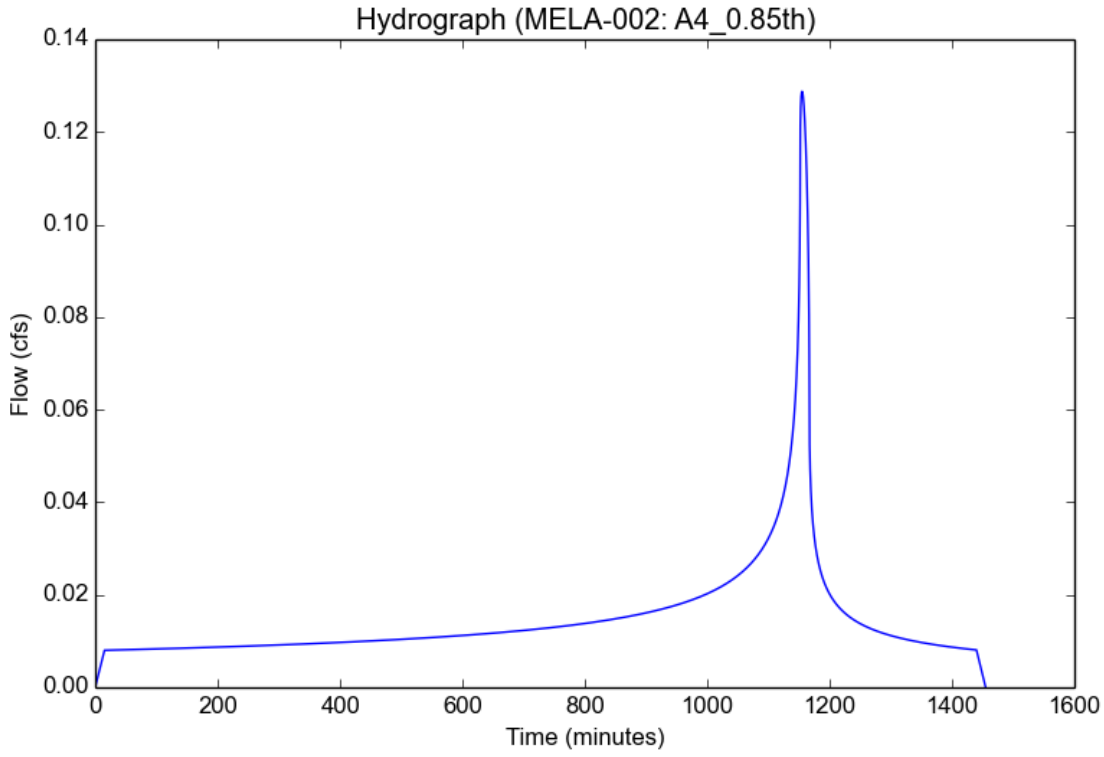
File location: P:/M/MELA-002/Admin/Reports/LID/Preliminary/Appendix A - Calcs/MELA-002 - A4_0.85th.pdf
Version: HydroCalc 1.0.3

Input Parameters

Project Name	MELA-002
Subarea ID	A4_0.85th
Area (ac)	0.51
Flow Path Length (ft)	196.7
Flow Path Slope (vft/hft)	0.011
85th Percentile Rainfall Depth (in)	0.9
Percent Impervious	0.86
Soil Type	13
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	0.9
Peak Intensity (in/hr)	0.3204
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.788
Time of Concentration (min)	15.0
Clear Peak Flow Rate (cfs)	0.1288
Burned Peak Flow Rate (cfs)	0.1288
24-Hr Clear Runoff Volume (ac-ft)	0.0299
24-Hr Clear Runoff Volume (cu-ft)	1302.0949



Peak Flow Hydrologic Analysis

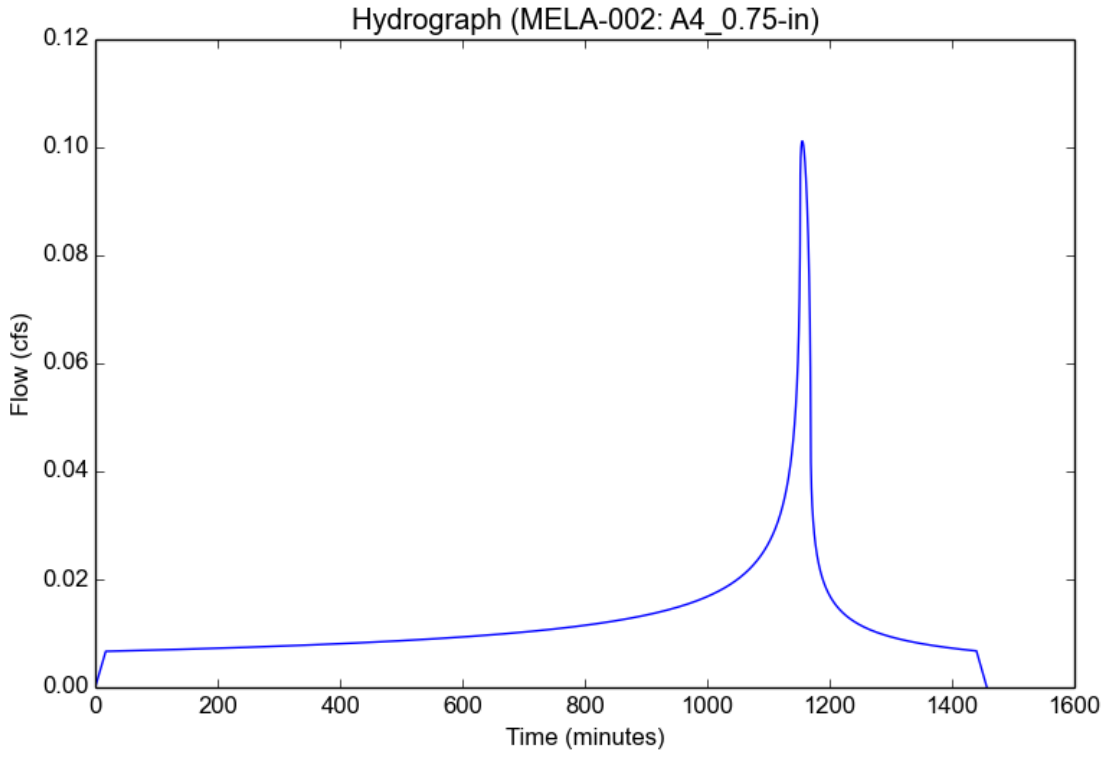
File location: P:/M/MELA-002/Admin/Reports/LID/Preliminary/Appendix A - Calcs/MELA-002 - A4_0.75-in.pdf
Version: HydroCalc 1.0.3

Input Parameters

Project Name	MELA-002
Subarea ID	A4_0.75-in
Area (ac)	0.51
Flow Path Length (ft)	196.7
Flow Path Slope (vft/hft)	0.011
0.75-inch Rainfall Depth (in)	0.75
Percent Impervious	0.86
Soil Type	13
Design Storm Frequency	0.75 inch storm
Fire Factor	0
LID	True

Output Results

Modeled (0.75 inch storm) Rainfall Depth (in)	0.75
Peak Intensity (in/hr)	0.2517
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.788
Time of Concentration (min)	17.0
Clear Peak Flow Rate (cfs)	0.1012
Burned Peak Flow Rate (cfs)	0.1012
24-Hr Clear Runoff Volume (ac-ft)	0.0249
24-Hr Clear Runoff Volume (cu-ft)	1085.08



Peak Flow Hydrologic Analysis

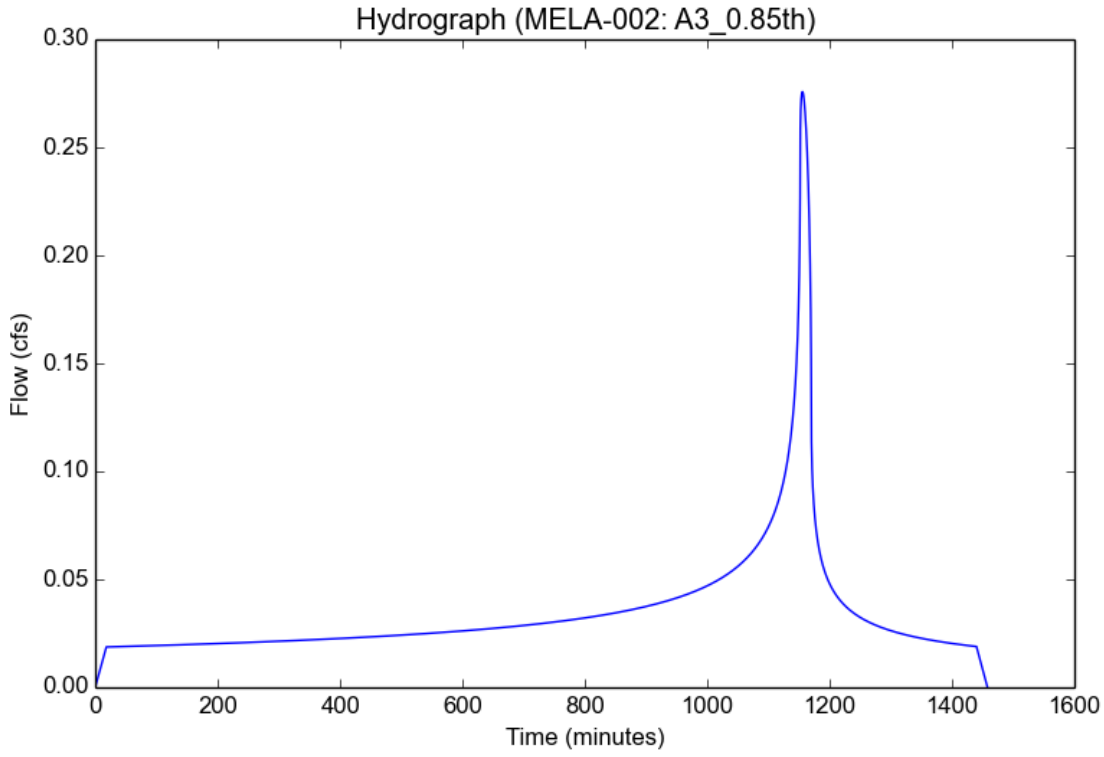
File location: P:/M/MELA-002/Admin/Reports/LID/Preliminary/Appendix A - Calcs/MELA-002 - A3_0.85th.pdf
Version: HydroCalc 1.0.3

Input Parameters

Project Name	MELA-002
Subarea ID	A3_0.85th
Area (ac)	1.19
Flow Path Length (ft)	278.7
Flow Path Slope (vft/hft)	0.013
85th Percentile Rainfall Depth (in)	0.9
Percent Impervious	0.86
Soil Type	13
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	0.9
Peak Intensity (in/hr)	0.2941
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.788
Time of Concentration (min)	18.0
Clear Peak Flow Rate (cfs)	0.2758
Burned Peak Flow Rate (cfs)	0.2758
24-Hr Clear Runoff Volume (ac-ft)	0.0697
24-Hr Clear Runoff Volume (cu-ft)	3038.2253



Peak Flow Hydrologic Analysis

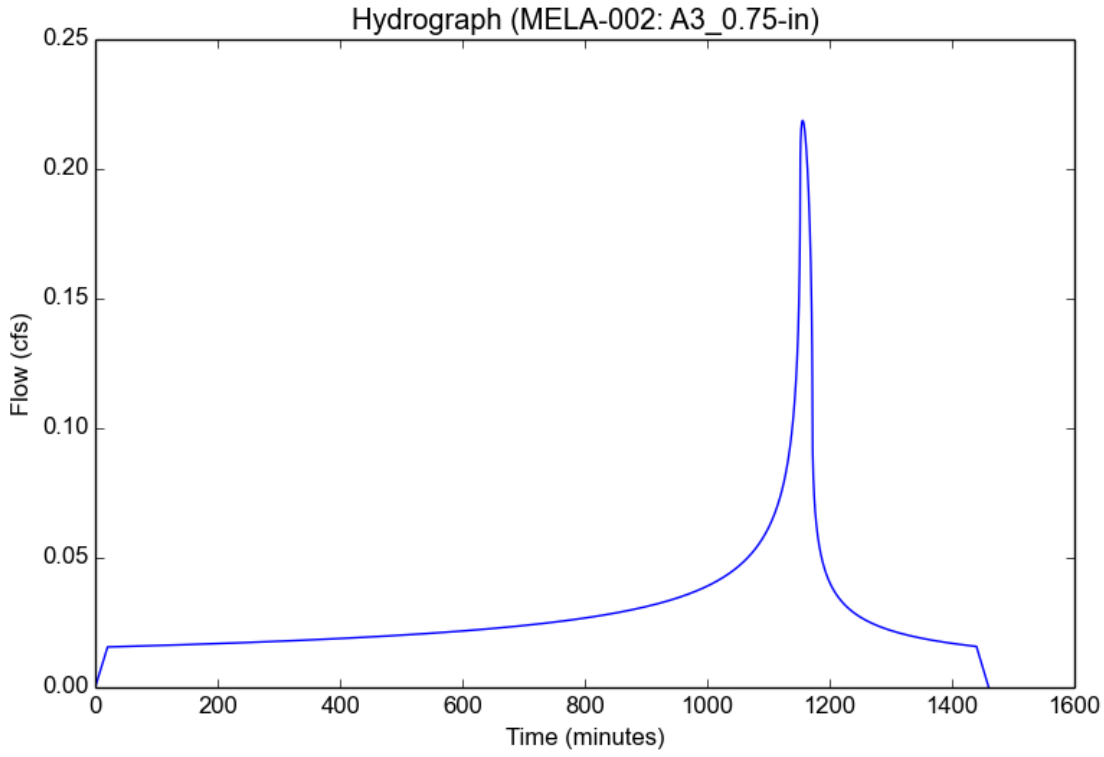
File location: P:/M/MELA-002/Admin/Reports/LID/Preliminary/Appendix A - Calcs/MELA-002 - A3_0.75-in.pdf
Version: HydroCalc 1.0.3

Input Parameters

Project Name	MELA-002
Subarea ID	A3_0.75-in
Area (ac)	1.19
Flow Path Length (ft)	278.7
Flow Path Slope (vft/hft)	0.013
0.75-inch Rainfall Depth (in)	0.75
Percent Impervious	0.86
Soil Type	13
Design Storm Frequency	0.75 inch storm
Fire Factor	0
LID	True

Output Results

Modeled (0.75 inch storm) Rainfall Depth (in)	0.75
Peak Intensity (in/hr)	0.2332
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.788
Time of Concentration (min)	20.0
Clear Peak Flow Rate (cfs)	0.2187
Burned Peak Flow Rate (cfs)	0.2187
24-Hr Clear Runoff Volume (ac-ft)	0.0581
24-Hr Clear Runoff Volume (cu-ft)	2531.8568



Peak Flow Hydrologic Analysis

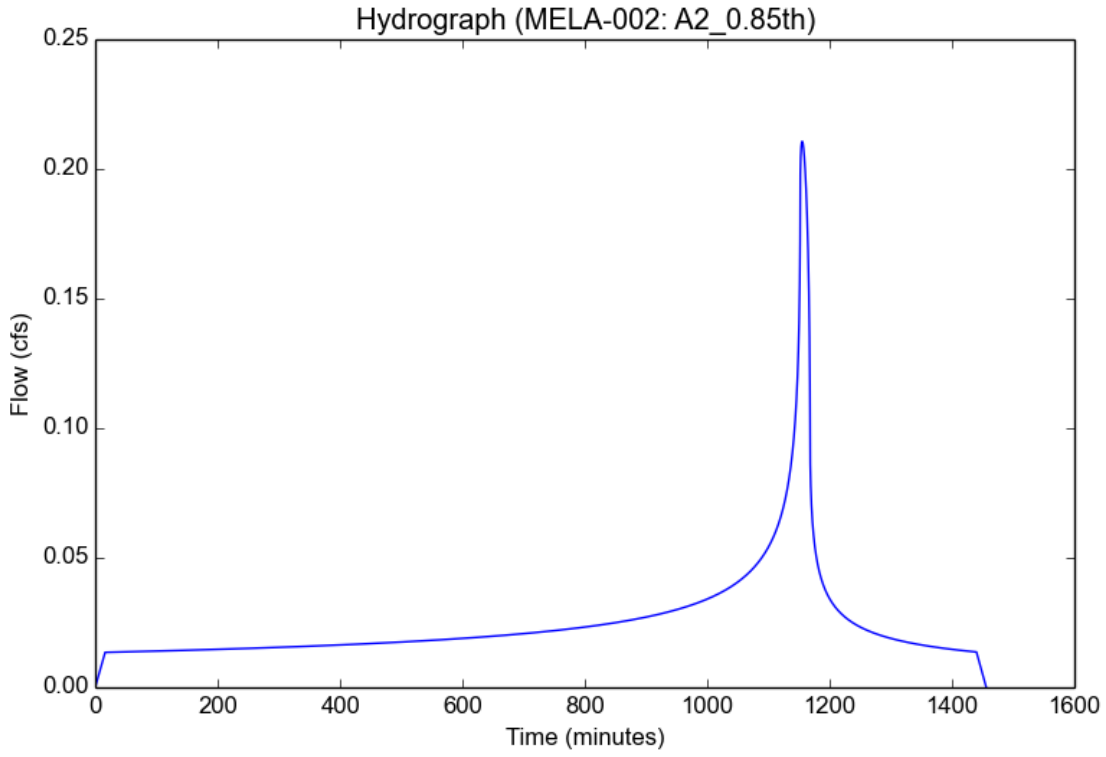
File location: P:/M/MELA-002/Admin/Reports/LID/Preliminary/Appendix A - Calcs/MELA-002 - A2_0.85th.pdf
Version: HydroCalc 1.0.3

Input Parameters

Project Name	MELA-002
Subarea ID	A2_0.85th
Area (ac)	0.86
Flow Path Length (ft)	229.2
Flow Path Slope (vft/hft)	0.014
85th Percentile Rainfall Depth (in)	0.9
Percent Impervious	0.86
Soil Type	13
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	0.9
Peak Intensity (in/hr)	0.3108
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.788
Time of Concentration (min)	16.0
Clear Peak Flow Rate (cfs)	0.2106
Burned Peak Flow Rate (cfs)	0.2106
24-Hr Clear Runoff Volume (ac-ft)	0.0504
24-Hr Clear Runoff Volume (cu-ft)	2195.6903



Peak Flow Hydrologic Analysis

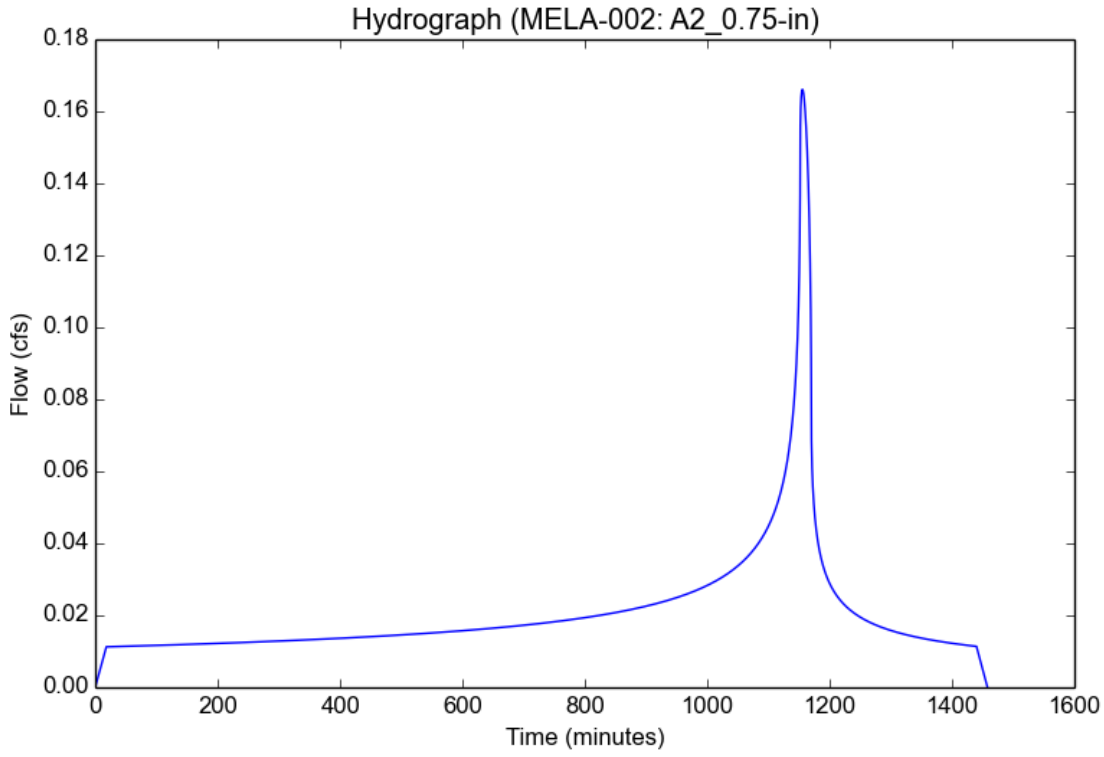
File location: P:/M/MELA-002/Admin/Reports/Hydrology/Preliminary/HydroCalc/MELA-002 - A2_0.75-in.pdf
Version: HydroCalc 1.0.3

Input Parameters

Project Name	MELA-002
Subarea ID	A2_0.75-in
Area (ac)	0.86
Flow Path Length (ft)	229.2
Flow Path Slope (vft/hft)	0.014
0.75-inch Rainfall Depth (in)	0.75
Percent Impervious	0.86
Soil Type	13
Design Storm Frequency	0.75 inch storm
Fire Factor	0
LID	True

Output Results

Modeled (0.75 inch storm) Rainfall Depth (in)	0.75
Peak Intensity (in/hr)	0.2451
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.788
Time of Concentration (min)	18.0
Clear Peak Flow Rate (cfs)	0.1661
Burned Peak Flow Rate (cfs)	0.1661
24-Hr Clear Runoff Volume (ac-ft)	0.042
24-Hr Clear Runoff Volume (cu-ft)	1829.7435



Peak Flow Hydrologic Analysis

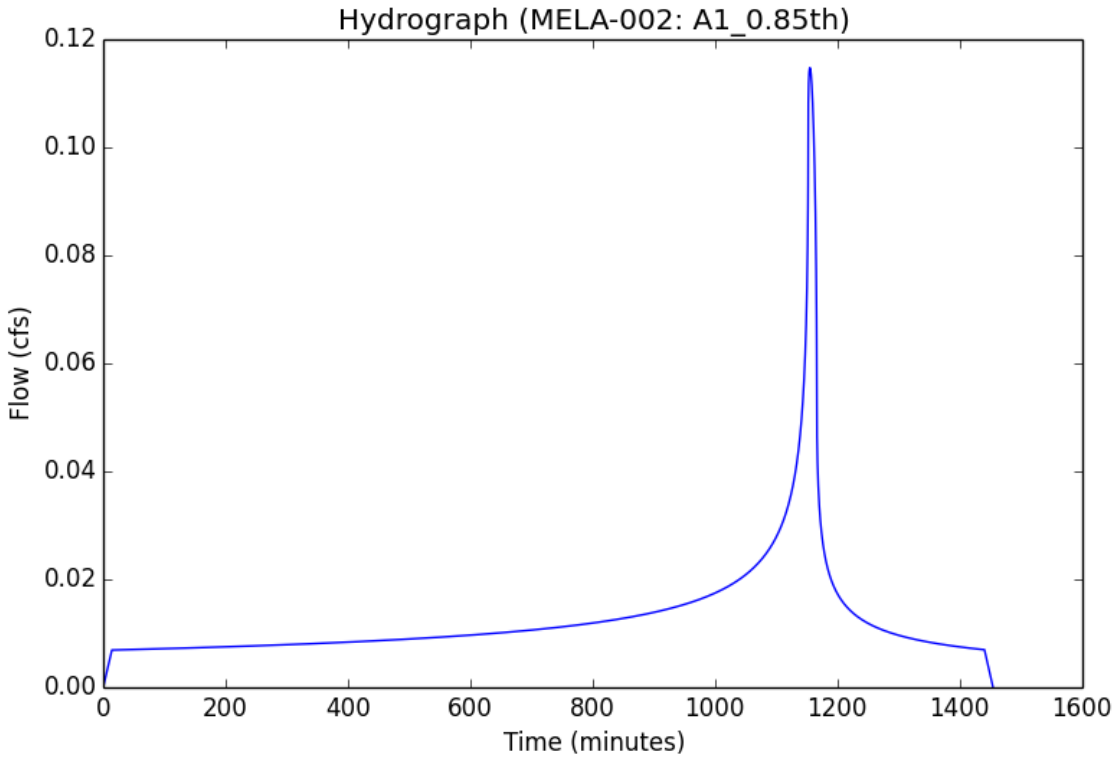
File location: P:/M/MELA-002/Admin/Reports/LID/Preliminary/Appendix A - Calcs/MELA-002 - A1_0.85th.pdf
Version: HydroCalc 0.3.1-beta

Input Parameters

Project Name	MELA-002
Subarea ID	A1_0.85th
Area (ac)	0.44
Flow Path Length (ft)	171.6
Flow Path Slope (vft/hft)	0.011
85th Percentile Rainfall Depth (in)	0.9
Percent Impervious	0.86
Soil Type	13
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	0.9
Peak Intensity (in/hr)	0.331
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.788
Time of Concentration (min)	14.0
Clear Peak Flow Rate (cfs)	0.1148
Burned Peak Flow Rate (cfs)	0.1148
24-Hr Clear Runoff Volume (ac-ft)	0.0258
24-Hr Clear Runoff Volume (cu-ft)	1123.3756



Peak Flow Hydrologic Analysis

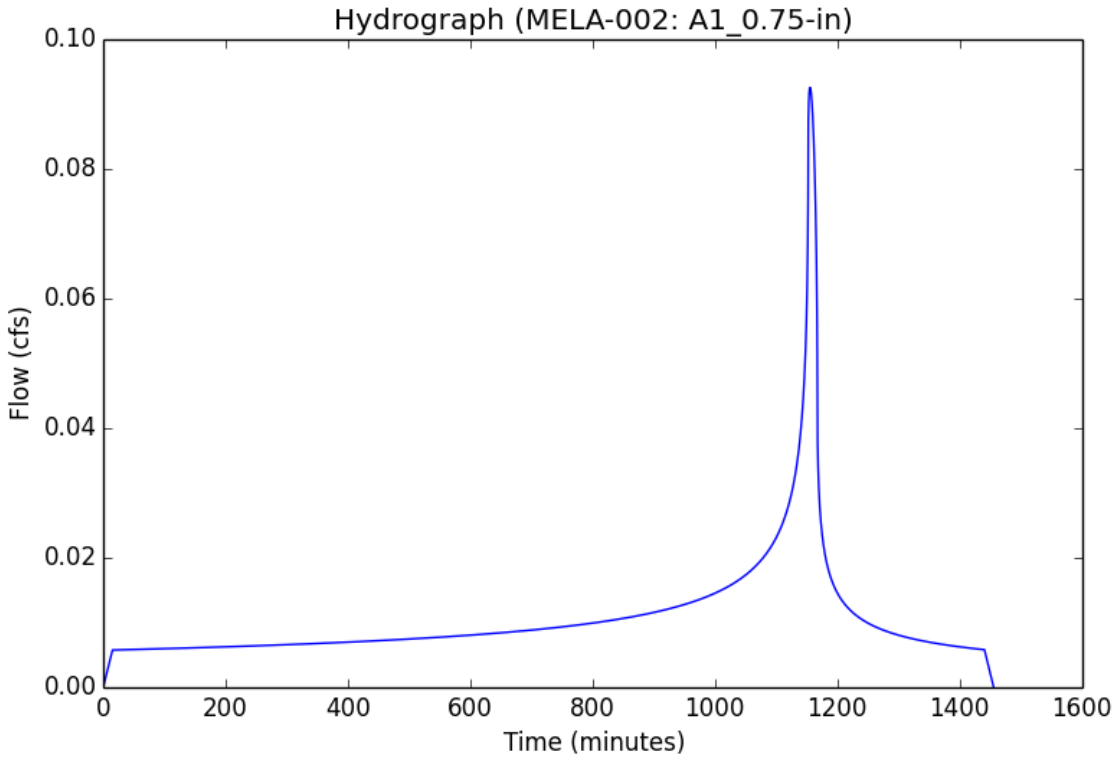
File location: P:/M/MELA-002/Admin/Reports/LID/Preliminary/Appendix A - Calcs/MELA-002 - A1_0.75-in.pdf
Version: HydroCalc 0.3.1-beta

Input Parameters

Project Name	MELA-002
Subarea ID	A1_0.75-in
Area (ac)	0.44
Flow Path Length (ft)	171.6
Flow Path Slope (vft/hft)	0.011
0.75-inch Rainfall Depth (in)	0.75
Percent Impervious	0.86
Soil Type	13
Design Storm Frequency	0.75 inch storm
Fire Factor	0
LID	True

Output Results

Modeled (0.75 inch storm) Rainfall Depth (in)	0.75
Peak Intensity (in/hr)	0.267
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.788
Time of Concentration (min)	15.0
Clear Peak Flow Rate (cfs)	0.0926
Burned Peak Flow Rate (cfs)	0.0926
24-Hr Clear Runoff Volume (ac-ft)	0.0215
24-Hr Clear Runoff Volume (cu-ft)	936.1467



Appendix B:
Site BMPs

BIO-1: Biofiltration

Definition

A biofiltration area is a vegetated shallow depression that is designed to receive and treat stormwater runoff from downspouts, piped inlets, or sheet flow from adjoining paved areas. A shallow ponding zone is provided above the vegetated surface for temporary storage of stormwater runoff. During storm events, stormwater runoff accumulates in the ponding zone and gradually infiltrates the surface and filters through the biofiltration soil media before being collected by an underdrain system.

Stormwater runoff treatment occurs through a variety of natural mechanisms as stormwater runoff filters through the vegetation root zone. In biofiltration areas, microbes and organic material in the biofiltration soil media help promote the adsorption of pollutants (e.g., dissolved metals and petroleum hydrocarbons) into the soil matrix. Plants utilize soil moisture and promote the drying of the soil through transpiration. Biofiltration areas are typically planted with native, drought-tolerant plant species that do not require fertilization and can withstand wet soils for at least 96 hours.

A schematic of a typical biofiltration area is presented in Figure E-7.

LID Ordinance Requirements

Biofiltration can be used as an alternative compliance measure.

Pollutant of Concern	Treated by Biofiltration?
Suspended solids	No
Total phosphorus	No
Total nitrogen	Yes
Total Kjeldahl nitrogen	Yes
Cadmium, total	No
Chromium, total	Yes
Copper, total	No
Lead, total	Yes
Zinc, total	No

Source: Treatment Best Management Practices Performance, Los Angeles Regional Water Quality Control Board, December 9, 2013.

Advantages

- Has a low cost for installation
- Enhances site aesthetics
- Requires little maintenance

Disadvantages

- May require individual owner/tenants to perform maintenance

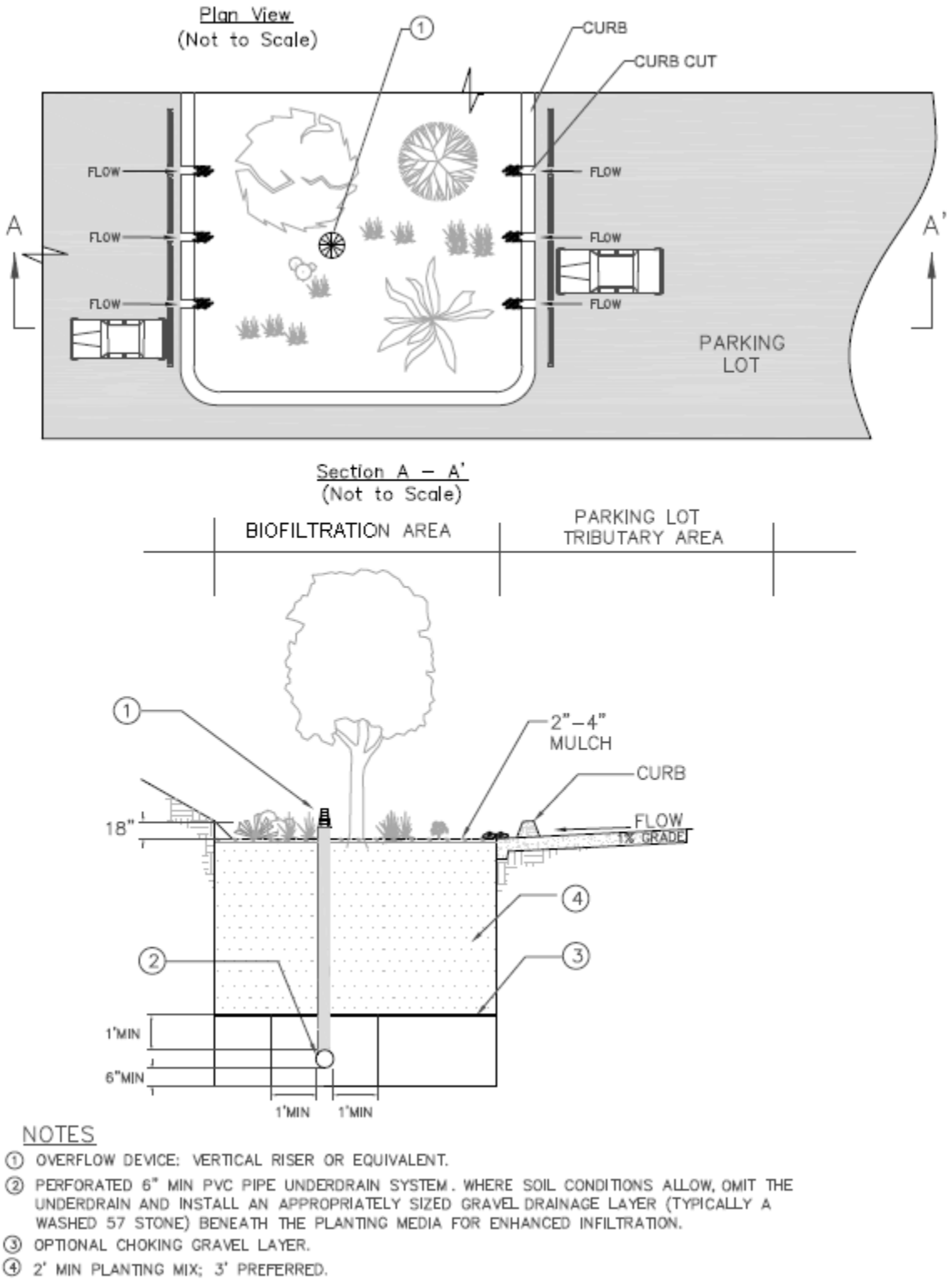


Figure E-7. Biofiltration Area Schematic

General Constraints and Implementation Considerations

- Biofiltration areas can be applied in various settings including, but not limited to:
  - Individual lots for rooftop, driveway, and other on-site impervious surface
  - Shared facilities located in common areas for individual lots
  - Areas within loop roads or cul-de-sacs
  - Landscaped parking lot islands
  - Within right-of-ways along roads
  - Common landscaped areas in apartment complexes or other multi-family housing designs
  - Parks and along open space perimeter
- If tire curbs are provided and parking stalls are shortened, cars are allowed to overhang the biofiltration area.
- Biofiltration areas must be located sufficiently far from structure foundations to avoid damage to structures (as determined by a certified structural or geotechnical engineer).
- Any parking areas bordering the biofiltration area must be monolithically poured concrete or deepended curb concrete to provide structural stability to the adjacent parking section.
- Geomembrane liners must be used in areas subject to spills or pollutant hot spots.
- During construction activities should avoid compaction of native soils below planting media layer or gravel zone.
- Stormwater runoff must be diverted around the biofiltration area during the period of vegetation establishment. If diversion is not feasible, the graded and seeded areas must be protected with suitable sediment controls (i.e., silt fences).All damaged areas should be repaired, seeded, or re-planted immediately.
- The general landscape irrigation system should incorporate the biofiltration area, as applicable.

Design Specifications

The following sections describe the design specifications for biofiltration areas.

Geotechnical

Due to the potential to contaminate groundwater, cause slope instability, impact surrounding structures, and potential for insufficient infiltration capacity, an extensive geotechnical site investigation must be conducted during the site planning process to verify site suitability for biofiltration. All geotechnical investigations must be performed according to the most recent GMED Policy GS 200.1. Soil infiltration rates and the

groundwater table depth must be evaluated to ensure that conditions are satisfactory for proper operation of a biofiltration area. The project applicant must demonstrate through infiltration testing, soil logs, and the written opinion of a licensed civil engineer that sufficiently permeable soils exist on-site to allow the construction of a properly functioning biofiltration system.

Biofiltration areas are appropriate for soils with a minimum corrected in-situ infiltration rate of 0.3 in/hr. The geotechnical report must determine if the proposed project site is suitable for a biofiltration area and must recommend a design infiltration rate (see "Design Infiltration Rate" under the "Sizing" section). The geotechnical investigation should be such that a good understanding is gained as to how the stormwater runoff will move through the soil (horizontally or vertically) and if there are any geological conditions that could inhibit the movement of water.

Pretreatment

Pretreatment refers to design features that provide settling of large particles before stormwater runoff enters a stormwater quality control measure in order to reduce the long-term maintenance burden. Pretreatment should be provided to reduce the sediment load entering a biofiltration area in order to maintain the infiltration rate of the biofiltration area. To ensure that biofiltration areas are effective, the project applicant must incorporate pretreatment devices that provide sediment removal (e.g., vegetated swales, vegetated filter strips, sedimentation manholes, and proprietary devices). The use of at least two pretreatment devices is highly recommended for biofiltration areas.

Geometry

- Biofiltration areas must be sized to capture and treat 1.5 times the SWQDv that is not reliably retained on the project site with an 18-inch maximum ponding depth.
- The planting soil depth must be a minimum of two feet, although three feet is preferred. The planting soil depth should provide a beneficial root zone for the chosen vegetation and adequate water storage for the stormwater runoff. A deeper planting soil depth will also provide a smaller surface area footprint.
- A gravel storage layer below the biofiltration area soil media is required to provide adequate temporary storage to retain 1.5 times the SWQDv that is not reliably retained on the project site and to promote infiltration.

Sizing

Biofiltration areas are sized using a simple sizing method where 1.5 times the SWQDv that is not reliably retained on the project site must be completely filtered within 96 hours. If the incoming stormwater runoff flow rate is lower than the long term filtration rate, above ground storage does not need to be provided. If the incoming stormwater runoff flow rate is higher than the long term filtration rate, above ground storage shall be provided (see steps below).

Step 1: Calculate the design volume

Biofiltration areas should be sized to capture and treat 1.5 times the portion of the SWQDv (see Section 6 for SWQDv calculation procedures) that is not reliability retained on the project site, as calculated by the equation below:

$$V_B = 1.5 \times (SWQDv - V_R)$$

Where:

V_B = Biofiltration volume [ft^3];
SWQDv = Stormwater quality design volume [ft^3]; and
V_R = Volume of stormwater runoff reliably retained on-site [ft^3].

Step 2: Calculate the design infiltration rate

Determine the corrected in-situ infiltration rate (f_{design}) of the native soil using the procedures described in the most recent GMED Policy GS 200.1.

Step 3: Calculate the surface area

Select a surface ponding depth (d) that satisfies the geometric criteria and meets the site constraints. Selecting a deeper ponding depth (up to 1.5 ft) generally yields a smaller footprint, however, it will require greater consideration for public safety, energy dissipation, and plant selection.

Calculate the time for the selected ponding depth to filter through the planting media using the following equation:

$$\mathrm{d} = t_p \times \frac{\mathrm{f_{design}}}{12}$$

Where:

d = Ponding depth (max 1.5 ft) [ft];
t_p = Required detention time for surface ponding (max 96 hr) [hr]; and
f_{design} = Design infiltration rate [in/hr].

If t_p exceeds 96 hours, reduce surface ponding depth (d). In nearly all cases, t_p should not approach 96 hours unless f_{design} is low.

Calculate the required infiltrating surface (filter bottom area) using the following equation:

$$A = \frac{V_B}{d}$$

Where:

A = Bottom surface area of biofiltration area [ft^2];
V_B = Biofiltration design volume [ft^3]; and
d = Ponding depth (max 1.5 ft) [ft].

Flow Entrance and Energy Dissipation

Maintain a minimum slope of 1 percent for pervious surfaces and 0.5 percent for impervious surfaces to the biofiltration area inlet. The following types of flow entrance can be used for biofiltration cells:

- Level spreaders (i.e., slotted curbs) can be used to facilitate sheet flow.
- Dispersed, low velocity flow across a landscape area. Dispersed flow may not be possible given space limitations or if the biofiltration area is controlling roadway or parking lot flows where curbs are mandatory.
- Dispersed flow across pavement or gravel and past wheel stops for parking areas.
- Flow spreading trench around perimeter of biofiltration area. May be filled with pea gravel or vegetated with 3:1 side slopes similar to a swale. A vertical-walled open trench may also be used at the discretion of LACDPW.
- Curb cuts for roadside or parking lot areas, if approved by LACDPW: curb cuts should include rock or other erosion controls in the channel entrance to dissipate energy. Flow entrance should drop two to three inches from curb line and provide an area for settling and periodic removal of sediment and coarse material before flow dissipates to the remainder of the biofiltration area.
- Piped entrances, such as roof downspouts, should include rock, splash blocks, or other erosion controls at the entrance to dissipate energy and disperse flows.
- Woody plants (trees, shrubs, etc.) can restrict or concentrate flows and can be damaged by erosion around the root ball and must not be placed directly in the entrance flow path.

Drainage

Biofiltration areas must be designed to drain below the planting soil in less than 96 hours. Soils must be allowed to dry out periodically in order to restore hydraulic capacity to receive stormwater runoff from subsequent storm events, maintain infiltration rates, maintain adequate soil oxygen levels for healthy soil biota and vegetation, and provide proper soil conditions for biodegradation and retention of pollutants.

Underdrain

Biofiltration areas require an underdrain to collect and discharge stormwater runoff that has been filtered through the soil media, but not infiltrated, to another stormwater quality control measure, storm drain system, or receiving water. The underdrain must have a mainline diameter of eight inches using slotted PVC SDR 26 or PVC C9000. Slotted PVC allows for pressure water cleaning and root cutting, if necessary. The slotted pipe

should have two to four rows of slots cut perpendicular to the axis of the pipe or at right angles to the pitch of corrugations. Slots should be 0.04 to 0.1 inches wide with a length of 1 to 1.25 inches. Slots should be longitudinally-spaced such that the pipe has a minimum of one square inch opening per lineal foot and should face down.

The underdrain should be placed in a gravel envelope (Class 2 Permeable Material per Caltrans Spec. 68-1.025) that measures three feet wide and six inches deep. The underdrain is elevated from the bottom of the biofiltration area by six inches within the gravel envelope to create a fluctuating anaerobic/aerobic zone below the underdrain to facilitate denitrification within the anaerobic/anoxic zone and reduce nutrient concentrations. The top and sides of the underdrain pipe should be covered with gravel to a minimum depth of 12 inches. The underdrain and gravel envelope should be covered with a geomembrane liner to prevent clogging. The following aggregate should be used for the gravel envelope:

Particle Size (ASTM D422)	% Passing by Weight
¾ inch	100%
¼ inch	30-60%
#8	20-50%
#50	3-12%
#200	0-1%

Underdrains should be sloped at a minimum of 0.5 percent and must drain freely to an approved discharge point.

Rigid non-perforated observation pipes with a diameter equal to the underdrain diameter should be connected to the underdrain to provide a clean-out port as well as an observation well to monitor drainage rates. The wells/clean-outs should be connected to the perforated underdrain with the appropriate manufactured connections. The wells/clean-outs should extend six inches above the top elevation of the biofiltration area mulch, and should be capped with a lockable screw cap. The ends of underdrain pipes not terminating in an observation well/clean-out should also be capped.

Hydraulic Restriction Layer

Lateral infiltration pathways may need to be restricted due to the close proximity of roads, foundations, or other infrastructure. A geomembrane liner, or other equivalent waterproofing, may be placed along the vertical walls to reduce lateral flows. This geomembrane liner must have a minimum thickness of 30 mils and meet the requirements of Table E-12. Generally, waterproof barriers should not be placed on the bottom of the biofiltration unit, as this would prevent incidental infiltration which is important to meeting the required pollutant load reduction.

Table E-12. Geomembrane Liner Specifications for Biofiltration Areas

Parameter	Test Method	Specifications
Material		Nonwoven geomembrane liner
Unit weight		8 oz/yd^3 (minimum)
Filtration rate		0.08 in/sec (minimum)
Puncture strength	ASTM D-751 (Modified)	125 lbs (minimum)
Mullen burst strength	ASTM D-751	400 lb/in^2 (minimum)
Tensile strength	AST D-1682	300 lbs (minimum)
Equiv. opening size	US Standard Sieve	No. 80 (minimum)

Planting/Storage Media

- The planting media placed in the biofiltration area should achieve a long-term, in-place infiltration rate of at least 5 in/hr. Higher infiltration rates of up to 12 in/hr are permissible. The biofiltration soil media must retain sufficient moisture to support vigorous plant growth.
- The planting media mix must consist of 60 to 80 percent sand and 20 to 40 percent compost.
- Sand should be free of wood, waste, coatings such as clay, stone dust, carbonate, or any other deleterious material. All aggregate passing the No. 200 sieve size should be non-plastic. Sand for biofiltration should be analyzed by an accredited laboratory using #200, #100, #40, #30, #16, #8, #4, and 3/8 sieves (ASTM D422 or as approved by the local permitting authority) and meet the following gradations (Note: all sand complying with ASTM C33 for fine aggregate comply with the gradation requirements listed below):

Particle Size (ASTM D422)	% Passing by Weight
3/8 inch	100%
#4	90-100%
#8	70-100%
#16	40-95%
#30	15-70%
#40	5-55%
#110	0-15%
#200	0-5%

Note: The gradation of the sand component of the biofiltration soil media is believed to be a major factor in the infiltration rate of the media mix. If the desired hydraulic conductivity of the biofiltration soil media cannot be achieved within the specified proportions of sand and compost (#2), then it may be necessary to utilize sand at the coarser end of the range specified minimum percent passing.

- Compost should be a well-decomposed, stable, weed-free organic matter source derived from waste materials including yard debris, wood wastes, or other organic material not including manure or biosolids meeting standards developed by the USCC. The product shall be certified through the USCC STA Program (a compost testing and information disclosure program). Compost quality shall be verified via a laboratory analysis to be:
    - Feedstock materials must be specified and include one or more of the following: landscape/yard trimmings, grass clippings, food scraps, and agricultural crop residues.
    - pH between 6.5 and 8.0 (may vary with plant palette)
    - Organic Matter: 35 to 75 percent dry weight basis
    - Carbon and Nitrogen Ratio: 15:1 < C:N < 25:1
    - Maturity/Stability: Compost must have a dark brown color and a soil-like odor. Compost exhibiting a sour or putrid smell, containing recognizable grass or leaves, or is hot (120°F) upon delivery or rewetting is not acceptable.
    - Toxicity: any one of the following measures is sufficient to indicate non-toxicity:
        - NH_4:NH_3 < 3
        - Ammonium < 500 ppm, dry weight basis
        - Seed germination > 80 percent of control
        - Plant trials > 80 percent of control
        - Solvita® > 5 index value
    - Nutrient content:
        - Total Nitrogen content ≥ 0.9 percent preferred
        - Total Boron should be < 80 ppm; soluble boron < 2.5 ppm
    - Salinity: < 6.0 mmhos/cm
    - Compost for biofiltration area should be analyzed by an accredited laboratory using #200, ¼-inch, ½-inch, and 1-inch sieves (ASTM D422) and meet the gradation requirements in the table below:

Particle Size (ASTM D422)	% Passing by Weight
1 inch	99-100
½ inch	90-100
¼ inch	40-90
#200	2-10

Tests should be sufficiently recent to represent the actual material that is anticipated to be delivered to the site. If processes or sources used by the supplier have changed significantly since the most recent testing, new tests should be requested.

The gradation of compost used in biofiltration soil media is believed to play an important role in the saturated infiltration rate of the media. To achieve a higher saturated infiltration rate, it may be necessary to utilize compost at the coarser end of the range (minimum percent passing). The percent passing the #200 sieve (fines) is believed to be the most important factor in hydraulic conductivity.

In addition, coarser compost mix provides more heterogeneity of the biofiltration soil media, which is believed to be advantageous for more rapid development of soil structure needed to support healthy biological processes. This may be an advantage for plant establishment with lower nutrient and water input.

- Biofiltration soil media not meeting the above criteria should be evaluated on a case-by-case basis. Alternative biofiltration soil media must meet the following specifications:

  "Soils for biofiltration facilities must be sufficiently permeable to infiltrate stormwater runoff at a minimum of rate of 5 in/hr during the life of the facility, and provide sufficient retention of moisture and nutrients to support healthy vegetation." The following steps shall be followed by LACDPW to verify that alternative biofiltration soil media mixes meet the specification:

  - Submittals – The applicant must submit to LACDPW for approval:
    - A sample of mixed biofiltration soil media.
    - Certification from the soil supplier or an accredited laboratory that the biofiltration soil media meets the requirements of this specification.
    - Certification from an accredited geotechnical testing laboratory that the biofiltration soil media has an infiltration rate between 5 and 12 in/hr.
    - Organic content test results of the biofiltration soil media. Organic content test shall be performed in accordance with the Testing Methods for the Examination of Compost and Composting (TMECC) 05.07A, "Loss-On-Ignition Organic Matter Method".
    - Organic grain size analysis results of mixed biofiltration soil media performed in accordance with ASTM D422, Standard Test Method for Particle Size Analysis of Soils.
    - A description of the equipment and methods used to mix the sand and compost to produce the biofiltration soil media.
  - The name of the testing laboratory(ies) and the following information:

- Contact person(s)
- Address(es)
- Phone contact(s)
- E-mail address(es)
- Qualifications of laboratory(ies) and personnel including date of current certification by STA, ASTM, or approved equal.

o Biofiltration soils shall be analyzed by an accredited laboratory using #200 and ½-inch sieves (ASTM D422 or as approved by LACDPW), and meet the gradation described in the table below:

Particle Size (ASTM D422)	% Passing by Weight
½ inch	97-100
#200	2-5

- Biofiltration soil media shall be analyzed by an accredited geotechnical laboratory for the following tests:
  - o Moisture – density relationships (compaction tests) must be conducted on biofiltration soil media. Biofiltration soil media for the permeability test shall be compacted to 85 to 90 percent of the maximum dry density (ASTM D1557).
  - o Constant head permeability testing in accordance with ASTM D2434 shall be conducted on a minimum of two samples with a 6-inch mold and vacuum saturation.
- Mulch is recommended for the purpose of retaining moisture, preventing erosion, and minimizing weed growth. Projects subject to the California Model Water Efficiency Landscaping Ordinance (or comparable local ordinance) will be required to provide at least 2 inches of mulch. Aged mulch, also called compost mulch, reduces the ability of weeds to establish, keeps soil moist, and replenishes soil nutrients. Biofiltration areas must be covered with two to four inches (average three inches) of mulch at the start and an annual placement (preferably in June after weeding) of one to two inches of mulch beneath plants.
- The planting media design height must be marked appropriately, such as a collar on the overflow device or with a stake inserted two feet into the planting media and notched, to show biofiltration surface level and ponding level.

Vegetation

Prior to installation, a licensed landscape architect must certify that all plants, unless otherwise specifically permitted, conform to the standards of the current edition of American Standard for Nursery Stock as approved by the American Standards Institute, Inc. All plant grades shall be those established in the current edition of American Standards for Nursery Stock.

- Shade trees must have a single main trunk. Trunks must be free of branches below the following heights:

CALIPER (in)	Height (ft)
1½-2½	5
3	6

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

The biofiltration area should be vegetated to resemble a terrestrial forest community ecosystem, which is dominated by understory trees, a shrub layer, and herbaceous ground cover. Select vegetation that:

- Is suited to well-drained soil;
- Will be dense and strong enough to stay upright, even in flowing water;
- Has minimum need for fertilizers;
- Is not prone to pests and is consistent with Integrated Pest Management practices; and
- Is consistent with local water conservation ordinance requirements.

Irrigation System

Provide an irrigation system to maintain viability of vegetation, if applicable. The irrigation system must be designed to local code or ordinance specifications.

Restricted Construction Materials

The use of pressure-treated wood or galvanized metal at or around a biofiltration area is prohibited.

Overflow Device

An overflow device is required at the 18-inch ponding depth. The following, or equivalent, should be provided:

- A vertical PVC pipe (SDR 26) to act as an overflow riser.
- The overflow riser(s) should be eight inches or greater in diameter, so it can be cleaned without damage to the pipe.

- The inlet to the riser should be at the ponding depth (18 inches for fenced biofiltration areas and 6 inches for areas that are not fenced), and be capped with a spider cap to exclude floating mulch and debris. Spider caps should be screwed in or glued (e.g., not removable). The overflow device should convey stormwater runoff in excess of 1.5 times the SWQDv that is not reliably retained on the project site to an approved discharge location (another stormwater quality control measure, storm drain system, or receiving water).

Maintenance Requirements

Maintenance and regular inspections are important for proper function of biofiltration areas. Biofiltration areas require annual plant, soil, and mulch layer maintenance to ensure optimal infiltration, storage, and pollutant removal capabilities. In general, biofiltration maintenance requirements are typical landscape care procedures and include:

- Irrigate plants as needed during prolonged dry periods. In general, plants should be selected to be drought-tolerant and not require irrigation after establishment (two to three years).
- Inspect flow entrances, ponding area, and surface overflow areas periodically, and replace soil, plant material, and/or mulch layer in areas if erosion has occurred. Properly-designed facilities with appropriate flow velocities should not cause erosion except potentially during in extreme events. If erosion occurs, the flow velocities and gradients within the biofiltration area and flow dissipation and erosion protection strategies in the pretreatment area and flow entrance should be reassessed. If sediment is deposited in the biofiltration area, identify the source of the sediment within the tributary area, stabilize the source, and remove excess surface deposits.
- Prune and remove dead plant material as needed. Replace all dead plants, and if specific plants have a high mortality rate, assess the cause and, if necessary, replace with more appropriate species.
- Remove weeds as needed until plants are established. Weed removal should become less frequent if the appropriate plant species are used and planting density is attained.
- Select the proper soil mix and plants for optimal fertility, plant establishment, and growth to preclude the use of nutrient and pesticide supplements. By design, biofiltration facilities are located in areas where phosphorous and nitrogen levels are often elevated such that these should not be limiting nutrients. Addition of nutrients and pesticides may contribute pollutant loads to receiving waters.
- In areas where heavy metals deposition is likely (i.e., tributary areas to industrial, vehicle dealerships/repair, parking lots, roads), replace mulch annually. In areas where metals deposition is less likely (i.e., residential lots), replace or add mulch as needed to maintain a two to three inch depth at least once every two years.

- Analyze soil for fertility and pollutant levels if necessary. Biofiltration soil media are designed to maintain long-term fertility and pollutant processing capability.
- Eliminate standing water to prevent vector breeding.
- Inspect overflow devices for obstructions or debris, which should be removed immediately. Repair or replace damaged pipes upon discovery.
- Inspect, and clean if necessary, the underdrain.

A summary of potential problems that need to be addressed by maintenance activities is presented in Table E-13.

The County requires execution of a maintenance agreement to be recorded by the property owner for the on-going maintenance of any privately-maintained stormwater quality control measures. The property owner is responsible for compliance with the maintenance agreement. A sample maintenance agreement is presented in Appendix H.

Table E-13. Biofiltration Troubleshooting Summary

Problem	Conditions When Maintenance Is Needed	Maintenance Required
Vegetation	Overgrown vegetation	Mow and prune vegetation as appropriate.
	Presence of invasive, poisonous, nuisance, or noxious vegetation or weeds	Remove this vegetation and plant native species as needed.
Trash and Debris	Trash, plant litter, and dead leaves present	Remove and properly dispose of trash and debris.
Irrigation (if applicable)	Not functioning correctly	Check irrigation system for clogs or broken lines and repair as needed.
Inlet/Overflow	Inlet/overflow areas clogged with sediment and/or debris	Remove material.
	Overflow pipe blocked or broken	Repair as needed.
Erosion/Sediment Accumulation	Splash pads or spreader incorrectly placed Presence of erosion or sediment accumulation	Check inlet structure to ensure proper function. Repair, or replace if necessary, the inlet device. Repair eroded areas with gravel as needed. Re-grade the biofiltration area as needed.
Contaminants and Pollution	Any evidence of oil, gasoline, contaminants, or other pollutants	Remove any evidence of visual contamination from floatables such as oil and grease.
Standing water	Standing water observed more than 96 hours after storm event	Inspect, and clean as needed, the underdrain to ensure proper function. Clear clogs as needed. Remove and replace planter media (sand, gravel, topsoil, mulch) and vegetation.

Drain Inserts MP-52

Description

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

California Experience

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

Advantages

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

Limitations

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

Design and Sizing Guidelines

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

Design Considerations

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

Targeted Constituents

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

Removal Effectiveness

See New Development and Redevelopment Handbook-Section 5.

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

Construction/Inspection Considerations

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

Performance

Few products have performance data collected under field conditions.

Siting Criteria

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

Additional Design Guidelines

Follow guidelines provided by individual manufacturers.

Maintenance

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

Cost

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

References and Sources of Additional Information

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

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

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

Manufacturers literature

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

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

Site Design & Landscape Planning SD-10

Design Objectives

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

Description

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

Approach

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

Suitable Applications

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

Design Considerations

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

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Designing New Installations

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

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

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

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

Conserve Natural Areas during Landscape Planning

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

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

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

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

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

- Preserve riparian areas and wetlands.

Maximize Natural Water Storage and Infiltration Opportunities Within the Landscape Unit

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

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

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

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

Protection of Slopes and Channels during Landscape Design

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

Redeveloping Existing Installations

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

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

Other Resources

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

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

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

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

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

Roof Runoff Controls SD-11

Rain Garden

Design Objectives

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

Description

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

Approach

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

Suitable Applications

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

Design Considerations

Designing New Installations

Cisterns or Rain Barrels

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

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

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

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

Dry wells and Infiltration Trenches

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

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

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

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

Pop-up Drainage Emitter

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

Foundation Planting

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

Redeveloping Existing Installations

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

Supplemental Information

Examples

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

Other Resources

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

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

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

Efficient Irrigation SD-12

Design Objectives

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

Description

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

Approach

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

Suitable Applications

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

Design Considerations

Designing New Installations

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

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

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

Redeveloping Existing Installations

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

Other Resources

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

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

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

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

Storm Drain Signage SD-13

Design Objectives

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

Description

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

Approach

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

Suitable Applications

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

Design Considerations

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

Designing New Installations

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

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

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

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

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

Redeveloping Existing Installations

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

Additional Information

Maintenance Considerations

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

Placement

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

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

Supplemental Information

Examples

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

Other Resources

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

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

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

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

Street Sweeping and Vacuuming SE-7

Categories

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

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

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

Potential Alternatives

None

If User/Subscriber modifies this fact sheet in any way, the CASQA name/logo and footer below must be removed from each page and not appear on the modified version.

Description and Purpose

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

Suitable Applications

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

Limitations

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

Implementation

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

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

Costs

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

Inspection and Maintenance

- Inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- When actively in use, points of ingress and egress must be inspected daily.
- When tracked or spilled sediment is observed outside the construction limits, it must be removed at least daily. More frequent removal, even continuous removal, may be required in some jurisdictions.
- Be careful not to sweep up any unknown substance or any object that may be potentially hazardous.
- Adjust brooms frequently; maximize efficiency of sweeping operations.
- After sweeping is finished, properly dispose of sweeper wastes at an approved dumpsite.

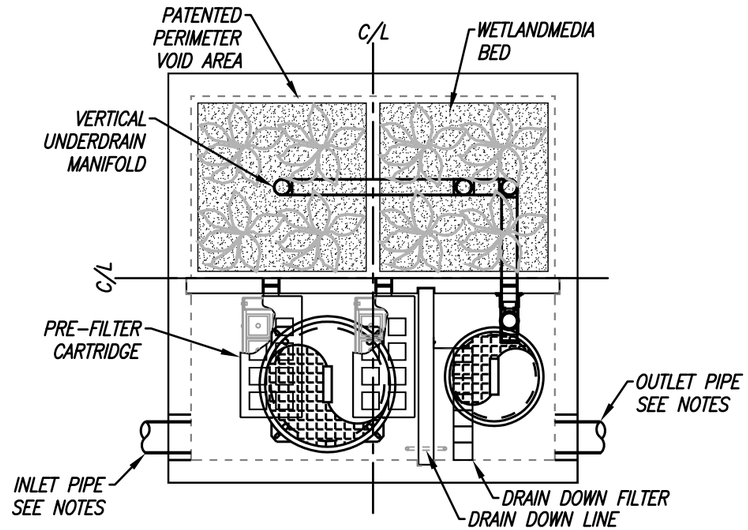
References

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

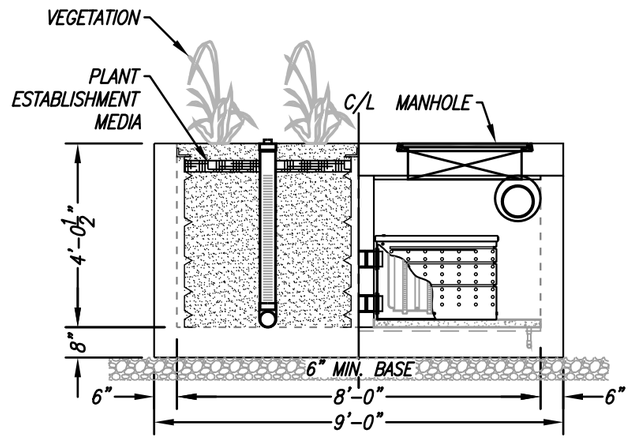
Labor Surcharge and Equipment Rental Rates, State of California Department of Transportation (Caltrans), April 1, 2002 – March 31, 2003.

Appendix C:
Modular Wetlands System Biofiltration Units & FloGard Catch Basin Insert Filter

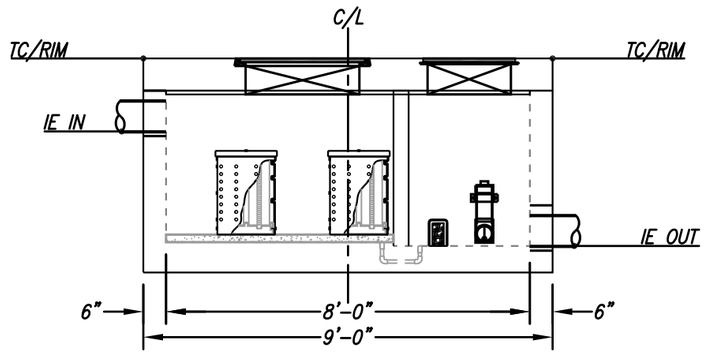
SITE SPECIFIC DATA			
PROJECT NAME			
PROJECT LOCATION			
STRUCTURE ID			
TREATMENT REQUIRED			
VOLUME BASED (CF)		FLOW BASED (CFS)	
TREATMENT HGL AVAILABLE (FT)			
PEAK BYPASS REQUIRED (CFS) – IF APPLICABLE			
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE 1			
INLET PIPE 2			
OUTLET PIPE			
	PRETREATMENT	BIOFILTRATION	DISCHARGE
RIM ELEVATION			
SURFACE LOAD	PARKWAY	OPEN PLANTER	PARKWAY
FRAME & COVER	ø30"	N/A	ø24"
WETLANDMEDIA VOLUME (CY)			4.84
WETLANDMEDIA DELIVERY METHOD			TBD
ORIFICE SIZE (DIA. INCHES)			ø2.16"
MAXIMUM PICK WEIGHT (LBS)			TBD
NOTES:			



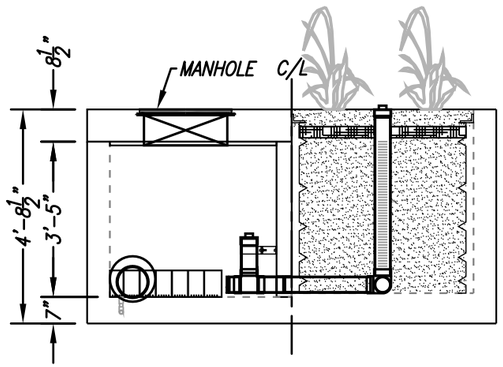
PLAN VIEW



LEFT END VIEW
BIOFILTRATION/PRETREATMENT



ELEVATION VIEW



RIGHT END VIEW
DISCHARGE/BIOFILTRATION

INSTALLATION NOTES

1. CONTRACTOR TO PROVIDE ALL LABOR, EQUIPMENT, MATERIALS AND INCIDENTALS REQUIRED TO OFFLOAD AND INSTALL THE SYSTEM AND APPURTENANCES IN ACCORDANCE WITH THIS DRAWING AND THE MANUFACTURERS SPECIFICATIONS, UNLESS OTHERWISE STATED IN MANUFACTURERS CONTRACT.
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.
3. 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 GAPS AROUND PIPES SHALL BE SEALED WATER TIGHT WITH A NON–SHRINK GROUT PER MANUFACTURERS STANDARD CONNECTION DETAIL AND SHALL MEET OR EXCEED REGIONAL PIPE CONNECTION STANDARDS.
4. CONTRACTOR TO SUPPLY AND INSTALL ALL EXTERNAL CONNECTING PIPES.
5. CONTRACTOR RESPONSIBLE FOR INSTALLATION OF ALL RISERS, MANHOLES, AND HATCHES. CONTRACTOR TO GROUT ALL MANHOLES AND HATCHES TO MATCH FINISHED SURFACE UNLESS SPECIFIED OTHERWISE.
6. DRIP OR SPRAY IRRIGATION REQUIRED ON ALL UNITS WITH VEGETATION.

GENERAL NOTES

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 MANUFACTURER.

TREATMENT FLOW (CFS)	0.230
OPERATING HEAD (FT)	3.4
PRETREATMENT LOADING RATE (GPM/SF)	TBD
WETLAND MEDIA LOADING RATE (GPM/SF)	1.0

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MWS-L-8-8-V
STORMWATER BIOFILTRATION SYSTEM
STANDARD DETAIL

SITE SPECIFIC DATA*	
PROJECT NAME	
PROJECT LOCATION	
STRUCTURE ID	

PERFORMANCE DATA	
TREATMENT VOLUME (CF)	
DRAINDOWN TIME (HR)	
TREATMENT HGL (FT)	
BYPASS FLOW RATE (CFS)	

PROJECT PARAMETERS			
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE 1			
OUTLET PIPE 1			
RIM ELEVATION			
SURFACE LOADING REQUIREMENT			

FRAME & COVER	PRETREATMENT	BIOFILTRATION	DISCHARGE

WETLANDMEDIA VOLUME (CY)	
MEDIA DELIVERED	
ORIFICE SIZE (DIA)	
MAX PICK WEIGHT (LBS)	

NOTES:

*PER ENGINEER OF RECORD

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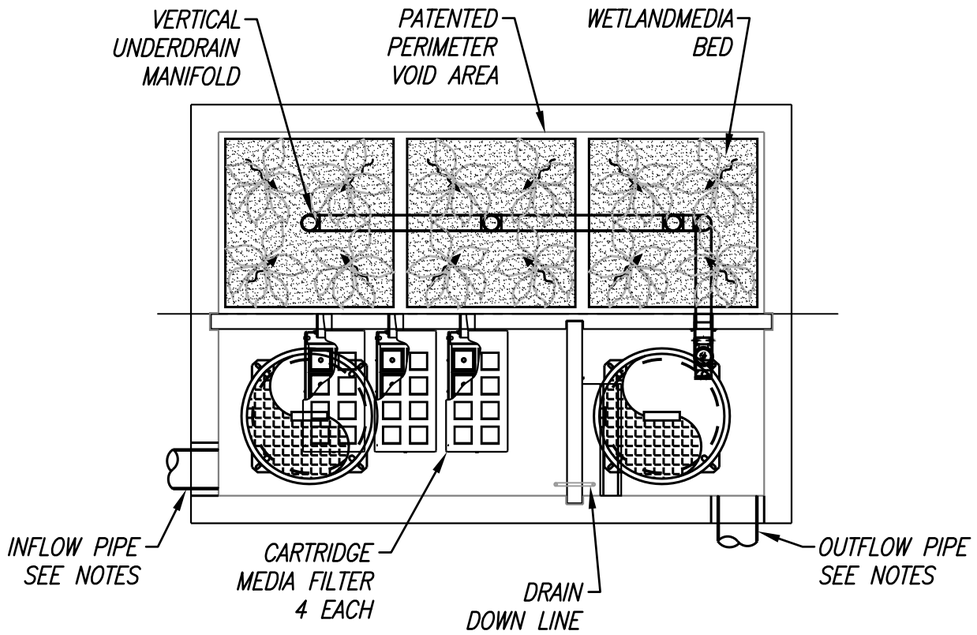
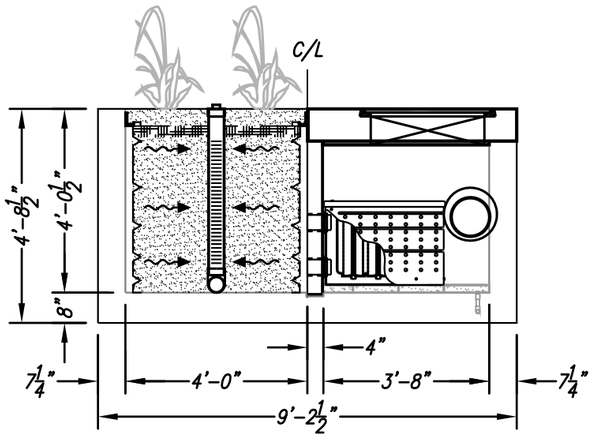
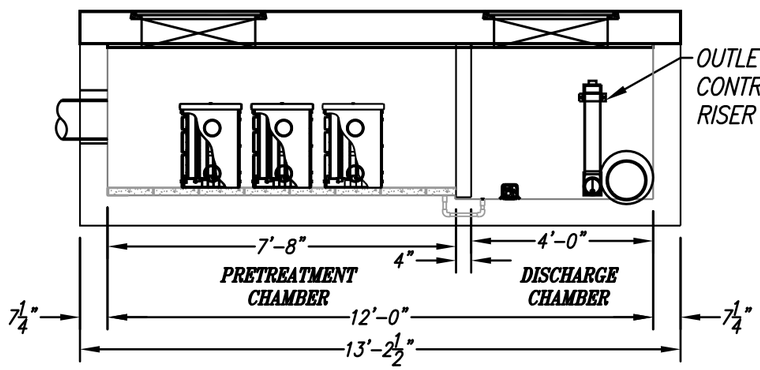


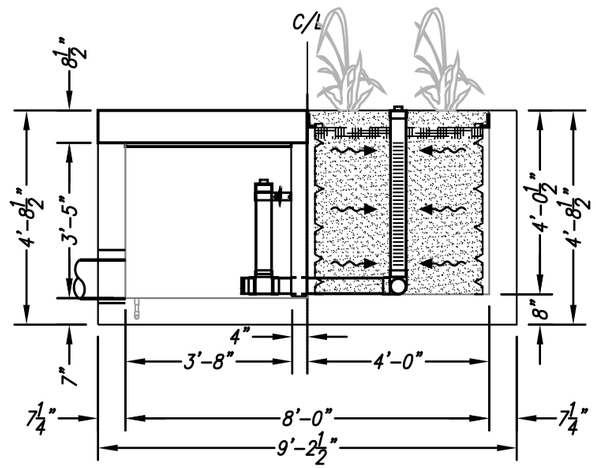
PLAN VIEW



LEFT END VIEW



ELEVATION VIEW



RIGHT END VIEW

MWS UNIT DESIGN DATA	
TREATMENT CAPACITY (CFS)	0.346
OPERATING HEAD (FT)	3.4
PRETREATMENT SURFACE AREA (SF)	105.84
WETLAND LOADING RATE (GPM/MIN)	1.04

MODULAR WETLANDS

MWS-L-8-12-V

STORMWATER BIOFILTRATION SYSTEM STANDARD DETAIL

SITE SPECIFIC DATA*	
PROJECT NAME	
PROJECT LOCATION	
STRUCTURE ID	

PERFORMANCE DATA	
TREATMENT VOLUME (CF)	
DRAINDOWN TIME (HR)	
TREATMENT HGL (FT)	
BYPASS FLOW RATE (CFS)	

PROJECT PARAMETERS			
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE 1			
OUTLET PIPE 1			
RIM ELEVATION			
SURFACE LOADING REQUIREMENT			

FRAME & COVER	PRETREATMENT	BIOFILTRATION	DISCHARGE

WETLANDMEDIA VOLUME (CY)	
MEDIA DELIVERED	
ORIFICE SIZE (DIA)	
MAX PICK WEIGHT (LBS)	

NOTES:

*PER ENGINEER OF RECORD

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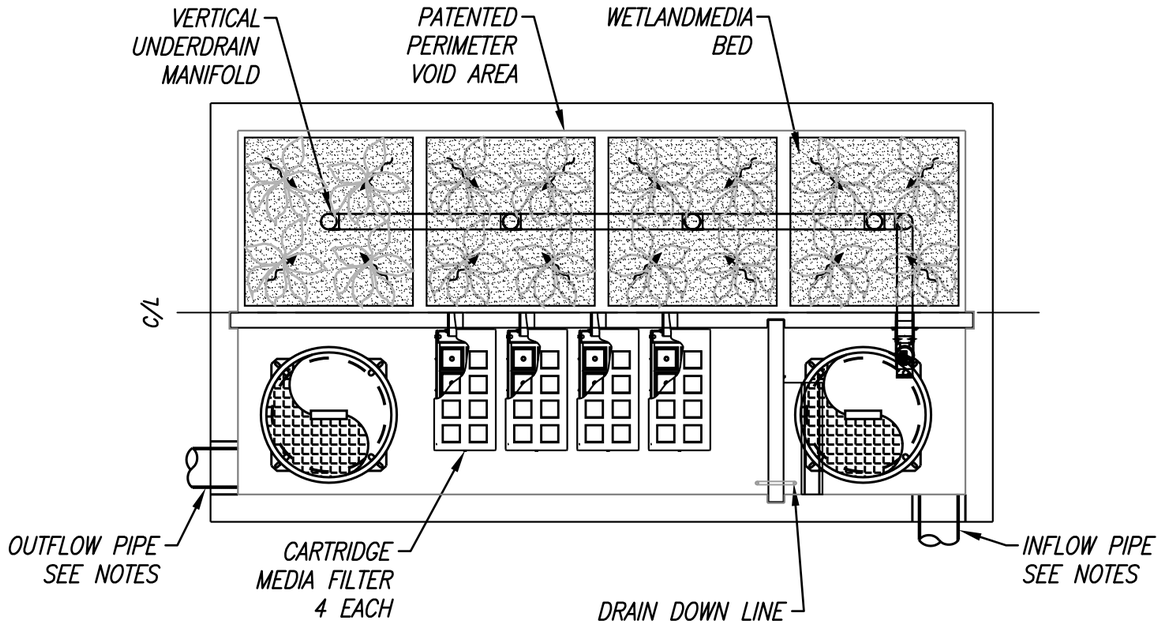
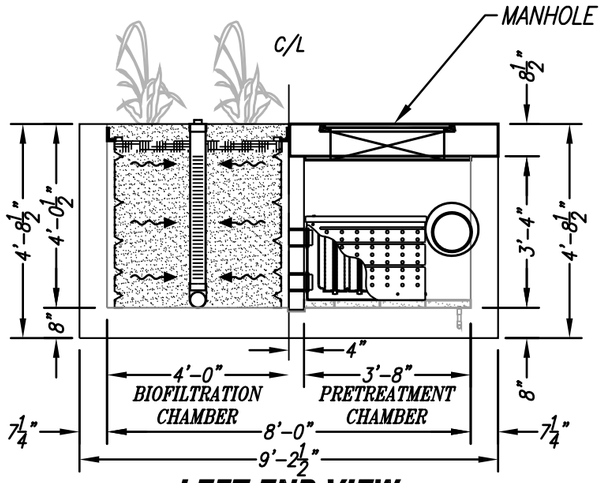
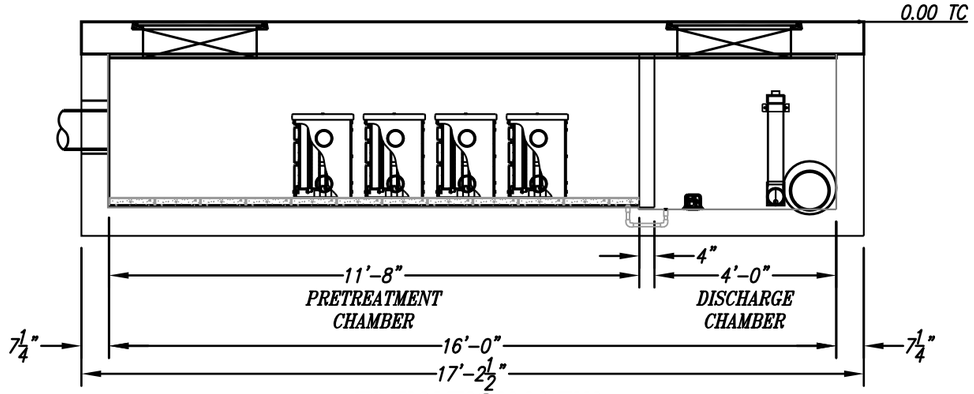


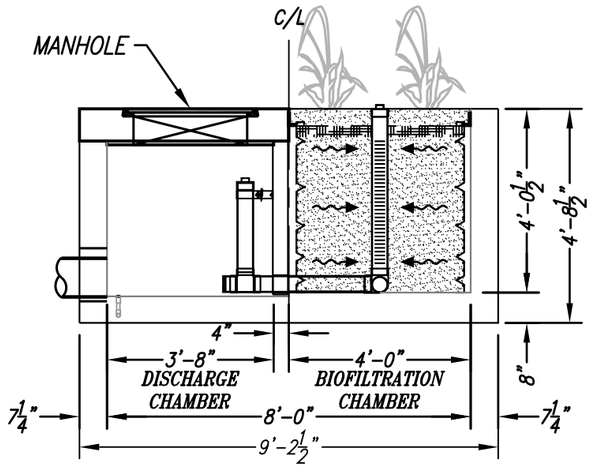
PLAN VIEW



LEFT END VIEW



ELEVATION VIEW



RIGHT END VIEW

MWS UNIT DESIGN DATA	
TREATMENT CAPACITY (CFS)	0.462
OPERATING HEAD (FT)	3.4
PRETREATMENT SURFACE AREA (SF)	141.12
WETLAND LOADING RATE (GPM/MIN)	1.03

MODULAR WETLANDS

MWS-L-8-16-V

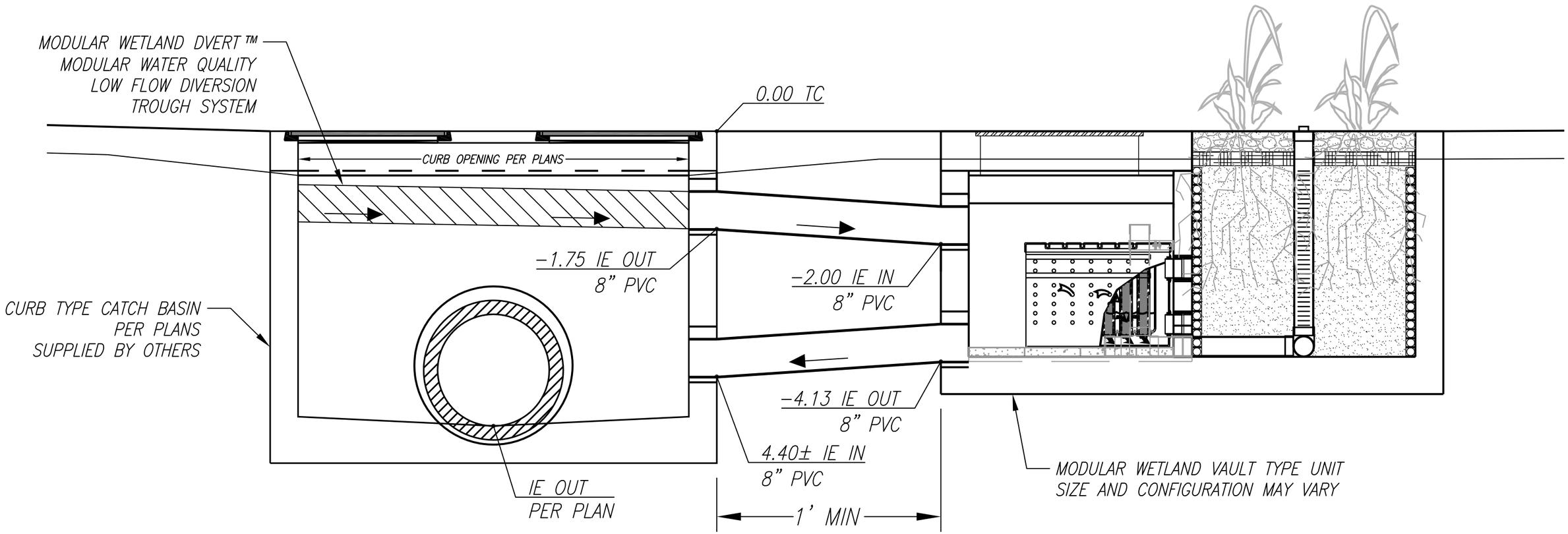
STORMWATER BIOFILTRATION SYSTEM

STANDARD DETAIL

MWS Linear 2.0 HGL Sizing Calculations

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

MODULAR WETLAND SYSTEMS - LINEAR 2.0
STANDARD DVERT ELEVATIONS



TYPICAL ELEVATION VIEW

MODULAR WETLAND SYSTEMS INC.
P.O. BOX 869
OCEANSIDE, CA 92049
www.ModularWetlands.com

	NAME	DATE
DRAWN		
EDITED		

COMMENTS:

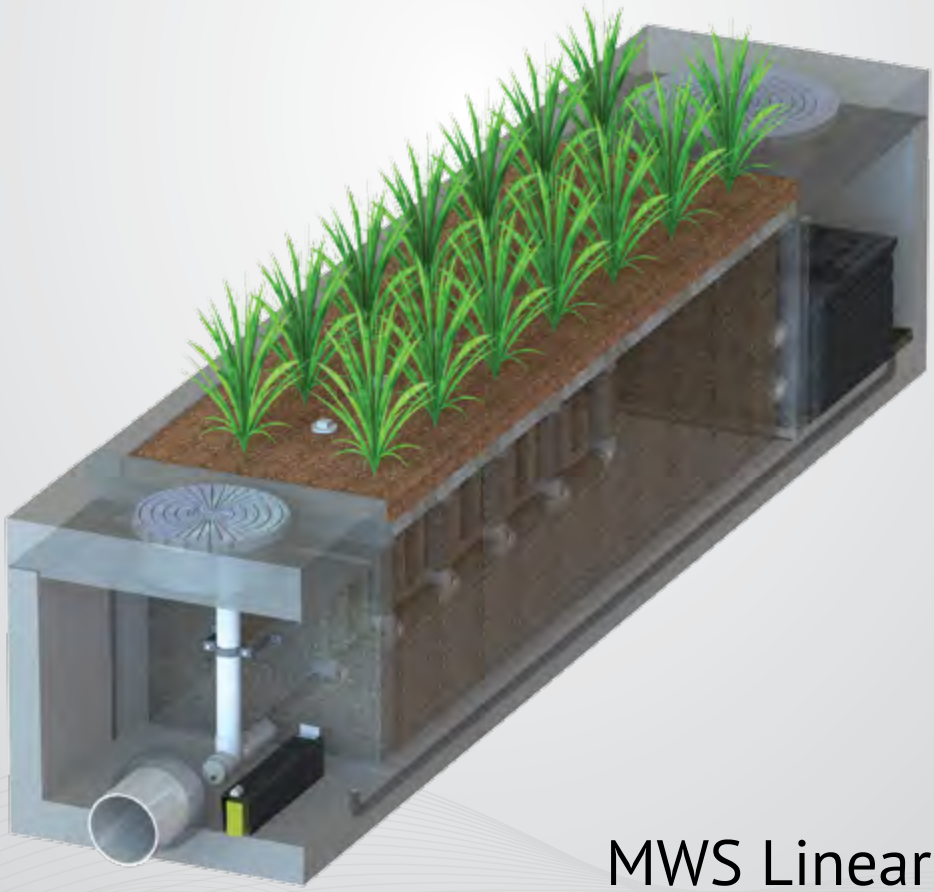
TITLE: MWS LINEAR 2.0 DVERT SETUP

SIZE	DWG. NO.	REV

SCALE NTS | UNITS = INCHES | SHEET 1 OF 1

MODULAR WETLANDS™

*Advanced **Stormwater** Biofiltration*



MWS Linear

Contents

The Urban Impact

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

Plant A Wetland

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

MWS Linear

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

Applications

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

Industrial

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

Residential

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

Streets

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

Parking Lots

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

Commercial

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

Mixed Use

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

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

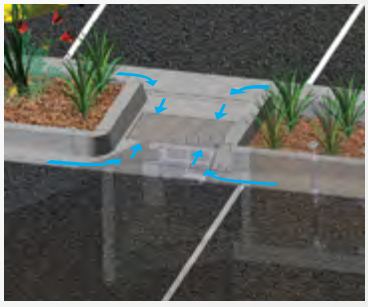
- Agriculture
- Reuse
- Low Impact Development
- Waste Water

Configurations

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

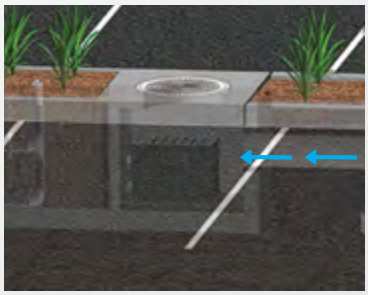
Curb Type

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



Grate Type

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



Vault Type

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

Downspout Type

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

Advantages & Operation

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

Featured Advantages

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

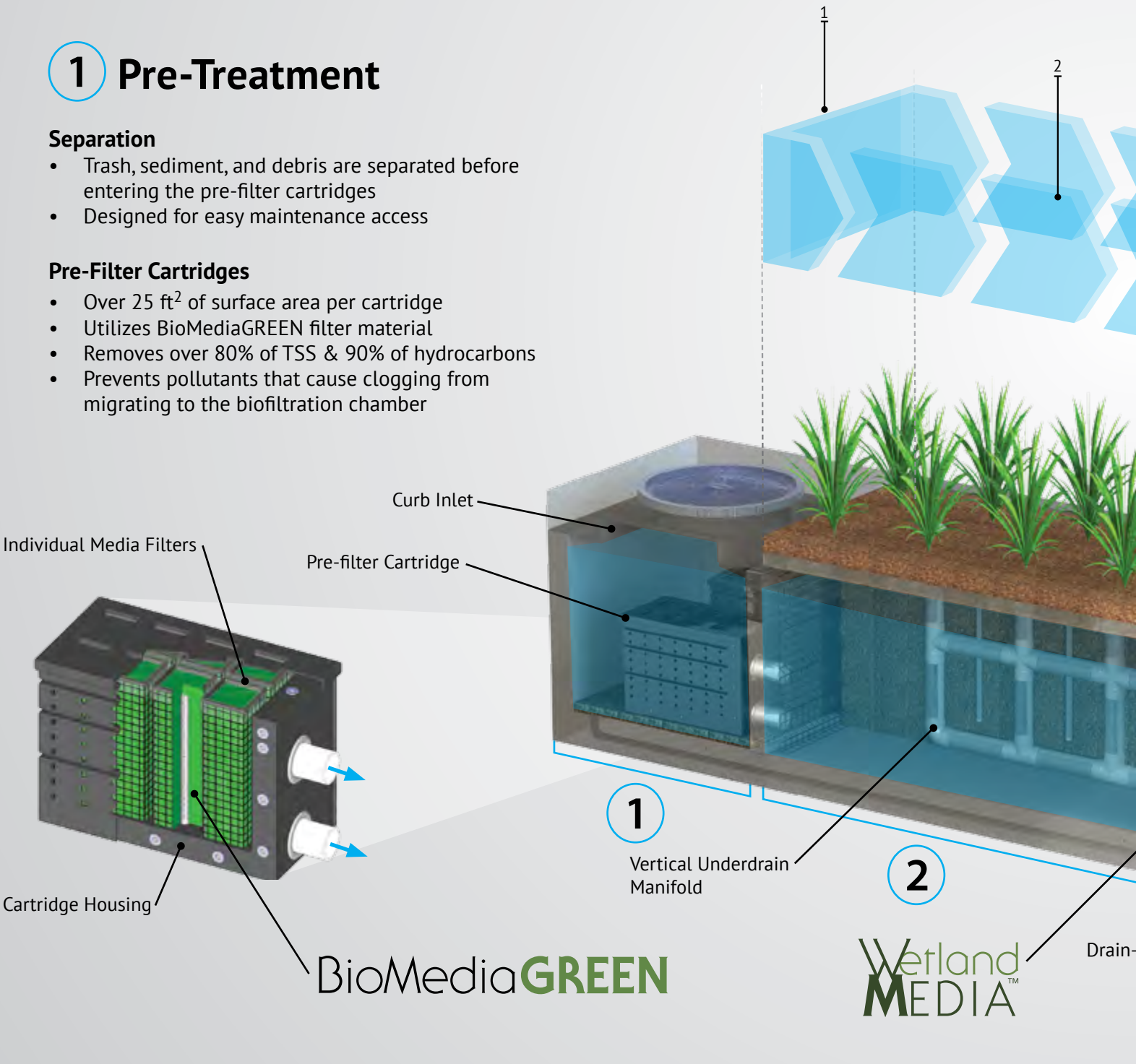
1 Pre-Treatment

Separation

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

Pre-Filter Cartridges

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



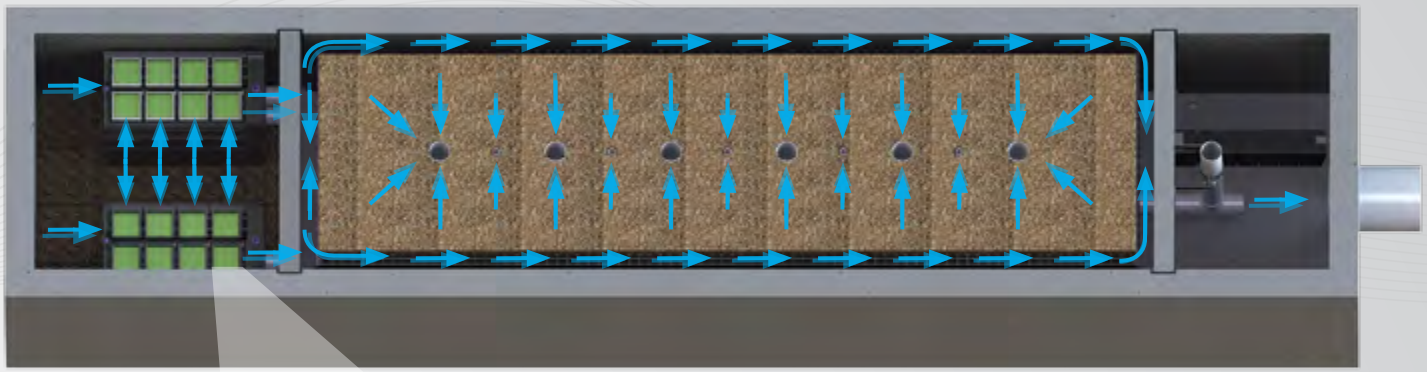


Fig. 2 - Top View

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

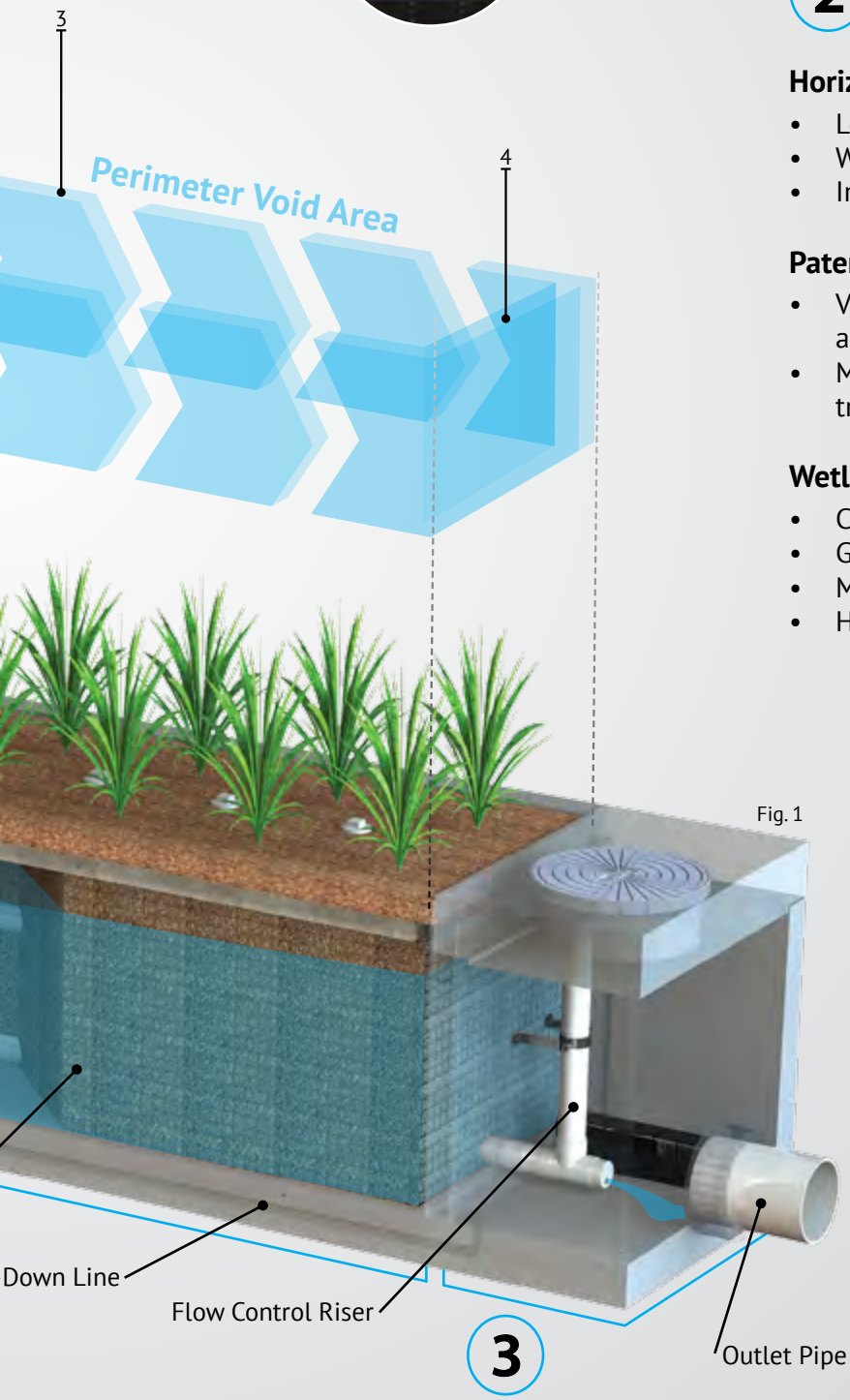


Fig. 1

2 Biofiltration

Horizontal Flow

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

Patented Perimeter Void Area

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

WetlandMEDIA

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

3 Discharge

Flow Control

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

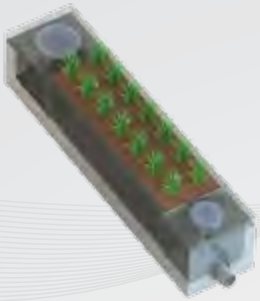
Drain-Down Filter

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

Orientations

Side-By-Side

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



End-To-End

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

Bypass

Internal Bypass Weir (Side-by-Side Only)

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

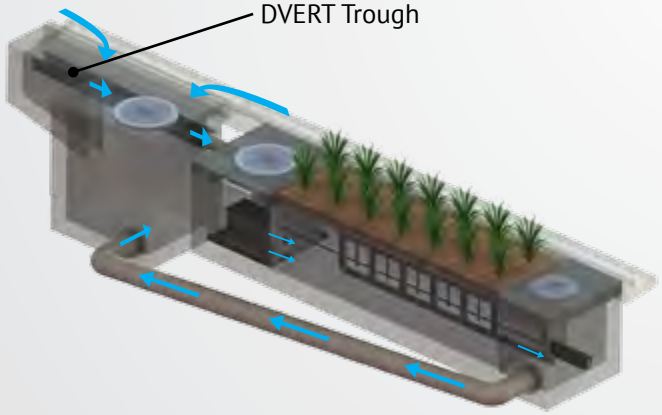
External Diversion Weir Structure

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

Flow By Design

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

DVERT Low Flow Diversion



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

Performance

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

Approvals

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

Washington State DOE Approved

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

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

DEQ Assignment

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

MASTEP Evaluation

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

Rhode Island DEM Approved

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

Flow Based Sizing

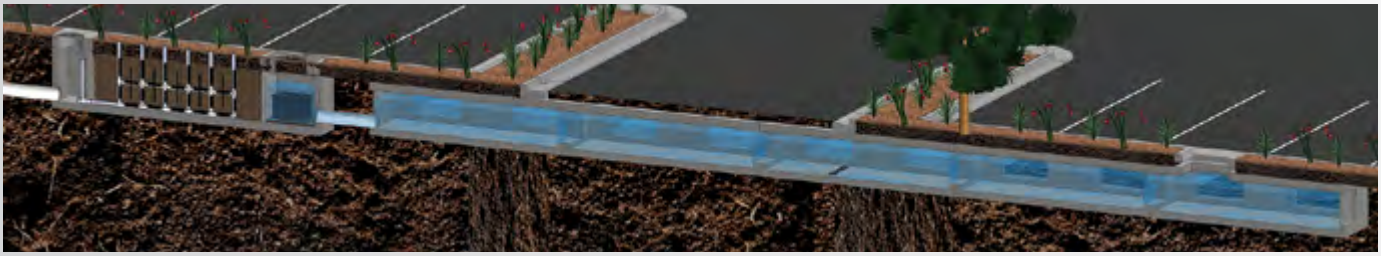
The MWS Linear can be used in stand alone applications to meet treatment flow requirements. Since the MWS Linear is the only biofiltration system that can accept inflow pipes several feet below the surface it can be used not only in decentralized design applications but also as a large central end-of-the-line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

Treatment Flow Sizing Table

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

Volume Based Sizing

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



Treatment Volume Sizing Table

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

Installation

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

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

Maintenance

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

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

Plant Selection

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

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

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

SPECIFICATIONS

MWS – Linear

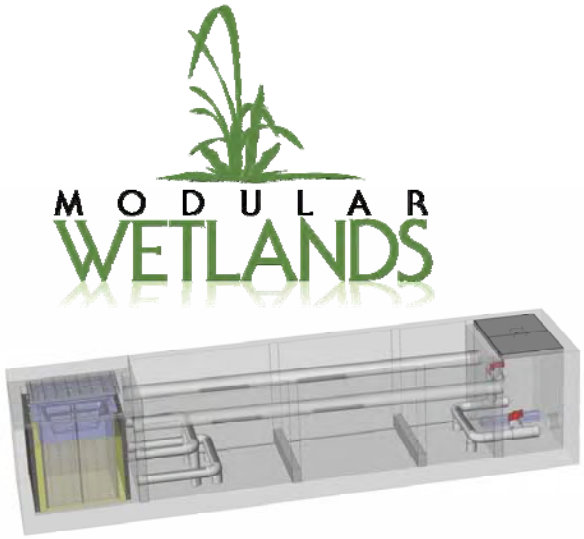
Hybrid Stormwater Filtration System

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

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

MWS – Linear

Hybrid Stormwater Filtration System



Save valuable space with small footprint for urban sites.

Improve BMP aesthetics with attractive native and tropical landscape plants.

Reduce lifetime costs with safer and less expensive maintenance

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

Tested Pollutant Removal Efficiencies:

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

"Nature and Harmony Working Together in Perfect Harmony"

SPECIFICATIONS – MWS- LINEAR

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

SPECIFICATIONS – BioMediaGREEN

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

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

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

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

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

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

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

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

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

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

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

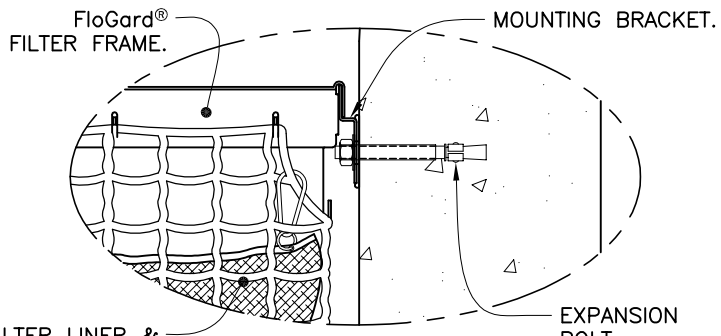
Field and laboratory tests have confirmed the BioMediaGREEN capability to capture large percentage of TSS, hydrocarbons, nutrients, and heavy metals. Microbial reduction efficiency will vary depending on colony size, flow rates and site specific conditions.

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

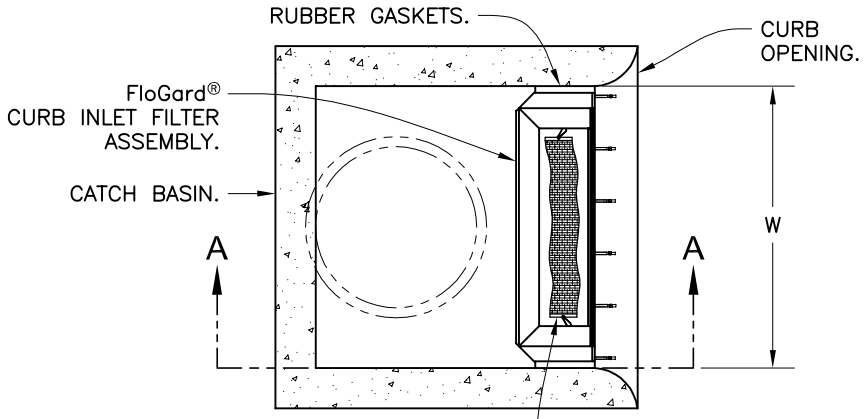
Sil-Co-Sil 106. Mean particle diameter = 19 microns

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

FGP-0002

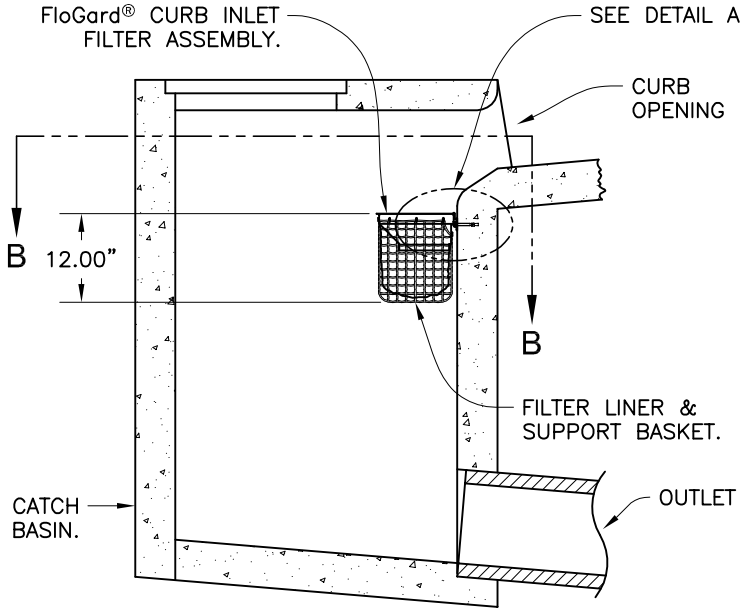


DETAIL A
MOUNTING BRACKET & EXPANSION BOLTS
SEE NOTE 2
SCALE: 6X



SECTION B-B
TOP VIEW
SCALE: 1X

SPECIFIER CHART				
MODEL NO.	Curb Opening Width - W -	Storage Capacity - Cu. Ft. -	Filtered Flow Rate - GPM/CFS -	Bypass Flow Rate - GPM/CFS -
FGP-24CI	2.0' (24")	.95	338 / .75	2,513 / 5.6
FGP-30CI	2.5' (30")	1.20	450 / 1.00	3,008 / 6.7
FGP-36CI	3.0' (36")	1.50	563 / 1.25	3,547 / 7.9
FGP-42CI	3.5' (42")	1.80	675 / 1.50	3,951 / 8.8
FGP-48CI	4.0' (48")	2.10	768 / 1.76	4,445 / 9.9
FGP-5.0CI	5.0' (60")	2.40	900 / 2.00	5,208 / 11.6
FGP-6.0CI	6.0' (72")	3.05	1,126 / 2.51	6,196 / 13.8
FGP-7.0CI	7.0' (84")	3.65	1,350 / 3.01	7,139 / 15.9
FGP-8.0CI	8.0' (96")	4.25	1,576 / 3.51	8,082 / 18.0
FGP-10.0CI	10.0' (120")	4.85	1,800 / 4.01	9,833 / 21.9
FGP-12.0CI	12.0' (144")	6.10	2,252 / 5.02	11,764 / 26.2
FGP-14.0CI	14.0' (168")	7.30	2,700 / 6.02	13,515 / 30.1
FGP-16.0CI	16.0' (192")	8.55	3.152 / 7.02	15,446 / 34.4
FGP-18.0CI	18.0' (216")	9.45	3,490 / 7.78	17,152 / 38.2
FGP-21.0CI	21.0' (252")	10.95	4,050 / 9.02	19,891 / 44.3
FGP-28.0CI	28.0 (336")	14.60	5,400 / 12.03	26,311 / 58.6



SECTION A-A
SIDE VIEW
SCALE: 1X

NOTES:

1. Filter insert shall have a high flow bypass feature.
2. Filter support frame shall be constructed from stainless steel Type 304.
3. Filter medium shall be *Fossil Rock* ™, installed and maintained in accordance with manufacturer specifications.
4. Storage capacity reflects 80% of maximum solids collection prior to impeding filtering bypass.

Inlet
Filtration

FloGard®

Catch Basin Insert Filter

Curb Inlet Style

Oldcastle®
Stormwater Solutions

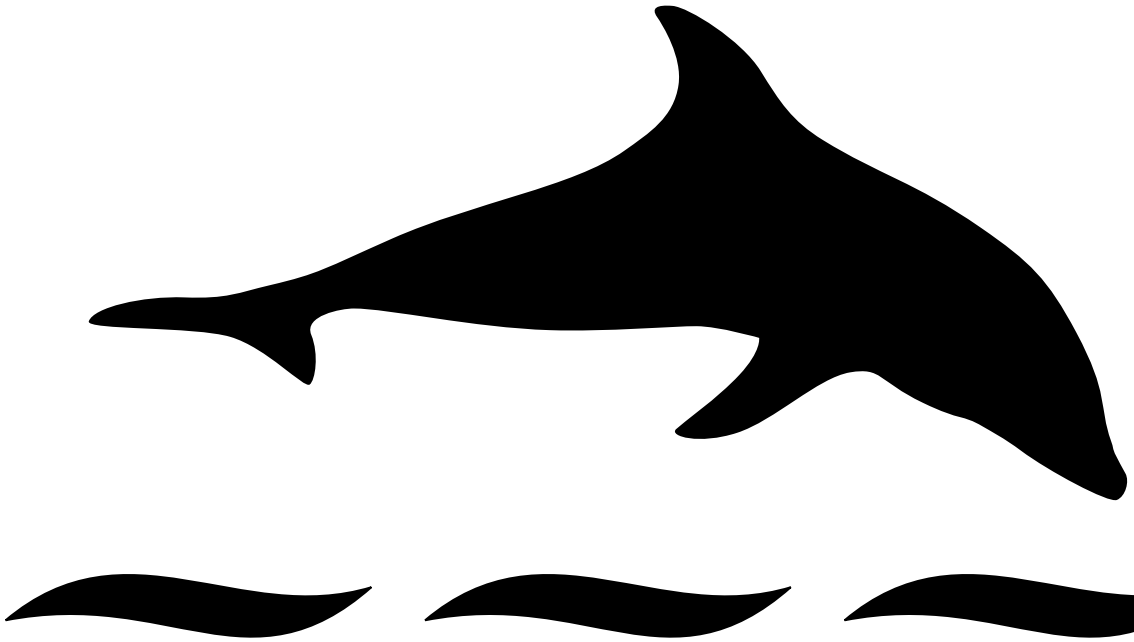
7921 Southpark Plaza, Suite 200 | Littleton, CO | 80120 | Ph: 800.579.8819 | oldcastlestormwater.com

DRAWING NO.	REV	ECO	DATE	
FGP-0002	E	ECO-0127 JPR 5/18/15	JPR 1/3/06	SHEET 1 OF 1

Appendix D:
"NO DUMPING – DRAINS TO OCEAN" Stencil Examples

Sample Stencil 1

NO DUMPING



DRAINS TO OCEAN

Sample Stencil 2

Appendix E:
Catch Basin Cleaning

OPERATION & MAINTENANCE PLAN
FOR FILTER INSERT

The maintenance program will include the following key components:

1. **REGULAR SWEEPING AND REMOVAL OF DEBRIS:**
   Vehicle parking lot will be swept on a regular basis. Sediment and debris (litter, leaves, papers and cans, etc.) within the area, especially around the drainage inlet, will be collected and removed. The frequency of sweeping will be based on the amount of sediment and debris generated.

2. **REGULAR INSPECTIONS:**
   The catch basin, downspout, or trench drain filter insert will be inspected on a regular basis. The frequency of inspection will be based on pollutant loading, amount of debris, leaves, etc., and amount of runoff. At a minimum, there will be three inspections per year.

3. **CONDUCT OF THE VISUAL INSPECTION:**
   a. Broom sweep around the inlet and remove the inlet grate.
   b. Inspect the filter liner for serviceability. If called for, the filter body will be replaced.
   c. Check the condition of the adsorbent pouches and visually check the condition of the enclosed adsorbent. If the surface of the granules is more than 50% coated with a dark gray or black substance, the pouches will be replaced with new ones.
   d. Check for loose or missing nuts (on some models) and gaps between the filter and the inlet wall, which would allow bypass of the filter during low flows.
   e. The filter components will be replaced in the inlet and the grate replaced.

4. **CLEANING OUT THE FILTER INSERT:**
   Regardless of the model of filter insert, the devices must be cleaned out on a recurring basis. The manufacturer recommends at least three cleanings per year – more in high exposure areas. For the Flo-Gard+Plus filters, the filter must be cleaned when the solids level reaches close to the fullel tip.
   a. The Standard Filter, in most cases, can be cleaned out by removing the device from the inlet and dumping the contents into a DOT approved drum for later disposal. If the oil-absorbant pouches need to be changed, the time to change them is immediately after dumping and before the filter is replaced in the inlet.
   b. Because of weight, method of installation and so forth, some filter inserts will be cleaned with the aid of a vactor truck. If necessary, the oil-absorbant pouches will be changed after the pollutants have been removed and as the filter is being returned to service.

5. **MAINTENANCE LOG:**
   Keep a log of all inspections and maintenance performed on the catch basins, trench drains, and filter inserts. Keep this log on-site.

CATCH BASIN MAINTENANCE RECORD

SITE INFORMATION	
Contact:	Phone: ( )
Project Name:	
Address:	
Filter No. & Model:	

SERVICE INFORMATION		
Date of Service:	By:	
☐ Inspection	☐ Clean Debris	☐ Clean Silt/Sediment
☐ Replace Pouch	☐ Replace Rock	☐ Repair/Replace Parts
Comments:		
Approval Signature:		

SITE INFORMATION	
Contact:	Phone: ( )
Project Name:	
Address:	
Filter No. & Model:	

SERVICE INFORMATION		
Date of Service:	By:	
☐ Inspection	☐ Clean Debris	☐ Clean Silt/Sediment
☐ Replace Pouch	☐ Replace Rock	☐ Repair/Replace Parts
Comments:		
Approval Signature:		

CATCH BASIN MAINTENANCE RECORD

SITE INFORMATION		
Contact:	Phone: ( )	
Project Name:		
Address:		
Filter No. & Model:		

SERVICE INFORMATION		
Date of Service:	By:	
☐ Inspection	☐ Clean Debris	☐ Clean Silt/Sediment
☐ Replace Pouch	☐ Replace Rock	☐ Repair/Replace Parts
Comments:		
Approval Signature:		

SITE INFORMATION		
Contact:	Phone: ( )	
Project Name:		
Address:		
Filter No. & Model:		

SERVICE INFORMATION		
Date of Service:	By:	
☐ Inspection	☐ Clean Debris	☐ Clean Silt/Sediment
☐ Replace Pouch	☐ Replace Rock	☐ Repair/Replace Parts
Comments:		
Approval Signature:		

Appendix F:
General Education Materials

Storm Drains are for Rain...

More than 50% of the automotive oil sold to do-it-yourself oil changers is not recycled. There are more than 600 State-certified used oil collection centers within Los Angeles County.

Never dispose of automotive fluids in the street or gutter. Take them to your local auto parts store, gas station or repair shop, or a household hazardous waste Roundup for recycling.

1(888)CLEAN LA
www.888CleanLA.com

...not automotive fluids.

Car Care Tips:

You can keep your car running smoothly and efficiently, and at the same time help prevent stormwater pollution by taking these easy steps...

- When changing vehicle fluids — motor oil, transmission, brake and radiator fluids — drain them into separate drip pans to avoid spills. Do not combine these fluids. Do not dispose of these fluids in the street, gutter or garbage. It is illegal.
- If a spill occurs, use kitty litter, sawdust or cornmeal for cleanup. Do not hose or rinse with water.
- Recycle all used vehicle fluids. Call 1(888)CLEAN LA or visitwww.888CleanLA.com for the location of an auto parts store or gas station that recycles these fluids, or for the location of a local household hazardous waste Roundup.
- Regularly check and maintain your car to keep it running safely and efficiently. Water runoff from streets, parking lots and driveways picks up oil and grease drippings, asbestos from brake linings, zinc from tires and organic compounds and metals from spilled fuels and carries them to the ocean.

PROJECT Pollution PREVENTION

Printed on recycled paper

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- Recycle all used vehicle fluids. Call 1(888)CLEAN LA or visit www.888CleanLA.com for the location of an auto parts store or gas station that recycles these fluids, or for the location of a local household hazardous waste Roundup.
- Regularly check and maintain your car to keep it running safely and efficiently. Water runoff from streets, parking lots and driveways picks up oil and grease drippings, asbestos from brake linings, zinc from tires and organic compounds and metals from spilled fuels and carries them to the ocean.

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Are You a Litter Bug and Don't Know It?

Take our quiz!

Have you ever...

- Dropped a cigarette butt or trash on the ground?
- Failed to pick up after your dog while out on a walk?
- Overwatered your lawn after applying fertilizers/pesticides?
- Disposed of used motor oil in the street, gutter or garbage?

If you answered **yes** to any of these actions, then **YOU ARE A LITTER BUG**!

Each of these behaviors contribute to stormwater pollution, which contaminates our ocean and waterways, kills marine life and causes beach closures.

You can become part of the solution!
To find out how, flip this card over.

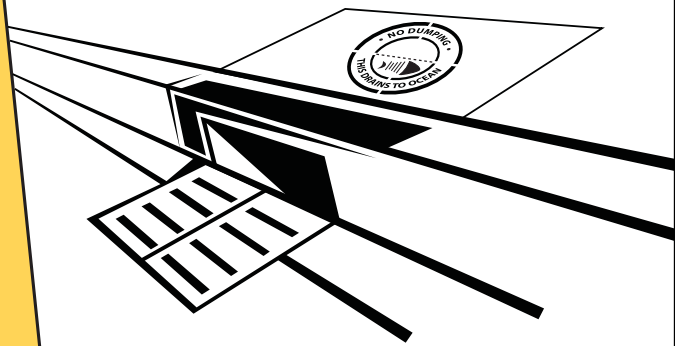
For more information, call or visit:

1 (888) CLEAN LA
www.888CleanLA.com

PROJECT Pollution PREVENTION

Follow these simple steps to prevent stormwater pollution:

- Put your garbage where it belongs — in the trash can.
- Pick up after your dog when out on a walk.
- Reduce pesticide and fertilizer use; don't overwater after application or apply if rain is forecast.
- Dispose of used motor oil at an oil recycling center or at a free Household Hazardous Waste/E-Waste collection event.



A message from the County of Los Angeles Department of Public Works.
Printed on recycled paper.

Don't Paint the Town Red!

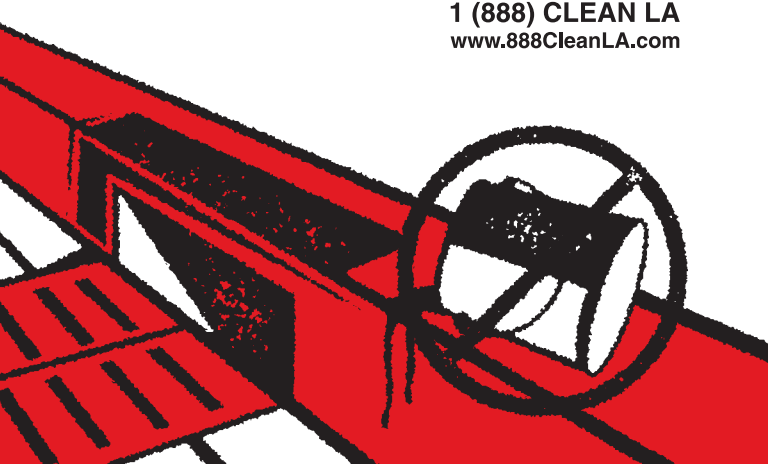
Storm drains are for rain…
they're not for paint disposal.

More than **197,000** times each month, L.A. County residents wash their dirty paint brushes under an outdoor faucet.

This dirty rinse water flows into the street, down the storm drain and straight to the ocean — **untreated**.

Remember to clean water-based paint brushes in the sink, rinse oil-based paint brushes with paint thinner, and take old paint and paint-related products to a Household Hazardous Waste/E-Waste collection event.

1 (888) CLEAN LA
www.888CleanLA.com



Tips for Paint Clean-Up:

L.A. County residents can help solve the stormwater pollution problem by taking these easy steps when working with paint and paint-related products…

- Never dispose of paint or paint-related products in the gutters or storm drains. This is called illegal dumping. Take them to a Household Hazardous Waste/E-Waste collection event. Call 1 (888) CLEAN LA or visit www.888CleanLA.com to locate an event near you.
- Buy only what you need. Reuse leftover paint for touch-ups or donate it to a local graffiti abatement program. Recycle or use excess paint.
- Clean water-based paint brushes in the sink.
- Oil-based paints should be cleaned with paint thinner. Filter and reuse paint thinner. Set the used thinner aside in a closed jar to settle-out paint particles.
- Store paints and paint-related products in rigid, durable and watertight containers with tight-fitting covers.

PROJECT Pollution PREVENTION

A message from the County of Los Angeles Department of Public Works.
Printed on recycled paper.

Storm Drains are for Rain...

More than 200,000 times each month, lawns and gardens throughout LA County are sprayed with pesticides. Overwatering or rain causes pesticides on leaves and grass to flow into the storm drain and to the ocean — untreated.

Please use pesticides wisely, not before a rain, and water carefully.

...not pesticides.

1(888)CLEAN LA
www.888CleanLA.com

Pesticide Tips:

You can keep your lawn and garden green and at the same time solve the pollution problem by taking these easy steps...

- Never dispose of lawn or garden chemicals in storm drains. This is called illegal dumping. Take them to a household hazardous waste roundup. Call 1(888)CLEAN LA or visit www.888CleanLA.com to locate a roundup or collection facility near you.
- More is not better. Use pesticides sparingly. "Spot" apply, rather than "blanket" apply.
- Read labels! Use only as directed.
- Use non-toxic products for your garden and lawn whenever possible.
- If you must store pesticides, make sure they are in a sealed, water-proof container that cannot leak.
- When watering your lawn, use the least amount of water possible so it doesn't run into the street and carry pesticide chemicals with it. Don't use pesticides before a rain storm. You will not only lose the pesticide, but also will be harming the environment.

PROJECT Pollution PREVENTION

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- More is not better. Use pesticides sparingly. "Spot" apply, rather than "blanket" apply.
- Read labels! Use only as directed.
- Use non-toxic products for your garden and lawn whenever possible.
- If you must store pesticides, make sure they are in a sealed, water-proof container that cannot leak.
- When watering your lawn, use the least amount of water possible so it doesn't run into the street and carry pesticide chemicals with it. Don't use pesticides before a rain storm. You will not only lose the pesticide, but also will be harming the environment.

PROJECT Pollution PREVENTION

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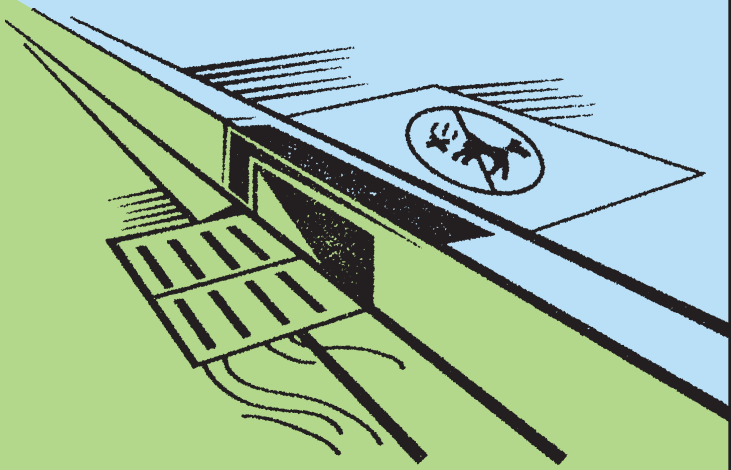
Pick Up After Your Pooch!



Storm drains are for rain…
they're not pooper scoopers.

L.A. County residents walk a dog without picking up the droppings more than **62,000** times per month.

Disease-causing dog waste washes from the ground and streets into storm drains and flows straight to the ocean — untreated.

Remember to bring a bag and clean up after your dog.

1 (888) CLEAN LA
www.888CleanLA.com

Tips for Dog Owners:

Dog owners can help solve the stormwater pollution problem by taking these easy steps…

- Clean up after your dog every single time.
- Take advantage of the complimentary waste bags offered in dispensers at local parks.
- Ensure you always have extra bags in your car so you are prepared when you travel with your dog.
- Carry extra bags when walking your dog and make them available to other pet owners who are without.
- Teach children how to properly clean up after a pet. Encourage them to throw the used bags in the nearest trash receptacle if they are away from home.
- Put a friendly message on the bulletin board at the local dog park to remind pet owners to clean up after their dogs.
- Tell friends and neighbors about the ill effects of animal waste on the environment. Encourage them to clean up after their pets as well.

PROJECT Pollution PREVENTION

Storm Drains are for Rain...

More than 50% of the automotive oil sold to do-it-yourself oil changers is not recycled. There are more than 600 State-certified used oil collection centers within Los Angeles County.

Never dispose of automotive fluids, recyclable products, or household hazardous wastes into the street or gutter. Take them to your local auto repair station, recycling center or a household hazardous waste roundup.

...they're not recycling centers.

1(888)CLEAN LA
www.888CleanLA.com

Recycling Tips:

You can help keep your community clean, protect our area waterways and make the beaches safe for ocean swimmers by putting recyclable materials where they belong — at a recycling center or household hazardous waste roundup. Never throw or pour anything into the streets or gutters...

- When changing vehicle fluids – transmission, hydraulic and motor oil, brake and radiator fluid – drain them into a drip pan to avoid spills. Do not combine these fluids. Do not dispose of them in the street, gutter or in the garbage. It is illegal.
- Recycle all used vehicle fluids. Call 1(888)CLEAN LA or visit www.888CleanLA.com for the location of a center that recycles these fluids, or for the location of a local household hazardous waste Roundup.
- Other materials that should be taken to a household hazardous waste Roundup are: paint and paint-related materials, household cleaners, batteries, pesticides and fertilizers, pool chemicals, and aerosol products.
- Aluminum, glass, plastic and newspapers should be placed in your curbside recycling bin or taken to a local recycling center.

Printed on recycled paper

PROJECT Pollution PREVENTION

Storm Drains are for Rain...

More than 50% of the automotive oil sold to do-it-yourself oil changers is not recycled. There are more than 600 State-certified used oil collection centers within Los Angeles County.

Never dispose of automotive fluids, recyclable products, or household hazardous wastes into the street or gutter. Take them to your local auto repair station, recycling center or a household hazardous waste roundup.

...they're not recycling centers.

1(888)CLEAN LA
www.888CleanLA.com

Recycling Tips:

You can help keep your community clean, protect our area waterways and make the beaches safe for ocean swimmers by putting recyclable materials where they belong — at a recycling center or household hazardous waste roundup. Never throw or pour anything into the streets or gutters...

- When changing vehicle fluids – transmission, hydraulic and motor oil, brake and radiator fluid – drain them into a drip pan to avoid spills. Do not combine these fluids. Do not dispose of them in the street, gutter or in the garbage. It is illegal.
- Recycle all used vehicle fluids. Call 1(888)CLEAN LA or visit www.888CleanLA.com for the location of a center that recycles these fluids, or for the location of a local household hazardous waste Roundup.
- Other materials that should be taken to a household hazardous waste Roundup are: paint and paint-related materials, household cleaners, batteries, pesticides and fertilizers, pool chemicals, and aerosol products.
- Aluminum, glass, plastic and newspapers should be placed in your curbside recycling bin or taken to a local recycling center.

Printed on recycled paper

PROJECT Pollution PREVENTION

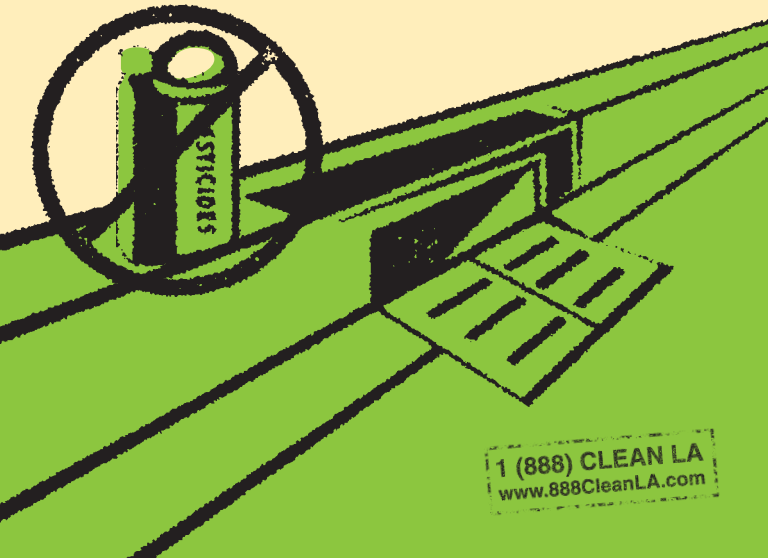
A Yard is a Terrible Thing to Waste!

Storm drains are for rain…**not yard waste.**

Residential yard waste represents about **13 percent** of the total waste generated in L.A. County.

Pesticides, fertilizer and yard waste such as leaves and mowed grass wash from the ground and streets into storm drains and flow straight to the ocean — **untreated**.

Remember to use pesticides and fertilizer wisely and pick-up yard waste.



Tips For Yard Care:

L.A. County residents can help solve the stormwater pollution problem by taking these easy steps…

- Do not over-fertilize and do not use fertilizer or pesticides near ditches, gutters or storm drains.
- Do not use fertilizer or pesticides before a rain.
- Follow the directions on the label carefully.
- Use pesticides sparingly — more is not better. "Spot" apply, rather than "blanket" apply.
- When watering your lawn, use the least amount of water possible so it doesn't run into the street carrying pesticides and other chemicals with it.
- Use non-toxic products for your garden and lawn whenever possible.
- If you must store pesticides or fertilizer, make sure they are in a sealed, water-proof container in a covered area to prevent runoff.
- Do not blow, sweep, hose or rake leaves or other yard trimmings into the street, gutter or storm drain.

PROJECT Pollution PREVENTION

A message from the County of Los Angeles Department of Public Works.
Printed on recycled paper.

Appendix G:
BMP Maintenance, Inspection, & Repair Log and Checklist

MAINTENANCE, INSPECTION, AND REPAIR LOG

Site: TTM 82390, Gardena ______ Page: ______ of ______

Date: ______ Inspector: ______ Followup: ______

Date: ______ Inspector: ______ Followup: ______

Date: ______ Inspector: ______ Followup: ______

Date: ______ Inspector: ______ Followup: ______

Date: ______ Inspector: ______ Followup: ______

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Date: ______ Inspector: ______ Followup: ______

MAINTENANCE, INSPECTION, AND REPAIR LOG

Site: TTM 82390, Gardena Page: 1 of 3

SE-7 – Street Sweeping & Vacuuming

No. Onsite: ____ No. Inspected: ____ No. Requiring Action: ____

____ No evidence of sediment or trash accumulation
____ Contractor scheduled for regular visits (more frequent during rainy season)
____ Signs posted indicating sweeping schedule

Corrective Action Required:

Scheduled Completion Date:

Modular Wetlands System, Biofiltration Unit

(Note: Refer to manufacturer specifications and details in Appendix C for more info)

No. Onsite: ____ No. Inspected: ____ No. Requiring Action: ____

____ Remove any trash buildup
____ No evidence of standing water.
____ Clean out under drains, if ponding is present
____ Repair any structural damage
____ Inspect, clean and/ or repair per manufacturer's specifications
____ Thatch grass and remove any accumulated sediment buildup

Corrective Action Required:

Scheduled Completion Date:

MAINTENANCE, INSPECTION, AND REPAIR LOG

Site: TTM 82390, Gardena Page: 2 of 3

SD-12 – Efficient Irrigation

No. Onsite: ____ No. Inspected: ____ No. Requiring Action: ____

_____ Timing of irrigation is proper for efficient irrigation
_____ Sprinkler heads are oriented properly to avoid overspray on pavement
_____ Proper amount of water is dispersed for the type of landscaping
_____ Drip line irrigation systems are still functioning properly
_____ Valves and switches are working properly

Corrective Action Required:

Scheduled Completion Date:

SD-13 – Storm Drain Signage

No. Onsite: ____ No. Inspected: ____ No. Requiring Action: ____

_____ Signs are in good condition and have not faded or broken

Corrective Action Required:

Scheduled Completion Date:

MAINTENANCE, INSPECTION, AND REPAIR LOG

Site: TTM 82390, Gardena Page: 3 of 3

SD-10 – Landscape Planning

No. Onsite: ____ No. Inspected: ____ No. Requiring Action: ____

____ Vegetated slopes show no signs of erosion

____ Planted areas allow water to enter, but not to leave the area

____ Adequate mulch or gravel is present in the landscape areas

Corrective Action Required:

Scheduled Completion Date:

Appendix H:
Geotechnical Report & Infiltration Evaluation

UPDATED GEOTECHNICAL AND INFILTRATION EVALUATION
FOR
PROPOSED MULTI-FAMILY RESIDENTIAL DEVELOPMENT
1515 WEST 178TH STREET
CITY OF GARDENA, LOS ANGELES COUNTY, CALIFORNIA

PREPARED FOR

MELIA HOMES
8951 RESEARCH DRIVE
IRVINE, CALIFORNIA 92618

PREPARED BY

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

PROJECT NO. 1949-CR **SEPTEMBER 10, 2018**

GEOTEK

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

September 10, 2018
Project No. 1949-CR

Melia Homes
8951 Research Drive
Irvine, California 92618

Attention: Mr. Chad Brown

Subject: Updated Geotechnical and Infiltration Evaluation
Proposed Multi-Family Residential Development
1515 West 178th Street
City of Gardena, Los Angeles County, California

Dear Mr. Brown:

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

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

Respectfully submitted,
GeoTek, Inc.

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

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

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

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

Distribution: (5) Addressee

G:\Projects\1901 to 1950\1949CR Melia Homes 1515 W. 178th Street Gardena\Geotechnical Report\1949-CR Geotechnical and Infiltration Evaluation 1515 W 178th Street Gardena.docx

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Appendix C – Laboratory Test Results by GeoTek
Appendix D – Infiltration Test Data by GeoTek
Appendix E – General Earthwork and Grading Guidelines

1. PURPOSE AND SCOPE OF SERVICES

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

- Research and review of available geologic and geotechnical data, and general information pertinent to the site,
- Site reconnaissance,
- Site exploration consisting of the excavation, logging, and sampling of three exploratory hollow-stem auger borings and logging and percolation testing of two hollow-stem auger borings,
- Collection of relatively undisturbed and bulk soil samples of the onsite materials,
- Laboratory testing of the soil samples obtained from the site,
- Review and evaluation of site seismicity, and
- Compilation of this geotechnical and infiltration report which presents our findings, conclusions, and recommendations for site development.

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

The scope of this study does not include an assessment of environmental concerns associated with the previous and current use of the site.

2. SITE DESCRIPTION AND PROPOSED DEVELOPMENT

2.1 SITE DESCRIPTION

The subject project site is located and addressed as 1515 West 178th Street in the city of Gardena, Los Angeles County, California. The site is a rectangular-shaped parcel consisting of

approximately 5.6 acres. The property is currently occupied by a company which provides services of storage and transportation of cargo. The subject facility includes a 94,000-square foot building and associated parking lot, underground utilities, as well as hardscape and landscape improvements.

The site has a generally flat topography with a gentle fall of three to five feet to the north-northwest. Surface drainage is to the north-northwest following site topography.

The site is bounded by an Edison easement to the north, a mobile home park to the west, commercial buildings to the east, and West 178th Street with commercial buildings to the south.

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

2.2 PROPOSED DEVELOPMENT

It is our understanding that proposed development will consist of demolition of the existing site improvements, earthwork, and subsequent construction of 118 townhomes and related parking/drive areas, underground utilities, and landscape improvements. The structures are anticipated to be up to three stories in height and to utilize either shallow foundations or post-tensioned slabs. Cuts and fills are estimated to be minor (less than five feet in height). In addition, stormwater at the site may be managed via a 25-foot wide basin to be constructed near the north property line. The specific depth of the basin is unknown currently. For the preparation of this report, however, we have considered infiltration tests at two locations within the proposed basin area at approximately five feet deep.

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

3. DOCUMENT REVIEW

On December 3, 2004, Petra Geotechnical Inc., (Petra) completed a report entitled *Geotechnical Investigation, Proposed Residential Development, 115 West 178th Street, Gardena, California.* This study excavated four hollow-stem auger borings to depths ranging from 21.5 feet to 51.5 feet across the site. Petra reported the presence artificial fills in all their borings ranging between two and four feet in thickness. The fills were described as moist, medium dense to dense clayey sand

containing varying amounts of gravel. Below the fills, terrace deposits were reported to exist and to be composed of moist to very moist, medium dense to hard (stiff to hard) clayey sand, sandy clay, silty sand, and silty clay. Borings B-1 and B-4 reportedly encountered groundwater at depths of about 29 and 32 feet, respectively. Petra stated that historic high groundwater level in the project area was about 15 to 20 feet below the ground surface, per the *Seismic Hazard Zone Report for the Torrance Quadrangle* (CDMG, 1998). The potential for liquefaction at the site was considered unlikely due to the high density of the sandy soils or clayey composition of the terrace deposits. The study recommended removal depths on the order of three to five feet. It also pointed out the on-site fill and native terrace deposits had a "medium" potential for expansion (EI ≈ 51), negligible sulfate content, and poor R-value characteristics (R-Value ≈ 6). Shrinkage on the order of 10 to 15 percent for the on-site fill and of 5 to 10 percent for the terrace deposits, as well as a subsidence of about 0.15 feet were estimated by Petra. The study furnished seismic design parameters for the site based on the 1997 *Uniform Building Code* and geotechnical parameters for design of conventional shallow foundations and post-tensioned slabs at the site.

On April 29, 2016, Petra completed a report entitled *Updated 2013 CBC Seismic Design Parameters; Proposed Residential Development, 1515 West 178th Street, Gardena, California*. The updated report utilized the findings of the site explorations and laboratory test results reported by Petra in 2004. The study provided updated seismic design parameters for the site based on the 2003 *California Building Code (CBC)* and updated soils parameters for design of conventional spread footings and post-tensioned slabs.

In April of 2016, Petra also finalized a *Percolation Test Summary, 1515 West 178th Street, Gardena*. This summary presented the data of two percolation tests performed within the western region of the site. Both tests were apparently conducted at a depth of 5.2 feet. After the application of the Porchet Method to the estimated percolation rates, infiltration rates of 4.09 and 8.77 inches per hour were estimated by Petra for the site soils at five feet. It should be noted that these results seem to disagree with the clayey soil profile displayed by Petra's boring logs.

Logs of the exploratory borings, laboratory test results, and infiltration test data by Petra (2004) are included in Appendix A. The locations of these explorations are shown on the Exploration Location Map presented as Figure 2.

4. FIELD EXPLORATION, LABORATORY TESTING, AND PERCOLATION TESTING

4.1 FIELD EXPLORATION

The soils underlying the site were explored on August 20, 2018 by means of excavating two exploratory borings (B-1 and B-2) within the intended building areas to depths of 26.5 feet below the existing ground surface. In addition, one exploratory boring (B-3) approximately 16.5 feet deep and two percolation test borings (P-1 and P-2) approximately six feet deep were advanced within the future basin area near the north property line. The borings were drilled with a truck-mounted hollow-stem auger drill rig.

The approximate locations of our site explorations and the borings by Petra are shown on the Exploration Location Map, Figure 2. Logs of the borings by GeoTek are provided in Appendix B.

4.2 LABORATORY TESTING

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

4.3 PERCOLATION TESTING

Percolation testing was performed at boring locations P-1 and P-2 to assess the infiltration characteristics of the site soils underlying the proposed basin area. At the time of this investigation, the specific depth of the basin invert was unknown. For this evaluation, we assumed that the invert of the basin will be located approximately five feet below the existing ground surface. Percolation test borings were excavated to approximately one foot below the anticipated invert of the basin (i.e. six feet). The boring diameter was approximately 8 inches. Percolation testing was performed within the lower 30 to 40 inches in the borings by a representative of our firm, in general conformance with the Boring Percolation Test Procedure outlined in the *Guidelines for Geotechnical Investigation and Reporting, Low Impact Development Stormwater Infiltration* (County of Los Angeles, 2017).

The field percolation rates are presented in the following table for each of the borings. As required, the percolation rates were corrected to account for discharge of water from both the

sides and bottom of the borings. This correction was done using the Porchet Method, obtaining the infiltration rates tabulated below:

SUMMARY OF TEST RESULTS		
Boring	Field Percolation Rate (inches per hour)	Field Infiltration Rate (inches per hour)
P-1	0.20	0.01
P-2	0.20	0.01

A suitable factor of safety should be applied to the field rates to design the infiltration system. Detailed percolation/infiltration test data is included in Appendix D.

5. GEOLOGIC AND SOILS CONDITIONS

5.1 REGIONAL SETTING

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

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

More specific to the subject property, the site is located in an area geologically mapped to be underlain by older alluvial deposits (Saucedo, G.J., Greene, G.H., Kennedy, M.P., and Bezore, S.P., 2016). The closest fault to the subject site is the Newport-Inglewood Fault North Los Angeles Basin Section located approximately 3.0 miles to the east.

5.2 GENERAL SOIL/GEOLOGIC CONDITIONS

A brief description of the earth materials encountered on the site by Petra (2004) and recently by GeoTek is presented in the following sections.

5.2.1 Undocumented Artificial Fill

Undocumented artificial fill was encountered in two of our borings (Boring B-3 and P-1) to approximately three to four feet below the existing ground surface. While the rest of our borings did not note fill, fill is anticipated to be present below the existing asphalt concrete pavement and building areas. Petra (2004) also reported about two to four of fill under the site. The fill consisted of brown to reddish brown, moist, loose/soft to medium dense/stiff silty sand with gravel and clayey sand.

5.2.2 Older Alluvial Deposits

Older alluvium was encountered in our borings below the fill or below the existing asphalt concrete and extended to the maximum depth explored of about 26.5 feet. The alluvium encountered generally consisted of surficial layers of sandy lean clay and sandy silt underlain by units of silty sand and sand. The alluvium was brown to olive brown in color, moist, and stiff/dense to very stiff/very dense to the total depth explored, based on our field observations, blow counts, and in-place density determinations. The logs of the borings reported by Petra (2004) display relatively similar conditions with more predominantly clayey soils at depths.

The near surface site soils tested were found to have a "low" expansion potential when tested and classified in accordance with ASTM D 4829. Petra reported a "medium" potential for expansion for the surficial site soils.

5.3 SURFACE AND GROUNDWATER

5.3.1 Surface Water

If encountered during the earthwork construction, surface water on this site is the result of precipitation or surface run-off from surrounding sites. Overall drainage in the area is variable, and most commonly directed toward the north-northwest. Provisions for surface drainage will need to be accounted for by the project civil engineer.

5.3.2 Groundwater

Groundwater was not encountered in any of our borings drilled at the site to a maximum depth of 26.5 feet. However, Petra's deepest borings B-1 and B-4 encountered groundwater at 29 feet and 32 feet below the ground surface, respectively.

Our review of the *Historically Highest Groundwater Map* published within the *Seismic Hazard Zone Report for the Torrance Quadrangle (DMG, 1998)* did not reveal past high groundwater levels in the general area of the site. High groundwater levels on the order of ten feet below ground

surface were shown on this map but for areas immediately adjacent to the existing Dominguez Channel located approximately one mile from the site to the east.

The GeoTracker database shows several groundwater monitoring wells for a property located across the street (addressed as 1500 West 178th Street) from the site, with depth to groundwater ranging from 30 to 35 feet. This information agrees with the groundwater levels of 29 to 32 feet reported by Petra (2004).

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

5.4 FAULTING AND SEISMICITY

The geologic structure of the entire southern California area is dominated mainly by northwest-trending faults associated with the San Andreas system. The site is in a seismically active region. No active or potentially active fault is known to exist at this site nor is the site situated within an *"Alquist-Priolo"* Earthquake Fault Zone (Bryant and Hart, 2007; CGS, 1986). The subject property is not located within a State of California Seismic Hazard Zone for earthquake induced liquefaction or landsliding. The nearest zoned fault is the Newport-Inglewood Fault North Los Angeles Basin Section, located approximately 3.0 miles to the west.

5.4.1 Seismic Design Parameters

The site is located at approximately 33.8699 Latitude and -118.3036 Longitude. Site spectral accelerations (S_a and S_1), for 0.2 and 1.0 second periods for a Class "D" site, was determined from the USGS Website, Earthquake Hazards Program, Interpolated Probabilistic Ground Motion for the Conterminous 48 States by Latitude/Longitude. The results are presented in the following table:

SITE SEISMIC PARAMETERS	
Mapped 0.2 sec Period Spectral Acceleration, S_s	1.603g
Mapped 1.0 sec Period Spectral Acceleration, S_1	0.593g
Site Coefficient for Site Class "D", F_a	1.0
Site Coefficient for Site Class "D", F_v	1.5
Maximum Considered Earthquake Spectral Response Acceleration for 0.2 Second, S_{MS}	1.603g
Maximum Considered Earthquake Spectral Response Acceleration for 1.0 Second, S_{M1}	0.890g
5% Damped Design Spectral Response Acceleration Parameter at 0.2 Second, S_{DS}	1.068g
5% Damped Design Spectral Response Acceleration Parameter at 1 second, S_{D1}	0.593g
Peak Ground Acceleration Adjusted for Site Class Effects, PGA_M	0.598g

5.5 LIQUEFACTION AND SEISMICALLY-INDUCED SETTLEMENT

The depth to groundwater in the site area is on the order of 30 feet. The logs of the deep borings reported by Petra (2004) indicate that mostly clayey soils, which are typically non-liquefiable, are present below 30 feet. The cited logs also show lesser layers with sandy soils at the referenced depths. High blow counts were recorded by Petra (2004) in these granular units; thus, they are considered to be not prone to liquefaction. Based on the above, the potential for soil liquefaction at the site is very low.

Seismically-induced settlement of the sandy soils above the groundwater table is anticipated to be on the order of 0.5 inches total and 0.25 inches differential.

5.6 OTHER SEISMIC HAZARDS

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

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

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 GENERAL

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

6.2 EARTHWORK CONSIDERATIONS

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

6.2.1 Site Clearing and Preparation

Site preparation should start with demolition/razing of existing site improvements and removal of deleterious materials, and vegetation. Demolition should include removal of all pavements,

floor slabs, foundations, and any other below-grade construction. These materials should be properly disposed of off-site. Voids resulting from site clearing (such as removals of underground utilities, private sewage disposal systems, foundations, etc) should be replaced with engineered fill materials.

6.2.2 Removals

All existing fills and loose/soft portions of the older alluvium should be removed to expose competent alluvial materials. Competent alluvium is defined as native materials that are visually non-porous and having a relative compaction of at least 85 percent of the soil's maximum dry density as determined per ASTM D 1557. Based on our boring data and the data reported by Petra (2004), combined fill and alluvial removals of about three to five feet are anticipated to be required within the structural grading limits. As a minimum, removals should extend down and away from foundation elements at a 1:1 (h:v) projection to the recommended removal depth, or a minimum of five feet laterally.

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

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

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

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

6.2.3 Fills

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

Concrete generated from the demolition of existing site improvements may be incorporated into site fills provided the following guidelines are implemented: 1) concrete should be free of rebar or other deleterious materials and should be broken down to a maximum dimension of six inches; 2) concrete should not be placed within three feet of finish grade in the building pad areas or

within one foot of subgrade elevations in the street/drive areas; 3) concrete should be distributed in the fill and should not be "nested" or placed in concentrated pockets.

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

6.2.4 Excavation Characteristics

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

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

6.2.5 Shrinkage and Subsidence

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

Shrinkage, bulking, and subsidence are primarily dependent upon the degree of compactive effort achieved during construction. For planning purposes, a shrinkage factor of 10 to 15 percent for the existing fills and of 5 to 10 percent for the upper alluvium may be considered. Site balance areas should be available in order to adjust project grades, depending on actual field conditions at the conclusion of site earthwork construction. Bulking is not considered to be a significant factor with the underlying materials within the vicinity of the anticipated construction. Subsidence on the order of up to 0.1-foot could occur.

6.2.6 Trench Excavations and Backfill

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

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

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

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

6.3 DESIGN RECOMMENDATIONS

6.3.1 Foundation Design Criteria

The site soils are expected to generally have "low" (21≤EI≤50) to "medium" (51≤EI≤90) expansion potential in accordance with ASTM D 4829. The foundation elements for the proposed structures should bear entirely in engineered fill soils and should be designed in accordance with the *2016 California Building Code (CBC).*

Presented below are post-tensioned foundation design parameters for the proposed residential dwellings at the site. These parameters are in general conformance with *Design of Post-Tensioned Slabs-on-Ground*, Third Edition *with 2008 Supplement* (PTI, 2008). These are minimal recommendations and are not intended to supersede the design by the project structural engineer.

DESIGN PARAMETERS FOR POST-TENSIONED SLABS		
Foundation Design Parameter	Design Value	
	"Low" Expansion Potential (LL≤34; PI≤19; Passing #200 Sieve ≈ 70%; Clay fines ≈ 30%)	"Medium" Expansion Potential (LL≤46; PI≤22; Passing #200 Sieve ≈ 83%; clay fines ≈ 14%)
Edge Moisture Variation Distance, e_m - Edge Lift (swelling) - Center Lift (shrinkage)	 4.8 ft 9.0 ft	 4.2 ft 8.2 ft
Soil Differential Movement, y_m - Edge Lift (swelling) - Center Lift (shrinkage)	 ≈0.48 in ≈-0.21 in	 ≈0.81 in ≈-0.34 in
Ext. Perimeter Beam Embedment	One- or Two-Story – 12 inches* Three-Story – 18 inches*	One- or Two-Story – 18 inches* Three-Story – 18 inches*
Presaturation of Subgrade Soil (Percent of Optimum)	Minimum 110% to a depth of 12 inches	Minimum 120% to a depth of 18 inches

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

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

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

A summary of our design recommendations for conventionally reinforced foundations is presented in the table below:

DESIGN PARAMETERS FOR CONVENTIONALLY REINFORCED FOUNDATIONS		
Design Parameter	"Low" Expansion Potential	"Medium" Expansion Potential
Foundation Depth or Minimum Perimeter Beam Depth for Both Interior and Exterior Footings (inches below lowest adjacent finished grade)	One- and Two-Story – 12 Three-Story - 18	One- and Two-Story – 18 Three-Story - 18
Minimum Foundation Width (Inches)*	One- and Two-Story – 12 Three-Story - 15	One- and Two-Story – 12 Three-Story - 15
Minimum Slab Thickness (inches)	4 (actual)	4 (actual)
Sand Blanket and Moisture Retardant Membrane below On-Grade Building Slabs	2 inches of sand** overlying moisture vapor retardant membrane overlying 2 inches of sand**	2 inches of sand** overlying moisture vapor retardant membrane overlying 2 inches of sand**
Minimum Slab Reinforcing	No. 3 rebars 24 inches on-center, each way, placed in middle 1/3 of slab thickness	No. 3 rebars 18 inches on-center, each way, placed in middle 1/3 of slab thickness
Minimum Footing Reinforcement for Continuous Footings, Grade Beams, and Retaining Wall Footings	Two No. 4 reinforcing bars, one top and one bottom	Four No. 4 reinforcing bars, two top and two bottom
Effective Plasticity Index***	13-20	20-25
Presaturation of Subgrade Soil (Percent of Optimum/Depth in inches)	Minimum 110% of the optimum moisture content to a depth of at least 12 inches prior to placing concrete.	Minimum 120% of the optimum moisture content to a depth of at least 18 inches prior to placing concrete.

*Code minimums per Table 1809.7 of the 2016 CBC should be complied with.
**Sand should have a sand equivalent of at least 30.
***Effective Plasticity Index should be verified at the completion of the rough grading

In general, an allowable bearing capacity of 1,500 pounds per square foot (psf) may be used for footings a minimum 12 inches deep and 12 inches wide. This value may be increased by 400 psf for each additional 12 inches in depth and 100 psf for each additional 12 inches in width to a maximum value of 3,000 psf.

The passive earth pressure may be computed as an equivalent fluid having a density of 200 psf per foot of depth, to a maximum earth pressure of 2,000 psf for footings founded on engineered fill. A coefficient of friction between soil and concrete of 0.35 may be used with dead load forces. The upper one foot of soil below the adjacent grade should not be used in calculating passive pressure.

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

For footings designed in accordance with the recommendations presented in this report, we would anticipate a maximum static settlement of less than one-inch and a maximum differential static settlement of less than ½-inch in a 40-foot span. Seismically-induced settlement is expected to be about 0.5 inches total and 0.25 inches differential in a 40-foot span.

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

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

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

6.3.2 Miscellaneous Foundation Recommendations

- To minimize moisture penetration beneath the slab on grade areas, utility trenches should be backfilled with engineered fill, lean concrete or concrete slurry where they intercept the perimeter footing or thickened slab edge.
- Soils from the footing excavations should not be placed in the slab-on-grade areas unless properly compacted and tested. The excavations should be free of loose/sloughed materials and be neatly trimmed at the time of concrete placement.

- Under-slab utility trenches should be compacted to project specifications. Compaction should be achieved with a mechanical compaction device. If backfill soils have dried out, they should be thoroughly moisture conditioned prior to placement in trenches.

6.3.3 Foundation Set Backs

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

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

6.3.4 Retaining Wall Design and Construction

6.3.4.1 General Design Criteria

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

Retaining wall foundations should be embedded into engineered fill and should be designed in accordance with *Section 6.3.1* of this report. Structural needs may govern and should be evaluated by the project structural engineer.

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

Earthwork considerations, site clearing and remedial earthwork for all earth retention structures should meet the requirements of this report, unless specifically provided otherwise, or more stringent requirements or recommendations are made by the designer. The backfill material placement for all earth retention structures should meet the requirement of *Section 6.3.4.4* in this report.

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

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

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

6.3.4.2 Cantilevered Walls

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

ACTIVE EARTH PRESSURES		
Surface Slope of Retained Materials (h:v)	Equivalent Fluid Pressure (pcf) Select Imported Backfill*	Equivalent Fluid Pressure (pcf) Select Native Backfill**
Level	36	51
2:1	55	112

*The design pressures assume the imported backfill material has an expansion index less than or equal to 20 and friction angle of at least 34 degrees. Backfill zone includes area between the back of the wall and footing to a plane (1:1 h:v) up from the bottom of the wall foundation to the ground surface.
**The design pressures assume the native backfill material has an expansion index less than or equal to 50 and friction angle of at least 25 degrees. Backfill zone includes area between the back of the wall and footing to a plane (1:1 h:v) up from the bottom of the wall foundation to the ground surface.

6.3.4.3 Restrained Retaining Walls

Retaining walls that will be restrained prior to placing and compacting backfill material or that have reentrant or male corners should be designed for an at-rest equivalent fluid pressure of 60 pcf, plus any applicable surcharge loading, for select imported backfill and level back slope condition. For select native backfill, an at-rest equivalent fluid pressure of 73 pcf should be used. For areas of male or reentrant corners, the restrained wall design should extend a minimum distance of twice the height of the wall laterally from the corner, or a distance otherwise determined by the project structural engineer.

6.3.4.4 Retaining Wall Backfill and Drainage

Retaining wall backfill should be free of deleterious and/or oversized materials and should have properties indicated in *Section 6.3.4.2*. Retaining walls should be provided with an adequate pipe and gravel back drain system to help prevent buildup of hydrostatic pressures. Backdrains should consist of a four-inch diameter perforated collector pipe (Schedule 40, SDR 35, or approved equivalent) embedded in a minimum of one-cubic foot per linear foot of ¾ to 1-inch clean crushed rock or an approved equivalent, wrapped in filter fabric (Mirafi 140N or an approved equivalent). The drain system should be connected to a suitable outlet. Waterproofing of site walls should be performed where moisture migration through the wall is undesirable.

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

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

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

6.3.4.5 Other Design Considerations

- Wall design should consider the additional surcharge loads from superjacent slopes and/or footings, where appropriate.
- No backfill should be placed against concrete until minimum design strengths are evident by compression tests of cylinders.
- The retaining wall footing excavations, backcuts, and backfill materials should be approved the project geotechnical engineer or their authorized representative.

6.3.5 Pavement Design Considerations

Pavement design for proposed street improvements was conducted per Caltrans *Highway Design Manual* guidelines for flexible pavements. Based on an assumed design R-value of 6 and for Traffic Indices (TIs) of 5.0 and 6.0 generally linked to roads with light vehicular traffic with occasional heavy truck traffic, the following preliminary sections were calculated:

GEOTECHNICAL RECOMMENDATION FOR MINIMUM PAVEMENT SECTION		
Traffic Index	Thickness of Asphalt Concrete (inches)	Thickness of Aggregate Base (inches)
5.0	4	8
6.0	4	12

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

The recommended pavement sections provided are intended as a minimum guideline and final selection of pavement cross section parameters should be made by the project civil engineer, based upon the local laws and ordinates, expected subgrade and pavement response, and desired level of conservatism. If thinner or highly variable pavement sections are constructed, increased maintenance and repair could be expected. Final pavement design should be checked by testing of soils exposed at subgrade (the upper 5 feet) after final grading has been completed.

Asphalt concrete and aggregate base should conform to current Caltrans Standard Specifications Section 39 and 26-1.02, respectively. As an alternative, asphalt concrete can conform to Section 203-6 of the current Standard Specifications for Public Work (Green Book). Crushed aggregate base or crushed miscellaneous base can conform to Section 200-2.2 and 200-2.4 of the Green Book, respectively. Pavement base should be compacted to at least 95 percent of the ASTM D1557 laboratory maximum dry density (modified proctor).

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

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

6.3.6 Soil Corrosivity

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

6.3.7 Soil Sulfate Content

The sulfate content was determined in the laboratory for a representative soil sample obtained during our field exploration. The results (0.0150%) indicate that the water soluble sulfate range

is less than 0.1 percent by weight which is considered "not applicable" (i.e. negligible) as per Table 4.2.1 of ACI 318. Based upon the test results, no special concrete mix design is required by Code for sulfate attack resistance. Additional testing of soils collected near finish grade should be performed subsequent to site grading.

6.3.8 Import Soils

Import soils should have an expansion index similar to the on-site soils or better. GeoTek also recommends that, as a minimum, proposed import soils be tested for soluble sulfate content. GeoTek should be notified a minimum of 72 hours of potential import sources so that appropriate sampling and laboratory testing can be performed.

6.3.9 Concrete Flatwork

6.3.9.1 Exterior Concrete Slabs, Sidewalks and Driveways

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

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

Subgrade soils, classified as having "low" expansion potential, should be pre-moistened prior to placing concrete. The subgrade soils below exterior slabs, sidewalks, driveways, etc. at the subject site should be pre-saturated to a minimum of 110 percent of optimum moisture content to a depth of 12 inches. Subgrade soils with a "medium" expansion potential should be pre-saturated to a minimum of 120 percent of optimum moisture content to a depth of 18 inches.

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

6.3.9.2 Concrete Performance

Concrete cracks should be expected. These cracks can vary from sizes that are essentially unnoticeable to more than 1/8 inch in width. Most cracks in concrete, while unsightly, do not significantly impact long-term performance. While it is possible to take measures (proper

concrete mix, placement, curing, control joints, etc.) to reduce the extent and size of cracks that occur, some cracking will occur despite the best efforts to minimize it. Concrete can also undergo chemical processes that are dependent on a wide range of variables, which are difficult, at best, to control. Concrete, while seemingly a stable material, is also subject to internal expansion and contraction due to external changes over time.

One of the simplest means to control cracking is to provide weakened control joints for cracking to occur along. These do not prevent cracks from developing; they simply provide a relief point for the stresses that develop. These joints are a widely accepted means to control cracks but are not always effective. Control joints are more effective the more closely spaced they are. GeoTek suggests that control joints be placed in two directions and located a distance apart roughly equal to 24 to 36 times the slab thickness.

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

6.4 POST CONSTRUCTION CONSIDERATIONS

6.4.1 Landscape Maintenance and Planting

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

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

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

6.4.2 Drainage

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

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

6.5 PLAN REVIEW AND CONSTRUCTION OBSERVATIONS

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

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

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

7. INTENT

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

The scope of our evaluation is limited to the boundaries of the subject site. This review does not and should in no way be construed to encompass any areas beyond the specific area of the proposed construction as indicated to us by the client. Further, no evaluation of any existing site improvements is included. The scope is based on our understanding of the project and the client's needs, our fee estimate (P-0501418) dated May 8, 2018 and geotechnical engineering standards normally used on similar projects in this region.

8. LIMITATIONS

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

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

9. SELECTED REFERENCES

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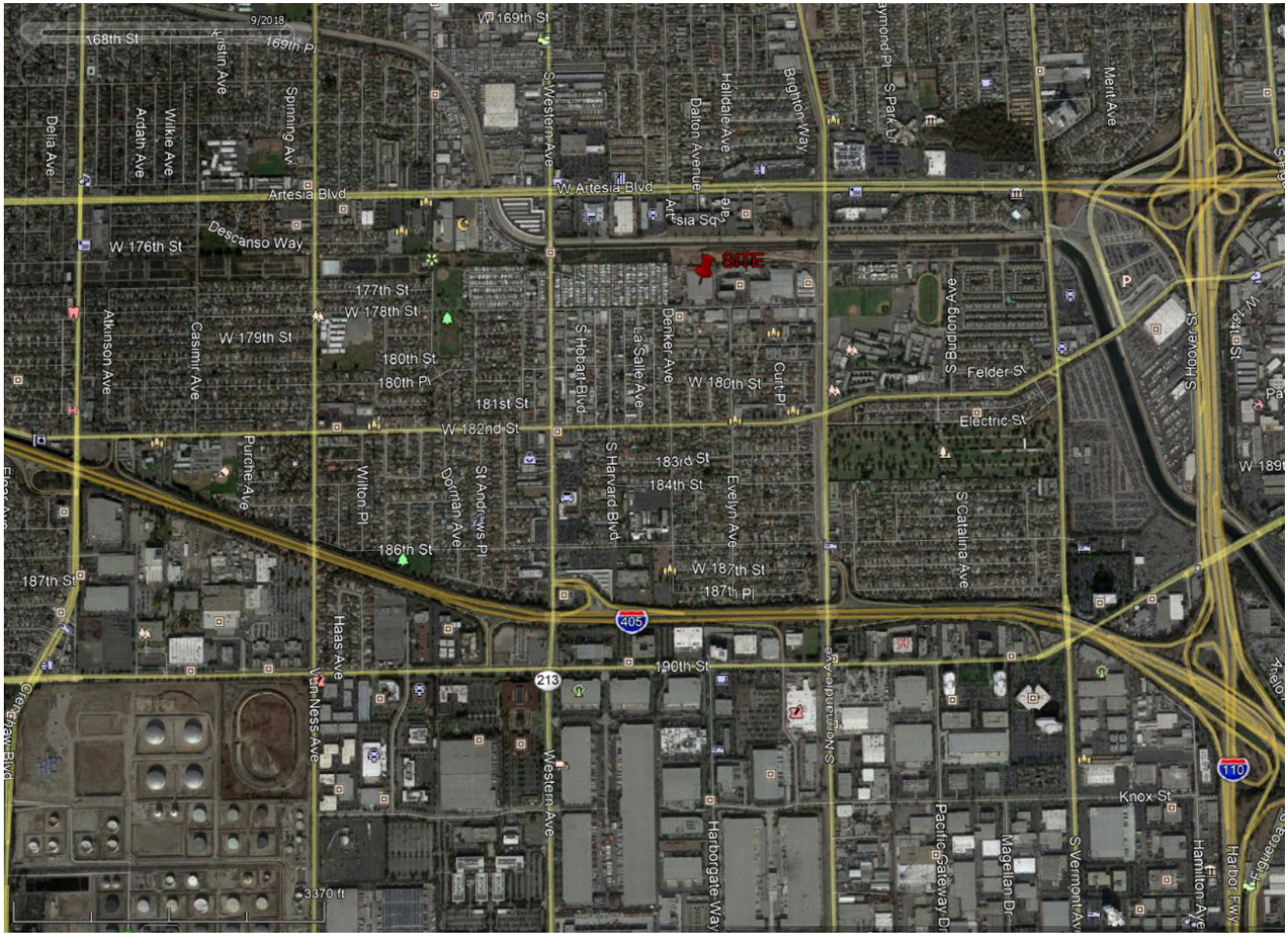

Melia Homes
1515 West 178th Street
Gardena, California

Project No. 1949-CR

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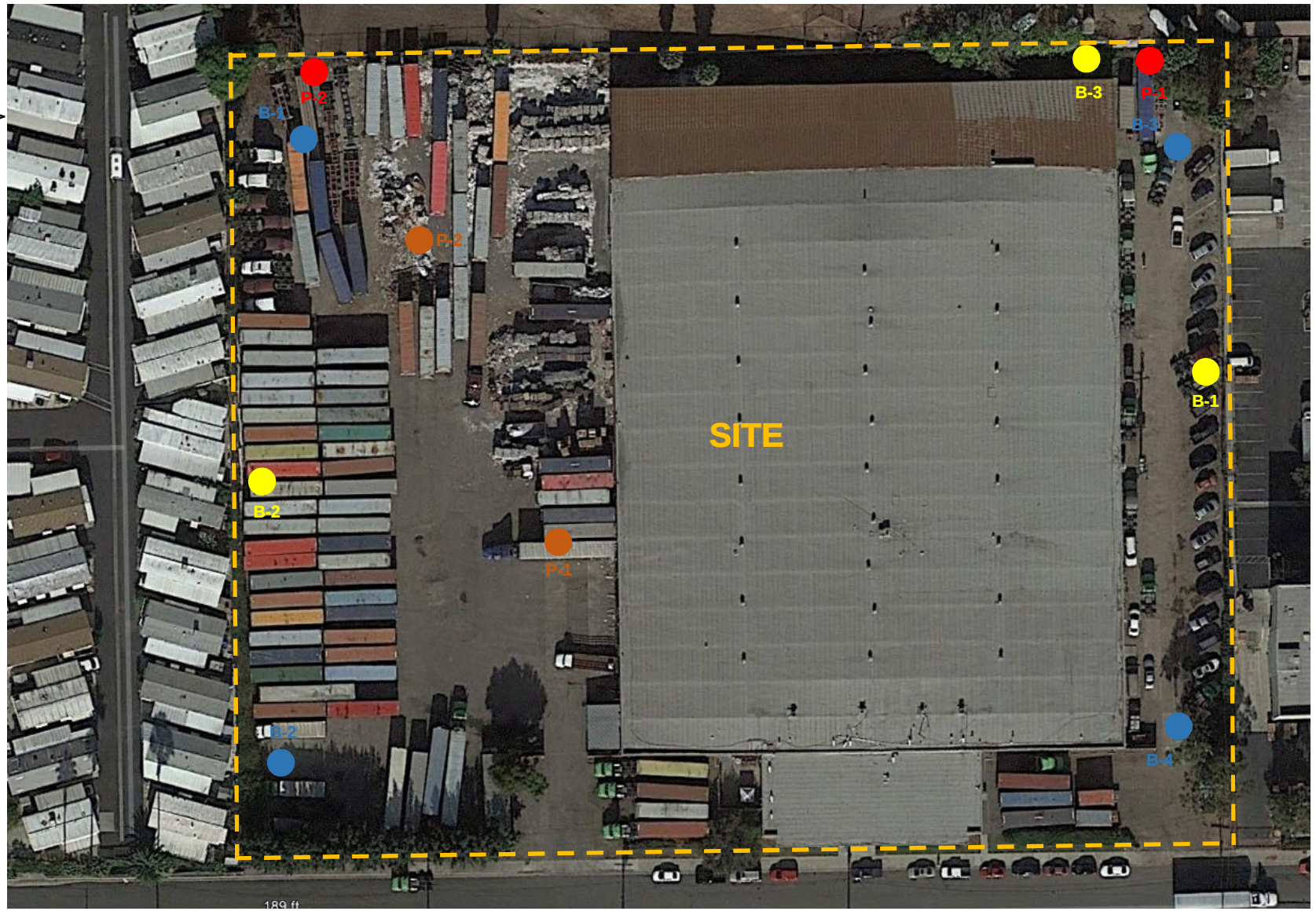
Figure 1

Site Location Map

GEOTEK



Melia Homes
1515 West 178th Street
Gardena, California

Project No. 1949-CR

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Figure 2

Exploration Location Map

GEOTEK

APPENDIX A

BORING LOGS, LABORATORY TEST RESULTS, AND INFILTRATION DATA BY PETRA (2004)

Updated Geotechnical and Infiltration Evaluation
1515 West 178th Street, Gardena, California
Project No. 1949-CR

GEOTEK

EXPLORATION LOG

Project: **Proposed 104 Townhomes**		Boring No.: **B-1**	
Location: **5151 W. 178th Street, Gardena, CA**		Elevation:	
Job No.: **496-04**	Client: **The Olson Company**	Date: **11/17/04**	
Drill Method: **Hollow-Stem Auger**	Driving Weight: **140 lbs / 30 in**	Logged By: **EG**	

Depth (Feet)	Lith-ology	Material Description	Water	Samples: Blows Per 6-inch	Samples: Core	Samples: Bulk	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Dry Density (pcf)	Laboratory Tests: Other Lab Tests
		Asphalt Pavement approximately 3 to 3.5" thick.							
		ARTIFICIAL FILL (Af) Clayey Sand (SC): Dark yellowish-brown; moist; medium dense; fine-grained sand.							R-V
		TERRACE DEPOSITS (Qpu) Clayey Sand (SC): Dark yellowish-brown; moist; medium dense to dense; fine-grained sand; slightly porous upper 3 feet; abundance of clay content.		6 12 20			13.0	108.2	
5		Sandy Clay (CL): Yellowish-brown to dark yellowish-brown; moist; very stiff; fine-grained sand; slightly micaceous.		8 22 37			13.0	118.5	
10		Sandy Clay (CL): Dark olive brown; moist to very moist; firm to stiff; fine-grained sand; slightly micaceous.		4 7 7			17.8	111.0	CON
15		Same as 10 feet.		3 7 9			11.7	105.6	
		Silty Sand (SM): Yellowish-brown; moist; medium dense; fine-grained sand; slightly micaceous.							
20				9 14 20			18.4	108.0	
		Clayey Sand (SC): Dark olive gray; very moist; dense; fine-grained sand; slightly micaceous.							
25		Silty Clay (CL): Dark olive gray; very moist; stiff; fine-grained sand.		3 5 6					HYD AT
		Groundwater.	▼						

EXPLORATION LOG - V3 496-04.GPJ PETRA.GDT 12/1/04

PLATE A-1

Petra Geotechnical, Inc.

EXPLORATION LOG

Project: **Proposed 104 Townhomes**		Boring No.: **B-1**	
Location: **5151 W. 178th Street, Gardena, CA**		Elevation:	
Job No.: **496-04**	Client: **The Olson Company**	Date:	**11/17/04**
Drill Method: **Hollow-Stem Auger**	Driving Weight: **140 lbs / 30 in**	Logged By:	**EG**

Depth (Feet)	Lith-ology	Material Description	Water	Samples: Blows Per 6-inch	Samples: Core	Samples: Bulk	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Dry Density (pcf)	Laboratory Tests: Other Lab Tests
		Sandy Clay to Silty Clay (CL): Dark olive gray; wet; very stiff; few to trace of fine-grained sand; slightly micaceous.		7 13 17	■		24.8	100.1	
35		Sandy Clay (CL): Olive brown; wet; stiff; fine-grained sand.		4 9 18	■				HYD AT
40		Sandy Clay (CL-CH): Olive brown; wet; very stiff; fine-grained sand.		14 29 44	■		26.3	98.5	
45		Same as 40 feet.		7 11 15	■				
50		Sandy Clay (CL): Brown; wet; hard; some fine-grained sand; some cemented clayey sand.		37 50-5"	■		23.3	104.4	
		Total Depth = 51.0 feet Groundwater at 29 feet Borehole backfilled with soil cuttings then patched with cold asphalt.							

EXPLORATION LOG - V3 496-04.GPJ PETRA.GDT 12/1/04

PLATE A-2

Petra Geotechnical, Inc.

EXPLORATION LOG

Project: **Proposed 104 Townhomes**		Boring No.: **B-2**	
Location: **5151 W. 178th Street, Gardena, CA**		Elevation:	
Job No.: **496-04**	Client: **The Olson Company**	Date: **11/17/04**	
Drill Method: **Hollow-Stem Auger**	Driving Weight: **140 lbs / 30 in**	Logged By: **EG**	

Depth (Feet)	Lith-ology	Material Description	Water	Samples: Blows Per 6-inch	Samples: Core	Samples: Bulk	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Dry Density (pcf)	Laboratory Tests: Other Lab Tests
		Asphalt pevement approximately 4" thick.							
		ARTIFICIAL FILL (Af)							
		Clayey Sand (SC): Olive brown; moist; medium dense to dense; fine-grained sand; trace of gravel up to 3 feet; abundance of clay.		4 12 12	■		11.7	94.8	
		@ 3.5 feet: A piece of plastic.							
5		**TERRACE DEPOSITS (Qpu)**							
		Sandy Clay (CL): Dark brown to dark olive brown; moist; stiff; fine-grained sand with some medium and coarse sand; trace of rootlets.		7 9 14	■		12.2	118.3	DSU
10		Sandy Clay (CL): Dark olive brown; very moist; stiff to very stiff; fine-grained sand; slightly micaceous.		11 14 18	■		12.7	119.1	
15		Clayey Sand (SC): Yellowish-brown; moist; very dense; fine-grained sand; micaceous.		17 23 38	■		15.4	111.9	
20		Clayey Sand (SC): Yellowish-brown; moist to very moist; very dense; fine-grained sand; some iron oxide staining; slightly micaceous; abundance of clay.		16 20 23	■		21.0	103.4	
		Total Depth = 21.5 feet No Groundwater Borehole backfilled with soil cuttings then patched with cold asphalt.							

EXPLORATION LOG - V3 496-04.GPJ PETRA.GDT 12/1/04

PLATE A-3

Petra Geotechnical, Inc.

EXPLORATION LOG

Project: **Proposed 104 Townhomes**		Boring No.: **B-3**	
Location: **5151 W. 178th Street, Gardena, CA**		Elevation:	
Job No.: **496-04**	Client: **The Olson Company**	Date: **11/17/04**	
Drill Method: **Hollow-Stem Auger**	Driving Weight: **140 lbs / 30 in**	Logged By: **EG**	

Depth (Feet)	Lith-ology	Material Description	Water	Samples: Blows Per 6-inch	Samples: Core	Samples: Bulk	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Dry Density (pcf)	Laboratory Tests: Other Lab Tests
		Asphalt pavement approximately 4 to 4.5" thick.							
		ARTIFICIAL FILL (Af)							
		Clayey Sand (SC): Brown; moist; medium dense to dense; fine-grained sand.		7 40 50-5"	■		12.5	118.7	
		TERRACE DEPOSITS (Qpu)							
		Clayey Sand (SC): Brown to light brown; moist; very dense; fine-grained sand with some medium sand; slightly micaceous.							
5		Sandy Clay (CL): Yellowish-brown; moist; very stiff to hard; fine-grained sand; slightly micaceous.		17 37 50-4"	■		14.1	114.8	
10		Sandy Clay (CL): Olive yellow; moist to very moist; very stiff; fine-grained sand.		13 20 27	■		16.6	114.1	
15		Silty Sand with Clay (SM-SC): Yellowish-brown; moist; very dense; fine-grained sand; slightly micaceous.		15 28 33	■		14.2	115.6	
20		Same as 15 feet. Becomes very dense to hard.		18 30 50-5"	■		10.5	112.8	
		Total Depth = 21.5 feet No Groundwater Borehole backfilled with soil cuttings then patched with cold asphalt.							

EXPLORATION LOG - V3 496-04.GPJ PETRA.GDT 12/1/04

PLATE A-4

Petra Geotechnical, Inc.

EXPLORATION LOG

Project: **Proposed 104 Townhomes**		Boring No.: **B-4**	
Location: **5151 W. 178th Street, Gardena, CA**		Elevation:	
Job No.: **496-04**	Client: **The Olson Company**	Date: **11/17/04**	
Drill Method: **Hollow-Stem Auger**	Driving Weight: **140 lbs / 30 in**	Logged By: **EG**	

Depth (Feet)	Lith-ology	Material Description	Water	Samples: Blows Per 6-inch	Samples: Core	Samples: Bulk	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Dry Density (pcf)	Laboratory Tests: Other Lab Tests
		Asphalt pavement approximately 3 to 3.5" thick.							
		ARTIFICIAL FILL (Af) Clayey Sand (SC): Olive brown; moist; medium dense to dense; fine-grained sand.							MAX EXP AT SO4 pH RES CL
		TERRACE DEPOSITS (Qpu) Sandy Clay (CL): Olive brown to brown; moist; very stiff; fine-grained sand.		7 22 38			13.6	113.8	
5		Silty Sand with Clay (SM-SC): Light brown to brown; moist; very dense; fine-grained sand.		10 12 27			11.0	116.2	
10		Sandy Clay (CL): Dark brown; moist; very stiff; fine-grained sand.		12 23 36			14.8	116.5	
15		Sandy Clay (CL): Light brown; moist to very moist; stiff; few fine-grained sand; some carbonates.		10 12 15					HYD AT
20		Silty Sand with Clay (SM-SC): Brown; mois; very dense; fine-grained sand; slightly micaceous.		9 21 33					
25		Clayey Sand (SC): Brown; moist to very moist; very dense; fine-grained sand with some medium sand; slightly micaceous.		24 33 47			17.9	107.7	

EXPLORATION LOG - V3 496-04.GPJ PETRA.GDT 12/1/04

PLATE A-5

Petra Geotechnical, Inc.

EXPLORATION LOG

Project: **Proposed 104 Townhomes**		Boring No.: **B-4**	
Location: **5151 W. 178th Street, Gardena, CA**		Elevation:	
Job No.: **496-04**	Client: **The Olson Company**	Date: **11/17/04**	
Drill Method: **Hollow-Stem Auger**	Driving Weight: **140 lbs / 30 in**	Logged By: **EG**	

Depth (Feet)	Lith-ology	Material Description	Water	Samples: Blows Per 6-inch	Samples: Core	Samples: Bulk	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Dry Density (pcf)	Laboratory Tests: Other Lab Tests
		Clayey Sand (SC): Olive brown; very moist to saturated; dense; fine-grained sand with some medium sand; some silt.		17					
				19					
			▼	14					
		Groundwater.							
35		Silty Sand with Clay (SM-SC): Olive brown; wet; very dense to hard; fine- to medium-grained sand with some coarse sand; trace of gravel.		19			18.7	112.2	
				32					
				50-4"					
40		Silty Sand (SM): Brown; wet; very dense to hard; fine-grained sand; some clay.		16					
				26					
				41					
45		Sandy Clay (CL): Olive brown; wet; dense; fine-grained sand.		14					HYD AT
				17					
				15					
50		Silty Clay (CL): Brown; wet; very stiff; fine-grained sand.		11					
				14					
				20					
		Total Depth = 51.5 feet Groundwater at 32 feet Borehole backfilled with soil cuttings then patched with cold asphalt.							

EXPLORATION LOG - V3 496-04.GPJ PETRA.GDT 12/1/04

PLATE A-6

Petra Geotechnical, Inc.

LABORATORY MAXIMUM DRY DENSITY[1]

Soil Type	Optimum Moisture (%)	Maximum Dry Density (pcf)
A - Clayey Sand (SC)	10.0	125

5EXPANSION INDEX TEST DATA[2]

Soil Type	Expansion Index	Expansion Potential [3]
A - Clayey Sand (SC)	51	Medium

SOLUBLE SULFATES AND CHLORIDES[4]

Soil Type	Sulfate Content (%)	Chloride Content (ppm)
A - Clayey Sand (SC)	0.0041	158

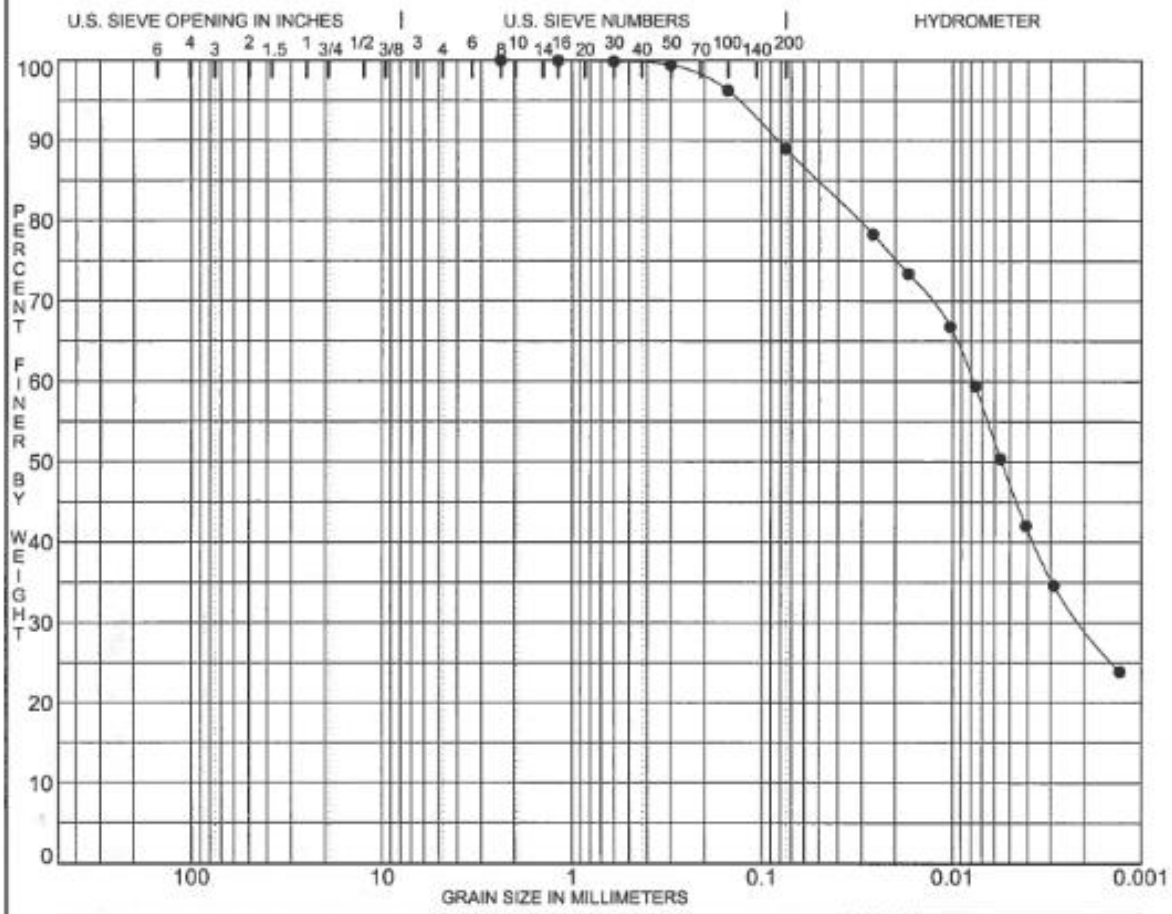
pH AND MINIMUM RESISTIVITY[5]

Soil Type	pH	Minimum Resistivity (Ohm-cn)
A - Clayey Sand (SC)	7.7	2,500

ATTERBERG LIMITS[6]

Boring Location	Liquid Limit	Plastic Limit	Plasticity Index
B-4 @ 1.5 feet	46	24	22

(1) Per ASTM Test Method D 1557-00
(2) Per Uniform Building Code Standard 18-2
(3) Per UBC Table 18-I-B, "Classification of Expansive Soils"
(4) Per California Test Method Nos. 417 and 422
(5) Per California Test Method Nos. 532 and 643
(6) Per ASTM Test Method D 4318-00



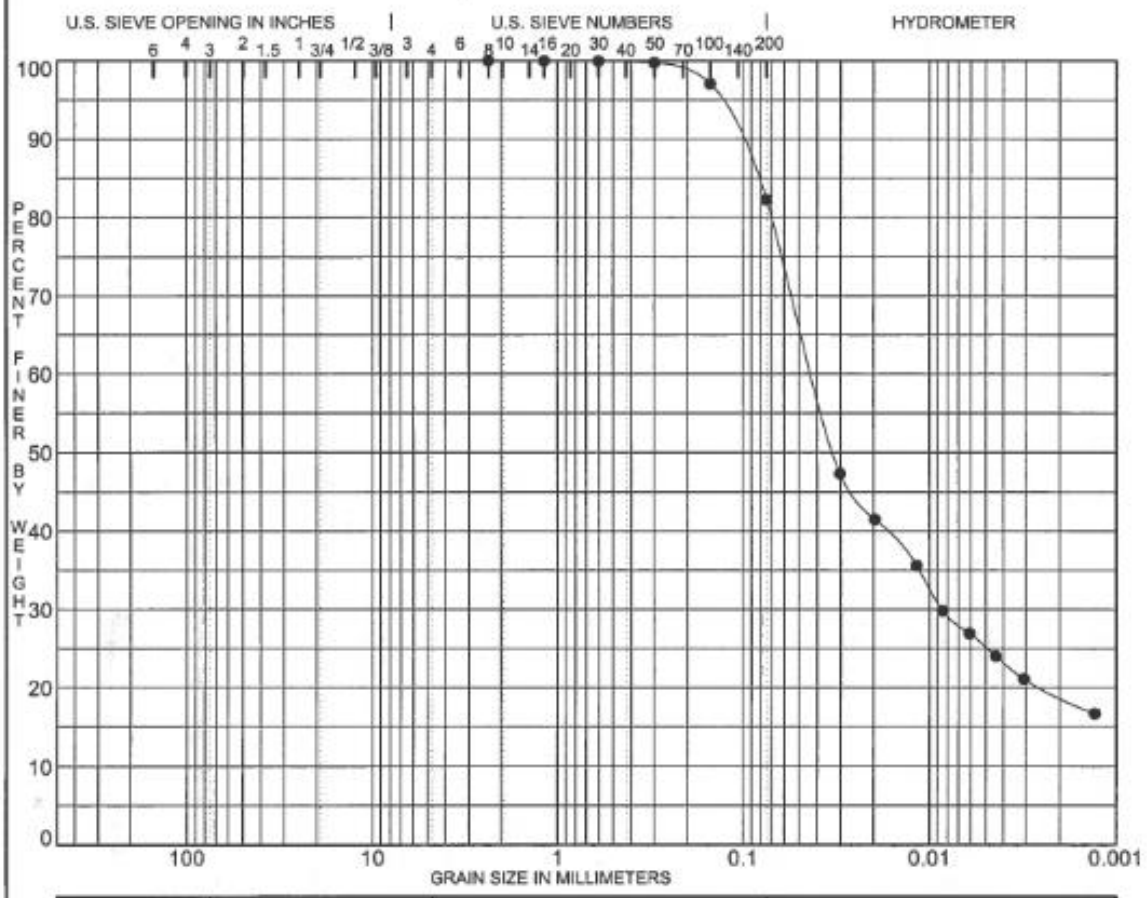
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	B-1	25.0	Silty Clay (CL)		48	26	22		

	Specimen Identification		D100	D60	D30	D50	%Gravel	%Sand	%Silt	%Clay
●	B-1	25.0	2.36	0.01	0.002	0.0055	0.0	11.0	41.7	47.3

GRAIN SIZE - V1 496-04.GPJ PETRA.GDT 12/1/04

J.N. 496-04	**GRAIN SIZE ANALYSIS**	December, 2004
PETRA GEOTECHNICAL, INC.		PLATE B-2



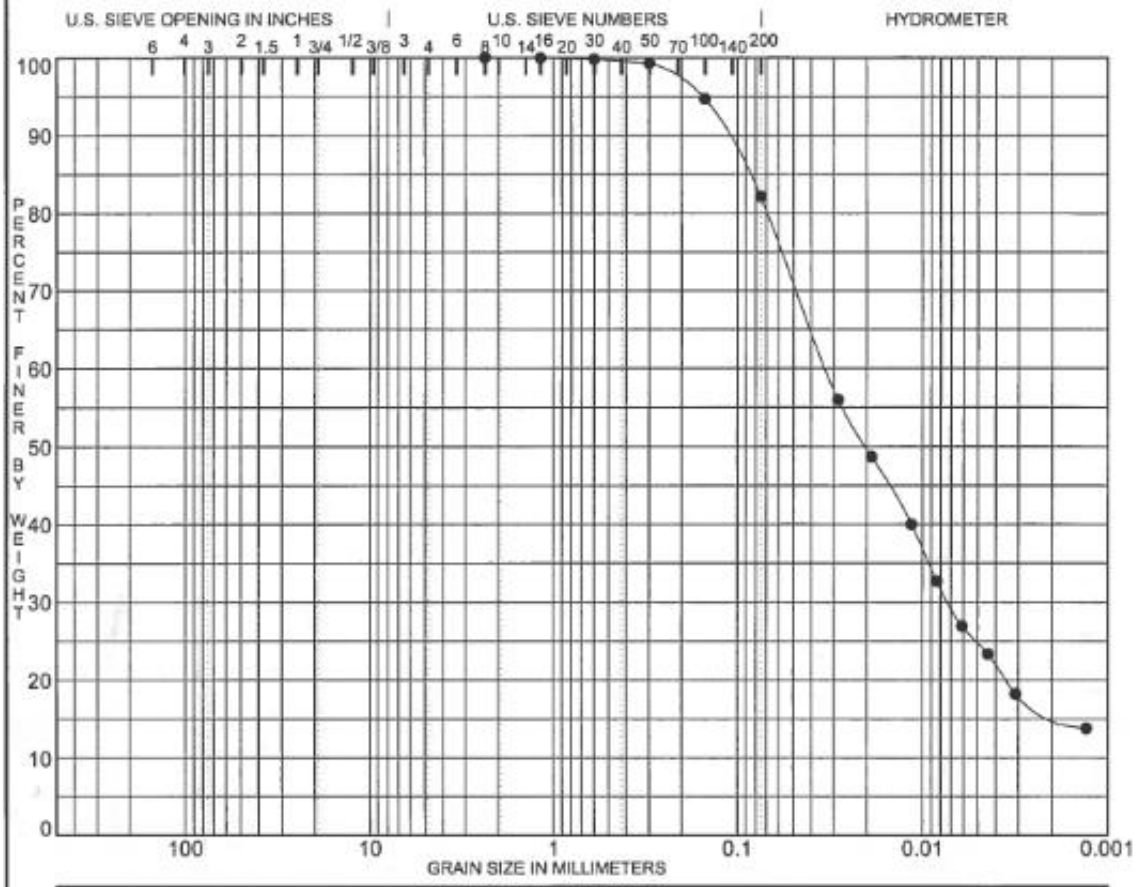
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	B-1	35.0	Sandy Clay (CL)		42	22	20		

	Specimen Identification		D100	D60	D30	D50	%Gravel	%Sand	%Silt	%Clay
●	B-1	35.0	2.36	0.04	0.009	0.0324	0.0	17.7	57.2	25.1

GRAIN SIZE - V1 496-04.GPJ PETRA.GDT 12/1/04

J.N. 496-04	**GRAIN SIZE ANALYSIS**	December, 2004
PETRA GEOTECHNICAL, INC.		PLATE B-3



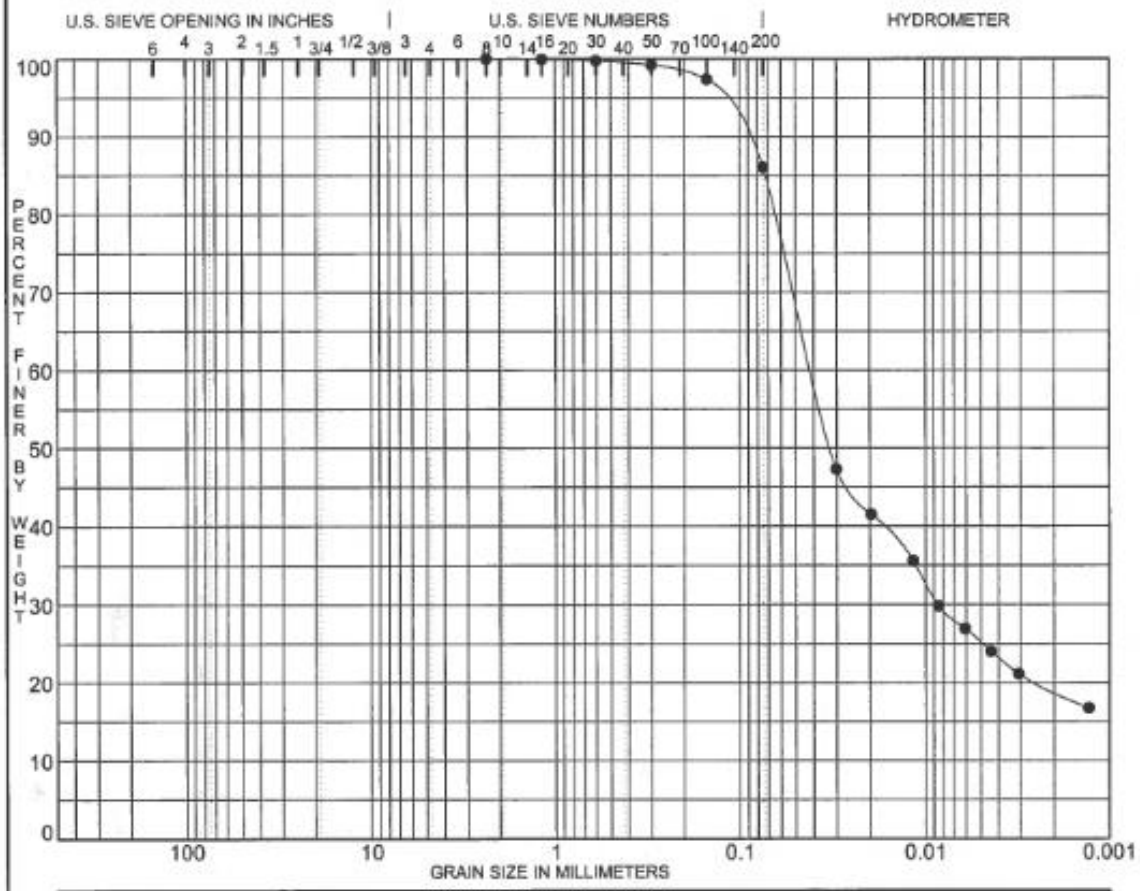
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	B-4	15.0	Sandy Clay (CL)		41	22	19		

	Specimen Identification		D100	D60	D30	D50	%Gravel	%Sand	%Silt	%Clay
●	B-4	15.0	2.36	0.03	0.007	0.0203	0.0	17.8	57.5	24.7

J.N. 496-04	**GRAIN SIZE ANALYSIS**	December, 2004
PETRA GEOTECHNICAL, INC.		PLATE B-4

GRAIN SIZE - V1 496-04.GPJ PETRA.GDT 12/1/04



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

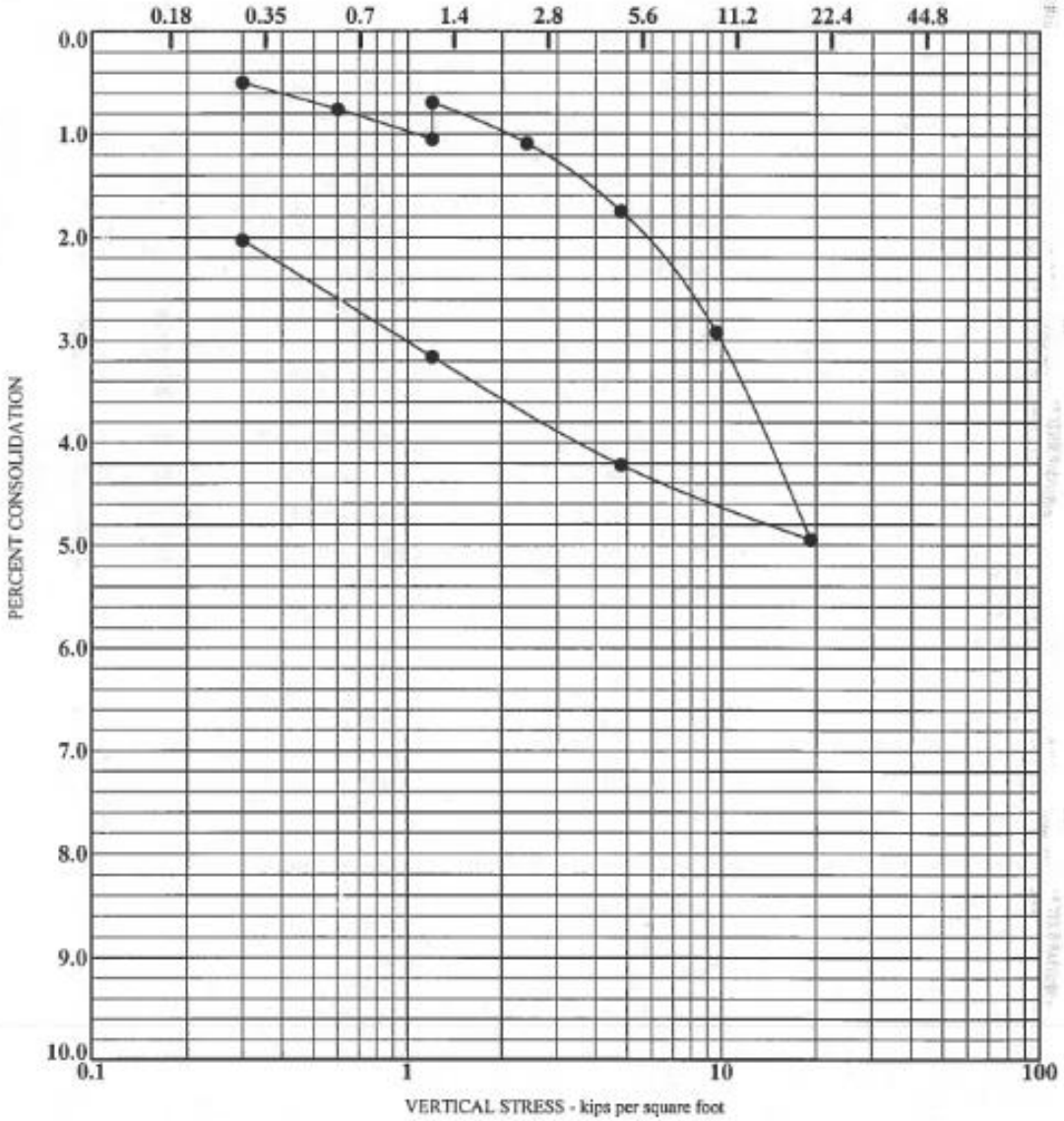
	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	B-4	45.0	Sandy Clay (CL)		43	23	20		

	Specimen Identification		D100	D60	D30	D50	%Gravel	%Sand	%Silt	%Clay
●	B-4	45.0	2.36	0.04	0.009	0.0322	0.0	14.0	60.9	25.1

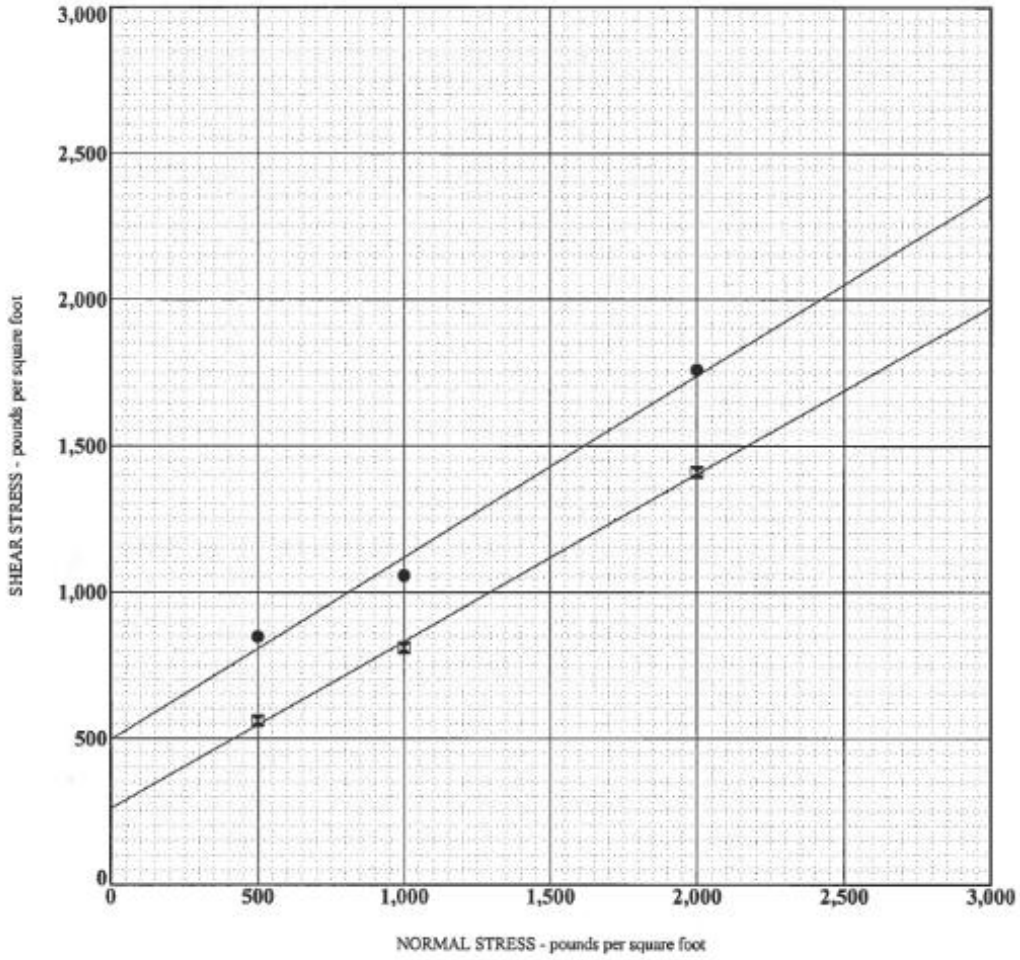
GRAIN SIZE - V1 496-04.GPJ PETRA.GDT 12/1/04

J.N. 496-04	**GRAIN SIZE ANALYSIS**	December, 2004
PETRA GEOTECHNICAL, INC.		PLATE B-5

SAMPLE LOCATION	MATERIAL DESCRIPTION	INITIAL			INUNDATED
		DENSITY (pcf)	MOISTURE (%)	SATURATION (%)	LOAD (ksf)
● B-1 @ 10.0	Sandy Clay (CL)	111.0	17.8	93	1.20



J.N. 496-04	CONSOLIDATION TEST RESULTS	November, 2004
PETRA GEOTECHNICAL, INC.		PLATE B-6



SAMPLE LOCATION	DESCRIPTION	FRICTION ANGLE (°)	COHESION (PSF)
● B-2 @ 5.0	Clayey Sand (SC) - Peak	32	500
⊠ B-2 @ 5.0	Clayey Sand (SC) - Ultimate	30	260

NOTES:

Undisturbed Test Samples
All Samples Were Inundated Prior to Shearing

J.N. 496-04	**DIRECT SHEAR TEST DATA**	December, 2004
PETRA GEOTECHNICAL, INC.	**UNDISTURBED TEST SAMPLES**	PLATE B-7

DIRECT SHEAR 496-04.GPJ PETRA.GDT 12/1/04

PROJECT NO. : 94170-00/PETRA GEO.#496-04 DATE : 22-Nov-04

PROJECT NAME : OLSON TESTED BY: RB

SAMPLE NO. / LOCATION : B-1 @ 1' - 5' SAMPLED BY: _____

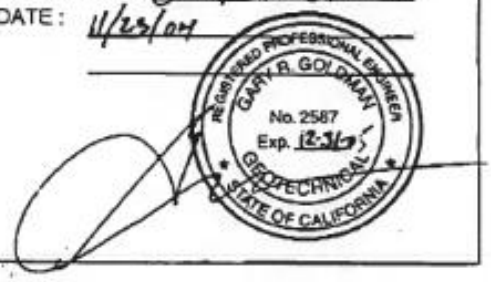
SAMPLE DESCRIPTIONS / CLASSIFICATION : DK. BROWN SANDY CLAY (CL/CH)

TRIAL NO.		1	2	3	4
MOLD NUMBER		11	7	AC1	
WATER ADDED	(ML)	95	100	105	
COMPACTOR PRESSURE	(PSI)	60	45	40	
GROSS WEIGHT	(GMS)	3223	3200	3201	
TARE WEIGHT	(GMS)	2133	2121	2120	
SAMPLE WET WEIGHT	(GMS)	1090	1079	1081	
EXUDATION PRESSURE	(PSI)	343	302	227	
SAMPLE HEIGHT	(IN.)	2.51	2.49	2.5	
EXPANSION	($IN.x10^{-4}$)	11	3	0	
STABILITY @ 160 PSI (2000 LBS) / @ 80 PSI (1000 LBS)		145 | 71	147 | 74	148 | 74	|
TURNS DISPLACEMENT		3.53	3.58	3.57	
R-VALUE UNCORRECTED		7	6	5	
R-VALUE CORRECTED		7	6	5	
MOISTURE CONTENT	(%)	18.9	19.2	19.5	
DRY DENSITY	(PCF)	110.7	110.2	109.8	
ASSUMED TRAFFIC INDEX		4.0	4.0	4.0	
G.E. BY STABILITY		0.95	0.96	0.97	
G.E. BY EXPANSION		0.37	0.10	0.00	
R-VALUE @ EQUILIBRIUM	(BY EXUDATION)	6			
Gf		1.25			

REMARKS :

CHECKED BY: GARY GOLDMAN

DATE : 11/23/04



THE DATA ABOVE IS BASED UPON PROCESSING AND TESTING OF SAMPLES "AS RECEIVED" FROM THE FIELD TEST PROCEEDURES IN GENERAL CONFORMANCE TO LATEST REVISIONS OF CA TEST METHOD 301.

ZEISER KLING CONSULTANTS, INC.
1221 E. Dyer Road, Suite 105; Santa Ana, CA 92705
Tel: (714) 755-1355; Fax: (714) 755-1366

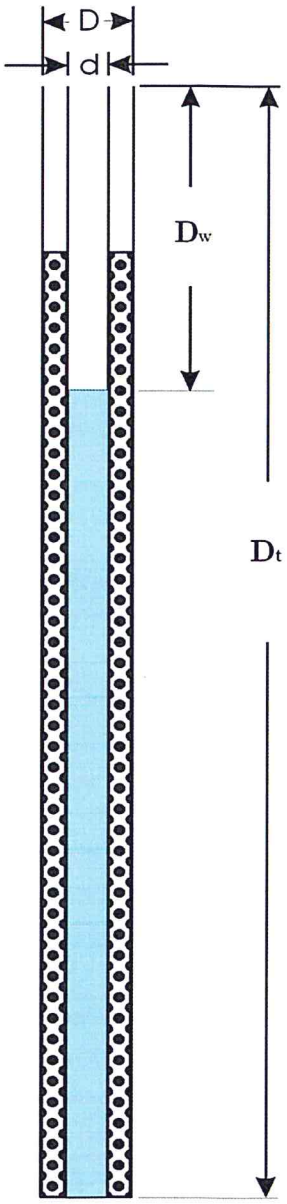
R - VALUE DATA

PLATE B-8

Test Number: P-1

Total Depth of Boring, D_t (ft): 5.2
Diameter of Hole, D (in): 7
Diameter of Pipe, d (in): 3
Agg. Correction (% Voids): 42

Time Interval (min)	Depth to Water Surface D_w (ft)		Change in Head (in)	Perc. Rate (min/in)	Perc. Rate (gal/day/ft^2)
	1st Reading	2nd Reading			
10	1.25	4.17	47.00	0.21	122.93
10	0.92	3.83	35.00	0.29	81.22
10	0.92	3.75	34.00	0.29	77.85
10	0.88	3.63	33.00	0.30	73.61
10	0.83	3.50	32.00	0.31	69.36
10	0.75	3.46	32.50	0.31	69.14



Percolation Rate: **0.31** **Minutes/Inch**
69.14 **gal/day/ft^2**

Infiltration Rate: **8.77** **Inches/Hour**
(Porchet Method)

Reference: RCFCWCD, Design Handbook for LIDBMP, dated September, 2011 or
SARWQCB, Technical Guidance Document Appendix VII, dated March 22, 2011

PETRA GEOSCIENCES, INC.
3190 Airport Loop Drive, Suite J-1
Costa Mesa, California 92626
PHONE: (714) 549-8921
COSTA MESA TEMECULA VALENCIA PALM DESERT CORONA

PERCOLATION TEST SUMMARY

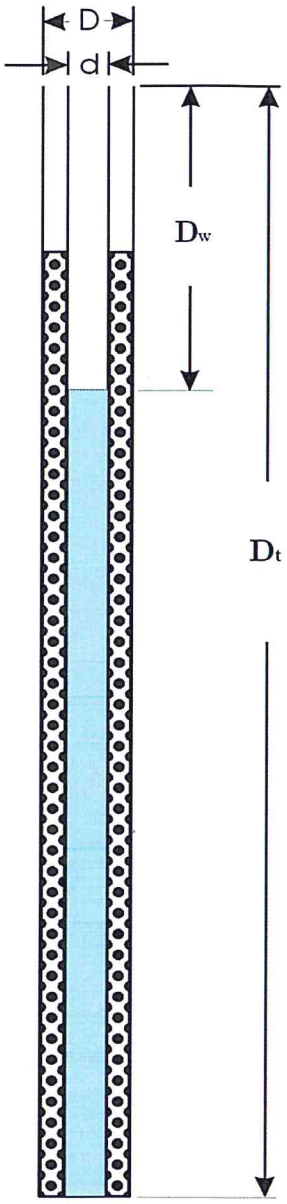
1515 West 178th Street
Gardena, California

PETRA GEOSCIENCES INC. | DATE: April, 2016 | J.N.: 16-149 | **Figure 1**

Test Number: P-2

Total Depth of Boring, D_t (ft): 5.2
Diameter of Hole, D (in): 7
Diameter of Pipe, d (in): 3
Agg. Correction (% Voids): 42

Time Interval (min)	Depth to Water Surface D_w (ft)		Change in Head (in)	Perc. Rate (min/in)	Perc. Rate (gal/day/ft^2)
	1st Reading	2nd Reading			
10	1.00	2.67	20.00	0.50	39.27
10	1.00	2.58	19.00	0.53	36.84
11	0.92	2.50	19.00	0.58	32.75
10	1.00	2.50	18.00	0.56	34.51
10	0.96	2.46	17.50	0.57	33.18
10	0.88	2.33	17.50	0.57	32.25



Percolation Rate: **0.57** **Minutes/Inch**
32.25 **gal/day/ft^2**

Infiltration Rate: **4.09** **Inches/Hour**
(Porchet Method)

Reference: RCFCWCD, Design Handbook for LIDBMP, dated September, 2011 **or**
SARWQCB, Technical Guidance Document Appendix VII, dated March 22, 2011

PETRA GEOSCIENCES, INC.
3190 Airport Loop Drive, Suite J-1
Costa Mesa, California 92626
PHONE: (714) 549-8921
COSTA MESA TEMECULA VALENCIA PALM DESERT CORONA

PERCOLATION TEST SUMMARY

1515 West 178th Street
Gardena, California

PETRA GEOSCIENCES INC. | DATE: April, 2016 | J.N.: 16-149 | **Figure 2**

APPENDIX B

BORING LOGS BY GEOTEK

Updated Geotechnical and Infiltration Evaluation
1515 West 178th Street, Gardena, California
Project No. 1949-CR

GEOTEK

A - FIELD TESTING AND SAMPLING PROCEDURES

The Modified Split-Barrel Sampler (Ring)

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

Bulk Samples (Large)

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

Bulk Samples (Small)

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

B – BORING LOG LEGEND

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

SOILS

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

GEOLOGIC

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

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

GeoTek, Inc.

LOG OF EXPLORATORY BORING

CLIENT:	Melia Homes	**DRILLER:**	2R Drilling	**LOGGED BY:**	D. Alvarez
PROJECT NAME:	1515 W 178th Street	**DRILL METHOD:**	Hollow-Stem Auger	**OPERATOR:**	Adrian
PROJECT NO.:	1949-CR	**HAMMER:**	140lbs/30in.	**RIG TYPE:**	SIMCO
LOCATION:	See Boring Location Map			**DATE:**	8/20/2018

BORING NO.: B-1

Depth (ft)	SAMPLES: Sample Type	SAMPLES: Blows/ 6 in	SAMPLES: Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Laboratory Testing: Dry Density (pcf)	Laboratory Testing: Others
					3" Asphaltic Concrete			
					Older Alluvium (Qal)			
				CL	Sandy CLAY, red-brown, slightly moist			EI, AL, SA
5		35 28 32		ML	Clayey SILT with some f sand, brown, slightly moist, stiff	11.5	126.0	
		11 18 23			Becomes red-brown, moist, stiff	14.1	117.1	
10		13 28 38		CL	Silty and sandy CLAY, olive brown, moist, very stiff	15.0	122.1	
15	#	13 26 20		SM	Silty f SAND with a trace clay, brown, moist, dense	12.3	119.4	
20		11 21 27		SM	Silty f-m SAND, brown, moist, dense			
25		10 15 20		SP	F-m SAND, brown, moist, dense	14.1	113.7	
					Boring Terminated at 26.5 feet Groundwater not encountered Boring backfilled with cuttings and capped with cold-patch asphalt			
30								

LEGEND

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

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

GeoTek, Inc.

LOG OF EXPLORATORY BORING

CLIENT:	Melia Homes	**DRILLER:**	2R Drilling	**LOGGED BY:**	D. Alvarez
PROJECT NAME:	1515 W 178th Street	**DRILL METHOD:**	Hollow-Stem Auger	**OPERATOR:**	Adrian
PROJECT NO.:	1949-CR	**HAMMER:**	140lbs/30in.	**RIG TYPE:**	SIMCO
LOCATION:	See Boring Location Map			**DATE:**	8/20/2018

BORING NO.: B-2

Depth (ft)	SAMPLES: Sample Type	SAMPLES: Blows/ 6 in	SAMPLES: Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Laboratory Testing: Dry Density (pcf)	Laboratory Testing: Others
					3" Asphaltic Concrete over 1" Agreggate Base			
					Older Alluvium (Qal)			
				CL	Sandy CLAY, olive brown, moist, stiff			MD, EI, SA, AL, DS, SR
5		7 11 13			Same as above	13.1	120.6	
		9 18 31		CL	Silty CLAY with some f sand and caliche, light red-brown, moist, very stiff	12.5	126.1	
10		15 28 30			Same as above with a trace of caliche	12.6	124.8	
		9 18 22		ML	F sandy SILT, olive moderate brown, moist, very stiff	14.3	118.9	
15	#	8 17 23		SM	Silty f SAND, light reddish brown, moist, dense			
20		10 23 27			Becomes moderate olive browin, moist, dense	12.4	118.3	
25		8 15 22		SM	Silty f SAND with few clay, moderate olive, moist, dense			
					Boring Terminated at 26.5 feet Groundwater not encountered Boring backfilled with cuttings and capped with cold-patch asphalt			
30								

LEGEND

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

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

GeoTek, Inc.

LOG OF EXPLORATORY BORING

CLIENT:	Melia Homes	**DRILLER:**	2R Drilling	**LOGGED BY:**	D. Alvarez
PROJECT NAME:	1515 W 178th Street	**DRILL METHOD:**	Hollow-Stem Auger	**OPERATOR:**	Adrian
PROJECT NO.:	1949-CR	**HAMMER:**	140lbs/30in.	**RIG TYPE:**	SIMCO
LOCATION:	See Boring Location Map			**DATE:**	8/20/2018

Depth (ft)	SAMPLES: Sample Type	SAMPLES: Blows/ 6 in	SAMPLES: Sample Number	USCS Symbol	BORING NO.: B-3 / MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Laboratory Testing: Dry Density (pcf)	Laboratory Testing: Others
					Artificial Fill			
				SM	Silty f SAND with gravel, moderate brown, slightly moist			
					Older Alluvium (Qal)			
5		28 50/6		ML	F sandy SILT, light reddish brown, slightly moist, hard			
10		18 26 32		SM/ML	Silty f SAND to f sandy SILT, light brown, slightly moist, dense to very stiff, trace rootlets	9.8	119.0	HC
15	#	13 25 36		SM/ML	Silty f SAND to f sandy SILT, light brown, slightly moist, dense to very stiff, trace rootlets	11.8	125.9	HC
					Boring Terminated at 16.5 feet Groundwater not encountered Boring backfilled with cuttings			
20								
25								
30								

LEGEND

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

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

GeoTek, Inc.

LOG OF EXPLORATORY BORING

CLIENT:	Melia Homes	**DRILLER:**	2R Drilling	**LOGGED BY:**	D. Alvarez
PROJECT NAME:	1515 W 178th Street	**DRILL METHOD:**	Hollow-Stem Auger	**OPERATOR:**	Adrian
PROJECT NO.:	1949-CR	**HAMMER:**	140lbs/30in.	**RIG TYPE:**	SIMCO
LOCATION:	See Boring Location Map			**DATE:**	8/20/2018

Depth (ft)	SAMPLES: Sample Type	SAMPLES: Blows/ 6 in	SAMPLES: Sample Number	USCS Symbol	BORING NO.: P-1 / MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Laboratory Testing: Dry Density (pcf)	Laboratory Testing: Others
					Artificial Fill			
				SM	Silty f SAND with gravel, moderate brown, slightly moist			
					Older Alluvium (Qal)			
5				ML	F sandy SILT, light reddish brown, slightly moist, hard			
					Boring Terminated at 6.0 feet			
10								
15	#							
20								
25								
30								

LEGEND

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

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

GeoTek, Inc.

LOG OF EXPLORATORY BORING

CLIENT:	Melia Homes	**DRILLER:**	2R Drilling	**LOGGED BY:**	D. Alvarez
PROJECT NAME:	1515 W 178th Street	**DRILL METHOD:**	Hollow-Stem Auger	**OPERATOR:**	Adrian
PROJECT NO.:	1949-CR	**HAMMER:**	140lbs/30in.	**RIG TYPE:**	SIMCO
LOCATION:	See Boring Location Map			**DATE:**	8/20/2018

BORING NO.: P-2

Depth (ft)	SAMPLES: Sample Type	SAMPLES: Blows/ 6 in	SAMPLES: Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Laboratory Testing: Dry Density (pcf)	Laboratory Testing: Others
					3" Asphaltic Concrete over 4" Agreggate Base			
					Older Alluvium (Qal)			
				ML/CL	Clayey SILT with some f sand, moderate brown, very moist			
					F sandy SILT, light reddish brown, very moist			
5								
					Boring Terminated at 6.0 feet			
10								
15	#							
20								
25								
30								

LEGEND

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

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

APPENDIX C

LABORATORY TEST RESULTS BY GEOTEK

Updated Geotechnical and Infiltration Evaluation
1515 West 178th Street, Gardena, California
Project No. 1949-CR

GEOTEK

SUMMARY OF LABORATORY TESTING

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

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

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

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

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

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

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

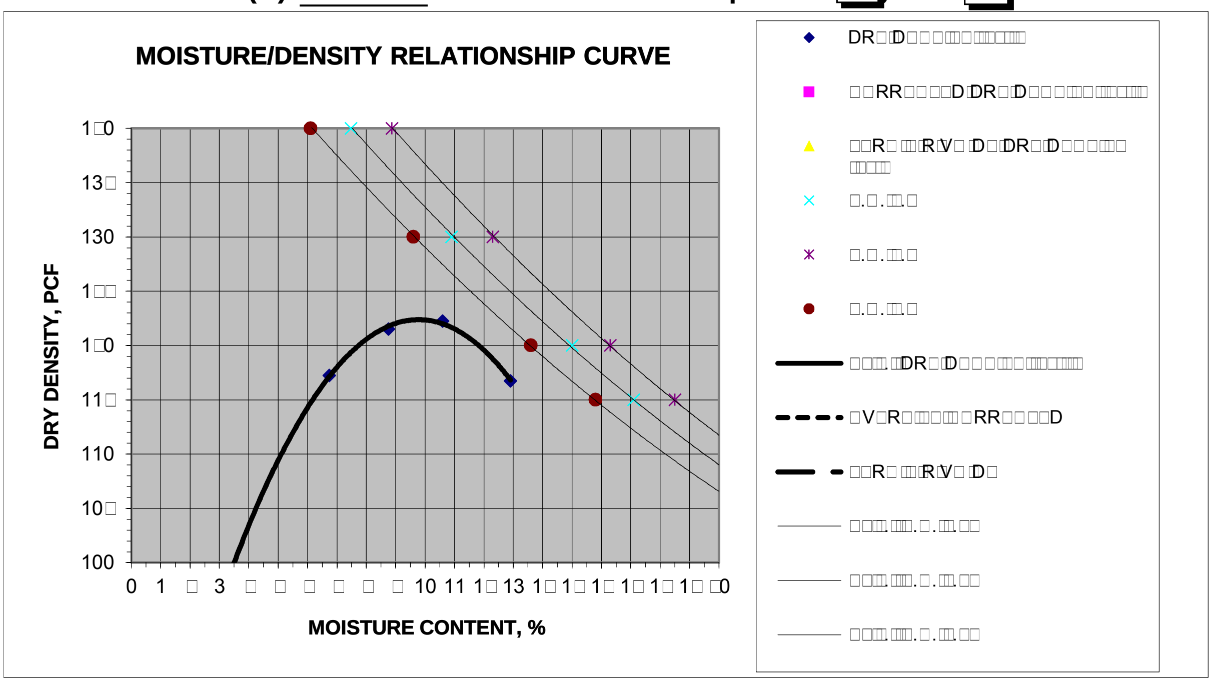
Sieve/Hydrometer
Sieve/hydrometer testing was performed on two clayey samples collected from the site. The tests were performed in general accordance with ASTM D 6913 and D 7928. The test results are presented herein.

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

GEOTEK

MOISTURE/DENSITY RELATIONSHIP

Client:	M□□□□□ □□ □□	**Job No.:**	1□□□□□R
Project:	1□1 □□□ .□1 □□□□□□□	**Lab No.:**	□□r□□□
Location:	□□rd□□□		
Material Type:	D□r□□□r□□ □□□ □□□□□□□□d		
Material Supplier:			
Material Source:			
Sample Location:	□□□□□ □1 □□□□□		
Sampled By:	D□	**Date Sampled:**	□1 □□ □□□1 □
Received By:	D□□	**Date Received:**	□□□□ □□□1 □
Tested By:	□□	**Date Tested:**	□□□□ □□□1 □
Reviewed By:		**Date Reviewed:**	
Test Procedure:	□□□M□1 □□□	**Method:**	□
Oversized Material (%):	□.0	**Correction Required:**	☐ yes ☒ no



MOISTURE DENSITY RELATIONSHIP VALUES

Maximum Dry Density, pcf	1□□.□	**@ Optimum Moisture, %**	10.0
Corrected Maximum Dry Density, pcf		**@ Optimum Moisture, %**	

MATERIAL DESCRIPTION

Grain Size Distribution:

	□□r□v□□r□□□□d□□□□ □.□□□
	□□□□d□□□ □□□□□□□□ □.□□□R□□□□□d□□□□□ □.□00□
	□□□□□□d□□ □□□□□ □□□□□□□□□ □.□00□

Atterberg Limits:

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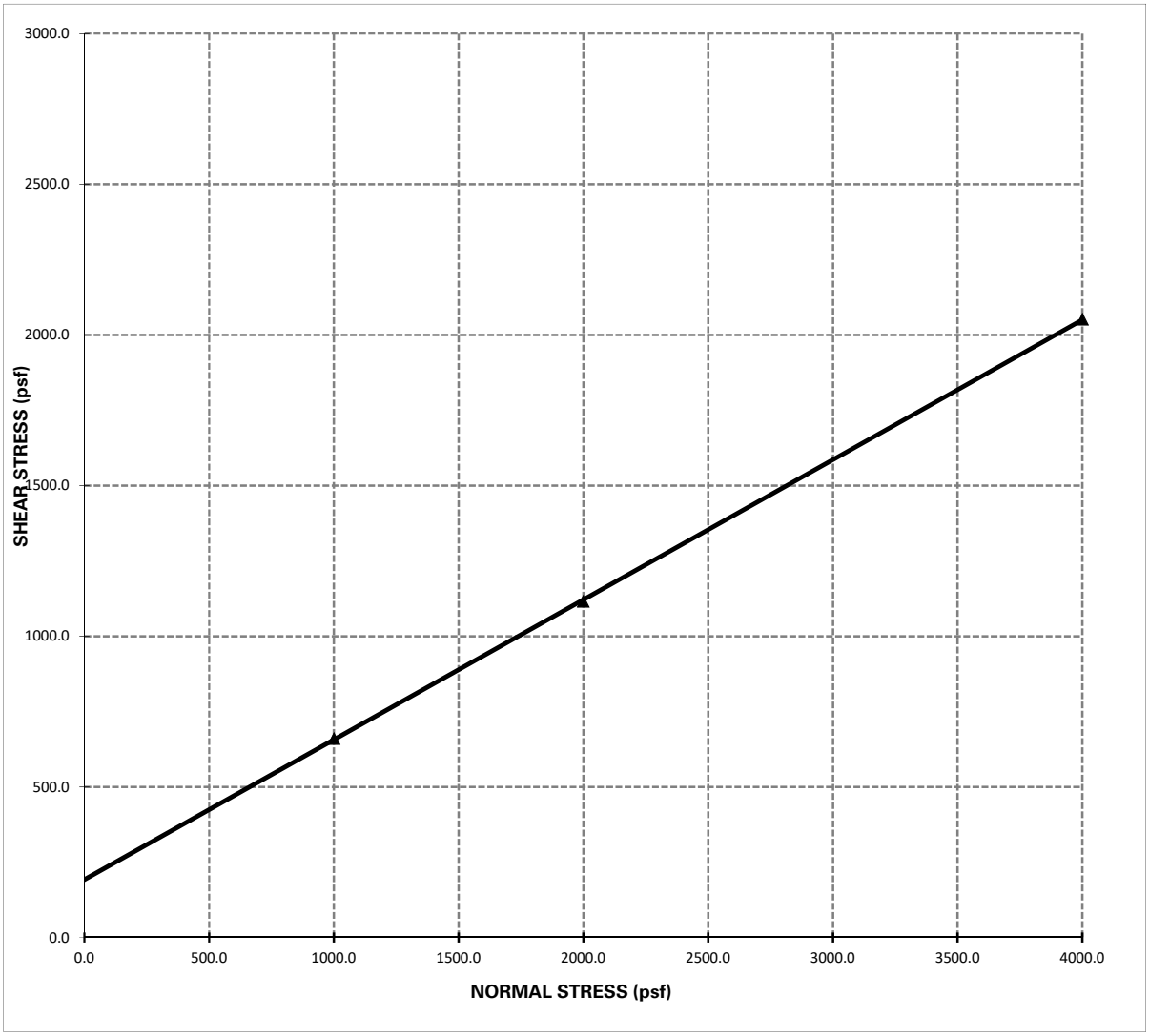
	□□□□□□□□□ □□□□
	□□□□□□□□□□d□□□□

Classification:

□□□□□d□□ □□□□□ □□□□□□□□□□□□
□□□□□□□ □□□□□□ □□□□□□□□□□□□

DIRECT SHEAR TEST

Project Name:	1515 W. 178TH St., Gardena	***Sample Location:***	B-2 @ 1 - 5 ft
Project Number:	1949-CR	***Date Tested:***	9/4/2018

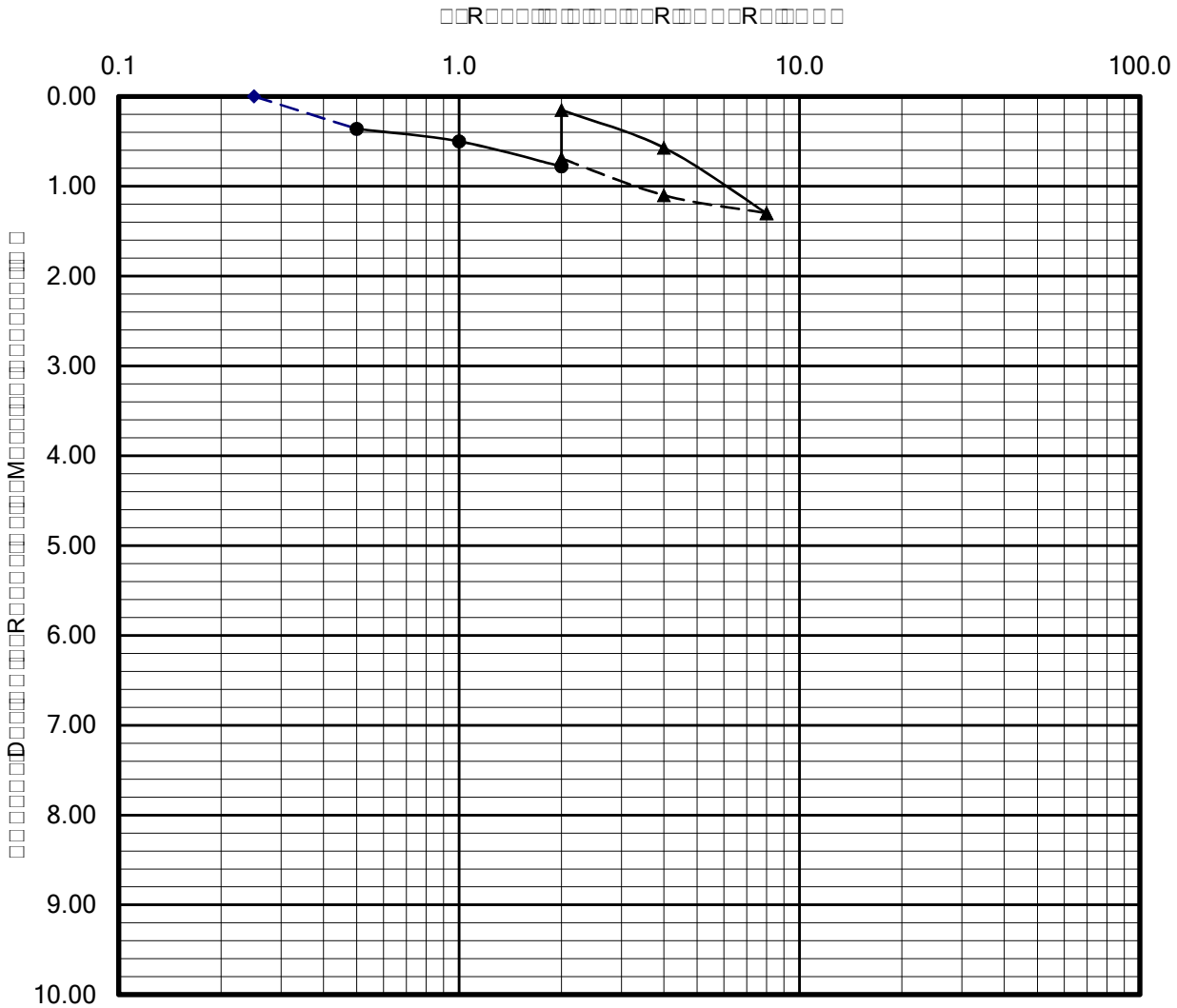


Shear Strength: Φ = **24.9** ^{o} , **C = 192.00 psf**

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

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

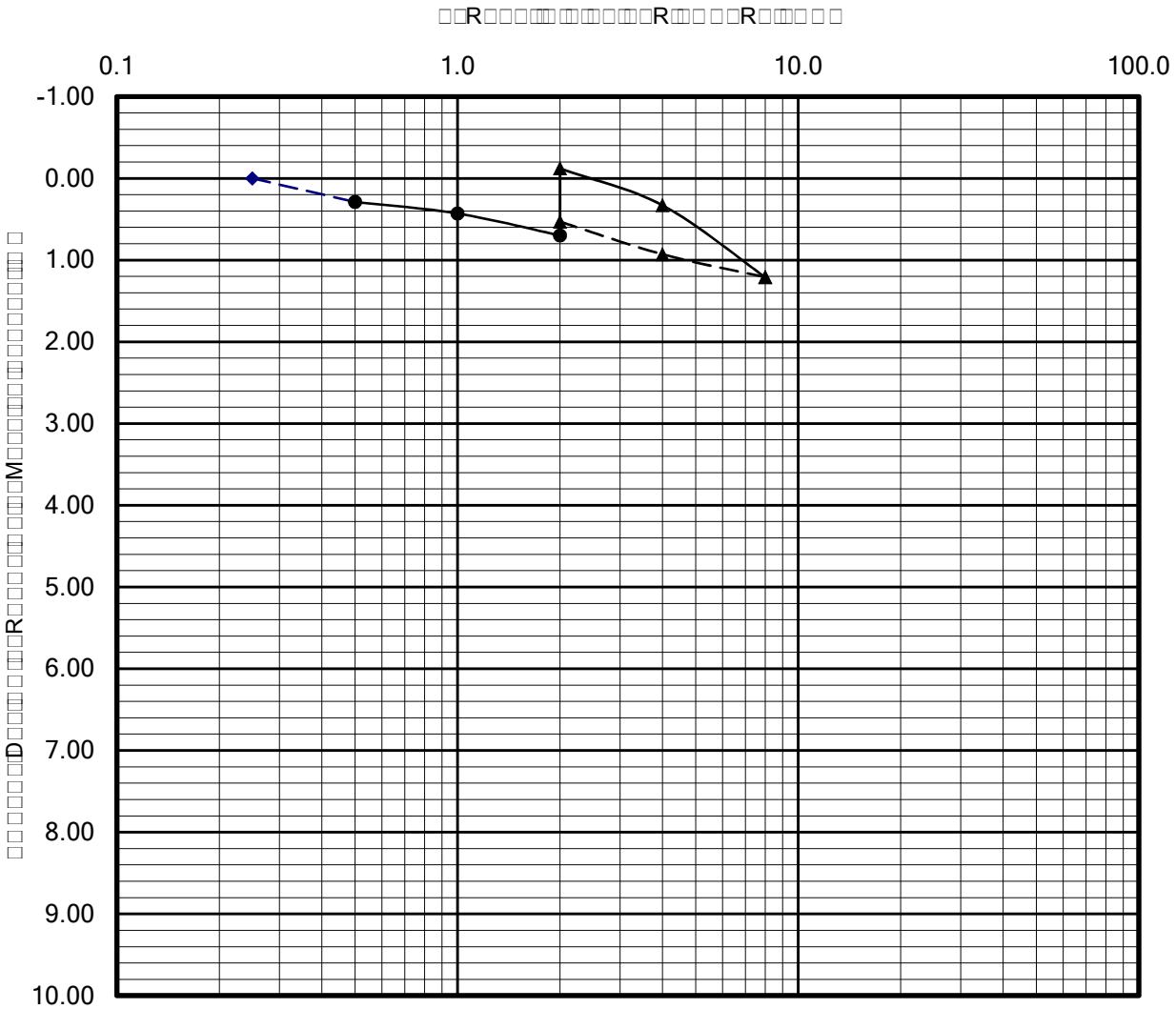
3 - The tests were run at a shear rate of 0.035 in/min.



CONSOLIDATION REPORT

Sample:

B-3 @ 10 ft



CONSOLIDATION REPORT

Sample:

B-3 @ 15 ft

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EXPANSION INDEX TEST

(ASTM D4829)

Client: M□□□□□□□□ □□ □□□

Project Number: 1□□□□□□R

Project Location: 1□1 □□□□ .□1 □□□□ □ □□□.□□□□ □rd □□□□

Tested/ Checked By: D□□D□ □□□□□□□ □ □□r□□□

Date Tested: □□□□□□□01□

Sample Source: □□1□□ □1 □□□□□□□□□

Sample Description:

R□□□□□□□ _____ R□□□□D□□□.□□□ _□.01" R□□□□□□□ □1"

DENSITY DETERMINATION

A	□ □□□□□□□□□□□□□□ □□□□□□d□□□□□ □□□□□□□□r□□□□□□□□□□ □	□□□□.□
B	□ □□□□□□□□□□□□r□□□□□□□□□ □	3□3.□
C	□ □□□□□ □□□□□□□□□□□□□□□□ □□□□□□□□□□ □	**396.2**
D	□ □□□D□□□□□□□□□□□□□□□□□□□□□□3□□□□□ □0.301□□□	**119.5**
E	Dr□□D□□□□□□□□□□□□□□□□□□□□□□□□3□□D□1.□□	**108.6**

SATURATION DETERMINATION

F	M□□□□□□r□□□□ □□□□□□□□□□□□□□	10.0
G	□□□□□□□□□□□□□□r□v□□□□□□□□□□□□□□ □d	**2.70**
H	□ □□□□□□ □□□□□□□□□ □□□□r□□□ □□□0 °C, (pcf)	**62.4**
I	□ □□□ □□□□r□□□□□□	**49.0**

READINGS

D□□□□	□□M□	R□□D□□□ □	
□□□□□□□□01□	□□□□0	0.13□0	□□□□□□□□□
	□□□□0	0.13□0	10□□□ □□□□Dr□
□□□□□□□□01□	□□00	0.1□□□0	□□□□□□□

FINAL MOISTURE

□□□□□□□□□ □□□□□□□□□□□□□□ □□□□ □□□□□□□□□□r□	□ □M□□□□□□□r□
□□□□.□	**19.8**

EXPANSION INDEX = 33

GEOTEK

EXPANSION INDEX TEST

(ASTM D4829)

Client:	M[illegible]	***Tested/ Checked By:***	D[illegible]D[illegible] [illegible] [illegible]r[illegible]
Project Number:	1[illegible]R	***Date Tested:***	[illegible]01[illegible]
Project Location:	1[illegible]1[illegible] .[illegible]1[illegible] [illegible].[illegible] [illegible]rd[illegible]	***Sample Source:***	[illegible] [illegible]1[illegible]
		Sample Description:	

R[illegible] ______ R[illegible]D[illegible]. [illegible] [illegible].01" R[illegible] [illegible].1"

DENSITY DETERMINATION

A	[illegible] d [illegible] r [illegible]	[illegible].[illegible]
B	[illegible] r [illegible]	3[illegible].[illegible]
C	[illegible]	**386.7**
D	[illegible]D[illegible]3 [illegible]0.301[illegible]	**116.6**
E	Dr[illegible]D[illegible]3 [illegible]D[illegible]1.[illegible]	**106.0**

SATURATION DETERMINATION

F	M[illegible]r[illegible]	10.0
G	[illegible]r[illegible]v[illegible]d	**2.56**
H	[illegible] [illegible]r[illegible] [illegible]0 °C, (pcf)	**62.4**
I	[illegible]r[illegible]	**50.5**

READINGS

D[illegible]	[illegible]M[illegible]	R[illegible]D[illegible]	
[illegible]01[illegible]	1[illegible]10	0.11[illegible]0	[illegible]
	1[illegible]0	0.11[illegible]0	10[illegible] [illegible]Dr[illegible]
[illegible]01[illegible]	1[illegible]30	0.1[illegible]0	[illegible]

FINAL MOISTURE

[illegible] [illegible]r[illegible]	[illegible]M[illegible]r[illegible]
[illegible].[illegible]	**20.4**

EXPANSION INDEX = 38

GEOTEK

ATTERBERG LIMITS DATA

□□□d□□□ □□□□□□□□□□□□□□□□		□□□□□□ □.	1□□□□□□R
□□□ □□□□□□ □□ □□r		□ □□□□□□	M□□□□□□□ □□ □□
□□□ □□□□□□□□	□□□□	□r□□□□□□	1□1□□□□ . □1 □□□□□ □□□ □□□□□ □rd□□□□
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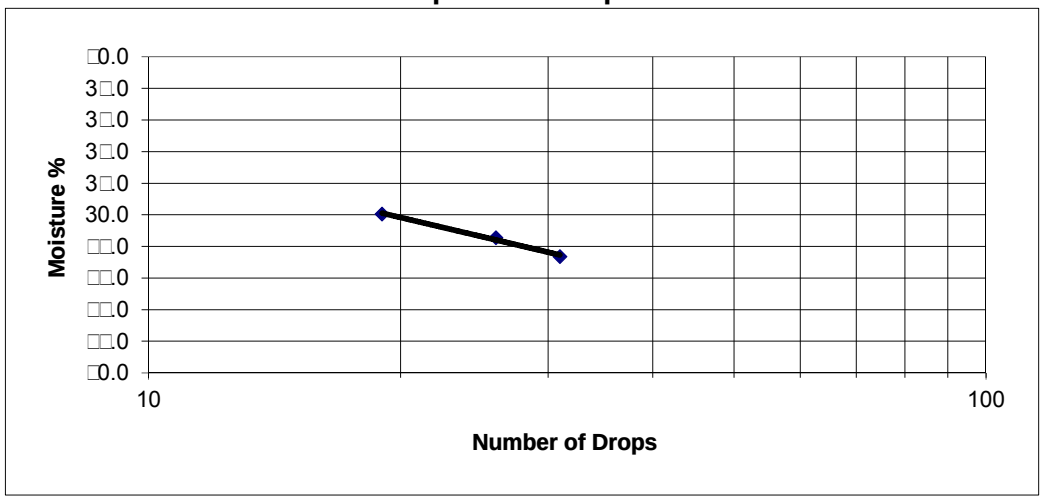
□□□□□d□□□□	D□		

	Plastic Limit			Liquid Limit		
Number of Blows				31	□□	1□
Determination	1	□	3	□	□	□
Dish						
Wt. of Dish + Wet Soil	13.3□	13.□□		□0.□3	□0.□□	□0.30
Wt. of Dish + Dry Soil	1□.3□	1□.□□		1□.1□	1□.1□	1□.00
Wt. of Moisture	1.00	1.0□		3.0□	3.1□	3.30
Wt. of Dish	□.0□	□.10		□.0□	□.0□	□.0□
Wt. of Dry Soil	□.□□	□.□□		11.11	11.03	10.□□
Moisture Content %	1□.0	1□.3		□□.□	□□.□	30.1

Liquid Limit Graph



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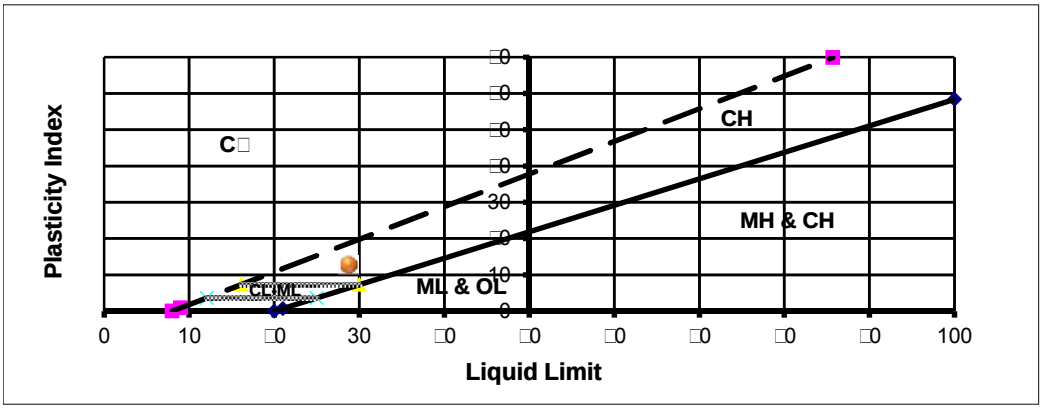
1□

□ □□□□□□□□□□□□□d □□
13



![GEOTEK logo]

ATTERBERG LIMITS DATA

□□d□ □□□□□□□□□		□□□□ □.	1□□□□R
□□□ □□□□ □□ □□r		□ □□□□	M□□□□ □□ □□
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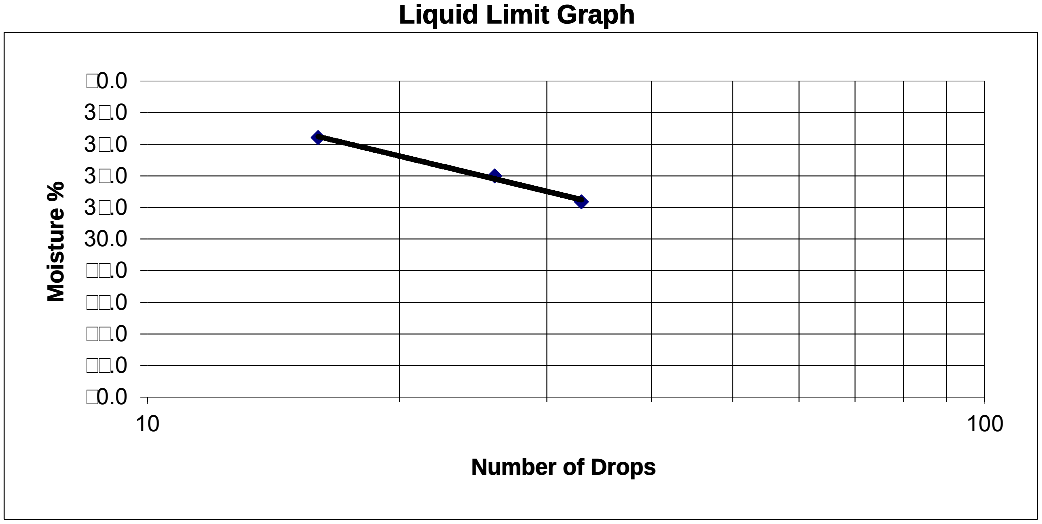
□□□□□□□	□□□□ □1□□□□		
□□□□d□□□	D□		

	Plastic Limit			Liquid Limit		
Number of Blows				33	□□	1□
Determination	1	□	3	□	□	□
Dish						
Wt. of Dish + Wet Soil	13.□□	13.3□		□0.□□	□0.□□	□0.1□
Wt. of Dish + Dry Soil	1□.□□	1□.□1		1□.□□	1□.□□	1□.□1
Wt. of Moisture	1.00	0.□□		3.□□	3.□0	3.□□
Wt. of Dish	□.0□	□.0□		□.11	□.0□	□.0□
Wt. of Dry Soil	□.□□	□.3□		10.□□	10.□□	10.3□
Moisture Content %	1□.□	1□.3		3□.□	3□.0	3□.□

Liquid Limit Graph



□□□□d □□□ □
3□

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1□

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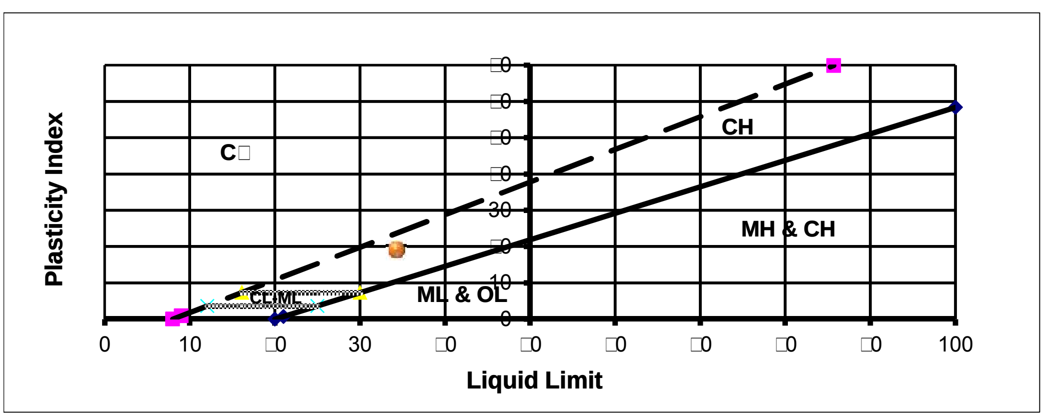
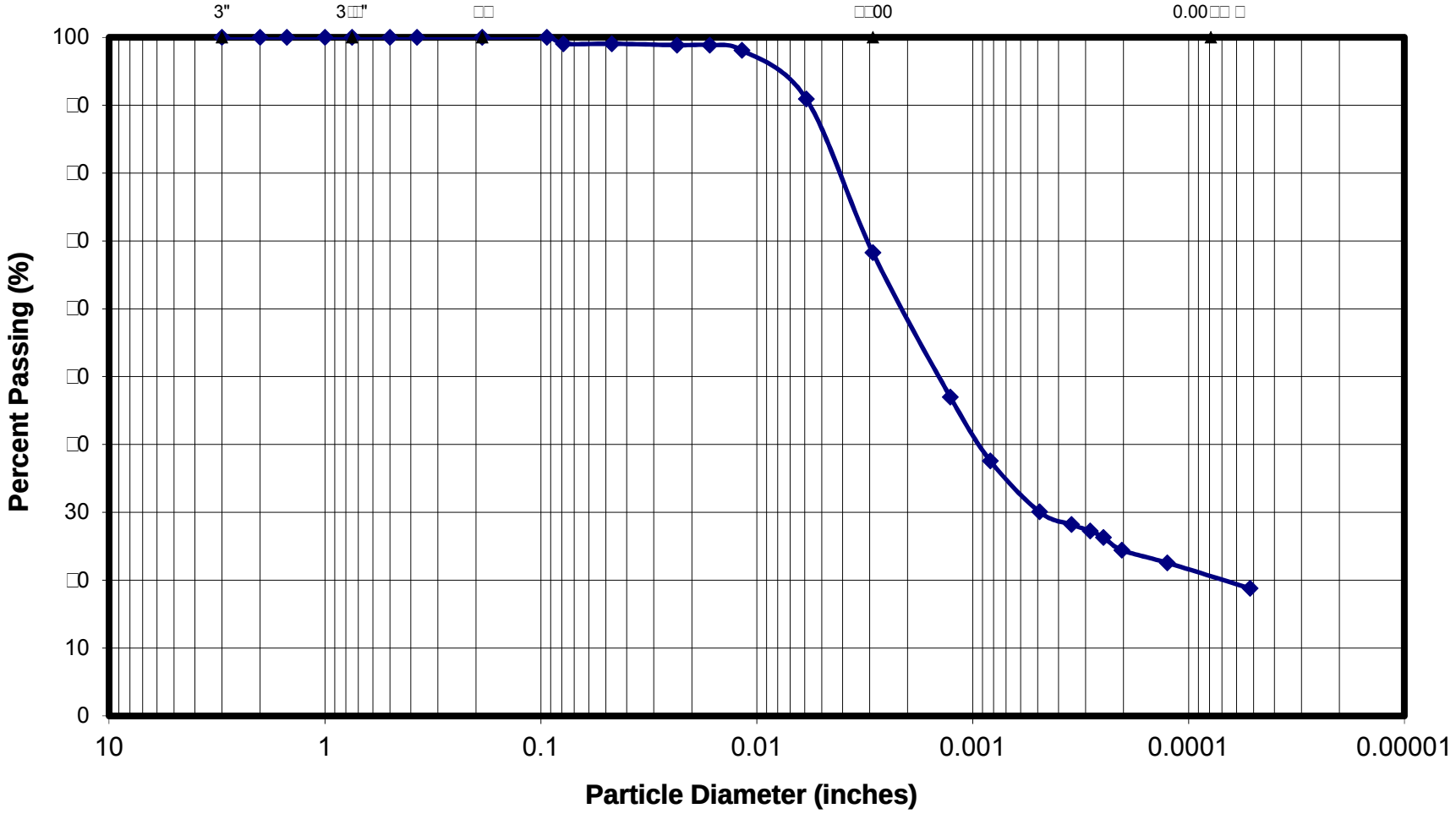
1□



GEOTEK

Project No.	1□□□□□R
Client:	M□□□□□□ □□ □□
Project Name:	1□□□ .1 □□□□ □□ .□□□ □rd□
Date:	□31 □□01□
Sample Desc:	□□1 □□ □1 □□□□□□
GeoTek Lab No:	0

Sieve Analysis w/Hydrometer ASTM D422

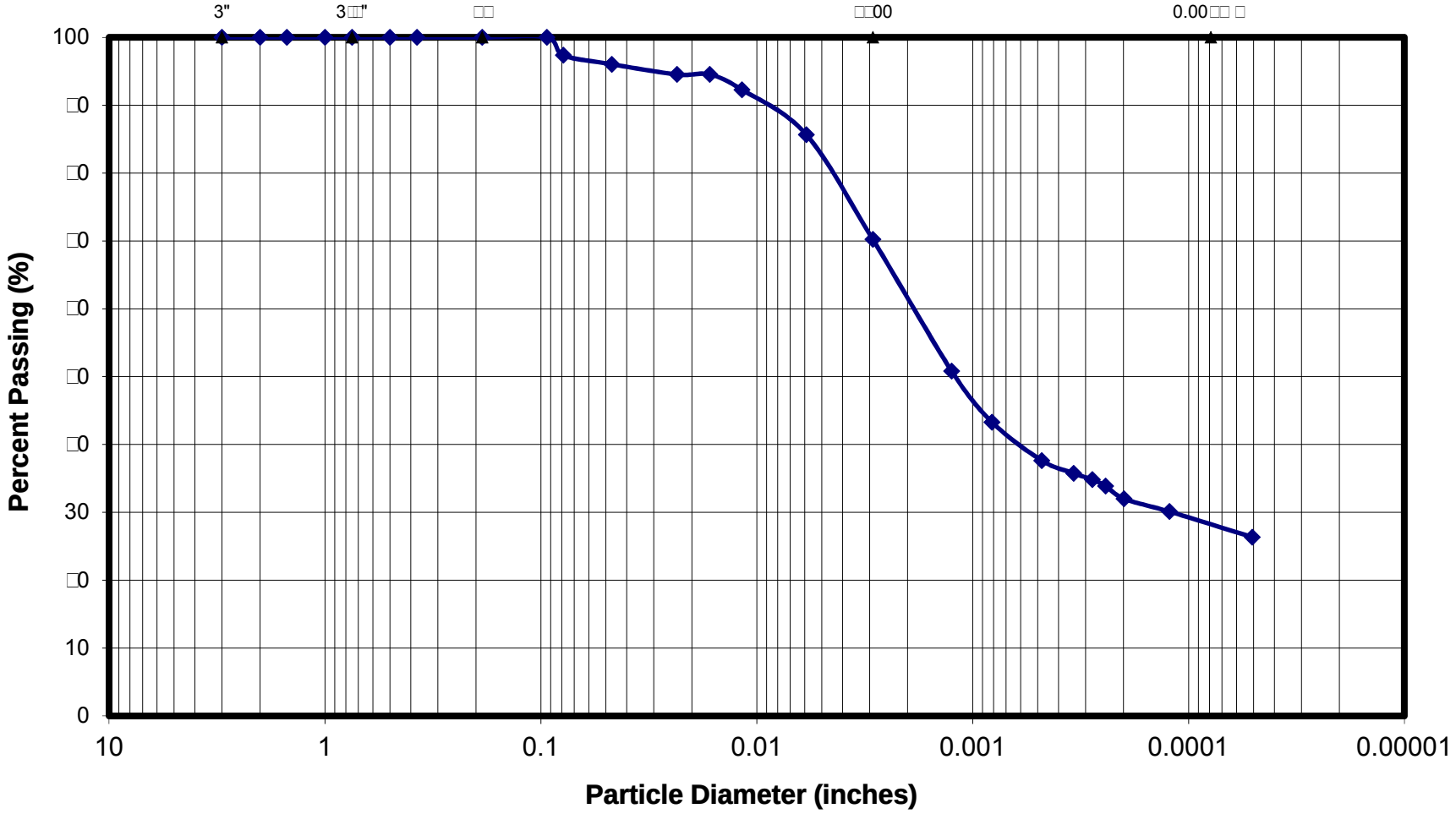


Reviewed By: _____ **Date:** _____

GEOTEK

Project No.	1□□□□□R
Client:	M□□□□□□ □□ □□
Project Name:	1□□□ .1 □□□□ □□ □□□ □rd□
Date:	□31 □□01□
Sample Desc:	□□□□□ □1 □□□□□□□
GeoTek Lab No:	0

Sieve Analysis w/Hydrometer ASTM D422



Reviewed By: _____ **Date:** _____

Soil Analysis Lab Results

Client: Geotek Inc
Job Name: 1515 W. 178th St., Gardena
Client Job Number: 1949-CR
Project X Job Number: S180830B
September 5, 2018

	Method	ASTM G187		ASTM D516		ASTM D512B		SM 4500-NO3-E	SM 4500-NH3-C	SM 4500-S2-D	ASTM G200	ASTM G51
Bore# / Description	**Depth**	**Resistivity** As Rec'd	Minimum	**Sulfates**		**Chlorides**		**Nitrate**	**Ammonia**	**Sulfide**	**Redox**	**pH**
	(ft)	(Ohm-cm)	(Ohm-cm)	(mg/kg)	(wt%)	(mg/kg)	(wt%)	(mg/kg)	(mg/kg)	(mg/kg)	(mV)	
B-2	0-5.0	18,760	2,010	150	0.0150	42	0.0042	30	0.5	0.03	197	7.77

Unk = Unknown
NT = Not Tested
ND = 0 = Not Detected
mg/kg = milligrams per kilogram (parts per million) of dry soil weight
Chemical Analysis performed on 1:3 Soil-To-Water extract

Please call if you have any questions.

Prepared by,

Nathan Jacob
Lab Technician

Respectfully Submitted,

Eddie Hernandez, M.Sc., P.E.
Sr. Corrosion Consultant
NACE Corrosion Technologist #16592
Professional Engineer
California No. M37102
ehernandez@projectxcorrosion.com

APPENDIX D

INFILTRATION TEST DATA BY GEOTEK

Updated Geotechnical and Infiltration Evaluation
1515 West 178th Street, Gardena, California
Project No. 1949-CR

GEOTEK

Client:	**Melia Homes**
Project:	**1515 West 178th Street, Gardena, CA**
Project No:	**1949-CR**
Date:	**8/21/2018**

Boring No. **P-1/I-1**

Percolation Rate (Porchet Method)

Time Interval, Δt =	30	min.
Final Depth to Water, D_F =	0.1	in.
Test Hole Radius, r =	4	in.
Initial Depth to Water, D_O =	0	in.
Total Test Hole Depth, D_T =	29.625	in.

Equation - $I_t = \dfrac{\Delta H\ (60r)}{\Delta t\ (r+2H_{avg})}$

$H_O = D_T - D_O$ =	29.625	in.
$H_F = D_T - D_F$ =	29.525	in.
$\Delta H = \Delta D = H_O - H_F$ =	0.1	in.
$H_{avg} = (H_O+H_F)/2$ =	29.575	in.

I_t = 0.01 **Inches per Hour**

GEOTEK

Client:	**Melia Homes**
Project:	**1515 West 178th Street, Gardena, CA**
Project No:	**1949-CR**
Date:	**8/21/2018**

Boring No. **P-2/I-2**

Percolation Rate (Porchet Method)

Time Interval, Δt =	30	min.
Final Depth to Water, D_F =	0.1	in.
Test Hole Radius, r =	4	in.
Initial Depth to Water, D_O =	0	in.
Total Test Hole Depth, D_T =	42	in.

Equation - $I_t = \dfrac{\Delta H\,(60r)}{\Delta t\,(r+2H_{avg})}$

$H_O = D_T - D_O$ =	42	in.
$H_F = D_T - D_F$ =	41.9	in.
$\Delta H = \Delta D = H_O - H_F$ =	0.1	in.
$H_{avg} = (H_O+H_F)/2$ =	41.95	in.

I_t = 0.01 **Inches per Hour**

GEOTEK

Boring/Excavation Percolation Testing Field Log

Date □□1□01□

Project Location 1□1□□ .□1□□□□□.□□ □rd□□□□□ □
Boring/Test Number □□□1
Earth Description
Diameter of Boring □.0" **Diameter of Casing** 3.0"
Tested by D□
Depth of Boring □.0□
Liquid Description □□□□□□□□□ □□r
Depth to Invert of BMP □.0□
Measurement Method □□□□d□r
Depth to Water Table 30.0□
Depth to Initial Water Depth (d_1) □□.□□□"

Time Interval Standard
Start Time for Pre-Soak □00□□
Water Remaining In Boring (Y/N) □□□
Start Time for Standard □30□□
Standard Time Interval Between Readings 30□ □

Reading Number	Time Start/End (hh:mm)	Elapsed Time Δtime (mins)	Water Drop During Standard Time Interval Δd (inches)	Percolation Rate for Reading (in/hr)	Soil Description/Notes/Comments
1	□30□□ □00□□	30	0.1	0.□	
□	□00□□ □30□□	30	0.1	0.□	
3	□30□□ □00□□	30	0.1	0.□	
□	□00□□ □30□□	30	0.1	0.□	
□	□30□□ 10□00□□	30	0.1	0.□	
□	10□00□□ 10□30□□	30	0.1	0.□	
□	10□30□□ 11□00□□	30	0.1	0.□	
□	11□00□□ 11□30□□	30	0.1	0.□	

Boring/Excavation Percolation Testing Field Log

Date □□1□01□

Project Location 1□1□□ .□1□□□□□.□□ □rd□□□□□□

Earth Description

Tested by D□

Liquid Description □□□□□□□□□ □□r

Measurement Method □□□□d□r

Boring/Test Number □□□□

Diameter of Boring □.0" **Diameter of Casing** 3.0"

Depth of Boring □.0□

Depth to Invert of BMP □.0□

Depth to Water Table 30.0□

Depth to Initial Water Depth (d_1) □□"

Time Interval Standard

Start Time for Pre-Soak □□3□□

Start Time for Standard □□3□□

Water Remaining In Boring (Y/N) □□□

Standard Time Interval Between Readings 30□□ □

Reading Number	Time Start/End (hh:mm)	Elapsed Time Δtime (mins)	Water Drop During Standard Time Interval Δd (inches)	Percolation Rate for Reading (in/hr)	Soil Description/Notes/Comments
	□□3□□				
1	□□3□□	30	0.1	0.□	
	□□3□□				
□	□□3□□	30	0.1	0.□	
	□□3□□				
3	□□3□□	30	0.1	0.□	
	□□3□□				
□	□□3□□	30	0.1	0.□	
	□□3□□				
□	□□3□□	30	0.1	0.□	
	□□3□□				
□	10□3□□	30	0.1	0.□	
	10□3□□				
□	10□3□□	30	0.1	0.□	
	10□3□□				
□	11□3□□	30	0.1	0.□	

APPENDIX E

GENERAL EARTHWORK AND GRADING GUIDELINES

Updated Geotechnical and Infiltration Evaluation
1515 West 178th Street, Gardena, California
Project No. 1949-CR

GEOTEK

GENERAL GRADING GUIDELINES

Guidelines presented herein are intended to address general construction procedures for earthwork construction. Specific situations and conditions often arise which cannot reasonably be discussed in general guidelines, when anticipated these are discussed in the text of the report. Often unanticipated conditions are encountered which may necessitate modification or changes to these guidelines. It is our hope that these will assist the contractor to more efficiently complete the project by providing a reasonable understanding of the procedures that would be expected during earthwork and the testing and observation used to evaluate those procedures.

General

Grading should be performed to at least the minimum requirements of governing agencies, Chapters 18 and 33 of the California Building Code, CBC (2016) and the guidelines presented below.

Preconstruction Meeting

A preconstruction meeting should be held prior to site earthwork. Any questions the contractor has regarding our recommendations, general site conditions, apparent discrepancies between reported and actual conditions and/or differences in procedures the contractor intends to use should be brought up at that meeting. The contractor (including the main onsite representative) should review our report and these guidelines in advance of the meeting. Any comments the contractor may have regarding these guidelines should be brought up at that meeting.

Grading Observation and Testing

1. Observation of the fill placement should be provided by our representative during grading. Verbal communication during the course of each day will be used to inform the contractor of test results. The contractor should receive a copy of the "Daily Field Report" indicating results of field density tests that day. If our representative does not provide the contractor with these reports, our office should be notified.
2. Testing and observation procedures are, by their nature, specific to the work or area observed and location of the tests taken, variability may occur in other locations. The contractor is responsible for the uniformity of the grading operations; our observations and test results are intended to evaluate the contractor's overall level of efforts during grading. The contractor's personnel are the only individuals participating in all aspect of site work. Compaction testing and observation should not be considered as relieving the contractor's responsibility to properly compact the fill.
3. Cleanouts, processed ground to receive fill, key excavations, and subdrains should be observed by our representative prior to placing any fill. It will be the contractor's responsibility to notify our representative or office when such areas are ready for observation.
4. Density tests may be made on the surface material to receive fill, as considered warranted by this firm.

5. In general, density tests would be made at maximum intervals of two feet of fill height or every 1,000 cubic yards of fill placed. Criteria will vary depending on soil conditions and size of the fill. More frequent testing may be performed. In any case, an adequate number of field density tests should be made to evaluate the required compaction and moisture content is generally being obtained.
6. Laboratory testing to support field test procedures will be performed, as considered warranted, based on conditions encountered (e.g. change of material sources, types, etc.) Every effort will be made to process samples in the laboratory as quickly as possible and in progress construction projects are our first priority. However, laboratory workloads may cause in delays and some soils may require a **minimum of 48 to 72 hours to complete test procedures**. Whenever possible, our representative(s) should be informed in advance of operational changes that might result in different source areas for materials.
7. Procedures for testing of fill slopes are as follows:
    a) Density tests should be taken periodically during grading on the flat surface of the fill, three to five feet horizontally from the face of the slope.
    b) If a method other than over building and cutting back to the compacted core is to be employed, slope compaction testing during construction should include testing the outer six inches to three feet in the slope face to determine if the required compaction is being achieved.
8. Finish grade testing of slopes and pad surfaces should be performed after construction is complete.

Site Clearing

1. All vegetation, and other deleterious materials, should be removed from the site. If material is not immediately removed from the site it should be stockpiled in a designated area(s) well outside of all current work areas and delineated with flagging or other means. Site clearing should be performed in advance of any grading in a specific area.
2. Efforts should be made by the contractor to remove all organic or other deleterious material from the fill, as even the most diligent efforts may result in the incorporation of some materials. This is especially important when grading is occurring near the natural grade. All equipment operators should be aware of these efforts. Laborers may be required as root pickers.
3. Nonorganic debris or concrete may be placed in deeper fill areas provided the procedures used are observed and found acceptable by our representative.

Treatment of Existing Ground

1. Following site clearing, all surficial deposits of alluvium and colluvium as well as weathered or creep effected bedrock, should be removed unless otherwise specifically indicated in the text of this report.

2. In some cases, removal may be recommended to a specified depth (e.g. flat sites where partial alluvial removals may be sufficient). The contractor should not exceed these depths unless directed otherwise by our representative.
3. Groundwater existing in alluvial areas may make excavation difficult. Deeper removals than indicated in the text of the report may be necessary due to saturation during winter months.
4. Subsequent to removals, the natural ground should be processed to a depth of six inches, moistened to near optimum moisture conditions and compacted to fill standards.
5. Exploratory back hoe or dozer trenches still remaining after site removal should be excavated and filled with compacted fill if they can be located.

Fill Placement

1. Unless otherwise indicated, all site soil and bedrock may be reused for compacted fill; however, some special processing or handling may be required (see text of report).
2. Material used in the compacting process should be evenly spread, moisture conditioned, processed, and compacted in thin lifts six (6) to eight (8) inches in compacted thickness to obtain a uniformly dense layer. The fill should be placed and compacted on a nearly horizontal plane, unless otherwise found acceptable by our representative.
3. If the moisture content or relative density varies from that recommended by this firm, the contractor should rework the fill until it is in accordance with the following:
    a) Moisture content of the fill should be at or above optimum moisture. Moisture should be evenly distributed without wet and dry pockets. Pre-watering of cut or removal areas should be considered in addition to watering during fill placement, particularly in clay or dry surficial soils. The ability of the contractor to obtain the proper moisture content will control production rates.
    b) Each six-inch layer should be compacted to at least 90 percent of the maximum dry density in compliance with the testing method specified by the controlling governmental agency. In most cases, the testing method is ASTM Test Designation D 1557.
4. Rock fragments less than eight inches in diameter may be utilized in the fill, provided:
    a) They are not placed in concentrated pockets;
    b) There is a sufficient percentage of fine-grained material to surround the rocks;
    c) The distribution of the rocks is observed by, and acceptable to, our representative.
5. Rocks exceeding eight (8) inches in diameter should be taken off site, broken into smaller fragments, or placed in accordance with recommendations of this firm in areas designated suitable for rock disposal. On projects where significant large quantities of oversized materials are anticipated, alternate guidelines for placement may be included. If significant oversize materials are encountered during construction, these guidelines should be requested.
6. In clay soil, dry or large chunks or blocks are common. If in excess of eight (8) inches minimum dimension, then they are considered as oversized. Sheepsfoot compactors or other suitable

methods should be used to break up blocks. When dry, they should be moisture conditioned to provide a uniform condition with the surrounding fill.

Slope Construction

1. The contractor should obtain a minimum relative compaction of 90 percent out to the finished slope face of fill slopes. This may be achieved by either overbuilding the slope and cutting back to the compacted core, or by direct compaction of the slope face with suitable equipment.
2. Slopes trimmed to the compacted core should be overbuilt by at least three (3) feet with compaction efforts out to the edge of the false slope. Failure to properly compact the outer edge results in trimming not exposing the compacted core and additional compaction after trimming may be necessary.
3. If fill slopes are built "at grade" using direct compaction methods, then the slope construction should be performed so that a constant gradient is maintained throughout construction. Soil should not be "spilled" over the slope face nor should slopes be "pushed out" to obtain grades. Compaction equipment should compact each lift along the immediate top of slope. Slopes should be back rolled or otherwise compacted at approximately every 4 feet vertically as the slope is built.
4. Corners and bends in slopes should have special attention during construction as these are the most difficult areas to obtain proper compaction.
5. Cut slopes should be cut to the finished surface. Excessive undercutting and smoothing of the face with fill may necessitate stabilization.

UTILITY TRENCH CONSTRUCTION AND BACKFILL

Utility trench excavation and backfill is the contractors responsibility. The geotechnical consultant typically provides periodic observation and testing of these operations. While efforts are made to make sufficient observations and tests to verify that the contractors' methods and procedures are adequate to achieve proper compaction, it is typically impractical to observe all backfill procedures. As such, it is critical that the contractor use consistent backfill procedures.

Compaction methods vary for trench compaction and experience indicates many methods can be successful. However, procedures that "worked" on previous projects may or may not prove effective on a given site. The contractor(s) should outline the procedures proposed, so that we may discuss them **prior** to construction. We will offer comments based on our knowledge of site conditions and experience.

1. Utility trench backfill in slopes, structural areas, in streets and beneath flat work or hardscape should be brought to at least optimum moisture and compacted to at least 90 percent of the laboratory standard. Soil should be moisture conditioned prior to placing in the trench.

2. Flooding and jetting are not typically recommended or acceptable for native soils. Flooding or jetting may be used with select sand having a Sand Equivalent (SE) of 30 or higher. This is typically limited to the following uses:

   a) shallow (12 + inches) under slab interior trenches and,

   b) as bedding in pipe zone.

   The water should be allowed to dissipate prior to pouring slabs or completing trench compaction.

3. Care should be taken not to place soils at high moisture content within the upper three feet of the trench backfill in street areas, as overly wet soils may impact subgrade preparation. Moisture may be reduced to 2% below optimum moisture in areas to be paved within the upper three feet below sub grade.

4. Sand backfill should not be allowed in exterior trenches adjacent to and within an area extending below a 1:1 projection from the outside bottom edge of a footing, unless it is similar to the surrounding soil.

5. Trench compaction testing is generally at the discretion of the geotechnical consultant. Testing frequency will be based on trench depth and the contractors procedures. A probing rod would be used to assess the consistency of compaction between tested areas and untested areas. If zones are found that are considered less compact than other areas, this would be brought to the contractors attention.

JOB SAFETY

General

Personnel safety is a primary concern on all job sites. The following summaries are safety considerations for use by all our employees on multi-employer construction sites. On ground personnel are at highest risk of injury and possible fatality on grading construction projects. The company recognizes that construction activities will vary on each site and that job site safety is the contractor's responsibility. However, it is, imperative that all personnel be safety conscious to avoid accidents and potential injury.

In an effort to minimize risks associated with geotechnical testing and observation, the following precautions are to be implemented for the safety of our field personnel on grading and construction projects.

1. Safety Meetings: Our field personnel are directed to attend the contractor's regularly scheduled safety meetings.

2. Safety Vests: Safety vests are provided for and are to be worn by our personnel while on the job site.

3. Safety Flags: Safety flags are provided to our field technicians; one is to be affixed to the vehicle when on site, the other is to be placed atop the spoil pile on all test pits.

In the event that the contractor's representative observes any of our personnel not following the above, we request that it be brought to the attention of our office.

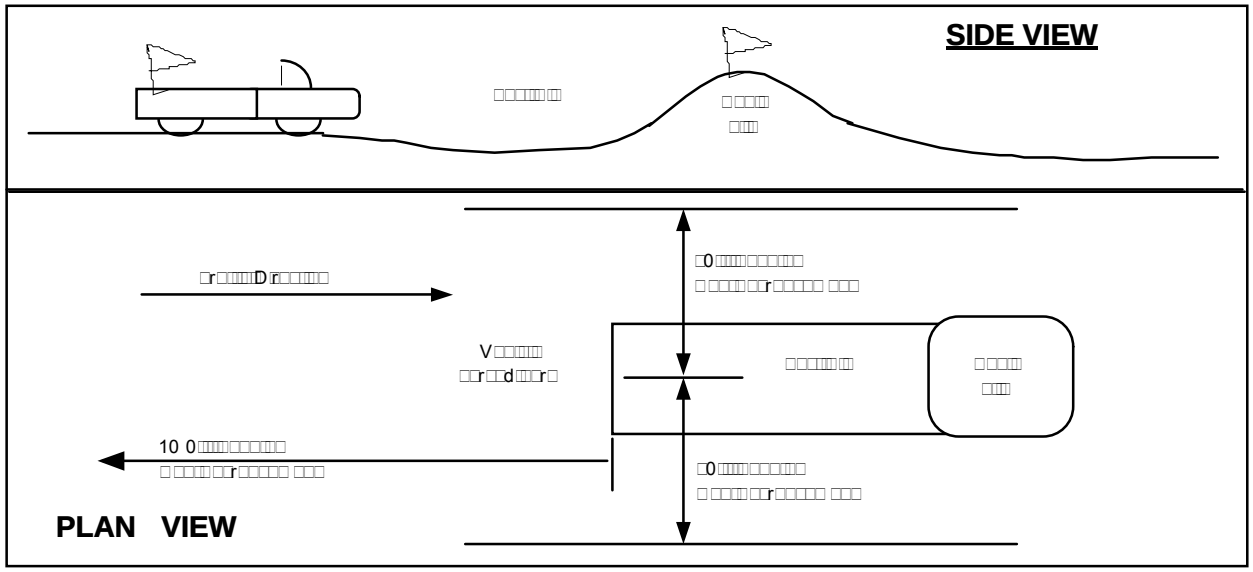
Test Pits Location, Orientation and Clearance

The technician is responsible for selecting test pit locations. The primary concern is the technician's safety. However, it is necessary to take sufficient tests at various locations to obtain a representative sampling of the fill. As such, efforts will be made to coordinate locations with the grading contractors authorized representatives (e.g. dump man, operator, supervisor, grade checker, etc.), and to select locations following or behind the established traffic pattern, preferably outside of current traffic. The contractors authorized representative should direct excavation of the pit and safety during the test period. Again, safety is the paramount concern.

Test pits should be excavated so that the spoil pile is placed away from oncoming traffic. The technician's vehicle is to be placed next to the test pit, opposite the spoil pile. This necessitates that the fill be maintained in a drivable condition. Alternatively, the contractor may opt to park a piece of equipment in front of test pits, particularly in small fill areas or those with limited access.

A zone of non-encroachment should be established for all test pits (see diagram below). No grading equipment should enter this zone during the test procedure. The zone should extend outward to the sides approximately 50 feet from the center of the test pit and 100 feet in the direction of traffic flow. This zone is established both for safety and to avoid excessive ground vibration, which typically decreases test results.

TEST PIT SAFETY PLAN



Slope Tests

When taking slope tests, the technician should park their vehicle directly above or below the test location on the slope. The contractor's representative should effectively keep all equipment at a safe operation distance (e.g. 50 feet) away from the slope during testing.

The technician is directed to withdraw from the active portion of the fill as soon as possible following testing. The technician's vehicle should be parked at the perimeter of the fill in a highly visible location.

Trench Safety

It is the contractor's responsibility to provide safe access into trenches where compaction testing is needed. Trenches for all utilities should be excavated in accordance with CAL-OSHA and any other applicable safety standards. Safe conditions will be required to enable compaction testing of the trench backfill.

All utility trench excavations in excess of 5 feet deep, which a person enters, are to be shored or laid back. Trench access should be provided in accordance with OSHA standards. Our personnel are directed not to enter any trench by being lowered or "riding down" on the equipment.

Our personnel are directed not to enter any excavation which;

1. is 5 feet or deeper unless shored or laid back,
2. exit points or ladders are not provided,
3. displays any evidence of instability, has any loose rock or other debris which could fall into the trench, or
4. displays any other evidence of any unsafe conditions regardless of depth.

If the contractor fails to provide safe access to trenches for compaction testing, our company policy requires that the soil technician withdraws and notifies their supervisor. The contractors representative will then be contacted in an effort to effect a solution. All backfill not tested due to safety concerns or other reasons is subject to reprocessing and/or removal.

Procedures

In the event that the technician's safety is jeopardized or compromised as a result of the contractor's failure to comply with any of the above, the technician is directed to inform both the developer's and contractor's representatives. If the condition is not rectified, the technician is required, by company policy, to immediately withdraw and notify their supervisor. The contractor's representative will then be contacted in an effort to effect a solution. No further testing will be performed until the situation is rectified. Any fill placed in the interim can be considered unacceptable and subject to reprocessing, recompaction or removal.

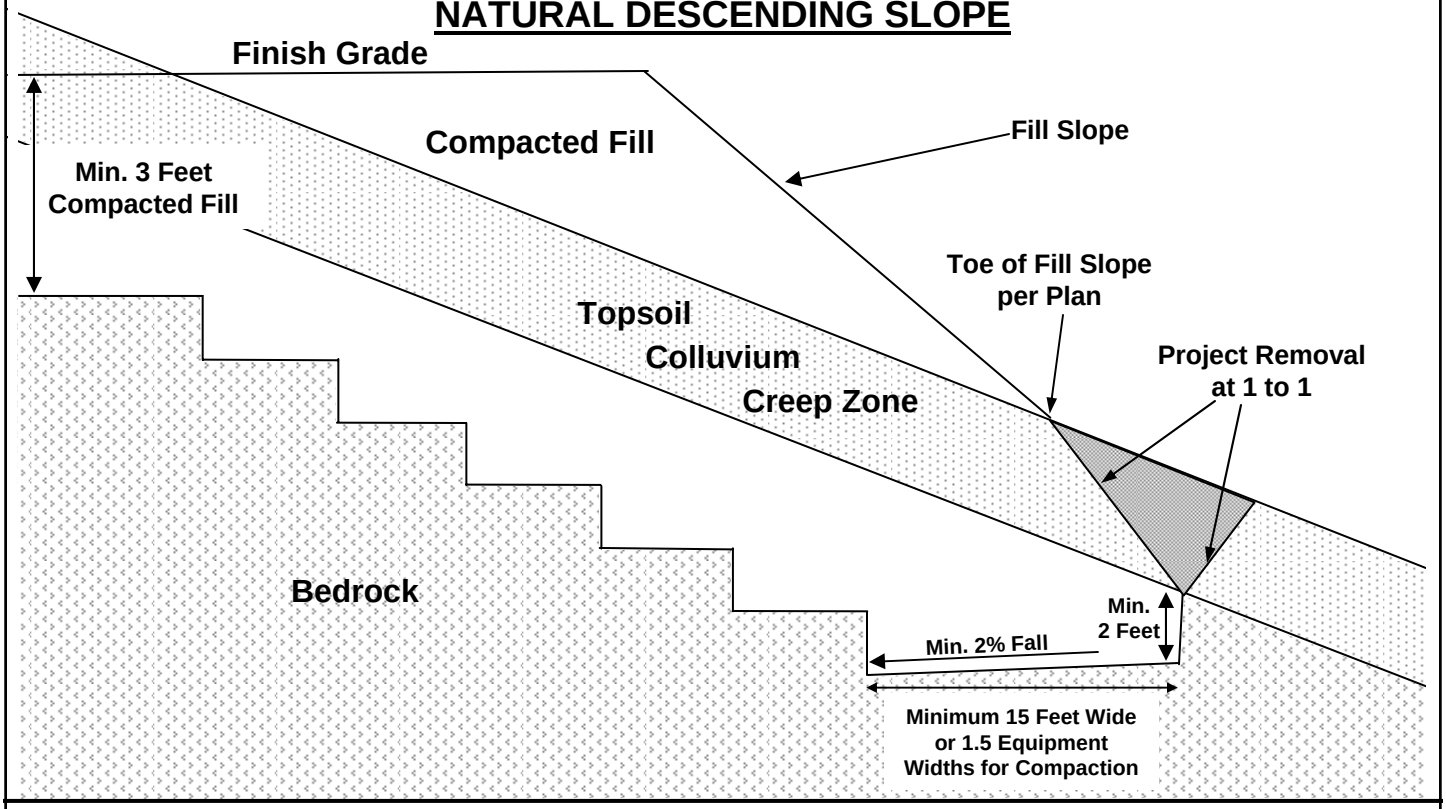
In the event that the soil technician does not comply with the above or other established safety guidelines, we request that the contractor bring this to technicians attention and notify our project

manager or office. Effective communication and coordination between the contractors' representative and the field technician(s) is strongly encouraged in order to implement the above safety program and safety in general.

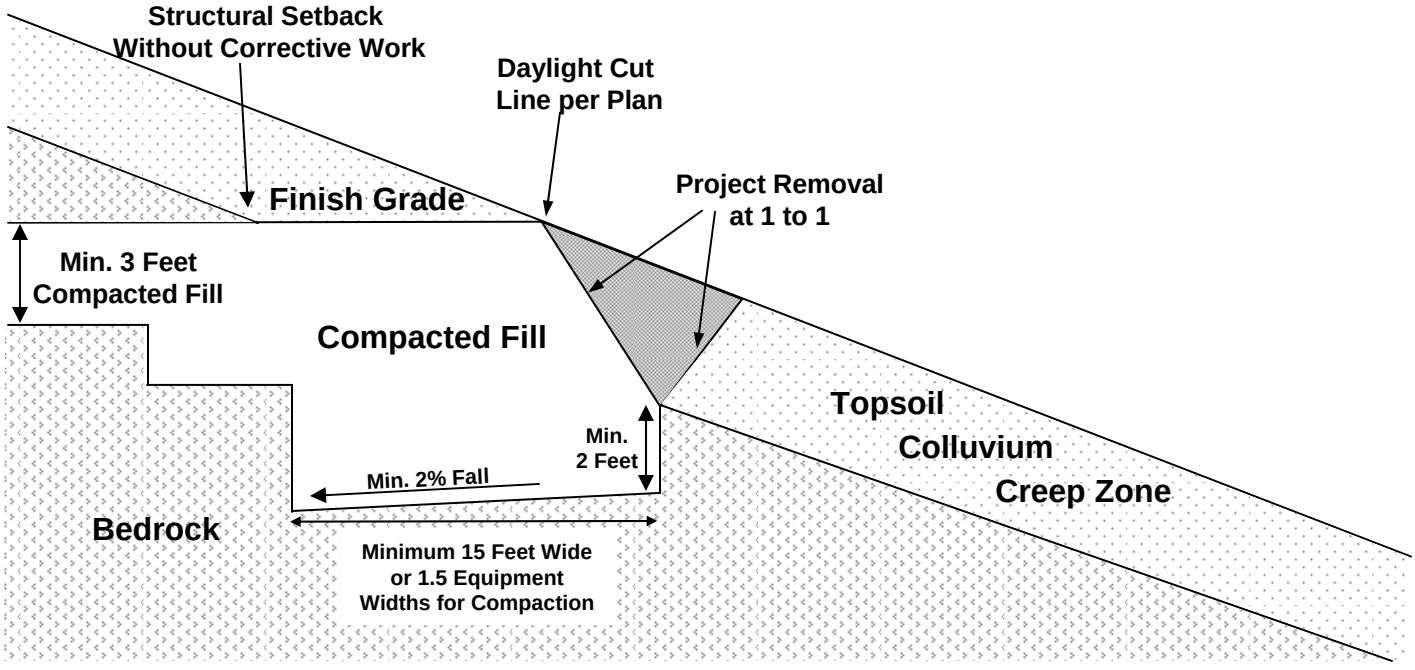
The safety procedures outlined above should be discussed at the contractor's safety meetings. This will serve to inform and remind equipment operators of these safety procedures particularly the zone of non-encroachment.

The safety procedures outlined above should be discussed at the contractor's safety meetings. This will serve to inform and remind equipment operators of these safety procedures particularly the zone of non-encroachment.

TYPICAL FILL SLOPE OVER NATURAL DESCENDING SLOPE



DAYLIGHT CUT AREA OVER NATURAL DESCENDING SLOPE



GEOTEK
1548 North Maple Street
Corona, California 92880

TREATMENT ABOVE NATURAL SLOPES

STANDARD GRADING GUIDELINES

PLATE E-1