FUSCOE
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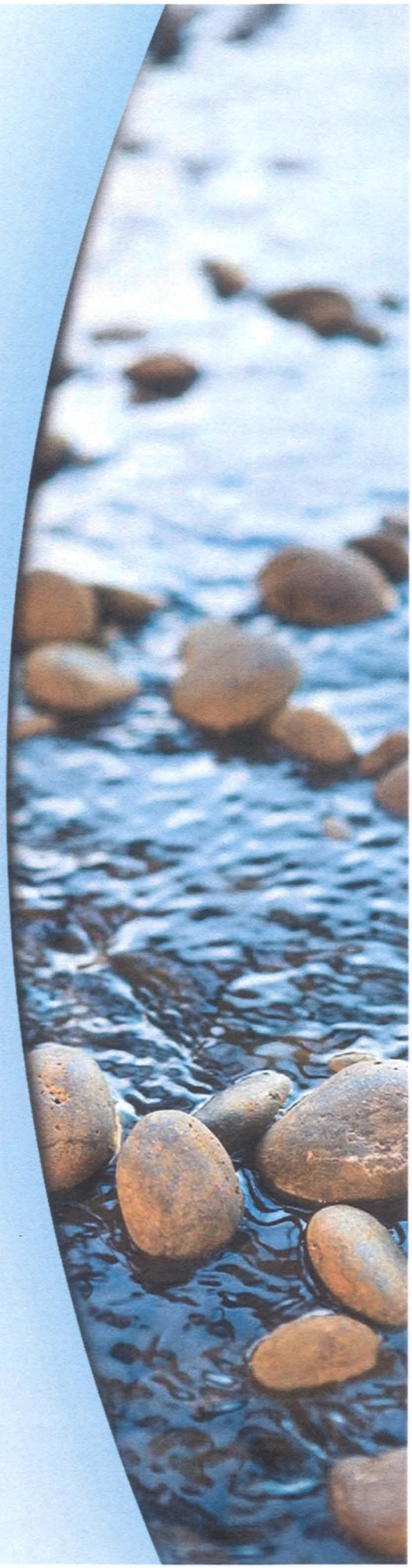
PRELIMINARY
WATER QUALITY MANAGEMENT PLAN (PWQMP)

TOWN CENTRE

TTM 17446

Lake Forest, California



Prepared For

BROOKFIELD RESIDENTIAL
3090 Bristol Street, Suite 200
Costa Mesa, CA 92626

Prepared By

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Date Prepared: January 31, 2012
Date Revised: April 6, 2012
2nd Revision: June 11, 2012
3rd Revision: July 23, 2012
Job Number: 308.44.01

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PRELIMINARY WATER QUALITY MANAGEMENT PLAN (PWQMP)

TOWN CENTRE

TTM 17446

July 23, 2012

308.44.01

PRELIMINARY WATER QUALITY MANAGEMENT PLAN (PWQMP)

TOWN CENTRE

City of Lake Forest, County of Orange

71 AUTO CENTER DRIVE, FOOTHILL RANCH, CA 92610
APN 612-161-11 & 612-161-12

Prepared for:

BROOKFIELD RESIDENTIAL
3090 Bristol Street, Suite 200
Costa Mesa, CA 92626
714.427.6868

Prepared by:

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Date Prepared: January 31, 2012
Date Revised: April 6, 2012
2nd Revision: June 11, 2012
3rd Revision: July 23, 2012

PROJECT OWNER'S CERTIFICATION			
Permit/Application No.:	Pending	**Grading Permit No.:**	Pending
Tract/Parcel Map and Lot(s)No.:	TTM 17446	**Building Permit No.:**	Pending
Address of Project Site and APN:	71 Auto Center Drive, Foothill Ranch, CA 92610 612-161-11 & 612-161-12		

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

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

OWNER:	BrookCal LF LLC
Name:	Craig Cristina
Title:	Director of Land Entitlement
Company:	Brookfield Residential
Address:	3090 Bristol Street, Ste 220, Costa Mesa, 92626
Email:	Craig.Cristina@BrookfieldRP.com
Telephone:	714-200-1605
Signature:	Date: 4-9-12

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Section I

SECTION 1 DISCRETIONARY PERMITS AND WATER QUALITY CONDITIONS

PROJECT INFORMATION			
Permit/Application No.:	GPA 2-12-2395 ZC 2-12-2394 SDP 2-12-2396	**Tract/Parcel Map No.:**	TTM 17446
Address of Project Site and APN:	71 Auto Center Drive, Foothill Ranch, CA 92610 612-161-11 & 612-161-12		
WATER QUALITY CONDITIONS			
Water Quality Conditions:	Pending Issuance – to be provided in the final WQMP.		
WATERSHED-BASED PLAN CONDITIONS			
Applicable conditions from watershed - based plans including WIHMPs and TMDLS:	The San Diego Creek / Newport Bay Watershed, of which this project site is a part of, has developed TMDLs for the following constituents: 1) Sediment/Siltation; 2) Nutrients; 3) Toxics (pesticides and metals); and 4) Fecal Coliform		

Section II

SECTION II PROJECT DESCRIPTION

II.1 PROJECT DESCRIPTION

The Town Centre project site encompasses approximately 9.08 acres in the City of Lake Forest. The project site is bounded by Portola Parkway to the northeast, Bake Parkway to the northwest and Auto Center Drive to the east/southeast. A Vicinity Map is included in Section VI.

The project site consists of two parcels. The northern portion of the site is currently developed with a former car dealership while the southern portion is currently vacant land with minor vegetation and a few isolated piles of soil.

The proposed project includes the demolition of the existing dealership for the construction of a new multi-family residential development. The table below summarizes the proposed project.

<table>
<tr><th colspan="6">DESCRIPTION OF PROPOSED PROJECT</th></tr>
<tr><td>WQMP Development Category:</td><td colspan="5">8. All significant redevelopment projects, where significant redevelopment is defined as the addition or replacement of 5,000 or more square feet of impervious surface on an already developed site. Redevelopment does not include routine maintenance activities that are conducted to maintain original line and grade, hydraulic capacity, original purpose of the facility, or emergency redevelopment activity required to protect public health and safety.</td></tr>
<tr><td>Project Area (ft^2):</td><td colspan="5">395,318 ft^2 (9.08 ac)</td></tr>
<tr><td># of Dwelling Units:</td><td colspan="5">151</td></tr>
<tr><td>SIC Code:</td><td colspan="5">Not applicable.</td></tr>
<tr><td>Narrative Project Description:</td><td colspan="5">The proposed project includes the demolition of the existing dealership for the construction of 151 motorcourt condominium units within 11 buildings. An additional recreational center with pool is also proposed. Parking will be provided on-site in the form of residential garages (279 spaces) and as surface spaces along the proposed street (76 spaces). Landscaping will be located surrounding the residential units, along the proposed street and around the proposed recreational area. Approximately 2.46 acres will be landscaped.</td></tr>
<tr><td rowspan="10">Residential Details</td><td>Plan Type</td><td># of Units</td><td>Bed/Bath</td><td>Unit Square Footage (±)</td><td>Total Square Footage (±)</td></tr>
<tr><td>1</td><td>21</td><td>1BR/1.5BA</td><td>763</td><td>16,023</td></tr>
<tr><td>2</td><td>22</td><td>2BR/2BA</td><td>1,081</td><td>23,782</td></tr>
<tr><td>3</td><td>21</td><td>2BR/2BA</td><td>1,256</td><td>26,376</td></tr>
<tr><td>3x</td><td>22</td><td>2BR/2BA</td><td>1,287</td><td>28,314</td></tr>
<tr><td>4</td><td>21</td><td>3BR/2BA</td><td>1,577</td><td>33,117</td></tr>
<tr><td>5</td><td>22</td><td>3BR/2.5BA</td><td>1,730</td><td>38,060</td></tr>
<tr><td>6</td><td>22</td><td>3BR/2BA</td><td>1,747</td><td>38,434</td></tr>
<tr><td>Total</td><td>151</td><td>--</td><td>--</td><td>204,106</td></tr>
</table>

Project Features	No specific site features of water quality concern are currently planned for the project site. The site is not anticipated to have any outdoor trash enclosures, loading docks, outdoor storage area, wash areas, or food preparation areas associated with food service establishments.			
Project Area:	**Pervious Area (ac or ft²)**	**Pervious Area Percentage**	**Impervious Area (ac or ft²)**	**Impervious Area Percentage**
Pre-Project Conditions:	4.09 ac	45%	4.99 ac	55%
Post-Project Conditions:	2.46 ac	14%	6.62 ac	73%
Drainage Patterns/ Connections:	Under existing conditions, the majority of runoff from the site drains to an existing 30" RCP storm drain pipe located south west and adjacent to the existing wall separating the existing dealership center from the adjacent vacant area of the project site. Under proposed conditions, new storm drains will be constructed on-site to collect runoff from the proposed residential units and streets. The new storm drain will drain to the existing 30" line at Bake Parkway.			

II.2 POTENTIAL STORM WATER POLLUTANTS

The table below, derived from Table 2 of the Countywide Model WQMP Technical Guidance Document (May 2011), summarizes the categories of land use or project features of concern and the general pollutant categories associated with them.

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

ANTICIPATED & POTENTIAL POLLUTANTS GENERATED BY LAND USE TYPE								
Priority Project Categories and/or Project Features	General Pollutant Categories							
	Suspended Solid/ Sediments	Nutrients	Heavy Metals	Pathogens (Bacteria/ Virus)	Pesticides	Oil & Grease	Toxic Organic Compounds	Trash & Debris
Streets, Highways, & Freeways	E	E(1)	E	E(4)	E(1)	E	E	E
Retail Gasoline Outlets	N	N	E	N	N	E	E	E

Notes:
E = expected to be of concern N = not expected to be of concern
(1) Expected pollutant if landscaping exists on-site, otherwise not expected.
(2) Expected pollutant if the project includes uncovered parking areas, otherwise not expected.
(3) Expected pollutant if land use involves food or animal waste products, otherwise not expected.
(4) Bacterial indicators are routinely detected in pavement runoff.
(5) Expected if outdoor storage or metal roofs, otherwise not expected.
Source: County of Orange. (2011, May 19). Technical Guidance Document for the Preparation of Conceptual/ Preliminary and/or Project Water Quality Management Plans (WQMPs). Table 2.1.

POLLUTANTS OF CONCERN		
Pollutant	E = Expected to be of concern N =Not Expected to be of concern	Additional Information and Comments
Suspended Solid/ Sediment	E	*San Diego Creek Watershed TMDL*
Nutrients	E	*San Diego Creek Watershed TMDL*
Heavy Metals	E	*San Diego Creek Watershed TMDL*
Pathogens (Bacteria/Virus)	E	*San Diego Creek Watershed TMDL*
Pesticides	E	*San Diego Creek Watershed TMDL*
Oil & Grease	E	
Toxic Organic Compounds	E	
Trash & Debris	E	

The project's primary pollutants of concern are sediment, nutrients, pesticides, metals and pathogens, as they are both an expected pollutant and also a pollutant with a TMDL established for the San Diego Creek/Newport Bay Watershed.

II.3 HYDROLOGIC CONDITIONS OF CONCERN

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

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

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

or

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

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

Is the proposed project potentially susceptible to hydromodification impacts?

☒ **Yes** ☐ **No (show map)**

Based on the 2011 Technical Guidance Document (TGD), the project site is located in an areas susceptible to hydromodification within the San Diego Creek Watershed (Figure XVI-3d, see Appendix A). In order to quantify the HCOC potential, the 2-year, 24-hour storm was evaluated for the existing and proposed project.

2-YEAR, 24-HOUR STORM SUMMARY				
Condition	**Acreage**	**Tc**	**Peak Runoff**	**Volume**
Pre-development	9.38 ac	8.5 min	13.75 cfs	0.90 ac-ft
Proposed	9.46 ac	11.03 min	11.91 cfs	1.15 ac-ft
Increase	**+ 0.08 ac**	**+ 2.53 min**	**– 1.84 cfs**	**0.25 ac-ft**
% Increase	**0.8%**	**30%**	**13% Reduction**	**28%**

The results indicate the 2-year time of concentration (Tc) increases by 30% as compared to existing conditions; however the TGD recognizes that increases in Tc are acceptable, as a longer Tc is generally associated with natural conditions and nearly universally results in lower concerns for hydromodification impacts (TGD, Section 2.2.3.1, footnote 4). The results also indicate that the change in volume increases by 28% as compared to the existing conditions. Due to the existing soil constraints (see Section III.2), infiltration of the increase in volume is not feasible, and reuse demands are not sufficient to draw down the volume within 48 hours. Therefore, as stated in the 4th Term Storm Water Permit, "In cases where the excess volume cannot be infiltrated or captured and reused, discharge from the site must be limited to a flow rate no greater than 110% of the pre-development 2-year peak flow." (Section XII.D.4) The 2-year peak flow rate reduces by 13% as compared to existing conditions, which is consistent with the Fourth Term MS4 permit. Therefore, the project complies with the hydromodification requirements and allowable discharge provisions. Calculations are provided in Appendix A.

II.4 POST DEVELOPMENT CHARACTERISTICS

New area drains and on-site storm drains will convey runoff from the project site, and connect to the existing public storm drain system in Bake Parkway (Bake Parkway Storm Drain, OCFCD Facility F19P06). Runoff is then conveyed south west along Bake Parkway, and outlets to the Los Alisos Channel (Facility F19S02) just upstream of Dimension. The Los Alisos Channel outlets to Serrano Creek (Facility F19), a tributary to the larger San Diego Creek (F05). San Diego Creek ultimately discharges to the Upper Newport Bay and Pacific Ocean. A map for the larger San Diego Creek watershed is included in Section VI.

II.5 PROPERTY OWNERSHIP/MANAGEMENT

PROPERTY OWNERSHIP/MANAGEMENT	
Public Streets:	City of Lake Forest
Private Streets:	Brookfield Residential / HOA
Landscaped Areas:	Brookfield Residential / HOA
Open Space:	None.
Easements:	City of Lake Forest – easements are described further in Section III.2 Ingress/egress, scenic easement, landscape easement Storm drain – to be quit-claimed Sewer & water to IRWD
Parks:	None.
Buildings:	Brookfield Residential / HOA
Structural BMPs:	Brookfield Residential / HOA

A Home Owners Association (HOA) will be formed upon project completion. The HOA will be responsible for inspecting and maintaining all BMPs prescribed for Town Centre. Until a HOA is formally established, Brookfield Residential shall assume all BMP maintenance and inspection responsibilities for the proposed project. Inspection and maintenance responsibilities are outlined in Section V of this report.

Section III

SECTION III SITE DESCRIPTION

III.1 PHYSICAL SETTING

Planning Area/ Community Name	Town Centre
Location/Address:	71 Auto Center Drive, Foothill Ranch, CA 92610
Project Area Description	Located south of the intersection of Bake Parkway and Portola Parkway along Auto Center Drive.
Land Use:	Existing: Commercial Proposed: Multi-Family Residential
Zoning:	PC-8 (Foothill Ranch Planned Community) Commercial
Acreage:	9.08 acres
Predominant Soil Type:	D

III.2 SITE CHARACTERISTICS

Precipitation Zone:	Design Storm Depth = 0.95 inches
Topography:	In general, the site is graded to drain to the southwest corner of the area. In the southern boundary of the site, a small descending slope with a toe-of-slope retaining wall is located adjacent to the existing commercial site. A descending variable slope is also located adjacent to Bake Parkway along the western boundary of the site. At the northern boundary of the site, an east-west trending berm currently exists, with a gentle gradient down to Portola Parkway at the north side and a steeper gradient down to the south side that has a small retaining wall at the toe.
Existing Drainage Patterns/Connections:	Under existing conditions, the majority of runoff from the site drains to an existing 30" RCP storm drain pipe located south west and adjacent to the existing wall separating the existing dealership center from the adjacent vacant area of the project site. The vacant portion of the project site has apparently been mass graded. It drains from the wall at the existing auto dealership on the north, southerly to the south corner of the site at Auto Center Drive and the existing retail site. It leaves the site and drains into a catch basin in Auto Center Drive near Towne Centre Drive connected to an 18" pipe.

Proposed Drainage Patterns/Connections:	Under proposed conditions, new storm drains will be constructed on-site to collect runoff from the proposed residential units and streets. The new storm drain will drain to the existing 30" line at Bake Parkway, which ultimately drains to the Los Alisos Channel and Serrano Creek located southeast of the project site.
Soil Type, Geology, and Infiltration Properties:	The western portions of the site consist generally of engineered fill placed during the grading activities for nearby Bake Parkway. The eastern/northeastern portion of the site generally consists as cut bedrock at the surface, with the exception of the placement of engineered fill for over-excavation of a cut to fill transition in support of the existing car dealership structure at the northeast portion of the site.
Hydrogeologic (Groundwater) Conditions:	Groundwater was not encountered during the geotechnical investigation.
Geotechnical Conditions (relevant to infiltration):	Infiltration testing was conducted on-site at three locations. The results show an average infiltration rate of 0.04 in/hr prior to applying a safety factor. After a safety factor of 3, the design infiltration rate is 0.014 in/hr, which is well below the minimum rate required for infiltration feasibility (0.3 in/hr). Infiltration of storm water runoff is considered infeasible. Further details are provided in Section IV.3.2.
Off-Site Drainage:	A proposed storm drain line will collect runoff from a portion of Auto Center Drive, and convey through the site to the existing 30" pipe on the north side of the vacant parcel.
Utility and Infrastructure Information/Easements:	Existing easements for scenic preservation, drainage and landscape maintenance run along and adjacent to the southerly side of Portola and along the easterly side of Bake Parkway. Additionally an easement for storm drain runs along the northeasterly property line of the vacant parcel, which provides for an existing 30" pipe that is connected to the main line in Bake Parkway. The easement then turns southwesterly parallel to Bake Parkway terminating approximately 200 feet from the southwesterly site boundary line. The existing storm drain easement will be quit-claimed under proposed conditions.

III.3 WATERSHED DESCRIPTION

Receiving Waters:	Serrano Creek, San Diego Creek Reach 2
303(d) Listed Impairments:	Per the 2010 List: ▪ Serrano Creek: ammonia (unionized), indicator bacteria, pH ▪ San Diego Creek Reach 2: indicator bacteria, nutrients, sedimentation/siltation, unknown toxicity ▪ San Diego Creek Reach 1: fecal coliform, nutrients, pesticides, sedimentation/siltation, selenium, toxaphene ▪ Upper Newport Bay: chlordane, copper, DDT, indicator bacteria, metals, nutrients, PCBs, pesticides, sediment toxicity, sedimentation/siltation ▪ Lower Newport Bay: chlordane, copper, DDT, indicator bacteria, nutrients, PCBs, pesticides, sediment toxicity
Applicable TMDLs:	The San Diego Creek / Newport Bay Watershed, of which this project site is a part of, has developed TMDLs for the following constituents: 1) Sediment/Siltation; 2) Nutrients; 3) Toxics (pesticides and metals); and 4) Fecal Coliform
Pollutants of Concern for the Project:	The project's primary pollutants of concern are sediment, nutrients, pesticides, metals and pathogens, as they are both an expected pollutant and also a pollutant with a TMDL established for the San Diego Creek/Newport Bay Watershed.
Environmentally Sensitive and Special Biological Significant Areas:	The project site is located within the larger San Diego Creek watershed, which is listed as impaired on the 303(d) list of impaired water bodies, and is designated as an Environmentally Sensitive Area (ESA) according to the OC DAMP. There are no Areas of Special Biological Significance (ASBS) within the project site.

Section IV

SECTION IV BEST MANAGEMENT PRACTICES (BMPs)

IV.1 PROJECT PERFORMANCE CRITERIA

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

☐ Yes ☒ No

PROJECT PERFORMANCE CRITERIA	
Hydromodification Control Performance Criteria (Model WQMP Section 7.II-2.4.2.2)	If a hydrologic condition of concern (HCOC) exists, priority projects shall implement onsite or regional hydromodification controls such that: ▪ Post-development runoff volume for the two-year frequency storm does not exceed that of the predevelopment condition by more than five percent, and ▪ Time of concentration of post-development runoff for the two-year storm event is not less than that for the predevelopment condition by more than five percent. Where the Project WQMP documents that excess runoff volume from the two-year runoff event cannot feasibly be retained and where in-stream controls cannot be used to otherwise mitigate HCOCs, the project shall implement on-site or regional hydromodification controls to: ▪ Retain the excess volume from the two-year runoff event to the MEP, and ▪ Implement on-site or regional hydromodification controls such that the post-development runoff two-year peak flow rate is no greater than 110 percent of the predevelopment runoff two-year peak flow rate.
LID Performance Criteria (Model WQMP Section 7.II-2.4.3)	Infiltrate, harvest and use, evapotranspire, or biotreat/biofilter, the 85th percentile, 24-hour storm event (Design Capture Volume). LID BMPs must be designed to retain, on-site, (infiltrate, harvest and use, or evapotranspire) storm water runoff up to 80 percent average annual capture efficiency
Treatment Control BMP Performance Criteria (Model WQMP Section 7.II-3.2.2)	If it is not feasible to meet LID performance criteria through retention and/or biotreatment provided on-site or at a sub-regional/regional scale, then treatment control BMPs shall be provided on-site or offsite prior to discharge to waters of the US. Sizing of treatment control BMP(s) shall be based on either the unmet volume after claiming applicable water quality credits, if appropriate.
LID Design Storm Capture Volume	8.2 acres, ~86% impervious (per hydrology map) DCV = 22,538.7 ft^3 *Note: DCV is greater than HCOC volume*

IV.2 SITE DESIGN AND DRAINAGE PLAN

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

IV.2.1 Site Design BMPs

Minimize Impervious Area

The project will increase impervious surfaces as compared to existing conditions. However, landscaping will be provided throughout the site within the common areas as well as around the perimeter of the building.

Maximize Natural Infiltration Capacity

Due to presence of Type D soils and high depths to groundwater, infiltration is not recommended on-site.

Preserve Existing Drainage Patterns and Time of Concentration

Runoff will continue to flow to the existing storm drain along Bake Parkway as under existing conditions. Time of Concentrations will not decrease (shorten) as compared to existing conditions.

Disconnect Impervious Areas

Landscaping will be provided adjacent to sidewalks and between the proposed buildings. Low-flows and first-flush runoff will drain to bioretention units for water quality treatment.

Protect Existing Vegetation and Sensitive Areas, and Revegetate Disturbed Areas

Under existing conditions, approximately half of the site is developed, and the remaining half of the site exists as a previously graded lot and there are no natural areas to conserve. All disturbed areas will either be paved or landscaped.

Xeriscape Landscaping

Native and/or tolerant landscaping will be incorporated into the site design consistent with City guidelines.

IV.2.2 Drainage Management Areas

In accordance with the MS4 permit and the new Model WQMP, the Design Capture Volumes (DCVs) presented in the following table represent the minimum volume of storm water runoff required to be treated by LID and/or treatment control BMPs for the proposed project. The total DCV noted in the table represents the treatment requirement for all of the development areas. Preliminary footprints and depths required by each BMP are summarized in the following sections. Detailed calculations are provided in Appendix A. Final design and calculations will be identified and documented during project Final WQMP development.

DRAINAGE MANAGEMENT AREAS								
Drainage Area Name	Drainage Area (acres)	% impervious	Runoff Coefficient	Design Storm Depth (in)	Average 2-year Tc (min)	Rainfall Intensity (in/hr)	DCV (ft^3)	Q (cfs)
A1+A2 (Filterra #1)	1.59	90%	0.83	0.95	9.11	0.23	4,531.8	0.30
A3 (Filterra #2)	1.12	80%	0.75	0.95	9.21	0.23	2,902.5	0.19
A4 (Filterra #3)	1.65	85%	0.79	0.95	9.7	0.225	4,489.4	0.29
A6 (Filterra #4)	1.29	90%	0.83	0.95	10	0.225	3,676.7	0.24
A5 North (Filterra #5)	1.25	85%	0.79	0.95	10	0.225	3,401.1	0.22
A5 South (Filterra #6)	1.30	85%	0.79	0.95	9	0.23	3,537.1	0.24
Total	**8.20**	**86.07%**	**0.80**	**0.95**	**9.5**	**0.225**	**22,538.7**	**1.47**

Notes:
1. Per Figure XVI-1 of the Model WQMP Technical Guidance Document (2011, May 19). See also Appendix A.
2. Per Figure III.4 of the Model WQMP Technical Guidance Document (2011, May 19). See also Appendix A.

IV.3 LID BMP SELECTION AND PROJECT CONFORMANCE ANALYSIS

Low Impact Development (LID) BMPs are required in addition to site design measures and source controls to reduce pollutants in storm water discharges. LID BMPs are engineered facilities that are designed to retain or biotreat runoff on the project site. The 4th Term MS4 Storm Water Permit (Order R9-2009-0009) requires the evaluation and use of LID features using the following hierarchy of treatment: infiltration, evapotranspiration, harvest/reuse, and biotreatment. The following sections summarize the LID BMPs proposed for the project in accordance with the permit hierarchy and performance criteria outlined in Section IV.1.

IV.3.1 Hydrologic Source Controls (HSCs)

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

HYDROLOGIC SOURCE CONTROLS		
ID	Name	Included?
HSC-1	Localized on-lot infiltration	☐
HSC-2	Impervious area dispersion (e.g. roof top disconnection)	☒

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

The project will utilize hydrologic source controls (impervious area dispersion) throughout the site with disconnected downspouts and sidewalks draining to adjacent landscaping. At this time, however, HSCs were not accounted for during design of downstream BMPs for a conservative sizing approach. HSC's will be accounted for during final design and the cumulative volume of the HSC's will be subtracted from the required treatment volume in the Final WQMP.

In addition, two rain gardens (bioretention cells) will be located in the northeast portion of the site to capture and treat a portion of runoff prior to discharging into downstream BMPs. These rain gardens will function similar to bioretention cells with underdrains as well as HSCs, and are sized in accordance with the Model WQMP TGD. Refer to Section IV.3.4 for details on the sizing of the proposed rain gardens in combination with biotreatment BMPs.

IV.3.2 Infiltration BMPs

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

INFILTRATION		
ID	**Name**	**Included?**
INF-3 INF-4	Bioretention Without Underdrains	☐
	Rain Gardens	☐
	Porous Landscaping	☐
	Infiltration Planters	☐
	Retention Swales	☐
INF-2	Infiltration Trenches	☐

INFILTRATION		
ID	**Name**	**Included?**
INF-1	Infiltration Basins	☐
INF-5	Drywells	☐
INF-7	Subsurface Infiltration Galleries	☐
--	French Drains	☐
INF-6	Permeable Asphalt	☐
	Permeable Concrete	☐
	Permeable Concrete Pavers	☐
	Other:	☐

A geotechnical study with infiltration testing was conducted for the project site. Soils on-site generally consist of engineered fill in the western portion, and cut bedrock with some fill in the eastern/ northeastern portions of the site. The infiltration testing conducted utilized three hollow-stem auger borings that were drilled to depths of approximately 16 feet below ground surface. The results of the testing indicated very low infiltration rates, and the geotechnical engineer recommended a design infiltration rate of 0.014 inches per hour after applying a safety factor of 3 (per Worksheet H, see Appendix A).

The Model WQMP TGD, Section 2.4.2.4 requires a minimum measured infiltration rate after applying safety factors of 0.3 inches per hour to be considered feasible. Since the design rate provided by the geotechnical engineer for infiltration is less than 0.3 in/hr, infiltration of the entire DCV is not recommended for the project. A copy of the geotechnical study with infiltration testing results is included as Appendix F. Feasibility worksheets for infiltration are included in Appendix A.

IV.3.3 Evapotranspiration, Rainwater Harvesting BMPs

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

EVAPOTRANSPIRATION		
ID	**Name**	**Included?**
--	HSCs, *see Section IV.3.1*	☒
--	Surface-based infiltration BMPs	☐
--	Biotreatment BMPs, see *Section VI.3.4*	☒
	Other:	☐

Bioretention BMPs are proposed which utilize evapotranspiration as physical process for runoff volume reduction. Bioretention BMPs are described further in Section IV.3.4.

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

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

In order to quantify harvested water irrigation demand for the common areas of the project, the Modified Estimated Applied Water Use (EAWU) method was used, consistent with Appendix X of the Model WQMP's Technical Guidance Document (TGD), dated May 19, 2011.

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

The equation used to calculate the Modified EAWU is:

$$Modified\ EAWU = \frac{(ETo_{wet} \times K_L \times LA \times 0.015)}{IE}$$

Where:

$Modified\ EAWU$ = estimated daily average water use during wet season

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

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

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

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

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

The following table summarizes the estimated applied water use for the common area landscaping of the project. Although specific irrigated areas and landscaping types are not available at this time, assumptions can be made based on similar product types and associated landscaping irrigation demands. For the purposes of this analysis, landscaping was assumed to consist of 50% turf and 50% conservation-type landscaping.

ESTIMATED APPLIED WATER USE (EAWU) FOR COMMON AREA LANDSCAPING										
Landscape Type	Total Area (ac)	% Impervious	Impervious Tributary (ac)	Irrigated LS Area (sf)	ETo_{Wet} [1] (in/mo)	K_L [2]	Modified EAWU (gpd)	Modified EAWU per impervious acre (gpd/ac)	Minimum Capture Threshold [3] (gpd/ac)	Meet Minimum Feasibility Threshold?
Mix of Turf & Conservation Landscaping Types	8.2	86%	7.06	1.14	3.0	0.55	1,368.3	193.9	770	No
Design Capture Volume (gal)				168,584	**Drawdown (days)**				123.2	No

Notes:
1 Per Table X.2 for Irvine Region (similar climate type), Model WQMP Technical Guidance Document, dated May 19, 2011.
2 Per Table X.4 of the Model WQMP Technical Guidance Document, dated May 19, 2011.
3 Per Table X.6 of Model WQMP Technical Guidance Document, dated May 19, 2011.

Based on the results of the minimum threshold analysis, harvest and use for landscaping is not considered feasible, as the irrigation demand is insufficient to meet the minimum harvest demand threshold. The captured DCV would not be able to drawdown in 30 days required for feasibility. Similarly, the resultant irrigated area to tributary impervious area is below the minimum threshold for capture feasibility.

IV.3.4 Biotreatment BMPs

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

BIOTREATMENT		
ID	Name	Included?
BIO-1	Bioretention with underdrains	☒
	Storm Water planter boxes with underdrains	☐
	Rain gardens with underdrains	☐
BIO-5	Constructed wetlands	☐
BIO-2	Vegetated swales	☐

BIOTREATMENT		
ID	Name	Included?
BIO-3	Vegetated filter strips	☐
BIO-7	Proprietary vegetated biotreatment systems	☒
BIO-4	Wet extended detention basin	☐
BIO-6	Dry extended detention basins	☐
--	Other:	☐

Since both infiltration and harvest and reuse are considered infeasible, biotreatment BMPs will be utilized on-site for water quality treatment. Proprietary biotreatment units (Filterra@ or equivalent) were selected for use on-site due to the limited amount of landscaping between the buildings and required setbacks. These systems were selected based on their ability to treat the project's pollutants of concerns to a medium or high effectiveness, in accordance with Table 4.2 of the Model WQMP Technical Guidance Document.

Table4.2 Relative Treatment Performance Ratings of Biotreatment BMPs

Unit Operations and Process	Assumed Principal Unit Operations and Processes Provided	Suspended solids / sediment/ turbidity	Nitrogen compounds	Phosphorus	Heavy metals	Microbial / viral pathogens	Oils and grease	Dissolved toxic organic compounds	Trash and debris
Bioretention system	• Particulate Settling • Size Exclusion • Inert Media Filtration • Sorption/Ion Exchange • Microbial Competition/Predation • Biological Uptake • Volume loss (via infiltration, ET)	H	L	L	H	M	H	M	H
Bioretention system with internal water storage zone and nutrient sensitive media design	Bioretention UOPs, plus: • Microbially Mediated Transformations (if designed with internal water storage zone)	H	M	M	H	M	H	M	H
Dry extended detention basin	• Particulate Settling • Size Exclusion • Floatable Capture • Vegetative Filtration (with low-flow channel) • Volume loss (via infiltration, ET)	M	L	M	M	L	M	L	H
Dry extended detention basin with vegetated sand filter outlet structure	Dry extended detention basin UOPs, plus: • Inert Media Filtration	H	L	M	M	M	M	L	H
Vegetated Swale	• Vegetative Filtration • Sorption/Ion Exchange • Volume loss (via infiltration, ET)	M	L	L	M	L	M	M	M
Vegetated Filter Strip	• Vegetative Filtration • Sorption/Ion Exchange • Volume loss (via infiltration, ET)	M	L	L	M	L	M	M	L
Wet detention basins and constructed stormwater wetlands	• Particulate Settling • Size Exclusion • Floatable Capture • Sorption/Ion Exchange • Microbially Mediated Transformations • Microbial Competition/Predation • Biological Uptake • Solar Irradiation • Volume loss (via infiltration, ET)	H	M	M	M	M	H	M	H
Proprietary Biotreatment and Treatment Control	• Varies by product.	Expected performance should be based on evaluation of unit processes provided by BMP and available testing data. Testing data should be evaluated based primarily on the effluent quality achieved by the BMP and the ability of the BMP to provide statistically significant removal under average conditions. Percent removal alone should not be used to evaluate the performance of proprietary BMPs (See Wright Water Engineers and Geosyntec Consultants, 2007). The basis for determining the rating of proposed proprietary BMPs must be documented in the Project WQMP. Approval is based on the discretion of the reviewing agency. Product-specific rankings may be published in the Technical Guidance Document at a later date.							

Sources

Strecker, E.W ., W.C Huber, J.P. Heaney, D. Bodine, J.J. Sansalone, M.M. Quigley, D. Pankani, M. Leisenring, and P. Thayumanavan, "Critical assessment of Stormwater Treatment and Control Selection Issues." Water Environment Research Federation, Report No. 02-SW-1. ISBN 1-84339-741-2. 290pp

International Stormwater Best Management Practices (BMP) Database Pollutant Category Summary: Bacteria. http://www.bmpdatabase.org/Docs/BMP%20Database%20Bacteria%20Paper%20Dec%202010.pdf

International Stormwater Best Management Practices (BMP) Database Pollutant Category Summary: Nutrients. http://www.bmpdatabase.org/Docs/BMP%20Database%20Nutrients%20Paper%20December%202010%20Final.pdf

International Stormwater Best Management Practices (BMP) Database Pollutant Category Summary: Sediment (Pre-publication).

Overview of Performance by BMP Category and Common Pollutant Type, International Stormwater Best Management Practices (BMP) Database [1998-2008] http://www.bmpdatabase.org/Docs/Performance%20Summary%20Cut%20Sheet%20June%202008.pdf

Oil and grease, Organics, and Trash and Debris based on review of unit operations and processes; comprehensive dataset not generally available. BMP must include design elements to address pollutants of concern.

Wright Water Engineers and Geosyntec Consultants, 2007. *Frequently Asked Questions Fact Sheet for the International Stormwater BMP Database: Why does the International Stormwater BMP Database Project omit percent removal as a measure of BMP performance?* (as posted on www.bmpdatabase.org)]

POLLUTANTS OF CONCERN AND PERFORMANCE RATINGS		
Pollutant of Concern [1]	Treatment Effectiveness	
	Bioretention System [2]	Filterra® Proprietary Bioretention Units [3]
Oil & Grease	High	High
Trash & Debris	High	N/A
Primary Pollutant of Concern		
Metals	High	High
Bacteria	Medium	High[4]
Suspended Solids/Sediments	High	High
Pathogens/Bacteria	Medium	High[4]
Nutrients	Low	High
Pesticides	N/A	N/A

1 See Section II.2 of this WQMP.
2 Per Table 4.2 of the Model WQMP Technical Guidance Document dated May 19, 2011.
3 Designated as "high" if tested effluent concentrations were reduced based on significance level $p<0.05$. Source: Herrera Environmental Consultants and Geosyntec Consultants. (2010, September 20). Filterra® Bioretention Systems: Technical Basis for High Flow Rate Treatment and Evaluation of Stormwater Quality Performance.
4 When used with Bacterra® blend media. Coffman, L.S., and Ruby. M. (n.d.) Bacterra™ by Filterra® Advanced Bioretention System Discussion of the Benefits, Mechanisms and Efficiencies for Bacteria Removal.

Filterra® units by Americast are structural media filtration device that also utilize bioretention processes for storm water treatment (functional equivalents are also acceptable). Filterra units feature a specially designed media filter mixture within a below-grade concrete box. One tree or large shrub is planted within the media to provide additional pollutant removal, and function similar to bioretention cells. The filter media is designed to capture and filter pollutants during the first-flush storm event, while biological processes degrade, metabolize, detoxify, and volatilize the pollutants during and between storms. Runoff enters the units through curb flow or area drains may be piped into the top of the unit. The adjacent catch basin serves as the high flow bypass, and also accepts treated flows from the unit.

The Filterra bioretention BMP blend is currently designed to remove typical stormwater pollutants such as TSS, phosphorus, nitrogen and heavy metals. Through extensive studies Bacterra media blend has been optimized to capture and destroy bacteria such as fecal coliform, E.coli and enterococcus. Once the Bacterra media blend has matured it develops a complex natural microbological ecosystem that enhances predation, and other physical, chemical and biological processes that all contribute to the removal process, achieving removal efficiencies ranging from 77% to 99%.

For the northeastern-most drainage area, rain gardens are proposed to be utilized in combination with Fitlerra units, functioning similar to HSCs. Rain gardens are a form of bioretention cells with underdrains, and are plant-based biotreatment systems that typically consist of a ponding area, mulch layer, planting soils and plants. As storm water passes down through the planting soil, pollutants are filtered, adsorbed, biodegrated and sequestered by the soil and plants. Perforated underdrains may be provided for soils with low infiltration rates to discharge treated water back into the storm drain system.

In accordance with the Model WQMP, the bioretention/biofiltration BMPs will be sized to capture and treat the volume of runoff produced from a 24-hour, 85th percentile storm event (termed Design Capture Volume [DCV]). The DCV is determined by the following equation:

$$DCV = C \times d \times A \times 43{,}560 \frac{sf}{ac} \times \frac{1}{12} ft/in$$

Where:

DCV = runoff volume during the design storm event (cubic feet)
C = runoff coefficient, where $C = (0.75 \times imp + 0.15)$
imp = impervious fraction of drainage area
d = design capture storm depth per Figure XVI-1 of the Model WQMP
A = tributary area (acres)

To calculate a flow rate (Q) associated with a water quality design storm intensity:

$$Q = C \times i_{design} \times A$$

Where:

Q= design flow rate (cfs)
C = runoff coefficient, where $C = (0.75 \times imp + 0.15)$
imp = impervious fraction of drainage area
i_{design} = design intensity based on time of concentration (Tc) per Model WQMP Figure III.4
A = tributary area (acres)

Preliminary sizes for the Filterra units are summarized below. Final designs will be detailed in the Final WQMP. Maintenance requirements and frequencies for the LID BMPs are discussed in Section V (BMP Inspection & Maintenance) of this report.

FILTERRA UNIT BMP DESIGN SUMMARY[1]

Drainage Area Name	Drainage Area (acres)	% Impervious	Design Storm Depth (in)	Average 2-year Tc (min)	Rainfall Intensity (in/hr)	DCV (ft^3)	Q (cfs)	Filterra Unit Sizes
A3 (Filterra #2)	1.12	80%	0.95	9.21	0.23	2,902.5	0.19	2 units 6'x8'
A4 (Filterra #3)	1.65	85%	0.95	9.7	0.225	4,489.4	0.29	2 units 6'x12'
A6 (Filterra #4)	1.29	90%	0.95	10	0.225	3,676.7	0.24	2 units 6'x10'
A5 North (Filterra #5)	1.25	85%	0.95	10	0.225	3,401.1	0.22	2 units 6'x8'
A5 South (Filterra #6)	1.30	85%	0.95	9	0.23	3,537.1	0.24	2 units 6'x10'

Notes:
1. Detailed calculations and worksheets are provided in Appendix A.
2. Per Figure XVI-1 of the Model WQMP Technical Guidance Document (2011, May 19). See also Appendix A.
3. Per Figure III.4 of the Model WQMP Technical Guidance Document (2011, May 19). See also Appendix A.

For the northeastern-most drainage area (Areas A1 & A2), the Capture Efficiency, Constant Drawdown BMP sizing methodology was utilized in accordance with the Model WQMP TGD Appendix III to achieve the target capture efficiency of 80%.

RAIN GARDEN BMP SIZING SUMMARY[1] (80% CAPTURE METHOD)										
Drainage Area Name	Drainage Area (ac)	% Impervious	Design Storm Depth[2] (in)	Average 2-year Tc (min)	Intensity[3] (in/hr)	DCV (ft^3)	Q_{Treat} (cfs)	BMP Type/Size	Capture Efficiency	Combined Capture Efficiency
A1+A2	1.59	90%	0.95	9.11	0.23	4,531.8	0.3	Rain Garden 370 ft^3	40%	80%
					0.17	4,531.8	0.22	Filterra 2 units 6'x8'	--	

Notes:
1. Detailed calculations and worksheets are provided in Appendix A.
2. Per Figure XVI-1 of the Model WQMP Technical Guidance Document (2011, May 19). See also Appendix A.
3. Per Figure III.4 of the Model WQMP Technical Guidance Document (2011, May 19). See also Appendix A.

IV.3.5 Hydromodification Control BMPs

As identified in Section II.3, the 2-year volume does not increase by more than 5% as compared to existing conditions, the time of concentration does not reduce (get shorter) and the 2-year peak discharge rate falls under the allowable discharge rate (110% of pre-development rate). The Project therefore complies with the hydromodification requirements and allowable discharge provision. No additional hydromodification control BMPs are required.

IV.3.6 Regional/Sub-Regional LID BMPs

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

IV.3.7 Treatment Control BMPs

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

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

TREATMENT CONTROL BMPs		
ID	Name	Included?
PRE-2	Catch Basin Insert	☐
	Other:	☐

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

IV.3.8 Non-Structural Source Control BMPs

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

NON-STRUCTURAL SOURCE CONTROL BMPs				
ID	Name	Included?	Not Applicable?	If Not Applicable, Provide Brief Reason
N1	Education for Property Owners, Tenants and Occupants	☒	☐	
N2	Activity Restrictions	☒	☐	
N3	Common Area Landscape Management	☒	☐	
N4	BMP Maintenance	☒	☐	
N5	Title 22 CCR Compliance (How development will comply)	☐	☒	Not applicable – no hazardous waste on-site.
N6	Local Industrial Permit Compliance	☐	☒	The City of Lake Forest does not issue water quality permits.
N7	Spill Contingency Plan	☐	☒	Not applicable – no hazardous waste on-site.
N8	Underground Storage Tank Compliance	☐	☒	No underground storage tanks are proposed.
N9	Hazardous Materials Disclosure Compliance	☐	☒	Not applicable – no hazardous waste on-site.
N10	Uniform Fire Code Implementation	☐	☒	Not applicable – no hazardous waste on-site.
N11	Common Area Litter Control	☒	☐	
N12	Employee Training	☒	☐	
N13	Housekeeping of Loading Docks	☐	☒	No loading docks are proposed.

NON-STRUCTURAL SOURCE CONTROL BMPs				
ID	Name	Included?	Not Applicable?	If Not Applicable, Provide Brief Reason
N14	Common Area Catch Basin Inspection	☒	☐	
N15	Street Sweeping Private Streets and Parking Lots	☒	☐	
N16	Retail Gasoline Outlets	☐	☒	No retail gasoline outlets are proposed.

N1, Education for Property Owners, Tenants and Occupants

The HOA will ensure that all homeowners will be given a copy of the recorded CC&Rs which will contain details on educational materials and restrictions to reduce pollutants from reaching the storm drain system. The owner shall establish requirements that these educational materials are distributed by the HOA to all members of the HOA, and periodically thereafter by the HOA after the first sale of the units. Examples of the environmental awareness materials are listed in Section VII. In addition, pet waste stations with waste removal bags and instructions will be provided throughout the common areas to encourage pet owners to remove pet waste from common areas.

N2, Activity Restrictions

The Owner shall develop activity restrictions (via CC&Rs or equivalent) that include language to restrict activities that have the potential to create adverse impacts on water quality. Activities include but are not limited to: the handling and disposal of contaminants, trash management and litter control, irrigation and landscaping practices, fertilizer applications and household waste management practices, prohibition of vehicle washing on-site, prohibiting washing or hosing of walkways and driveways, etc.

N3, Common Area Landscape Management

Management programs will be designed and implemented by the HOA, which will maintain all the common areas within the project site (via landscape contractor). These programs will cover how to reduce the potential pollutant sources of fertilizer and pesticide uses, utilization of water-efficient landscaping practices and proper disposal of landscape wastes in accordance with local guidelines, ordinances, consistent with Management Guidelines for Use of Fertilizers (DAMP Section 5.5) and City ordinances.

N4, BMP Maintenance

The HOA will be responsible for the implementation and maintenance of each applicable non-structural BMP, as well as scheduling inspections and maintenance of all applicable structural BMP facilities through its landscape contractor and any other necessary maintenance contractors. Further details on maintenance for source control and treatment control BMPs are included in Section V.

N11, Common Area Litter Control

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

N12, Employee Training

All employees of the HOA and any contractors of the HOA will require training to ensure that employees are aware of maintenance activities that may result in pollutants reaching the storm drain. Materials that may be utilized during training are listed in Section VII.

N14, Common Area Catch Basin Inspection

All private catch basins will be maintained and cleaned by the HOA. All public catch basins will be maintained and cleaned by the City of Lake Forest. These activities will be done prior to the rainy season, no later than October 1st of each year.

N15, Street Sweeping Private Streets and Parking Lots

All private streets and parking areas shall be swept by the HOA prior to the rainy season, no later than October 1st each year.

IV.3.9 Structural Source Control BMPs

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

STRUCTURAL SOURCE CONTROL BMPs				
ID	**Name**	**Included?**	**Not Applicable?**	**If Not Applicable, Provide Brief Reason**
S1 SD-13	Provide storm drain system stenciling and signage	☒	☐	
S2 SD-34	Design and construct outdoor material storage areas to reduce pollution introduction	☐	☒	Not applicable – no hazardous waste on-site.
S3 SD-32	Design and construct trash and waste storage areas to reduce pollution introduction	☐	☒	No trash storage areas are proposed on-site.
S4 SD-12	Use efficient irrigation systems & landscape design, water conservation, smart controllers, and source control	☒	☐	
S5	Protect slopes and channels and provide energy dissipation	☒	☐	
S6 SD-31	Properly Design: Dock areas	☐	☒	No loading docks are proposed.
S7 SD-31	Properly Design: Maintenance bays	☐	☒	No maintenance bays are proposed.

STRUCTURAL SOURCE CONTROL BMPs				
ID	Name	Included?	Not Applicable?	If Not Applicable, Provide Brief Reason
S8 SD-33	Properly Design: Vehicle wash areas	☐	☒	No vehicle wash areas are proposed.
S9 SD-36	Properly Design: Outdoor processing areas	☐	☒	No outdoor processing areas are proposed.
S10	Properly Design: Equipment wash areas	☐	☒	No equipment wash areas are proposed.
S11 SD-30	Properly Design: Fueling areas	☐	☒	No fueling areas are proposed.
S12 SD-10	Properly Design: Hillside landscaping	☐	☒	Not applicable. Project site is not located on a hillside.
S13	Properly Design: Wash water control for food preparation areas	☐	☒	No food preparation areas are proposed.
S14	Properly Design: Community car wash racks	☐	☒	No community car wash racks are proposed.

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

The developer will be responsible for the stenciling of all catch basins to include a legible message such as "No Dumping - Drains to Ocean" or an equally effective phrase. The HOA will be responsible for maintaining and replacement of signage when necessary.

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

The developer will be responsible for the installation and maintenance of all common landscape areas utilizing similar planting materials with similar water requirements to reduce excess irrigation runoff. The developer will be responsible for implementing all efficient irrigation systems for common area landscaping including but not limited to provisions for water sensors and programmable irrigation cycles. The irrigation systems shall be in conformance with water use efficiency guidelines.

S5, Protect slopes and channels and provide energy dissipation

All slopes shall be vegetated and stabilized to prevent erosion, in accordance with "Efficient Irrigation and Landscape Design" source control BMP to prevent erosion.

IV.4 ALTERNATIVE COMPLIANCE PLAN

IV.4.1 Water Quality Credits

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

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

At this time, however, no water quality credits have been applied to the project's DCV. Should any applicable credits be applied in the future, they shall be documented in the Final WQMP.

IV.4.2 Alternative Compliance Plan Information

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

SECTION V INSPECTION/MAINTENANCE RESPONSIBILITY FOR BMPs

It has been determined that Brookfield Residential (via HOA) shall assume all BMP inspection and maintenance responsibilities for the Town Centre project.

Contact Name:	Pending – to be provided in the Final WQMP.
Title:	
Company:	
Address:	
Phone:	
Fax:	
Email:	

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

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

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

The Owner/HOA shall ensure long-term funding for BMP maintenance is provided. Should a HOA be formed, Brookfield Residential, which will set up the HOA, shall oversee that adequate funding for BMP maintenance is included within the HOA fee structure including annual maintenance fees and long-term maintenance reserve funds.

BMP INSPECTION & MAINTENANCE RESPONSIBILITY MATRIX				
	BMP	Inspection/Maintenance Activities	Minimum Frequency	Responsible Party
BIOTREATMENT BMPs				
BIO-1	Biotreatment: Rain Gardens	Inspections should occur semi-annually or after major storm events to check for the following and remove accordingly: standing water, sediment, and trash & debris. Inspections should also look for potential clogging and clean planters or, if necessary, replace the entire filter bed. Inspect for weeds, and prune and/or replace plants in accordance with routine landscape maintenance activities. Replace mulch and prune shrubs as necessary.	2x per year	Brookfield Residential / HOA
BIO-7	Proprietary Biotreatment: Filterra® or equivalent	Annual maintenance consists of a minimum of two scheduled visits, one after the rainy season to clean up after the wet season, and one before the wet season to inspect and clean the unit. Each maintenance visit consists of the following: Inspection; removal of trash, debris, sediment; Filter media and plant health evaluation and replacement if necessary; replacement of mulch.	2x per year	Brookfield Residential / HOA
NON-STRUCTURAL SOURCE CONTROL BMPs				

BMP INSPECTION & MAINTENANCE RESPONSIBILITY MATRIX				
	BMP	**Inspection/Maintenance Activities**	**Minimum Frequency**	**Responsible Party**
N1	Education for Property Owners, Tenants and Occupants	Educational materials will be provided to residents/tenants, annually. Examples include tips for pet care, proper waste oil disposal, and other household tips. Tenants will be provided storm water pollution prevention materials by the Property Management prior to occupancy and annually thereafter.	Annually	Brookfield Residential / HOA
N2	Activity Restrictions	The Owner will prescribe activity restrictions to protect surface water quality, through lease terms or other equally effective measure, for the property.	Ongoing	Brookfield Residential / HOA
N3	Common Area Landscape Management	Maintenance shall be consistent with City requirements, plus fertilizer and/or pesticide usage shall be consistent with County Management Guidelines for Use of Fertilizers (OC DAMP Section 5.5). Maintenance includes mowing, weeding, and debris removal on a weekly basis. Trimming, replanting and replacement of mulch shall be performed on an as-needed basis. Trimmings, clippings, and other waste shall be properly disposed of off-site in accordance with local regulations. Materials temporarily stockpiled during maintenance activities shall be placed away from water courses and storm drain inlets.	Monthly	Brookfield Residential / HOA

BMP INSPECTION & MAINTENANCE RESPONSIBILITY MATRIX				
	BMP	**Inspection/Maintenance Activities**	**Minimum Frequency**	**Responsible Party**
N4	BMP Maintenance	Maintenance of BMPs implemented at the project site shall be performed at the frequency prescribed in this WQMP. Records of inspections and BMP maintenance shall be maintained by the Owner and shall be available for review upon request.	Ongoing	Brookfield Residential / HOA
N5	Title 22 CCR Compliance (How development will comply)	Not Applicable		
N6	Local Industrial Permit Compliance	Not Applicable		
N7	Spill Contingency Plan	Not Applicable		
N8	Underground Storage Tank Compliance	Not Applicable		
N9	Hazardous Materials Disclosure Compliance	Not Applicable		
N10	Uniform Fire Code Implementation	Not Applicable		
N11	Common Area Litter Control	Litter patrol, violations investigation, reporting and other litter control activities shall be performed weekly and in conjunction with maintenance activities.	Weekly	Brookfield Residential / HOA
N12	Employee Training	The Owner shall educate all new employees/managers on storm water pollution prevention, particularly good housekeeping practices, prior to the start of the rainy season (October 1). Refresher courses shall be conducted on an as needed basis. Materials that may be utilized on BMP maintenance are attached to this WQMP.	Annually	Brookfield Residential / HOA

BMP INSPECTION & MAINTENANCE RESPONSIBILITY MATRIX				
	BMP	**Inspection/Maintenance Activities**	**Minimum Frequency**	**Responsible Party**
N13	Housekeeping of Loading Docks	Not Applicable		
N14	Common Area Catch Basin Inspection	On-site catch basin inlets and other drainage facilities shall be inspected after each storm event and once per year. Inlets and other facilities shall be cleaned prior to the storm season by October 1st each year.	Annually	Brookfield Residential / HOA
N15	Street Sweeping Private Streets and Parking Lots	Private streets and parking areas within the project shall be swept at a minimum frequency quarterly as well as once per year prior to the storm season, no later than October 1st each year.	Quarterly	Brookfield Residential / HOA
N16	Retail Gasoline Outlets	Not Applicable		
STRUCTURAL SOURCE CONTROL BMPs				
S1 SD-13	Provide storm drain system stenciling and signage	Storm drain stencils shall be inspected for legibility, at minimum, once prior to the storm season, no later than October 1st each year. Those determined to be illegible will be re-stenciled as soon as possible.	Annually	Brookfield Residential / HOA
S2 SD-34	Design and construct outdoor material storage areas to reduce pollution introduction	Not Applicable		
S3 SD-32	Design and construct trash and waste storage areas to reduce pollution introduction	Not Applicable		

BMP INSPECTION & MAINTENANCE RESPONSIBILITY MATRIX				
	BMP	**Inspection/Maintenance Activities**	**Minimum Frequency**	**Responsible Party**
S4 SD-12	Use efficient irrigation systems & landscape design, water conservation, smart controllers, and source control	In conjunction with routine maintenance activities, verify that landscape design continues to function properly by adjusting properly to eliminate overspray 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 nighttime temperatures based on system specifications and local climate patterns. System testing shall occur twice per year. Water from testing/flushing shall be collected and properly disposed to sewer system and shall not discharge to storm drain system.	Monthly	Brookfield Residential / HOA
S5	Protect slopes and channels and provide energy dissipation	To be performed in conjunction with maintenance activities. Maintain vegetative cover and/or mulch to eliminate exposed soils. Any eroded surfaces to be repaired immediately. Inspections to be performed twice each year (spring and fall) and after major storm events to check for signs of erosion, gullies, and sloughing.	Monthly	Brookfield Residential / HOA
S6 SD-31	Properly Design: Dock areas	Not Applicable		
S7 SD-31	Properly Design: Maintenance bays	Not Applicable		
S8 SD-33	Properly Design: Vehicle wash areas	Not Applicable		

BMP INSPECTION & MAINTENANCE RESPONSIBILITY MATRIX				
	BMP	Inspection/Maintenance Activities	Minimum Frequency	Responsible Party
S9 SD-36	Properly Design: Outdoor processing areas	Not Applicable		
S10	Properly Design: Equipment wash areas	Not Applicable		
S11 SD-30	Properly Design: Fueling areas	Not Applicable		
S12 SD-10	Properly Design: Hillside landscaping	Not Applicable		
S13	Properly Design: Wash water control for food preparation areas	Not Applicable		
S14	Properly Design: Community car wash racks	Not Applicable		

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

Section VI

SECTION VI SITE PLAN AND DRAINAGE PLAN

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

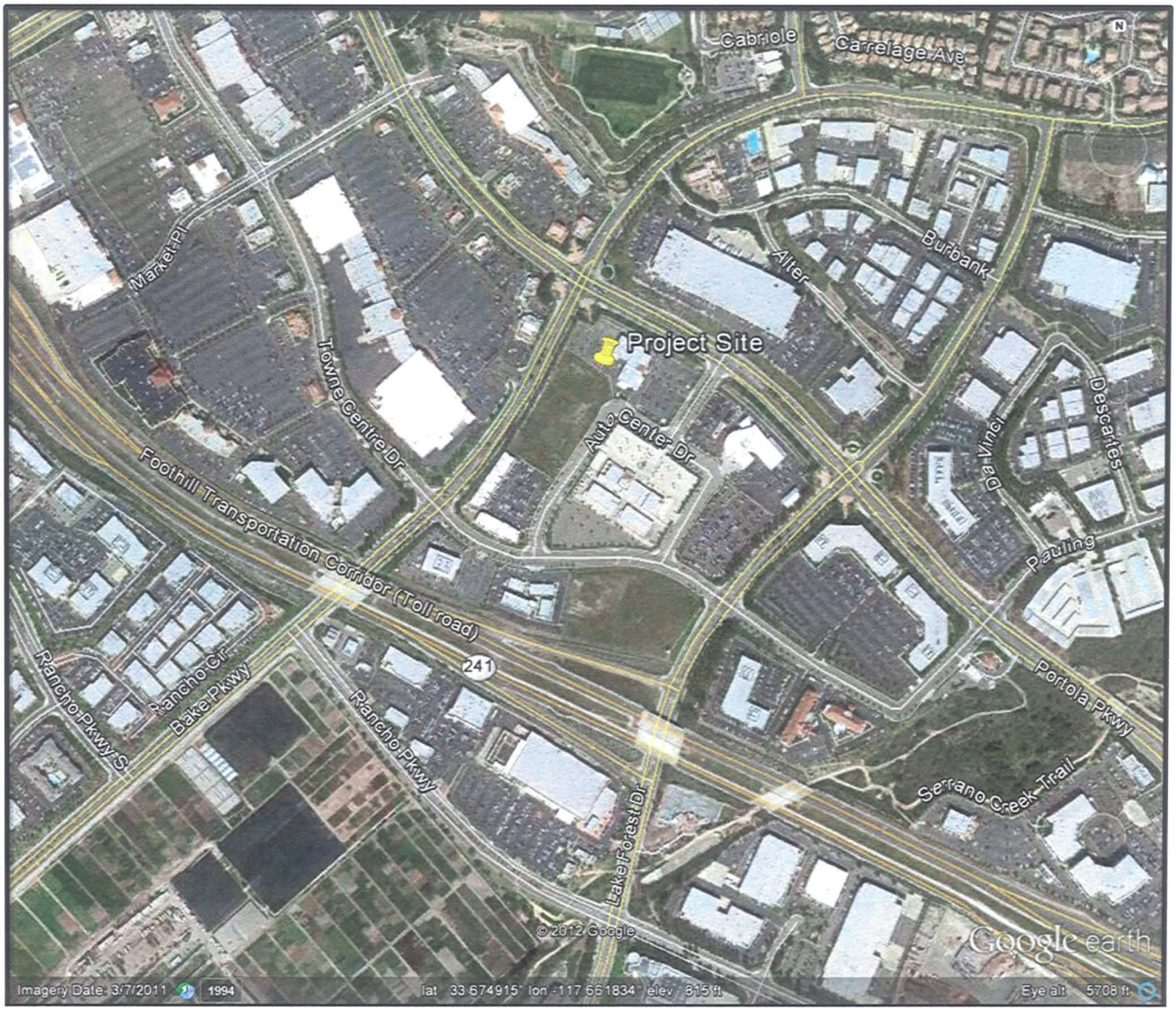
EXHIBITS

- Vicinity Map
- Site Plan / Preliminary WQMP Exhibit

BMP DETAILS

- Bioretention with Underdrains
- Filterra® Bioretention Units

VICINITY MAP



LEGEND

- PROPERTY BOUNDARY
- EASEMENT
- EXISTING STORM DRAIN
- PROPOSED STORM DRAIN
- BMP DRAINAGE AREA BOUNDARY
- OFF-SITE DRAINAGE AREA
- COMMON AREA LANDSCAPE MANAGEMENT EFFICIENT IRRIGATION SYSTEMS & LANDSCAPE DESIGN
- STREET SWEEPING PRIVATE STREETS
- RAIN GARDEN / BIORETENTION CELL
- CATCH BASIN STENCILING COMMON AREA CATCH BASIN INSPECTION
- PROPOSED FILTERRA UNIT
- DIRECTION OF FLOW

GRAPHIC SCALE

80 0 40 80 160

(IN FEET)

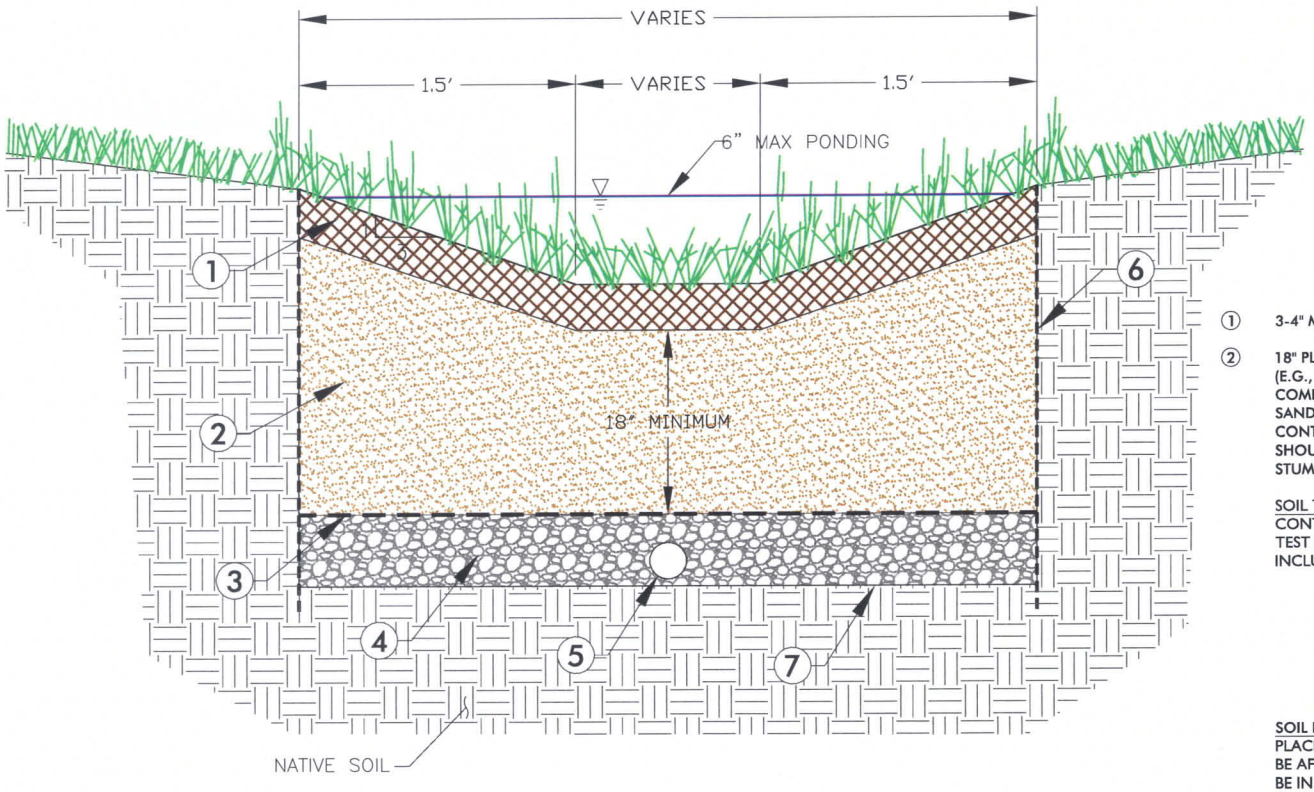
1 inch = 80 ft.

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

Scale: 1" = 80'

Exhibit Date: 7/23/2012

SITE PLAN / PRELIMINARY WQMP TOWN CENTRE TTM 17446 LAKE FOREST, CA



BIORETENTION CELL TYPICAL CROSS-SECTION

NOT TO SCALE

NOTES:

① 3-4" MULCH PER LANDSCAPE PLANS & SPECIFICATIONS

② 18" PLANTING MEDIA TO BE HIGHLY PERMEABLE AND HIGH IN ORGANIC MATTER (E.G., LOAMY SAND MIXED THOROUGHLY WITH COMPOST AMENDMENTS WITH COMPOST AMENDMENTS). PLANTING MEDIA MIXTURE TO CONSIST OF 60-70% SAND, 15-25% COMPOST, AND 10-20% CLEAN TOPSOIL. THE ORGANIC CONTENT OF THE SOIL MIXTURE SHOULD BE 8% TO 12%; THE pH RANGE SHOULD BE 5.5-7.5. THE SOIL MUST BE A UNIFORM MIX, FREE OF STONES, STUMPS, ROOTS, OR OTHER SIMILAR OBJECTS LARGER THAN 2 INCHES.

SOIL TESTING:
CONTRACTOR SHALL SUBMIT SOIL TESTS RESULTS TO THE ENGINEER (ONE TEST PER BIO-RETENTION CELL) PRIOR TO INSTALLATION. TESTING SHALL INCLUDE:

- a - GRANULOMETRIC ANALYSIS (SAND, SILT & CLAY) PER WEIGHT (SAND BETWEEN 60% - 70%; CLAY LESS THAN 5%)
- b - PH (5.5 TO 7.5)
- c - PERCENTAGE OF ORGANIC MATTER IN THE SOIL (8% TO 12%)
- d - SIEVE ANALYSIS
- e - SATURATED HYDRAULIC CONDUCTIVITY TEST (HIGHER THAN 0.5 in/hr)

SOIL PLACEMENT
PLACEMENT OF THE PLANTING MEDIA IN THE BIO-RETENTION AREA SHOULD BE AFTER SCARIFYING THE INVERT AREA OF THE PROPOSED FACILITY, AND BE IN LIFTS OF 12 TO 18 INCHES AND MINIMALLY COMPACTED TO REDUCE THE POSSIBILITY OF EXCESSIVE SETTLEMENT. NO ADDITIONAL COMPACTION OF SOIL IS NECESSARY. INSTALLATION OF PLANTING MEDIA MUST BE DONE IN A MANNER THAT WILL ENSURE ADEQUATE FILTRATION.

③ FILTER FABRIC MIRAFI 160N OR EQUIVALENT.

④ UNDERDRAIN GRAVEL (AASHTO M-43), PEA GRAVEL SIZE FROM 0.5" TO 1" IN DIAMETER

⑤ OPTIONAL 6" PERFORATED PIPE SCHEDULE 40

⑥ ROOT BARRIER OR IMPERMEABLE LINER

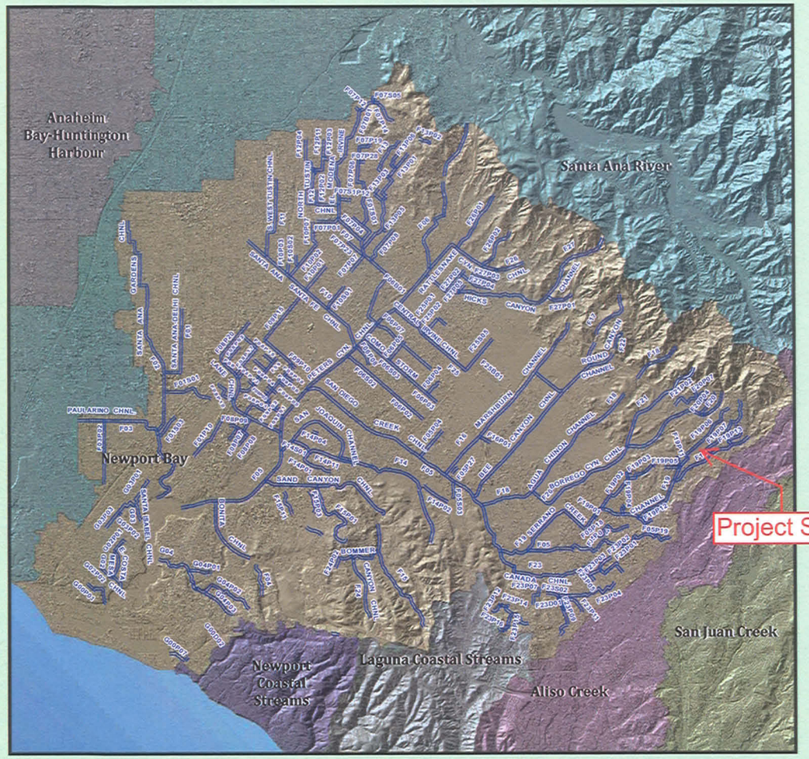
⑦ OPTIONAL IMPERMEABLE LINER TO RESTRICT INFILTRATION

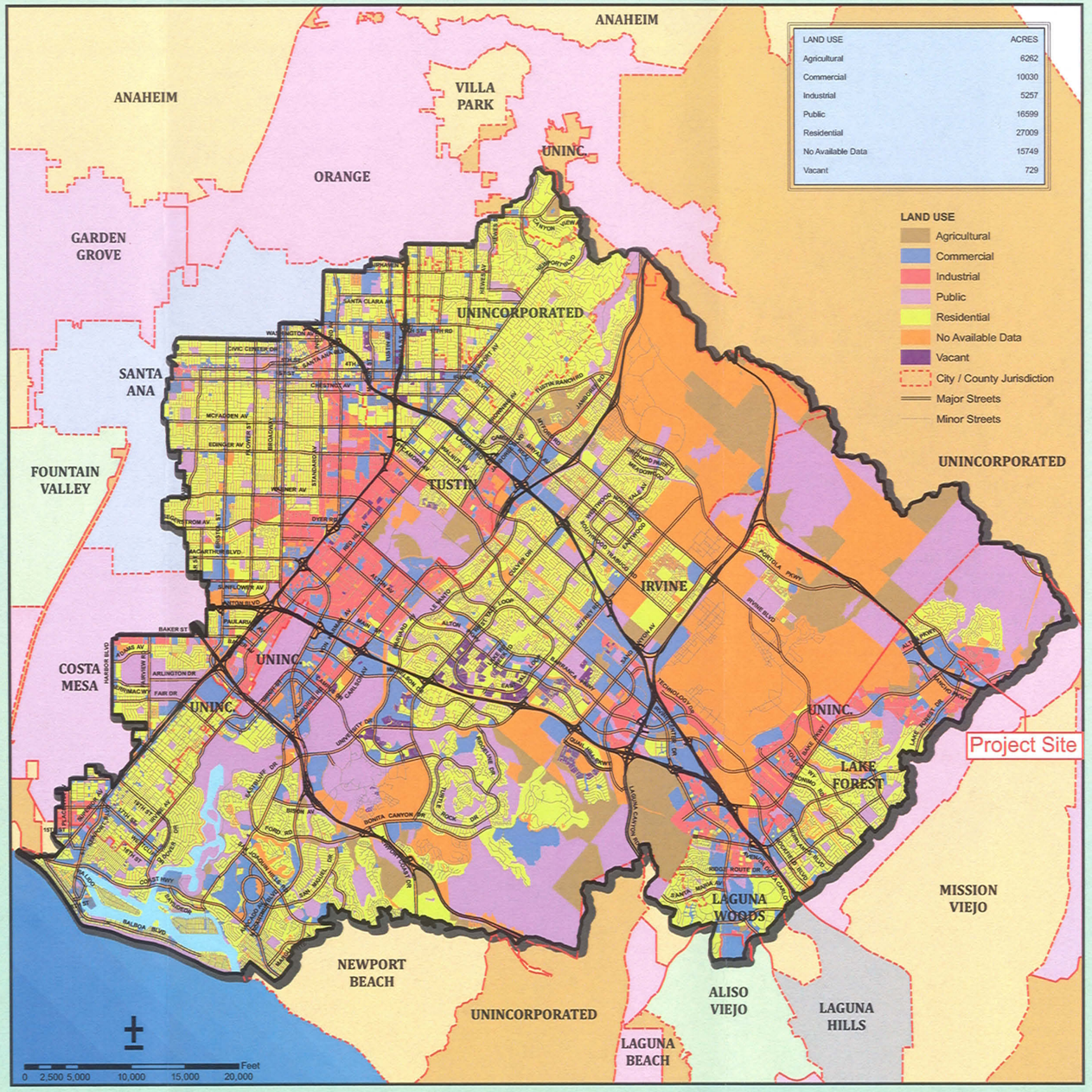
FUSCOE ENGINEERING
16795 Von Karman, Suite 100
Irvine, California 92606
tel 949.474.1960 fax 949.474.5315
www.fuscoe.com

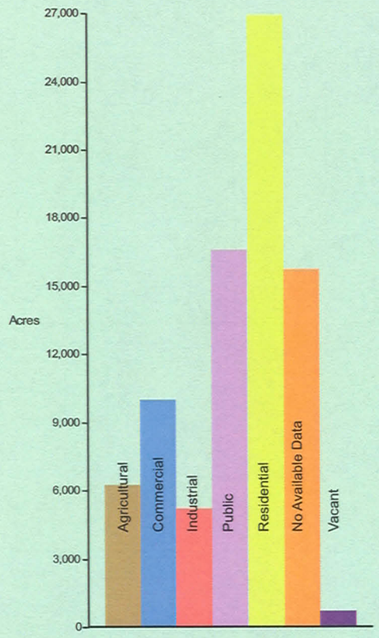
Not-to-Scale
Exhibit Date: 4/6/2012

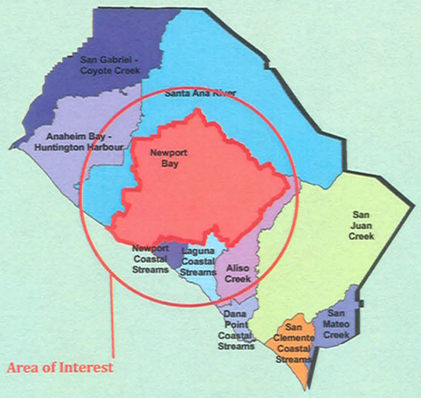
BMP DETAILS

TOWN CENTRE
LAKE FOREST, CA









97294 Acres

WATERSHED: NEWPORT BAY

COUNTY OF ORANGE, CALIFORNIA

DESIGNED AND PRODUCED BY:
OC Public Works
GIS Mapping Unit
Philip Pappas

DATA SOURCE:
- Geomatics Land Information Systems Division

DATE: November 18, 2009

XIV.5. Biotreatment BMP Fact Sheets (BIO)

Conceptual criteria for biotreatment BMP selection, design, and maintenance are contained in **Appendix XII**. These criteria are generally applicable to the design of biotreatment BMPs in Orange County and BMP-specific guidance is provided in the following fact sheets.

Note: Biotreatment BMPs shall be designed to provide the maximum feasible infiltration and ET based on criteria contained in ***Appendix*** **XI.2.**

BIO-1: Bioretention with Underdrains

Also known as:

- *Rain gardens with underdrains*
- *Vegetated media filter*
- *Downspout planter boxes*

Bioretention
Source: Geosyntec Consultants

Bioretention stormwater treatment facilities are landscaped shallow depressions that capture and filter stormwater runoff. These facilities function as a soil and plant-based filtration device that removes pollutants through a variety of physical, biological, and chemical treatment processes. The facilities normally consist of a ponding area, mulch layer, planting soils, and plants. As stormwater passes down through the planting soil, pollutants are filtered, adsorbed, biodegraded, and sequestered by the soil and plants. Bioretention with an underdrain are utilized for areas with low permeability native soils or steep slopes where the underdrain system that routes the treated runoff to the storm drain system rather than depending entirely on infiltration. **Bioretention must be designed without an underdrain** in areas of high soil permeability.

Feasibility Screening Considerations

- If there are no hazards associated with infiltration (such as groundwater concerns, contaminant plumes or geotechnical concerns), **bioinfiltration facilities**, which achieve partial infiltration, should be used to maximize infiltration.
- Bioretention with underdrain facilities should be lined if contaminant plumes or geotechnical concerns exist. If high groundwater is the reason for infiltration infeasibility, bioretention facilities with underdrains do not need to be lined.

Opportunity Criteria

- Land use may include commercial, residential, mixed use, institutional, and subdivisions. Bioretention may also be applied in parking lot islands, cul-de-sacs, traffic circles, road shoulders, road medians, and next to buildings in planter boxes.
- Drainage area is ≤ 5 acres.
- Area is available for infiltration.

- Site must have adequate relief between land surface and the stormwater conveyance system to permit vertical percolation through the soil media and collection and conveyance in underdrain to stormwater conveyance system.

OC-Specific Design Criteria and Considerations

- ☐ Ponding depth should not exceed 18 inches; fencing may be required if ponding depth is greater than 6 inches to mitigate drowning.
- ☐ The minimum soil depth is 2 feet (3 feet is preferred).
- ☐ The maximum drawdown time of the bioretention ponding area is 48 hours. The maximum drawdown time of the planting media and gravel drainage layer is 96 hours, if applicable.
- ☐ Infiltration pathways may need to be restricted due to the close proximity of roads, foundations, or other infrastructure. A geomembrane liner, or other equivalent water proofing, may be placed along the vertical walls to reduce lateral flows. This liner should have a minimum thickness of 30 mils.
- ☐ If infiltration in bioretention location is hazardous due to groundwater or geotechnical concerns, a geomembrane liner must be installed at the base of the bioretention facility. This liner should have a minimum thickness of 30 mils.
- ☐ The planting media placed in the cell shall be designed per the recommendations contained in MISC-1: Planting/Storage Media
- ☐ Plant materials should be tolerant of summer drought, ponding fluctuations, and saturated soil conditions for 48 hours; native place species and/or hardy cultivars that are not invasive and do not require chemical inputs should be used to the maximum extent feasible
- ☐ The bioretention area should be covered with 2-4 inches (average 3 inches) or mulch at the start and an additional placement of 1-2 inches of mulch should be added annually.
- ☐ Underdrain should be sized with a 6 inch minimum diameter and have a 0.5% minimum slope. Underdrain should be slotted polyvinyl chloride (PVC) pipe; underdrain pipe should be more than 5 feet from tree locations (if space allows).
- ☐ A gravel blanket or bedding is required for the underdrain pipe(s). At least 0.5 feet of washed aggregate must be placed below, to the top, and to the sides of the underdrain pipe(s).
- ☐ An overflow device is required at the top of the bioretention area ponding depth.
- ☐ Dispersed flow or energy dissipation (i.e. splash rocks) for piped inlets should be provided at basin inlet to prevent erosion.
- ☐ Ponding area side slopes shall be no steeper than 3:1 (H:V) unless designed as a planter box BMP with appropriate consideration for trip and fall hazards.

Simple Sizing Method for Bioretention with Underdrain

If the Simple Design Capture Volume Sizing Method described in **Appendix III.3.1** is used to size a bioretention with underdrain facility, the user selects the basin depth and then determines the appropriate surface area to capture the DCV. The sizing steps are as follows:

Step 1: Determine DCV

Calculate the DCV using the Simple Design Capture Volume Sizing Method described in **Appendix III.3.1**.

Step 2: Verify that the Ponding Depth will Draw Down within 48 Hours

The ponding area drawdown time can be calculated using the following equation:

$DD_P = (d_P / K_{MEDIA}) \times 12$ in/ft

Where:

DD_P = time to drain ponded water, hours

d_P = depth of ponding above bioretention area, ft (not to exceed 1.5 ft)

K_{MEDIA} = media design infiltration rate, in/hr (equivalent to the media hydraulic conductivity with a factor of safety of 2; K_{MEDIA} of 2.5 in/hr should be used unless other information is available)

If the drawdown time exceeds 48 hours, adjust ponding depth and/or media infiltration rate until 48 hour drawdown time is achieved.

Step 3: Determine the Depth of Water Filtered During Design Capture Storm

The depth of water filtered during the design capture storm can be estimated as the amount routed through the media during the storm, or the ponding depth, whichever is smaller.

$d_{FILTERED}$ = Minimum [$((K_{MEDIA} \times T_{ROUTING})/12)$, d_P]

Where:

$d_{FILTERED}$ = depth of water that may be considered to be filtered during the design storm event, ft

K_{MEDIA} = media design infiltration rate, in/hr (equivalent to the media hydraulic conductivity with a factor of safety of 2; K_{MEDIA} of 2.5 in/hr should be used unless other information is available)

$T_{ROUTING}$ = storm duration that may be assumed for routing calculations; this should be assumed to be no greater than 3 hours. If the designer desires to account for further routing effects, the Capture Efficiency Method for Volume-Based, Constant Drawdown BMPs (See **Appendix III.3.2**) should be used.

d_P = depth of ponding above bioretention area, ft (not to exceed 1.5 ft)

Step 4: Determine the Facility Surface Area

$A = DCV / (d_P + d_{FILTERED})$

Where:

A = required area of bioretention facility, sq-ft

DCV = design capture volume, cu-ft

$d_{FILTERED}$ = depth of water that may be considered to be filtered during the design storm event, ft

d_P = depth of ponding above bioretention area, ft (not to exceed 1.5 ft)

Capture Efficiency Method for Bioretention with Underdrains

If the bioretention geometry has already been defined and the user wishes to account more explicitly for routing, the user can determine the required footprint area using the Capture Efficiency Method for Volume-Based, Constant Drawdown BMPs (See **Appendix III.3.2**) to determine the fraction of the DCV that must be provided to manage 80 percent of average annual runoff volume. This method accounts for drawdown time different than 48 hours.

Step 1: Determine the drawdown time associated with the selected basin geometry

$DD = (d_p / K_{DESIGN}) \times 12$ in/ft

Where:

DD = time to completely drain infiltration basin ponding depth, hours

d_P = bioretention ponding depth, ft (should be less than or equal to 1.5 ft)

K_{DESIGN} = design media infiltration rate, in/hr (assume 2.5 inches per hour unless otherwise proposed)

If drawdown is less than 3 hours, the drawdown time should be rounded to 3 hours or the Capture Efficiency Method for Flow-based BMPs (See **Appendix III.3.3)** shall be used.

Step 2: Determine the Required Adjusted DCV for this Drawdown Time

Use the Capture Efficiency Method for Volume-Based, Constant Drawdown BMPs (See **Appendix III.3.2**) to calculate the fraction of the DCV the basin must hold to achieve 80 percent capture of average annual stormwater runoff volume based on the basin drawdown time calculated above.

Step 3: Determine the Basin Infiltrating Area Needed

The required infiltrating area (i.e. the surface area of the top of the media layer) can be calculated using the following equation:

A = Design Volume / d_p

Where:

A = required infiltrating area, sq-ft (measured at the media surface)

Design Volume = fraction of DCV, adjusted for drawdown, cu-ft (see Step 2)

d_p = ponding depth of water stored in bioretention area, ft (from Step 1)

This does not include the side slopes, access roads, etc. which would increase bioretention footprint. If the area required is greater than the selected basin area, adjust surface area or adjust ponding depth and recalculate required area until the required area is achieved.

Configuration for Use in a Treatment Train

- Bioretention areas may be preceeded in a treatment train by HSCs in the drainage area, which would reduce the required design volume of the bioretention cell. For example, bioretention could be used to manage overflow from a cistern.
- Bioretention areas can be used to provide pretreatment for underground infiltration systems.

Additional References for Design Guidance

- CASQA BMP Handbook for New and Redevelopment: http://www.cabmphandbooks.com/Documents/Development/TC-32.pdf
- SMC LID Manual (pp 68): http://www.lowimpactdevelopment.org/guest75/pub/All_Projects/SoCal_LID_Manual/SoCalLID_Manual_FINAL_040910.pdf
- Los Angeles County Stormwater BMP Design and Maintenance Manual, Chapter 5: http://dpw.lacounty.gov/DES/design_manuals/StormwaterBMPDesignandMaintenance.pdf
- San Diego County LID Handbook Appendix 4 (Factsheet 7): http://www.sdcounty.ca.gov/dplu/docs/LID-Appendices.pdf

  Los Angeles Unified School District (LAUSD) Stormwater Technical Manual, Chapter 4: http://www.laschools.org/employee/design/fs-studies-and-reports/download/white_paper_report_material/Storm_Water_Technical_Manual_2009-opt-red.pdf?version_id=76975850
- County of Los Angeles Low Impact Development Standards Manual, Chapter 5: http://dpw.lacounty.gov/wmd/LA_County_LID_Manual.pdf

Bioretention TC-32

Design Considerations

- Soil for Infiltration
- Tributary Area
- Slope
- Aesthetics
- Environmental Side-effects

Description

The bioretention best management practice (BMP) functions as a soil and plant-based filtration device that removes pollutants through a variety of physical, biological, and chemical treatment processes. These facilities normally consist of a grass buffer strip, sand bed, ponding area, organic layer or mulch layer, planting soil, and plants. The runoff's velocity is reduced by passing over or through buffer strip and subsequently distributed evenly along a ponding area. Exfiltration of the stored water in the bioretention area planting soil into the underlying soils occurs over a period of days.

Targeted Constituents

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

Legend ***(Removal Effectiveness)***

● Low ■ High

▲ Medium

California Experience

None documented. Bioretention has been used as a stormwater BMP since 1992. In addition to Prince George's County, MD and Alexandria, VA, bioretention has been used successfully at urban and suburban areas in Montgomery County, MD; Baltimore County, MD; Chesterfield County, VA; Prince William County, VA; Smith Mountain Lake State Park, VA; and Cary, NC.

Advantages

- Bioretention provides stormwater treatment that enhances the quality of downstream water bodies by temporarily storing runoff in the BMP and releasing it over a period of four days to the receiving water (EPA, 1999).
- The vegetation provides shade and wind breaks, absorbs noise, and improves an area's landscape.

Limitations

- The bioretention BMP is not recommended for areas with slopes greater than 20% or where mature tree removal would

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be required since clogging may result, particularly if the BMP receives runoff with high sediment loads (EPA, 1999).

- Bioretention is not a suitable BMP at locations where the water table is within 6 feet of the ground surface and where the surrounding soil stratum is unstable.
- By design, bioretention BMPs have the potential to create very attractive habitats for mosquitoes and other vectors because of highly organic, often heavily vegetated areas mixed with shallow water.
- In cold climates the soil may freeze, preventing runoff from infiltrating into the planting soil.

Design and Sizing Guidelines

- The bioretention area should be sized to capture the design storm runoff.
- In areas where the native soil permeability is less than 0.5 in/hr an underdrain should be provided.
- Recommended minimum dimensions are 15 feet by 40 feet, although the preferred width is 25 feet. Excavated depth should be 4 feet.
- Area should drain completely within 72 hours.
- Approximately 1 tree or shrub per 50 ft^2 of bioretention area should be included.
- Cover area with about 3 inches of mulch.

Construction/Inspection Considerations

Bioretention area should not be established until contributing watershed is stabilized.

Performance

Bioretention removes stormwater pollutants through physical and biological processes, including adsorption, filtration, plant uptake, microbial activity, decomposition, sedimentation and volatilization (EPA, 1999). Adsorption is the process whereby particulate pollutants attach to soil (e.g., clay) or vegetation surfaces. Adequate contact time between the surface and pollutant must be provided for in the design of the system for this removal process to occur. Thus, the infiltration rate of the soils must not exceed those specified in the design criteria or pollutant removal may decrease. Pollutants removed by adsorption include metals, phosphorus, and hydrocarbons. Filtration occurs as runoff passes through the bioretention area media, such as the sand bed, ground cover, and planting soil.

Common particulates removed from stormwater include particulate organic matter, phosphorus, and suspended solids. Biological processes that occur in wetlands result in pollutant uptake by plants and microorganisms in the soil. Plant growth is sustained by the uptake of nutrients from the soils, with woody plants locking up these nutrients through the seasons. Microbial activity within the soil also contributes to the removal of nitrogen and organic matter. Nitrogen is removed by nitrifying and denitrifying bacteria, while aerobic bacteria are responsible for the decomposition of the organic matter. Microbial processes require oxygen and can result in depleted oxygen levels if the bioretention area is not adequately

aerated. Sedimentation occurs in the swale or ponding area as the velocity slows and solids fall out of suspension.

The removal effectiveness of bioretention has been studied during field and laboratory studies conducted by the University of Maryland (Davis et al, 1998). During these experiments, synthetic stormwater runoff was pumped through several laboratory and field bioretention areas to simulate typical storm events in Prince George's County, MD. Removal rates for heavy metals and nutrients are shown in Table 1.

Table 1 Laboratory and Estimated Bioretention Davis et al. (1998); PGDER (1993)

Pollutant	Removal Rate
Total Phosphorus	70-83%
Metals (Cu, Zn, Pb)	93-98%
TKN	68-80%
Total Suspended Solids	90%
Organics	90%
Bacteria	90%

Results for both the laboratory and field experiments were similar for each of the pollutants analyzed. Doubling or halving the influent pollutant levels had little effect on the effluent pollutants concentrations (Davis et al, 1998).

The microbial activity and plant uptake occurring in the bioretention area will likely result in higher removal rates than those determined for infiltration BMPs.

Siting Criteria

Bioretention BMPs are generally used to treat stormwater from impervious surfaces at commercial, residential, and industrial areas (EPA, 1999). Implementation of bioretention for stormwater management is ideal for median strips, parking lot islands, and swales. Moreover, the runoff in these areas can be designed to either divert directly into the bioretention area or convey into the bioretention area by a curb and gutter collection system.

The best location for bioretention areas is upland from inlets that receive sheet flow from graded areas and at areas that will be excavated (EPA, 1999). In order to maximize treatment effectiveness, the site must be graded in such a way that minimizes erosive conditions as sheet flow is conveyed to the treatment area. Locations where a bioretention area can be readily incorporated into the site plan without further environmental damage are preferred. Furthermore, to effectively minimize sediment loading in the treatment area, bioretention only should be used in stabilized drainage areas.

Additional Design Guidelines

The layout of the bioretention area is determined after site constraints such as location of utilities, underlying soils, existing vegetation, and drainage are considered (EPA, 1999). Sites with loamy sand soils are especially appropriate for bioretention because the excavated soil can be backfilled and used as the planting soil, thus eliminating the cost of importing planting soil.

The use of bioretention may not be feasible given an unstable surrounding soil stratum, soils with clay content greater than 25 percent, a site with slopes greater than 20 percent, and/or a site with mature trees that would be removed during construction of the BMP.

Bioretention can be designed to be off-line or on-line of the existing drainage system (EPA, 1999). The drainage area for a bioretention area should be between 0.1 and 0.4 hectares (0.25 and 1.0 acres). Larger drainage areas may require multiple bioretention areas. Furthermore, the maximum drainage area for a bioretention area is determined by the expected rainfall intensity and runoff rate. Stabilized areas may erode when velocities are greater than 5 feet per second (1.5 meter per second). The designer should determine the potential for erosive conditions at the site.

The size of the bioretention area, which is a function of the drainage area and the runoff generated from the area is sized to capture the water quality volume.

The recommended minimum dimensions of the bioretention area are 15 feet (4.6 meters) wide by 40 feet (12.2 meters) long, where the minimum width allows enough space for a dense, randomly-distributed area of trees and shrubs to become established. Thus replicating a natural forest and creating a microclimate, thereby enabling the bioretention area to tolerate the effects of heat stress, acid rain, runoff pollutants, and insect and disease infestations which landscaped areas in urban settings typically are unable to tolerate. The preferred width is 25 feet (7.6 meters), with a length of twice the width. Essentially, any facilities wider than 20 feet (6.1 meters) should be twice as long as they are wide, which promotes the distribution of flow and decreases the chances of concentrated flow.

In order to provide adequate storage and prevent water from standing for excessive periods of time the ponding depth of the bioretention area should not exceed 6 inches (15 centimeters). Water should not be left to stand for more than 72 hours. A restriction on the type of plants that can be used may be necessary due to some plants' water intolerance. Furthermore, if water is left standing for longer than 72 hours mosquitoes and other insects may start to breed.

The appropriate planting soil should be backfilled into the excavated bioretention area. Planting soils should be sandy loam, loamy sand, or loam texture with a clay content ranging from 10 to 25 percent.

Generally the soil should have infiltration rates greater than 0.5 inches (1.25 centimeters) per hour, which is typical of sandy loams, loamy sands, or loams. The pH of the soil should range between 5.5 and 6.5, where pollutants such as organic nitrogen and phosphorus can be adsorbed by the soil and microbial activity can flourish. Additional requirements for the planting soil include a 1.5 to 3 percent organic content and a maximum 500 ppm concentration of soluble salts.

Soil tests should be performed for every 500 cubic yards (382 cubic meters) of planting soil, with the exception of pH and organic content tests, which are required only once per bioretention area (EPA, 1999). Planting soil should be 4 inches (10.1 centimeters) deeper than the bottom of the largest root ball and 4 feet (1.2 meters) altogether. This depth will provide adequate soil for the plants' root systems to become established, prevent plant damage due to severe wind, and provide adequate moisture capacity. Most sites will require excavation in order to obtain the recommended depth.

Planting soil depths of greater than 4 feet (1.2 meters) may require additional construction practices such as shoring measures (EPA, 1999). Planting soil should be placed in 18 inches or greater lifts and lightly compacted until the desired depth is reached. Since high canopy trees may be destroyed during maintenance the bioretention area should be vegetated to resemble a terrestrial forest community ecosystem that is dominated by understory trees. Three species each of both trees and shrubs are recommended to be planted at a rate of 2500 trees and shrubs per hectare (1000 per acre). For instance, a 15 foot (4.6 meter) by 40 foot (12.2 meter) bioretention area (600 square feet or 55.75 square meters) would require 14 trees and shrubs. The shrub-to-tree ratio should be 2:1 to 3:1.

Trees and shrubs should be planted when conditions are favorable. Vegetation should be watered at the end of each day for fourteen days following its planting. Plant species tolerant of pollutant loads and varying wet and dry conditions should be used in the bioretention area.

The designer should assess aesthetics, site layout, and maintenance requirements when selecting plant species. Adjacent non-native invasive species should be identified and the designer should take measures, such as providing a soil breach to eliminate the threat of these species invading the bioretention area. Regional landscaping manuals should be consulted to ensure that the planting of the bioretention area meets the landscaping requirements established by the local authorities. The designers should evaluate the best placement of vegetation within the bioretention area. Plants should be placed at irregular intervals to replicate a natural forest. Trees should be placed on the perimeter of the area to provide shade and shelter from the wind. Trees and shrubs can be sheltered from damaging flows if they are placed away from the path of the incoming runoff. In cold climates, species that are more tolerant to cold winds, such as evergreens, should be placed in windier areas of the site.

Following placement of the trees and shrubs, the ground cover and/or mulch should be established. Ground cover such as grasses or legumes can be planted at the beginning of the growing season. Mulch should be placed immediately after trees and shrubs are planted. Two to 3 inches (5 to 7.6 cm) of commercially-available fine shredded hardwood mulch or shredded hardwood chips should be applied to the bioretention area to protect from erosion.

Maintenance

The primary maintenance requirement for bioretention areas is that of inspection and repair or replacement of the treatment area's components. Generally, this involves nothing more than the routine periodic maintenance that is required of any landscaped area. Plants that are appropriate for the site, climatic, and watering conditions should be selected for use in the bioretention cell. Appropriately selected plants will aide in reducing fertilizer, pesticide, water, and overall maintenance requirements. Bioretention system components should blend over time through plant and root growth, organic decomposition, and the development of a natural

soil horizon. These biologic and physical processes over time will lengthen the facility's life span and reduce the need for extensive maintenance.

Routine maintenance should include a biannual health evaluation of the trees and shrubs and subsequent removal of any dead or diseased vegetation (EPA, 1999). Diseased vegetation should be treated as needed using preventative and low-toxic measures to the extent possible. BMPs have the potential to create very attractive habitats for mosquitoes and other vectors because of highly organic, often heavily vegetated areas mixed with shallow water. Routine inspections for areas of standing water within the BMP and corrective measures to restore proper infiltration rates are necessary to prevent creating mosquito and other vector habitat. In addition, bioretention BMPs are susceptible to invasion by aggressive plant species such as cattails, which increase the chances of water standing and subsequent vector production if not routinely maintained.

In order to maintain the treatment area's appearance it may be necessary to prune and weed. Furthermore, mulch replacement is suggested when erosion is evident or when the site begins to look unattractive. Specifically, the entire area may require mulch replacement every two to three years, although spot mulching may be sufficient when there are random void areas. Mulch replacement should be done prior to the start of the wet season.

New Jersey's Department of Environmental Protection states in their bioretention systems standards that accumulated sediment and debris removal (especially at the inflow point) will normally be the primary maintenance function. Other potential tasks include replacement of dead vegetation, soil pH regulation, erosion repair at inflow points, mulch replenishment, unclogging the underdrain, and repairing overflow structures. There is also the possibility that the cation exchange capacity of the soils in the cell will be significantly reduced over time. Depending on pollutant loads, soils may need to be replaced within 5-10 years of construction (LID, 2000).

Cost

Construction Cost

Construction cost estimates for a bioretention area are slightly greater than those for the required landscaping for a new development (EPA, 1999). A general rule of thumb (Coffman, 1999) is that residential bioretention areas average about $3 to $4 per square foot, depending on soil conditions and the density and types of plants used. Commercial, industrial and institutional site costs can range between $10 to $40 per square foot, based on the need for control structures, curbing, storm drains and underdrains.

Retrofitting a site typically costs more, averaging $6,500 per bioretention area. The higher costs are attributed to the demolition of existing concrete, asphalt, and existing structures and the replacement of fill material with planting soil. The costs of retrofitting a commercial site in Maryland, Kettering Development, with 15 bioretention areas were estimated at $111,600.

In any bioretention area design, the cost of plants varies substantially and can account for a significant portion of the expenditures. While these cost estimates are slightly greater than those of typical landscaping treatment (due to the increased number of plantings, additional soil excavation, backfill material, use of underdrains etc.), those landscaping expenses that would be required regardless of the bioretention installation should be subtracted when determining the net cost.

Perhaps of most importance, however, the cost savings compared to the use of traditional structural stormwater conveyance systems makes bioretention areas quite attractive financially. For example, the use of bioretention can decrease the cost required for constructing stormwater conveyance systems at a site. A medical office building in Maryland was able to reduce the amount of storm drain pipe that was needed from 800 to 230 feet - a cost savings of $24,000 (PGDER, 1993). And a new residential development spent a total of approximately $100,000 using bioretention cells on each lot instead of nearly $400,000 for the traditional stormwater ponds that were originally planned (Rappahanock,). Also, in residential areas, stormwater management controls become a part of each property owner's landscape, reducing the public burden to maintain large centralized facilities.

Maintenance Cost

The operation and maintenance costs for a bioretention facility will be comparable to those of typical landscaping required for a site. Costs beyond the normal landscaping fees will include the cost for testing the soils and may include costs for a sand bed and planting soil.

References and Sources of Additional Information

Coffman, L.S., R. Goo and R. Frederick, 1999: Low impact development: an innovative alternative approach to stormwater management. Proceedings of the 26th Annual Water Resources Planning and Management Conference ASCE, June 6-9, Tempe, Arizona.

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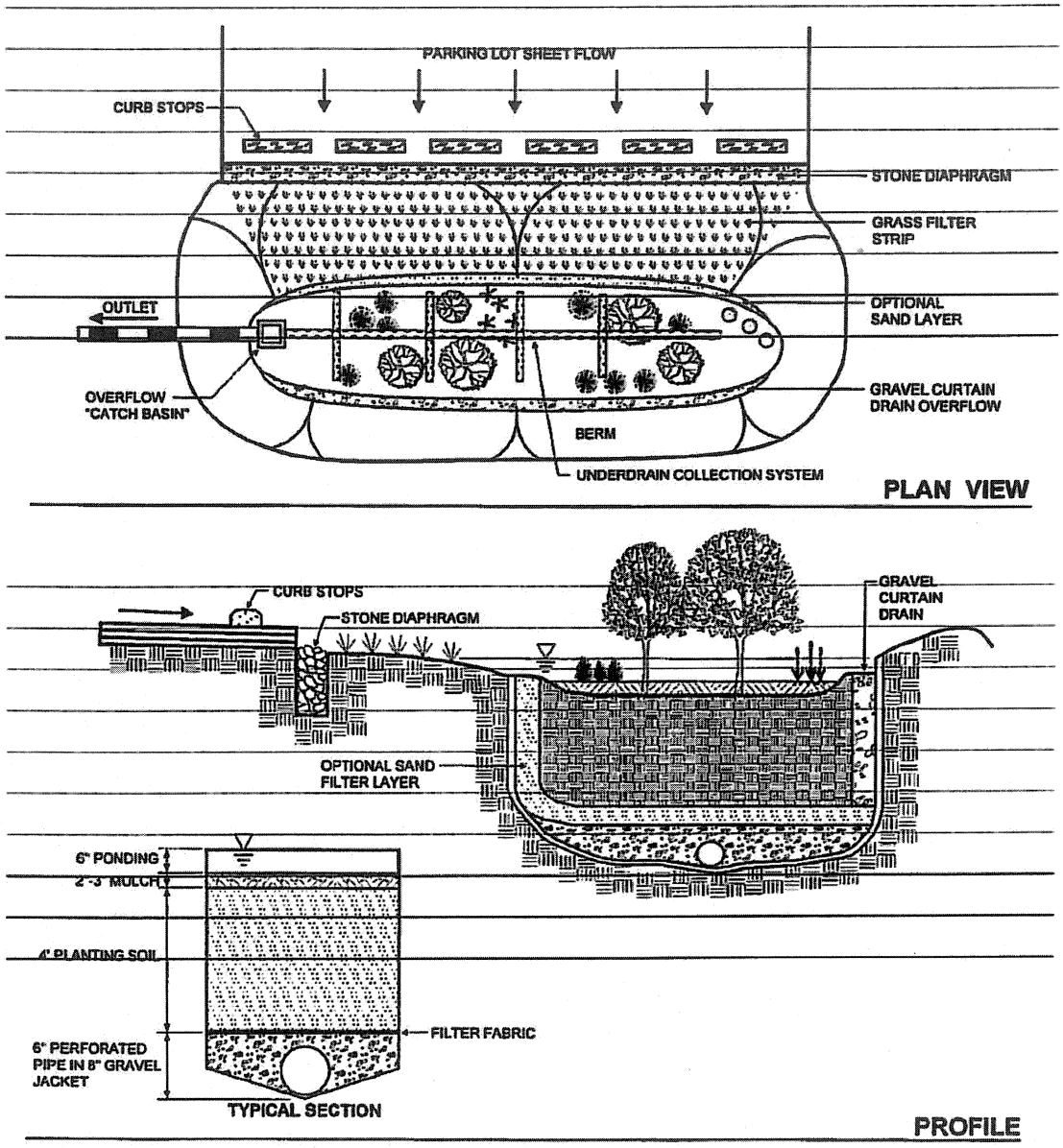
Weinstein, N. Davis, A.P. and Veeramachaneni, R. "Low Impact Development (LID) Stormwater Management Approach for the Control of Diffuse Pollution from Urban Roadways," *5th International Conference Diffuse/Nonpoint Pollution and Watershed Management Proceedings*, C.S. Melching and Emre Alp, Eds. 2001 International Water Association



Schematic of a Bioretention Facility (MDE, 2000)

BIO-7: Proprietary Biotreatment

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

Also known as:

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

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

Feasibility Screening Considerations

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

Opportunity Criteria

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

OC-Specific Design Criteria and Considerations

- ☐ Frequent maintenance and the use of screens and grates to keep trash out may decrease the likelihood of clogging and prevent obstruction and bypass of incoming flows.
- ☐ Consult proprietors for specific criteria concerning the design and performance.
- ☐ Proprietary biotreatment may include specific media to address pollutants of concern. However, for proprietary device to be considered a biotreatment device the media must be capable of supporting rigorous growth of vegetation.
- ☐ Proprietary systems must be acceptable to the reviewing agency. Reviewing agencies shall have the discretion to request performance information. Reviewing agencies shall have the discretion to deny the use of a proprietary BMP on the grounds of performance, maintenance considerations, or other relevant factors.

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

Computing Sizing Criteria for Proprietary Biotreatment Device

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

Additional References for Design Guidance

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

Filterra Bioretention Systems

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(866) 349-3458

Low Impact Development Solutions for Stormwater Runoff

Filterra Bioretention Systems is the leading provider of stormwater biofiltration systems for the treatment of stormwater runoff generated from parking lots, roadways, commercial and residential developments. The Filterra System can be built in a variety of sizes, models and configurations. Filterra's compact size makes it ideal for both urban retrofits and space-constrained new developments. Filterra is easy to install, simple to maintain, and is approved by over 500 local, regional and state agencies.

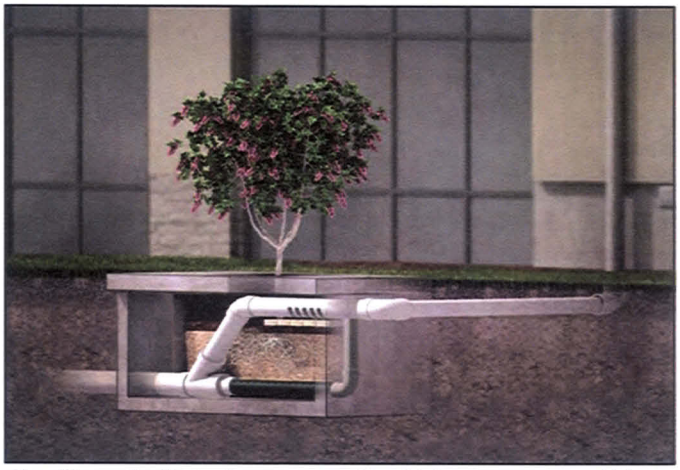
Standard Filterra® System

The standard Filterra System is similar in concept to "raingardens" in its function and application but has been optimized for high volume/flow treatment and high pollutant removal.

Filterra® Curb Inlet with Internal Bypass System

The Filterra Curb Inlet with Internal Bypass system incorporates biofiltration and an internal high flow bypass chamber into one single structure. This system eliminates the need and cost of installing a separate bypass structure and enables placement on grade or at low points.

Filterra® Roofdrain System



The Filterra Roofdrain System treats "Piped-In" stormwater runoff from rooftops and area drains. Using biofiltration, the system captures and immobilizes pollutants of concern such as: TSS, nutrients, oils, greases, metals and bacteria.

Filterra® combined with Underground Storage

Filterra combined with underground storage provides complete stormwater capture, treatment and storage in one packaged system. Surface flows can be conveyed into the Filterra and discharged to any underground storage system for detention, retention and re-use applications including landscape irrigation systems.

Filterra Bioretention Systems

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Standard Filterra System
Richmond, VA

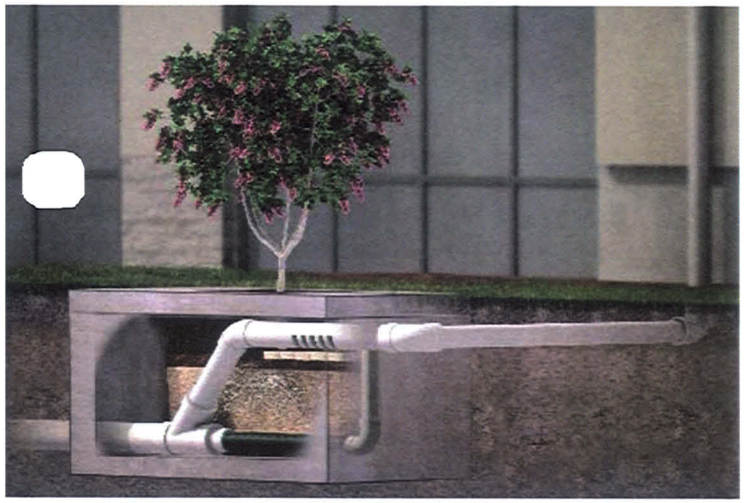
Standard Filterra System
Independence, WA

Filterra Roofdrain System
Salem, VA

Filterra Curb Inlet with Internal Bypass
Everett, WA

Standard Filterra System with Modified Recessed Top
Charlottesville, VA

Standard Filterra System Linear/ROW Application
Mill Creek, WA



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Bioretention Systems
CELEBRATING 10 YEARS
by KRISTAR

Filterra® Roofdrain Stormwater Treatment System

A Greenroof at Ground Level™

Filterra® Roofdrain System

The Filterra Roofdrain System treats piped in stormwater runoff from rooftops. Using bioretention filtration the system captures and immobilizes pollutants of concern such as: TSS, nutrients and metals.

Stormwater continues to flow through the media and into the underdrain system, where treated water is discharged. Higher flows bypass the bioretention treatment via an overflow/bypass pipe design.

Features and Benefits

Best Value for Rooftop Treatment.

- **compact size**
- **needs no external bypass**
- **easy installation**
- **simple maintenance**

Versatile.
Filterra Roofdrain can be used for:

- **new construction**
- **retrofits**
- **commercial or residential applications.**

Filterra Roofdrain can be placed:

- **At grade**
- **Above grade with effluent below grade to meet elevation challenges of high water tables**
- **Install next to or away from your building**

Maintenance. Maintenance is simple and safe (at ground level), and the first year is provided FREE with the purchase of every unit. The procedure is so easy you can perform it yourself.

Protection. The Filterra Roofdrain's hydraulic configuration was tested by the Colorado State University Hydraulics Laboratory.

Below grade treatment using Filterra Roofdrain avoids the slipping hazard liabilities of daylighted roofdrains during freezing weather.

Protect from erosion with Filterra's monolithic water tight design.

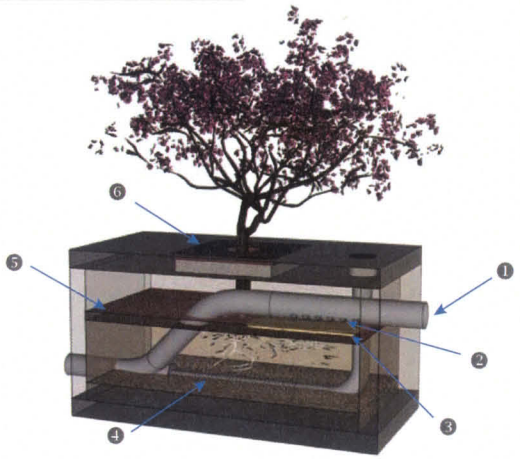
Expected Pollutant Removal

(Ranges Varying with Particle Size, Pollutant Loading and Site Conditions)

TSS Removal	85%
Phosphorus Removal	60% - 70%
Zinc Removal	> 66%
Copper Removal	>58%
Nitrogen Removal	43%
Oil & Grease	> 93%

Information on the pollutant removal efficiency of the filter soil/plant media is based on third party lab and field studies.

Filterra media has been TAPE and TARP tested and approved.



1. Influent Pipe from Roof Leader
2. Pipe slots allow treatment flow to media surface
3. Erosion Control
4. Perforated Underdrain for Treatment Flows
5. Protective Mulch Layer
6. Cast Iron Tree Grate for Maintenance Access

filterra
Bioretention Systems
CELEBRATING 10 YEARS
by KRISTAR

Filterra® Roofdrain Stormwater Treatment System

A Greenroof at Ground Level™

Design Guidelines

1) Use the Filterra Roofdrain Design Guidance as a reference available from info@kristar.com.

2) Select Filterra Roofdrain model according to your Regional Sizing Table, and according to the building's roof drainage area and associated roof drain pipe sizes.

3) Determine Filterra Roofdrain placement next to a building, or away from your building.

4) Ensure piping to and from Filterra Roofdrain system is free-draining at minimum 1% slope, or per local codes.

Placement Review

Because we want your project with Filterra to be a great success, we respectfully require that each Filterra Roofdrain project be reviewed by our placement/design staff. This review is mandatory, as proper placement ensures you of the most efficient and cost effective solution, as well as optimum performance and minimal maintenance.

Proper Placement

1) Pipe flow of the Filterra Roofdrain System eliminates the cross-linear flow requirements necessary with standard Filterra.

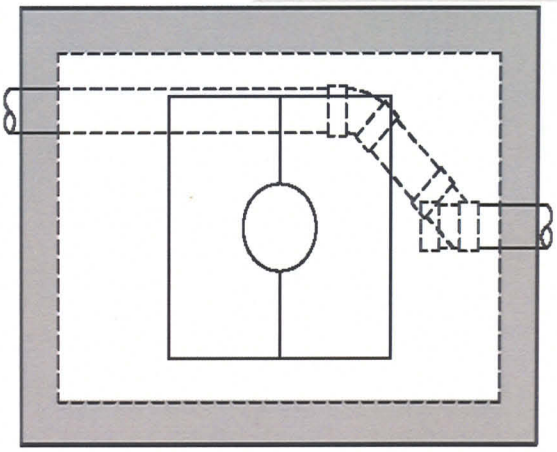
2) Filterra Roofdrain Systems should only receive piped in runoff.

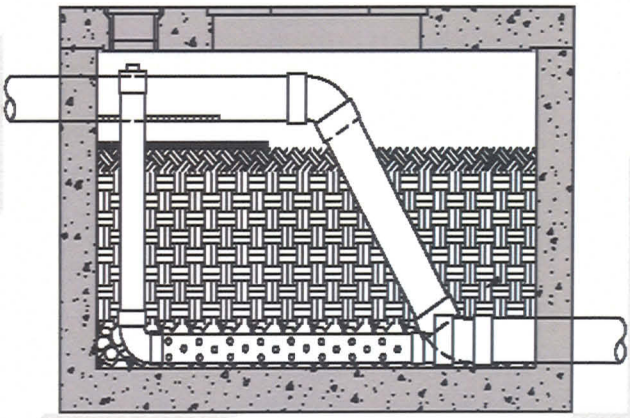
3) Rooftop drainage should still be designed with emergency bypass relief prior to the Filterra Roofdrain System (e.g.: rooftop scuppers, etc.)

Always follow local plumbing codes for roof drainage requirements.

The Filterra System is not a substitute for rooftop overflow/bypass.

4) Send completed project information form along with plans to KriStar for placement and application review.





Filterra Roofdrain System
One pipe in, one pipe out, with internal high-flow bypass.

Western Region Support
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Yucaipa, CA 92399

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360 Sutton Place
Santa Rosa, CA 95407

Toll Free: (800) 579-8819 • F: (707) 524-8186

E-mail: info@kristar.com • Web: www.kristar.com

Bacterra™ is ideal for urban retrofits

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Bacterra™ Media Blend

Optimized Filterra® media blend for bacteria removal

Why Bacterra™ ?

Adverse economic and public health impacts are on the rise due to increasing bacterial contamination of our swimmable and fishable waters from urban runoff. In response to this growing problem, Filterra® Bioretention Systems has developed Bacterra media blend, an effective stormwater treatment technology for removal of bacteria from urban runoff. Designed to treat bacteria at the source, Bacterra can help meet local TMDLs, and reduce public health threats and sources of bacteria to beaches and rivers.

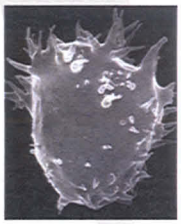
Removal Mechanisms

The standard Filterra media blend is currently designed to remove typical stormwater pollutants such as TSS, phosphorus, nitrogen, heavy metals, and oil and grease. Bacterra media blend has been optimized to capture and destroy bacteria, and relies on multiple pollutant removal mechanisms. Once the Bacterra media has matured, it develops a complex natural microbiological ecosystem that enhances predation, and other physical, chemical and biological processes that all contribute to the removal process. The coarse sand filtration media provides both pore space and a high degree of surface area to support biofilm development. The complex organics and plants support growth of an advanced biological population. Microscopic examination of mulch and media samples from in-service Bacterra units reveals the presence of a dynamic and diverse microbial population including flagellates, ciliates and amoebae (Figure 1). These results were notable for the high concentrations of protozoa, a higher order class of organisms that are known to prey upon bacterial populations as a primary food source.

Figure 1 (Protozoan Classes Observed in Bacterra™ Media Blend)

Ciliate

Flagellate



Amoeba

1. Photos courtesy www.blm.gov/nstc/soil/protozoa/index.html and www.tvt-bio.com/micro2.html

07/2011

Pollutant Removal

Like standard Filterra media blend which removes typical stormwater pollutants, Bacterra media blend is expected to remove as much or more pollutants with higher bacteria removal. Bacterra media blend is recommended if higher bacteria removal is desired.

(Ranges Varying with Particle Size, Pollutant Loading and Site Conditions)

E. coli	99%[1], 99%[2]
Fecal Coliform	98%[1], 99%[2]
Enterococcus	95%[1], 99%[2]
TSS*	87%[1], 92%[2]
Predicted Phosphorus	60% - 70%
Predicted Nitrogen	42% - 45%
Predicted Oil & Grease	> 93%
Predicted Total Zinc	> 66%
Predicted Total Copper	> 58%

*For influent concentration >10mg/L [1]Average [2]Median percentages

Information on the pollutant removal efficiency of the filter soil/plant media is based on third party field studies and lab data.

Filterra standard media blend has been TAPE and TARP tested and approved.

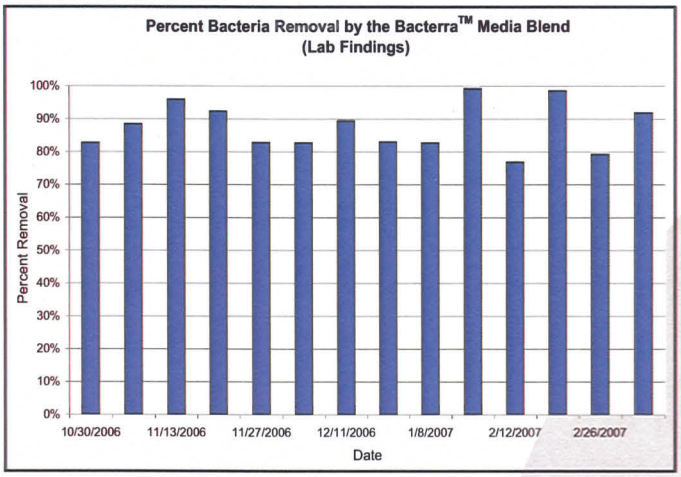
filterra
Bioretention Systems
CELEBRATING 10 YEARS
by KRISTAR

Bacterra™ Media Blend

Optimized Filterra® media blend for bacteria removal

Laboratory Findings

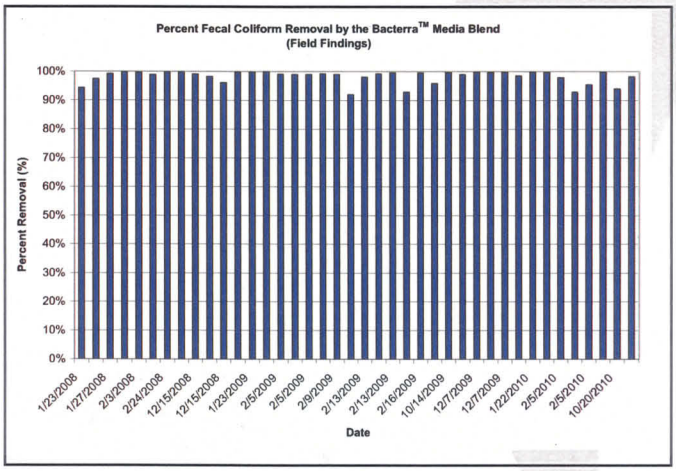
- Removal efficiencies ranging from 77% - 99%.



Field Findings

- Average Fecal coliform , E. coli, & Enterococcus removal efficiencies of **95% - 99%**

- Average TSS removal efficiencies of 87% for influent concentration >10mg/L



E.coli & Enterococcus field findings showed similar results to Fecal coliform.

Based on lab and field data, Bacterra demonstrates that a high flow rate media can achieve high removal efficiencies. Lab data showing removal rates of 77% - 99% has been supported by field results showing removal rates of 95% - 99%.

All testing conducted using approved EPA methods. Field data obtained by third parties.

Features and Benefits

Water Quality. Achieve receiving water quality goals and reduce sources of bacteria to beaches, rivers and fisheries.

Best Value. The most cost effective stormwater treatment system available featuring low cost, easy installation and maintenance.

Aesthetics. Landscaping enhances the appearance of your site making it more attractive while removing pollutants.

Maintenance Support. Maintenance is safe and inexpensive; a one year maintenance agreement is included free with the purchase of every unit.

Versatility. Use for new construction or as an urban retrofit device.

- **Streetscapes**
- **Parking lots**
- **Highways**
- **Industrial settings**
- **Urban settings**
- **Filterra Roofdrains**
- **Combined Sewer Overflows (CSO)**

Design Support. KriStar engineers can assist you with all aspects of each Bacterra application, including flora selection and sizing. *Contact us to request a sizing table for your region.

Adaptability. May be used alone or in combination with other BMPs.

Selection. Varying configurations to meet both standard and unique site conditions.

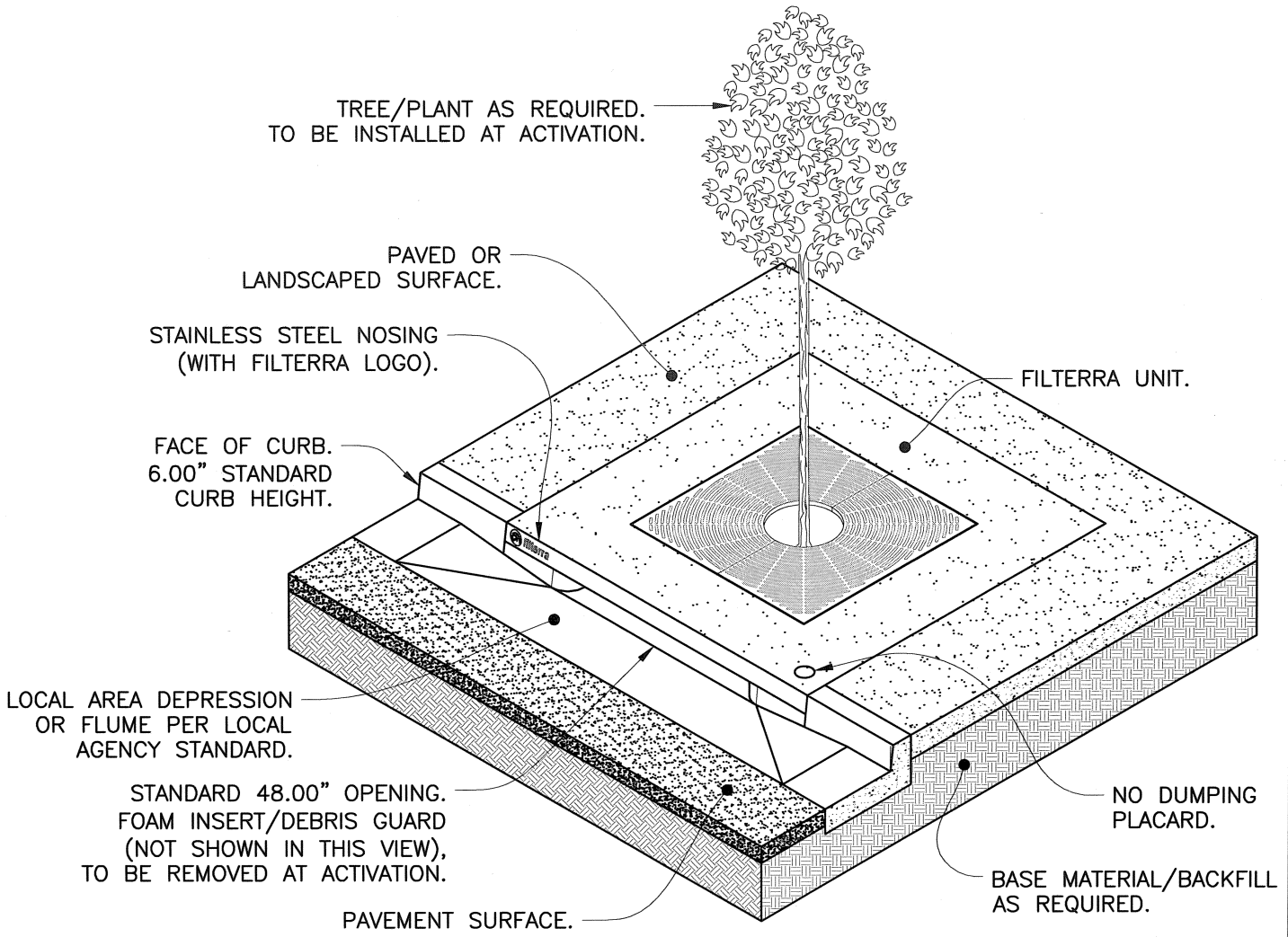
More Information

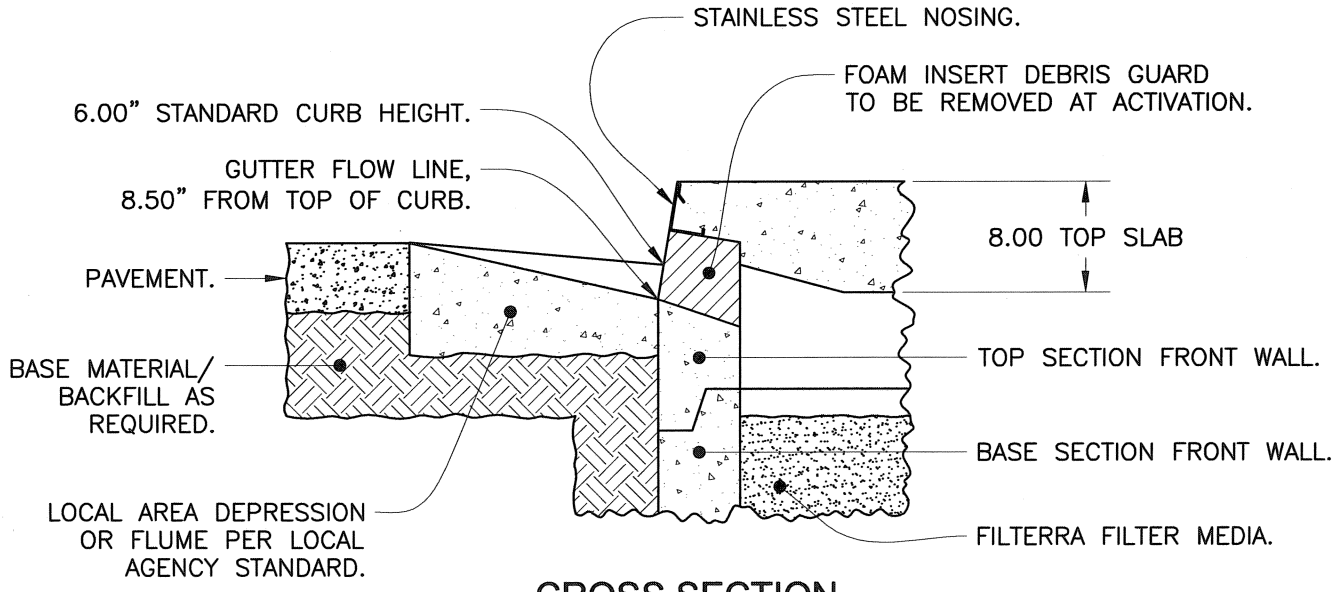
Visit **www.filterra.com** for a list of FAQ's about the standard Filterra system and Bacterra media blend, and a product animation featuring how the Filterra system works and maintenance.

Western Region Support
34428 Yucaipa Blvd., Suite E-312
Yucaipa, CA 92399

KriStar Enterprises, Inc.
360 Sutton Place
Santa Rosa, CA 95407

Toll Free: (800) 579-8819 • F: (707) 524-8186
E-mail: info@kristar.com • Web: www.kristar.com





CROSS SECTION

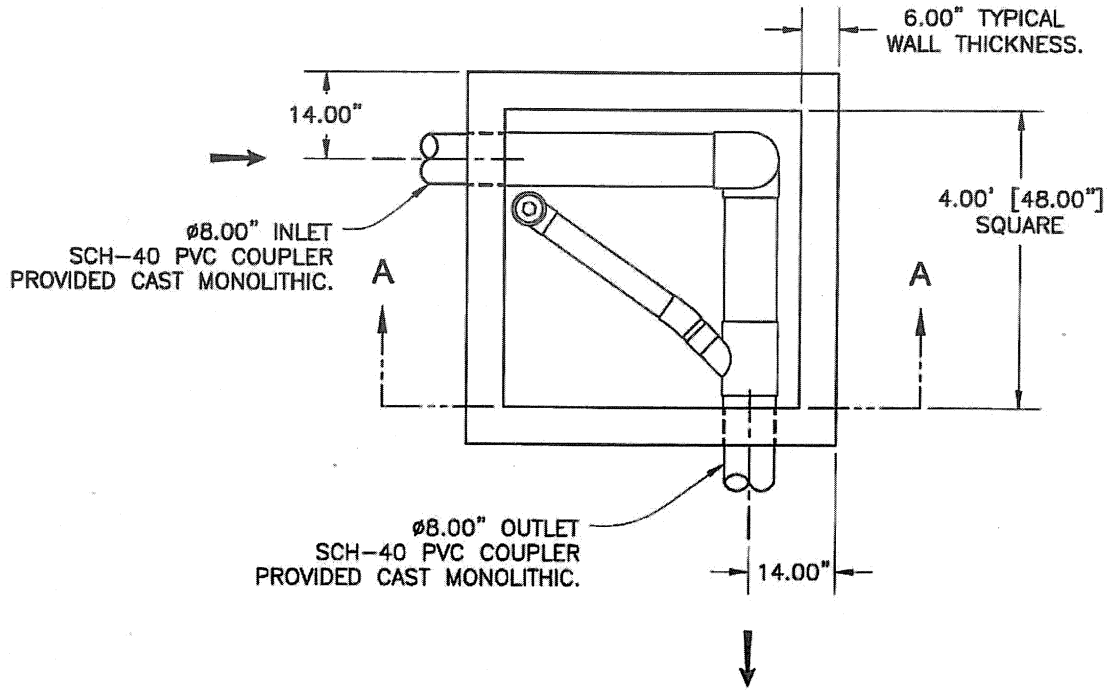
Filterra®
Precast Curb Inlet Opening and Gutter / Flume Detail

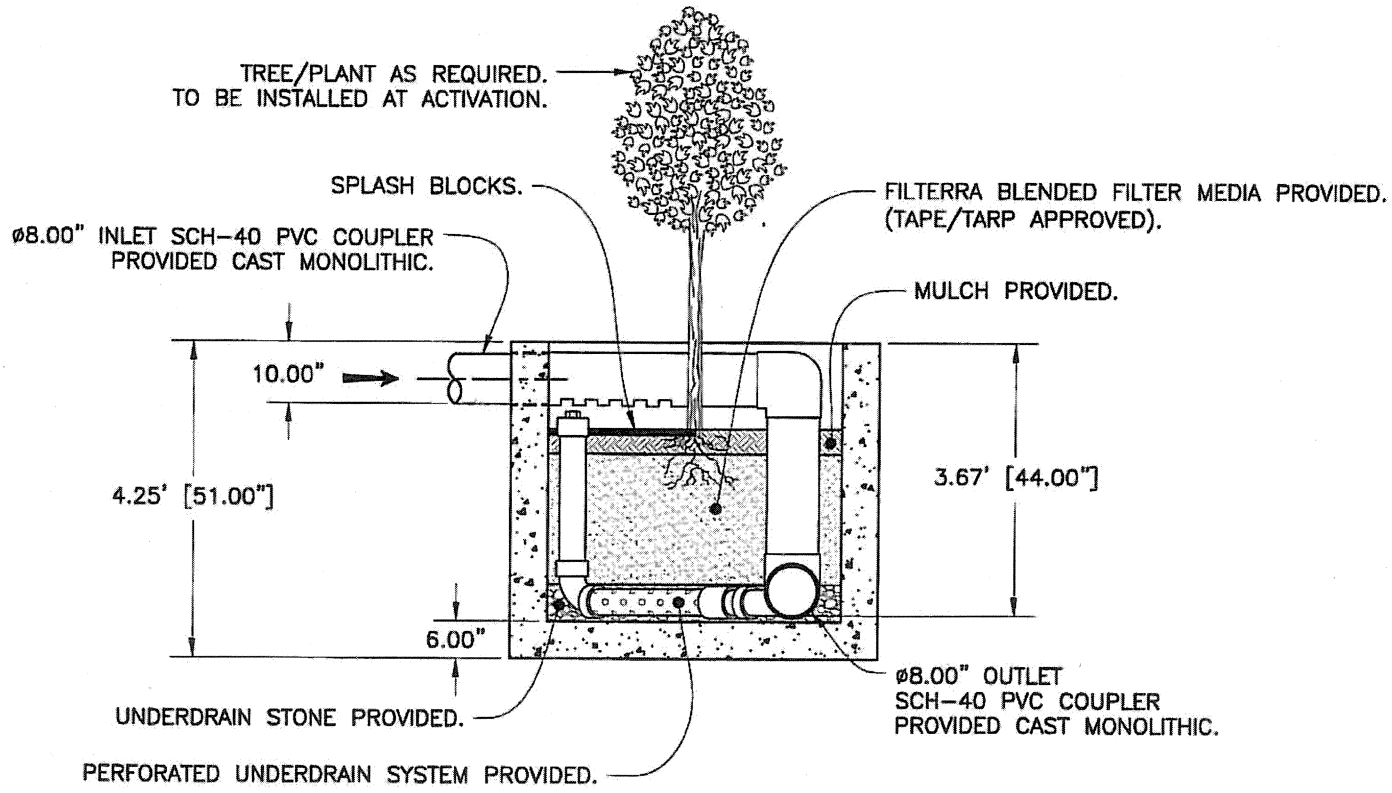
KriStar Enterprises, Inc.
360 Sutton Place, Santa Rosa, CA 95407
Ph: 800.579.8819, Fax: 707.524.8186, www.kristar.com

filterra®
US PAT 6,277,274
AND 6,569,321

DRAWING NO.	REV	F-ECO	DATE
K-CGT	03	0006 JPR 6/17/11	JPR 1/17/11

K-FTRD-4X4-8D





ILE

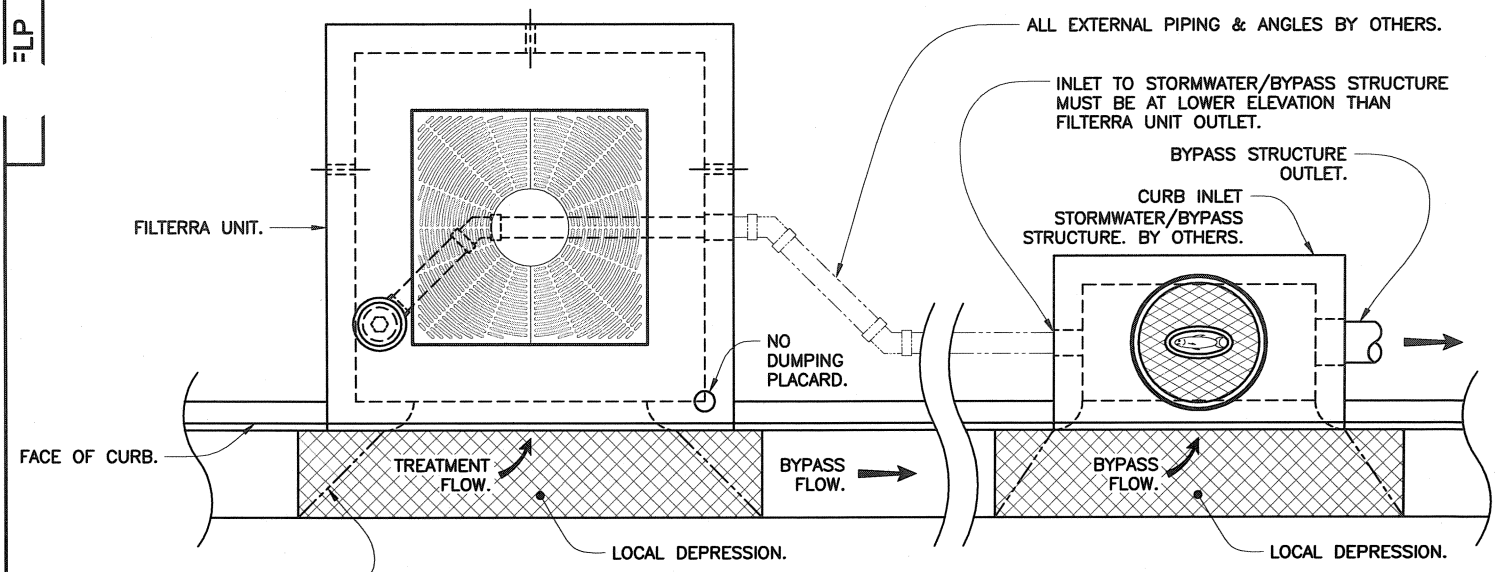
4'X4' Precast Filterra® Unit Roof Drain Configuration with Ø8" PVC Inlet

KriStar Enterprises, Inc.
360 Sutton Place, Santa Rosa, CA 95407
Ph: 800.579.8819, Fax: 707.524.8186, www.kristar.com

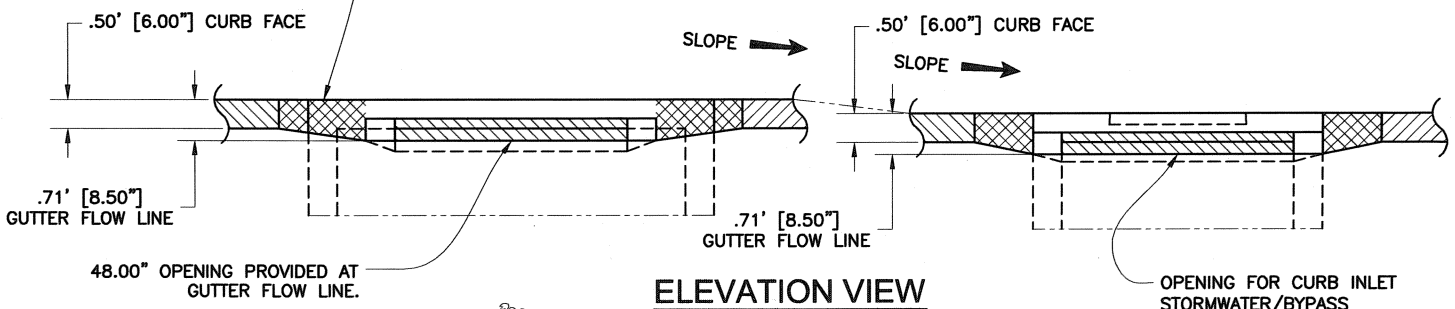
filterra® US PAT 6,277,274 AND 6,569,321

DRAWING NO.	REV	F-ECO	DATE
K-FTRD-4X4-8D	02	0006 NEW 6/17/11	JPR 1/19/11

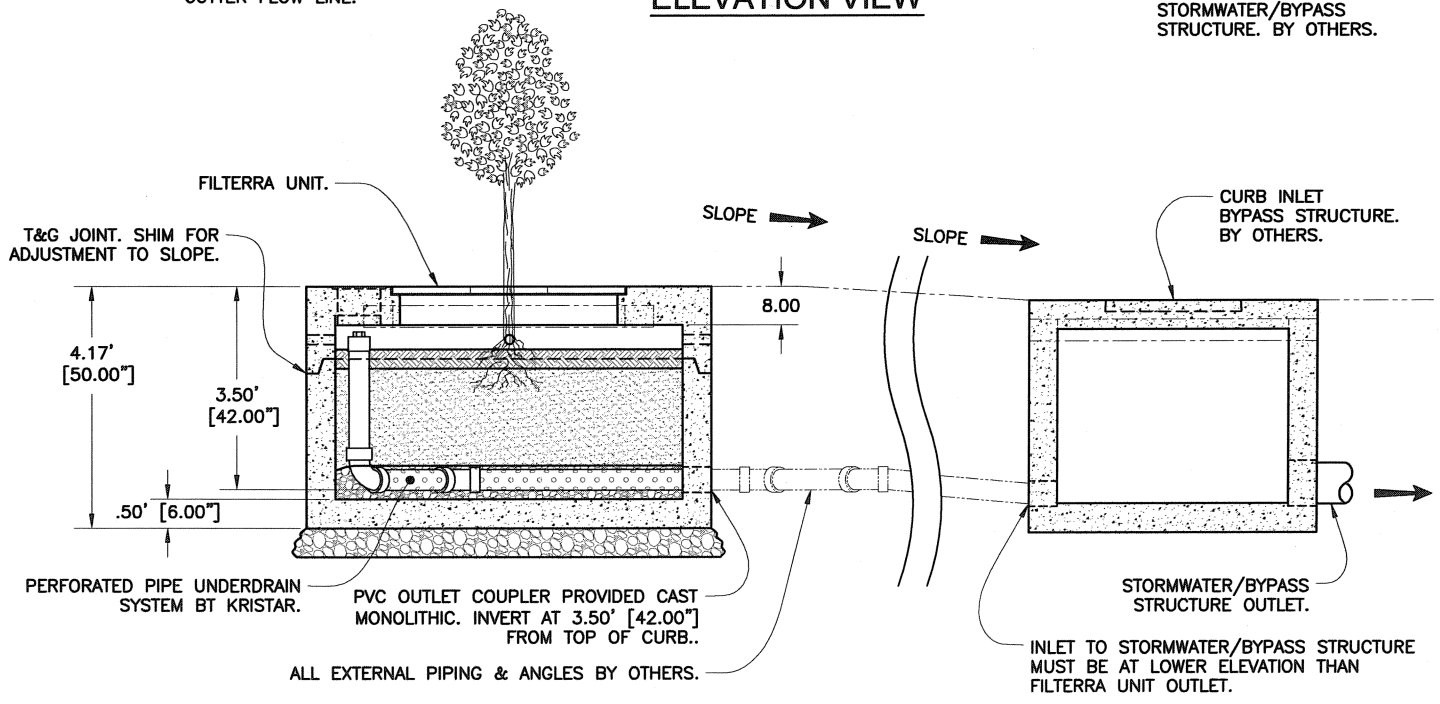
=LP



PLAN VIEW



ELEVATION VIEW



CROSS SECTION

TITLE

Filterra®

Typical Flowline and Outlet Pipe Relationship

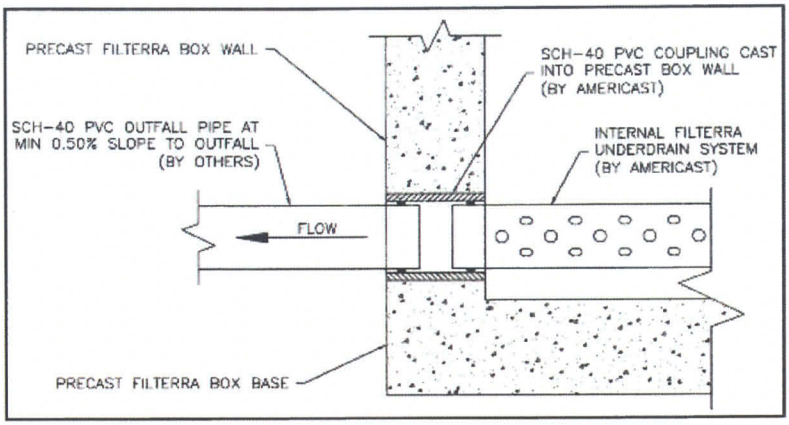
KriStar Enterprises, Inc.
360 Sutton Place, Santa Rosa, CA 95407
Ph: 800.579.8819, Fax: 707.524.8186, www.kristar.com

filterra®
US PAT 6,277,274 AND 6,569,321

DRAWING NO.	REV	F-ECO	DATE
K-FLP	03	0006 JPR 6/17/11	JPR 1/5/11

Filterra® Piping Technical Details

Filterra® is supplied with an internal underdrain system that exits a wall in a perpendicular direction. Most efficient drainage is accomplished when the drain exits on the lower side of the Filterra®, i.e. nearest the overflow bypass. This is more important when using the larger sized Filterra® Systems.



Drawing DP1:
Section View through Filterra Precast Box Wall at Outfall Pipe Connection

All units are supplied with the drainage pipe coupling precast into the wall, at a depth of 3.50 feet (INV to TC). Drawing DP1 is a detail of the coupling. The coupling used is SCH-40 PVC.

Typically, a minimum slope of 0.5% is adequate to accommodate the flow of treated water from the Filterra®, but each site may present unique conditions based on routing of the outfall pipe (elbows). The pipe must not be a restricting point for the successful operation of Filterra®. All connecting pipes must accommodate freefall flow. Table 3 lists WA DOE approved treatment sizing flow rates of the various size Filterra® units. A safety factor of at least two should be used to size piping from the Filterra based on these conservative approved treatment flow rates.

Table 3: Filterra Flow Rates & Pipe Details

Important Note: Actual flow rate may be more than double rates below.

Filterra® Size (feet)	Expected Flow Rate (cubic feet/second)	Connecting Drainage Pipe
4x4	0.037	4" SCH-40 PVC
4 x 6 or 6 x 4	0.061	4" SCH-40 PVC
4x6.5 or 6.5x4	0.061	4" SCH-40 PVC
4 x 8 or 8 x 4	0.075	4" SCH-40 PVC
4x16 or 16x4	0.150	6" SCH-40 PVC
6 x 6	0.084	4" SCH-40 PVC
6 x 8 or 8 x 6	0.112	4" SCH-40 PVC
6 x 10 or 10 x 6	0.140	6" SCH-40 PVC
6 x 12 or 12 x 6	0.168	6" SCH-40 PVC
8x12 or 12x8	0.224	6" SCH-40 PVC
8x16 or 16x8	0.229	6" SCH-40 PVC
8x18 or 18x8	0.337	6" SCH-40 PVC
8x20 or 20x8	0.374	6" SCH-40 PVC

Filterra® Maintenance Steps

1. Inspection of Filterra and surrounding area

2. Removal of tree grate and erosion control stones

3. Removal of debris, trash and mulch

4. Mulch replacement

5. Clean area around Filterra

6. Complete paperwork and record plant height and width

For additional information please contact your local Filterra sales representative.
Eastern Zone: 866-349-3458, Western Zone: 877-345-1450.

Section VII

SECTION VII EDUCATIONAL MATERIALS

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

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

Appendices

APPENDICES

Appendix A.....Supporting Calculations
Appendix B.....Notice of Transfer of Responsibility
Appendix C.....Educational Materials
Appendix D.....BMP Maintenance Supplement / O&M Plan
Appendix E.....Conditions of Approval (Placeholder – Pending)
Appendix F.....Infiltration Test Results

Appendix A

APPENDIX A

SUPPORTING CALCULATIONS

SUBJECT TO FURTHER REVISION

LEGEND

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

Rainfall Zones

Design Capture Storm Depth (inches)

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

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

Project Site

0 3 6 12 Kilometers

0 1.8 3.6 7.2 Miles

TITLE

RAINFALL ZONES

ORANGE COUNTY TECHNICAL GUIDANCE DOCUMENT

CA

JOB

ORANGE CO.

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

PACE
Advanced Water Engineering

FIGURE

XVI-1

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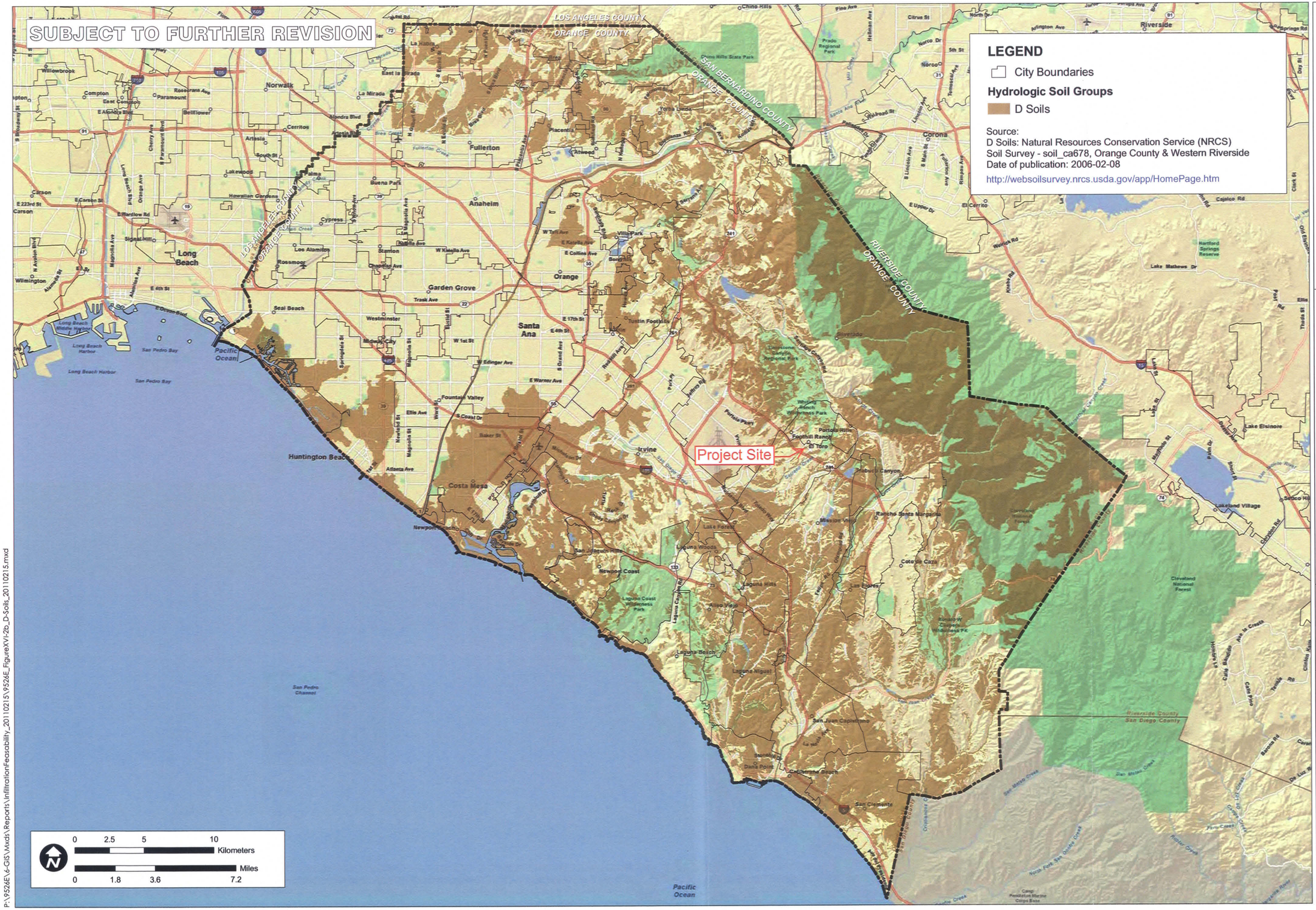
SUBJECT TO FURTHER REVISION



LEGEND

City Boundaries

Hydrologic Soil Groups

D Soils

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

TITLE: HYDROLOGIC SOIL GROUP
TYPE D NRCS SOIL SURVEY

ORANGE COUNTY
INFILTRATION STUDY

CA

JOB: ORANGE CO.

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

PACE
Advanced Water Engineering

FIGURE
XVI-2b

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Preliminary Storm Water Quality Design Calculations

4/3/2012

Storm Water Design Capture Volume (DCV)

										Biotreatment	
Drainage Area Name	% impervious	Runoff Coefficient	Design Storm Depth (in)	Average 2-year Tc (min)	Rainfall Intensity (in/hr)	Drainage Area (ft^2)	Drainage Area (acres)	DCV (ft^3)	Q (cfs)	Unit Size	Cost Estimate
Assumes No HSCs											
A1+A2 (Filterra #1)	90%	0.83	0.95	9.11	0.23	69,260	1.59	**4,531.8**	**0.30**	see 80% Capture	
A3 (Filterra #2)	80%	0.75	0.95	9.21	0.23	48,787	1.12	**2,902.5**	**0.19**	2-6x8	$26,800
A4 (Filterra #3)	85%	0.79	0.95	9.7	0.225	71,874	1.65	**4,489.4**	**0.29**	2-6x12	$40,000
A6 (Filterra #4)	90%	0.83	0.95	10	0.225	56,192	1.29	**3,676.7**	**0.24**	2-6x10	$34,200
A5 North (Filterra #5)	85%	0.79	0.95	10	0.225	54,450	1.25	**3,401.1**	**0.22**	2-6x8	$26,800
A5 South (Filterra #6)	85%	0.79	0.95	9	0.23	56,628	1.30	**3,537.1**	**0.24**	2-6x10	$34,200
Total	86.07%	0.80	0.95	9.5	0.225	357,192	8.20	**22,538.7**	**1.47**		$188,800
80% Capture											
A1+A2 (Filterra #1)	90%	0.83	0.95	9.11	0.17	69,260	1.59	**4,531.8**	**0.22**	2-6x8	$26,800

assumes Filterra

Worksheets from Orange County Technical Guidance Document (5-19-2011)

See TGD for instructions and/or examples related to these worksheets:
www.ocwatersheds.com/WQMP.aspx

Table 2.7: Infiltration BMP Feasibility Worksheet

	Infeasibility Criteria	*Yes*	*No*
1	**Would Infiltration BMPs pose significant risk for groundwater related concerns?** Refer to Appendix VII (Worksheet I) for guidance on groundwater-related infiltration feasibility criteria.		X
Provide basis: *Groundwater was not encountered during the geotechnical investigations.* Summarize findings of studies provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability.			
2	Would Infiltration BMPs **pose significant risk of increasing risk of geotechnical hazards that cannot be mitigated to an acceptable level**? (Yes if the answer to any of the following questions is yes, as established by a geotechnical expert): The BMP can only be located less than 50 feet away from slopes steeper than 15 percent The BMP can only be located less than eight feet from building foundations or an alternative setback. A study prepared by a geotechnical professional or an available watershed study substantiates that storm water infiltration would potentially result in significantly increased risks of geotechnical hazards that cannot be mitigated to an acceptable level.		X
Provide basis: *The site is relatively flat. The western portions of the site consist generally of engineered fill placed during the grading activities for nearby Bake Parkway. The eastern/northeastern portion of the site generally consists as cut bedrock at the surface, with the exception of the placement of engineered fill for over-excavation of a cut to fill transition in support of the existing car dealership structure at the northeast portion of the site.* Summarize findings of studies provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability.			
3	Would infiltration of the DCV from drainage area **violate downstream water rights**?		X
Provide basis: Summarize findings of studies provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability.			

Table 2.7: Infiltration BMP Feasibility Worksheet (continued)

	Partial Infeasibility Criteria	*Yes*	*No*
4	Is proposed infiltration facility **located on HSG D soils** or the site geotechnical investigation identifies presence of soil characteristics which support categorization as D soils?	X	
Provide basis: *Refer to Figure XVI-db in Appendix A.* Summarize findings of studies provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability.			
5	Is **measured infiltration rate below proposed facility less than 0.3 inches per hour**? This calculation shall be based on the methods described in Appendix VII.	X	
Provide basis: *Based on 3 borings conducted on-site, the measured infiltration rate averaged 0.044 in/hr prior to applying safety factors. After applying a safety factor of 3, the design infiltration rate provided by the geotechnical engineer is 0.014 in/hr. Refer to Appendix F for infiltration test results.* Summarize findings of studies provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability.			
6	Would **reduction of over predeveloped conditions cause impairments to downstream beneficial uses, such as change of seasonality of ephemeral washes or increased discharge of contaminated groundwater to surface waters?**		X
Provide citation to applicable study and summarize findings relative to the amount of infiltration that is permissible: Summarize findings of studies provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability.			
7	Would **an increase in infiltration over predeveloped conditions cause impairments to downstream beneficial uses, such as change of seasonality of ephemeral washes or increased discharge of contaminated groundwater to surface waters?**		X
Provide citation to applicable study and summarize findings relative to the amount of infiltration that is permissible: Summarize findings of studies provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability.			

Table 2.7: Infiltration BMP Feasibility Worksheet (continued)

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

Worksheet H: Factor of Safety and Design Infiltration Rate Worksheet

Factor Category		Factor Description	Assigned Weight (w)	Factor Value (v)	Product (p) p = w x v
A	Suitability Assessment	Soil assessment methods	0.25	1	0.25
		Predominant soil texture	0.25	3	0.75
		Site soil variability	0.25	1	0.25
		Depth to groundwater / impervious layer	0.25	1	0.25
		Suitability Assessment Safety Factor, $S_A = \Sigma p$			1.5
B	Design	Tributary area size	0.25	2	0.5
		Level of pretreatment/ expected sediment loads	0.25	1	0.25
		Redundancy	0.25	2	0.5
		Compaction during construction	0.25	3	0.75
		Design Safety Factor, $S_B = \Sigma p$			2
Combined Safety Factor, $S_{TOT} = S_A \times S_B$					3
Measured Infiltration Rate, inch/hr, K_M (corrected for test-specific bias)					0.044
Design Infiltration Rate, in/hr, $K_{DESIGN} = S_{TOT} / K_M$					0.014

Supporting Data

Briefly describe infiltration test and provide reference to test forms:

See Appendix F for infiltration test information & data.

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

For all high concerns, assign a factor value of 3, for medium concerns, assign a factor value of 2, and for low concerns assign a factor value of 1.

Table VII.3: Suitability Assessment Related considerations for Infiltration Facility Safety Factors

Consideration	High Concern	Medium Concern	Low Concern
Assessment methods (see explanation below)	Use of soil survey maps or simple texture analysis to estimate short-term infiltration rates	Direct measurement of ≥ 20 percent of infiltration area with localized infiltration measurement methods (e.g., infiltrometer)	Direct measurement of ≥ 50 percent of infiltration area with localized infiltration measurement methods or Use of extensive test pit infiltration measurement methods
Texture Class	Silty and clayey soils with significant fines	Loamy soils	Granular to slightly loamy soils
Site soil variability	Highly variable soils indicated from site assessment or limited soil borings collected during site assessment	Soil borings/test pits indicate moderately homogeneous soils	Multiple soil borings/test pits indicate relatively homogeneous soils
Depth to groundwater/ impervious layer	<5 ft below facility bottom	5-10 ft below facility bottom	>10 below facility bottom

Localized infiltration testing refers to methods such as the double ring infiltrometer test (ASTM D3385-88) which measure infiltration rates over an area less than 10 sq-ft, may include lateral flow, and do not attempt to account for heterogeneity of soil. The amount of area each test represents should be estimated depending on the observed heterogeneity of the soil.

Extensive infiltration testing refers to methods that include excavating a significant portion of the proposed infiltration area, filling the excavation with water, and monitoring drawdown. The excavation should be to the depth of the proposed infiltration surface and ideally be at least 50 to 100 square feet.

In all cases, testing should be conducted in the area of the proposed BMP where, based on review of available geotechnical data, soils appear least likely to support infiltration.

Table VII.4: Design Related Considerations for Infiltration Facility Safety Factors

Consideration	High Concern	Medium Concern	Low Concern
Tributary area size	Greater than 10 acres	Greater than 2 acres but less than 10 acres	2 acres or less
Level of pretreatment/ expected influent sediment loads	Pretreatment from gross solids removal devices only, such as Hydrodynamic separators, racks and screens AND tributary area includes landscaped areas, steep slopes, high traffic areas, or any other areas expected to produce high sediment, trash, or debris loads.	Good pretreatment with BMPs that mitigate coarse sediments such as vegetated swales AND influent sediment loads from the tributary area are expected to be relatively low (e.g., low traffic, mild slopes, disconnected impervious areas, etc.).	Excellent pretreatment with BMPs that mitigate fine sediments such as bioretention or media filtration OR sedimentation or facility only treats runoff from relatively clean surfaces, such as rooftops.
Redundancy of treatment	No redundancy in BMP treatment train	Medium redundancy, other BMPs available in treatment train to maintain at least 50% of function of facility in event of failure.	High redundancy, multiple components capable of operating independently and in parallel, maintaining at least 90% of facility functionality in event of failure.
Compaction during construction	Construction of facility on a compacted site or elevated probability of unintended/ indirect compaction.	Medium probability of unintended/ indirect compaction.	Heavy equipment actively prohibited from infiltration areas during construction and low probability of unintended/ indirect compaction.

Worksheet J: Summary of Harvested Water Demand and Feasibility

1	What demands for harvested water exist in the tributary area (check all that apply):			
2	Toilet and urinal flushing			
3	Landscape irrigation		X	
4	Other:_____			
5	What is the design capture storm depth? (Figure III.1)	d	0.95	inches
6	What is the project size?	A	8.2	ac
7	What is the acreage of impervious area?	IA	7.06	ac
	For projects with multiple types of demand (toilet flushing, irrigation demand, and/or other demand)			
8	What is the minimum use required for partial capture? (Table X.6)	--		gpd
9	What is the project estimated wet season total daily use (Section X.2)?	--		gpd
10	Is partial capture potentially feasible? (Line 9 > Line 8?)	--		
	For projects with only toilet flushing demand			
11	What is the minimum TUTIA for partial capture? (Table X.7)	--		
12	What is the project estimated TUTIA?	--		
13	Is partial capture potentially feasible? (Line 12 > Line 11?)	--		
	For projects with only irrigation demand			
14	What is the minimum irrigation area required based on conservation landscape design? (Table X.8)	3.67 (see explanation below)		ac
15	What is the proposed project irrigated area? (multiply conservation landscaping by 1; multiply active turf by 2)	1.14		ac
16	Is partial capture potentially feasible? (Line 15 > Line 14?)	No		

Provide supporting assumptions and citations for controlling demand calculation:

0.52 ac landscaping required per acre of impervious area
7.06 acres impervious on the project site, landscaping required = 0.52 x 7.06 = 3.67 ac minimum
Actual landscaping proposed on-site = 1.14 ac

Worksheet assumes conservation landscape design. Actual landscaping on-site will consist of a mix of both turf and conservation landscape design. Refer to detailed harvest & reuse calculations (EAWU Method) performed in accordance with the WQMP TGD Appendix X.

Table X.6: Harvested Water Demand Thresholds for Minimum Partial Capture

Design Capture Storm Depth[1], inches	Wet Season Demand Required for Minimum Partial Capture, gpd per impervious acre
0.60	490
0.65	530
0.70	570
0.75	610
0.80	650
0.85	690
0.90	730
0.95	770
1.00	810

1- Based on isopluvial map (See XIV.1)

Table X.8: Minimum Irrigated Area for Potential Partial Capture Feasibility

General Landscape Type	Conservation Design: K_L = 0.35			Active Turf Areas: K_L = 0.7		
Closest ET Station	*Irvine*	*Santa Ana*	*Laguna*	*Irvine*	*Santa Ana*	*Laguna*
Design Capture Storm Depth, inches	**Minimum Required Irrigated Area per Tributary Impervious Acre for Potential Partial Capture, ac/ac**					
0.60	0.66	0.68	0.72	0.33	0.34	0.36
0.65	0.72	0.73	0.78	0.36	0.37	0.39
0.70	0.77	0.79	0.84	0.39	0.39	0.42
0.75	0.83	0.84	0.90	0.41	0.42	0.45
0.80	0.88	0.90	0.96	0.44	0.45	0.48
0.85	0.93	0.95	1.02	0.47	0.48	0.51
0.90	0.99	1.01	1.08	0.49	0.51	0.54
0.95	1.04	1.07	1.14	0.52	0.53	0.57
1.00	1.10	1.12	1.20	0.55	0.56	0.60

Worksheet E: Determining Capture Efficiency of Volume Based, Constant Drawdown BMP based on Design Volume

Rain Gardens (A1 + A2)

Step 1: Determine the design capture storm depth used for calculating volume				
1	Enter design capture storm depth from Figure III.1, *d* (inches)	d=	0.95	inches
2	Enter the storage volume provided in the BMP, *V* (cu-ft)	V=	370	cu-ft
3	Enter Project area tributary to BMP (s), *A* (acres)	A=	1.59	acres
4	Enter Project Imperviousness, *imp* (unitless)	imp=	90%	
5	Calculate runoff coefficient, *C= (0.75 x imp) + 0.15*	C=	0.83	
6	Calculate the effective design storm depth provided (inches), $d_{provided}=(V \times 12)/(C \times A \times 43560)$	$d_{provided}$=	0.077	inches
7	Calculate the design storm depth as a fraction of the design capture depth, $X_{fraction} = d_{provided}/d$	$X_{fraction}$=	0.08	
Step 2: Calculate the capture efficiency of the BMP system				
1	Determine the drawdown time of the proposed BMP based on equations provided in the applicable BMP Fact Sheet, *T* (hours)	T=	2.4	hours
2	Enter the effect of provided HSCs upstream, d_{HSC} (inches) (Worksheet A)	d_{HSC}=	--	inches
3	Enter capture efficiency corresponding to d_{HSC} from Table 6.7 (regionally based), Y_1 (Worksheet A)	Y_1=	--	%
4	Using Figure III.2, determine the fraction of "design capture storm depth" at which the drawdown time (T) achieves the upstream capture efficiency(Y_1), X_1	X_1=	--	
5	Determine the fraction of design capture storm depth corresponding to the cumulative capture efficiency, $X_2=X_1+X_{fraction}$	X_2=	0.08	
6	Using Figure III.2, determine the capture efficiency corresponding to total fraction of design storm depth (X_2) for drawdown time (T), Y_2	Y_2=	40%	
Supporting Calculations				

Describe system:

370 ft2 total rain garden footprint
6" ponding depth; 2 ft media depth
Treats 370 ft^3 in accordance w/ Fact Sheet BIO-1

$$d_{provided} = \frac{V\ (ft^3) \times 12\ in/ft}{C \times A\ (ac) \times 43{,}560\ ft^2/ac}$$

$$d_{provided} = \frac{370\ ft^3 \times 12\ in/ft}{0.83 \times 1.59 \times 43{,}560\ ft^2/ac} = 0.077$$

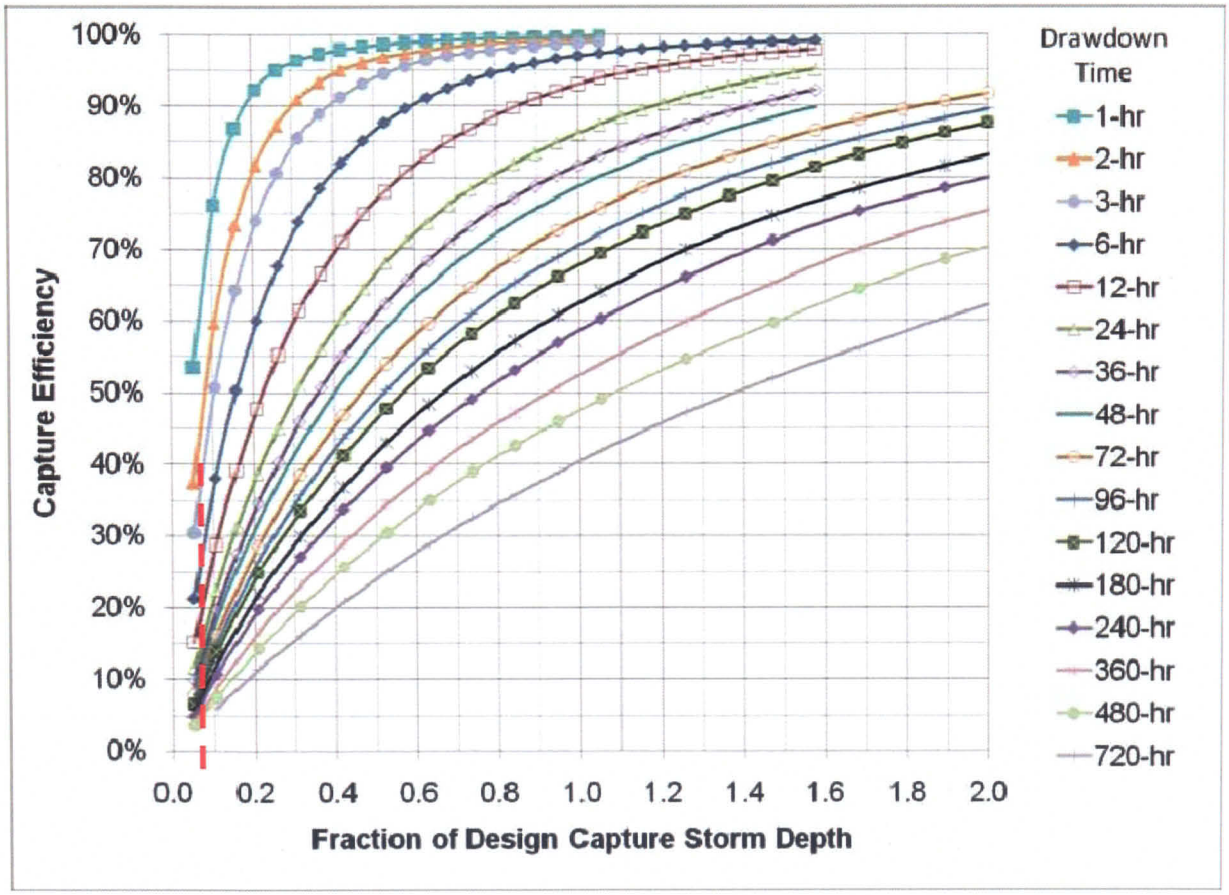
Provide drawdown calculations per equations in applicable BMP Fact Sheet:

$$Drawdown\ Time\ (hr) = \frac{ponding\ depth\ (ft)}{K_{design}\ (\frac{in}{hr})} \times 12\ in/ft$$

$$Drawdown\ Time\ (hr) = \frac{0.5\ ft}{2.5\ (\frac{in}{hr})} \times 12\frac{in}{ft} = 2.4\ hr$$

Graphical Operations

Figure III.2. Capture Efficiency Nomograph for Constant Drawdown Systems in Orange County



Use this graph to provide the supporting graphical operations. See Example III.8.

Worksheet D: Capture Efficiency Method for Flow-Based BMPs

Filterra #1

Step 1: Determine the design capture storm depth used for calculating volume				
1	Enter the time of concentration, T_c (min) (See Appendix IV.2)	T_c=	9.11	min
2	Using Figure III.4, determine the design intensity at which the estimated time of concentration (T_c) achieves 80% capture efficiency, I_1	I_1=	0.23	in/hr
3	Enter the effect depth of provided HSCs upstream, d_{HSC} (inches) (Worksheet A)	d_{HSC}=	--	inches
4	Enter capture efficiency corresponding to d_{HSC}, Y_2 (Worksheet A)	Y_2=	40%	
5	Using Figure III.4, determine the design intensity at which the time of concentration (T_c) achieves the upstream capture efficiency(Y_2), I_2	I_2=	0.06	
6	Determine the design intensity that must be provided by BMP, $I_{design}= I_1-I_2$	I_{design}=	0.17	
Step 2: Calculate the design flowrate				
1	Enter Project area tributary to BMP (s), *A* (acres)	A=	1.59	acres
2	Enter Project Imperviousness, *imp* (unitless)	imp=	90%	
3	Calculate runoff coefficient, $C= (0.75 \times imp) + 0.15$	C=	0.83	
4	Calculate design flowrate, $Q_{design}= (C \times i_{design} \times A)$	Q_{design}=	0.22	cfs
Supporting Calculations				

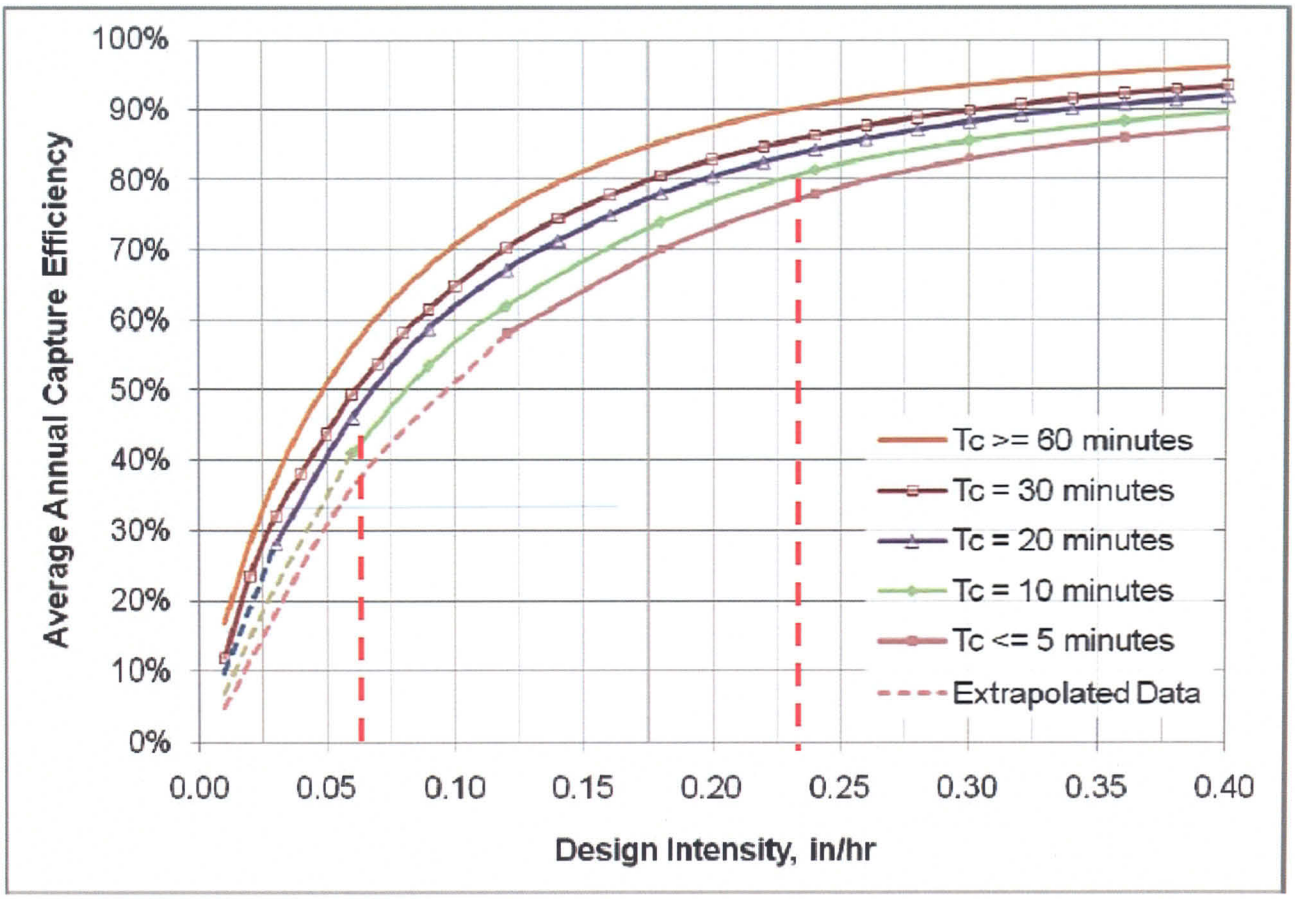
Describe system:

2 units 6' x 8' each – used in combination with upstream Rain Gardens. See Worksheet E.

Provide time of concentration assumptions:

9.11 minutes per 2-year hydrology map

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



Provide supporting graphical operations. See Example III.7.

Worksheet F: Determining Capture Efficiency of a Flow-based BMP based on Treatment Capacity

Rain Gardens + Filterra #1 Combined Treatment Efficiency

Step 1: Determine the design intensity used for calculating design flowrate				
1	Determine the design flowrate of the BMP, *Q* (cfs)	Q=	0.224	cfs
2	Enter Project Imperviousness, *imp* (unitless)	imp=	90%	
3	Calculate runoff coefficient, *C= (0.75 x imp) + 0.15*	C=	0.83	
4	Back calculate the equivalent intensity of rainfall treated in the BMP (cfs), $i_{provided}=Q/C$	$i_{provided}$=	0.17	in/hr
Step 2: Calculate the capture efficiency of theflow-based BMP				
1	Enter the time of concentration, T_c (min) (Section IV.2)	T_c=	9.11	min
2	Enter the effect of provided HSCs upstream, d_{HSC} (inches) (Worksheet A)	d_{HSC}=	--	inches
3	Enter the upstream capture efficiency corresponding to d_{HSC} from Table III.1 (regionally based), Y_1 (Worksheet A)	Y_1=	40%	%
4	Using Figure III.4, determine the design intensity at which the time of concentration (T_c) achieves the upstream capture efficiency(Y_1), I_1	I_1=	0.06	in/hr
5	Determine the cumulative design intensity that is provided by upstream and project BMPs, $I_2 = I_{provided} + I_1$	I_2=	0.23	in/hr
6	Using Figure III.4, determine the capture efficiency corresponding to the total intensity captured (I_2) for time of concentration (T_c) for upstream and Project BMPs, Y_2	Y_2=	80%	%

Supporting Calculations

Describe system:

See Worksheets E and D

$$Q = C \times i \times A$$

$$i = \frac{Q}{C \times A}$$

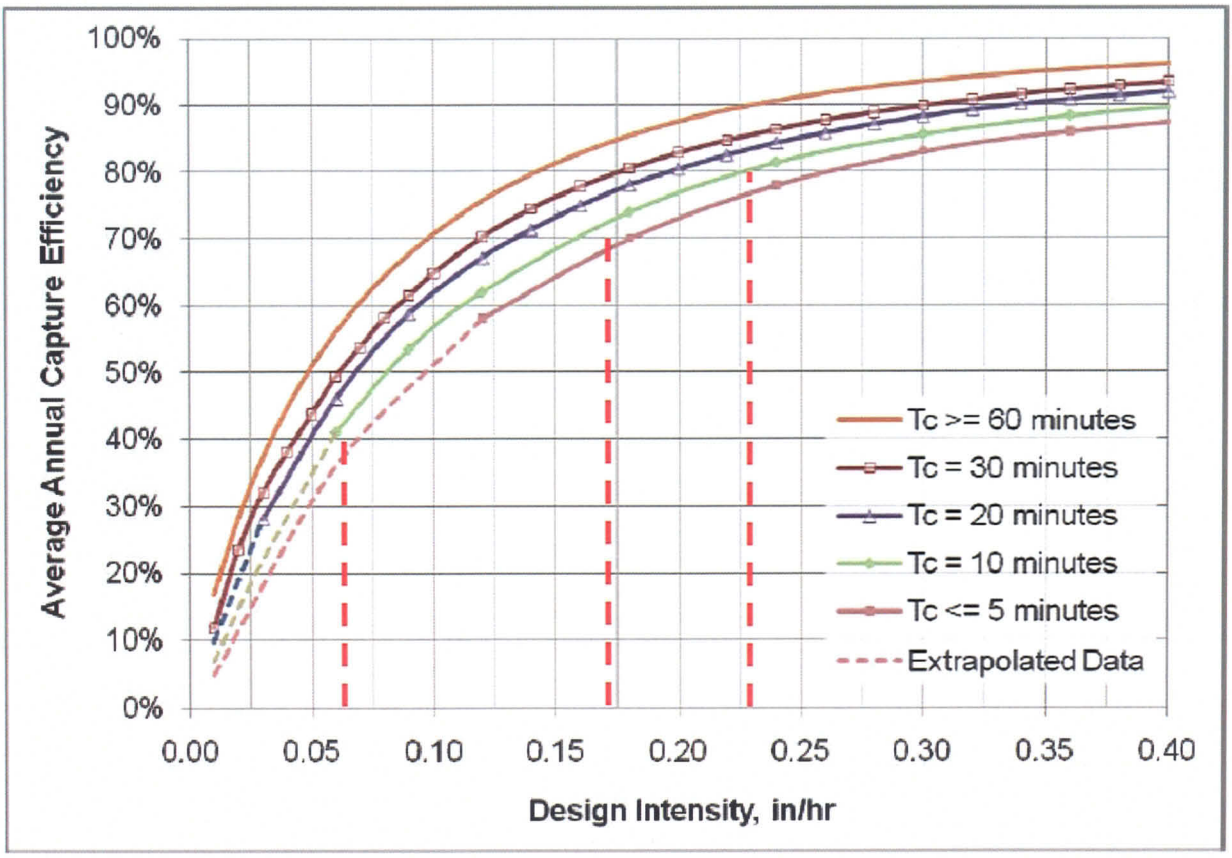
$$i = \frac{0.224}{0.83 \times 1.59} = 0.17$$

Provide time of concentration assumptions:

9.11 minutes per hydrology map

Graphical Operations

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



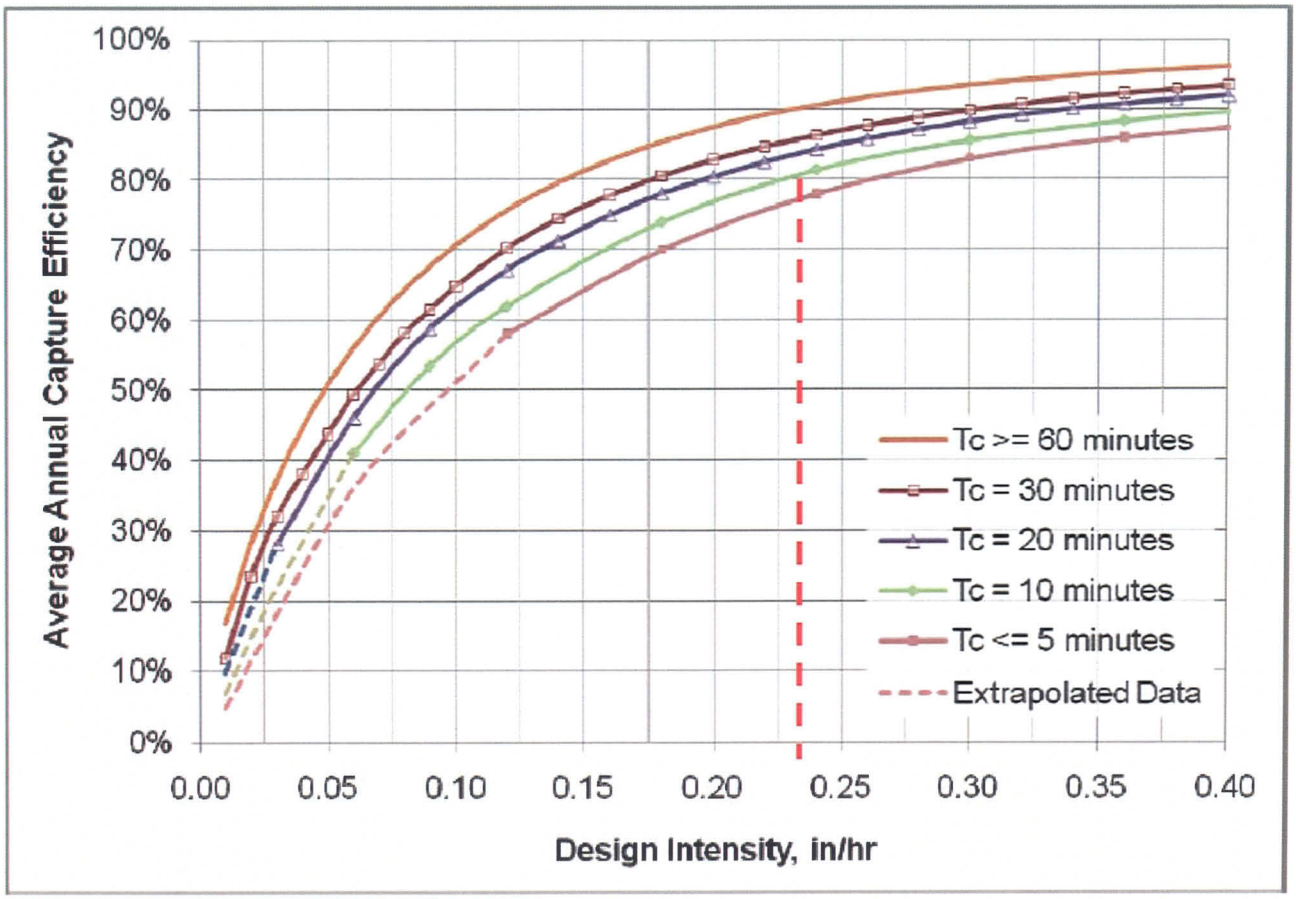
Provide supporting graphical operations.

Worksheet D: Capture Efficiency Method for Flow-Based BMPs

Filterra #2 (A3)

Step 1: Determine the design capture storm depth used for calculating volume				
1	Enter the time of concentration, T_c (min) (See Appendix IV.2)	T_c=	9.21	min
2	Using Figure III.4, determine the design intensity at which the estimated time of concentration (T_c) achieves 80% capture efficiency, I_1	I_1=	0.23	in/hr
3	Enter the effect depth of provided HSCs upstream, d_{HSC} (inches) (Worksheet A)	d_{HSC}=	--	inches
4	Enter capture efficiency corresponding to d_{HSC}, Y_2 (Worksheet A)	Y_2=	--	%
5	Using Figure III.4, determine the design intensity at which the time of concentration (T_c) achieves the upstream capture efficiency(Y_2), I_2	I_2=	--	
6	Determine the design intensity that must be provided by BMP, $I_{design}= I_1-I_2$	I_{design}=	0.23	
Step 2: Calculate the design flowrate				
1	Enter Project area tributary to BMP (s), *A* (acres)	A=	1.12	acres
2	Enter Project Imperviousness, *imp* (unitless)	imp=	80%	
3	Calculate runoff coefficient, $C= (0.75 \times imp) + 0.15$	C=	0.75	
4	Calculate design flowrate, $Q_{design}= (C \times i_{design} \times A)$	Q_{design}=	0.19	cfs
Supporting Calculations				
Describe system: *2 units 6' x 8' each*				
Provide time of concentration assumptions: *9.21 minutes per 2-year hydrology map*				

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



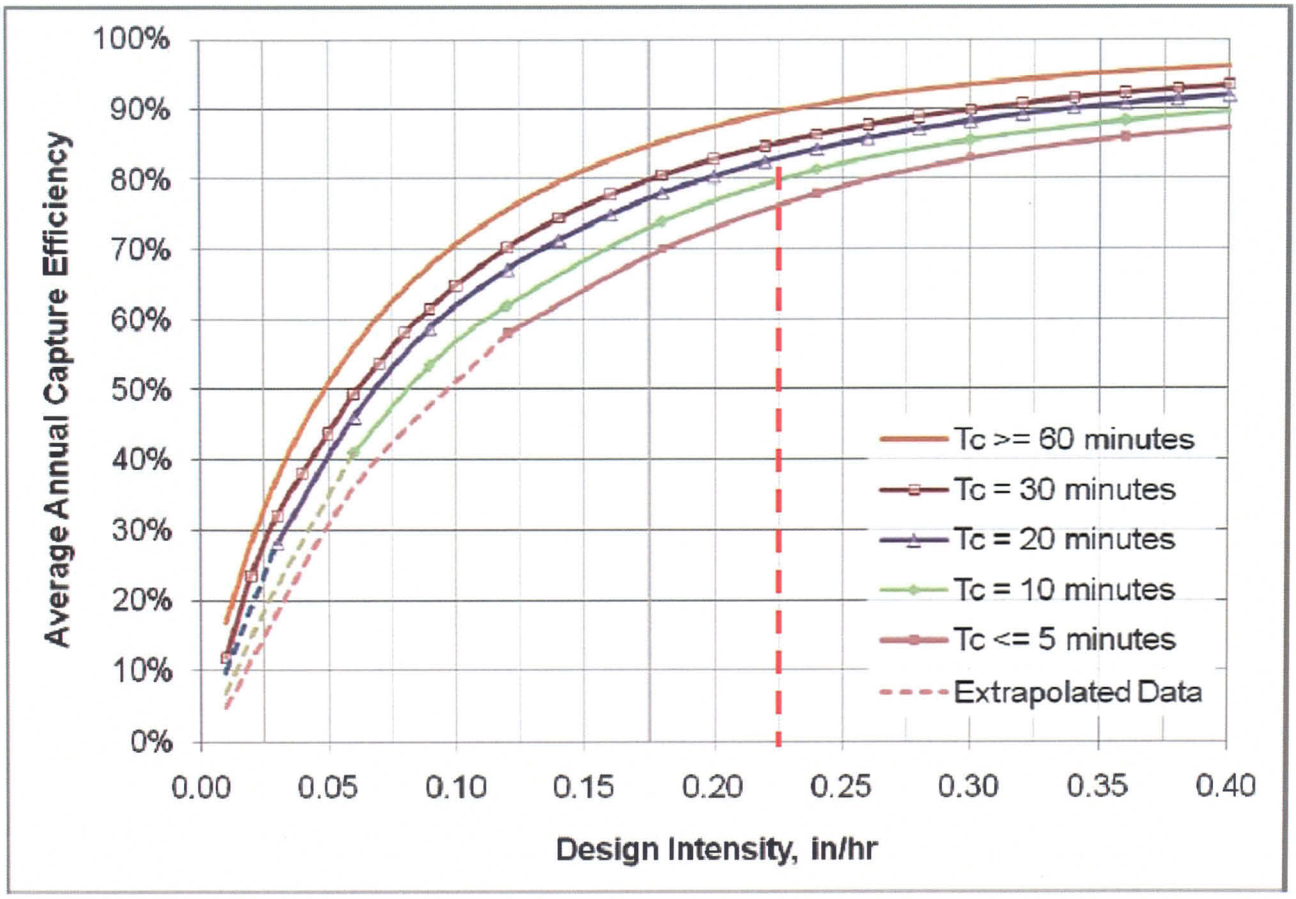
Provide supporting graphical operations. See Example III.7.

Worksheet D: Capture Efficiency Method for Flow-Based BMPs

Filterra #3 (A4)

Step 1: Determine the design capture storm depth used for calculating volume				
1	Enter the time of concentration, T_c (min) (See Appendix IV.2)	T_c=	9.7	min
2	Using Figure III.4, determine the design intensity at which the estimated time of concentration (T_c) achieves 80% capture efficiency, I_1	I_1=	0.225	in/hr
3	Enter the effect depth of provided HSCs upstream, d_{HSC} (inches) (Worksheet A)	d_{HSC}=	--	inches
4	Enter capture efficiency corresponding to d_{HSC}, Y_2 (Worksheet A)	Y_2=	--	%
5	Using Figure III.4, determine the design intensity at which the time of concentration (T_c) achieves the upstream capture efficiency(Y_2), I_2	I_2=	--	
6	Determine the design intensity that must be provided by BMP, $I_{design}= I_1-I_2$	I_{design}=	0.225	
Step 2: Calculate the design flowrate				
1	Enter Project area tributary to BMP (s), *A* (acres)	A=	1.65	acres
2	Enter Project Imperviousness, *imp* (unitless)	imp=	85%	
3	Calculate runoff coefficient, *C= (0.75 x imp) + 0.15*	C=	0.79	
4	Calculate design flowrate, $Q_{design}= (C \times i_{design} \times A)$	Q_{design}=	0.29	cfs
Supporting Calculations				
Describe system: *2 units 6' x 12' each*				
Provide time of concentration assumptions: *9.7 minutes per 2-year hydrology map*				

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



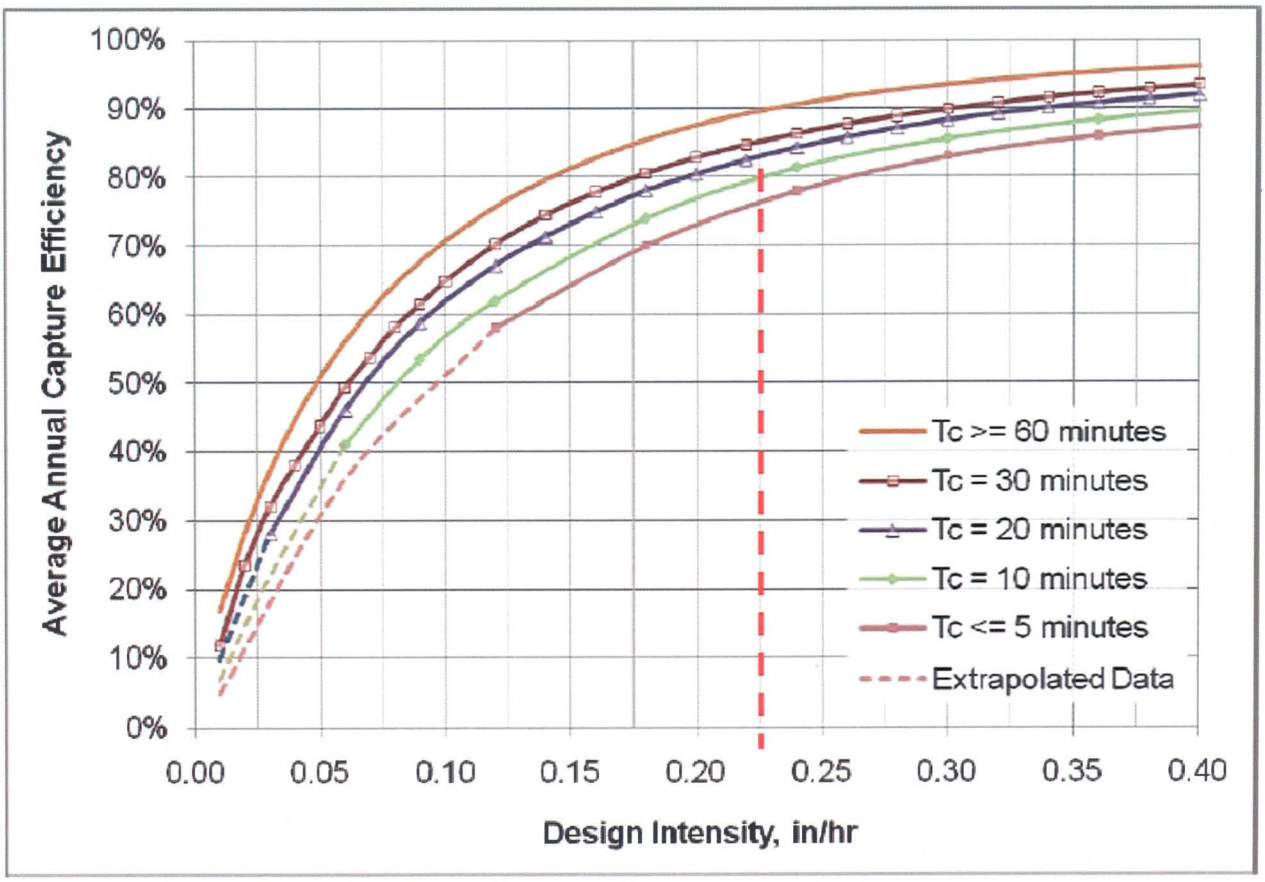
Provide supporting graphical operations. See Example III.7.

Worksheet D: Capture Efficiency Method for Flow-Based BMPs

Filterra #4 (A6)

Step 1: Determine the design capture storm depth used for calculating volume				
1	Enter the time of concentration, T_c (min) (See Appendix IV.2)	T_c=	10	min
2	Using Figure III.4, determine the design intensity at which the estimated time of concentration (T_c) achieves 80% capture efficiency, I_1	I_1=	0.225	in/hr
3	Enter the effect depth of provided HSCs upstream, d_{HSC} (inches) (Worksheet A)	d_{HSC}=	--	inches
4	Enter capture efficiency corresponding to d_{HSC}, Y_2 (Worksheet A)	Y_2=	--	%
5	Using Figure III.4, determine the design intensity at which the time of concentration (T_c) achieves the upstream capture efficiency(Y_2), I_2	I_2=	--	
6	Determine the design intensity that must be provided by BMP, $I_{design}= I_1-I_2$	I_{design}=	0.225	
Step 2: Calculate the design flowrate				
1	Enter Project area tributary to BMP (s), *A* (acres)	A=	1.29	acres
2	Enter Project Imperviousness, *imp* (unitless)	imp=	90%	
3	Calculate runoff coefficient, $C= (0.75 \times imp) + 0.15$	C=	0.83	
4	Calculate design flowrate, $Q_{design}= (C \times i_{design} \times A)$	Q_{design}=	0.24	cfs
Supporting Calculations				
Describe system: *2 units 6' x 10' each*				
Provide time of concentration assumptions: *10 minutes per hydrology map*				

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



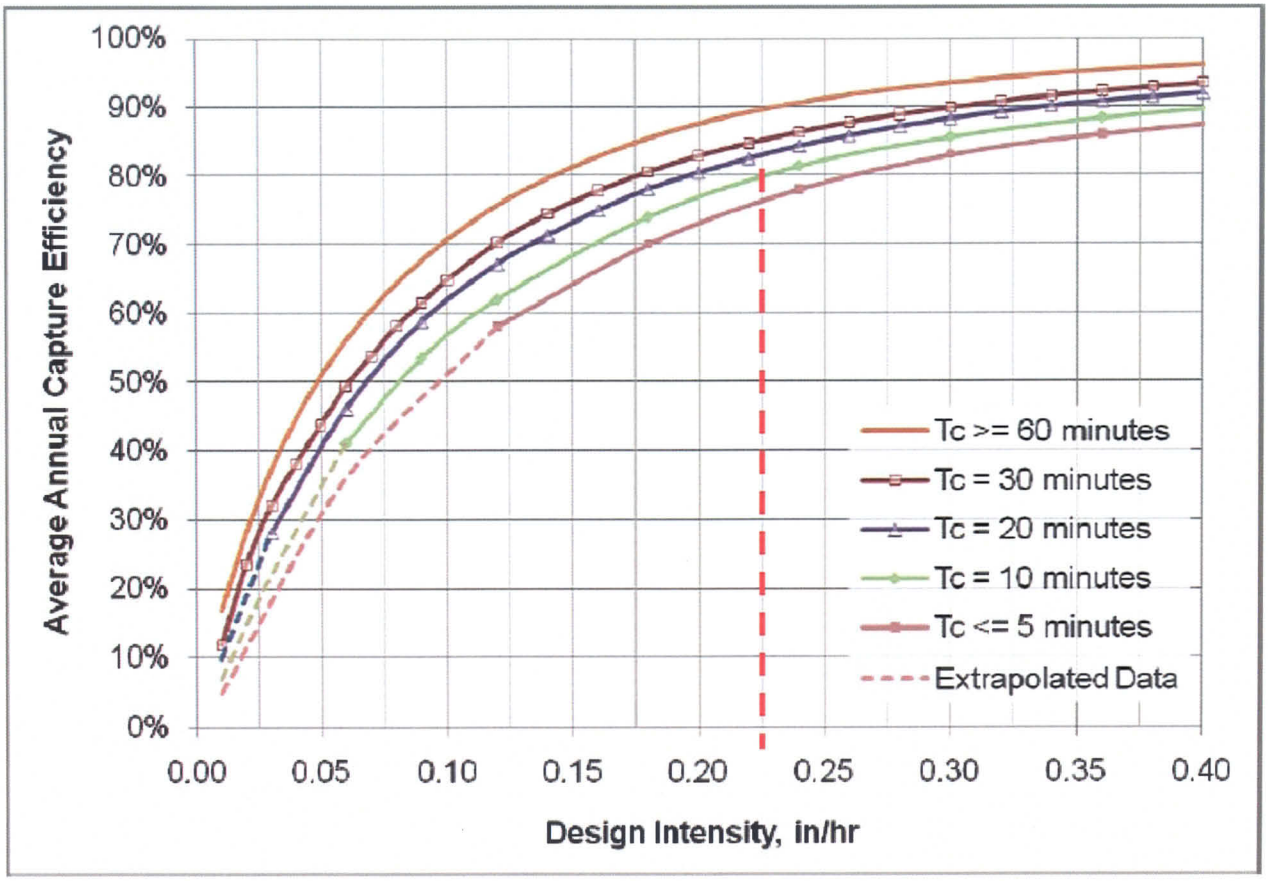
Provide supporting graphical operations. See Example III.7.

Worksheet D: Capture Efficiency Method for Flow-Based BMPs

Filterra #5 (A5 North)

Step 1: Determine the design capture storm depth used for calculating volume				
1	Enter the time of concentration, T_c (min) (See Appendix IV.2)	T_c=	10	min
2	Using Figure III.4, determine the design intensity at which the estimated time of concentration (T_c) achieves 80% capture efficiency, I_1	I_1=	0.225	in/hr
3	Enter the effect depth of provided HSCs upstream, d_{HSC} (inches) (Worksheet A)	d_{HSC}=	--	inches
4	Enter capture efficiency corresponding to d_{HSC}, Y_2 (Worksheet A)	Y_2=	--	%
5	Using Figure III.4, determine the design intensity at which the time of concentration (T_c) achieves the upstream capture efficiency(Y_2), I_2	I_2=	--	
6	Determine the design intensity that must be provided by BMP, $I_{design}= I_1-I_2$	I_{design}=	0.225	
Step 2: Calculate the design flowrate				
1	Enter Project area tributary to BMP (s), *A* (acres)	A=	1.25	acres
2	Enter Project Imperviousness, *imp* (unitless)	imp=	85%	
3	Calculate runoff coefficient, $C= (0.75 \times imp) + 0.15$	C=	0.79	
4	Calculate design flowrate, $Q_{design}= (C \times i_{design} \times A)$	Q_{design}=	0.22	cfs
Supporting Calculations				
Describe system: *2 units 6' x 8' each*				
Provide time of concentration assumptions: *10 minutes per hydrology map*				

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



Provide supporting graphical operations. See Example III.7.

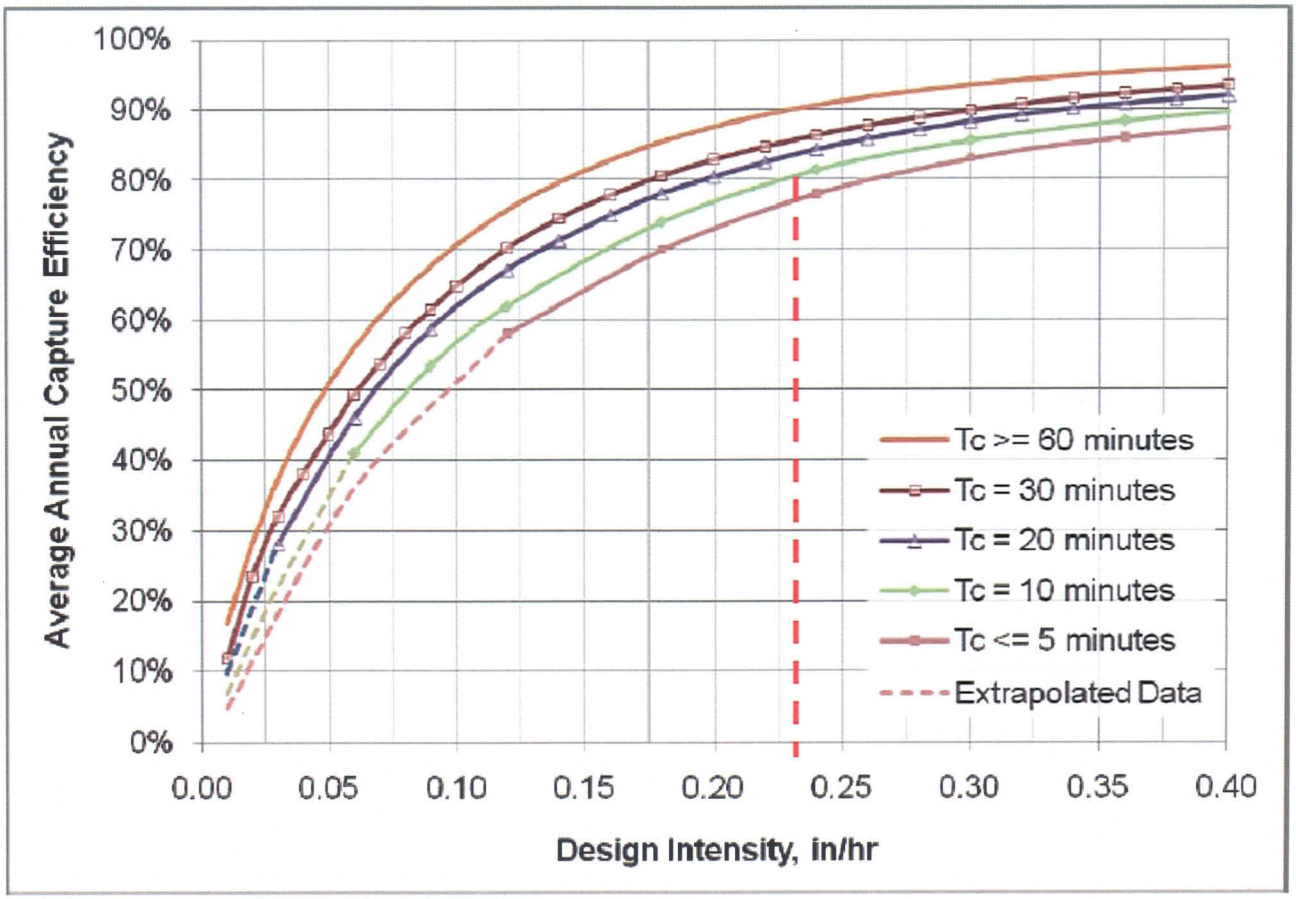
Worksheet D: Capture Efficiency Method for Flow-Based BMPs

Filterra #6 (A5 South)

Step 1: Determine the design capture storm depth used for calculating volume				
1	Enter the time of concentration, T_c (min) (See Appendix IV.2)	T_c=	9	min
2	Using Figure III.4, determine the design intensity at which the estimated time of concentration (T_c) achieves 80% capture efficiency, I_1	I_1=	0.23	in/hr
3	Enter the effect depth of provided HSCs upstream, d_{HSC} (inches) (Worksheet A)	d_{HSC}=	--	inches
4	Enter capture efficiency corresponding to d_{HSC}, Y_2 (Worksheet A)	Y_2=	--	%
5	Using Figure III.4, determine the design intensity at which the time of concentration (T_c) achieves the upstream capture efficiency(Y_2), I_2	I_2=	--	
6	Determine the design intensity that must be provided by BMP, $I_{design}= I_1-I_2$	I_{design}=	0.23	
Step 2: Calculate the design flowrate				
1	Enter Project area tributary to BMP (s), *A* (acres)	A=	1.3	acres
2	Enter Project Imperviousness, *imp* (unitless)	imp=	85%	
3	Calculate runoff coefficient, $C= (0.75 \times imp) + 0.15$	C=	0.79	
4	Calculate design flowrate, $Q_{design}= (C \times i_{design} \times A)$	Q_{design}=	0.24	cfs
Supporting Calculations				
Describe system: *2 units 6' x 10' each*				
Provide time of concentration assumptions: *9 minutes per hydrology map*				

Graphical Operations

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



Provide supporting graphical operations. See Example III.7.

Harvest & Reuse Irrigation Demand Calculations

Storm Water Design Caputre Volume (SQDV)

Drainage Area / Land Use Type	% impervious	Runoff Coefficient	Rainfall Intensity (in)	Drainage Area (acres)	DCV (ft^3)	DCV (gal)
entire site	86.07%	0.80	0.95	8.200	**22,538.0**	**168,584**
		0.15			**0.0**	**0**
		0.15			**0.0**	**0**
		0.15			**0.0**	**0**
		0.15			**0.0**	**0**

	Eto
Irvine	3.00
Laguna Beach	2.75
Santa Ana	2.93

High-use Turf Landscaping

Drainage Area / Land Use Type	Total Area (ac)	Total Area (sf)	% Impervious	Impervious (sf)	Pervious / LA (sf)	Eto	KL	Modified EAWU	EAWU/ Impervious Acre	Minimum EAWU/ Impervious Acre (Table X.6)	Feasible?	EIATA	Minimum EIATA (Table X.8)	Drawdown (days)	Drawdown (hours)	% Capture (Fig. III.2)
entire site	8.200	357,192	86%	307,435	49,757	3	0.7	1,741.49	246.75	690	No	0.13	1.04	96.8	2,323	<40%
0	0.000	0	0%	0	0		0.7	0.00	#DIV/0!	690		#DIV/0!		#DIV/0!	#DIV/0!	
0	0.000	0	0%	0	0		0.7	0.00	#DIV/0!	690		#DIV/0!		#DIV/0!	#DIV/0!	
0	0.000	0	0%	0	0		0.7	0.00	#DIV/0!	690		#DIV/0!		#DIV/0!	#DIV/0!	
0	0.000	0	0%	0	0		0.7	0.00	#DIV/0!	690		#DIV/0!		#DIV/0!	#DIV/0!	
0	0.000	0	0%	0	0		0.7	0.00	#DIV/0!	690		#DIV/0!		#DIV/0!	#DIV/0!	

Low Water Use Landscaping

Drainage Area / Land Use Type	Total Area (ac)	Total Area (sf)	% Impervious	Impervious (sf)	Pervious / LA (sf)	Eto	KL	Modified EAWU	EAWU/ Impervious Acre	Minimum EAWU/ Impervious Acre (Table X.6)	Feasible?	EIATA	Minimum EIATA (Table X.8)	Drawdown (days)	Drawdown (hours)	% Capture (Fig. III.2)
entire site	8.200	357,192	86%	307,435	49,757	3	0.35	870.74	123.37	690	No	0.06	0.52	193.6	4,647	<40%
0	0.000	0	0%	0	0		0.35	0.00	#DIV/0!	690		#DIV/0!		#DIV/0!	#DIV/0!	
0	0.000	0	0%	0	0		0.35	0.00	#DIV/0!	690		#DIV/0!		#DIV/0!	#DIV/0!	
0	0.000	0	0%	0	0		0.35	0.00	#DIV/0!	690		#DIV/0!		#DIV/0!	#DIV/0!	
0	0.000	0	0%	0	0		0.35	0.00	#DIV/0!	690		#DIV/0!		#DIV/0!	#DIV/0!	
0	0.000	0	0%	0	0		0.35	0.00	#DIV/0!	690		#DIV/0!		#DIV/0!	#DIV/0!	

Blend of High-Use and Low-Use Landscaping

Drainage Area / Land Use Type	Total Area (ac)	Total Area (sf)	% Impervious	Impervious (sf)	Pervious / LA (sf)	Eto	KL	Modified EAWU	EAWU/ Impervious Acre	Minimum EAWU/ Impervious Acre (Table X.6)	Feasible?	EIATA	Minimum EIATA (extrapolated)	Drawdown (days)	Drawdown (hours)	% Capture (Fig. III.2)
entire site	8.200	357,192	86%	307,435	49,757	3	0.55	1,368.31	193.87	690	No	0.10	0.78	123.2	2,957	<40%
0	0.000	0	0%	0	0		0.55	0.00	#DIV/0!	690		#DIV/0!	0.00	#DIV/0!	#DIV/0!	
0	0.000	0	0%	0	0		0.55	0.00	#DIV/0!	690		#DIV/0!	0.00	#DIV/0!	#DIV/0!	
0	0.000	0	0%	0	0		0.55	0.00	#DIV/0!	690		#DIV/0!	0.00	#DIV/0!	#DIV/0!	
0	0.000	0	0%	0	0		0.55	0.00	#DIV/0!	690		#DIV/0!	0.00	#DIV/0!	#DIV/0!	
0	0.000	0	0%	0	0		0.55	0.00	#DIV/0!	690		#DIV/0!	0.00	#DIV/0!	#DIV/0!	

Susceptibility

Potential Areas of Erosion, Habitat, & Physical Structure Susceptibility

Channel Type

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

Tidel Influence

- <= Mean High Water Line (4.28')

Water Body

- Basin
- Dam
- Lake
- Reservoir

Other Lands

- Airport/Military

AnaheimBay-HuntingtonHarbor Watershed

Santa Ana River Watershed

Santa Ana River Watershed

South Orange County

EL MODENA-IRVINE RETARDING BASIN

LOWER PETERS CANYON RETARDING BASIN

EASTFORK RETARDING BASIN

ORCHARD ESTATES RETENTION BASIN

HICKS CANYON RETARDING BASIN

RATTLESNAKE RESERVOIR

EAST HICKS CANYON RETARDING BASIN

SIPHON RESERVOIR

BEE CANYON RETARDING BASIN

TRABUCO RETARDING BASIN

ROUND CANYON RETARDING BASIN

AGUA CHINON RETARDING BASIN

MARSHBURN RETARDING BASIN

NORTH LAKE

SOUTH LAKE

BASIN NUMBER 2

BASIN NUMBER 1

SAND CANYON RESERVOIR

LAGUNA RESERVOIR

BONITA CANYON RESERVOIR

VILLAGE POND PARK

BIG CANYON RESERVOIR

SAN JOAQUIN RESERVOIR

HARBOR VIEW DAM

John Wayne Airport

Pacific Ocean

PRELIMINARY MAP
SUBJECT TO FURTHER REVISION

N

0 4,000 8,000 16,000 Feet

P:\ 9526E\ 6-GIS\ Mxds\ Reports\ InfiltrationFeasability_20110215\ 9526E_FigureXVI-3d_NewportBaySusceptibility_20100430.mxd

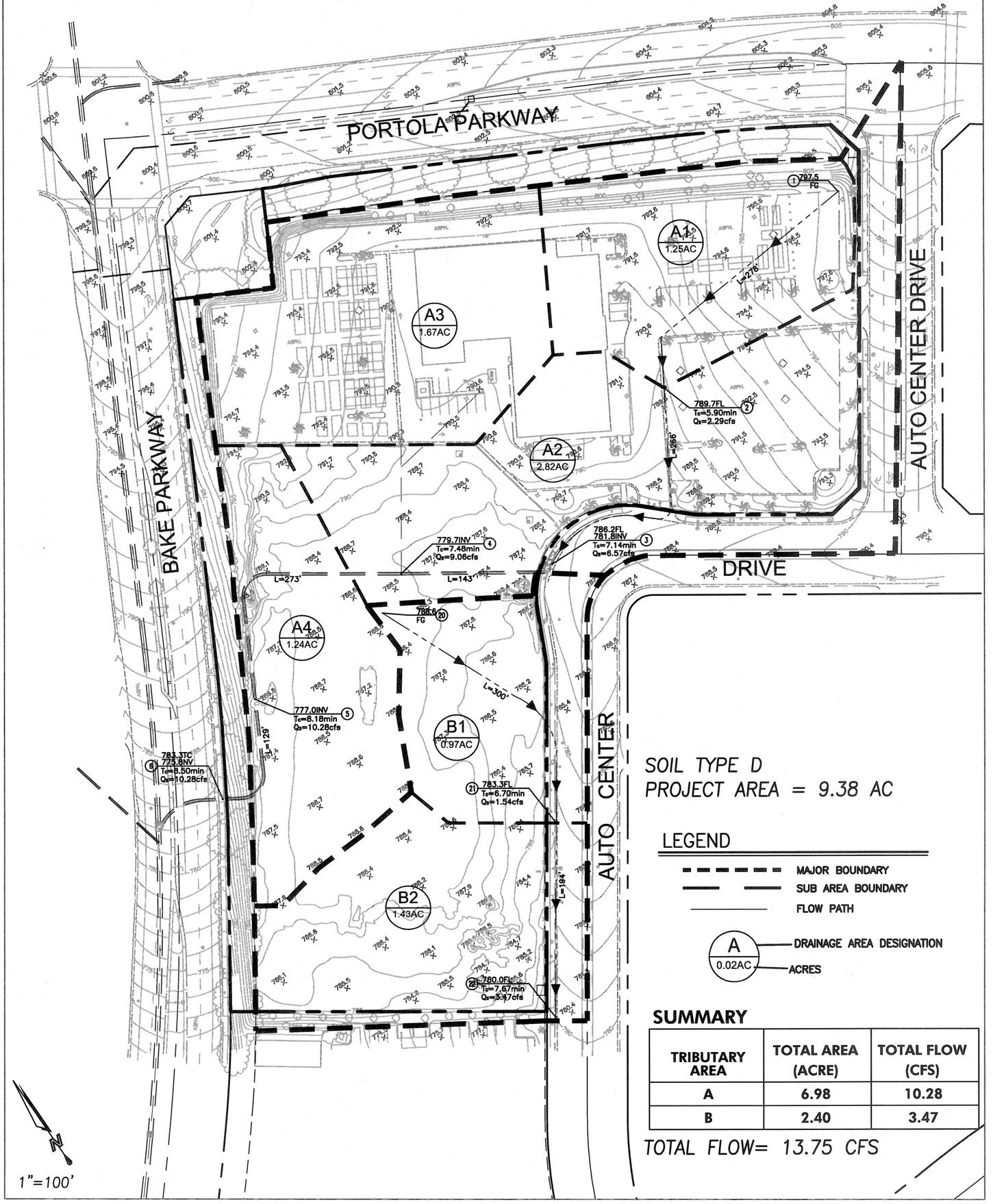
TITLE
SUSCEPTIBILITY ANALYIS
NEWPORT BAY-
NEWPORT COASTAL STREAMS

JOB
ORANGE COUNTY
WATERSHED
MASTER PLANNING
ORANGE CO. CA

SCALE	1" = 4000'
DESIGNED	TH
DRAWING	TH
CHECKED	BMP
DATE	04/30/10
JOB NO.	9526-E

PACE
Advanced Water Engineering

FIGURE
XVI-3d



SOIL TYPE D
PROJECT AREA = 9.38 AC

LEGEND

- MAJOR BOUNDARY
- SUB AREA BOUNDARY
- FLOW PATH
- A / 0.02AC — DRAINAGE AREA DESIGNATION / ACRES

SUMMARY

TRIBUTARY AREA	TOTAL AREA (ACRE)	TOTAL FLOW (CFS)
A	6.98	10.28
B	2.40	3.47

TOTAL FLOW= 13.75 CFS

FOOTHILL RANCH TOWN CENTER
EX. HYDROLOGY MAP
LAKE FOREST, CALIFORNIA
APRIL 5, 2012

BROOKFIELD HOMES

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

P:\PROJECTS\308\44\ENG\EXHIBITS\HYDROLOGY\HYDROMOD\X30844-HYDROLOGY-EX-2YR.DWG (04-06-12 1:27:36PM) Plotted by: April McMillian

```
**************************************************************************
            RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
           (Reference: 1986 ORANGE COUNTY HYDROLOGY CRITERION)
        (c) Copyright 1983-2010 Advanced Engineering Software (aes)
            Ver. 17.0  Release Date: 07/01/2010  License ID 1355

                          Analysis prepared by:

                             Fuscoe Engineering, Inc.
                          16795 Von Karman Ave. Ste. 100
                             Irvine, California 92606
                        PH: 949-474-1960    Fax: 949-474-5315

 ************************** DESCRIPTION OF STUDY **************************
* FOOHILL RANCH TOWN CENTER                                               *
* EX. 2 YR HYDROLOGY                                                      *
* 120327-SS                                                               *
 *************************************************************************

  FILE NAME: 30844X2.DAT
  TIME/DATE OF STUDY: 14:04 03/27/2012
==========================================================================
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
==========================================================================
                      --*TIME-OF-CONCENTRATION MODEL*--

  USER SPECIFIED STORM EVENT(YEAR) =    2.00
  SPECIFIED MINIMUM PIPE SIZE(INCH) =   6.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.95
  *DATA BANK RAINFALL USED*
  *ANTECEDENT MOISTURE CONDITION (AMC) I ASSUMED FOR RATIONAL METHOD*

  *USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL*
     HALF-  CROWN TO   STREET-CROSSFALL:   CURB  GUTTER-GEOMETRIES:  MANNING
     WIDTH  CROSSFALL  IN-  / OUT-/PARK-  HEIGHT  WIDTH  LIP   HIKE  FACTOR
NO.   (FT)     (FT)    SIDE / SIDE/ WAY    (FT)    (FT)  (FT)  (FT)    (n)
===  =====  =========  =================  ======  ===== ====== ===== =======
  1   30.0     20.0    0.018/0.018/0.020   0.67    2.00 0.0313 0.167 0.0150

  GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
    1. Relative Flow-Depth =  0.00 FEET
       as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
    2. (Depth)*(Velocity) Constraint =  6.0 (FT*FT/S)
  *SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
   OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*
  *USER-SPECIFIED MINIMUM TOPOGRAPHIC SLOPE ADJUSTMENT NOT SELECTED

**************************************************************************
  FLOW PROCESS FROM NODE      1.00 TO NODE      2.00 IS CODE =  21
--------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
==========================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   278.00
  ELEVATION DATA: UPSTREAM(FEET) =    797.50  DOWNSTREAM(FEET) =    789.70

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    5.900
  *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  2.058
  SUBAREA Tc AND LOSS RATE DATA(AMC  I ):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                  D        1.25      0.20      0.100    57    5.90
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
```

```
 SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
 SUBAREA RUNOFF(CFS) =      2.29
 TOTAL AREA(ACRES) =      1.25   PEAK FLOW RATE(CFS) =      2.29

****************************************************************************
 FLOW PROCESS FROM NODE      2.00 TO NODE      3.00 IS CODE =  51
----------------------------------------------------------------------------
 >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
 >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =    789.70  DOWNSTREAM(FEET) =    786.20
 CHANNEL LENGTH THRU SUBAREA(FEET) =   266.00   CHANNEL SLOPE =  0.0132
 CHANNEL BASE(FEET) =    1.00   "Z" FACTOR =  10.000
 MANNING'S FACTOR = 0.015   MAXIMUM DEPTH(FEET) =   1.00
 *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.846
 SUBAREA LOSS RATE DATA(AMC  I ):
  DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS
      LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
 COMMERCIAL                  D        2.08      0.20      0.100    57
 NATURAL POOR COVER
 "BARREN"                    D        0.74      0.20      1.000    83
 SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
 SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.336
 TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       4.56
 TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =   3.59
 AVERAGE FLOW DEPTH(FEET) =   0.31   TRAVEL TIME(MIN.) =   1.24
 Tc(MIN.) =    7.14
 SUBAREA AREA(ACRES) =     2.82       SUBAREA RUNOFF(CFS) =    4.51
 EFFECTIVE AREA(ACRES) =      4.07     AREA-AVERAGED Fm(INCH/HR) =   0.05
 AREA-AVERAGED Fp(INCH/HR) =   0.20  AREA-AVERAGED Ap =   0.26
 TOTAL AREA(ACRES) =        4.1         PEAK FLOW RATE(CFS) =       6.57

 END OF SUBAREA CHANNEL FLOW HYDRAULICS:
 DEPTH(FEET) =  0.36   FLOW VELOCITY(FEET/SEC.) =   3.90
 LONGEST FLOWPATH FROM NODE      1.00 TO NODE      3.00 =     544.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE      3.00 TO NODE      4.00 IS CODE =  31
----------------------------------------------------------------------------
 >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =   781.80  DOWNSTREAM(FEET) =   779.70
 FLOW LENGTH(FEET) =   143.00   MANNING'S N =  0.013
 DEPTH OF FLOW IN  15.0 INCH PIPE IS  10.7 INCHES
 PIPE-FLOW VELOCITY(FEET/SEC.) =   6.99
 ESTIMATED PIPE DIAMETER(INCH) =  15.00    NUMBER OF PIPES =   1
 PIPE-FLOW(CFS) =       6.57
 PIPE TRAVEL TIME(MIN.) =   0.34    Tc(MIN.) =    7.48
 LONGEST FLOWPATH FROM NODE      1.00 TO NODE      4.00 =     687.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE      4.00 TO NODE      4.00 IS CODE =  81
----------------------------------------------------------------------------
 >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
 MAINLINE Tc(MIN.) =    7.48
 *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.797
 SUBAREA LOSS RATE DATA(AMC  I ):
  DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS
      LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
 COMMERCIAL                  D        1.67      0.20      0.100    57
 SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
 SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
 SUBAREA AREA(ACRES) =    1.67       SUBAREA RUNOFF(CFS) =    2.67
```

```
  EFFECTIVE AREA(ACRES) =      5.74   AREA-AVERAGED Fm(INCH/HR) =  0.04
  AREA-AVERAGED Fp(INCH/HR) =  0.20  AREA-AVERAGED Ap =  0.22
  TOTAL AREA(ACRES) =        5.7       PEAK FLOW RATE(CFS) =       9.06

****************************************************************************
  FLOW PROCESS FROM NODE      4.00 TO NODE      5.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   779.70  DOWNSTREAM(FEET) =   777.00
  FLOW LENGTH(FEET) =   273.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN  18.0 INCH PIPE IS  13.2 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   6.51
  ESTIMATED PIPE DIAMETER(INCH) =  18.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       9.06
  PIPE TRAVEL TIME(MIN.) =   0.70    Tc(MIN.) =    8.18
  LONGEST FLOWPATH FROM NODE      1.00 TO NODE      5.00 =     960.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE      5.00 TO NODE      5.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
  MAINLINE Tc(MIN.) =    8.18
  *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.707
  SUBAREA LOSS RATE DATA(AMC  I ):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
  NATURAL POOR COVER
  "BARREN"                   D        1.24      0.20      1.000    83
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  1.000
  SUBAREA AREA(ACRES) =    1.24      SUBAREA RUNOFF(CFS) =    1.68
  EFFECTIVE AREA(ACRES) =      6.98   AREA-AVERAGED Fm(INCH/HR) =  0.07
  AREA-AVERAGED Fp(INCH/HR) =  0.20  AREA-AVERAGED Ap =  0.36
  TOTAL AREA(ACRES) =        7.0       PEAK FLOW RATE(CFS) =      10.28

****************************************************************************
  FLOW PROCESS FROM NODE      5.00 TO NODE      6.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   777.00  DOWNSTREAM(FEET) =   775.80
  FLOW LENGTH(FEET) =   129.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN  21.0 INCH PIPE IS  12.8 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   6.68
  ESTIMATED PIPE DIAMETER(INCH) =  21.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =      10.28
  PIPE TRAVEL TIME(MIN.) =   0.32    Tc(MIN.) =    8.50
  LONGEST FLOWPATH FROM NODE      1.00 TO NODE      6.00 =    1089.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE     20.00 TO NODE     21.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   300.00
  ELEVATION DATA: UPSTREAM(FEET) =    788.50  DOWNSTREAM(FEET) =    783.30

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    6.698
  *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.914
```

```
 SUBAREA Tc AND LOSS RATE DATA(AMC  I ):
  DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
      LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
 NATURAL POOR COVER
 "BARREN"                    D        0.71      0.20      1.000    83   11.57
 COMMERCIAL                  D        0.26      0.20      0.100    57    6.70
 SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
 SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.759
 SUBAREA RUNOFF(CFS) =      1.54
 TOTAL AREA(ACRES) =      0.97   PEAK FLOW RATE(CFS) =      1.54

****************************************************************************
 FLOW PROCESS FROM NODE     21.00 TO NODE     22.00 IS CODE =  51
----------------------------------------------------------------------------
 >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
 >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =    783.30  DOWNSTREAM(FEET) =    780.00
 CHANNEL LENGTH THRU SUBAREA(FEET) =   194.00   CHANNEL SLOPE =  0.0170
 CHANNEL BASE(FEET) =    1.00   "Z" FACTOR =  10.000
 MANNING'S FACTOR = 0.015   MAXIMUM DEPTH(FEET) =   1.00
 *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.771
 SUBAREA LOSS RATE DATA(AMC  I ):
  DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS
      LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
 NATURAL POOR COVER
 "BARREN"                    D        1.23      0.20      1.000    83
 COMMERCIAL                  D        0.20      0.20      0.100    57
 SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
 SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.874
 TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =      2.57
 TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =   3.34
 AVERAGE FLOW DEPTH(FEET) =   0.23   TRAVEL TIME(MIN.) =   0.97
 Tc(MIN.) =    7.67
 SUBAREA AREA(ACRES) =     1.43       SUBAREA RUNOFF(CFS) =    2.05
 EFFECTIVE AREA(ACRES) =      2.40     AREA-AVERAGED Fm(INCH/HR) =   0.17
 AREA-AVERAGED Fp(INCH/HR) =   0.20  AREA-AVERAGED Ap =   0.83
 TOTAL AREA(ACRES) =        2.4         PEAK FLOW RATE(CFS) =       3.47

 END OF SUBAREA CHANNEL FLOW HYDRAULICS:
 DEPTH(FEET) =  0.26   FLOW VELOCITY(FEET/SEC.) =   3.65
 LONGEST FLOWPATH FROM NODE     20.00 TO NODE     22.00 =     494.00 FEET.
============================================================================
 END OF STUDY SUMMARY:
 TOTAL AREA(ACRES)      =        2.4  TC(MIN.) =      7.67
 EFFECTIVE AREA(ACRES) =      2.40  AREA-AVERAGED Fm(INCH/HR)=  0.17
 AREA-AVERAGED Fp(INCH/HR) =  0.20  AREA-AVERAGED Ap = 0.827
 PEAK FLOW RATE(CFS)   =       3.47
============================================================================
============================================================================
 END OF RATIONAL METHOD ANALYSIS
```

♀

LOSS-2YR-EX

LOSS CALCULATION - EXISTING 2 YR (120328-SS)

==========

*** NON-HOMOGENEOUS WATERSHED AREA-AVERAGED LOSS RATE (Fm)
AND LOW LOSS FRACTION ESTIMATIONS FOR AMC I:

TOTAL 24-HOUR DURATION RAINFALL DEPTH = 2.05 (inches)

SOIL-COVER TYPE	AREA (Acres)	PERCENT OF PERVIOUS AREA	SCS CURVE NUMBER	LOSS RATE Fp(in./hr.)	YIELD
1	5.46	10.00	95.(AMC II)	0.200	0.847
2	3.92	100.00	83.(AMC II)	0.200	0.092

TOTAL AREA (Acres) = 9.38

AREA-AVERAGED LOSS RATE, $\bar{F}m$ (in./hr.) = 0.095

AREA-AVERAGED LOW LOSS FRACTION, $\bar{Y}$ = 0.468

==========

VOLUME-2YR-EX

VOLUME CALCULATION - 2 YR EXISTING (120328-SS)

RATIONAL METHOD CALIBRATION COEFFICIENT = 0.93
TOTAL CATCHMENT AREA(ACRES) = 9.38
SOIL-LOSS RATE, Fm,(INCH/HR) = 0.095
LOW LOSS FRACTION = 0.468
TIME OF CONCENTRATION(MIN.) = 8.50
SMALL AREA PEAK Q COMPUTED USING PEAK FLOW RATE FORMULA
ORANGE COUNTY "VALLEY" RAINFALL VALUES ARE USED
RETURN FREQUENCY(YEARS) = 2
5-MINUTE POINT RAINFALL VALUE(INCHES) = 0.19
30-MINUTE POINT RAINFALL VALUE(INCHES) = 0.40
1-HOUR POINT RAINFALL VALUE(INCHES) = 0.53
3-HOUR POINT RAINFALL VALUE(INCHES) = 0.89
6-HOUR POINT RAINFALL VALUE(INCHES) = 1.22
24-HOUR POINT RAINFALL VALUE(INCHES) = 2.05

TOTAL CATCHMENT RUNOFF VOLUME(ACRE-FEET) = 0.90
TOTAL CATCHMENT SOIL-LOSS VOLUME(ACRE-FEET) = 0.70

****

TIME (HOURS)	VOLUME (AF)	Q (CFS)	0.	5.0	10.0	15.0	20.0
0.13	0.0009	0.15	Q	.	.	.	.
0.28	0.0026	0.15	Q	.	.	.	.
0.42	0.0044	0.15	Q	.	.	.	.
0.56	0.0061	0.15	Q	.	.	.	.
0.70	0.0079	0.15	Q	.	.	.	.
0.84	0.0097	0.15	Q	.	.	.	.
0.98	0.0115	0.15	Q	.	.	.	.
1.12	0.0133	0.15	Q	.	.	.	.
1.27	0.0151	0.16	Q	.	.	.	.
1.41	0.0169	0.16	Q	.	.	.	.
1.55	0.0188	0.16	Q	.	.	.	.
1.69	0.0206	0.16	Q	.	.	.	.
1.83	0.0225	0.16	Q	.	.	.	.
1.98	0.0243	0.16	Q	.	.	.	.
2.12	0.0262	0.16	Q	.	.	.	.
2.26	0.0281	0.16	Q	.	.	.	.
2.40	0.0300	0.16	Q	.	.	.	.
2.54	0.0319	0.16	Q	.	.	.	.
2.68	0.0339	0.17	Q	.	.	.	.
2.83	0.0358	0.17	Q	.	.	.	.
2.97	0.0378	0.17	Q	.	.	.	.
3.11	0.0397	0.17	Q	.	.	.	.
3.25	0.0417	0.17	Q	.	.	.	.
3.39	0.0437	0.17	Q	.	.	.	.
3.53	0.0457	0.17	Q	.	.	.	.
3.67	0.0477	0.17	Q	.	.	.	.
3.82	0.0498	0.17	Q	.	.	.	.
3.96	0.0518	0.18	Q	.	.	.	.
4.10	0.0539	0.18	Q	.	.	.	.
4.24	0.0560	0.18	Q	.	.	.	.
4.38	0.0581	0.18	Q	.	.	.	.
4.53	0.0602	0.18	Q	.	.	.	.
4.67	0.0623	0.18	Q	.	.	.	.
4.81	0.0645	0.18	Q	.	.	.	.

4.95	0.0667	0.19	Q	.	.	.	.
5.09	0.0688	0.19	Q	.	.	.	.
5.23	0.0710	0.19	Q	.	.	.	.
5.38	0.0733	0.19	Q	.	.	.	.
5.52	0.0755	0.19	Q	.	.	.	.
5.66	0.0778	0.19	Q	.	.	.	.
5.80	0.0800	0.19	Q	.	.	.	.
5.94	0.0823	0.20	Q	.	.	.	.
6.08	0.0846	0.20	Q	.	.	.	.
6.22	0.0870	0.20	Q	.	.	.	.
6.37	0.0893	0.20	Q	.	.	.	.
6.51	0.0917	0.20	Q	.	.	.	.
6.65	0.0941	0.21	Q	.	.	.	.
6.79	0.0965	0.21	Q	.	.	.	.
6.93	0.0990	0.21	Q	.	.	.	.
7.07	0.1014	0.21	Q	.	.	.	.
7.22	0.1039	0.21	Q	.	.	.	.
7.36	0.1065	0.22	Q	.	.	.	.
7.50	0.1090	0.22	Q	.	.	.	.
7.64	0.1116	0.22	Q	.	.	.	.
7.78	0.1142	0.22	Q	.	.	.	.
7.93	0.1168	0.23	Q	.	.	.	.
8.07	0.1195	0.23	Q	.	.	.	.
8.21	0.1221	0.23	Q	.	.	.	.
8.35	0.1249	0.23	Q	.	.	.	.
8.49	0.1276	0.24	Q	.	.	.	.
8.63	0.1304	0.24	Q	.	.	.	.
8.77	0.1332	0.24	Q	.	.	.	.
8.92	0.1360	0.24	Q	.	.	.	.
9.06	0.1389	0.25	Q	.	.	.	.
9.20	0.1418	0.25	Q	.	.	.	.
9.34	0.1448	0.25	Q	.	.	.	.
9.48	0.1478	0.26	Q	.	.	.	.
9.62	0.1508	0.26	Q	.	.	.	.
9.77	0.1539	0.26	Q	.	.	.	.
9.91	0.1570	0.27	Q	.	.	.	.
10.05	0.1602	0.27	Q	.	.	.	.
10.19	0.1634	0.28	Q	.	.	.	.
10.33	0.1666	0.28	Q	.	.	.	.
10.48	0.1699	0.29	Q	.	.	.	.
10.62	0.1733	0.29	Q	.	.	.	.
10.76	0.1767	0.29	Q	.	.	.	.
10.90	0.1802	0.30	Q	.	.	.	.
11.04	0.1837	0.31	Q	.	.	.	.
11.18	0.1873	0.31	Q	.	.	.	.
11.32	0.1910	0.32	Q	.	.	.	.
11.47	0.1947	0.32	Q	.	.	.	.
11.61	0.1985	0.33	Q	.	.	.	.
11.75	0.2024	0.33	Q	.	.	.	.
11.89	0.2063	0.34	Q	.	.	.	.
12.03	0.2103	0.35	Q	.	.	.	.
12.18	0.2149	0.43	Q	.	.	.	.
12.32	0.2200	0.44	Q	.	.	.	.
12.46	0.2253	0.45	Q	.	.	.	.
12.60	0.2306	0.46	Q	.	.	.	.
12.74	0.2360	0.47	Q	.	.	.	.
12.88	0.2416	0.48	Q	.	.	.	.
13.02	0.2473	0.50	Q	.	.	.	.
13.17	0.2532	0.50	.Q	.	.	.	.
13.31	0.2592	0.52	.Q	.	.	.	.
13.45	0.2654	0.53	.Q	.	.	.	.
13.59	0.2717	0.55	.Q	.	.	.	.
13.73	0.2783	0.57	.Q	.	.	.	.

VOLUME-2YR-EX

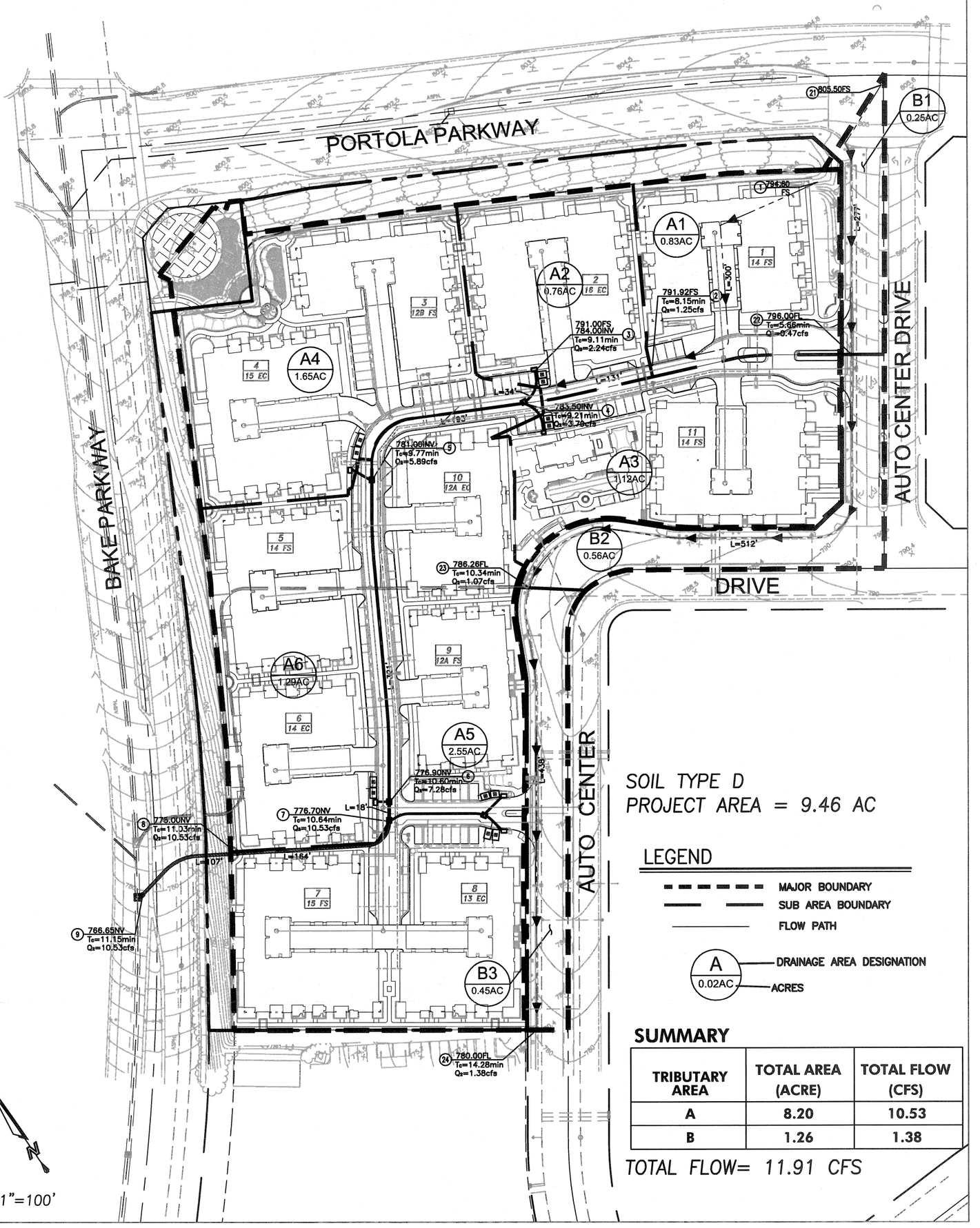
13.88	0.2851	0.59	.Q
14.02	0.2921	0.61	.Q
14.16	0.2995	0.66	.Q
14.30	0.3073	0.68	.Q
14.44	0.3155	0.72	.Q
14.58	0.3240	0.74	.Q
14.73	0.3330	0.79	.Q
14.87	0.3425	0.82	.Q
15.01	0.3525	0.90	.Q
15.15	0.3633	0.94	.Q
15.29	0.3755	1.15	. Q
15.43	0.3897	1.27	. Q
15.57	0.4050	1.35	. Q
15.72	0.4224	1.63	. Q
15.86	0.4480	2.74	. Q
16.00	0.4877	4.04	. Q
16.14	0.5918	13.75	. Q
16.28	0.6843	2.06	. Q
16.42	0.7031	1.14	. Q
16.57	0.7159	1.04	. Q
16.71	0.7270	0.86	.Q
16.85	0.7365	0.77	.Q
16.99	0.7450	0.70	.Q
17.13	0.7528	0.63	.Q
17.27	0.7598	0.58	.Q
17.42	0.7664	0.54	.Q
17.56	0.7726	0.51	.Q
17.70	0.7784	0.49	Q
17.84	0.7840	0.47	Q
17.98	0.7893	0.45	Q
18.12	0.7942	0.38	Q
18.27	0.7984	0.34	Q
18.41	0.8022	0.32	Q
18.55	0.8060	0.31	Q
18.69	0.8096	0.30	Q
18.83	0.8130	0.29	Q
18.98	0.8164	0.28	Q
19.12	0.8197	0.27	Q
19.26	0.8228	0.27	Q
19.40	0.8259	0.26	Q
19.54	0.8289	0.25	Q
19.68	0.8318	0.25	Q
19.83	0.8346	0.24	Q
19.97	0.8374	0.23	Q
20.11	0.8401	0.23	Q
20.25	0.8428	0.22	Q
20.39	0.8454	0.22	Q
20.53	0.8479	0.22	Q
20.67	0.8504	0.21	Q
20.82	0.8529	0.21	Q
20.96	0.8553	0.20	Q
21.10	0.8576	0.20	Q
21.24	0.8599	0.20	Q
21.38	0.8622	0.19	Q
21.52	0.8645	0.19	Q
21.67	0.8667	0.19	Q
21.81	0.8688	0.18	Q
21.95	0.8710	0.18	Q
22.09	0.8731	0.18	Q
22.23	0.8751	0.18	Q
22.38	0.8772	0.17	Q
22.52	0.8792	0.17	Q
22.66	0.8812	0.17	Q

VOLUME-2YR-EX

22.80	0.8831	0.17	Q	.	.	.	.
22.94	0.8850	0.16	Q	.	.	.	.
23.08	0.8870	0.16	Q	.	.	.	.
23.23	0.8888	0.16	Q	.	.	.	.
23.37	0.8907	0.16	Q	.	.	.	.
23.51	0.8925	0.16	Q	.	.	.	.
23.65	0.8943	0.15	Q	.	.	.	.
23.79	0.8961	0.15	Q	.	.	.	.
23.93	0.8979	0.15	Q	.	.	.	.
24.08	0.8997	0.15	Q	.	.	.	.
24.22	0.9005	0.00	Q	.	.	.	.

TIME DURATION(minutes) OF PERCENTILES OF ESTIMATED PEAK FLOW RATE:
(Note: 100% of Peak Flow Rate estimate assumed to have
an instantaneous time duration)

Percentile of Estimated Peak Flow Rate	Duration (minutes)
0%	1445.0
10%	42.5
20%	17.0
30%	8.5
40%	8.5
50%	8.5
60%	8.5
70%	8.5
80%	8.5
90%	8.5



TRIBUTARY AREA	TOTAL AREA (ACRE)	TOTAL FLOW (CFS)
A	8.20	10.53
B	1.26	1.38

FOOTHILL RANCH TOWN CENTER
PR. HYDROLOGY MAP
LAKE FOREST, CALIFORNIA
MARCH 28, 2012

BROOKFIELD HOMES

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**************************************************************************
            RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
          (Reference: 1986 ORANGE COUNTY HYDROLOGY CRITERION)
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            Ver. 17.0  Release Date: 07/01/2010  License ID 1355

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 ************************** DESCRIPTION OF STUDY **************************
* LAKE FOREST TOWN CENTER                                                 *
* PROPOSED 2 YR HYDROLOGY                                                 *
* 120328-SS                                                               *
 *************************************************************************

  FILE NAME: 30844P2.DAT
  TIME/DATE OF STUDY: 16:11 03/28/2012
==========================================================================
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
==========================================================================
                     --*TIME-OF-CONCENTRATION MODEL*--

  USER SPECIFIED STORM EVENT(YEAR) =    2.00
  SPECIFIED MINIMUM PIPE SIZE(INCH) =   6.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.95
  *DATA BANK RAINFALL USED*
  *ANTECEDENT MOISTURE CONDITION (AMC) I ASSUMED FOR RATIONAL METHOD*

  *USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL*
     HALF-  CROWN TO   STREET-CROSSFALL:   CURB  GUTTER-GEOMETRIES:  MANNING
     WIDTH  CROSSFALL  IN-  / OUT-/PARK-  HEIGHT  WIDTH  LIP   HIKE  FACTOR
NO.    (FT)     (FT)    SIDE / SIDE/ WAY    (FT)    (FT)  (FT)  (FT)    (n)
===  =====  =========  =================  ======  ===== ====== ===== =======
  1   30.0     20.0    0.018/0.018/0.020   0.67    2.00 0.0313 0.167 0.0150

  GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
    1. Relative Flow-Depth =  0.00 FEET
       as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
    2. (Depth)*(Velocity) Constraint =  6.0 (FT*FT/S)
  *SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
   OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*
  *USER-SPECIFIED MINIMUM TOPOGRAPHIC SLOPE ADJUSTMENT NOT SELECTED

**************************************************************************
  FLOW PROCESS FROM NODE      1.00 TO NODE      2.00 IS CODE =  21
--------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
==========================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   300.00
  ELEVATION DATA: UPSTREAM(FEET) =    794.60  DOWNSTREAM(FEET) =    791.92

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    8.151
  *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.710
  SUBAREA Tc AND LOSS RATE DATA(AMC  I ):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  APARTMENTS                  D        0.83      0.20      0.200    57    8.15
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
```

```
 SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.200
 SUBAREA RUNOFF(CFS) =      1.25
 TOTAL AREA(ACRES) =      0.83   PEAK FLOW RATE(CFS) =      1.25

****************************************************************************
 FLOW PROCESS FROM NODE      2.00 TO NODE      3.00 IS CODE =  51
----------------------------------------------------------------------------
 >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
 >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =    791.92  DOWNSTREAM(FEET) =    791.00
 CHANNEL LENGTH THRU SUBAREA(FEET) =   131.00   CHANNEL SLOPE =  0.0070
 CHANNEL BASE(FEET) =    0.00   "Z" FACTOR =  10.000
 MANNING'S FACTOR = 0.015   MAXIMUM DEPTH(FEET) =   1.00
 *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.604
 SUBAREA LOSS RATE DATA(AMC  I ):
  DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap      SCS
      LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
 APARTMENTS                 D        0.76      0.20      0.200    57
 SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
 SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.200
 TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       1.78
 TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =   2.28
 AVERAGE FLOW DEPTH(FEET) =   0.28   TRAVEL TIME(MIN.) =   0.96
 Tc(MIN.) =    9.11
 SUBAREA AREA(ACRES) =     0.76       SUBAREA RUNOFF(CFS) =    1.07
 EFFECTIVE AREA(ACRES) =      1.59     AREA-AVERAGED Fm(INCH/HR) =   0.04
 AREA-AVERAGED Fp(INCH/HR) =   0.20  AREA-AVERAGED Ap =   0.20
 TOTAL AREA(ACRES) =        1.6         PEAK FLOW RATE(CFS) =       2.24

 END OF SUBAREA CHANNEL FLOW HYDRAULICS:
 DEPTH(FEET) =  0.31   FLOW VELOCITY(FEET/SEC.) =   2.36
 LONGEST FLOWPATH FROM NODE      1.00 TO NODE      3.00 =     431.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE      3.00 TO NODE      4.00 IS CODE =  31
----------------------------------------------------------------------------
 >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =   784.00  DOWNSTREAM(FEET) =   783.50
 FLOW LENGTH(FEET) =    34.00   MANNING'S N =  0.013
 DEPTH OF FLOW IN  12.0 INCH PIPE IS   6.2 INCHES
 PIPE-FLOW VELOCITY(FEET/SEC.) =   5.45
 ESTIMATED PIPE DIAMETER(INCH) =  12.00    NUMBER OF PIPES =   1
 PIPE-FLOW(CFS) =       2.24
 PIPE TRAVEL TIME(MIN.) =   0.10    Tc(MIN.) =    9.21
 LONGEST FLOWPATH FROM NODE      1.00 TO NODE      4.00 =     465.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE      4.00 TO NODE      4.00 IS CODE =  81
----------------------------------------------------------------------------
 >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
 MAINLINE Tc(MIN.) =    9.21
 *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.594
 SUBAREA LOSS RATE DATA(AMC  I ):
  DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap      SCS
      LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
 APARTMENTS                 D        1.12      0.20      0.200    57
 SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
 SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.200
 SUBAREA AREA(ACRES) =     1.12       SUBAREA RUNOFF(CFS) =    1.57
 EFFECTIVE AREA(ACRES) =      2.71   AREA-AVERAGED Fm(INCH/HR) =  0.04
 AREA-AVERAGED Fp(INCH/HR) =  0.20  AREA-AVERAGED Ap =  0.20
```

```
 TOTAL AREA(ACRES) =        2.7       PEAK FLOW RATE(CFS) =       3.79

****************************************************************************
 FLOW PROCESS FROM NODE      4.00 TO NODE      5.00 IS CODE =  31
----------------------------------------------------------------------------
 >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =   783.50  DOWNSTREAM(FEET) =   781.00
 FLOW LENGTH(FEET) =   193.00   MANNING'S N =  0.013
 DEPTH OF FLOW IN  12.0 INCH PIPE IS   9.4 INCHES
 PIPE-FLOW VELOCITY(FEET/SEC.) =   5.73
 ESTIMATED PIPE DIAMETER(INCH) =  12.00    NUMBER OF PIPES =   1
 PIPE-FLOW(CFS) =       3.79
 PIPE TRAVEL TIME(MIN.) =   0.56    Tc(MIN.) =    9.77
 LONGEST FLOWPATH FROM NODE      1.00 TO NODE      5.00 =     658.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE      5.00 TO NODE      5.00 IS CODE =  81
----------------------------------------------------------------------------
 >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
 MAINLINE Tc(MIN.) =    9.77
 *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.541
 SUBAREA LOSS RATE DATA(AMC  I ):
  DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS
      LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
 APARTMENTS                  D        1.65      0.20      0.200    57
 SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
 SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.200
 SUBAREA AREA(ACRES) =    1.65      SUBAREA RUNOFF(CFS) =    2.23
 EFFECTIVE AREA(ACRES) =      4.36   AREA-AVERAGED Fm(INCH/HR) =  0.04
 AREA-AVERAGED Fp(INCH/HR) =  0.20  AREA-AVERAGED Ap =  0.20
 TOTAL AREA(ACRES) =        4.4       PEAK FLOW RATE(CFS) =       5.89

****************************************************************************
 FLOW PROCESS FROM NODE      5.00 TO NODE      6.00 IS CODE =  31
----------------------------------------------------------------------------
 >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =   781.00  DOWNSTREAM(FEET) =   776.90
 FLOW LENGTH(FEET) =   321.00   MANNING'S N =  0.013
 DEPTH OF FLOW IN  15.0 INCH PIPE IS  10.4 INCHES
 PIPE-FLOW VELOCITY(FEET/SEC.) =   6.48
 ESTIMATED PIPE DIAMETER(INCH) =  15.00    NUMBER OF PIPES =   1
 PIPE-FLOW(CFS) =       5.89
 PIPE TRAVEL TIME(MIN.) =   0.83    Tc(MIN.) =   10.60
 LONGEST FLOWPATH FROM NODE      1.00 TO NODE      6.00 =     979.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE      6.00 TO NODE      6.00 IS CODE =  81
----------------------------------------------------------------------------
 >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
 MAINLINE Tc(MIN.) =   10.60
 *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.471
 SUBAREA LOSS RATE DATA(AMC  I ):
  DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS
      LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
 APARTMENTS                  D        1.29      0.20      0.200    57
 SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
 SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.200
 SUBAREA AREA(ACRES) =    1.29      SUBAREA RUNOFF(CFS) =    1.66
 EFFECTIVE AREA(ACRES) =      5.65   AREA-AVERAGED Fm(INCH/HR) =  0.04
```

```
 AREA-AVERAGED Fp(INCH/HR) =  0.20  AREA-AVERAGED Ap =  0.20
 TOTAL AREA(ACRES) =        5.7       PEAK FLOW RATE(CFS) =       7.28

****************************************************************************
 FLOW PROCESS FROM NODE      6.00 TO NODE      7.00 IS CODE =  31
----------------------------------------------------------------------------
 >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =   776.90  DOWNSTREAM(FEET) =   776.70
 FLOW LENGTH(FEET) =    18.00   MANNING'S N =  0.013
 DEPTH OF FLOW IN  18.0 INCH PIPE IS  10.8 INCHES
 PIPE-FLOW VELOCITY(FEET/SEC.) =   6.56
 ESTIMATED PIPE DIAMETER(INCH) =  18.00    NUMBER OF PIPES =   1
 PIPE-FLOW(CFS) =       7.28
 PIPE TRAVEL TIME(MIN.) =   0.05    Tc(MIN.) =   10.64
 LONGEST FLOWPATH FROM NODE      1.00 TO NODE      7.00 =     997.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE      7.00 TO NODE      7.00 IS CODE =  81
----------------------------------------------------------------------------
 >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
 MAINLINE Tc(MIN.) =   10.64
 *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.467
 SUBAREA LOSS RATE DATA(AMC  I ):
  DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS
      LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
 APARTMENTS                  D        1.25      0.20      0.200    57
 APARTMENTS                  D        1.30      0.20      0.200    57
 SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
 SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.200
 SUBAREA AREA(ACRES) =    2.55      SUBAREA RUNOFF(CFS) =    3.28
 EFFECTIVE AREA(ACRES) =      8.20   AREA-AVERAGED Fm(INCH/HR) =  0.04
 AREA-AVERAGED Fp(INCH/HR) =  0.20  AREA-AVERAGED Ap =  0.20
 TOTAL AREA(ACRES) =        8.2       PEAK FLOW RATE(CFS) =      10.53

****************************************************************************
 FLOW PROCESS FROM NODE      7.00 TO NODE      8.00 IS CODE =  31
----------------------------------------------------------------------------
 >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =   776.70  DOWNSTREAM(FEET) =   775.00
 FLOW LENGTH(FEET) =   164.00   MANNING'S N =  0.013
 DEPTH OF FLOW IN  21.0 INCH PIPE IS  12.6 INCHES
 PIPE-FLOW VELOCITY(FEET/SEC.) =   7.00
 ESTIMATED PIPE DIAMETER(INCH) =  21.00    NUMBER OF PIPES =   1
 PIPE-FLOW(CFS) =      10.53
 PIPE TRAVEL TIME(MIN.) =   0.39    Tc(MIN.) =   11.03
 LONGEST FLOWPATH FROM NODE      1.00 TO NODE      8.00 =    1161.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE      8.00 TO NODE      9.00 IS CODE =  31
----------------------------------------------------------------------------
 >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =   775.00  DOWNSTREAM(FEET) =   766.65
 FLOW LENGTH(FEET) =   107.00   MANNING'S N =  0.013
 DEPTH OF FLOW IN  15.0 INCH PIPE IS   8.4 INCHES
 PIPE-FLOW VELOCITY(FEET/SEC.) =  14.98
 ESTIMATED PIPE DIAMETER(INCH) =  15.00    NUMBER OF PIPES =   1
 PIPE-FLOW(CFS) =      10.53
 PIPE TRAVEL TIME(MIN.) =   0.12    Tc(MIN.) =   11.15
```

```
 LONGEST FLOWPATH FROM NODE      1.00 TO NODE      9.00 =    1268.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE     21.00 TO NODE     22.00 IS CODE =  21
----------------------------------------------------------------------------
 >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
 >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
 INITIAL SUBAREA FLOW-LENGTH(FEET) =   277.00
 ELEVATION DATA: UPSTREAM(FEET) =    805.50  DOWNSTREAM(FEET) =    796.00

 Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
 SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    5.660
 *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  2.108
 SUBAREA Tc AND LOSS RATE DATA(AMC  I ):
  DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
      LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
 COMMERCIAL                  D        0.25      0.20      0.100     57    5.66
 SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
 SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
 SUBAREA RUNOFF(CFS) =      0.47
 TOTAL AREA(ACRES) =      0.25   PEAK FLOW RATE(CFS) =      0.47

****************************************************************************
 FLOW PROCESS FROM NODE     22.00 TO NODE     23.00 IS CODE =  51
----------------------------------------------------------------------------
 >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
 >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =    796.00  DOWNSTREAM(FEET) =    786.26
 CHANNEL LENGTH THRU SUBAREA(FEET) =   512.00   CHANNEL SLOPE =  0.0190
 CHANNEL BASE(FEET) =    0.00   "Z" FACTOR =  50.000
 MANNING'S FACTOR = 0.015   MAXIMUM DEPTH(FEET) =   1.00
 *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.492
 SUBAREA LOSS RATE DATA(AMC  I ):
  DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS
      LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
 COMMERCIAL                  D        0.56      0.20      0.100     57
 SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
 SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
 TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =      0.85
 TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =   1.82
 AVERAGE FLOW DEPTH(FEET) =   0.10   TRAVEL TIME(MIN.) =   4.68
 Tc(MIN.) =   10.34
 SUBAREA AREA(ACRES) =     0.56       SUBAREA RUNOFF(CFS) =    0.74
 EFFECTIVE AREA(ACRES) =      0.81     AREA-AVERAGED Fm(INCH/HR) =   0.02
 AREA-AVERAGED Fp(INCH/HR) =   0.20  AREA-AVERAGED Ap =   0.10
 TOTAL AREA(ACRES) =        0.8         PEAK FLOW RATE(CFS) =       1.07

 END OF SUBAREA CHANNEL FLOW HYDRAULICS:
 DEPTH(FEET) =  0.10   FLOW VELOCITY(FEET/SEC.) =   1.99
 LONGEST FLOWPATH FROM NODE     21.00 TO NODE     23.00 =     789.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE     23.00 TO NODE     24.00 IS CODE =  51
----------------------------------------------------------------------------
 >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
 >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =    786.26  DOWNSTREAM(FEET) =    780.00
 CHANNEL LENGTH THRU SUBAREA(FEET) =   438.00   CHANNEL SLOPE =  0.0143
 CHANNEL BASE(FEET) =    0.00   "Z" FACTOR =  50.000
 MANNING'S FACTOR = 0.015   MAXIMUM DEPTH(FEET) =   1.00
 *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.239
 SUBAREA LOSS RATE DATA(AMC  I ):
```

DEVELOPMENT TYPE/ LAND USE	SCS SOIL GROUP	AREA (ACRES)	Fp (INCH/HR)	Ap (DECIMAL)	SCS CN
COMMERCIAL	D	0.45	0.20	0.100	57

SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) = 0.20
SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap = 0.100
TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) = 1.32
TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) = 1.85
AVERAGE FLOW DEPTH(FEET) = 0.12 TRAVEL TIME(MIN.) = 3.94
Tc(MIN.) = 14.28
SUBAREA AREA(ACRES) = 0.45 SUBAREA RUNOFF(CFS) = 0.49
EFFECTIVE AREA(ACRES) = 1.26 AREA-AVERAGED Fm(INCH/HR) = 0.02
AREA-AVERAGED Fp(INCH/HR) = 0.20 AREA-AVERAGED Ap = 0.10
TOTAL AREA(ACRES) = 1.3 PEAK FLOW RATE(CFS) = 1.38

END OF SUBAREA CHANNEL FLOW HYDRAULICS:
DEPTH(FEET) = 0.12 FLOW VELOCITY(FEET/SEC.) = 1.77
LONGEST FLOWPATH FROM NODE 21.00 TO NODE 24.00 = 1227.00 FEET.

==========

END OF STUDY SUMMARY:
TOTAL AREA(ACRES) = 1.3 TC(MIN.) = 14.28
EFFECTIVE AREA(ACRES) = 1.26 AREA-AVERAGED Fm(INCH/HR)= 0.02
AREA-AVERAGED Fp(INCH/HR) = 0.20 AREA-AVERAGED Ap = 0.100
PEAK FLOW RATE(CFS) = 1.38

==========
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END OF RATIONAL METHOD ANALYSIS

♀

LOSS-2YR-PR

LOSS CALCULATION - PROPOSED 2 YR (120328-SS)

==========

*** NON-HOMOGENEOUS WATERSHED AREA-AVERAGED LOSS RATE (Fm)
AND LOW LOSS FRACTION ESTIMATIONS FOR AMC I:

TOTAL 24-HOUR DURATION RAINFALL DEPTH = 2.05 (inches)

SOIL-COVER TYPE	AREA (Acres)	PERCENT OF PERVIOUS AREA	SCS CURVE NUMBER	LOSS RATE Fp(in./hr.)	YIELD
1	8.20	20.00	57.(AMC II)	0.200	0.712
2	1.26	10.00	95.(AMC II)	0.200	0.847

TOTAL AREA (Acres) = 9.46

AREA-AVERAGED LOSS RATE, $\bar{F}m$ (in./hr.) = 0.037

AREA-AVERAGED LOW LOSS FRACTION, $\bar{Y}$ = 0.270

==========

VOLUME-2YR-PR

VOLUME CALCULATION - PROPOSED 2 YR (120328-SS)

RATIONAL METHOD CALIBRATION COEFFICIENT = 0.90
TOTAL CATCHMENT AREA(ACRES) = 9.46
SOIL-LOSS RATE, Fm,(INCH/HR) = 0.037
LOW LOSS FRACTION = 0.270
TIME OF CONCENTRATION(MIN.) = 11.03
SMALL AREA PEAK Q COMPUTED USING PEAK FLOW RATE FORMULA
ORANGE COUNTY "VALLEY" RAINFALL VALUES ARE USED
RETURN FREQUENCY(YEARS) = 2
5-MINUTE POINT RAINFALL VALUE(INCHES) = 0.19
30-MINUTE POINT RAINFALL VALUE(INCHES) = 0.40
1-HOUR POINT RAINFALL VALUE(INCHES) = 0.53
3-HOUR POINT RAINFALL VALUE(INCHES) = 0.89
6-HOUR POINT RAINFALL VALUE(INCHES) = 1.22
24-HOUR POINT RAINFALL VALUE(INCHES) = 2.05

TOTAL CATCHMENT RUNOFF VOLUME(ACRE-FEET) = 1.15
TOTAL CATCHMENT SOIL-LOSS VOLUME(ACRE-FEET) = 0.47

****

TIME (HOURS)	VOLUME (AF)	Q (CFS)	0.	5.0	10.0	15.0	20.0
0.01	0.0000	0.00	Q	.	.	.	.
0.19	0.0015	0.20	Q	.	.	.	.
0.37	0.0045	0.20	Q	.	.	.	.
0.56	0.0076	0.20	Q	.	.	.	.
0.74	0.0107	0.20	Q	.	.	.	.
0.93	0.0138	0.20	Q	.	.	.	.
1.11	0.0169	0.21	Q	.	.	.	.
1.29	0.0201	0.21	Q	.	.	.	.
1.48	0.0232	0.21	Q	.	.	.	.
1.66	0.0264	0.21	Q	.	.	.	.
1.84	0.0297	0.21	Q	.	.	.	.
2.03	0.0329	0.21	Q	.	.	.	.
2.21	0.0362	0.22	Q	.	.	.	.
2.40	0.0395	0.22	Q	.	.	.	.
2.58	0.0428	0.22	Q	.	.	.	.
2.76	0.0462	0.22	Q	.	.	.	.
2.95	0.0496	0.22	Q	.	.	.	.
3.13	0.0530	0.23	Q	.	.	.	.
3.32	0.0565	0.23	Q	.	.	.	.
3.50	0.0599	0.23	Q	.	.	.	.
3.68	0.0634	0.23	Q	.	.	.	.
3.87	0.0670	0.23	Q	.	.	.	.
4.05	0.0706	0.24	Q	.	.	.	.
4.23	0.0742	0.24	Q	.	.	.	.
4.42	0.0778	0.24	Q	.	.	.	.
4.60	0.0815	0.24	Q	.	.	.	.
4.79	0.0852	0.25	Q	.	.	.	.
4.97	0.0890	0.25	Q	.	.	.	.
5.15	0.0928	0.25	Q	.	.	.	.
5.34	0.0966	0.25	Q	.	.	.	.
5.52	0.1005	0.26	Q	.	.	.	.
5.71	0.1044	0.26	Q	.	.	.	.
5.89	0.1084	0.26	Q	.	.	.	.
6.07	0.1124	0.26	Q	.	.	.	.

VOLUME-2YR-PR

6.26	0.1165	0.27	Q
6.44	0.1206	0.27	Q
6.62	0.1247	0.28	Q
6.81	0.1289	0.28	Q
6.99	0.1332	0.28	Q
7.18	0.1375	0.28	Q
7.36	0.1418	0.29	Q
7.54	0.1463	0.29	Q
7.73	0.1507	0.30	Q
7.91	0.1553	0.30	Q
8.10	0.1599	0.31	Q
8.28	0.1646	0.31	Q
8.46	0.1693	0.32	Q
8.65	0.1741	0.32	Q
8.83	0.1790	0.32	Q
9.01	0.1840	0.33	Q
9.20	0.1890	0.34	Q
9.38	0.1941	0.34	Q
9.57	0.1993	0.35	Q
9.75	0.2047	0.35	Q
9.93	0.2101	0.36	Q
10.12	0.2156	0.36	Q
10.30	0.2212	0.37	Q
10.49	0.2269	0.38	Q
10.67	0.2327	0.39	Q
10.85	0.2387	0.40	Q
11.04	0.2448	0.41	Q
11.22	0.2510	0.41	Q
11.40	0.2574	0.43	Q
11.59	0.2639	0.43	Q
11.77	0.2707	0.45	Q
11.96	0.2775	0.46	Q
12.14	0.2851	0.54	.Q
12.32	0.2937	0.59	.Q
12.51	0.3027	0.61	.Q
12.69	0.3120	0.62	.Q
12.87	0.3216	0.64	.Q
13.06	0.3315	0.66	.Q
13.24	0.3418	0.69	.Q
13.43	0.3523	0.70	.Q
13.61	0.3633	0.74	.Q
13.79	0.3747	0.76	.Q
13.98	0.3866	0.81	.Q
14.16	0.3992	0.84	.Q
14.35	0.4128	0.95	.Q
14.53	0.4277	1.00	. Q
14.71	0.4438	1.12	. Q
14.90	0.4614	1.19	. Q
15.08	0.4808	1.37	. Q
15.26	0.5024	1.48	. Q
15.45	0.5264	1.67	. Q
15.63	0.5523	1.74	. Q
15.82	0.5857	2.66	. Q
16.00	0.6345	3.76	. Q
16.18	0.7536	11.91	. Q
16.37	0.8598	2.07	. Q
16.55	0.8879	1.62	. Q
16.74	0.9099	1.27	. Q
16.92	0.9276	1.06	. Q
17.10	0.9425	0.91	.Q
17.29	0.9554	0.78	.Q
17.47	0.9668	0.72	.Q
17.65	0.9774	0.67	.Q

				VOLUME-2YR-PR			
17.84	0.9873	0.63	.Q	.	.	.	.
18.02	0.9967	0.60	.Q	.	.	.	.
18.21	1.0047	0.47	Q	.	.	.	.
18.39	1.0116	0.44	Q	.	.	.	.
18.57	1.0182	0.42	Q	.	.	.	.
18.76	1.0244	0.40	Q	.	.	.	.
18.94	1.0304	0.38	Q	.	.	.	.
19.13	1.0361	0.37	Q	.	.	.	.
19.31	1.0416	0.36	Q	.	.	.	.
19.49	1.0469	0.34	Q	.	.	.	.
19.68	1.0520	0.33	Q	.	.	.	.
19.86	1.0570	0.32	Q	.	.	.	.
20.04	1.0618	0.31	Q	.	.	.	.
20.23	1.0665	0.30	Q	.	.	.	.
20.41	1.0710	0.29	Q	.	.	.	.
20.60	1.0754	0.29	Q	.	.	.	.
20.78	1.0798	0.28	Q	.	.	.	.
20.96	1.0840	0.27	Q	.	.	.	.
21.15	1.0881	0.27	Q	.	.	.	.
21.33	1.0921	0.26	Q	.	.	.	.
21.52	1.0960	0.26	Q	.	.	.	.
21.70	1.0998	0.25	Q	.	.	.	.
21.88	1.1036	0.24	Q	.	.	.	.
22.07	1.1073	0.24	Q	.	.	.	.
22.25	1.1109	0.24	Q	.	.	.	.
22.43	1.1144	0.23	Q	.	.	.	.
22.62	1.1179	0.23	Q	.	.	.	.
22.80	1.1213	0.22	Q	.	.	.	.
22.99	1.1247	0.22	Q	.	.	.	.
23.17	1.1280	0.22	Q	.	.	.	.
23.35	1.1313	0.21	Q	.	.	.	.
23.54	1.1345	0.21	Q	.	.	.	.
23.72	1.1376	0.21	Q	.	.	.	.
23.90	1.1407	0.20	Q	.	.	.	.
24.09	1.1438	0.20	Q	.	.	.	.
24.27	1.1453	0.00	Q	.	.	.	.

TIME DURATION(minutes) OF PERCENTILES OF ESTIMATED PEAK FLOW RATE:
(Note: 100% of Peak Flow Rate estimate assumed to have
an instantaneous time duration)

Percentile of Estimated Peak Flow Rate	Duration (minutes)
0%	1444.9
10%	110.3
20%	33.1
30%	22.1
40%	11.0
50%	11.0
60%	11.0
70%	11.0
80%	11.0
90%	11.0

APPENDIX B

NOTICE OF TRANSFER OF RESPONSIBILITY

NOTICE OF TRANSFER OF RESPONSIBILITY

WATER QUALITY MANAGEMENT PLAN

The Village at Foothill Ranch
VTTM 17466

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

I. Previous Owner/ Previous Responsible Party Information

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

II. Information about Site Transferred

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

III. New Owner/ New Responsible Party Information

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

IV. Ownership Transfer Information

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

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

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

V. Purpose of Notice of Transfer

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

VI. Certifications

A. Previous Owner

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

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

B. New Owner

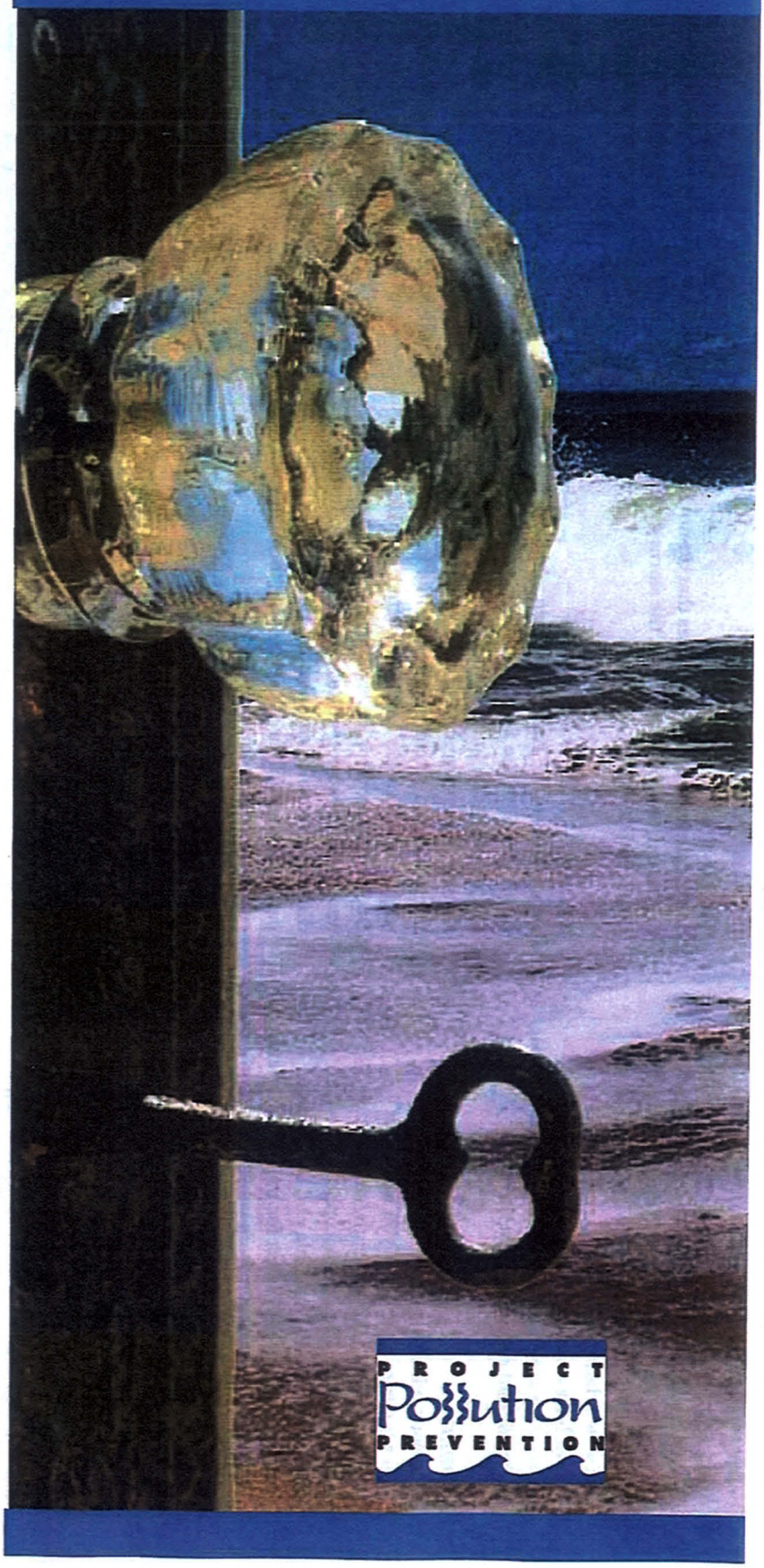
I certify under penalty of law that I am the owner of the Transferred Site, as described in Section II above, that I have been provided a copy of the WQMP, and that I have informed myself and understand the New Owner's responsibilities related to the WQMP, its implementation, and Best Management Practices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

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

Appendix C

APPENDIX C
EDUCATIONAL MATERIALS

The Ocean Begins at Your Front Door



Follow these simple steps to help reduce water pollution:

Household Activities

- Do not rinse spills with water. Use dry cleanup methods such as applying cat litter or another absorbent material, sweep and dispose of in the trash. Take items such as used or excess batteries, oven cleaners, automotive fluids, painting products and cathode ray tubes, like TVs and computer monitors, to a Household Hazardous Waste Collection Center (HHWCC).
- For a HHWCC near you call (714) 834-6752 or visit www.oclandfills.com.
- Do not hose down your driveway, sidewalk or patio to the street, gutter or storm drain. Sweep up debris and dispose of it in the trash.

Automotive

- Take your vehicle to a commercial car wash whenever possible. If you wash your vehicle at home, choose soaps, cleaners, or detergents labeled non-toxic, phosphate-free or biodegradable. Vegetable and citrus-based products are typically safest for the environment.
- Do not allow washwater from vehicle washing to drain into the street, gutter or storm drain. Excess washwater should be disposed of in the sanitary sewer (through a sink or toilet) or onto an absorbent surface like your lawn.
- Monitor your vehicles for leaks and place a pan under leaks. Keep your vehicles well maintained to stop and prevent leaks.
- Never pour oil or antifreeze in the street, gutter or storm drain. Recycle these substances at a service station, a waste oil collection center or used oil recycling center. For the nearest Used Oil Collection Center call 1-800-CLEANUP or visit www.1800cleanup.org.

Pool Maintenance

- Pool and spa water must be dechlorinated and free of excess acid, alkali or color to be allowed in the street, gutter or storm drain.
- When it is not raining, drain dechlorinated pool and spa water directly into the sanitary sewer.
- Some cities may have ordinances that do not allow pool water to be disposed of in the storm drain. Check with your city.

Landscape and Gardening

- Do not over-water. Water your lawn and garden by hand to control the amount of water you use or set irrigation systems to reflect seasonal water needs. If water flows off your yard onto your driveway or sidewalk, your system is over-watering. Periodically inspect and fix leaks and misdirected sprinklers.
- Do not rake or blow leaves, clippings or pruning waste into the street, gutter or storm drain. Instead, dispose of waste by composting, hauling it to a permitted landfill, or as green waste through your city's recycling program.
- Follow directions on pesticides and fertilizer, (measure, do not estimate amounts) and do not use if rain is predicted within 48 hours.
- Take unwanted pesticides to a HHWCC to be recycled. For locations and hours of HHWCC, call (714) 834-6752 or visit www.oclandfills.com.

Trash

- Place trash and litter that cannot be recycled in securely covered trash cans.
- Whenever possible, buy recycled products.
- Remember: Reduce, Reuse, Recycle.

Pet Care

- Always pick up after your pet. Flush waste down the toilet or dispose of it in the trash. Pet waste, if left outdoors, can wash into the street, gutter or storm drain.
- If possible, bathe your pets indoors. If you must bathe your pet outside, wash it on your lawn or another absorbent/permeable surface to keep the washwater from entering the street, gutter or storm drain.
- Follow directions for use of pet care products and dispose of any unused products at a HHWCC.

Common Pollutants

Home Maintenance

- Detergents, cleaners and solvents
- Oil and latex paint
- Swimming pool chemicals
- Outdoor trash and litter

Lawn and Garden

- Pet and animal waste
- Pesticides
- Clippings, leaves and soil
- Fertilizer

Automobile

- Oil and grease
- Radiator fluids and antifreeze
- Cleaning chemicals
- Brake pad dust

The Ocean Begins at Your Front Door

Never allow pollutants to enter the street, gutter or storm drain!

Did You Know?

- Most people believe that the largest source of water pollution in urban areas comes from specific sources such as factories and sewage treatment plants. In fact, the largest source of water pollution comes from city streets, neighborhoods, construction sites and parking lots. This type of pollution is sometimes called "non-point source" pollution.
- There are two types of non-point source pollution: stormwater and urban runoff pollution.
- Stormwater runoff results from rainfall. When rainstorms cause large volumes of water to rinse the urban landscape, picking up pollutants along the way.
- Urban runoff can happen any time of the year when excessive water use from irrigation, vehicle washing and other sources carries trash, lawn clippings and other urban pollutants into storm drains.

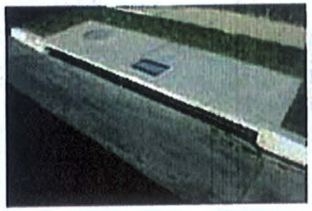
Where Does It Go?

- Anything we use outside homes, vehicles and businesses – like motor oil, paint, pesticides, fertilizers and cleaners – can be blown or washed into storm drains.
- A little water from a garden hose or rain can also send materials into storm drains.
- Storm drains are separate from our sanitary sewer systems; unlike water in sanitary sewers (from sinks or toilets), water in storm drains is not treated before entering our waterways.

Sources of Non-Point Source Pollution

- Automotive leaks and spills.
- Improper disposal of used oil and other engine fluids.
- Metals found in vehicle exhaust, weathered paint, rust, metal plating and tires.
- Pesticides and fertilizers from lawns, gardens and farms.
- Improper disposal of cleaners, paint and paint removers.
- Soil erosion and dust debris from landscape and construction activities.
- Litter, lawn clippings, animal waste, and other organic matter.
- Oil stains on parking lots and paved surfaces.

The Effect on the Ocean



Non-point source pollution can have a serious impact on water quality in Orange County. Pollutants from the storm drain system can harm marine life as well as coastal and wetland habitats. They can also degrade recreation areas such as beaches, harbors and bays.

Stormwater quality management programs have been developed throughout Orange County to educate and encourage the public to protect water quality, monitor runoff in the storm drain system, investigate illegal dumping and maintain storm drains.

Support from Orange County residents and businesses is needed to improve water quality and reduce urban runoff pollution. Proper use and disposal of materials will help stop pollution before it reaches the storm drain and the ocean.

For More Information

Orange County Stormwater Program

California Environmental Protection Agency
www.calepa.ca.gov

- **Air Resources Board**
  www.arb.ca.gov
- **Department of Pesticide Regulation**
  www.cdpr.ca.gov
- **Department of Toxic Substances Control**
  www.dtsc.ca.gov
- **Integrated Waste Management Board**
  www.ciwmb.ca.gov
- **Office of Environmental Health Hazard Assessment**
  www.oehha.ca.gov
- **State Water Resources Control Board**
  www.waterboards.ca.gov

Earth 911 - Community-Specific Environmental Information 1-800-cleanup or visit www.1800cleanup.org

Health Care Agency's Ocean and Bay Water Closure and Posting Hotline
(714) 433-6400 or visit www.ocbeachinfo.com

Integrated Waste Management Dept. of Orange County (714) 834-6752 or visit www.oclandfills.com for information on household hazardous waste collection centers, recycling centers and solid waste collection

O.C. Agriculture Commissioner
(714) 447-7100 or visit www.ocagcomm.com

Stormwater Best Management Practice Handbook
Visit www.cabmphandbooks.com

UC Master Gardener Hotline
(714) 708-1646 or visit www.uccemg.com

The Orange County Stormwater Program has created and moderates an electronic mailing list to facilitate communications, take questions and exchange ideas among its users about issues and topics related to stormwater and urban runoff and the implementation of program elements. To join the list, please send an email to ocstormwaterinfo-join@list.ocwatersheds.com

Aliso Viejo	(949)	425-2535
Anaheim Public Works Operations	(714)	765-6860
Brea Engineering	(714)	990-7666
Buena Park Public Works	(714)	562-3655
Costa Mesa Public Services	(714)	754-5323
Cypress Public Works	(714)	229-6740
Dana Point Public Works	(949)	248-3584
Fountain Valley Public Works	(714)	593-4441
Fullerton Engineering Dept.	(714)	738-6853
Garden Grove Public Works	(714)	741-5956
Huntington Beach Public Works	(714)	536-5431
Irvine Public Works	(949)	724-6315
La Habra Public Services	(562)	905-9792
La Palma Public Works	(714)	690-3310
Laguna Beach Water Quality	(949)	497-0378
Laguna Hills Public Services	(949)	707-2650
Laguna Niguel Public Works	(949)	362-4337
Laguna Woods Public Works	(949)	639-0500
Lake Forest Public Works	(949)	461-3480
Los Alamitos Community Dev.	(562)	431-3538
Mission Viejo Public Works	(949)	470-3056
Newport Beach, Code & Water Quality Enforcement	(949)	644-3215
Orange Public Works	(714)	532-6480
Placentia Public Works	(714)	993-8245
Rancho Santa Margarita	(949)	635-1800
San Clemente Environmental Programs	(949)	361-6143
San Juan Capistrano Engineering	(949)	234-4413
Santa Ana Public Works	(714)	647-3380
Seal Beach Engineering	(562)	431-2527 x317
Stanton Public Works	(714)	379-9222 x204
Tustin Public Works/Engineering	(714)	573-3150
Villa Park Engineering	(714)	998-1500
Westminster Public Works/Engineering	(714)	898-3311 x446
Yorba Linda Engineering	(714)	961-7138
Orange County Stormwater Program	(877)	897-7455

Orange County 24-Hour Water Pollution Problem Reporting Hotline
1-877-89-SPILL (1-877-897-7455)

On-line Water Pollution Problem Reporting Form

w w w . o c w a t e r s h e d s . c o m

Do your part to prevent water pollution in our creeks, rivers, bays and ocean.

Clean beaches and healthy creeks, rivers, bays, and ocean are important to Orange County. However, many common household activities can lead to water pollution if you're not careful.

REMEMBER THE WATER IN YOUR STORM DRAIN IS NOT TREATED BEFORE IT ENTERS OUR WATERWAYS

Litter, oil, chemicals and other substances that are left on your yard or driveway can be blown or washed into storm drains that flow to the ocean. Over-watering your lawn and washing your car can also flush materials into the storm drains. Unlike water in sanitary sewers (from sinks and toilets), water in storm drains is not treated.

You would never pour soap, fertilizers or oil into the ocean, so don't let them enter streets, gutters or storm drains. Follow the easy tips in this brochure to help prevent water pollution.

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

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

For emergencies, dial 911.

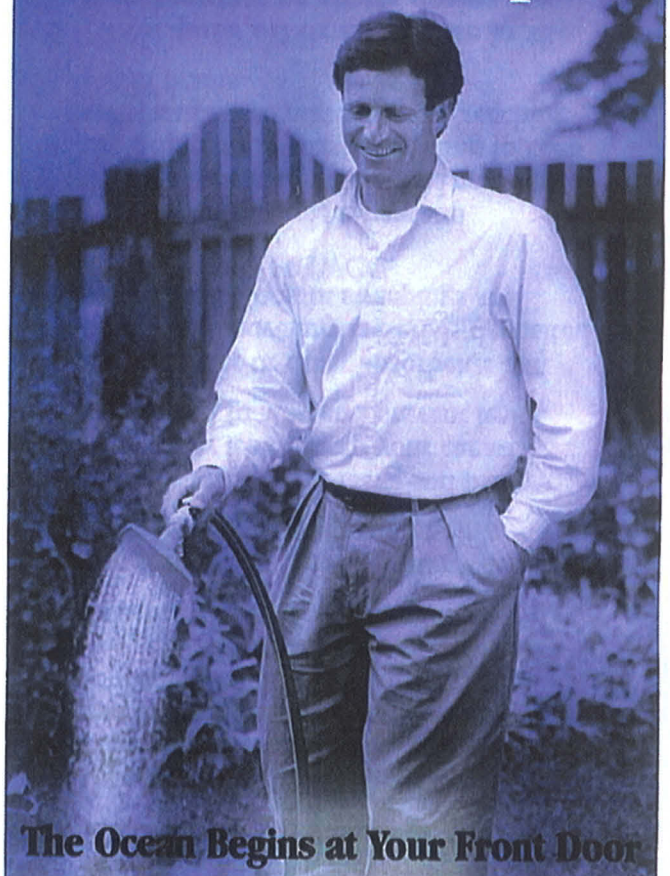
The tips contained in this brochure provide useful information to help prevent water pollution while performing everyday household activities. If you have other suggestions, please contact your city's stormwater representatives or call the Orange County Stormwater Program.

GENUINE RECYCLED PAPER
50% PRE-CONSUMER AND 10% POST-CONSUMER

RECYCLE USED OIL

Help Prevent Ocean Pollution:

Household Tips



The Ocean Begins at Your Front Door

PROJECT Pollution PREVENTION

Pollution Prevention

Household Activities

- **Do not rinse spills with water!** Sweep outdoor spills and dispose of in the trash. For wet spills like oil, apply cat litter or another absorbent material, then sweep and bring to a household hazardous waste collection center (HHWCC).
- Securely cover trash cans.
- Take household hazardous waste to a household hazardous waste collection center.
- Store household hazardous waste in closed, labeled containers inside or under a cover.
- Do not hose down your driveway, sidewalk or patio. Sweep up debris and dispose of in trash.
- Always pick up after your pet. Flush waste down the toilet or dispose of in the trash.
- Bathe pets indoors or have them professionally groomed.

Household Hazardous Wastes include:

- ▲ **Batteries**
- ▲ **Paint thinners, paint strippers and removers**
- ▲ **Adhesives**
- ▲ **Drain openers**
- ▲ **Oven cleaners**
- ▲ **Wood and metal cleaners and polishes**
- ▲ **Herbicides and pesticides**
- ▲ **Fungicides/wood preservatives**
- ▲ **Automotive fluids and products**
- ▲ **Grease and rust solvents**
- ▲ **Thermometers and other products containing mercury**
- ▲ **Fluorescent lamps**
- ▲ **Cathode ray tubes, e.g. TVs, computer monitors**
- ▲ **Pool a[illegible]pa chemicals**

Gardening Activities

- Follow directions on pesticides and fertilizers, (measure, do not estimate amounts) and do not use if rain is predicted within 48 hours.
- Water your lawn and garden by hand to control the amount of water you use. Set irrigation systems to reflect seasonal water needs. If water flows off your yard and onto your driveway or sidewalk, your system is over-watering.
- Mulch clippings or leave them on the lawn. If necessary, dispose in a green waste container.
- Cultivate your garden often to control weeds.

Washing and Maintaining Your Car

- Take your car to a commercial car wash whenever possible.
- Choose soaps, cleaners, or detergents labeled "non-toxic," "phosphate free" or "biodegradable." Vegetable and citrus-based products are typically safest for the environment, **but even these should not be allowed into the storm drain.**
- Shake floor mats into a trash can or vacuum to clean.
- Do not use acid-based wheel cleaners and "hose off" engine degreasers at home. They can be used at a commercial facility, which can properly process the washwater.
- **Do not dump washwater onto your driveway, sidewalk, street, gutter or storm drain.** Excess washwater should be disposed of in the sanitary sewers (through a sink, or toilet) or onto an absorbent surface like your lawn.
- Use a nozzle to turn off water when not actively washing down automobile.
- Monitor vehicles for leaks and place pans under leaks. Keep your car well maintained to stop and prevent leaks.
- Use cat litter or other absorbents and sweep to remove any materials deposited by vehicles. Contain sweepings and dispose of at a HHWCC.
- Perform automobile repair and maintenance under a covered area and use drip pans or plastic sheeting to keep spills and waste material from reaching storm drains.
- **Never pour oil or antifreeze in the street, gutter or storm drains.** Recycle these substances at a service station, HHWCC, or used oil recycling center. For the nearest Used Oil Collection Center call 1-800-CLEANUP or visit www.ciwmb.ca.gov/UsedOil.

For locations and hours of Household Hazardous Waste Collection Centers in Anaheim, Huntington Beach, Irvine and San [illegible]an Capistrano, call (714)834-6752 or visit www.oclandfills.com.

Do your part to prevent water pollution in our creeks, rivers, bays and ocean.

Clean beaches and healthy creeks, rivers, bays and ocean are important to Orange County. However, not properly disposing of household hazardous waste can lead to water pollution. Batteries, electronics, paint, oil, gardening chemicals, cleaners and other hazardous materials cannot be thrown in the trash. They also must never be poured or thrown into yards, sidewalks, driveways, gutters or streets. Rain or other water could wash the materials into the storm drain and eventually into our waterways and the ocean. In addition, hazardous waste must not be poured in the sanitary sewers (sinks and toilets).

NEVER DISPOSE OF HOUSEHOLD HAZARDOUS WASTE IN THE TRASH, STREET, GUTTER, STORM DRAIN OR SEWER.

For more information,
please call the
Orange County Stormwater Program
at **(714) 567-6363**
or visit
www.ocwatersheds.com

To Report Illegal Dumping of Household Hazardous Waste call 1-800-69-TOXIC

To report a spill,
call the
Orange County 24-Hour Water Pollution Problem Reporting Hotline (714) 567-6363.

For emergencies, dial 911.

RECYCLE USED OIL

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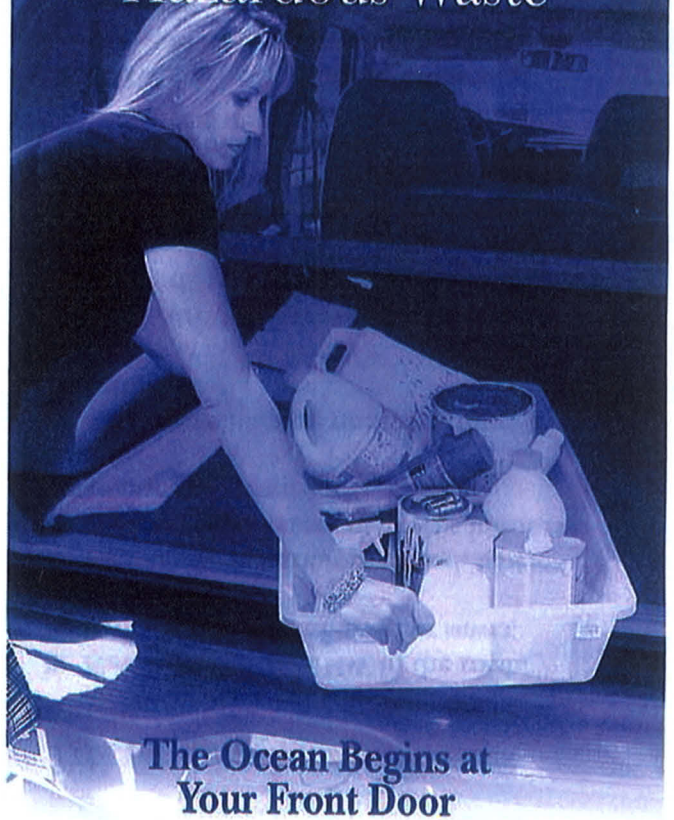
Help Prevent Ocean Pollution:

Proper Disposal of Household Hazardous Waste



The Ocean Begins at Your Front Door

PROJECT Pollution PREVENTION

ORANGE COUNTY

Pollution Prevention

Leftover household products that contain corrosive, toxic, ignitable, or reactive ingredients are considered to be "household hazardous waste" or "HHW." HHW can be found throughout your home, including the bathroom, kitchen, laundry room and garage.

WHEN POSSIBLE, USE NON-HAZARDOUS OR LESS-HAZARDOUS PRODUCTS.

Disposal of HHW down the drain, on the ground, into storm drains, or in the trash is illegal and unsafe.

Proper disposal of HHW is actually easy. Simply drop them off at a Household Hazardous Waste Collection Center (HHWCC) for free disposal and recycling. Many materials including anti-freeze, latex-based paint, motor oil and batteries can be recycled. Some centers have a "Stop & Swap" program that lets you take partially used home, garden, and automobile products free of charge. There are four HHWCCs in Orange County:

Anaheim:.....1071 N. Blue Gum St
Huntington Beach:.....17121 Nichols St
Irvine:..... 6411 Oak Canyon
San Juan Capistrano:... 32250 La Pata Ave

Centers are open Tuesday-Saturday, 9 a.m.-3 p.m. Centers are closed on rainy days and major holidays. For more information, call **(714) 834-6752** or visit **www.oclandfills.com.**

Common household hazardous wastes

- Batteries
- Paint and paint products
- Adhesives
- Drain openers
- Household cleaning products
- Wood and metal cleaners and polishes
- Pesticides
- Fungicides/wood preservatives
- Automotive products (antifreeze, motor oil, fluids)
- Grease and rust solvents
- Fluorescent lamps
- Mercury (thermometers & thermostats)
- All forms of electronic waste including computers and microwaves
- Pool & spa chemicals
- Cleaners
- Medications
- Propane (camping & BBQ)
- Mercury-containing lamps
- Television & monitors (CRTs, flatscreens)

Tips for household hazardous waste

- Never dispose of HHW in the trash, street, gutter, storm drain or sewer.
- Keep these materials in closed, labeled containers and store materials indoors or under a cover.
- When possible, use non-hazardous products.
- Reuse products whenever possible or share with family and friends.
- Purchase only as much of a product as you'll need. Empty containers may be disposed of in the trash.
- HHW can be harmful to humans, pets and the environment. Report emergencies to 911.

Did you know that just one quart of oil can pollute 250,000 gallons of water?

A clean ocean and healthy creeks, rivers, bays and beaches are important to Orange County. However, not properly disposing of used oil can lead to water pollution. If you pour or drain oil onto driveways, sidewalks or streets, it can be washed into the storm drain. Unlike water in sanitary sewers (from sinks and toilets), water in storm drains is not treated before entering the ocean. Help prevent water pollution by taking your used oil to a used oil collection center.

Included in this brochure is a list of locations that will accept up to five gallons of used motor oil at no cost. Many also accept used oil filters. Please contact the facility before delivering your used oil. This listing of companies is for your reference and does not constitute a recommendation or endorsement of the company.

Please note that used oil filters may not be disposed of with regular household trash. They must be taken to a household hazardous waste collection or recycling center in Anaheim, Huntington Beach, Irvine or San Juan Capistrano. For information about these centers, visit www.oclandfills.com.

Please do not mix your oil with other substances!

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

For information about the proper disposal of household hazardous waste, call the Household Waste Hotline at (714) 834-6752 or visit www.oclandfills.com.

RECYCLE USED OIL

For additional information about the nearest oil recycling center, call the Used Oil Program at 1-800-CLEANUP or visit www.cleanup.org.

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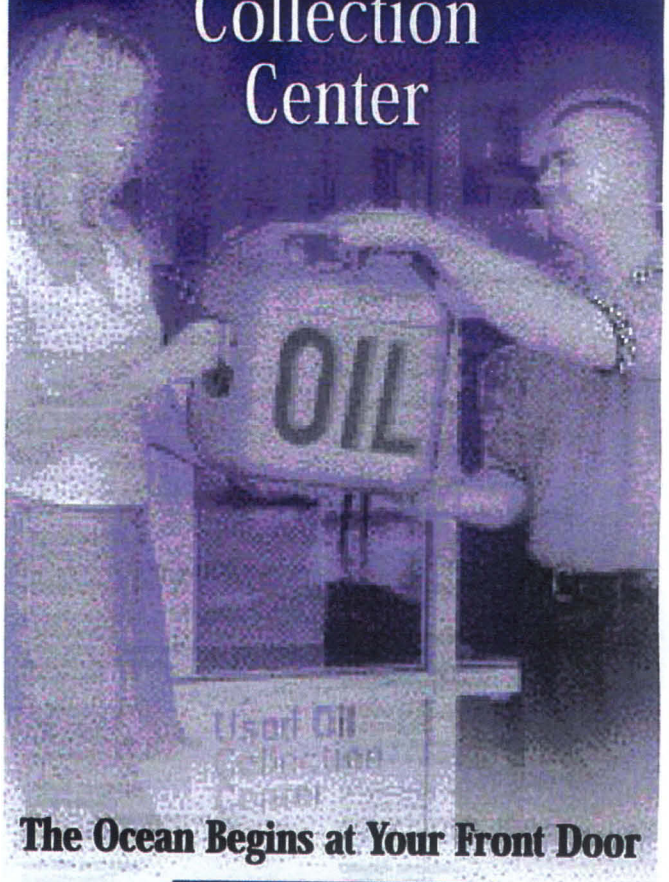
Help Prevent Ocean Pollution:

Recycle at Your Local Used Oil Collection Center



The Ocean Begins at Your Front Door

PROJECT Pollution PREVENTION

CENTRAL COUNTY

Used Oil Collection Centers

Balboa

Hill's Boat Service
814 E Bay Ave., Balboa, CA 92661
(949)675-0740( )
CIWMB#: 30-C-03538

Balboa Island

Island Marine Fuel
406 S Bay Front, Balboa Island, CA 92662
(949)673-1103( )
CIWMB#: 30-C-03728

Corona Del Mar

Corona Del Mar 76
2201 E. Pacific Coast Hwy., Corona Del Mar, CA 92625
(949)673-3320( )
CIWMB#: 30-C-06620

Corona Del Mar Chevron
2546 E. Coast Hwy., Corona Del Mar, CA 92625
(949)495-0774(14)
CIWMB#: 30-C-06424

Mobil (Harbor View)
2500 San Joaquin Hills Rd., Corona Del Mar, CA 92625
(949)640-4759( )
CIWMB#: 30-C-03363

Costa Mesa

AutoZone #5520
744 W. 19th St., Costa Mesa, CA 92627
(901)495-7159( )
CIWMB#: 30-C-05992

Big O Tires #5571
3161 Harbor Blvd., Costa Mesa, CA 92626
(949)443-4155( )
CIWMB#: 30-C-04676

Big O Tires #694
322 E. 17th St., Costa Mesa, CA 92627
(949)642-4131( )
CIWMB#: 30-C-05811

Coast General Performance
2855 Harbor Blvd., Costa Mesa, CA 92626
(714)540-5710( )
CIWMB#: 30-C-05916

Connell Chevrolet
2828 Harbor Blvd., Costa Mesa, CA 92626
(714)546-1200( )
CIWMB#: 30-C-06286

EZ Lube Inc #15
3599 Harbor Blvd., Costa Mesa, CA 92626
(714)966-1647( )
CIWMB#: 30-C-03137

EZ Lube Inc #46
400 E 17th St., Costa Mesa, CA 92627
(714)556-1312( )
CIWMB#: 30-C-05779

EZ Lube Inc. #44
2248 Harbor Blvd., Costa Mesa, CA 92627
(714)556-1312( )
CIWMB#: 30-C-05737

Firestone Store #71T7
475 E 17th St., Costa Mesa, CA 92627
(949)646-2444( )
CIWMB#: 30-C-02120

Jiffy Lube #1969
300 E 17th St., Costa Mesa, CA 92627
(949)548-2505( )
CIWMB#: 30-C-05553

Jiffy Lube #1970
2175 Newport Blvd., Costa Mesa, CA 92627
(949)548-4150( )
CIWMB#: 30-C-05554

Jiffy Lube #667
2255 Fairview Rd., Costa Mesa, CA 92627
(949)650-5823( )
CIWMB#: 30-C-05551

Jiffy Lube #861
375 Bristol St., Costa Mesa, CA 92626
(714)557-5823( )
CIWMB#: 30-C-05552

Kragen Auto Parts #0725
1739 Superior Ave., Costa Mesa, CA 92627
(949)642-3384( )
CIWMB#: 30-C-02624

Kragen Auto Parts #0796
1175 Baker Blvd., Unit E, Costa Mesa, CA 92626
(714)662-2005( )
CIWMB#: 30-C-02664

Nabers Cadillac
2600 Harbor Blvd., Costa Mesa, CA 92626
(714)444-5200( )
CIWMB#: 30-C-05051

Oil Stop Inc.
Oil Stop Inc. Costa Mesa, CA 92626
(714)434-8350( )
CIWMB#: 30-C-06293

Pep Boys #660
2946 Bristol St., Costa Mesa, CA 92626
(714)549-1533( )
CIWMB#: 30-C-03416

Plaza Chevron Service Center
3048 Bristol Costa Mesa, CA 92626
(714)545-4257( )
CIWMB#: 30-C-01123

Scher Tire Inc #15 dba Goodyear Tire
1596 Newport Blvd., Costa Mesa, CA 92627
(949)548-9384( )
CIWMB#: 30-C-03034

Fountain Valley

Firestone Store #7147
17975 Magnolia Ave., Fountain Valley, CA 92708
(714)842-3341( )
CIWMB#: 30-C-01219

Golden Shell
8520 Warner Ave., Fountain Valley, CA 92708
(714)842-7150( )
CIWMB#: 30-P-05002

Kragen Auto Parts #0734
9880 Warner Ave., Fountain Valley, CA 92708
(714)964-6427( )
CIWMB#: 30-C-02609

Kragen Auto Parts #1505
16147 Harbor Blvd., Fountain Valley, CA 92708
(714)531-8525( )
CIWMB#: 30-C-04125

Oil Can Henry's
9525 Warner Ave., Fountain Valley, CA 92708
(714)473-7705( )
CIWMB#: 30-C-05843

Purrfect Auto Service #10
16780 Harbor Blvd., Fountain Valley, CA 92708
(714)839-3899( )
CIWMB#: 30-C-01380

Huntington Beach

AutoZone #5526
6800 Warner Ave., Huntington Beach, CA 92647
(714)891-8211( )
CIWMB#: 30-C-04777

Bella Terra Car Wash
16061 Beach Blvd., Huntington Beach, CA 92647
(714)847-4924( )
CIWMB#: 30-C-06195

Big O Tires #583
19411 Beach Blvd., Huntington Beach, CA 92648
(714)536-7571( )
CIWMB#: 30-C-00970

Econo Lube N' Tune #26
19961 Beach Blvd., Huntington Beach, CA 92648
(714)536-6519( )
CIWMB#: 30-C-06117

Expertec Automotive
7680 Talbert Ave Suite A & B, Huntington Beach, CA 92648
(714)848-9222( )
CIWMB#: 30-C-05914

EZ Lube Inc #16
7361 Edinger Ave., Huntington Beach, CA 92647
(714)899-3600( )
CIWMB#: 30-C-03289

EZ Lube Inc. #79
9862 Adams St., Huntington Beach, CA 92647
(714)556-1312( )
CIWMB#: 30-C-06547

Firestone Store #71T5
16171 Beach Blvd., Huntington Beach, CA 92647
(714)847-6081( )
CIWMB#: 30-C-02118

Huntington Beach Car Wash
18971 Beach Blvd., Huntington Beach, CA 92648
(714)847-4924( )
CIWMB#: 30-C-05303

Jiffy Lube #1857
8971 Warner Ave., Huntington Beach, CA 92647
(714)596-7213( )
CIWMB#: 30-C-05053

Kragen Auto Parts #1468
10072 Adams Ave., Huntington Beach, CA 92646
(714)593-6156( )
CIWMB#: 30-C-04284

Kragen Auto Parts #1511
7171 Warner Ave., Huntington Beach, CA 92647
(714)842-4531( )
CIWMB#: 30-C-04129

Kragen Auto Parts #1633
18888 Beach Blvd., Huntington Beach, CA 92648
(714)965-2353( )
CIWMB#: 30-C-02645

Ollmax 10 Minute Lube/Wash
9862 Adams Ave., Huntington Beach, CA 92646
(714)964-7110( )
CIWMB#: 30-C-03219

Pep Boys #799
19122 Brookhurst St., Huntington Beach, CA 92646
(714)964-0777( )
CIWMB#: 30-C-03439

Quik Change Lube & Oil
5841 Warner Ave., Huntington Beach, CA 92649
(714)840-2331( )
CIWMB#: 30-C-03208

R Kids Tire and Service #6
5062 Warner Ave., Huntington Beach, CA 92647
(714)846-1189( )
CIWMB#: 30-C-05691

Saturn of Huntington Beach
18801 Beach Blvd., Huntington Beach, CA 92648
(714)841-5428( )
CIWMB#: 30-C-05221

USA Express Tire & Service Inc
7232 Edinger Ave., Huntington Beach, CA 92647
(714)842-0717( )
CIWMB#: 30-C-04429

Zito's Auto Care
19002 Magnolia St., Huntington Beach, CA 92646
(714)968-8788( )
CIWMB#: 30-C-03251

Irvine

Firestone Store #71W4
51 Auto Center Dr., Irvine, CA 92618
(949)829-8710( )
CIWMB#: 30-C-03689

Irvine City Auto Parts
14427 Culver Dr., Irvine, CA 92604
(949)551-5568( )
CIWMB#: 30-C-02186

Jiffy Lube #1856 Irvine Spectrum
8777 Irvine Center Dr., Irvine, CA 92618
(949)753-0485( )
CIWMB#: 30-C-06094

Jiffy Lube #1988
3080 Main St., Irvine, CA 92614
(714)961-5491(27)
CIWMB#: 30-C-04450

Kragen Auto Parts #4174
15315 Culver Dr., Ste.#170, Irvine, CA 92604
(602)631-7115( )
CIWMB#: 30-C-06417

Newport Beach

Jiffy Lube #2811
1520 W Coast Hwy., Newport Beach, CA 92663
(949)764-9255( )
CIWMB#: 30-C-05629

Newport Landing Fuel Dock
503 E Edgewater Newport Beach, CA 92661
(949)673-7878( )
CIWMB#: 30-C-03628

Orange

AutoZone #5942
1330 N. Glassell Orange, CA 92867
(714)538-4551( )
CIWMB#: 30-C-04553

Big O Tires #570
1825 E Katella Ave., Orange, CA 92867
(714)538-0016( )
CIWMB#: 30-C-00974

David Wilsons Ford of Orange
1350 W Katella Ave., Orange, CA 92867
(714)633-8731( )
CIWMB#: 30-C-02341

EZ Lube #74
3232 Chapman Ave. #E, Orange, CA 92869
(714)556-1312(106)
CIWMB#: 30-C-06627

Firestone Store #7185
1690 N Tustin Ave., Orange, CA 92867
(714)282-8144( )
CIWMB#: 30-C-0122

Jiffy Lube #1457
433 W. Katella Ave., Orange, CA 92867
(714)720-5757( )
CIWMB#: 30-C-06280

Kragen Auto Parts #1764
910 Tustin St., Orange, CA 92867
(714)771-3000( )
CIWMB#: 30-C-02625

Managed Mobile, Inc.
1030 N Batavia St., #B, Orange, CA 92867
(714)400-0250( )
CIWMB#: 30-C-05776

Pep Boys #806
215 E Katella Ave., Orange, CA 92867
(714)997-1540( )
CIWMB#: 30-C-01759

Santiago Hills Car Care
6544 East Chapman Ave., Orange, CA 92869
(714)919-1060( )
CIWMB#: 30-C-05622

Scher Tire #33
1821 E. Katella Ave., Orange, CA 92867
(909)343-3100( )
CIWMB#: 30-C-06324

Tabassi Shell Service Station
830 E Katella Ave., Orange, CA 92867
(714)771-6990( )
CIWMB#: 30-C-00552

The Tune-up Center
193 S Main St., Orange, CA 92868
(714)633-1876( )
CIWMB#: 30-C-02091

Tony's Fuel and Towing
1650 W La Veta Ave., Orange, CA 92868
(714)953-7676( )
CIWMB#: 30-C-00868

Truck Lubrication Company
143 S. Pixley Orange, CA 92868
(714)997-7730( )
CIWMB#: 30-C-06001

Santa Ana

All Phase Environmental
910 E. Fourth St., Santa Ana, CA 92701
(714)731-5995( )
CIWMB#: 30-C-06116

Archie's Tire & Towing
4518 Westminster Ave., Santa Ana, CA 92703
(714)636-4518( )
CIWMB#: 30-C-02058

AutoZone #3320
2007 S. Main St., Santa Ana, CA 92707
(901)495-7217( )
CIWMB#: 30-C-06508

AutoZone #5232
430 W 17th Santa Ana, CA 92706
(714)547-7003( )
CIWMB#: 30-C-04809

AutoZone #5538
1101 S Bristol Santa Ana, CA 92704
(714)241-0335( )
CIWMB#: 30-C-00829

Big O Tires
1211 W. Warner Ave., Santa Ana, CA 92707
(714)540-8646( )
CIWMB#: 30-C-04679

Big O Tires #712
1302 E. 17th St., Santa Ana, CA 92705
(714)541-6811( )
CIWMB#: 30-C-05813

Firestone Store #7175
3733 S Bristol Santa Ana, CA 92704
(714)549-4015( )
CIWMB#: 30-C-01223

Firestone Store #71TA
101 S Main St., Santa Ana, CA 92701
(714)542-8857( )
CIWMB#: 30-C-02123

Firestone Store #71W6
2005 N Tustin Ave., Ste A. Santa Ana, CA 92705
(714)541-7977( )
CIWMB#: 30-C-03688

Guaranty Chevrolet Motors Inc.
711 E 17th St., Santa Ana, CA 92701
(714)973-1711(277)
CIWMB#: 30-C-06506

Jiffy Lube #1303
2025 N. Tustin Santa Ana, CA 92701
(714)720-5757( )
CIWMB#: 30-C-06283

John's Mobil
1465 S Main St., Santa Ana, CA 92707
(714)835-3266( )
CIWMB#: 30-C-00578

Kragen Auto Parts #0736
1302 E 17th St., Santa Ana, CA 92705
(714)953-6061( )
CIWMB#: 30-C-02610

Kragen Auto Parts #1253
1400 W Edinger Ave., Santa Ana, CA 92704
(714)754-1432( )
CIWMB#: 30-C-02627

Kragen Auto Parts #1376
521 W 17th St., Santa Ana, CA 92706
(714)543-4492( )
CIWMB#: 30-C-03901

Kragen Auto Parts #1516
2337 S Bristol Ave., Santa Ana, CA 92704
(714)557-0787( )
CIWMB#: 30-C-04106

Kragen Auto Parts #1648
1015 S Main St., Santa Ana, CA 92701
(714)568-1570( )
CIWMB#: 30-C-05664

Pep Boys #609
120 E 1st St., Santa Ana, CA 92701
(714)547-7477( )
CIWMB#: 30-C-01738

Pep Boys #802
1107 S Harbor Blvd., Santa Ana, CA 92704
(714)775-0828( )
CIWMB#: 30-C-01739

Purrfect Auto Service
2519 S Main St., Santa Ana, CA 92707
(714)549-7900( )
CIWMB#: 30-C-02085

Saturn of Santa Ana
1350 Auto Mall Dr., Santa Ana, CA 92705
(714)648-2444( )
CIWMB#: 30-C-05222

Scher Tire #28
1805 N Grand Ave., Santa Ana, CA 92705
(714)558-8544( )
CIWMB#: 30-C-03225

Tustin

Big O Tires #556
131 E 1st St., Tustin, CA 92780
(714)544-9431( )
CIWMB#: 30-C-00972

EZ Lube #42
12972 Newport Ave., Tustin, CA 92780
(714)556-1312( )
CIWMB#: 30-C-06408

Jiffy Lube #1406
3067 Edinger Ave., Tustin, CA 92780
(949)651-8814( )
CIWMB#: 30-C-03778

Kragen Auto Parts #1533
502 B E 1st St., Tustin, CA 92780
(714)544-9249( )
CIWMB#: 30-C-04128

Scher Tire Inc #17 dba Goodyear Tire
14511 Redhill Ave., Tustin, CA 92780
(714)832-6011( )
CIWMB#: 30-C-03035

Villa Park

Phil's Villa Park 76
17771 Santiago Blvd., Villa Park, CA 92861
(714)637-0854( )
CIWMB#: 30-C-06579

This information was provided by the County of Orange Integrated Waste Management Department and the California Integrated Waste Management Board (CIWMB)

Clean beaches and healthy creeks, rivers, bays and ocean are important to Orange County. However, many common activities can lead to water pollution if you're not careful. Home improvement projects and work sites must be maintained to ensure that building materials do not enter the street, gutter or storm drain. Unlike water in sanitary sewers (from sinks and toilets), water in storm drains is not treated before entering our waterways.

You would never dump building materials into the ocean, so don't let them enter the storm drains. Follow these tips to help prevent water pollution.

For more information, please call the **Orange County Stormwater Program** at **(714) 567-6363** or visit **www.ocwatersheds.com**

To report a spill, call the **Orange County 24-Hour Water Pollution Problem Reporting Hotline** at **(714) 567-6363.**

For emergencies, dial 911.

The tips contained in this brochure provide useful information to help prevent water pollution while performing home improvement projects. If you have other suggestions, please contact your city's stormwater representatives or call the Orange County Stormwater Program.

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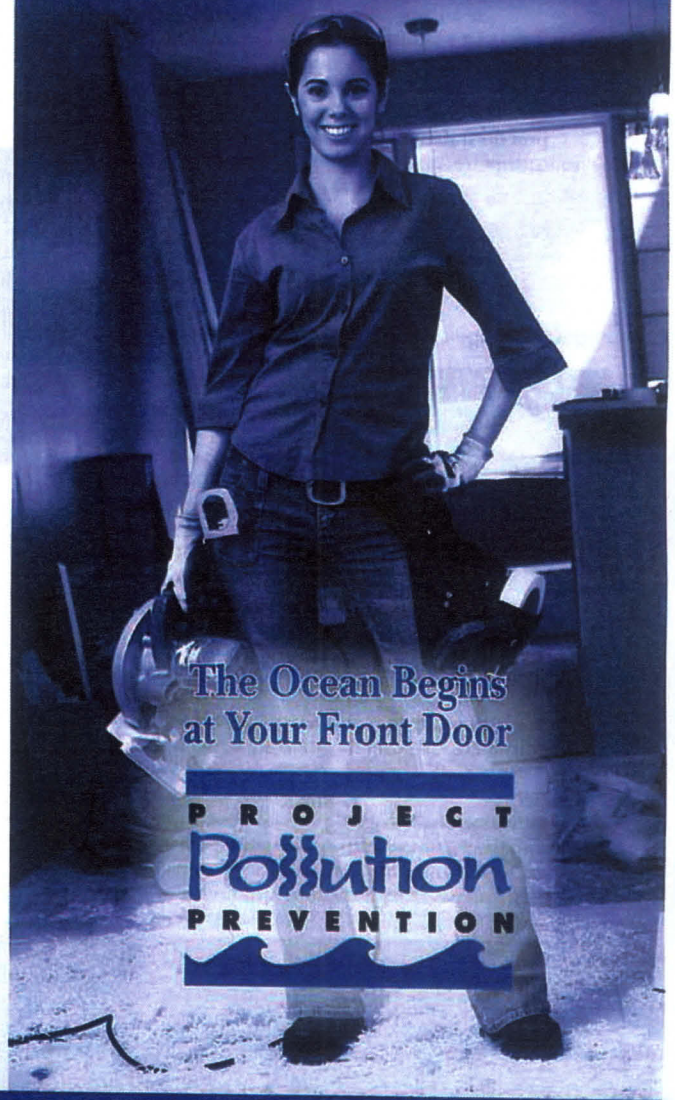
Help Prevent Ocean Pollution:

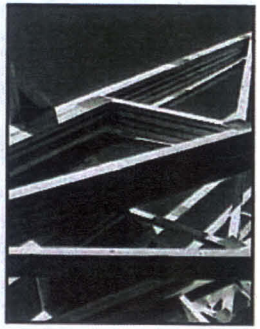
Tips for Home Improvement Projects



Tips for Home Improvement Projects

Home improvement projects can cause significant damage to the environment. Whether you hire a contractor or work on the house yourself, it is important to follow these simple tips while renovating, remodeling or improving your home:

General Construction



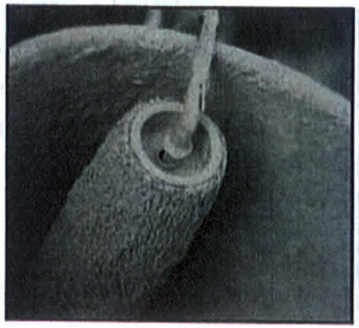
- Schedule projects for dry weather.
- Keep all construction debris away from the street, gutter and storm drain.
- Store materials under cover with temporary roofs or plastic sheets to eliminate or reduce the possibility that rainfall, runoff or wind will carry materials from the project site to the street, storm drain or adjacent properties.

Building Materials

- Never hose materials into a street, gutter or storm drain.
- Exposed piles of construction material should not be stored on the street or sidewalk.
- Minimize waste by ordering only the amount of materials needed to complete the job.
- Do not mix more fresh concrete than is needed for each project.
- Wash concrete mixers and equipment in a designated washout area where the water can flow into a containment area or onto dirt.
- Dispose of small amounts of dry excess materials in the trash. Powdery waste, such as dry concrete, must be properly contained within a box or bag prior to disposal. Call your local trash hauler for weight and size limits.

Paint

- Measure the room or object to be painted, then buy only the amount needed.
- Place the lid on firmly and store the paint can upside-down in a dry location away from the elements.
- Tools such as brushes, buckets and rags should never be washed where excess water can drain into the street, gutter or storm drain. All tools should be rinsed in a sink connected to the sanitary sewer.
- When disposing of paint, never put wet paint in the trash.
- Dispose of water-based paint by removing the lid and letting it dry in the can. Large amounts must be taken to a Household Hazardous Waste Collection Center (HHWCC).



- Oil-based paint is a household hazardous waste. All leftover paint should be taken to a HHWCC.
- For HHWCC locations and hours, call **(714) 834-6752** or visit **www.oclandfills.com**.

Erosion Control

- Schedule grading and excavation projects for dry weather.
- When temporarily removing soil, pile it in a contained, covered area where it cannot spill into the street, or obtain the required temporary encroachment or street closure permit and follow the conditions instructed by the permit.
- When permanently removing large quantities of soil, a disposal location must be found prior to excavation. Numerous businesses are available to handle disposal needs. For disposal options, visit **www.ciwmb.ca.gov/SWIS**.
- Prevent erosion by planting fast-growing annual and perennial grasses. They will shield and bind the soil.

Recycle

- Use a construction and demolition recycling company to recycle lumber, paper, cardboard, metals, masonry (bricks, concrete, etc.), carpet, plastic, pipes (plastic, metal and clay), drywall, rocks, dirt and green waste.

- For a listing of construction and demolition recycling locations in your area, visit **www.ciwmb.ca.gov/recycle.**

Spills

- Clean up spills immediately by using an absorbent material such as cat litter, then sweep it up and dispose of it in the trash.
- Immediately report spills that have entered the street, gutter or storm drain to the County's 24-Hour Water Pollution Problem Reporting Hotline at **(714) 567-6363** or visit **www.ocwatersheds.com** to fill out an incident reporting form.

PROJECT Pollution PREVENTION

Clean beaches and healthy creeks, rivers, bays and ocean are important to Orange County. However, many common activities can lead to water pollution if you're not careful. Fertilizers, pesticides and other chemicals that are left on yards or driveways can be blown or washed into storm drains that flow to the ocean. Overwatering lawns can also send materials into storm drains. Unlike water in sanitary sewers (from sinks and toilets), water in storm drains is not treated before entering our waterways.

You would never pour gardening products into the ocean, so don't let them enter the storm drains. Follow these easy tips to help prevent water pollution.

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

UCCE Master Gardener Hotline: (714) 708-1646

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

For emergencies, dial 911.

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

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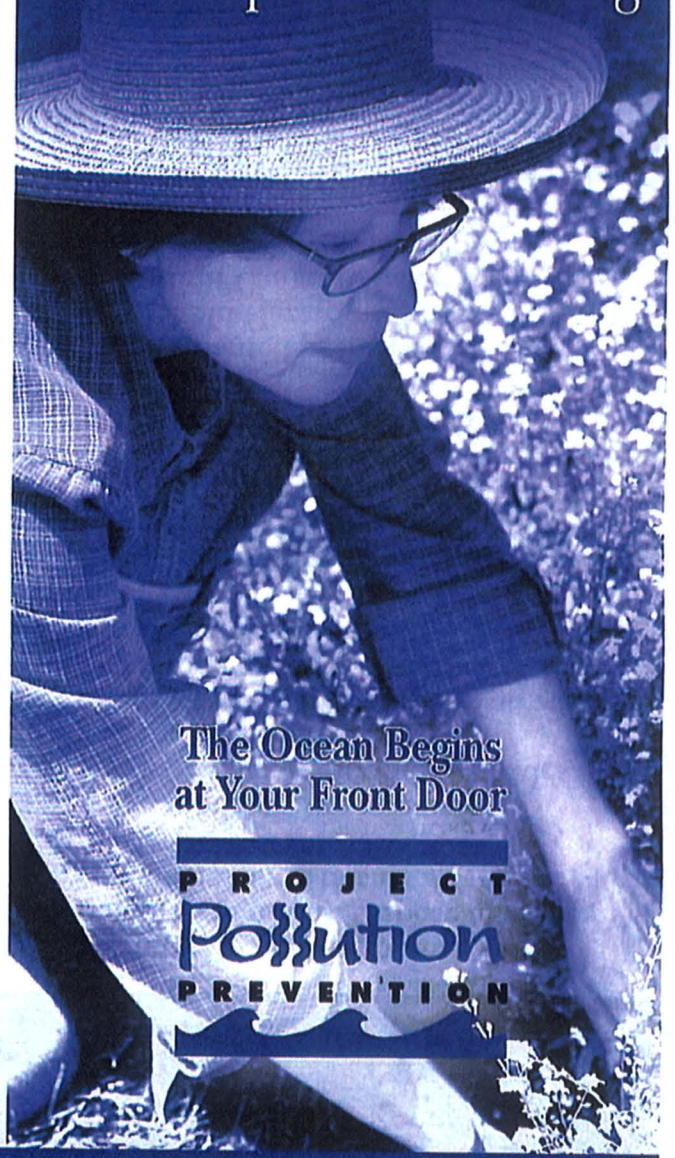
Help Prevent Ocean Pollution:

Tips for Landscape & Gardening



Tips for Landscape & Gardening

Never allow gardening products or polluted water to enter the street, gutter or storm drain.

General Landscaping Tips

- Protect stockpiles and materials from wind and rain by storing them under tarps or secured plastic sheeting.
- Prevent erosion of slopes by planting fast-growing, dense ground covering plants. These will shield and bind the soil.
- Plant native vegetation to reduce the amount of water, fertilizers, and pesticide applied to the landscape.

- Never apply pesticides or fertilizers when rain is predicted within the next 48 hours.

Garden & Lawn Maintenance

- Do not overwater. Use irrigation practices such as drip irrigation, soaker hoses or micro spray systems. Periodically inspect and fix leaks and misdirected sprinklers.
- Do not rake or blow leaves, clippings or pruning waste into the street, gutter or storm drain. Instead, dispose of green waste by composting, hauling it to a permitted landfill, or recycling it through your city's program.

- Use slow-release fertilizers to minimize leaching, and use organic fertilizers.
- Read labels and use only as directed. Do not over-apply pesticides or fertilizers. Apply to spots as needed, rather than blanketing an entire area.
- Store pesticides, fertilizers and other chemicals in a dry covered area to prevent exposure that may result in the deterioration of containers and packaging.

- Rinse empty pesticide containers and re-use rinse water as you would use the product. Do not dump rinse water down storm drains. Dispose of empty containers in the trash.
- When available, use non-toxic alternatives to traditional pesticides, and use pesticides specifically designed to control the pest you are targeting. For more information, visit **www.ipm.ucdavis.edu.**
- If fertilizer is spilled, sweep up the spill before irrigating. If the spill is liquid, apply an absorbent material such as cat litter, and then sweep it up and dispose of it in the trash.
- Take unwanted pesticides to a Household Hazardous Waste Collection Center to be recycled. Locations are provided below.

Household Hazardous Waste Collection Centers

Anaheim:	1071 N. Blue Gum St.
Huntington Beach:	17121 Nichols St.
Irvine:	6411 Oak Canyon
San Juan Capistrano:	32250 La Pata Ave.

For more information, call (714) 834-6752 or visit www.oclandfills.com

Clean beaches and healthy creeks, rivers, bays and ocean are important to Orange County. However, many common activities can lead to water pollution if you're not careful. Pet waste and pet care products can be washed into the storm drains that flow to the ocean. Unlike water in sanitary sewers (from sinks and toilets), water in storm drains is not treated before entering our waterways.

You would never put pet waste or pet care products into the ocean, so don't let them enter the storm drains. Follow these easy tips to help prevent water pollution.

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

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

For emergencies, dial 911.

The tips contained in this brochure provide useful information to help prevent water pollution while caring for your pet. If you have other suggestions, please contact your city's stormwater representatives or call the Orange County Stormwater Program.

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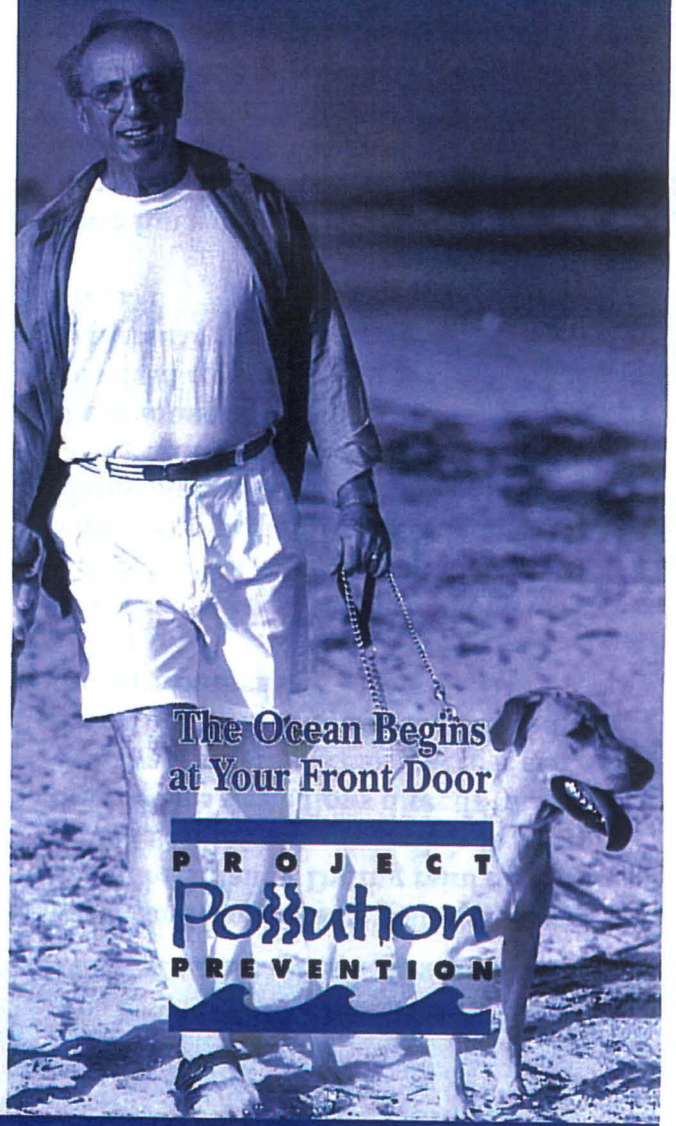
Help Prevent Ocean Pollution:

Tips for Pet Care



Tips for Pet Care

Never let any pet care products or washwater run off your yard and into the street, gutter or storm drain.

Washing Your Pets

Even biodegradable soaps and shampoos can be harmful to marine life and the environment.

- If possible, bathe your pets indoors using less-toxic shampoos or have your pet professionally groomed. Follow instructions on the products and clean up spills.

- If you bathe your pet outside, wash it on your lawn or another absorbent/ permeable surface to keep the washwater from running into the street, gutter or storm drain.

Flea Control

- Consider using oral or topical flea control products.

- If you use flea control products such as shampoos, sprays or collars, make sure to dispose of any unused products at a Household Hazardous Waste Collection Center. For location information, call **(714) 834-6752.**

Why You Should Pick Up After Your Pet

It's the law! Every city has an ordinance requiring you to pick up after your pet. Besides being a nuisance, pet waste can lead to water pollution, even if you live inland. During rainfall, pet waste left outdoors can wash into storm drains. This waste flows directly into our waterways and the ocean where it can harm human health, marine life and the environment.

As it decomposes, pet waste demands a high level of oxygen from water. This decomposition can contribute to killing marine life by reducing the amount of dissolved oxygen available to them.

Have fun with your pets, but please be a responsible pet owner by taking care of them and the environment.

- Take a bag with you on walks to pick up after your pet.

- Dispose of the waste in the trash or in a toilet.

PROJECT Pollution PREVENTION

Clean beaches and healthy creeks, rivers, bays, and ocean are important to Orange County. However, many common activities can lead to water pollution if you're not careful. Swimming pools and spas are common in Orange County, but they must be maintained properly to guarantee that chemicals aren't allowed to enter the street, where they can flow into the storm drains and then into the waterways. Unlike water in sanitary sewers (from sinks and toilets), water in storm drains is not treated before entering our waterways.

You would never dump pool chemicals into the ocean, so don't let it enter the storm drains. Follow these easy tips to help prevent water pollution.

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

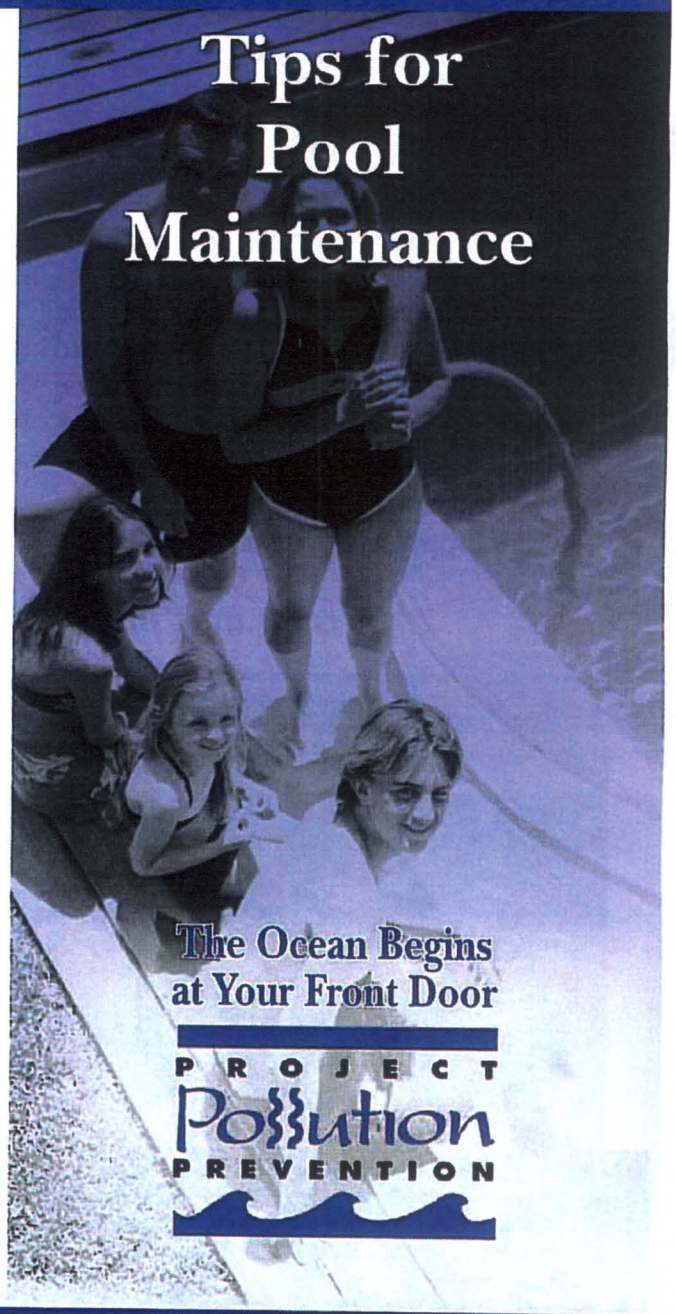
To report a spill, call the **Orange County 24-Hour Water Pollution Reporting Hotline 1-877-89-SPILL** (1-877-897-7455).

For emergencies, dial 911.

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

Help Prevent Ocean Pollution:

Tips for Pool Maintenance

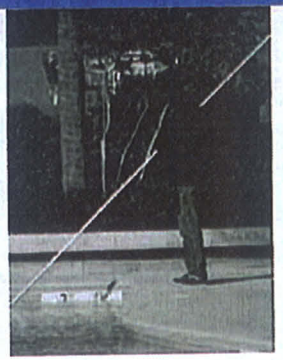


The Ocean Begins at Your Front Door

PROJECT Pollution PREVENTION

Tips for Pool Maintenance

Many pools are plumbed to allow the pool to drain directly to the sanitary sewer. If yours is not, follow these instructions for disposing of pool and spa water.



Acceptable and Preferred Method of Disposal

When you cannot dispose of pool water in the sanitary sewer, the release of dechlorinated swimming pool water is allowed if all of these tips are followed:

- The residual chlorine does not exceed 0.1 mg/l (parts per million).
- The pH is between 6.5 and 8.5.
- The water is free of any unusual coloration, dirt or algae.
- There is no discharge of filter media.
- There is no discharge of acid cleaning wastes.
- Some cities may have ordinances that do not allow pool water to be disposed into a storm drain. Check with your city.

How to Know if You're Following the Standards

You can find out how much chlorine is in your water by using a pool testing kit. Excess chlorine can be removed by discontinuing the use of chlorine for a few days prior to discharge or by purchasing dechlorinating chemicals from a local pool supply company. Always make sure to follow the instructions that come with any products you use.

Doing Your Part

By complying with these guidelines, you will make a significant contribution toward keeping pollutants out of Orange County's creeks, streams, rivers, bays and the ocean. This helps to protect organisms that are sensitive to pool chemicals, and helps to maintain the health of our environment.

PROJECT Pollution PREVENTION

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

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

For emergencies, dial 911.

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

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Help Prevent Ocean Pollution:

Tips for Residential Pool, Landscape and Hardscape Drains

The Ocean Begins at Your Front Door

PROJECT Pollution PREVENTION

Tips for Residential Pool, Landscape and Hardscape Drains

Pool Maintenance

All pool water discharged to the curb, gutter or permitted pool drain from your property must meet the following water quality criteria:

- The residual chlorine does not exceed 0.1 mg/L (parts per million).
- The pH is between 6.5 and 8.5.
- The water is free of any unusual coloration.
- There is no discharge of filter media or acid cleaning wastes.

Some cities have ordinances that do not allow pool water to be discharged to the storm drain. Check with your city.

Landscape and Hardscape Drains

The following recommendations will help reduce or prevent pollutants from your landscape and hardscape drains from entering the street, gutter or storm drain. Unlike water that enters the sewer (from sinks and toilets), water that enters a landscape or hardscape drain is not treated before entering our creeks, rivers, bays and ocean.

Household Activities

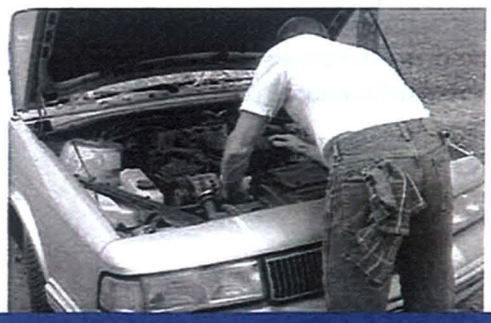
- Do not rinse spills of materials or chemicals to any drain.
- Use dry cleanup methods such as applying cat litter or another absorbent material, then sweep it up and dispose of it in the trash. If the material is hazardous, dispose of it at a Household Hazardous Waste Collection Center (HHWCC). For locations, call **(714) 834-6752** or visit **www.oclandfills.com**.
- Do not hose down your driveways, sidewalks or patios to your landscape or hardscape drain. Sweep up debris and dispose of it in the trash.
- Always pick up after your pet. Flush waste down the toilet or dispose of it in the trash.
- Do not store items such as cleaners, batteries, automotive fluids, paint products, TVs, or computer monitors uncovered outdoors. Take them to a HHWCC for disposal.

Yard Maintenance

- Do not overwater. Water by hand or set automated irrigation systems to reflect seasonal water needs.
- Follow directions on pesticides and fertilizers (measure, do not estimate amounts) and do not use if rain is predicted within 48 hours.
- Cultivate your garden often to control weeds and reduce the need to use chemicals.

Vehicle Maintenance

- Never pour oil or antifreeze down your landscape or hardscape drain. Recycle these substances at a service station, a waste collection center or used oil recycling center. For locations, contact the Used Oil Program at **1-800-CLEANUP** or visit **www.CLEANUP.org**.
- Whenever possible, take your vehicle to a commercial car wash.
- If you do wash your vehicle at home, do not allow the washwater to go down your landscape or hardscape drain. Instead, dispose of it in the sanitary sewer (a sink or toilet) or onto an absorbent surface such as your lawn.
- Use a spray nozzle that will shut off the water when not in use.



Clean beaches and healthy creeks, rivers, bays and ocean are important to Orange County. However, many common activities such as painting can lead to water pollution if you're not careful. Paint must be used, stored and disposed of properly to ensure that it does not enter the street, gutter or storm drain. Unlike water in sanitary sewers (from sinks and toilets), water in storm drains is not treated before entering our waterways.

You would never dump paint into the ocean, so don't let it enter the storm drains. Follow these easy tips to help prevent water pollution.

For more information, please call the **Orange County Stormwater Program** at **(714) 567-6363** or visit **www.ocwatersheds.com**

To report a spill, call the **Orange County 24-Hour Water Pollution Problem Reporting Hotline** at **(714) 567-6363.**

For emergencies, dial 911.

The tips contained in this brochure provide useful information to help prevent water pollution while using, storing and disposing of paint. If you have other suggestions, please contact your city's stormwater representatives or call the Orange County Stormwater Program.

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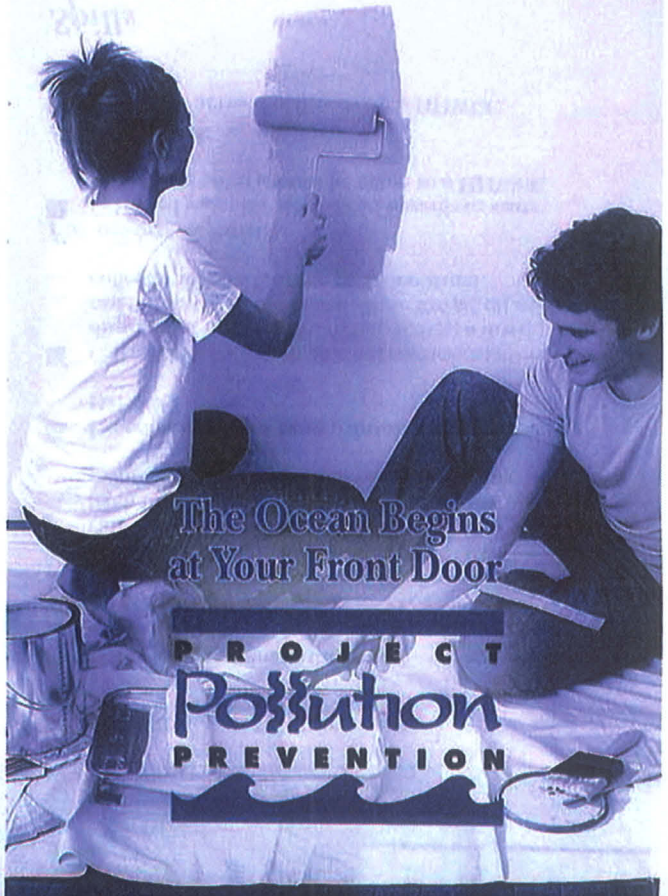
Help Prevent Ocean Pollution:

Tips for Projects Using Paint



Tips for Projects Using Paint

Paint can cause significant damage to our environment. Whether you hire a contractor or do it yourself, it is important to follow these simple tips when purchasing, using, cleaning, storing and disposing of paint.

Purchasing Paint

- Measure the room or object to be painted, then buy only the amount needed.
- Whenever possible, use water-based paint since it usually does not require hazardous solvents such as paint thinner for cleanup.

Painting

- Use only one brush or roller per color of paint to reduce the amount of water needed for cleaning.
- Place open paint containers or trays on a stable surface and in a position that is unlikely to spill.
- Always use a tarp under the area or object being painted to collect paint drips and contain spills.

Cleaning

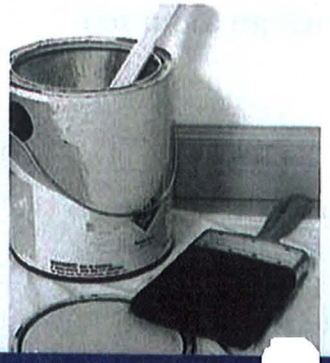
- Never clean brushes or rinse paint containers in the street, gutter or storm drain.
- For oil-based products, use as much of the paint on the brushes as possible. Clean brushes with thinner. To reuse thinner, pour it through a fine filter (e.g. nylon, metal gauze or filter paper) to remove solids such as leftover traces of paint.
- For water-based products, use as much of the paint on the brushes as possible, then rinse in the sink.
- Collect all paint chips and dust. Chips and dust from marine paints or paints containing lead, mercury or tributyl tin are hazardous waste. Sweep up and dispose of at a Household Hazardous Waste Collection Center (HHWCC).

Storing Paint

- Store paint in a dry location away from the elements.
- Store leftover water-based paint, oil-based paint and solvents separately in original or clearly marked containers.
- Avoid storing paint cans directly on cement floors. The bottom of the can will rust much faster on cement.
- Place the lid on firmly and store the paint can upside-down to prevent air from entering. This will keep the paint usable longer. Oil-based paint is usable for up to 15 years. Water-based paint remains usable for up to 10 years.

Alternatives to Disposal

- Use excess paint to apply another coat, for touch-ups, or to paint a closet, garage, basement or attic.
- Give extra paint to friends or family. Extra paint can also be donated to a local theatre group, low-income housing program or school.
- Take extra paint to an exchange program such as the **"Stop & Swap"** that allows you to drop off or pick up partially used home care products free of charge. **"Stop & Swap"** programs are available at most HHWCCs.
- For HHWCC locations and hours, call **(714) 834-6752** or visit **www.oclandfills.com**.



Disposing of Paint

- Never put wet paint in the trash.

For water-based paint:

- If possible, brush the leftover paint on cardboard or newspaper. Otherwise, allow the paint to dry in the can with the lid off in a well-ventilated area protected from the elements, children and pets. Stirring the paint every few days will speed up the drying.
- Large quantities of extra paint should be taken to a HHWCC.
- Once dried, paint and painted surfaces may be disposed of in the trash. When setting a dried paint can out for trash collection, leave the lid off so the collector will see that the paint has dried.

For oil-based paint:

- Oil-based paint is a household hazardous waste. All leftover paint should be taken to a HHWCC.

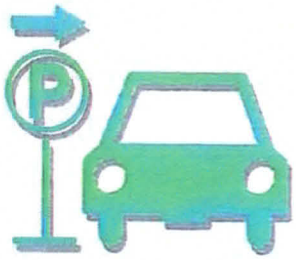
Aerosol paint:

- Dispose of aerosol paint cans at a HHWCC.

Spills

- Never hose down pavement or other impermeable surfaces where paint has spilled.
- Clean up spills immediately by using an absorbent material such as cat litter. Cat litter used to clean water-based paint spills can be disposed of in the trash. When cleaning oil-based paint spills with cat litter, it must be taken to a HHWCC.
- Immediately report spills that have entered the street, gutter or storm drain to the County's 24-Hour Water Pollution Problem Reporting Hotline at **(714) 567-6363** or visit **www.ocwatersheds.com** to fill out an incident reporting form.

PROJECT Pollution PREVENTION



R-3
AUTOMOBILE PARKING

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

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

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

Required Activities

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

Recommended Activities

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

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

R-4
HOME AND GARDEN CARE ACTIVITIES

HOME CARE

Many hazardous materials may be used in and around residences during routine maintenance activities (such as: oils, paints, cleaners, bleaches, pesticides, glues, solvents, and other products). Improper or excessive use of these products can increase the potential for pollutants to be transported to the storm drain by runoff. The pollution prevention activities outlined in this fact sheets are used to prevent the discharge of pollutants to the storm drain system.

Think before conducting home care activities. Remember - The ocean starts at your front door.

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

Required Activities

- Clean out painting equipment in an area where the waste can be contained and properly disposed of (latex – sewer, oil based – household hazardous waste center).
- Rinse off cement mixers and cement laden tools in a contained washout area. Dispose of dried concrete waste in household trash.
- If safe, contain, clean up, and properly dispose all household hazardous waste spills. If an unsafe condition exists, call 911 to activate the proper response team.
- Household hazardous materials must be stored indoors or under cover, and in closed and labeled containers. Dispose of them at a household hazardous waste center.
- Household wash waters (e.g. washer machine effluent, mop water, etc.) must be disposed of in the sanitary sewer.
- Pool and spa water may be discharged to the storm drain if residual chlorine is less than 0.1 mg/L, the pH is between 6.5 and 8.5, and the water is free from any unusual coloration. (Call 714-834-6107 to obtain information on a pool drain permit). Pool filter media must be contained and disposed of properly.

Recommended Activities

- Only purchase the types and amounts of materials needed.
- Share unused portions of products with neighbors or community programs (latex paint)

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GARDEN CARE

Garden activities may contribute pollutants via soil erosion, green waste, fertilizer and pesticide use. Plant and garden care activities such as landscape maintenance, fertilization, and pesticide application have the potential to discharge significant quantities of pollutants to the storm drain system. Nonvegetated surfaces may allow for significant erosion leading to high sediment loads. Other pollutants such as pesticides may adsorb onto the soil particles and be transported off site. Excess fertilizer and pesticide pollutants from over application may be carried to the storm drain by dissolving in irrigation runoff or rainwater. Green wastes may also contain organic matter and may have adsorbed fertilizers and pesticides.

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

Excessive irrigation is often the most significant factor in home and garden care activities. Pollutants may dissolve in irrigation water and then be transported to the storm drain, or particles and materials coated with fertilizers and pesticides may be suspended in the irrigation flow and carried to the storm drain. The pollution prevention activities outlined in this fact sheets are used to prevent the discharge of pollutants to the storm drain system.

Think before conducting garden care activities. Remember - The ocean starts at your front door.

Required Activities

- Irrigation systems must be properly adjusted to reflect seasonal water needs.
- Minimize the use of pesticides and fertilizers. Read the labels and follow directions to avoid improper use. Do not apply chemicals if it is windy or about to rain.
- Properly clean up and dispose of spills of gardening chemicals, fertilizes, or soils. If possible, return the spilled material to the container for future use.
- Lawn and garden care products must be stored in closed labeled containers, in covered areas, or off-ground and under protective tarps.
- Household hazardous waste must be properly disposed at a household hazardous waste center.
- Cover nonvegetated surfaces to prevent erosion.

Recommended Activities

- Utilize xeroscaping and use of drought and insect resistant landscaping.
- Cultivate garden often to control weeds
- Use integrated pest management (IPM). Planting pest repelling plants (e.g. Marigolds) or using pest eating insects (e.g. ladybugs) may reduce the need for pesticides.
- Do not leave food (human or pet) outside overnight
- Remove fruit and garden waste

For additional information contact:
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or visit our website at: www.ocwatersheds.com

R-5
DISPOSAL OF PET WASTES

Pet wastes left in the environment may introduce solids, bacteria, and nutrients to the storm drain. The type and quantity of waste will dictate the proper disposal method. Small quantities of waste are best disposed with regular trash or flushed down a toilet. Large quantities of wastes from herbivore animals may be composted for subsequent use or disposal to landfill.

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

Pick up after your pet! It's as easy as 1-2-3. 1) Bring a bag. 2) Clean it up. 3) Dispose of it properly (toilet or trash). The pollution prevention activities outlined in this fact sheets are used to prevent the discharge of pollutants to the storm drain system.

Think before you dispose of any pet wastes. Remember - The ocean starts at your front door.

Required Activities

- All pet wastes must be picked up and properly disposed of. Pet waste should be disposed of in the regular trash, flushed down a toilet, or composted as type and quantities dictate.
- Properly dispose of unused flea control products (shampoo, sprays, or collars).
- Manure produced by livestock in uncovered areas should be removed at least daily for composting, or storage in water-tight container prior to disposal. Never hose down to stream or storm drain. Composting or storage areas should be configured and maintained so as not to allow contact with runoff. Compost may be donated to greenhouses, nurseries, and botanical parks. Topsoil companies and composting centers may also accept composted manure.
- Line waste pits or trenches with an impermeable layer, such as thick plastic sheeting.
- When possible, allow wash water to infiltrate into the ground, or collect in an area that is routed to the sanitary sewer.
- Confine livestock in fenced in areas except during exercise and grazing times. Restrict animal access to creeks and streams, preferably by fencing.

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- Install gutters that will divert roof runoff away from livestock areas.

Recommended Activities

- In order to properly dispose of pet waste, carry bags, pooper-scooper, or equivalent to safely pick up pet wastes while walking with pets.
- Bathe pets indoors and use less toxic shampoos. When possible, have pets professionally groomed.
- Properly inoculate your pet in order to maintain their health and reduce the possibility of pathogens in pet wastes.
- Maintain healthy and vigorous pastures with at least three inches of leafy material.
- Consider indoor feeding of livestock during heavy rainfall, to minimize manure exposed to potential runoff.
- Locate barns, corrals, and other high use areas on portions of property that either drain away from or are located distant form nearby creeks or storm drains.

For additional information contact:
County of Orange, OC **Watershed**
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R-6
DISPOSAL OF GREEN WASTES

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

Green wastes entering the storm drain may clog the system creating flooding problems. Green wastes washed into receiving waters create an oxygen demand as they are decomposed, reducing the available oxygen for aquatic life. Pesticide and nutrient residues may be carried to the receiving water with the green wastes. The pollution prevention activities outlined in this fact sheets are used to prevent the discharge of pollutants to the storm drain system.

Think before disposing of any green wastes – Remember - The ocean starts at your front door.

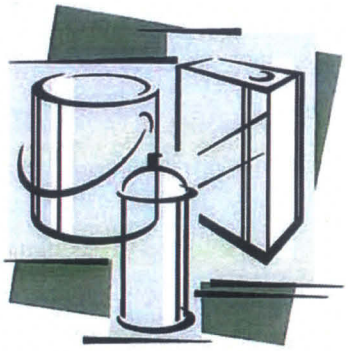
Required Activities

- Green wastes can not be disposed of in the street, gutter, public right-of-way, storm drain, or receiving water. Dispose of green wastes as a part of the household trash. If the quantities are too large, arrange a pick up with the local waste hauler.
- After conducting yard or garden activities sweep the area and properly dispose of the clippings and waste. Do not sweep or blow out into the street or gutter.

Recommended Activities

- Utilize a commercial landscape company to conduct the landscape activities and waste disposal.
- Utilize native plants and drought tolerant species to reduce the water use and green waste produced.
- Use a lawn mower that has a mulcher so that the grass clippings remain on the lawn and do not have to be collected and disposed of.
- Compost materials in a designated area within the yard.
- Recycle lawn clippings and greenery waste through local programs if available.

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



R-7
HOUSEHOLD HAZARDOUS WASTE

Household hazardous wastes (HHW) are defined as waste materials which are typically found in homes or similar sources, which exhibit characteristics such as: corrosivity, ignitability, reactivity, and/or toxicity, or are listed as hazardous materials by EPA.

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

List of most common HHW products:

- Drain openers
- Oven cleaners
- Wood and metal cleaners and polishes
- Automotive oil and fuel additives
- Grease and rust solvents
- Carburetor and fuel injection cleaners
- Starter fluids
- Batteries
- Paint Thinners
- Paint strippers and removers
- Adhesives
- Herbicides
- Pesticides
- Fungicides/wood preservatives

Many types of waste can be recycled, however options for each waste type are limited. Recycling is always preferable to disposal of unwanted materials. All gasoline, antifreeze, waste oil, and lead-acid batteries can be recycled. Latex and oil-based paint can be reused, as well as recycled. Materials that cannot be reused or recycled should be disposed of at a properly permitted landfill.

Think before disposing of any household hazardous waste. Remember - The ocean starts at your front door.

RECYCLE USED OIL

Required Activities

- Dispose of HHW at a local collection facility. Call (714) 834-6752 for the household hazardous waste center closest to your area.
- Household hazardous materials must be stored indoors or under cover, and in closed and labeled containers.
- If safe, contain, clean up, and properly dispose all household hazardous waste spills. If an unsafe condition exists, call 911 to activate the proper response team.

Recommended Activities

- Use non-hazardous or less-hazardous products.
- Participate in HHW reuse and recycling. Call (714) 834-6752 for the participating household hazardous waste centers.

The California Integrated Waste Management Board has a Recycling Hotline (800) 553-2962, that provides information and recycling locations for used oil.

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

R-8
WATER CONSERVATION

Excessive irrigation and/or the overuse of water is often the most significant factor in transporting pollutants to the storm drain system. Pollutants from a wide variety of sources including automobile repair and maintenance, automobile washing, automobile parking, home and garden care activities and pet care may dissolve in the water and be transported to the storm drain. In addition, particles and materials coated with fertilizers and pesticides may be suspended in the flow and be transported to the storm drain.

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

Hosing off outside areas to wash them down not only consumes large quantities of water, but also transports any pollutants, sediments, and waste to the storm drain system. The pollution prevention activities outlined in this fact sheets are used to prevent the discharge of pollutants to the storm drain system.

Think before using water. Remember - The ocean starts at your front door.

Required Activities

- Irrigation systems must be properly adjusted to reflect seasonal water needs.
- Do not hose off outside surfaces to clean, sweep with a broom instead.

Recommended Activities

- Fix any leaking faucets and eliminate unnecessary water sources.
- Use xeroscaping and drought tolerant landscaping to reduce the watering needs.
- Do not over watering lawns or gardens. Over watering wastes water and promotes diseases.
- Use a bucket to re-soak sponges/rags while washing automobiles and other items outdoors. Use hose only for rinsing.
- Wash automobiles at a commercial car wash employing water recycling.

For additional information contact:
County of Orange, OC **Watershed**
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or visit our website at: www.ocwatersheds.com

Site Design & Landscape Planning SD-10

Design Objectives

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

Description

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

Approach

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

Suitable Applications

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

Design Considerations

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

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SD-10 Site Design & Landscape Planning

Designing New Installations

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

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

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

Conserve Natural Areas during Landscape Planning

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

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

Maximize Natural Water Storage and Infiltration Opportunities Within the Landscape Unit

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

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

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

Protection of Slopes and Channels during Landscape Design

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

Redeveloping Existing Installations

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

SD-10 Site Design & Landscape Planning

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

Other Resources

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

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

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

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

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

Roof Runoff Controls SD-11

Rain Garden

Design Objectives

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

Description

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

Approach

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

Suitable Applications

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

Design Considerations

Designing New Installations

Cisterns or Rain Barrels

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

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

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

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

Dry wells and Infiltration Trenches

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

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

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

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

Pop-up Drainage Emitter

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

Foundation Planting

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

Redeveloping Existing Installations

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

Supplemental Information

Examples

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

Other Resources

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

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

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

Efficient Irrigation SD-12

Design Objectives

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

Description

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

Approach

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

Suitable Applications

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

Design Considerations

Designing New Installations

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

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

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

Redeveloping Existing Installations

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

Other Resources

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

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

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

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

Storm Drain Signage SD-13

Design Objectives

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

Description

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

Approach

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

Suitable Applications

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

Design Considerations

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

Designing New Installations

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

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

CASQA
CALIFORNIA STORMWATER QUALITY ASSOCIATION

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

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

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

Redeveloping Existing Installations

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

Additional Information

Maintenance Considerations

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

Placement

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

Supplemental Information

Examples

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

Other Resources

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

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

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

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

Appendix D

APPENDIX D

BMP MAINTENANCE SUPPLEMENT

RECORD OF BMP IMPLEMENTATION, MAINTENANCE, AND INSPECTION

Today's Date: _____

Name of Person Performing Activity (Printed): _____

Signature: _____

BMP NAME (AS SHOWN IN O&M PLAN)	BRIEF DESCRIPTION OF IMPLEMENTATION, MAINTENANCE, AND INSPECTION ACTIVITY PERFORMED

RECORD OF BMP IMPLEMENTATION, MAINTENANCE, AND INSPECTION

Today's Date: _____

Name of Person Performing Activity (Printed): _____

Signature: _____

BMP NAME (AS SHOWN IN O&M PLAN)	BRIEF DESCRIPTION OF IMPLEMENTATION, MAINTENANCE, AND INSPECTION ACTIVITY PERFORMED

OPERATIONS AND MAINTENANCE (O&M) PLAN

Water Quality Management Plan

For

The Village at Foothill Ranch

71 Auto Center Drive, Foothill Ranch, CA 92610

APN 612-161-11 & 612-161-12

BMP INSPECTION & MAINTENANCE RESPONSIBILITY MATRIX			
BMP Applicable? Yes/No	**BMP Name and BMP Implementation, Maintenance and Inspection Procedures**	**Implementation, Maintenance, and Inspection Frequency and Schedule**	**Person or Entity with Operation & Maintenance Responsibility**
NON-STRUCTURAL SOURCE CONTROL BMPs			
Yes	N1. Education for Property Owners, Tenants and Occupants The HOA will ensure that all homeowners will be given a copy of the recorded CC&Rs which will contain details on educational materials and restrictions to reduce pollutants from reaching the storm drain system. Examples of the environmental awareness materials are listed in Section VII.	Educational materials will be provided to residents/tenants, annually. Examples include tips for pet care, proper waste oil disposal, and other household tips. Tenants will be provided storm water pollution prevention materials by the Property Management prior to occupancy and annually thereafter. Frequency: Anually	Brookfield Residential / HOA
Yes	N2. Activity Restrictions The Owner shall develop activity restrictions (via CC&Rs or equivalent) that include language to restrict activities that have the potential to create adverse impacts on water quality. Activities include but are not limited to: the handling and disposal of contaminants, trash management and litter control, irrigation and landscaping practices, fertilizer applications and household waste management practices, prohibition of vehicle washing on-site, prohibiting washing or hosing of walkways and driveways, etc.	The Owner will prescribe activity restrictions to protect surface water quality, through lease terms or other equally effective measure, for the property. Frequency: Ongoing	Brookfield Residential / HOA

BMP INSPECTION & MAINTENANCE RESPONSIBILITY MATRIX			
BMP Applicable? Yes/No	**BMP Name and BMP Implementation, Maintenance and Inspection Procedures**	**Implementation, Maintenance, and Inspection Frequency and Schedule**	**Person or Entity with Operation & Maintenance Responsibility**
Yes	**N3. Common Area Landscape Management** Management programs will be designed and implemented by the HOA, which will maintain all the common areas within the project site (via landscape contractor). These programs will cover how to reduce the potential pollutant sources of fertilizer and pesticide uses, utilization of water-efficient landscaping practices and proper disposal of landscape wastes in accordance with local guidelines, ordinances, consistent with Management Guidelines for Use of Fertilizers (DAMP Section 5.5) and City ordinances.	Maintenance shall be consistent with City requirements, plus fertilizer and/or pesticide usage shall be consistent with County Management Guidelines for Use of Fertilizers (OC DAMP Section 5.5). Maintenance includes mowing, weeding, and debris removal on a weekly basis. Trimming, replanting and replacement of mulch shall be performed on an as-needed basis. Trimmings, clippings, and other waste shall be properly disposed of off-site in accordance with local regulations. Materials temporarily stockpiled during maintenance activities shall be placed away from water courses and storm drain inlets. Frequency: Monthly	Brookfield Residential / HOA
Yes	**N4. BMP Maintenance** The HOA will be responsible for the implementation and maintenance of each applicable non-structural BMP, as well as scheduling inspections and maintenance of all applicable structural BMP facilities through its landscape contractor and any other necessary maintenance contractors.	Maintenance of BMPs implemented at the project site shall be performed at the frequency prescribed in this WQMP. Records of inspections and BMP maintenance shall be maintained by the Owner and shall be available for review upon request. Frequency: Ongoing	Brookfield Residential / HOA
No	**N5. Title 22 CCR Compliance (How development will comply)**	Not Applicable	
No	**N6. Local Industrial Permit Compliance**	Not Applicable	
No	**N7. Spill Contingency Plan**	Not Applicable	
No	**N8. Underground Storage Tank Compliance**	Not Applicable	

BMP INSPECTION & MAINTENANCE RESPONSIBILITY MATRIX			
BMP Applicable? Yes/No	**BMP Name and BMP Implementation, Maintenance and Inspection Procedures**	**Implementation, Maintenance, and Inspection Frequency and Schedule**	**Person or Entity with Operation & Maintenance Responsibility**
No	N9. Hazardous Materials Disclosure Compliance	Not Applicable	
No	N10. Uniform Fire Code Implementation	Not Applicable	
Yes	N11. Common Area Litter Control The HOA will be responsible for performing trash pickup and sweeping of littered common areas on a weekly basis or whenever necessary. Responsibilities will also include noting improper disposal materials by homeowners and reporting such violations to the HOA for investigation.	Litter patrol, violations investigation, reporting and other litter control activities shall be performed weekly and in conjunction with maintenance activities. Frequency: Weekly	Brookfield Residential / HOA
Yes	N12. Employee Training All employees of the HOA and any contractors of the HOA will require training to ensure that employees are aware of maintenance activities that may result in pollutants reaching the storm drain. Materials that may be utilized during training are listed in Section VII.	The Owner shall educate all new employees/managers on storm water pollution prevention, particularly good housekeeping practices prior to the start of the rainy season (October 1). Refresher courses shall be conducted on an as needed basis. Materials that may be utilized on BMP maintenance are attached to this WQMP. Frequency: Annually	Brookfield Residential / HOA
No	N13. Housekeeping of Loading Docks	Not Applicable	
Yes	N14. Common Area Catch Basin Inspection All private catch basins will be maintained and cleaned by the HOA. All public catch basins will be maintained and cleaned by the City of Lake Forest.	On-site catch basin inlets and other drainage facilities shall be inspected after each storm event and once per year. Inlets and other facilities shall be cleaned prior to the storm season by October 1st each year. Frequency: Annually	Brookfield Residential / HOA

BMP INSPECTION & MAINTENANCE RESPONSIBILITY MATRIX			
BMP Applicable? Yes/No	**BMP Name and BMP Implementation, Maintenance and Inspection Procedures**	**Implementation, Maintenance, and Inspection Frequency and Schedule**	**Person or Entity with Operation & Maintenance Responsibility**
Yes	**N15. Street Sweeping Private Streets and Parking Lots** All private streets and parking areas shall be swept by the HOA prior to the rainy season, no later than October 1st each year.	Private streets and parking areas within the project shall be swept at a minimum frequency quarterly as well as once per year prior to the storm season, no later than October 1st each year. Frequency: Quarterly	Brookfield Residential / HOA
No	**N16. Retail Gasoline Outlets**	Not Applicable	
STRUCTURAL SOURCE CONTROL BMPs			
Yes	**S1. Provide storm drain system stenciling and signage** The developer will be responsible for the stenciling of all catch basins to include a legible message such as "No Dumping - Drains to Ocean" or an equally effective phrase.	Storm drain stencils shall be inspected for legibility, at minimum, once prior to the storm season, no later than October 1st each year. Those determined to be illegible will be re-stenciled as soon as possible. Frequency: Annually	Brookfield Residential / HOA
No	**S2. Design and construct outdoor material storage areas to reduce pollution introduction**	Not Applicable	
No	**S3. Design and construct trash and waste storage areas to reduce pollution introduction**	Not Applicable	

BMP INSPECTION & MAINTENANCE RESPONSIBILITY MATRIX			
BMP Applicable? Yes/No	**BMP Name and BMP Implementation, Maintenance and Inspection Procedures**	**Implementation, Maintenance, and Inspection Frequency and Schedule**	**Person or Entity with Operation & Maintenance Responsibility**
Yes	**S4. Use efficient irrigation systems & landscape design, water conservation, smart controllers, and source control** Includes installation and maintenance of all common landscape areas utilizing similar planting materials with similar water requirements to reduce excess irrigation runoff. Also includes implementing all efficient irrigation systems for common area landscaping including but not limited to provisions for water sensors and programmable irrigation cycles in conformance with water use efficiency guidelines.	In conjunction with routine maintenance activities, verify that landscape design continues to function properly by adjusting properly to eliminate overspray 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 nighttime temperatures based on system specifications and local climate patterns. System testing shall occur twice per year. Water from testing/flushing shall be collected and properly disposed to sewer system and shall not discharge to storm drain system. Frequency: Monthly	Brookfield Residential / HOA
Yes	**S5. Protect slopes and channels and provide energy dissipation** All slopes shall be vegetated and stabilized to prevent erosion, in accordance with "Efficient Irrigation and Landscape Design" source control BMP to prevent erosion.	To be performed in conjunction with maintenance activities. Maintain vegetative cover and/or mulch to eliminate exposed soils. Any eroded surfaces to be repaired immediately. Inspections to be performed twice each year (spring and fall) and after major storm events to check for signs of erosion, gullies, and sloughing. Frequency: Monthly	Brookfield Residential / HOA
No	**S6. Dock areas**	Not Applicable	
No	**S7. Maintenance bays**	Not Applicable	
No	**S8. Vehicle wash areas**	Not Applicable	

BMP INSPECTION & MAINTENANCE RESPONSIBILITY MATRIX			
BMP Applicable? Yes/No	BMP Name and BMP Implementation, Maintenance and Inspection Procedures	Implementation, Maintenance, and Inspection Frequency and Schedule	Person or Entity with Operation & Maintenance Responsibility
No	S9. Outdoor processing areas	Not Applicable	
No	S10. Equipment wash areas	Not Applicable	
No	S11. Fueling areas	Not Applicable	
No	S12. Hillside landscaping	Not Applicable	
No	S13. Wash water control for food preparation areas	Not Applicable	
No	S14. Community car wash racks	Not Applicable	

BMP INSPECTION & MAINTENANCE RESPONSIBILITY MATRIX		
BMP Name and BMP Implementation, Maintenance and Inspection Procedures	**Implementation, Maintenance, and Inspection Frequency and Schedule**	**Person or Entity with Operation & Maintenance Responsibility**
LOW IMPACT DEVELOPMENT BMPs		
Biotreatment: Rain Gardens	Inspections should occur semi-annually or after major storm events to check for the following and remove accordingly: standing water, sediment, and trash & debris. Inspections should also look for potential clogging and clean planters or, if necessary, replace the entire filter bed. Inspect for weeds, and prune and/or replace plants in accordance with routine landscape maintenance activities. Replace mulch and prune shrubs as necessary. Frequency: 2x per year	Brookfield Residential / HOA
Biotreatment: Filterra Bioretention Units	Maintenance consists of a minimum of two scheduled visits, one after the rainy season and one before the wet season to inspect and clean the unit. Each visit consists of: Inspection; removal of trash, debris, sediment; filter media and plant health evaluation and replacement if necessary; replacement of mulch. Frequency: 2x per year	Brookfield Residential / HOA

Required Permits

Permits are not required for BMP maintenance.

Forms to Record BMP Implementation, Maintenance, and Inspection

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

Recordkeeping

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

Waste Disposal

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

RECORD OF BMP IMPLEMENTATION, MAINTENANCE, AND INSPECTION

Today's Date: _____

Name of Person Performing Activity (Printed): _____

Signature: _____

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

Filterra® - Americast
11352 Virginia Precast Road
Ashland, VA 23005

Maintenance Services

for

Filterra® Stormwater Bioretention Filtration Systems

- Extended Maintenance Service
- Maintenance Training for your Landscape Contractor or Local DPW

Corporate Headquarters
11352 Virginia Precast Road
Ashland, VA 23005
Toll Free: (866) 349-3458
Fax: (804) 798-8400

E-mail: design@filterra.com
www.filterra.com

Why Main ı?

All stormwater treatment systems require maintenance for effective operation. This necessity is often incorporated in your property's permitting process as a legally binding BMP Maintenance Agreement.

Maintei ce Includes

Filterra maintenance includes:

- Unit inspection
- Debris, trash & mulch removal & disposal
- Filter media evaluation
- Plant health evaluation
- Replacement of mulch
- Updated and stored records of performed maintenance

- **Avoid legal challenges from your jurisdiction's maintenance enforcement program.**
- **Prolong the expected lifespan of your Filterra media.**
- **Avoid more costly media replacement.**
- **Help reduce pollutant loads leaving your property.**

Why use Filterra Services?

- As the manufacturer we have performed 1,000's of maintenance visits.
- Filterra will schedule visits and keep maintenance records for you.
- Cost effective, multi-year plans available.
- Backed by Filterra's technical department.
- Use only Filterra approved materials.

Training Includes

- Site visit by Filterra personnel.
- Full maintenance demonstration on a single unit.
- Instructional DVD.
- *Maintenance Instruction Manual* complete with color photos.
- Maintenance forms for keeping your own records.

Please complete all sections, detach and return to Filterra® or call 866-349-3458

Project Name: _____

Site Address: _____

_____

Contact Information:

Name: _____

Company Name (if applicable): _____

_____

Phone: _____ E-mail: _____

☐ Owner
☐ Owner Representative
☐ Current Occupant
☐ Home Owner Association

I am interested in:

☐ Extended Maintenance
☐ Maintentance Training

Operation & Maintenance (OM) Manual v01

filterra®

Bioretention Systems

A Growing Idea in Stormwater Filtration.

by KRISTAR

A Division of:

AMERICAST

Filterra® Stormwater Bioretention Filtration System

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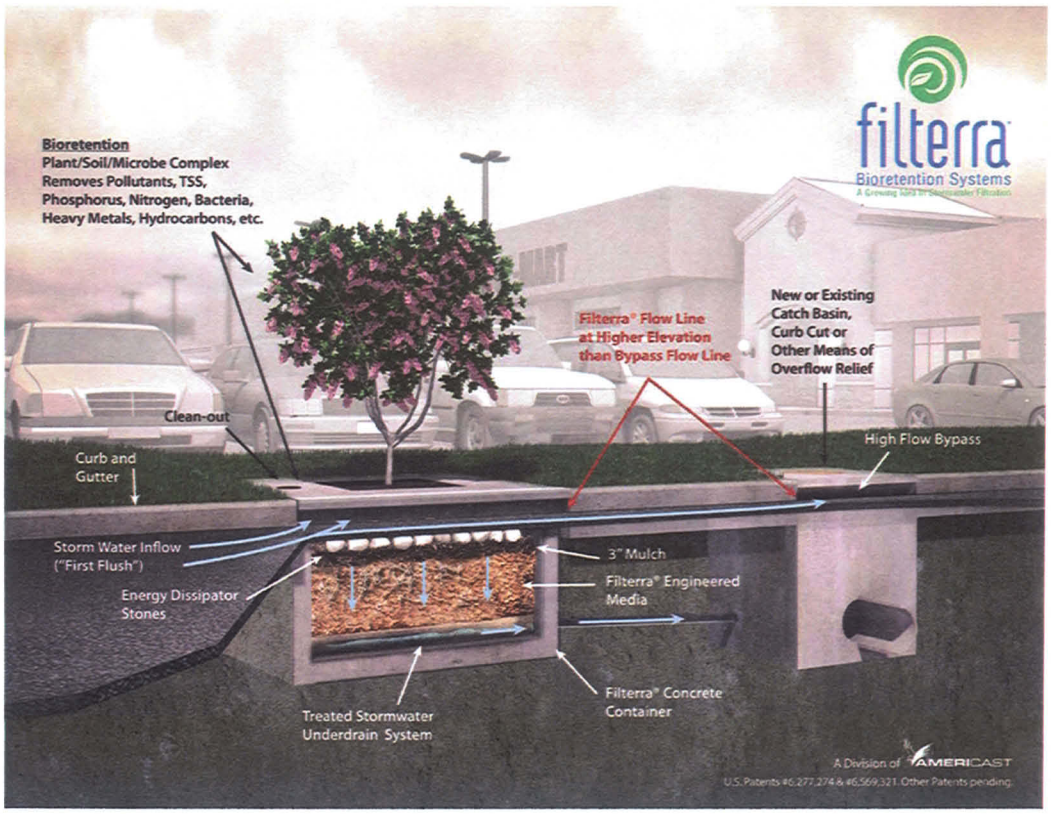
General Description

The following general specifications describe the general operations and maintenance requirements for the Americast stormwater bioretention filtration system, the Filterra®. The system utilizes physical, chemical and biological mechanisms of a soil, plant and microbe complex to remove pollutants typically found in urban stormwater runoff. The treatment system is a fully equipped, pre-constructed drop-in place unit designed for applications in the urban landscape to treat contaminated runoff.



Stormwater flows through a specially designed filter media mixture contained in a landscaped concrete container. The mixture immobilizes pollutants which are then decomposed, volatilized and incorporated into the biomass of the Filterra® system's micro/macro fauna and flora. Stormwater runoff flows through the media and into an underdrain system at the bottom of the container, where the treated water is discharged. Higher flows bypass the Filterra® to a downstream inlet or outfall.

Maintenance is a simple, inexpensive and safe operation that does not require confined space access, pumping or vacuum equipment or specialized tools. Properly trained landscape personnel can effectively maintain Filterra® Stormwater systems by following instructions in this manual.

Basic Operations

Filterra® is a bioretention system in a concrete box. Contaminated stormwater runoff enters the filter box through the curb inlet spreading over the 3-inch layer of mulch on the surface of the filter media. As the water passes through the mulch layer, most of the larger sediment particles and heavy metals are removed through sedimentation and chemical reactions with the organic material in the mulch. Water passes through the soil media where the finer particles are removed and other chemical reactions take place to immobilize and capture pollutants in the soil media. The cleansed water passes into an underdrain and flows to a pipe system or other appropriate discharge point. Once the pollutants are in the soil, the bacteria begin to break down and metabolize the materials and the plants begin to uptake and metabolize the pollutants. Some pollutants such as heavy metals, which are chemically bound to organic particles in the mulch, are released over time as the organic matter decomposes to release the metals to the feeder roots of the plants and the cells of the bacteria in the soil where they remain and are recycled. Other pollutants such as phosphorus are chemically bound to the soil particles and released slowly back to the plants and bacteria and used in their metabolic processes. Nitrogen goes through a very complex variety of biochemical processes where it can ultimately end up in the plant/bacteria biomass, turned to nitrogen gas or dissolves back into the water column as nitrates depending on soil temperature, pH and the availability of oxygen. The pollutants ultimately are retained in the mulch, soil and biomass with some passing out of the system into the air or back into the water.

Design and Installation

Each project presents different scopes for the use of Filterra® systems. To ensure the safe and specified function of the stormwater BMP, Americast reviews each application before supply. Information and help may be provided to the design engineer during the planning process. Correct Filterra® box sizing (by rainfall region) is essential to predict pollutant removal rates for a given area. The engineer shall submit calculations for approval by the local jurisdiction. The contractor is responsible for the correct installation of Filterra units as shown in approved plans. A comprehensive installation manual is available at filterra.com.

Maintenance

Why Maintain?

All stormwater treatment systems require maintenance for effective operation. This necessity is often incorporated in your property's permitting process as a legally binding BMP maintenance agreement.

- Avoid legal challenges from your jurisdiction's maintenance enforcement program.
- Prolong the expected lifespan of your Filterra media.
- Avoid more costly media replacement.
- Help reduce pollutant loads leaving your property.

Simple maintenance of the Filterra® is required to continue effective pollutant removal from stormwater runoff before discharge into downstream waters. This procedure will also extend the longevity of the living biofilter system. The unit will recycle and accumulate pollutants within the biomass, but is also subjected to other materials entering the throat. This may include trash, silt and leaves etc. which will be contained within the void below the top grate and above the mulch layer. Too much silt may inhibit the Filterra's® flow rate, which is the reason for site stabilization before activation. Regular replacement of the mulch stops accumulation of such sediment.

When to Maintain?

Americast includes a 1-year maintenance plan with each system purchase. Annual included maintenance consists of a maximum of two (2) scheduled visits. Additional maintenance may be necessary depending on sediment and trash loading (by Owner or at additional cost). The start of the maintenance plan begins when the system is activated for full operation. Full operation is defined as the unit installed, curb and gutter and transitions in place and activation (by Supplier) when mulch and plant are added and temporary throat protection removed.

Activation cannot be carried out until the site is **fully** stabilized (full landscaping, grass cover, final paving and street sweeping completed). Maintenance visits are scheduled seasonally; the spring visit aims to clean up after winter loads including salts and sands. The fall visit helps the system by removing excessive leaf litter.

A first inspection to determine if maintenance is necessary should be performed at least twice annually after every major storm event of greater than (1) one inch total depth (subject to regional climate). Please refer to the maintenance checklist for specific conditions that indicate if maintenance is necessary.

It has been found that in regions which receive between 30-50 inches of annual rainfall, (2) two visits are generally required. Regions with less rainfall often only require (1) one visit per annum. Varying land uses can affect maintenance frequency; e.g. some fast food restaurants require more frequent trash removal. Contributing drainage areas which are subject to new development wherein the recommended erosion and sediment control measures have not been implemented require additional maintenance visits.

Some sites may be subjected to extreme sediment or trash loads, requiring more frequent maintenance visits. This is the reason for detailed notes of maintenance actions per unit, helping the Supplier and Owner predict future maintenance frequencies, reflecting individual site conditions.

Owners must promptly notify the (maintenance) Supplier of any damage to the plant(s), which constitute(s) an integral part of the bioretention technology. Owners should also advise other landscape or maintenance contractors to leave all maintenance to the Supplier (i.e. no pruning or fertilizing).

Exclusion of Services

It is the responsibility of the owner to provide adequate irrigation when necessary to the plant of the Filterra® system.

Clean up due to major contamination such as oils, chemicals, toxic spills, etc. will result in additional costs and are not covered under the Supplier maintenance contract. Should a major contamination event occur, the Owner must block off the outlet pipe of the Filterra® (where the cleaned runoff drains to, such as drop-inlet) and block off the throat of the Filterra®. The Supplier should be informed immediately.

Maintenance Visit Summary

Each maintenance visit consists of the following simple tasks (detailed instructions below).

1. Inspection of Filterra® and surrounding area
2. Removal of tree grate and erosion control stones
3. Removal of debris, trash and mulch
4. Mulch replacement
5. Plant health evaluation and pruning or replacement as necessary
6. Clean area around Filterra®
7. Complete paperwork

Maintenance Tools, Safety Equipment and Supplies

Ideal tools include: camera, bucket, shovel, broom, pruners, hoe/rake, and tape measure. Appropriate Personal Protective Equipment (PPE) should be used in accordance with local or company procedures. This may include impervious gloves where the type of trash is unknown, high visibility clothing and barricades when working in close proximity to traffic and also safety hats and shoes. A T-Bar or crowbar should be used for moving the tree grates (up to 170 lbs ea.).

Most visits require only replacement mulch. Three bags of double shredded mulch are used per unit (on a standard 6x6' size). Some visits may require additional Filterra® engineered soil media available from the Supplier.

Maintenance Visit Procedure

1. Inspection of Filterra® and surrounding area

- Record individual unit **before** maintenance with photograph (numbered). Record on Maintenance Report (see example in this document) the following:

Record on Maintenance Report the following:

Standing Water	yes | no
Damage to Box Structure Damage	yes | no
to Grate	yes | no
Is Bypass Clear	yes | no

If yes answered to any of these observations, record with close-up photograph (numbered).

2. Removal of tree grate and erosion control stones

- Remove metal grates for access into Filterra® box.
- Dig out silt (if any) and mulch and remove trash & foreign items.

Record on Maintenance Report the following:

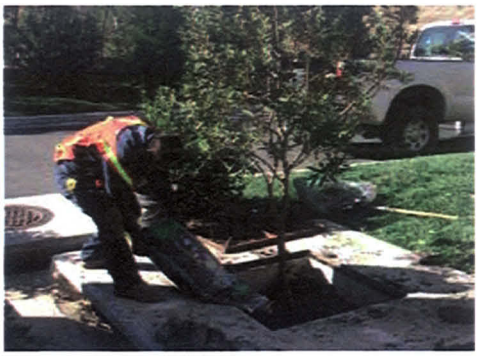
Silt/Clay	yes | no
Cups/ Bags	yes | no
Leaves	yes | no
# of Buckets Removed	

3. Removal of debris, trash and mulch

- After removal of mulch and debris, measure distance from the top of the Filterra® engineered media soil to the bottom of the top slab. If this distance is greater than 12", add Filterra® media (not top soil or other) to recharge to a 9" distance.

Record on Maintenance Report the following:

Distance to Bottom of Top Slab (inches)
# of Buckets of Media Added



4. Mulch replacement

- Please see mulch specifications.
- Add double shredded mulch evenly across the entire unit to a depth of 3".
- Ensure correct repositioning of erosion control stones by the Filterra® inlet to allow for entry of trash during a storm event.
- Replace Filterra® grates correctly using appropriate lifting or moving tools, taking care not to damage the plant.

5. Plant health evaluation and pruning or replacement as necessary

- Examine the plant's health and replace if dead.
- Prune as necessary to encourage growth in the correct directions

Record on Maintenance Report the following:

Height above Grate	(feet)
Width at Widest Point	(feet)
Health	alive | dead
Damage to Plant	yes | no
Plant Replaced	yes | no

6. Clean area around Filterra®

- Clean area around unit and remove all refuse to be disposed of appropriately.

7. Complete paperwork

- Deliver Maintenance Report and photographs to appropriate location (normally Americast during maintenance contract period).
- Some jurisdictions may require submission of maintenance reports in accordance with approvals. It is the responsibility of the Owner to comply with local regulations.

Maintenance Checklist

Drainage System Failure	Problem	Conditions to Check For	Conditions That Should Exist	Actions
Inlet	Excessive sediment or trash accumulation	Accumulated sediments or trash impair free flow of water into Filterra	Inlet should be free of obstructions allowing free distributed flow of water into Filterra.	Sediments and/or trash should be removed.
Mulch Cover	Trash and floatable debris accumulation	Excessive trash and/or debris accumulation.	Minimal trash or other debris on mulch cover.	Trash and debris should be removed and mulch cover raked level. Ensure bark nugget mulch is not used.
Mulch Cover	"Ponding" of water on mulch cover.	"Ponding" in unit could be indicative of clogging due to excessive fine sediment accumulation or spill of petroleum oils.	Stormwater should drain freely and evenly through mulch cover.	Recommend contact manufacturer and replace mulch as a minimum.
Vegetation	Plants not growing or in poor condition.	Soil/mulch too wet, evidence of spill. Incorrect plant selection. Pest infestation. Vandalism to plants.	Plants should be healthy and pest free.	Contact manufacturer for advice.
Vegetation	Plant growth excessive	Plants should be appropriate to the species and location of Filterra.		Trim/prune plants in accordance with typical landscaping and safety needs.
Structure	Structure has visible cracks	Cracks wider than ½ inch or evidence of soil particles entering the structure through the cracks.		Vault should be repaired.

Maintenance is ideally to be performed twice annually.
Inspection to be performed after every major storm event >1 inch total depth, subject to climate.

Filterra® Project Maintenance Order

Project	
Address	
Directions	
Project Owner	
Filterra Units on this Order	
Total Units on this Project	
Date of Maintenance	
Arrival Time	
Departure Time	
# of Workers	
Notes on Project	
Maintenance Supervisor	

Note : All maintenance debris, trash and mulch must go to landfill.

03/22/11

Filterra® Structure Maintenance Report

Project		**Structure Number**	
Plant Type		**Structure Size**	
Date		**GPS**	
		Pre Mtce Photo #	

Initial Observations

Standing Water	Y N	Damage to Grate	Y N
IF Yes, STOP NOW & call 888-950-8826		Is Bypass Clear	Y N
		Notes	
Damage to Box Structure	Y N		
If YES to any observation take close up photo			

Waste

Silt / Clay	Y N	Buckets Removed (# of)	
Cups/Bags	Y N	Notes	
Leaves	Y N		
Other			

Media

Distance to Bottom of Top Slab (in.)		Notes	
Buckets of Media Added (# of)			

Mulch

Netting Replaced	Y N	Bags of Mulch Added (# of)	
Stones Replaced	Y N	Notes	

Plant

	#1	(#2)		#1	(#2)
Height above Grate (ft., in.)			Plant Replaced	Y / N	Y / N
Stem diameter/Caliper (in.)					
Width at Widest Point (ft., in.)			Notes		
Health	Alive/Dead	Alive/Dead			
Damage to Plant	Y / N	Y / N			
If YES to plant damage take close up photo					

Other Notes
(use back if necessary)

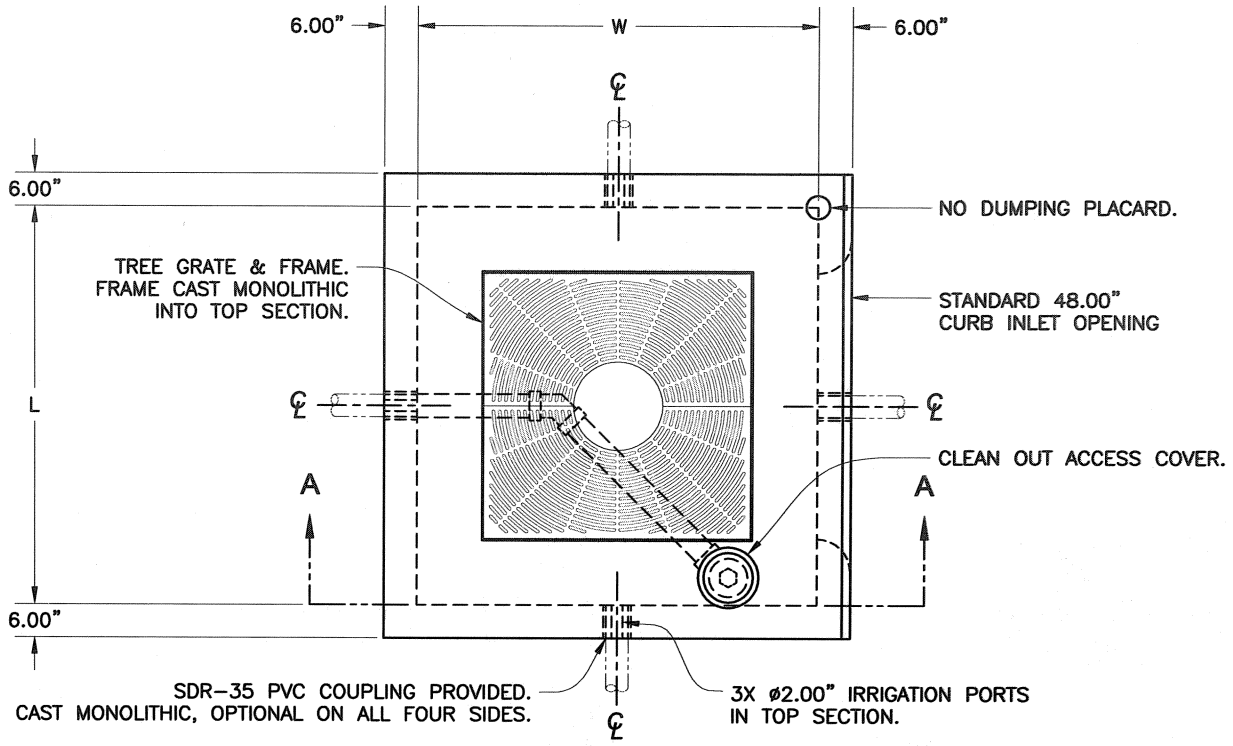
Filterra® Warranty

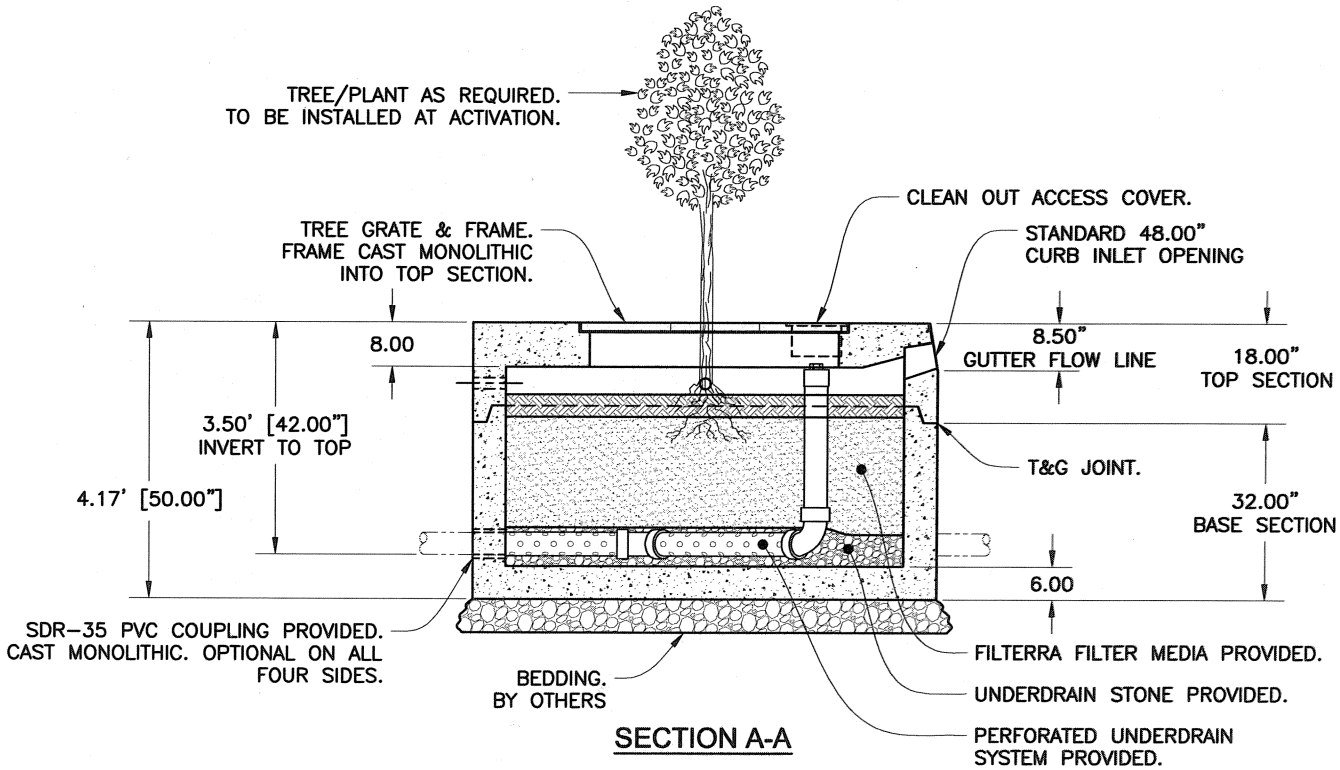
Seller warrants goods sold hereunder against defects in materials and workmanship only, for a period of (1) year from date the Seller activates the system into service. Seller makes no other warranties, expressed or implied.

Seller's liability hereunder shall be conditioned upon the Buyer's installation, maintenance, and service of the goods in strict compliance with the written instructions and specifications provided by the Seller. Any deviation from Seller's instructions and specifications or any abuse or neglect shall void all warranties.

In the event of any claim upon Seller's warranty, the burden shall be upon the buyer to prove strict compliance with all instructions and specifications provided by the Seller.

Seller's liability hereunder shall be limited only to the cost or replacement of the goods. Buyer agrees that Seller shall not be liable for any consequential losses arising from the purchase, installation, and/or use of the goods.





SECTION A-A

TABULATION				
Size / Designation	L (Feet)	W (Feet)	Tree Grate Quantity / Size	Outlet Pipe PVC SDR-35
4' x 4'	4.00'	4.00'	1Ea. / 3' x 3'	Ø4.00"
6' x 6'	6.00'	6.00'	1Ea. / 3' x 3'	Ø4.00"

Precast Filterra® Unit

Standard Configuration (Square)

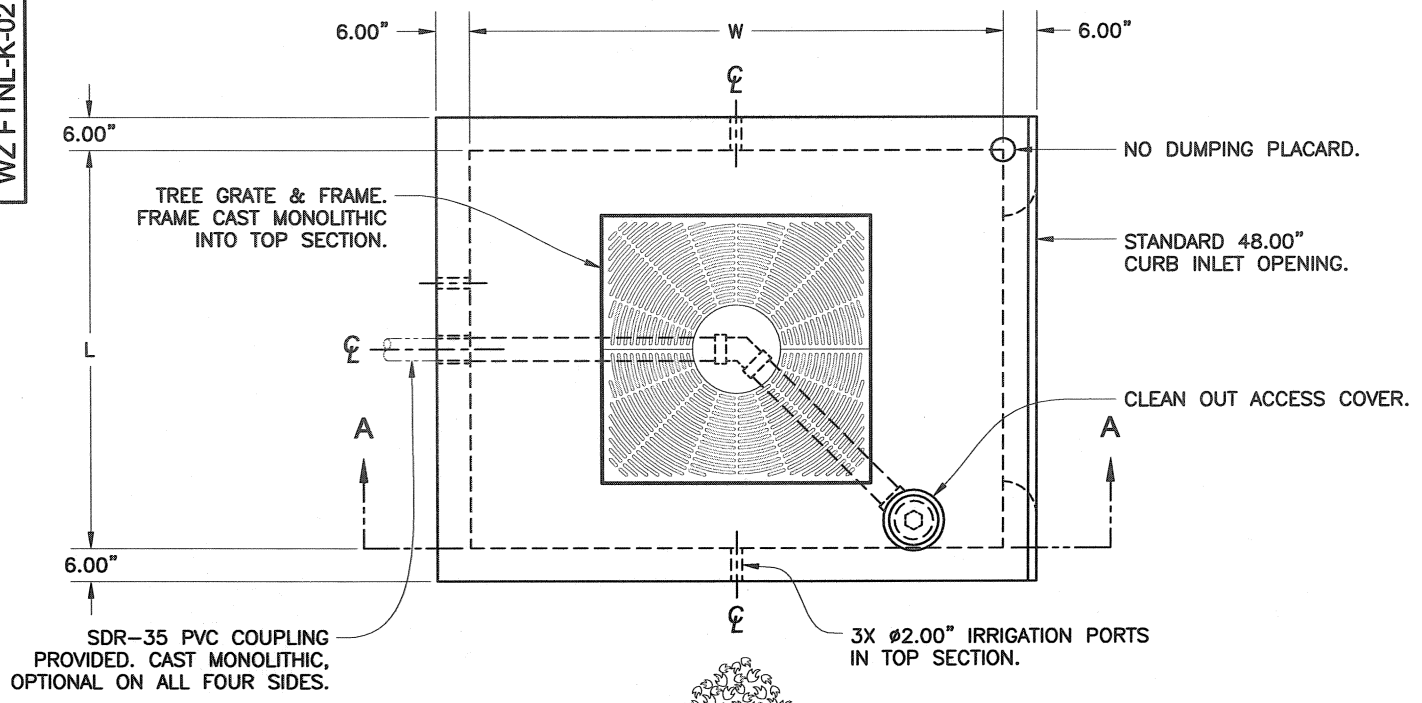
Western Zone

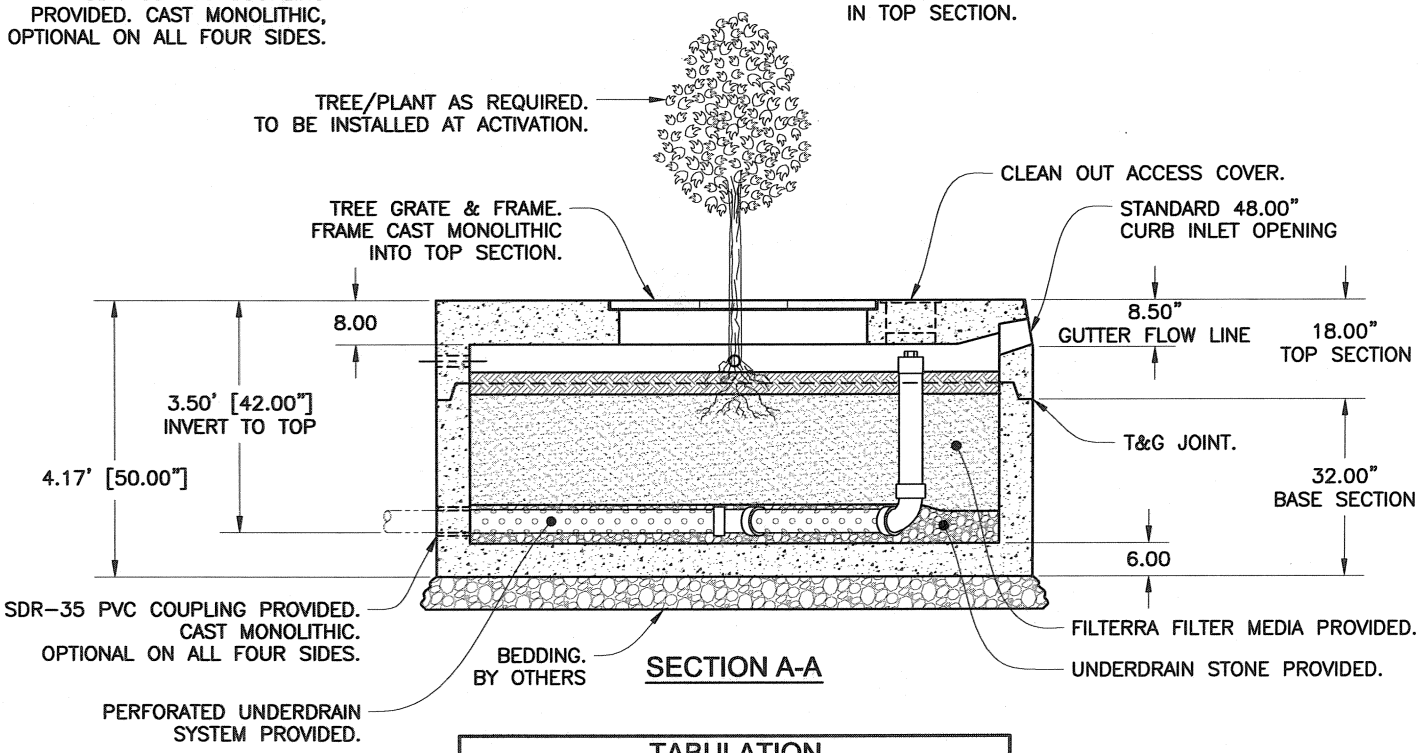
KriStar Enterprises, Inc.
360 Sutton Place, Santa Rosa, CA 95407
Ph: 800.579.8819, Fax: 707.524.8186, www.kristar.com

filterra®
US PAT 6,277,274
AND 6,569,321

DRAWING NO.	REV	F-ECO	DATE
WZ FTST-K-01	02	0004 JPR 3/28/11	JPR 1/7/11

WZ FTNL-K-02





TABULATION

Size / Designation	L (Feet)	W (Feet)	Tree Grate Quantity / Size	Outlet Pipe PVC SDR-35
4' X 6'	4.00'	6.00'	1ea. / 3' x 3'	Ø4.00"
4' x 6.5'	4.00'	6.50'	1ea. / 3' x 3'	Ø4.00"
4' x 8'	4.00'	8.00'	1ea. / 3' x 3'	Ø4.00"
4' x 16'	4.00'	16.00'	2ea. / 3' x 3'	Ø4.00"
6' x 8'	6.00'	8.00'	1ea. / 4' x 4'	Ø4.00"
6' x 10'	6.00'	10.00'	1ea. / 4' x 4'	Ø6.00"
6' x 12'	6.00'	12.00'	2ea. / 4' x 4'	Ø6.00"
8' x 16'	8.00'	16.00'	2ea. / 4' x 4'	Ø6.00"
8' x 18'	8.00'	18.00'	3ea. / 4' x 4'	Ø6.00"
8' x 20'	8.00'	20.00'	3ea. / 4' x 4'	Ø6.00"

TITLE

Precast Filterra® Unit

Narrow Length Configuration

Western Zone

KriStar Enterprises, Inc.
360 Sutton Place, Santa Rosa, CA 95407
Ph: 800.579.8819, Fax: 707.524.8186, www.kristar.com

filterra®
US PAT 6,277,274
AND 6,569,321

DRAWING NO.	REV	F–ECO	DATE
WZ FTNL-K-02	02	0004 JPR 3/28/11	JPR 1/7/11

Appendix E

APPENDIX E
CONDITIONS OF APPROVAL

Placeholder – pending issuance by the City of Lake Forest

Appendix F

APPENDIX F

INFILTRATION TEST RESULTS

LGC Geotechnical, Inc.

PROJECT MEMORANDUM

REGISTERED PROFESSIONAL ENGINEER
DENNIS BORATYNEC
No. 2770
Exp. 12/31/12
GEOTECHNICAL
STATE OF CALIFORNIA

To: Brookfield Homes
3090 Bristol Street, Ste. 200
Costa Mesa, CA 92626

Date: April 5, 2012
Project No.: 11142-01

Attention: Mr. Craig Cristina

From: Dennis Boratynec DJB

Subject: Infiltration Design Rate, Tentative Tract 17446, "Town Centre", Lake Forest, California

---

LGC Geotechnical, Inc. has prepared this memorandum to summarize our data collected during field infiltration testing and to provide a design infiltration rate based on the procedures outlined in Appendix VII of the Orange County Technical Guidance Document. Based on using this methodology, we recommend an average design infiltration rate of 0.014 inches per hour, based on a factor of safety of 3.

Should you have any questions regarding this memorandum, please do not hesitate to contact our office.

Attachments: Boring Logs H-2, H-3 and H-3
Field Infiltration Rates for H-2, H-3 and H-4

cc: Winnie Tham, Fuscoe Engineering

Geotechnical Boring Log Borehole HS-2

Date: 9/22/2011 | **Drilling Company:** Martini Drilling

Project Name: Brookfield - Lake Forest | **Type of Rig:** HSA

Project Number: 11142-01 | **Drop:** 30" | **Hole Diameter:** 8"

Elevation of Top of Hole: ~791' MSL | **Drive Weight:** 140 pounds

Hole Location: See Geotechnical Map

Logged By KTM
Sampled By KTM
Checked By BJE

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
755	0	B-1						3" Asphalt over 4" base **Tertiary Capistrano Formation, Oso Member (Tso)**	
750	5		R-1	6 15 20	121.3	7.9	[SM]	Silty SANDSTONE with trace Clay: mottled light gray and brown, moist, dense, very fine to coarse subangular grains	
745	10		R-2	30 50/3"	122.7	7.7	[SM]	Silty SANDSTONE with trace Clay: light gray, moist, very dense, fine to coarse subangular grains, well indurated, lacks cementation	#200
740	15		R-3	19 50/4"	111.3	7.8	[SM]	same as above	S&H, Perm
735	20							Total Depth = 16' Groundwater Not Encountered Backfilled with 2" Diameter Slotted PVC Pipe and Pea Gravel on 9/22/2011; Pipe Pulled and Cuttings Placed in Void on 9/23/11	
730	25								
	30								

LGC Geotechnical, Inc.

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

SAMPLE TYPES:

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

TEST TYPES:

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

Last Edited: 10/6/2011

Geotechnical Boring Log Borehole HS-3

Date: 9/22/2011 | **Drilling Company:** Martini Drilling

Project Name: Brookfield - Lake Forest | **Type of Rig:** HSA

Project Number: 11142-01 | **Drop:** 30" | **Hole Diameter:** 8"

Elevation of Top of Hole: ~787' MSL | **Drive Weight:** 140 pounds

Hole Location: See Geotechnical Map

Logged By KTM
Sampled By KTM
Checked By BJE

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
755	0							Grass covered topsoil; dark brown, dry, dense **Older Artificial Fill (Afo)**	
								Tertary Capistrano Formation, Oso Member (Tso)	
	5		R-1	10 22 26	124.2	7.6	[SM]	Silty SANDSTONE: light gray and brown, moist, dense, very fine to coarse subangular grains, well indurated, lacks cementation	
750									
	10		R-2	12 21 34	123.3	8.4	[SM]	same as above	
745									
	15		R-3	12 18 31	125.3	7.5	[SM]	same as above	S&H, Perm
740									
								Total Depth = 16' Groundwater Not Encountered Backfilled with 2" Diameter Slotted PVC Pipe and Pea Gravel on 9/22/2011; Pipe Pulled and Cuttings Placed in Void on 9/23/11	
	20								
735									
	25								
730									
	30								

LGC Geotechnical, Inc.

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

SAMPLE TYPES:

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

TEST TYPES:

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

Last Edited: 10/6/2011

Geotechnical Boring Log Borehole HS-4

Date: 9/22/2011 | **Drilling Company:** Martini Drilling

Project Name: Brookfield - Lake Forest | **Type of Rig:** HSA

Project Number: 11142-01 | **Drop:** 30" | **Hole Diameter:** 8"

Elevation of Top of Hole: ~786' MSL | **Drive Weight:** 140 pounds

Hole Location: See Geotechnical Map

Logged By KTM
Sampled By KTM
Checked By BJE

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
755	0							Grass covered topsoil; dark brown, dry, dense **Older Artificial Fill (Afo)**	
	5	B-1	R-1	10 15 16	119.2	9.8	SC-CL	Clayey SAND - Sandy CLAY: brown, moist, dense, sand is very fine to medium with few coarse grains	EI CR
750									
	10		R-2	7 12 18	119.2	12.1	SC	Clayey SAND: brown, moist, dense, sand is very fine to medium with few coarse grains	
745									
	15		R-3	8 14 28	120.5	12.1	SC	Clayey SAND: brown, moist, dense, sand is fine to coarse	#200
740									
	20							Total Depth = 16' Groundwater Not Encountered Backfilled with 2" Diameter Slotted PVC Pipe and Pea Gravel on 9/22/2011; Pipe Pulled and Cuttings Placed in Void on 9/23/11	
735									
	25								
730									
	30								

LGC Geotechnical, Inc.

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

SAMPLE TYPES:

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

TEST TYPES:

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

Last Edited: 10/6/2011

Infiltration Test Data Sheet

LGC Geotechnical, Inc
120 Calle Iglesia Suite A, San Clemente, CA 92672 tel. (949) 369-6141

Project Name: Brookfield Lake Forest
Project Number: 11142-01
Date:
Boring Number: LGC -2
USCS Soil Classification:

Test hole dimensions (if circular)	
Boring Depth (feet)*:	16
Boring Diameter (inches):	8
Pipe Diameter (inches):	4

*measured at time of test

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

*Pre-Test (Sandy Soil Criteria)**

Trial No.	Start Time (24:HR)	Stop Time (24:HR)	Time Interval (min)	Initial Depth to Water (feet)	Final Depth to Water (feet)	Total Change in Water Level (feet)	Greater Than or Equal to 0.5 feet (yes/no)
1							
2							

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

Main Test Data

Trial No.	Start Time (24:HR)	Stop Time (24:HR)	Time Interval, Δt (min)	Initial Depth to Water, D_o (feet)	Final Depth to Water, D_f (feet)	Change in Water Level, ΔD (feet)	Raw Infiltration Rate (in/hr)	Design Infiltration Rate (in/hr)
1			30.0	9.95	10.09	0.14	0.091	0.030
2			30.0	10.09	10.16	0.07	0.046	0.015
3			30.0	10.16	10.26	0.1	0.067	0.022
4			30.0	10.26	10.35	0.09	0.061	0.020
5			30.0	10.35	10.45	0.1	0.069	0.023
6			30.0	10.45	10.49	0.04	0.028	0.009
7			30.0	10.49	10.61	0.12	0.085	0.028
8			30.0	10.61	10.69	0.08	0.058	0.019
9			30.0	10.69	10.76	0.07	0.051	0.017
10			30.0	10.76	10.85	0.09	0.067	0.022
11			30.0	10.85	10.92	0.07	0.053	0.018
12								
						Recommended Design Infiltration Rate (Including Factor of Safety of 3)		**0.019**

Sketch:

Notes:

LGC Geotechnical, Inc.

Infiltration Test Data Sheet

LGC Geotechnical, Inc
120 Calle Iglesia Suite A, San Clemente, CA 92672 tel. (949) 369-6141

Project Name: Brookfield Lake Forest
Project Number: 11142-01
Date:
Boring Number: LGC -3
USCS Soil Classification:

Test hole dimensions (if circular)	
Boring Depth (feet)*:	16
Boring Diameter (inches):	8
Pipe Diameter (inches):	4

*measured at time of test

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

*Pre-Test (Sandy Soil Criteria)**

Trial No.	Start Time (24:HR)	Stop Time (24:HR)	Time Interval (min)	Initial Depth to Water (feet)	Final Depth to Water (feet)	Total Change in Water Level (feet)	Greater Than or Equal to 0.5 feet (yes/no)
1							
2							

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

Main Test Data

Trial No.	Start Time (24:HR)	Stop Time (24:HR)	Time Interval, Δt (min)	Initial Depth to Water, D_o (feet)	Final Depth to Water, D_f (feet)	Change in Water Level, ΔD (feet)	Raw Infiltration Rate (in/hr)	Design Infiltration Rate (in/hr)
1			30.0	10.4	10.58	0.18	0.127	0.042
2			30.0	10.58	10.68	0.1	0.072	0.024
3			30.0	10.05	10.11	0.06	0.039	0.013
4			30.0	10.17	10.24	0.07	0.047	0.016
5			30.0	10.24	10.32	0.08	0.054	0.018
6			30.0	10.32	10.41	0.09	0.062	0.021
7			30.0	10.41	10.45	0.04	0.028	0.009
8			30.0	10.45	10.51	0.06	0.042	0.014
9			30.0	10.51	10.58	0.07	0.050	0.017
10			30.0	10.58	10.65	0.07	0.050	0.017
11			30.0	10.65	10.74	0.09	0.066	0.022
12			30.0	10.74	10.8	0.06	0.044	0.015
						Recommended Design Infiltration Rate (Including Factor of Safety of 3)		**0.018**

Sketch:

Notes:

LGC Geotechnical, Inc.

Infiltration Test Data Sheet

LGC Geotechnical, Inc
120 Calle Iglesia Suite A, San Clemente, CA 92672 tel. (949) 369-6141

Project Name: Brookfield Lake Forest
Project Number: 11142-01
Date:
Boring Number: LGC -4
USCS Soil Classification:

Test hole dimensions (if circular)	
Boring Depth (feet)*:	15
Boring Diameter (inches):	8
Pipe Diameter (inches):	4

*measured at time of test

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

*Pre-Test (Sandy Soil Criteria)**

Trial No.	Start Time (24:HR)	Stop Time (24:HR)	Time Interval (min)	Initial Depth to Water (feet)	Final Depth to Water (feet)	Total Change in Water Level (feet)	Greater Than or Equal to 0.5 feet (yes/no)
1							
2							

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

Main Test Data

Trial No.	Start Time (24:HR)	Stop Time (24:HR)	Time Interval, Δt (min)	Initial Depth to Water, D_o (feet)	Final Depth to Water, D_f (feet)	Change in Water Level, ΔD (feet)	Raw Infiltration Rate (in/hr)	Design Infiltration Rate (in/hr)
1			30.0	3.6	3.62	0.02	0.007	0.002
2			30.0	3.62	3.67	0.05	0.017	0.006
3			30.0	3.67	3.71	0.04	0.014	0.005
4			30.0	3.71	3.75	0.04	0.014	0.005
5			30.0	3.75	3.81	0.06	0.021	0.007
6			30.0	3.81	3.84	0.03	0.011	0.004
7			30.0	3.84	3.88	0.04	0.014	0.005
8			30.0	3.88	3.92	0.04	0.014	0.005
9			30.0	3.92	3.96	0.04	0.014	0.005
10			30.0	3.96	4	0.04	0.014	0.005
11			30.0	4	4.05	0.05	0.018	0.006
12			30.0	4.05	4.1	0.05	0.018	0.006
						Recommended Design Infiltration Rate (Including Factor of Safety of 3)		**0.006**

Sketch:

Notes:

LGC Geotechnical, Inc.

LGC Geotechnical, Inc.

November 18, 2011 Project No. 11142-01

Mr. Craig Cristina
Brookfield Homes
3090 Bristol St., Ste. 200
Costa Mesa, CA 92626

Subject: ***Geotechnical Evaluation of the Proposed Residential Development of The Village at Foothill Ranch, City of Lake Forest, California***

In accordance with your request, LGC Geotechnical, Inc. has performed a geotechnical evaluation for the proposed residential development of The Village at Foothill Ranch, City of Lake Forest, California. The purpose of our work was to evaluate the existing subsurface geotechnical conditions and review the readily available geotechnical and geologic reports and maps pertinent to the site. This report presents the results of our subsurface exploration and geotechnical analysis and provides a summary of our conclusions and preliminary recommendations relative to the proposed development of the site.

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

Respectfully,

LGC Geotechnical, Inc.

Katie Maes, CEG 2216
Project Geologist

REGISTERED GEOLOGIST
KATHERIN M. MAES
No. 2216
CERTIFIED ENGINEERING GEOLOGIST
STATE OF CALIFORNIA

Dennis Boratynec, GE 2770
Vice President

REGISTERED PROFESSIONAL ENGINEER
DENNIS BORATYNEC
No. 2770
Exp. 12/31/12
GEOTECHNICAL
STATE OF CALIFORNIA

BJE/KTM/DJB/abs

Distribution: (4) Addressee (3 wet-signed copies)

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1.0 INTRODUCTION

1.1 Purpose and Scope of Services

This report presents the results of our geotechnical evaluation for the proposed residential development of The Village at Foothill Ranch in the City of Lake Forest, California (see Figure 1 - Site Location Map). The purpose of our work was to evaluate the geotechnical conditions at the site and to provide preliminary geotechnical recommendations relative to the proposed development of the site.

Our scope of services included:

- Review of pertinent readily available geotechnical reports and geologic maps (Appendix A);
- Subsurface evaluation consisting of four hollow stem-auger borings (HS-1 through HS-4) to depths of up to approximately 50.5 feet below existing grade. A representative of LGC Geotechnical was onsite to coordinate the subsurface work, collect samples, and log the borings (Appendix B). The borings were backfilled with the excavated materials;
- Perform three in-situ field infiltration test to assess the onsite infiltration characteristics;
- Laboratory testing on relatively undisturbed and bulk samples obtained during our subsurface evaluation (Appendix C);
- Geotechnical analysis of the data reviewed/obtained; and
- Preparation of this report presenting our findings, conclusions, and preliminary recommendations with respect to the proposed site development.

1.2 Existing Site Conditions and Proposed Project

The site consists of an irregular piece of land located south of the intersection of Bake Parkway and Portola Parkway in the City of Lake Forest. The northern portion of the site is currently developed with a former car dealership while the southern portion is currently vacant land with minor vegetation and a few isolated piles of soil. Existing topography at the site is generally sheet graded to drain to the southwest corner of the area. A small descending slope with a toe-of-slope retaining wall adjacent to an existing commercial site defines the southern boundary of the site, and another descending, slightly variable slope to the adjacent Bake Parkway defines the western boundary of the site. At the northern boundary of the site, an east-west trending berm currently exists, with a gentle gradient down to Portola Parkway at the north side and a steeper gradient down to the south side that has a small retaining wall at the toe.

Existing improvements at the site will be demolished, removed, and replaced with slab-on-grade multi-family residential buildings and associated interior streets and utilities as depicted on the base map dated October 18, 2011, utilized for the Geotechnical Map, Figure 2 (Rear of Text). Additionally, along the northern and western boundaries of the site, retaining walls are proposed.

1.3 *Subsurface Evaluation*

Our subsurface evaluation consisted of the excavation of four small-diameter hollow stem auger borings. One boring (HS-1) was advanced to a depth of approximately 50.5 feet below existing ground surface, and the remaining borings (HS-2 through HS-4) were drilled to depths of approximately 16.5 feet below existing ground surface. During drilling, the borings were sampled and logged from the surface by field personnel from our firm to evaluate the geotechnical characteristics of the subsurface materials. The hollow stem borings were geotechnically logged and sampled using California Ring Samplers (Ring) at selected intervals. The Ring samplers were driven using a 140-pound hammer falling freely for 30 inches until a total penetration of 18 inches was achieved; the number of blow counts required for each 6 inches of sampler penetration was recorded. In addition, bulk samples were collected at various depths from selected borings.

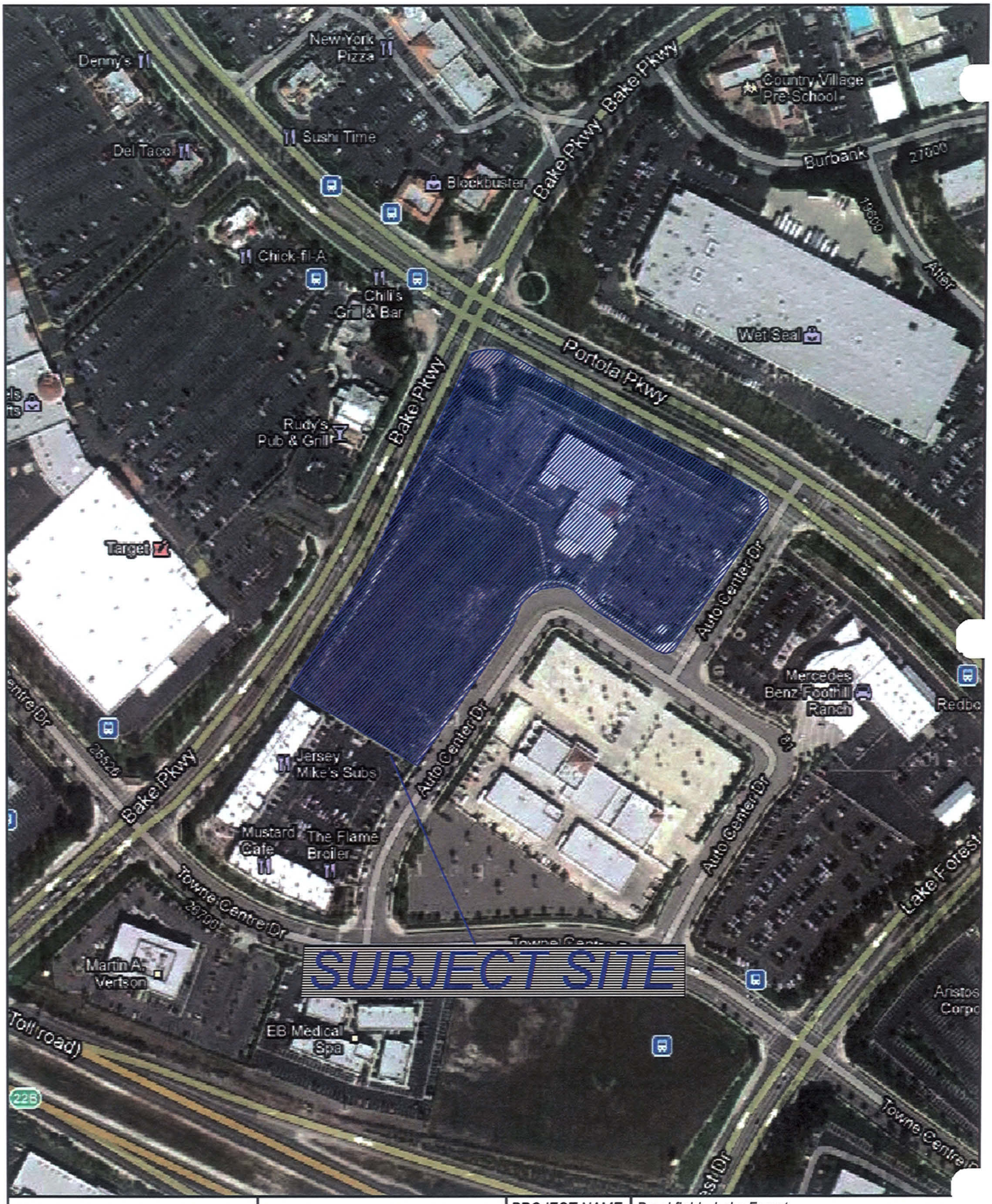
Three of the borings were utilized to assess infiltration characteristics of the onsite materials. Infiltration testing was performed in boreholes with the installation of perforated PVC pipe, backfilled with pea gravel. Upon completion of the tests, the PVC pipe was removed and the remaining voids were backfilled with cuttings.

Descriptions of the materials encountered during our subsurface exploration are further discussed in Section 2.2 of this report and are also presented in the boring logs in Appendix B. The approximate locations of the borings are indicated on our Geotechnical Map, Figure 2.

1.4 *Laboratory Testing*

Representative bulk and driven (relatively undisturbed) samples were obtained during our subsurface exploration for laboratory testing. Laboratory testing included in-situ moisture content and in-situ density, laboratory hydraulic conductivity, sieve and hydrometer, expansion potential, direct shear, and corrosion potential.

- In-situ dry density values ranged from approximately 96 pounds per cubic foot (pcf) to 127 pcf, with an average of approximately 118 pcf. Field moisture contents ranged from approximately 6 percent to 12 percent, with an average of approximately 9 percent.
- Hydraulic conductivity values were determined to range between 1.7×10^{-5} cm/sec and 3.6×10^{-7} cm/sec based on laboratory test results.
- Sieve and hydrometer testing indicated the fines content ranges between 17 to 26 percent.
- The results of an expansion potential test indicated an expansion index ranging from 8 to 24, which corresponds to the "Very Low" category (per Chapter 18 of the 2007 C.B.C.; ASTM D 4829 Section 5.3).
- Direct shear testing was performed on one sample. The results indicate peak friction angle of 39 degrees and cohesion of 1089 psf.
- Corrosion testing performed on a representative bulk sample from an approximate depth of 4 to 7 feet resulted in a pH of 7.3, chloride content of 31 ppm, a sulfate content of 55 ppm, and a minimum resistivity value of 1,350 ohm-cm.
- A summary of the results are presented in Appendix C. The moisture and density test results are presented on the boring logs in Appendix B.



PROJECT NAME	Brookfield - Lake Forest
PROJECT NO.	11142-01
ENG. / GEOL.	DJB / KTM
SCALE	Not to Scale
DATE	November 2011

LGC Geotechnical, Inc.

FIGURE 1
Site Location Map

2.0 GEOTECHNICAL CONDITIONS

2.1 Regional Geology

The site is located within the foothills of the Santa Ana Mountains, part of the Peninsular Ranges Geomorphic Province. The region consists of dissected foothills bordering the Los Angeles Basin to the northwest and the granite-core Santa Ana Mountains to the east. The Southern California Batholith forms the core of the Santa Ana Mountains, which is overlain by a thick sequence of sedimentary units, which comprise the foothills. The foothills have been tilted, folded, and faulted since deposition as a result of regional uplift. Drainage from the nearby mountains has dissected the subject area and alluvial deposits in a previously existing (prior to grading) southwest-trending finger canyon underlie the site at depth; ultimately those alluvial deposits are connected to alluvium of the Tustin Plain to the southwest of the site. Late Miocene to Early Pliocene bedrock materials that underlie a portion of the subject site are primarily composed of sandstone and silty sandstone.

2.2 Site-Specific Geology

Prior to grading of the subject site, a southwest-trending canyon with alluvial deposits existed at the western portion of the site, some of which remains in place. The flank of the canyon rising to the eastern portion of the site exposed the bedrock geologic unit mapped as the Oso Member of the Tertiary-aged Capistrano Formation. Grading activities for the nearby Bake Parkway resulted in placement of engineered fill at depth along the western portion of the site, followed by additional grading activities that resulted in engineered fill placement to the current grades at the western portion of the site. The eastern/northeastern portion of the site was left as cut bedrock at the surface, with the exception of the placement of engineered fill for overexcavation of a cut to fill transition in support of the existing car dealership structure at the northeast portion of the site (Coleman, 2005). The three phases of fill placement are undifferentiated on the Geotechnical Map (Figure 2, rear of text). Limited zones of undocumented stockpiled materials were observed in piles during the recent site work, reportedly from nearby building excavations.

Based on our review of the State of California Seismic Hazard Zones El Toro 7.5 Minute Quadrangle (CDMG, 2001), no zones of potential earthquake induced landslide or potential liquefaction are depicted within the limits of the site.

The following material types are anticipated to underlie the subject area. Approximate limits of the materials are depicted on the Geotechnical Map, Figure 2, and described in the boring logs, Appendix B, where observed during the recent subsurface evaluation.

2.2.1 Quaternary Alluvium/Colluvium (Map Symbol – Qac)

Alluvium was not encountered during our subsurface field work. However, descriptions by others indicate up to 7 feet of alluvium, consisting of clayey sand, moist, dense, was left in place below the engineered fill. The alluvium was tested for hydro collapse potential by others and was evaluated to posses approximately 0.5 inch of potential collapse if fully saturated (PSE, 2007).

2.2.2 *Artificial Fill - Older (Map Symbol – Afo)*

As described in Section 2.2, three phases of older engineered fill materials were identified on the site associated with the grading of Bake Parkway on the western side of the site, construction of the current graded superpad configuration, and construction of the car dealership structure at the northeast portion of the site (References). In general, the existing fill materials should be considered suitable to receive additional fill placement and/or for support of the proposed improvements, with the exception of the near surface materials which are anticipated to be desiccated and contain some organics.

2.2.3 *Capistrano Formation – Oso Member (Map Symbol - Tco)*

The Oso Member of the Tertiary Capistrano Formation is exposed within the western portion of the site and underlies the majority of the site at depth. As encountered, this material generally consists of medium to coarse, weakly cemented, dense to very dense silty sandstone. The material is generally light gray to off-white in color.

2.3 *Ground Water*

During our subsurface evaluation, ground water was not encountered. Seasonal fluctuations of ground water elevations should be expected over time. In general, ground water levels fluctuate with the seasons and local zones of perched ground water may be present within the near-surface deposits due to local seepage or during rainy seasons. Local perched ground water conditions or surface seepage may develop once site development is completed and landscape irrigation commences.

2.4 *Assessment of Infiltration Characteristics*

Field infiltration testing consisted of utilizing three hollow-stem auger borings (HS-2, HS-3 and HS-4) that were each drilled to the depth of approximately 16 feet below existing grade. Boring HS-2 was excavated into bedrock, Boring HS-3 was excavated into a thin layer of fill over bedrock, and Boring HS-4 was excavated into existing engineered fill materials that were previously placed by others. Three-inch-diameter perforated PVC pipe was placed in each hole and the annulus filled with pea gravel. Prior to conducting the infiltration tests, each location was presoaked overnight with water. Results of infiltration testing indicate the site to posses a relatively low infiltration rate as discussed in Section 4.6 of this report.

2.5 *Faulting*

California is located on the boundary between the Pacific and North American Lithospheric Plates. The average motion along this boundary is on the order of 50-mm/yr in a right-lateral sense. The majority of the motion is expressed at the surface along the northwest trending San Andreas Fault Zone with lesser amounts of motion accommodated by sub-parallel faults located predominantly west of the San Andreas including the Elsinore, Newport-Inglewood, Rose Canyon, and Coronado Bank Faults. Within Southern California, a large bend in the San Andreas Fault north of the San Gabriel Mountains has resulted in a transfer of a portion of the right-lateral motion between the plates into left-lateral displacement and vertical uplift. Compression south and west of the bend has resulted in folding, left-lateral reverse thrust faulting, and regional uplift creating the east-west trending Transverse Ranges and several east-west trending faults. Further south within the Los Angeles Basin, "blind thrust" faults are believed to have developed below the surface also as a result of this compression, which have resulted in earthquakes such as the 1994 Northridge event along faults with little to no surface expression.

Prompted by damaging earthquakes in Northern and Southern California, State legislation and policies concerning the classification and land-use criteria associated with faults have been developed. Their purpose was to prevent the construction of urban developments across the trace of active faults. The result is the Alquist-Priolo Earthquake Fault Zoning Act, which was most recently revised in 1997. According to the State Geologist, an active fault is defined as one, which has had surface displacement within the Holocene Epoch (roughly the last 11,000 years). A potentially active fault is defined as any fault, which has had surface displacement during Quaternary time (last 1,600,000 years), but not within the Holocene. Earthquake Fault Zones have been delineated along the traces of active faults within California. Where developments for human occupation are proposed within these zones, the state requires detailed fault evaluations be performed so that engineering geologists can mitigate the hazards associated with active faulting by identifying the location of active faults and allowing for a setback from the zone of previous ground rupture.

The subject site is not located within an Alquist-Priolo Earthquake Fault Zone and no faults were identified on the site during our site evaluation or previous site evaluations by others during grading. The possibility of damage due to ground rupture is considered low since no active faults are known to transect the site.

Secondary effects of seismic shaking resulting from large earthquakes on the major faults in the Southern California region, which may affect the site, include ground lurching and shallow ground rupture, soil liquefaction, and dynamic settlement. These secondary effects of seismic shaking are a possibility throughout the Southern California region and are dependant on the distance between the site and causative fault and the onsite geology. Seiches and tsunamis are potential hazards for sites near bodies of water and the ocean, respectively. The closest major active faults that could produce these secondary effects include the Elsinore, Whittier, Chino-Central and Newport Inglewood Fault Systems. A discussion of these secondary effects is provided in the following sections.

2.5.1 *Lurching and Shallow Ground Rupture*

Soil lurching refers to the rolling motion on the ground surface by the passage of seismic surface waves. Effects of this nature are not likely to be significant where the thickness of soft sediments does not vary appreciably under structures.

Ground rupture, due to active faulting, is not likely to occur on site due to the absence of known active fault traces. Minor cracking of near-surface soils, due to shaking from distant seismic events, is not considered a significant hazard, although it is a possibility at any site in the region.

2.5.2 Liquefaction and Dynamic Settlement

Liquefaction and liquefaction-induced dynamic settlement of soils can be caused by strong vibratory motion due to earthquakes. Liquefaction is typified by a build-up of pore-water pressure in the affected soil layer to a point where a total loss of shear strength occurs, causing the soil to behave as a liquid. Liquefaction primarily occurs in loose, saturated, granular soils while cohesive soils such as silty clays and clays are generally not considered susceptible to soil liquefaction. The effect of liquefaction may be manifested at the ground surface by rapid settlement and/or sand boils. Based on our review of the State of California Seismic Hazard Zones El Toro 7.5 Minute Quadrangle (CDMG, 2001), no zones having a potential for liquefaction have been depicted within the proposed site. Based on the proposed finish grades, depth of compacted fill, and lack of a shallow groundwater table, the potential for post construction liquefaction and liquefaction-induced settlement is considered very low.

2.5.3 Lateral Spreading

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

Due to the low potential for liquefaction, the potential for lateral spreading is also considered very low.

2.6 Seismic Design Parameters

The site seismic characteristics were evaluated per the guidelines set forth in Chapter 16, Section 1613 of the 2010 C.B.C. Site coordinates of latitude 33.6767 degrees north and longitude -117.6615 degrees west, which are representative of the site, were utilized in our analyses. The initial results of our analyses for the maximum considered earthquake spectral response accelerations (S_S and S_1) are presented in Table 1.

TABLE 1

Seismic Design Values

Selected Parameters from the 2010 C.B.C. Section 1613 - Earthquake Loads	Seismic Design Values
Site Class per Table 1613.5.2	D
Spectral Acceleration for Short Periods (S_S)*	1.397 g
Spectral Accelerations for 1-Second Periods (S_1)*	0.501 g
Site Coefficient F_a per Table 1613.5.3(1)	1.0
Site Coefficient F_v per Table 1613.5.3(2)	1.5

* Calculated from the USGS computer program "Seismic Hazard Curves, Response Parameters and Design Parameters" v5.1.0 (02/20/11)

The spectral response accelerations (S_{MS} and S_{M1}) and design spectral response acceleration parameters (S_{DS} and S_{D1}), adjusted for Site Class D, were evaluated for the site in general accordance with section 1613 of the 2010 C.B.C. These site class adjusted parameters are presented in Table 2.

TABLE 2

Seismic Design Values Modified for Site Class D

Selected Parameters from the 2010 C.B.C. Section 1613 - Earthquake Loads	Seismic Design Values Modified for Site Class D
Site Modified Spectral Acceleration for Short Periods (S_{MS}) for Site Class D [Note: $S_{MS} = F_aS_S$]	1.397 g
Site Modified Spectral Acceleration for 1-Second Periods (S_{M1}) for Site Class D [Note: $S_{M1} = F_vS_1$]	0.751 g
Design Spectral Acceleration for Short Periods (S_{DS}) for Site Class D [Note: $S_{DS} = (^2/_3)S_{MS}$]	0.931 g
Design Spectral Acceleration for 1-Second Periods (S_{D1}) for Site Class D [Note: $S_{D1} = (^2/_3)S_{M1}$]	0.501 g

In accordance with Tables 1613.5.6 (1 & 2), the seismic design category for the subject site is Category D, where $S_{DS} \geq 0.50$g and $S_{D1} \geq 0.20$g.

Section 1803.5.12 of the 2010 C.B.C. states that the PGA for a site may be defined as $S_{DS}/2.5$. The S_{DS} for the subject site has been calculated as 0.931 g. Therefore, PGA = 0.931 /2.5 = **0.37 g**

2.7 *Corrosivity to Concrete and Metal*

Based on our laboratory test results of representative site soil samples, onsite soils should be considered as having a severity categorization of "not applicable" and are designated class "S0" per ACI 318, Table 4.2.1, sulfate. As a result, the minimum compressive strength of the concrete shall be 2,500 psi.

Due to the low minimum resistivity, the onsite soils may be corrosive to buried metal. However, LGC Geotechnical is not a corrosion consultant and does not provide recommendations related to corrosion. Laboratory testing may need to be performed at the completion of grading by the project corrosion engineer to further evaluate the as-graded soil corrosivity characteristics. Accordingly, revision of the corrosion potential may be needed, should future test results differ substantially from the conditions reported herein. The client and/or other members of the development team should consider this during the design and planning phase of the project, and formulate an appropriate course of action.

3.0 CONCLUSIONS

Our geotechnical evaluation has included a review of previous geotechnical reports, limited subsurface exploration, laboratory testing, and geotechnical analyses of the data collected. Based on geotechnical data gathered/reviewed and the results of our analyses, it is our opinion that the subject site is located within a geotechnically favorable area, and that development of the subject site for residential construction is considered feasible from a geotechnical standpoint. The major geotechnical items to be considered in the design, and ultimately construction of the proposed project, are discussed in greater detail below.

- Near-surface fill materials have been exposed to the elements over the years and will need to be reworked to provide support of future site development. Additionally, structures that are planned in areas of cut-fill transitions or that are underlain by fill less than 5 feet thick with a transition to deep fill under the same structure, should be overexcavated followed by replacement with engineered compacted fill. Recommendations for near surface improvement and site preparation are presented in Section 4.1 of this report.
- Excavations into the existing site materials (engineered fill and bedrock) should be achievable with heavy construction equipment in good working order. We anticipate that the earth materials generated from the recommended earthwork will be generally suitable for re-use as compacted fill, provided they are relatively free of rocks larger than 6 inches in dimension, demolition debris, and organic material.
- Future compacted fill materials derived from site excavations are anticipated to have a very low to low expansion potential. However, future testing and analysis needs to be performed after grading has been completed.
- Future compacted fill materials derived from onsite materials are anticipated to have sulfate severity categorization of "not applicable" and are designated class "S0" with regards to potential sulfate attack on concrete. However, further testing will be needed to confirm this upon completion of grading.
- Ground water was not encountered within the upper 50.5 feet of the site during our subsurface evaluation. Laboratory test results from moisture and density testing indicate that the average degree of saturation of the subsurface materials is also relatively low.
- The subject study area is not located within a mapped Earthquake Fault-Rupture Zone and based upon our review of published geologic mapping, no known active or potentially active faults cross the site. The nearest mapped active fault, the Elsinore Fault, is located more than approximately 16 kilometers away from the site. Therefore, the potential for ground rupture as a result of faulting is considered remote.
- The subject site is not located within an area considered susceptible to liquefaction.
- Laboratory testing by others indicates that a deep, thin layer of alluvial material left in place during grading of the site, has the potential to collapse up to approximately 0.5 inch when inundated with water (PSE, 2007).
- Seismic hazards associated with a significant earthquake generated from one of the active regional faults include ground shaking. The estimated peak horizontal ground acceleration is 0.37g. **New improvements will need to be designed for seismic forces in accordance with current building codes and regulations.** However, there is still a risk that the proposed structures and associated improvements could be damaged as a result of an earthquake. Repair of the planned residential structures may be needed after a seismic event.

4.0 RECOMMENDATIONS

The following recommendations are to be considered preliminary and should be confirmed upon completion of final development plans, grading, and earthwork operations. In addition, they should be considered minimal from a geotechnical viewpoint, as there may be more restrictive requirements from the architect, structural engineer, building codes, governing agencies, or the owner. A grading plan review should also be performed by LGC Geotechnical prior to the start of earthwork activities. Additional and/or revised recommendations may be provided at the conclusion of plan review, including recommendations for additional subsurface evaluation and laboratory testing.

It should be noted that the following geotechnical recommendations are intended to provide the owner with sufficient information to develop the site in general accordance with the 2010 C.B.C. requirements. With regard to the potential occurrence of potentially catastrophic geotechnical hazards such as fault rupture, earthquake-induced landslides, liquefaction, etc., the following geotechnical recommendations should provide adequate protection for the proposed development to the extent required to reduce seismic risk to an "acceptable level". The "acceptable level" of risk is defined by the California Code of Regulations as "that level that provides reasonable protection of the public safety, though it does not necessarily ensure continued structural integrity and functionality of the project" [Section 3721(a)]. Therefore, repair and remedial work of the proposed structures may be required after a significant seismic event. With regards to the potential for less significant geologic hazards to the proposed development, the recommendations contained herein are intended as a reasonable protection against the potential damaging effects of geotechnical phenomena such as expansive soils, soil settlement, groundwater seepage, etc. It should be understood, however, that our recommendations are intended to maintain the structural integrity of the proposed development and structures given the site geotechnical conditions, but cannot preclude the potential for some cosmetic distress or nuisance issues to develop as a result of the site geotechnical conditions.

4.1 Site Earthwork

We anticipate that after demolition of existing improvements and asphalt parking lots at the northern portion of the site is complete, rough grading earthwork at the site will then generally consist of clearing and grubbing of demolition debris and organic materials, earthwork cuts and overexcavations below structures in accordance with project specifications, remedial removals for areas of fill and shallow cuts, and placement of engineered compacted fill to design grades. Precise grading earthwork will include shallow trenching for construction of slab-on-grade type foundations and utilities. Site earthwork operations should be performed in accordance with the following recommendations, in addition to those contained in the 2010 C.B.C., and the General Earthwork and Grading Specifications for Rough Grading included in Appendix D of this report. In case of conflict, the following recommendations shall supersede those included as a part of Appendix D.

4.1.1 Site Preparation

Prior to grading, the proposed construction areas should be stripped of all vegetation and any remaining construction debris; these materials should be removed and properly disposed of offsite. Holes resulting from the removal of buried obstructions should be replaced with suitable compacted fill material (refer to Section 4.1.4). Soft or yielding subgrade materials encountered within bottom excavations should also be removed to a depth that exposes firm materials. The

actual depth of removals in these areas will be determined by the geotechnical consultant in the field based on the observed conditions.

4.1.2 Remedial Measures

The subject site has been previously graded to the current existing superpad grades, and the southern portion has been left vacant for several years. The northern portion of the site has been improved with a structure, a parking lot and associated utilities and landscaping. Approximate limits of recommended remedial earthwork are presented on the Remedial Measures Map, Figure 3 (Rear of Text).

Actual limits of over-excavation below structures may vary significantly depending on the actual thickness of fill encountered during grading. Limits of the recommended 10 feet over-excavation area, shown on Figure 3, are based on limited subsurface information. Actual limits of the western boundary of the 10 feet overexcavation area shall be determined based on field observations during grading.

Removal bottom areas and over-excavated bottom areas to receive compacted fill should be scarified to a minimum depth of 6 inches, brought to a near-optimum moisture condition, and recompacted to at least 90 percent relative compaction (based on American Standard of Testing and Materials, ASTM, Test Method D1557).

Local conditions, such as deeper than anticipated weathered or unsuitable fill or excessively loose and yielding native materials, may be encountered during excavation. These conditions could require additional removals beyond the above noted minimum in order to obtain an acceptable subgrade. The actual depths and lateral extents of remedial grading will be determined by the geotechnical consultant in the field, based on subsurface conditions encountered during grading.

4.1.3 Earthwork Shrinkage and Bulking

Based upon the results of our subsurface evaluation and laboratory testing, it is our opinion that the existing fill material will shrink less than approximately 5 percent. We estimate that the surface bedrock materials will bulk on the order of 5 to 10 percent. The actual amount of shrinkage depends on many factors including type of equipment used, contractor's technique, homogeneity of onsite soils, etc.

4.1.4 *Fill Placement and Compaction*

The onsite engineered fill and bedrock are considered generally suitable for use as compacted fill provided they are screened of rocks greater than 6 inches in dimension, excessive organic materials, and demolition debris. Fill materials should be moisture conditioned or dried (as needed) to near optimum-moisture content and recompacted to at least 90 percent relative compaction (based on ASTM Test Method D1557). The optimum lift thickness to produce a uniformly compacted fill will depend on the type and size of compaction equipment used. In general, fill should be placed in uniform lifts not exceeding 8 inches in thickness. Placement and compaction of fill should be performed in accordance with local grading ordinances under the observation and testing of LGC Geotechnical.

Import soils (if required) should consist of granular soils of low expansion potential (expansion index 50 or less based on ASTM D4829 Section 5.3 Classification), and should be free of organic debris and hard materials over 6 inches in dimension. Prior to import, LGC should be provided with the location of the import source for geotechnical evaluation.

Aggregate base or crushed miscellaneous base material should be placed at a minimum relative compaction of 95 percent based on ASTM Test Method D1557 and conform to the specifications of the current edition of the Standard Specifications for Public Works Construction ("Greenbook").

4.1.5 *Trench Backfill and Compaction*

Utility trench backfills should be compacted to a minimum relative compaction of 90 percent. Trench backfill materials should be placed in loose lifts no greater than approximately 8 inches in thickness, moisture-conditioned to optimum-moisture content or greater, and compacted with conventional compaction equipment. If trenches are shallow and conventional equipment may result in damage to the utilities, clean sand, having sand equivalent (SE) of 30 or greater, may be imported to bed and shade the utilities. Sand backfill should be densified. Densification by jetting or flooding may be considered, but tamping of the sand with relatively light, hand-operated equipment should be employed to ensure adequate compaction. A representative from LGC Geotechnical should observe, probe, and test the bedding sand and compacted backfill to verify compliance with the project specifications.

4.2 *Preliminary Foundation Recommendations*

Given that the expansion index exceeds 20, the foundation system shall be designed for effects of expansive soil. The foundation designer/client may elect to design the foundation in accordance with either the WRI or post-tensioned methodology. Due to potential for hydro-consolidation, either foundation system should be designed to accommodate an anticipated differential settlement of approximately ½ inch in 40 feet.

4.2.1 *Conventional Foundation Recommendations (WRI Methodology)*

Shallow foundation slabs may be designed in accordance with the Wire Reinforcement Institute, Inc. method (WRI/CRSI-81 Design of Slab-on-ground Foundations - with 1996 Update) using an effective plasticity index value of 15 for the subgrade soils. From a geotechnical perspective, we recommend a minimum slab thickness of 4 inches.

4.2.2 *Post-Tensioned Foundation Recommendations*

A post-tensioned slab should be designed by the foundation designer using the parameters in Table 3. The geotechnical parameters presented in Table 3 were determined in general accordance with the 2010 California Building Code (C.B.C.)

TABLE 3

Post-Tensioned Foundation Design Parameters

Parameter	PT Slab with Perimeter Footing
Thornthwaite Moisture Index	-20
Depth to Constant Soil Suction (depth to constant moisture content over time, but within C.B.C. limits)	7 feet
Constant Soil Suction	PF 3.6
Moisture Velocity	0.7 in/month
Center Lift Edge moisture variation distance, e_m Center lift, y_m	 9.0 feet 0.50 inches
Edge Lift Edge moisture variation distance, e_m Edge lift, y_m	 5.5 feet 0.75 inch
Minimum Perimeter footing embedment below finish grade	12 inches
Minimum slab thickness	5 inches[1]

4.3 *Bearing Pressure*

A soil bearing pressure of 2,000 psf may be used for a minimum of 12-inch-wide continuous footings extending a minimum of 12 inches below adjacent pad grade. Resistance to lateral loads can be provided by friction acting at the base of foundations and by passive earth pressure. A coefficient of friction of 0.35 may be assumed with dead-load forces. An ultimate passive lateral earth pressure of 300 psf per foot of depth to a maximum of 3,000 psf may be used for the sides of footings poured against properly compacted fill. This passive pressure is applicable for level (ground slope equal to or flatter than 5H:1V) conditions only.

Bearing values indicated above are for total dead loads and frequently applied live loads. The above vertical bearing may be increased by ⅓ for short durations of loading which will include the effect of wind or seismic forces. The passive pressure may be increased by ⅓ due to wind or seismic forces. These lateral and frictional resistance values represent ultimate values, so appropriate safety factors should be applied by the structural designer during design.

4.4 Slab Underlayment

Slab underlayment (for the purpose of reducing moisture transmission through the slab) should, at a minimum, comprise of a 10-mil polyolefin (or approved equivalent) moisture/vapor retarder. The vapor retarder should meet or exceed the permeance, puncture resistance and tensile strength requirements of an ASTM E 1745 Class A material, and be properly installed in accordance with ACI publication 302. The use of a sand or gravel layer above and/or below the vapor retarder is the purview of the foundation engineer.

4.5 Non-structural Concrete Flatwork

Concrete flatwork (such as walkways, patio slabs, etc.) has a potential for cracking due to changes in soil volume related to soil-moisture fluctuations. To reduce the potential for excessive cracking and lifting, concrete should be designed in accordance with the guidelines outlined in Table 4. These guidelines will help reduce the potential for irregular cracking and promote cracking along construction joints, but will not eliminate all cracking or lifting. Thickening the concrete and/or adding additional reinforcement will further reduce cosmetic distress.

TABLE 4

Preliminary Geotechnical Parameters for Non-structural Concrete Flatwork

	Homeowner Sidewalks	Private Drives	Patios/Entryways	City Sidewalk Curb and Gutters
Minimum Thickness (in.)	4 (nominal)	4 (full)	4 (full)	City/Agency Standard
Presoaking	Wet down prior to placing	Wet down prior to placing	Wet down prior to placing	City/Agency Standard
Reinforcement	—	No. 3 at 36 inches on-centers	No. 3 at 36 inches on-centers	City/Agency Standard
Thickened Edge	—	8 inches wide x 8 inches total thickness	—	City/Agency Standard
Crack Control Joints	Saw cut or tool joint minimum 0.75 inches	Saw cut or tool joint minimum 0.75 inches	Saw cut or tool joint minimum 0.75 inches	City/Agency Standard
Maximum Joint Spacing	10 feet	10 feet or quarter cut whichever is closer	6 feet	City/Agency Standard
Aggregate Base Thickness (in.)	—	—	—	City/Agency Standard

To reduce the potential for sidewalks to separate from the building slab, the owner may elect to install dowels to tie these two elements together.

4.6 Pavement Recommendations

We recommend that the pavement sections within the subject area be designed in accordance with the City of Lake Forest's Standards. Based on the City of Lake Forest's Street Section Standard (163), a pavement section consisting of 4 inches of asphalt over 4 inches of crushed aggregate base for a local road is considered geotechnically adequate. This design shall be confirmed after grading, and should be confirmed with final traffic indices provided by the civil engineer and the City of Lake Forest.

4.7 Excavation Stability and Shoring Requirements

During earthwork operations and site construction, temporary excavations should be made in accordance with the requirements of Cal/OSHA Construction Safety Orders. It is the contractor's responsibility to ensure that these requirements are met. In general, vertical excavations up to approximately 3 feet in height may be considered temporarily stable. Given the sandy nature of the site soils, excavations deeper than 3 feet may need to be either laid back at a 1.5:1 (horizontal to vertical)

gradient or may require the use of shoring. Special consideration may be necessary when working adjacent to sensitive improvements.

4.8 Storm Water Mitigation System

It is our understanding that a portion of the onsite storm water may be infiltrated into the subsurface soils. It should be noted that intentionally collecting and concentrating surface water for the purpose of subsurface infiltration has conflicting objectives with the fundamentals of geotechnical engineering as it relates to satisfactory performance of slopes, foundations, and other improvements. In general we recommend that surface water be collected and transported off of the site in a storm drain system and not infiltrated into the subsurface soils. However, we have conducted a field infiltration evaluation because we understand the local agency is requiring infiltration of storm water.

Given the results of our infiltration testing, and that the majority of the site near-surface materials consist of a combination of well sorted sands and fine grained materials, the recommended design infiltration rate is 0.25 inches per hour. Due to the relatively low infiltration rate, any infiltration system proposed for the site should have an overflow system that connects to the local storm drain system. This rate shall be confirmed once the type of the infiltration system has been determined and the corresponding head of water is known.

The design infiltration rate assumes that the storm water system which is entering the system is clear and does not contain suspended soil particles. The presence of suspended solids may clog the pores within the soil and thereby reduce the infiltration rate.

Please note, as a result of directing large quantities of water into the underlying soils, there is the potential for soil settlement (hydro collapse) to occur and/or to have nuisance related water issues, etc. It is our opinion that if soil settlement occurs, the majority of it will occur within 10 to 20 feet from the edge of the infiltration system. Therefore, we recommend that settlement sensitive improvements not be constructed within this zone. As for nuisance water related issues, due to variability in geologic and hydraulic conductivity characteristics, these effects may be experienced at the onsite locations and/or potentially at other locations beyond the physical limits of the subject site.

4.9 Control of Surface Water and Drainage Control

Positive drainage of surface water away from structures is very important. Water should not be allowed to pond adjacent to buildings or to flow freely down a graded slope. Positive drainage may be accomplished by providing drainage away from buildings. Where necessary, drainage paths may be shortened by use of area drains and collector pipes. Eave gutters are recommended and should reduce water infiltration into the subgrade soils if the downspouts are properly connected to appropriate outlets.

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

4.10 Construction Observation, Testing, & Geotechnical Plan Review

The recommendations provided in this report are based on limited subsurface observations and geotechnical analysis. The interpolated subsurface conditions should be checked in the field during grading operations by a representative of LGC Geotechnical.

Construction observation and testing should also be performed by LGC Geotechnical during future earthwork grading at the site. Grading plans and final project drawings should be reviewed by this office prior to the start of construction.

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

- During rough grading, precise grading, and pad recertification process (where applicable);
- After building footing and retaining wall footing excavation and prior to placing concrete and/or reinforcing;
- During installation of retaining wall drainage and placing backfill;
- After moisture conditioning of building pads and other concrete-flatwork subgrades, but prior to the placement of concrete;
- During preparation of subgrade and placing of aggregate base; and
- When any unusual soil conditions are encountered during any construction operation subsequent to issuance of this report.

5.0 LIMITATIONS

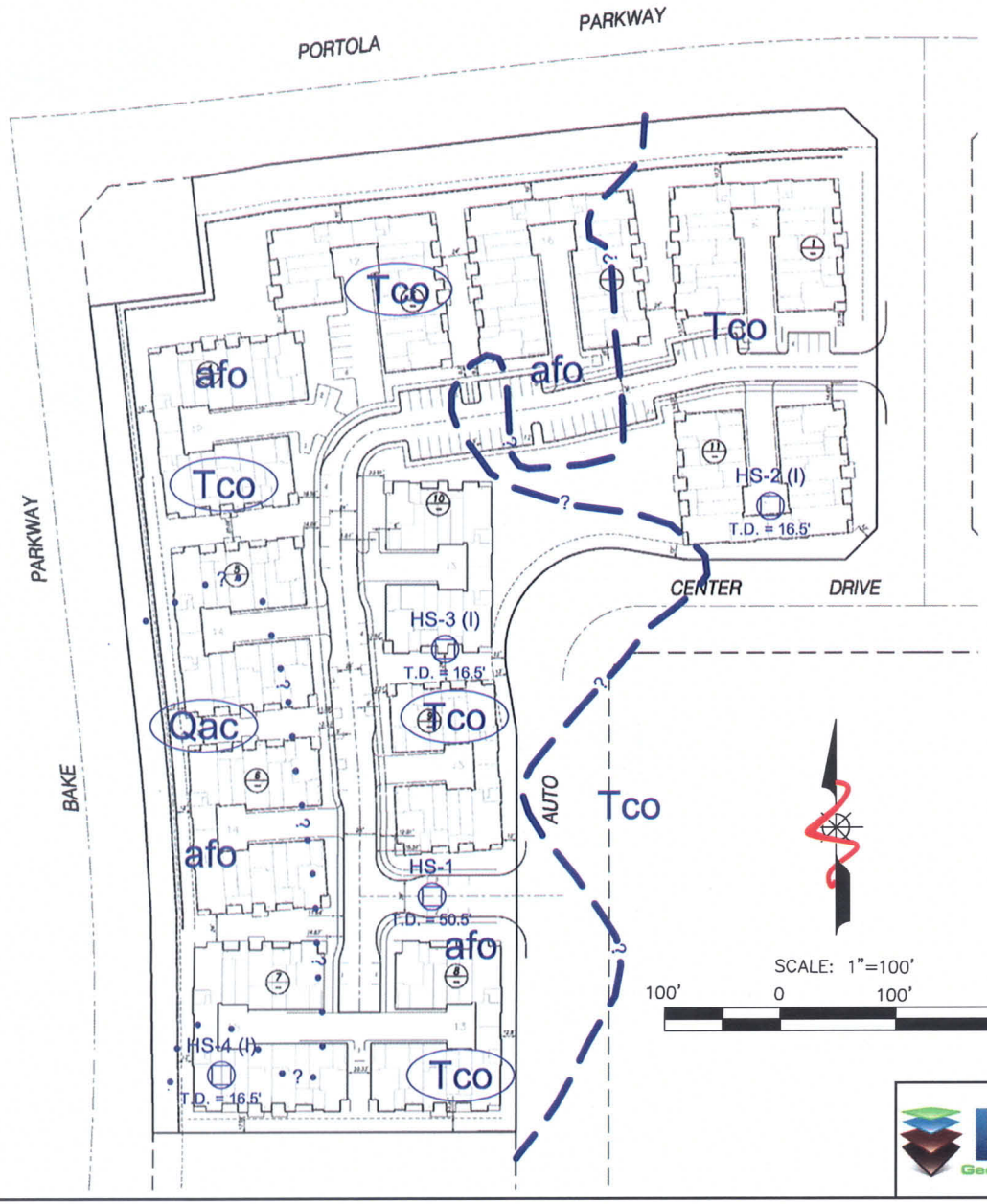
Our services were performed using the degree of care and skill ordinarily exercised, under similar circumstances, by reputable soils engineers and geologists practicing in this or similar localities. No other warranty, expressed or implied, is made as to the conclusions and professional advice included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

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

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

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

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



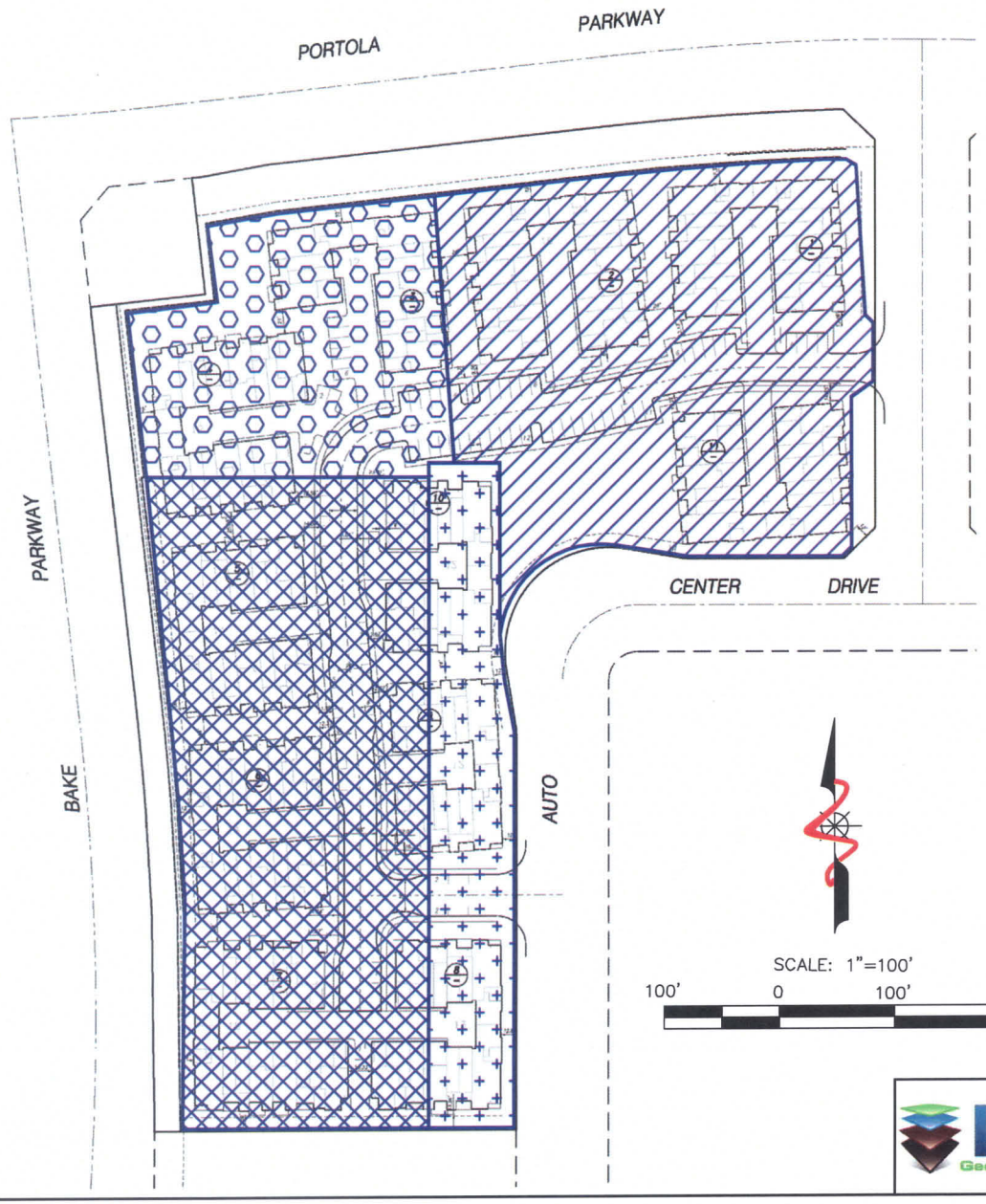
LEGEND:

afo	Older artificial fill by others (undifferentiated)
Qac	Quaternary alluvium/colluvium, circled where buried
Tco	Tertiary Capistrano formation, Oso member, circled where buried
—?—	Approximate location of geologic contact, queried where uncertain
· · ·?· ·	Approximate location of buried geologic contact, queried where uncertain
HS-4 (I) T.D. = 16.5'	Approximate location of hollow-stem auger boring with total depth in feet. "(I)" indicates infiltration test location

LGC Geotechnical, Inc.

FIGURE 2
Geotechnical Map

PROJECT NAME	Brookfield - Lake Forest
PROJECT NO.	11142-01
ENG. / GEOL.	DJB / KTM
SCALE	1" = 100'
DATE	November 2011



LEGEND OF RECOMMENDED REMEDIAL EARTHWORK:

- Five (5) foot overexcavation below **finished pad grade**
- Ten (10) foot overexcavation below **finished pad grade** (Note - western boundary is approximate)
- Two (2) foot removal below **existing grade**
- Three (3) foot removal below **existing grade**

LGC Geotechnical, Inc.

FIGURE 3
Remedial Measures Map

PROJECT NAME	Brookfield - Lake Forest
PROJECT NO.	11142-01
ENG. / GEOL.	DJB / KTM
SCALE	1" = 100'
DATE	November 2011

Appendix A
References

APPENDIX A

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Appendix B
Boring Logs

Geotechnical Boring Log Borehole HS-1

Date: 9/22/2011 | **Drilling Company:** Martini Drilling

Project Name: Brookfield - Lake Forest | **Type of Rig:** HSA

Project Number: 11142-01 | **Drop:** 30" | **Hole Diameter:** 8"

Elevation of Top of Hole: ~788' MSL | **Drive Weight:** 140 pounds

Hole Location: See Geotechnical Map

Logged By KTM
Sampled By KTM
Checked By BJE

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
755	0							Grass covered topsoil; Gravelly SAND: dark brown, dry, very dense **Older Artificial Fill: Afo**	
750	5	B-1	R-1	10 23 30	115.9	8.8	SM-SP	Silty SAND to SAND with Silt and trace Clay: mottled light gray and brown with black biotite grains, moist, dense to very dense, very fine to medium subangular grains	EI
745	10		R-2	10 17 21	120.1	11.9	SP	SAND with Silt and trace Clay: light gray with dark specks, moist, dense to very dense, subangular grains	#20
740	15		R-3	13 30 50/5"	127.5	8.9	SP	SAND with Silt: light gray with dark specks, moist, very dense, coarse grains	DS
735	20		R-4	8 17 31	120.5	10.9	SW	SAND with some Silt: mottled light gray and light brown, moist, very dense, fine to coarse subangular grains, few fine gravels	
730	25	B-2	R-5	8 19 30	120.2	9.4	SC-SM	Interbedded Sandy CLAY to Clayey SAND and Silty SAND: gray and brown, moist, dense to very dense	
	30								

LGC Geotechnical, Inc.

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

SAMPLE TYPES:

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

TEST TYPES:

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

Last Edited: 10/6/2011

Geotechnical Boring Log Borehole HS-1

Date: 9/22/2011 | **Drilling Company:** Martini Drilling

Project Name: Brookfield - Lake Forest | **Type of Rig:** HSA

Project Number: 11142-01 | **Drop:** 30" | **Hole Diameter:** 8"

Elevation of Top of Hole: ~788' MSL | **Drive Weight:** 140 pounds

Hole Location: See Geotechnical Map

Logged By KTM
Sampled By KTM
Checked By BJE

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
725	30		R-6	10 18 33	119.5	7.2	SM	Silty SAND: light gray brown, moist, dense to very dense, fine to coarse grains	#200
720	35		R-7	10 20 32	120.8	7.2	SM	Silty SAND: light gray brown, moist, dense to very dense, fine to medium grains with few coarse	
715	40		R-8	31 50/3"	107.9	5.9	SM	Silty SAND: light gray/white with faint greenish oxidation, moist, very dense, well indurated near shoe, possibly bedrock **Tertiary Capistrano Formation, Oso Member (Tso)**	
710	45		R-9	50/6"	96.8	5.9	[SM]	Silty SANDSTONE: light gray/white with faint greenish oxidation, moist, very dense, lacks cementation	
705	50		R-10	50/5"	107.3	6.5	[SM]	same as above	
								Total Depth = 50.5' Groundwater Not Encountered Backfilled with Cuttings on 9/22/2011	
700	55								
	60								

LGC Geotechnical, Inc.

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

SAMPLE TYPES:

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

TEST TYPES:

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

Geotechnical Boring Log Borehole HS-2

Date: 9/22/2011 | **Drilling Company:** Martini Drilling

Project Name: Brookfield - Lake Forest | **Type of Rig:** HSA

Project Number: 11142-01 | **Drop:** 30" | **Hole Diameter:** 8"

Elevation of Top of Hole: ~791' MSL | **Drive Weight:** 140 pounds

Hole Location: See Geotechnical Map

Logged By KTM
Sampled By KTM
Checked By BJE

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
755	0	B-1						3" Asphalt over 4" base **Tertiary Capistrano Formation, Oso Member (Tso)**	
750	5		R-1	6 15 20	121.3	7.9	[SM]	Silty SANDSTONE with trace Clay: mottled light gray and brown, moist, dense, very fine to coarse subangular grains	
745	10		R-2	30 50/3"	122.7	7.7	[SM]	Silty SANDSTONE with trace Clay: light gray, moist, very dense, fine to coarse subangular grains, well indurated, lacks cementation	#2(
740	15		R-3	19 50/4"	111.3	7.8	[SM]	same as above	S&H, Perm
735	20							Total Depth = 16' Groundwater Not Encountered Backfilled with 2" Diameter Slotted PVC Pipe and Pea Gravel on 9/22/2011; Pipe Pulled and Cuttings Placed in Void on 9/23/11	
730	25								
	30								

LGC Geotechnical, Inc.

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

SAMPLE TYPES:

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

TEST TYPES:

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

Last Edited: 10/6/2011

Geotechnical Boring Log Borehole HS-3

Date: 9/22/2011 | **Drilling Company:** Martini Drilling

Project Name: Brookfield - Lake Forest | **Type of Rig:** HSA

Project Number: 11142-01 | **Drop:** 30" | **Hole Diameter:** 8"

Elevation of Top of Hole: ~787' MSL | **Drive Weight:** 140 pounds

Hole Location: See Geotechnical Map

Logged By KTM
Sampled By KTM
Checked By BJE

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
755	0							Grass covered topsoil; dark brown, dry, dense **Older Artificial Fill (Afo)**	
750	5		R-1	10 22 26	124.2	7.6	[SM]	**Tertary Capistrano Formation, Oso Member (Tso)** Silty SANDSTONE: light gray and brown, moist, dense, very fine to coarse subangular grains, well indurated, lacks cementation	
745	10		R-2	12 21 34	123.3	8.4	[SM]	same as above	
740	15		R-3	12 18 31	125.3	7.5	[SM]	same as above	S&H, Perm
735	20							Total Depth = 16' Groundwater Not Encountered Backfilled with 2" Diameter Slotted PVC Pipe and Pea Gravel on 9/22/2011; Pipe Pulled and Cuttings Placed in Void on 9/23/11	
730	25								
	30								

LGC Geotechnical, Inc.

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

SAMPLE TYPES:

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

TEST TYPES:

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

Last Edited: 10/6/2011

Geotechnical Boring Log Borehole HS-4

Date: 9/22/2011 | **Drilling Company:** Martini Drilling

Project Name: Brookfield - Lake Forest | **Type of Rig:** HSA

Project Number: 11142-01 | **Drop:** 30" | **Hole Diameter:** 8"

Elevation of Top of Hole: ~786' MSL | **Drive Weight:** 140 pounds

Hole Location: See Geotechnical Map

Logged By KTM
Sampled By KTM
Checked By BJE

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
755	0							Grass covered topsoil; dark brown, dry, dense **Older Artificial Fill (Afo)**	
	5	B-1	R-1	10 15 16	119.2	9.8	SC-CL	Clayey SAND - Sandy CLAY: brown, moist, dense, sand is very fine to medium with few coarse grains	EI CR
750									
	10		R-2	7 12 18	119.2	12.1	SC	Clayey SAND: brown, moist, dense, sand is very fine to medium with few coarse grains	
745									
	15		R-3	8 14 28	120.5	12.1	SC	Clayey SAND: brown, moist, dense, sand is fine to coarse	#200
740									
	20							Total Depth = 16' Groundwater Not Encountered Backfilled with 2" Diameter Slotted PVC Pipe and Pea Gravel on 9/22/2011; Pipe Pulled and Cuttings Placed in Void on 9/23/11	
735									
	25								
730									
	30								

LGC Geotechnical, Inc.

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

SAMPLE TYPES:

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

TEST TYPES:

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

Last Edited: 10/6/2011

Appendix C
Laboratory Test Results

Location	Sample No.	Depth (ft)	Molding Moisture Content (%)	Initial Dry Density (pcf)	Final Moisture Content (%)	Expansion Index	Expansion Classification[1]
LGC-1	B-1	5'-8'	7.6	110.5	14.5	8	Very Low

[1] Per ASTM D4829-08a

LGC Geotechnical, Inc.

EXPANSION INDEX
(ASTM D 4829)

Project Number: 11142-01
Date: Nov-11

Brookfield Lake Forest

Location	Sample No.	Depth (ft)	Percent Passing No. 200 Sieve
LGC-1	R-2	10	19
LGC-1	R-6	30	19
LGC-2	R-2	10	17
LGC-4	R-3	15	26

LGC Geotechnical, Inc.	**PERCENT PASSING THE No. 200 SIEVE**	**Project Number:**	11142-01
		Date:	Nov-11
		Brookfield Lake Forest	

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM D 422

Project Name: Lake Forest
Project No. : 11142-01
Exploration No.: LGC-2
Sample No.: R-3
Soil Identification: White clayey sand (SC)

Tested By : A. Santos
Data Input By: J. Ward
Depth (feet) : 15.0

Date: 10/18/11
Date: 10/27/11

% Gravel	0
% Sand	79
% Fines	21

Soil Type: SC

			Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
Specific Gravity (Assumed)	2.70	Wt.of Air-Dry Soil + Cont.(g)	0.00	0.00	
Correction for Specific Gravity	0.99	Dry Wt. of Soil + Cont. (g)	0.00	0.00	154.64
Wt.of Air-Dry Soil + Cont. (g)	512.10	Wt. of Container No.___ (g)	1.00	1.00	76.37
Wt. of Container	109.15	Moisture Content (%)	0.00	0.00	
Dry Wt. of Soil (g)	402.95	Wt. of Dry Soil (g)			78.27

Coarse Sieve

U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"	0.00	100.0
1½"	0.00	100.0
3/4"	0.00	100.0
3/8"	0.00	100.0
No. 4	0.00	100.0
No. 10	27.59	93.2
Pan		

Sieve after Hydrometer & Wet Sieve

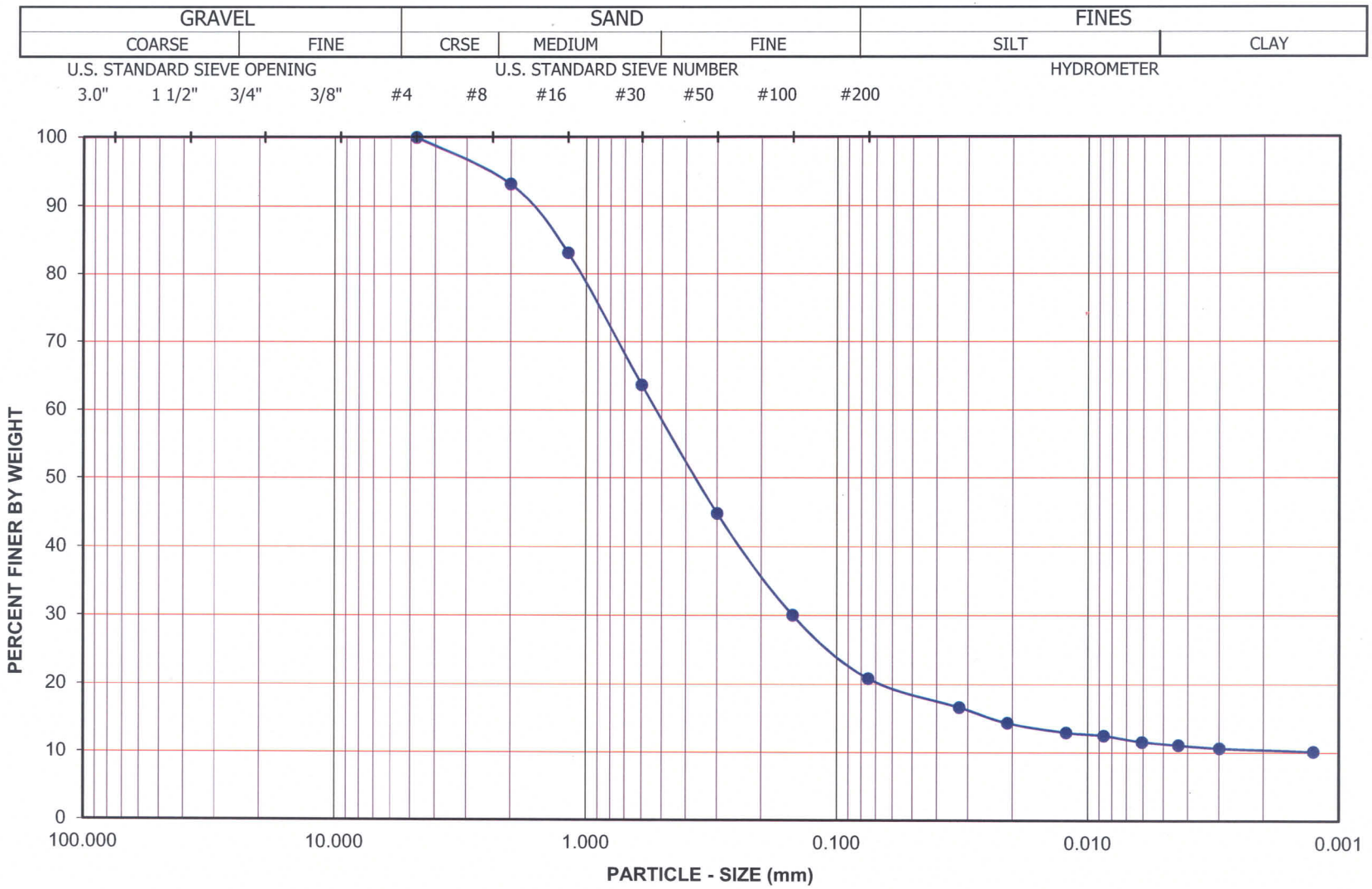
U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	93.2
No. 16	10.82	89.2	83.1
No. 30	31.69	68.3	63.7
No. 50	51.95	48.1	44.8
No. 100	67.86	32.2	30.0
No. 200	77.72	22.4	20.8
Pan			

Hydrometer

Wt. of Air-Dry Soil (g): 100.10
Wt. of Dry Soil (g): 100.10

Deflocculant 125 cc of 4% Solution

Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
19-Oct-11	9:29	0		6.5			
	9:31	2	22.7	6.5	24.5	16.6	0.0325
	9:34	5	22.7	6.5	22.0	14.3	0.0209
	9:44	15	22.8	6.5	20.5	12.9	0.0122
	9:59	30	22.9	6.5	20.0	12.5	0.0086
	10:29	60	23.1	6.5	19.0	11.5	0.0061
	11:29	120	22.9	6.5	18.5	11.1	0.0044
	13:39	250	23.2	6.5	18.0	10.6	0.0030
20-Oct-11	9:29	1440	22.6	6.5	17.5	10.2	0.0013



Project Name: Lake Forest

Project No.: 11142-01

PARTICLE - SIZE DISTRIBUTION ASTM D 422

Exploration No.: LGC-2 Sample No.: R-3

Depth (feet) : 15.0 Soil Type : SC

Soil Identification: White clayey sand (SC)

GR:SA:FI : (%) 0 : 79 : 21

Oct-11

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM D 422

Project Name: Lake Forest | Tested By : A. Santos | Date: 10/18/11

Project No. : 11142-01 | Data Input By: J. Ward | Date: 10/27/11

Exploration No.: LGC-3

Sample No.: R-3 | Depth (feet) : 15.0

Soil Identification: Very light gray clayey sand (SC)

% Gravel	**0**	**Soil Type**
% Sand	**79**	**SC**
% Fines	**21**	

			Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
Specific Gravity (Assumed)	2.70	Wt.of Air-Dry Soil + Cont.(g)	0.00	0.00	
Correction for Specific Gravity	0.99	Dry Wt. of Soil + Cont. (g)	0.00	0.00	153.78
Wt.of Air-Dry Soil + Cont. (g)	554.80	Wt. of Container No.___ (g)	1.00	1.00	75.17
Wt. of Container	108.50	Moisture Content (%)	0.00	0.00	
Dry Wt. of Soil (g)	446.30	Wt. of Dry Soil (g)			78.61

Coarse Sieve

U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"	0.00	100.0
1½"	0.00	100.0
3/4"	0.00	100.0
3/8"	0.00	100.0
No. 4	0.45	99.9
No. 10	26.05	94.2
Pan		

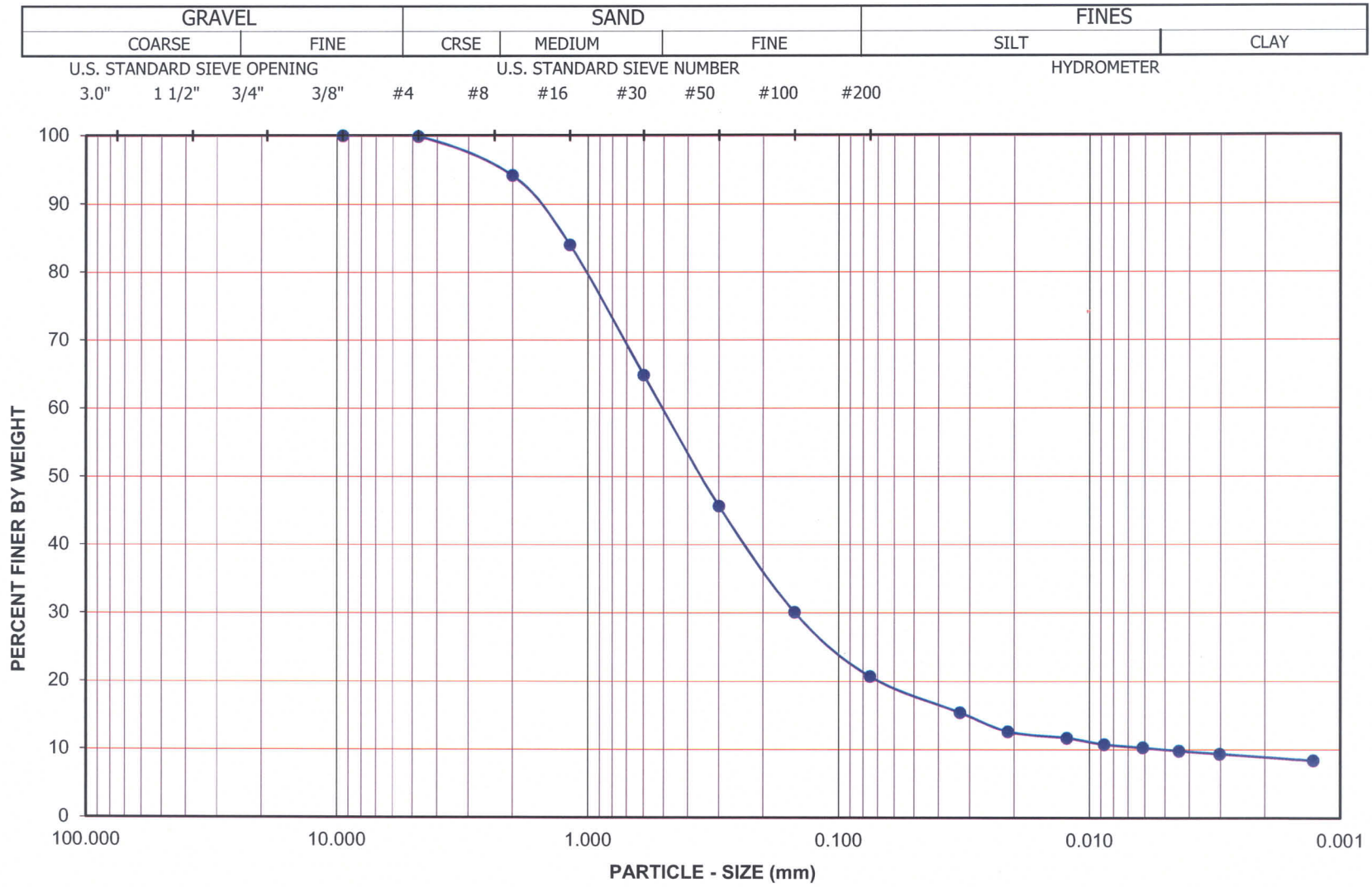
Sieve after Hydrometer & Wet Sieve

U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	94.2
No. 16	10.81	89.2	84.0
No. 30	31.18	68.9	64.9
No. 50	51.59	48.5	45.7
No. 100	68.20	31.9	30.1
No. 200	78.17	22.0	20.7
Pan			

Hydrometer Wt. of Air-Dry Soil (g) 100.20 Wt. of Dry Soil (g) 100.20

Deflocculant 125 cc of 4% Solution

Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
19-Oct-11	9:25	0		6.5			
	9:27	2	22.7	6.5	23.0	15.4	0.0328
	9:30	5	22.7	6.5	20.0	12.6	0.0212
	9:40	15	22.8	6.5	19.0	11.7	0.0123
	9:55	30	22.9	6.5	18.0	10.7	0.0087
	10:25	60	23.1	6.5	17.5	10.3	0.0061
	11:25	120	22.9	6.5	17.0	9.8	0.0044
	13:35	250	23.2	6.5	16.5	9.3	0.0030
20-Oct-11	9:25	1440	22.6	6.5	15.5	8.4	0.0013



Project Name: Lake Forest

Project No.: 11142-01

PARTICLE - SIZE DISTRIBUTION ASTM D 422

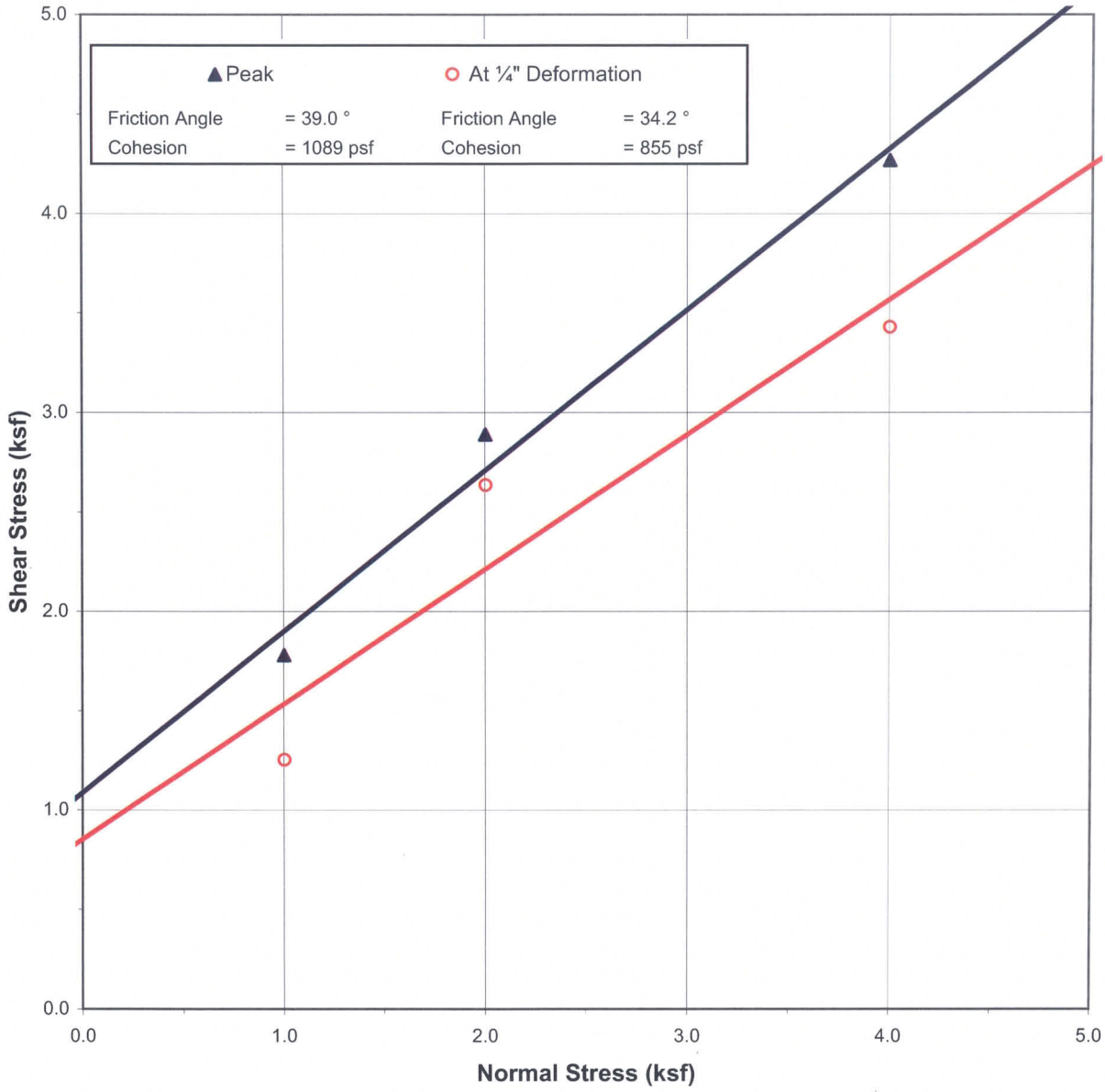
Exploration No.: LGC-3 Sample No.: R-3

Depth (feet) : 15.0 Soil Type : SC

Soil Identification: Very light gray clayey sand (SC)

GR:SA:FI : (%) 0 : 79 : 21

Oct-11



Location:	Sample No.:	Depth (ft)	Sample Type	Shear Rate (inch/min)	Dry Density (pcf)	Initial Moisture Content (%)	Final Moisture Content (%)
LGC-1	**R-3**	**15**		**0.004**	**127.5**	**8.9**	**15.3**

Sample Description: Silty Sand

LGC Geotechnical, Inc.

DIRECT SHEAR PLOT

Project Number: 11142-01
Date: Nov-11

Brookfield Lake Forest

SATURATED HYDRAULIC CONDUCTIVITY

FALLING HEAD METHOD

ASTM D 5084

Project Name:	Lake Forest	Tested by:	A. Santos	Date:	10/17/11
Project No.:	11142-01	Input By:	J. Ward	Date:	10/27/11
Boring No.:	LGC-2	Sample Type:		Drive	
Sample No.:	R-3	Depth (ft.)	15.0		
Soil Identification:	White clayey sand (SC)				

		INITIAL CONDITION	FINAL CONDITION
Diameter (in)	1	2.424	2.416
	2	2.425	2.415
	3	2.423	2.410
	Average	2.424	2.414
Height (in)	1	2.998	2.984
	2	3.001	2.994
	3	2.997	2.990
	Average	2.999	2.989
Moisture Content (%)		7.82	16.15
Wt. Wet Sample + Container (g)		543.60	545.30
Wt. Dry Sample + Container (g)		512.10	479.80
Wt. Container (g)		109.15	74.26
Density and Saturation			
Wt. Wet Sample + Container (g)		544.60	Calculated from initial dry weight and final moisture
Wt. Container (g)		102.70	
Wet Density (pcf)		121.6	132.6
Dry Density (pcf)		112.8	114.2
Void Ratio		0.494	0.476
Total Porosity		0.331	0.323
Pore Volume (cc)		75.0	72.3
% Saturation		42.7	91.5

Specific Gravity, Gs (assumed) = 2.70

Back Pressure Saturation

B Value (%) = 97

Consolidation

Cell Pressure (psi) =	113.65	Burette Area (sq. in.)=	0.380
Back Pressure(psi) =	101.30	Initial Burette Ht.(cm)=	15.6
Effective Pressure (psi) =	12.35	Final Burette Ht.(cm)=	16.8

SATURATED HYDRAULIC CONDUCTIVITY

FALLING HEAD METHOD (ASTM D 5084)

Project Name:	Lake Forest	Cell Pressure:	113.65	psi	Initial Sample Height:	2.9987	in
Project No:	11142-01	Bottom Pressure (Pb):	102.90	psi	Initial Area of Sample:	4.6148	in.²
Boring No.:	LGC-2	Top Pressure (Pt):	101.30	psi	Final Sample Ht.* (L):	2.9857	in
Sample No. :	R-3	Consolidation Pressure:	12.35	psi	Final Sample Area* (A):	4.5747	in.²
Depth(ft):	15.0	Burette Area (influent) (Ai):	0.390	in.²			
Sample Type:	Drive	Burette Area (effluent) (Ao):	0.380	in.²			
Soil Identification:	White clayey sand (SC)	Vol. Change During Consol.:	0.180	in.³			

* After Consolidation

Date	Time (min.)	Incremental Elapsed Time (t) (min)	Temperature (°C)	Water Height Influent Burette (hi) (cm)	Water Height Effluent Burette (ho) (cm)	Uncorrected Hydraulic Conductivity (cm/sec)	Corrected Conductivity at 20 °C (cm/sec)	Inflow Rate / Outflow Rate
20-Oct-11	09:04:00	0		27.9	2.9	Initial Reading		
20-Oct-11	09:14:00	10	22.7	25.1	5.9	2.3E-05	2.2E-05	0.96
20-Oct-11	09:24:00	10	22.8	22.7	8.4	2.0E-05	1.9E-05	0.99
20-Oct-11	09:34:00	10	22.8	20.4	10.7	2.0E-05	1.8E-05	1.03
20-Oct-11	09:44:00	10	22.8	18.3	12.8	1.9E-05	1.7E-05	1.03
20-Oct-11	09:54:00	10	22.8	16.5	14.6	1.6E-05	1.5E-05	1.03
20-Oct-11	10:04:00	10	22.8	14.8	16.3	1.6E-05	1.5E-05	1.03

RESULTS	
Hydraulic Conductivity (cm/sec)	
Average of Last 4 Readings	**1.7E-05**
Upper Limit	2.1E-05
Lower Limit	1.2E-05
Remarks	

k=Ai.Ao.L.ln(h1/h2)/(A.t.(Ai+Ao)) where h1, h2= ((Pb-Pt)/Y+(hi-ho) at t0-(change in hi + change in ho) at t1 and t2

SATURATED HYDRAULIC CONDUCTIVITY

FALLING HEAD METHOD

ASTM D 5084

Project Name:	Lake Forest		Tested by:	A. Santos	Date: 10/17/11
Project No.:	11142-01		Input By:	J. Ward	Date: 10/27/11
Boring No.:	LGC-3		Sample Type:		Drive
Sample No.:	R-3		Depth (ft.)	15.0	
Soil Identification:	Very light gray clayey sand (SC)				

		INITIAL CONDITION	FINAL CONDITION
Diameter (in)	1	2.423	2.423
	2	2.422	2.424
	3	2.425	2.424
	Average	2.423	2.424
Height (in)	1	3.015	3.016
	2	3.016	3.019
	3	3.014	3.018
	Average	3.015	3.018
Moisture Content (%)		7.51	12.49
Wt. Wet Sample + Container (g)		588.30	579.70
Wt. Dry Sample + Container (g)		554.80	523.80
Wt. Container (g)		108.60	76.20
Density and Saturation			
Wt. Wet Sample + Container (g)		594.90	Calculated from initial dry weight and final moisture
Wt. Container (g)		102.70	
Wet Density (pcf)		134.8	140.9
Dry Density (pcf)		125.4	125.3
Void Ratio		0.344	0.346
Total Porosity		0.256	0.257
Pore Volume (cc)		58.3	58.6
% Saturation		58.9	97.6

Specific Gravity, Gs (assumed) = 2.70

Back Pressure Saturation

B Value (%) = 97

Consolidation

Cell Pressure (psi) =	103.40	Burette Area (sq. in.)=	0.391
Back Pressure(psi) =	91.04	Initial Burette Ht.(cm)=	19.1
Effective Pressure (psi) =	12.36	Final Burette Ht.(cm)=	20.0

SATURATED HYDRAULIC CONDUCTIVITY

FALLING HEAD METHOD (ASTM D 5084)

Project Name:	Lake Forest	Cell Pressure:	103.40	psi	Initial Sample Height:	3.0150	in
Project No:	11142-01	Bottom Pressure (Pb):	94.06	psi	Initial Area of Sample:	4.6123	in.²
Boring No.:	LGC-3	Top Pressure (Pt):	91.04	psi	Final Sample Ht.* (L):	3.0050	in
Sample No. :	R-3	Consolidation Pressure:	12.36	psi	Final Sample Area* (A):	4.5815	in.²
Depth(ft):	15.0	Burette Area (influent) (Ai):	0.382	in.²			
Sample Type:	Drive	Burette Area (effluent) (Ao):	0.391	in.²			
Soil Identification:	Very light gray clayey sand (SC)	Vol. Change During Consol.:	0.139	in.³			

* After Consolidation

Date	Time (min.)	Incremental Elapsed Time (t) (min)	Temperature (°C)	Water Height Influent Burette (hi) (cm)	Water Height Effluent Burette (ho) (cm)	Uncorrected Hydraulic Conductivity (cm/sec)	Corrected Conductivity at 20 °C (cm/sec)	Inflow Rate / Outflow Rate
20-Oct-11	09:17:00	0		26.00	4.10	Initial Reading		
20-Oct-11	09:27:00	10	22.8	25.90	4.20	4.6E-07	4.3E-07	0.98
20-Oct-11	10:00:00	33	22.8	25.60	4.50	4.2E-07	3.9E-07	0.98
20-Oct-11	10:30:00	30	22.8	25.35	4.75	3.8E-07	3.6E-07	0.98
20-Oct-11	11:00:00	30	22.9	25.10	5.00	3.8E-07	3.6E-07	0.98
20-Oct-11	11:30:00	30	22.9	24.85	5.25	3.8E-07	3.6E-07	0.98
20-Oct-11	12:00:00	30	23.0	24.60	5.50	3.9E-07	3.6E-07	0.98

RESULTS	
Hydraulic Conductivity (cm/sec)	
Average of Last 4 Readings	**3.6E-07**
Upper Limit	4.5E-07
Lower Limit	2.7E-07
Remarks	

k=Ai.Ao.L.ln(h1/h2)/(A.t.(Ai+Ao)) where h1, h2= ((Pb-Pt)/Y+(hi-ho) at t0-(change in hi + change in ho) at t1 and t2

EXPANSION INDEX of SOILS

ASTM D 4829

Project Name:	Lake Forest		Tested By:	S. Felter	Date: 11/01/11
Project No. :	11142-01		Checked By:	J. Ward	Date: 11/03/11
Boring No.:	LGC-4		Depth (ft.)	4-7	
Sample No. :	B-4				
Soil Identification:	Very dark gray clayey sand (SC)				

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

MOLDED SPECIMEN		Before Test	After Test
Specimen Diameter	(in.)	4.01	4.01
Specimen Height	(in.)	1.0000	1.0240
Wt. Comp. Soil + Mold	(g)	611.50	428.34
Wt. of Mold	(g)	208.70	0.00
Specific Gravity (Assumed)		2.70	2.70
Container No.		O	O
Wet Wt. of Soil + Cont.	(g)	798.10	637.04
Dry Wt. of Soil + Cont.	(g)	725.50	574.90
Wt. of Container	(g)	0.00	208.70
Moisture Content	(%)	10.01	16.97
Wet Density	(pcf)	121.5	126.2
Dry Density	(pcf)	110.4	107.9
Void Ratio		0.526	0.563
Total Porosity		0.345	0.360
Pore Volume	(cc)	71.4	76.3
Degree of Saturation (%) [S_{meas}]		**51.3**	81.4

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

Date	Time	Pressure (psi)	Elapsed Time (min.)	Dial Readings (in.)
11/01/11	8:00	1.0	0	0.2220
11/01/11	8:10	1.0	10	0.2220
Add Distilled Water to the Specimen				
11/01/11	10:44	1.0	154	0.2445
11/02/11	6:12	1.0	1322	0.2460
11/02/11	7:15	1.0	1385	0.2460

Expansion Index (EI_{meas}) = ((Final Rdg - Initial Rdg) / Initial Thick.) x 1000	**24**

TESTS for SULFATE CONTENT
CHLORIDE CONTENT and pH of SOILS

Project Name: Lake Forest Tested By : V. Juliano Date: 10/31/11

Project No. : 11142-01 Data Input By: J. Ward Date: 11/03/11

Boring No.	LGC-4			
Sample No.	B-4			
Sample Depth (ft)	4-7			
Soil Identification:	Very dark gray (SC)			
Wet Weight of Soil + Container (g)	155.20			
Dry Weight of Soil + Container (g)	152.50			
Weight of Container (g)	56.00			
Moisture Content (%)	2.80			
Weight of Soaked Soil (g)	100.20			

SULFATE CONTENT, DOT California Test 417, Part II

Beaker No.	8			
Crucible No.	21			
Furnace Temperature (°C)	830			
Time In / Time Out	7:50/8:35			
Duration of Combustion (min)	45			
Wt. of Crucible + Residue (g)	18.8063			
Wt. of Crucible (g)	18.8050			
Wt. of Residue (g) (A)	0.0013			
PPM of Sulfate (A) x 41150	53.50			
PPM of Sulfate, Dry Weight Basis	**55**			

CHLORIDE CONTENT, DOT California Test 422

ml of Chloride Soln. For Titration (B)	30			
ml of AgNO3 Soln. Used in Titration (C)	0.5			
PPM of Chloride (C -0.2) * 100 * 30 / B	30			
PPM of Chloride, Dry Wt. Basis	**31**			

pH TEST, DOT California Test 532/643

pH Value	**7.25**			
Temperature °C	20.5			

SOIL RESISTIVITY TEST

DOT CA TEST 532 / 643

Project Name: Lake Forest
Project No. : 11142-01
Boring No.: LGC-4
Sample No. : B-4
Soil Identification:* Very dark gray (SC)

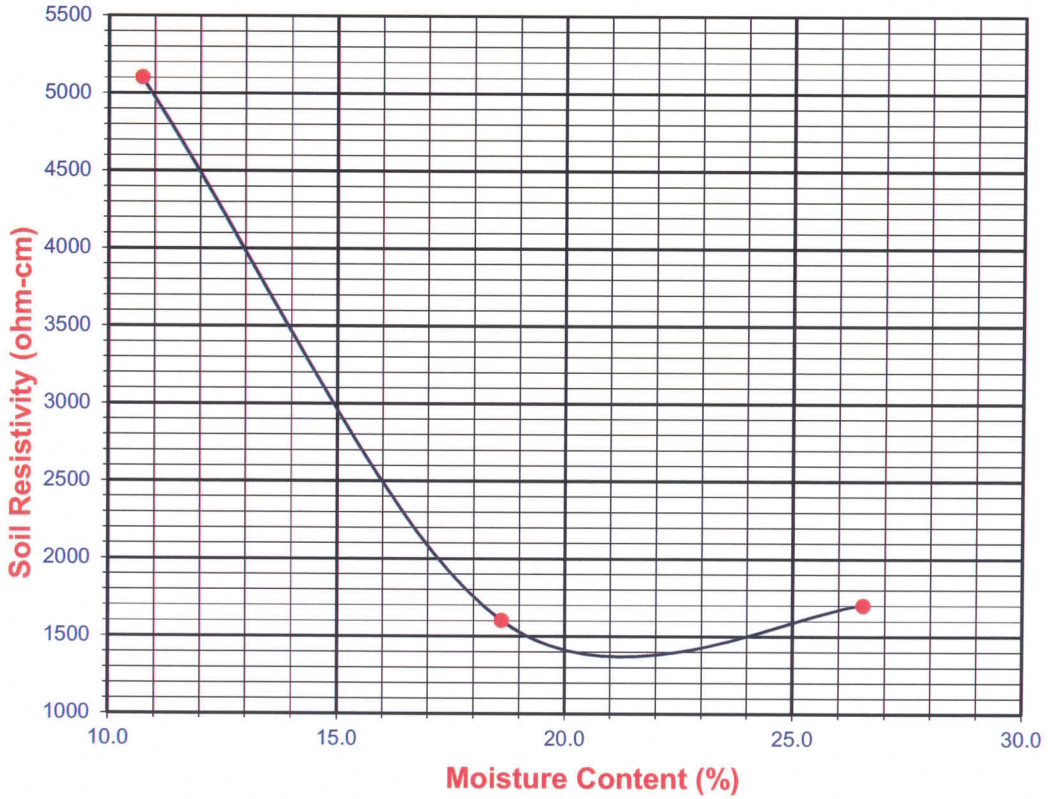
Tested By : V. Juliano Date: 11/01/11
Data Input By: J. Ward Date: 11/03/11
Depth (ft.) : 4-7

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

Specimen No.	Water Added (ml) (Wa)	Adjusted Moisture Content (MC)	Resistance Reading (ohm)	Soil Resistivity (ohm-cm)
1	10	10.71	5100	5100
2	20	18.61	1600	1600
3	30	26.52	1700	1700
4				
5				

Moisture Content (%) (MCi)	2.80
Wet Wt. of Soil + Cont. (g)	155.20
Dry Wt. of Soil + Cont. (g)	152.50
Wt. of Container (g)	56.00
Container No.	
Initial Soil Wt. (g) (Wt)	130.00
Box Constant	1.000
MC =(((1+Mci/100)x(Wa/Wt+1))-1)x100	

Min. Resistivity (ohm-cm)	Moisture Content (%)	Sulfate Content (ppm)	Chloride Content (ppm)	Soil pH	
				pH	Temp. (°C)
DOT CA Test 532 / 643		DOT CA Test 417 Part II	DOT CA Test 422	DOT CA Test 532 / 643	
1350	**21.2**	**55**	**31**	**7.25**	**20.5**



Appendix D
General Earthwork and Grading Specifications for Rough Grading

APPENDIX D

General Earthwork and Grading Specifications For Rough Grading

1.0 General

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

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

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

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

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

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

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

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

2.0 Preparation of Areas to be Filled

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

The Geotechnical Consultant shall evaluate the extent of these removals depending on specific site conditions. Earth fill material shall not contain more than 1 percent of organic materials (by volume). No fill lift shall contain more than 5 percent of organic matter. Nesting of the organic materials shall not be allowed.

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

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

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

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

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

2.5 ***Evaluation/Acceptance of Fill Areas:*** All areas to receive fill, including removal and processed areas, key bottoms, and benches, shall be observed, mapped, elevations recorded, and/or tested prior to being accepted by the Geotechnical Consultant as suitable to receive fill. The Contractor shall obtain a written acceptance from the Geotechnical Consultant prior to fill placement. A licensed surveyor shall provide the survey control for determining elevations of processed areas, keys, and benches.

3.0 *Fill Material*

3.1 ***General:*** Material to be used as fill shall be essentially free of organic matter and other deleterious substances evaluated and accepted by the Geotechnical Consultant prior to placement. Soils of poor quality, such as those with unacceptable gradation, high expansion potential, or low strength shall be placed in areas acceptable to the Geotechnical Consultant or mixed with other soils to achieve satisfactory fill material.

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

3.3 ***Import:*** If importing of fill material is required for grading, proposed import material shall meet the requirements of the geotechnical consultant. The potential import source shall be given to the Geotechnical Consultant at least 96 hours (4 working days) before importing begins so that its suitability can be determined and appropriate tests performed.

4.0 Fill Placement and Compaction

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

4.2 ***Fill Moisture Conditioning:*** Fill soils shall be watered, dried back, blended, and/or mixed, as necessary to attain a relatively uniform moisture content at or slightly over optimum. Maximum density and optimum soil moisture content tests shall be performed in accordance with the American Society of Testing and Materials (ASTM Test Method D1557).

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

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

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

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

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

5.0 Subdrain Installation

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

6.0 Excavation

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

7.0 Trench Backfills

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

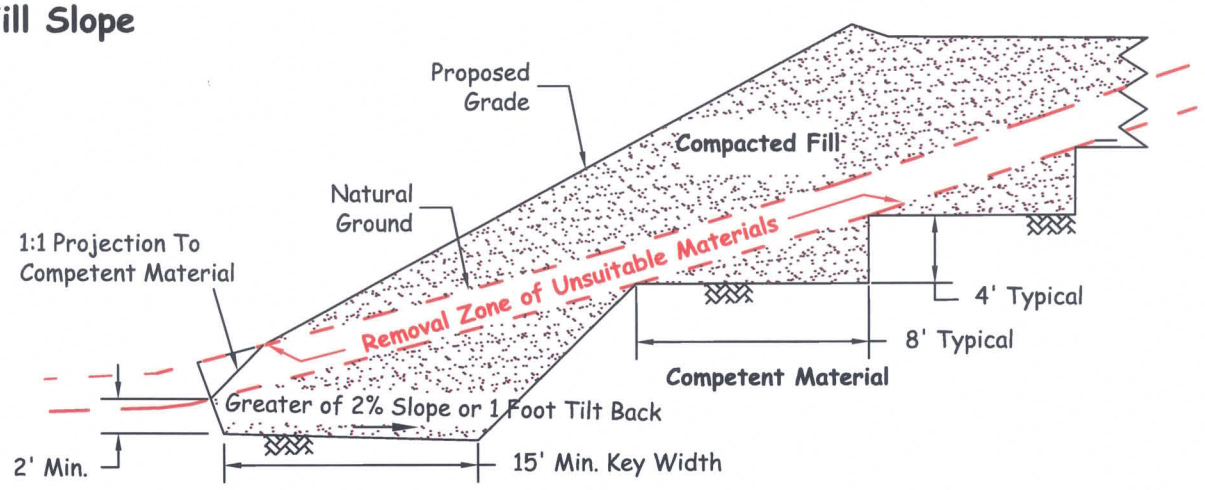
7.2 All bedding and backfill of utility trenches shall be done in accordance with the applicable provisions of Standard Specifications of Public Works Construction. Bedding material shall have a Sand Equivalent greater than 30 (SE>30). The bedding shall be placed to 1 foot over the top of the conduit and densified by jetting. Backfill shall be placed and densified to a minimum of 90 percent of maximum from 1 foot above the top of the conduit to the surface.

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

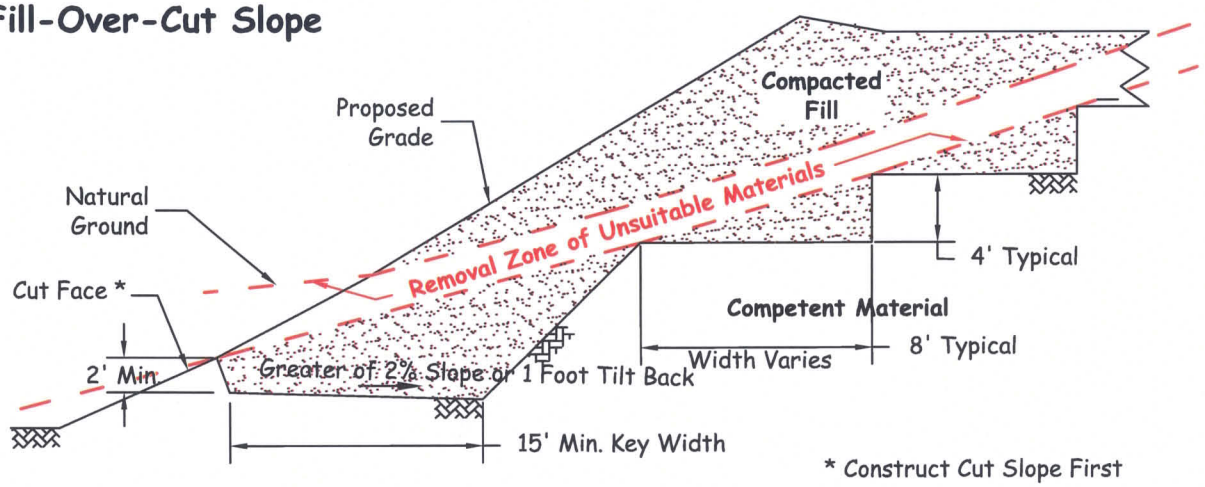
7.4 The Geotechnical Consultant shall test the trench backfill for relative compaction. At least one test should be made for every 300 feet of trench and 2 feet of fill.

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

Fill Slope

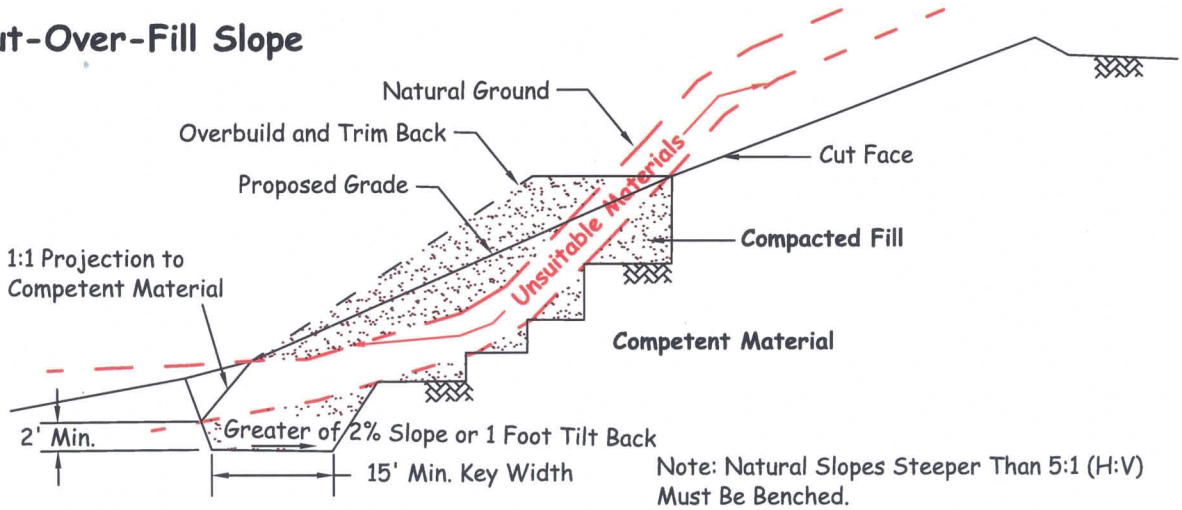


Fill-Over-Cut Slope



* Construct Cut Slope First

Cut-Over-Fill Slope



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

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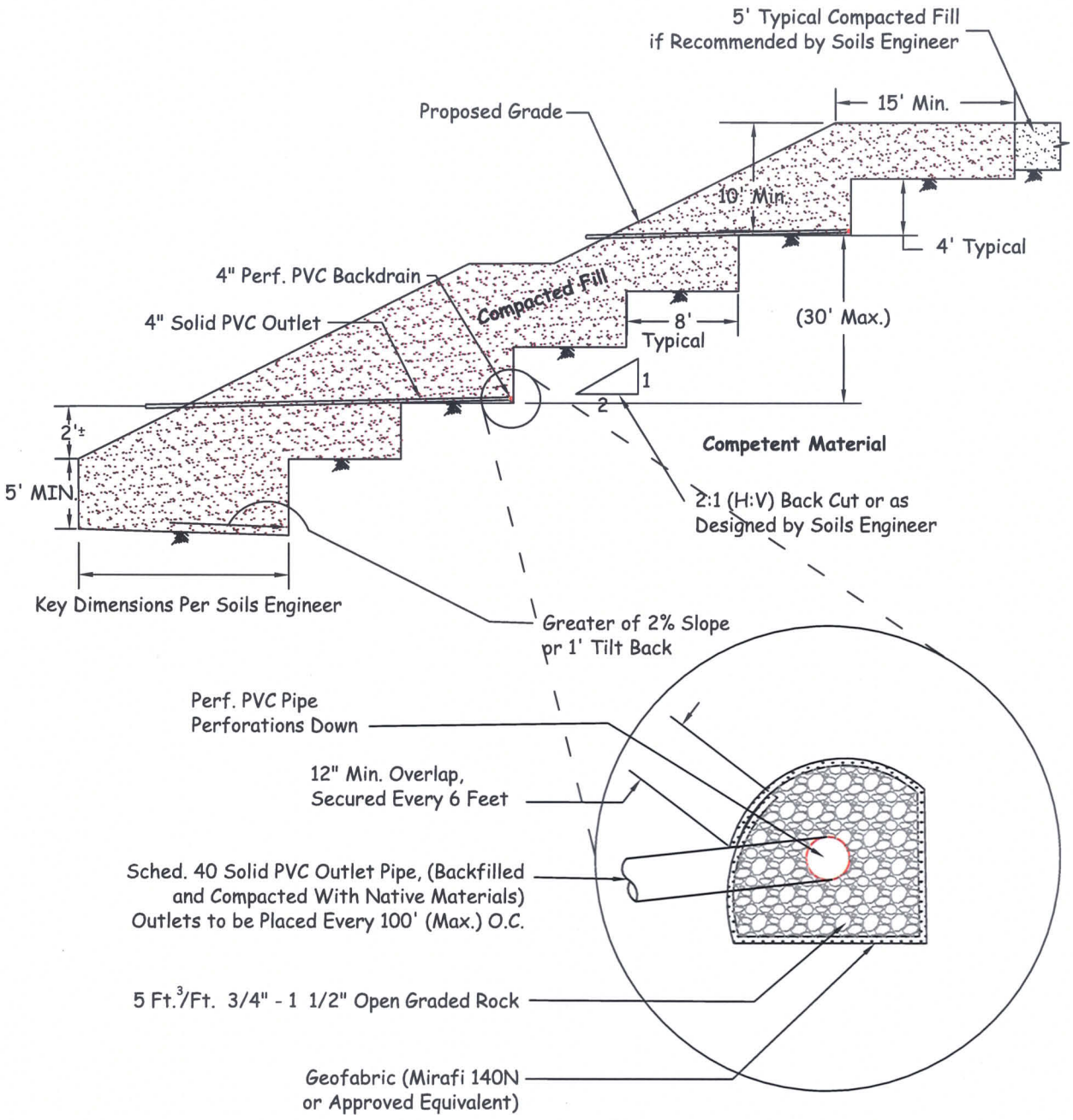
KEYING AND BENCHING



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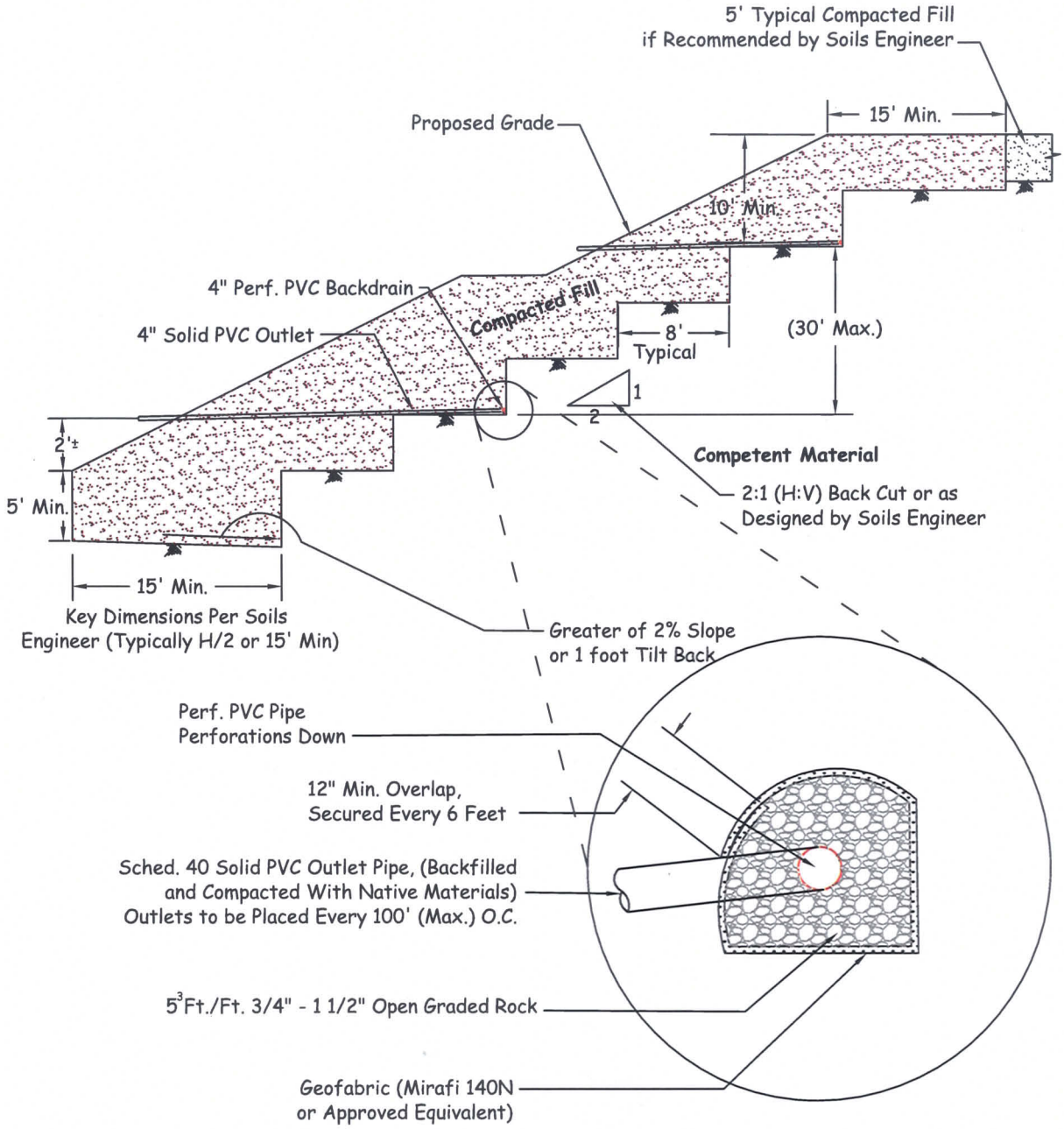
TYPICAL BUTTRESS DETAIL



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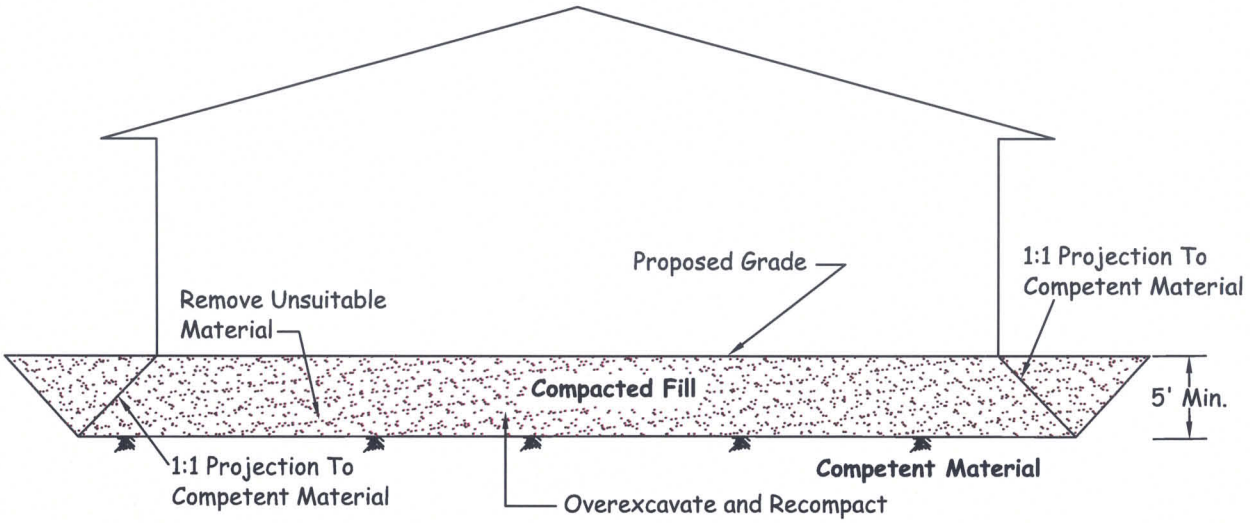
TYPICAL STABILIZATION FILL DETAIL

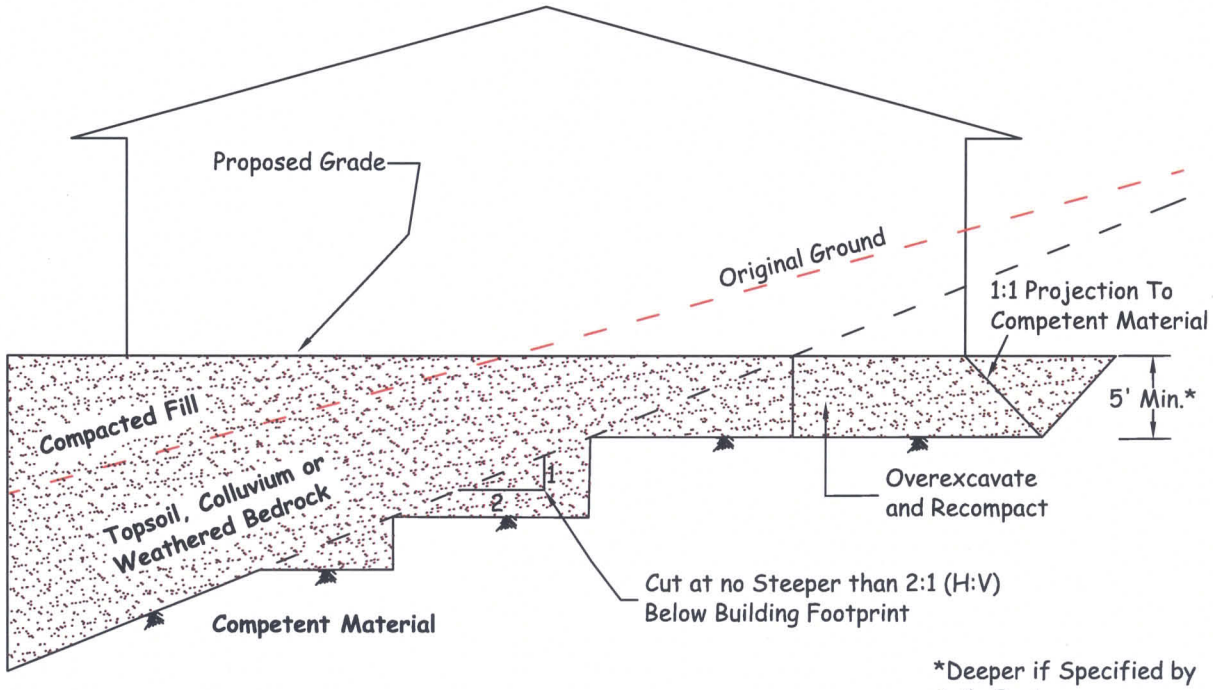
Cut Lot
(Exposing Unsuitable Soils at Design Grade)



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

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

Cut/Fill Transition Lot



*Deeper if Specified by Soils Engineer

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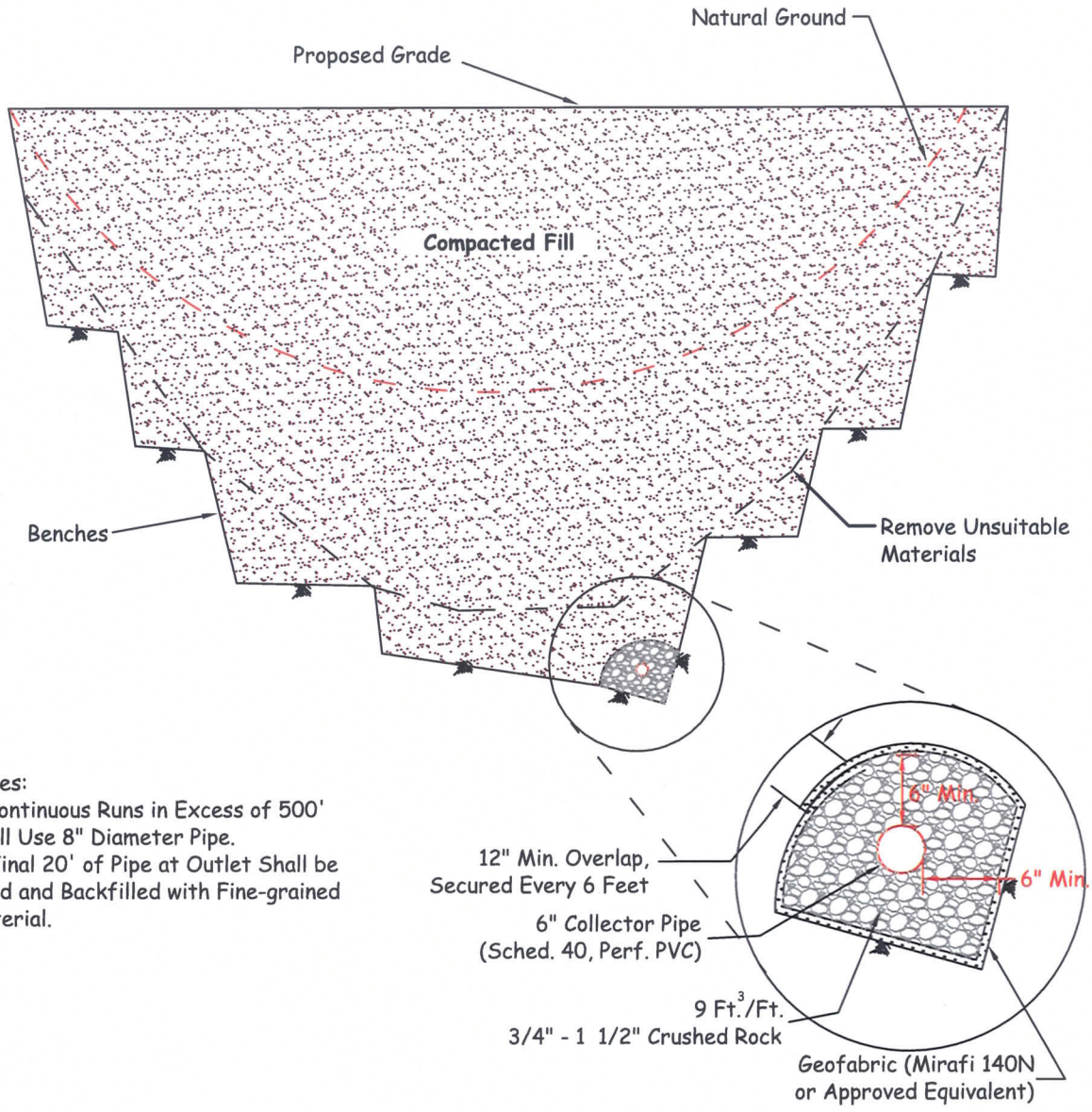
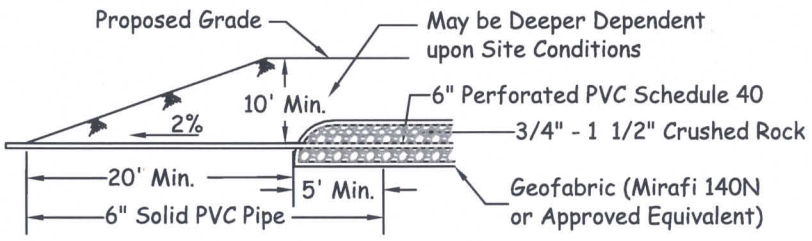
CUT AND TRANSITION LOT OVEREXCAVATION DETAIL



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

Proposed Outlet Detail



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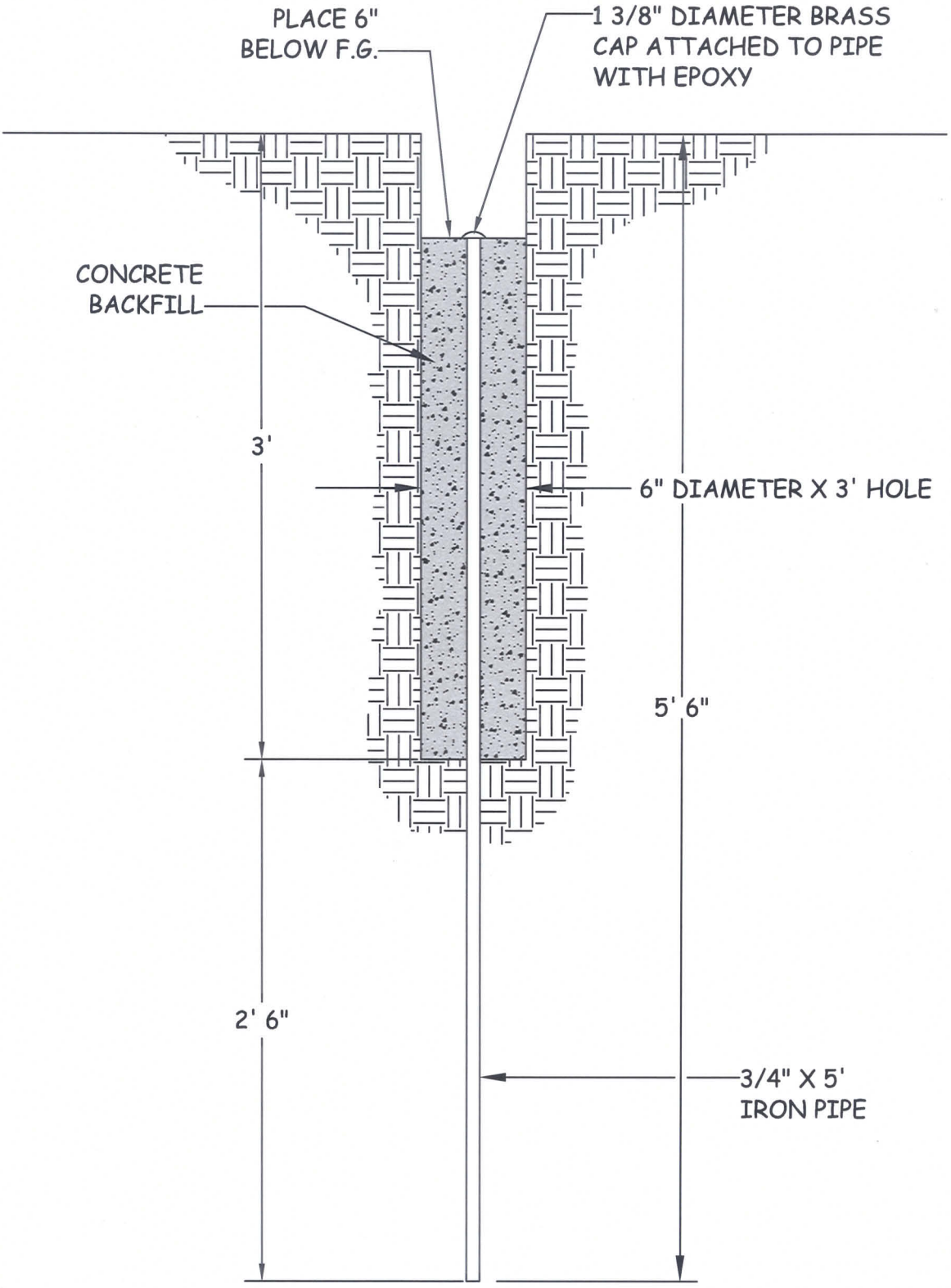
CANYON SUBDRAINS



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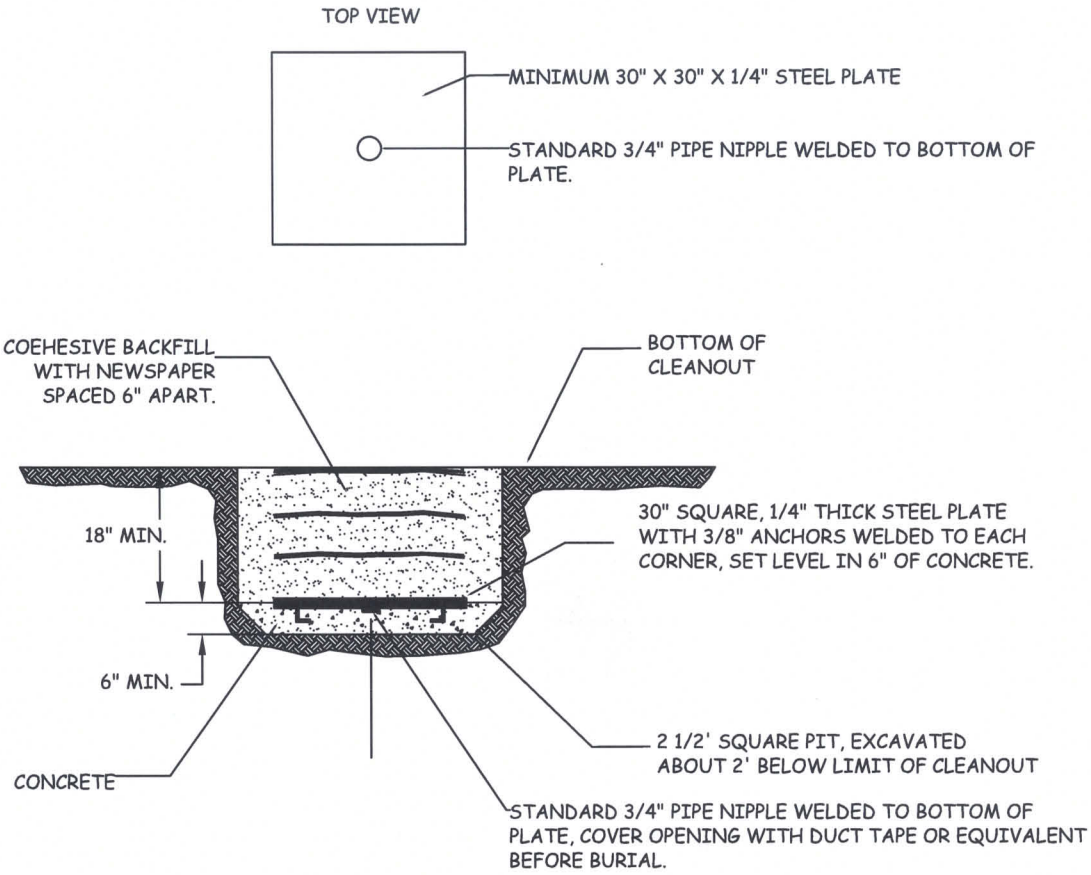
TYPICAL SURFACE SETTLEMENT MONUMENT



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

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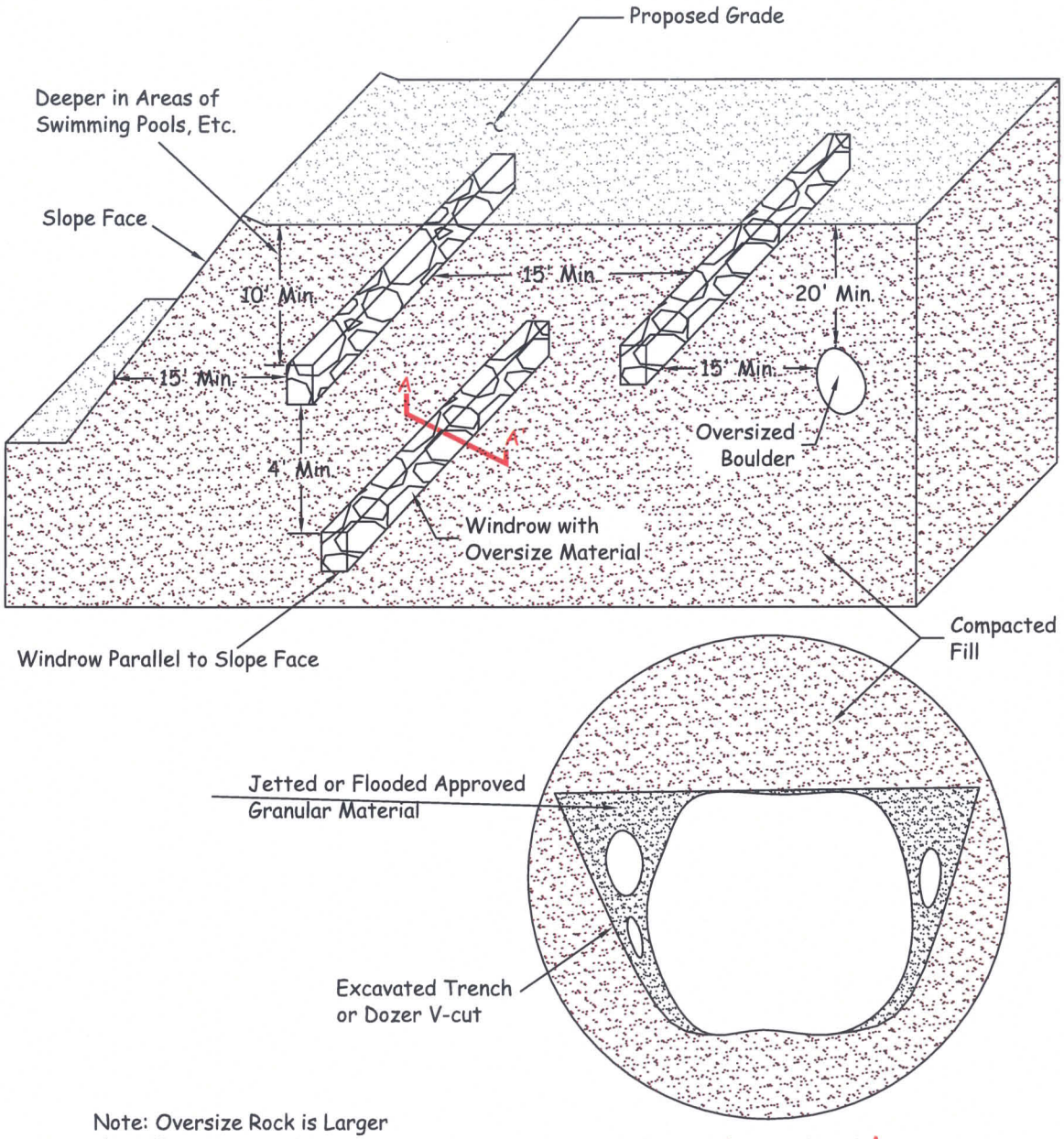
TYPICAL SETTLEMENT PLATE AND RISER



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

Section A-A'

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OVERSIZE ROCK DISPOSAL DETAIL