Appendix A. Submittal Requirements

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Blank - Preliminary Stormwater Quality Compliance Form (Sacramento County)

The following information is presented for example purposes only and may not be the current version. The other permitting agencies in the region may use different forms. Contact the local permitting agency for their submittal requirements.

Sacramento County Supplemental Application:
Preliminary Stormwater Quality Compliance Form

This form is provided for example purposes only.
Check with your local permitting agency for copies of forms and procedures appropriate for your project site.

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1) Project Information

Applicant Name: ____________________ Phone Number: ____________________

Address: ____

Project Contact: ____________________ Phone Number: ____________________

Project name: ____________________ Assessor Parcel Number(s): ____________

Site Address: ____

Project Category (check all that apply): ***Refer to Design Manual Table 3-2 for Priority Project Categories***

- ☐ Residential (Single Family)
- ☐ Residential (Multi-Family)
- ☐ Commercial Development
- ☐ Automotive Repair Shop
- ☐ Retail Gasoline Outlet
- ☐ Restaurant
- ☐ Industrial Development
- ☐ Street/Road
- ☐ Hillside Development
- ☐ Parking Lot

Project Gross Acres: ____________________ Project Net Acres: ____________________

Existing Impervious Surface Area: __________ Proposed Impervious Surface Area: __________

Project Density (Residential Only): __________ Proposed Pervious Surface Area: __________

Watershed or Receiving Water: ____

303(d) Listed Water Bodies: ____

TMDLs: ____

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2) Source Controls (check source control measure or applicable pollutant sources, check Design Manual Chapter 4 for more information on source control measures)

Refer to Design Manual Table 3-2 for Requirements

- ☐ Storm Drain Message and Signage
- ☐ Fueling Areas
- ☐ Loading/Unloading Areas
- ☐ Outdoor Storage Areas
- ☐ Outdoor Work Areas
- ☐ Vehicle/Equipment Wash Areas
- ☐ Waste Management Areas
- ☐ Other. Describe: ____________________

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3) Low Impact Development Measures

Refer to Design Manual Table 3-2 for Requirements

Will LID measures be utilized for this project? ☐ Yes ☐ No

If yes, check selected LID measures below; attach completed worksheet (Design Manual Appendix D).

- ☐ Alternative Driveway Design
- ☐ Disconnected Roof Drains
- ☐ Disconnected Pavement
- ☐ Green Roof
- ☐ Interceptor Trees
- ☐ Porous Pavement
- ☐ Other. Describe: ______________________________

4) Stormwater Quality Treatment Requirements

Refer to Design Manual Table 3-2 for Requirements

Is treatment required? ☐ Yes ☐ No

If no, form is complete with signature. If yes, complete this section.

Indicate number of drainage subwatersheds for the site: ______________

Early consideration of stormwater quality during site planning may reduce the overall cost of treatment controls. Low Impact Development (LID) methods and innovative design options can reduce the size of treatment options. In addition, early consideration allows for non-proprietary treatment options that can significantly reduce construction and maintenance costs.

5) Attach Project Overview and Stormwater Quality Narrative

☐ Include Project description indicating nature of project (e.g., is it a newly developing site, replacement of a previously developed site, is it an infill site). Describe activities planned for site that may impact water quality such as a retail gasoline outlet as part of a development. Describe selected treatment options. <u>Developers should keep in mind that proprietary devices require extensive maintenance by the owners of the property and do not qualify for LID credit, and should consider alternative treatment measures first.</u> Project description should be no more than 1 page relating to stormwater quality.

☐ Include annotated copy of Figure 3-1 of the Design Manual demonstrating applicability of stormwater quality requirements.

☐ Include a copy of the discretionary level conditions of approval (if applicable).

6) Attach Site Plans* and/or Drawings Showing:

☐ Existing and natural hydrologic features

☐ Existing and proposed drainage system (including material, size, slope, and invert elevations)

☐ Locations where site discharges to municipal storm drain system and/or receiving waters

☐ Proposed grades/contours (agency may specify contour interval)

☐ Proposed drainage subwatersheds including (**Refer to item #4, if treatment is required)**

- Name of subwatershed
- Existing amount of pervious and impervious areas
- Proposed amount of pervious and impervious areas
- Proposed treatment option(s) for each subwatershed
- WQV or WQF to be treated

☐ Pollutant source areas including loading docks, food service areas, refuse areas, outdoor processes and storage, vehicle cleaning, repair or maintenance, fuel dispensing, equipment washing, etc.

☐ Proposed design features to minimize impervious areas, applicable runoff reduction techniques, innovative design, and all treatment options selected.

☐ Details for post-construction control measures, including the following information, where applicable:

- Dimensions and setbacks from property lines and structures
- Profile view, including typical cross-sections and dimensions
- Water surface elevations/freeboard
- Inlets, outlet structures, and release points
- Vegetation & growing medium specifications, including provisions for temporary irrigation if needed
- Specifications for construction materials, such as filter fabric and infiltration materials
- Installation requirements

*Note: Plans will not be checked for adequacy of treatment options until design review of drainage system. For information related to correct sizing and other requirements refer to *Stormwater Quality Design Manual for the Sacramento Region.*

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7) Attach HMP Calculations (SAHM Output Report):

☐ Include SAHM output summary report demonstrating compliance with HMP flow duration criteria.

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8) Attach LID Credit Backup:

☐ Include LID credit worksheet for either Residential or Commercial development (as applicable), or other backup documentation of LID credits.

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9) Attach Treatment Calculations:

☐ Include miscellaneous treatment calculations for any BMPs that are not already included in item 7 (HMP calculations) or item 8 (LID Credit Spreadsheet) above.

10) List Subwatersheds and Selected Stormwater Quality Measures (as required)

Subwatershed Name	Total Subwatershed Area		Flow (cfs) or Volume (ft^3)	Control Measures Selected (for Hydromodification Management, LID, and/or Treatment)
	Impervious Area	Pervious Area		

11) Signature

Print Name: ______________________________ Indicate Owner or Title: ______________________________

Signature: ________________________________ Date: ________________________

*Control measures may be those included in the *Stormwater Quality Design Manual for the Sacramento Region* or alternative measures. For projects proposing use of control measures not specified in the Design Manual, the review and approval process may take longer. Also, slight variations to design criteria stated in the manual may be approved on occasion, provided the agency determines that performance of the facility itself or other site structures/features is not compromised. For agencies in Sacramento County, proposals of alternative proprietary structural devices may be accepted if the manufacturer can satisfy the agencies' protocol or the property owner agrees to conduct a pilot scale monitoring study.

To avoid delays, all alternative proposals should be discussed with the stormwater quality staff at the permitting agency as early as possible in the planning stages of the project, preferably at the pre-application meeting.

Sample (Residential) - Stormwater Quality Compliance Package (Sacramento County)

The following information is presented for example purposes only and may not be the current version. The other permitting agencies in the region may use different forms. Contact the local permitting agency for their submittal requirements.

Sutter Memorial Subdivision – Project Description

Sutter Memorial Subdivisions is a residential subdivision located in the City of Sacramento. The project is 20 acres and consists of 125 units. The development includes 275 proposed deciduous trees and approximately 35,000 square feet of bioretention running along the interior streets.

Existing development consists of several hospital buildings and associated parking lots.

The project is not located in an HMP exempt area, it is not a previously approved project, it does not discharge directly to an exempt channel, and it does not meet the infill exemption requirements.

Sacramento County Supplemental Application:
Preliminary Stormwater Quality Compliance Form

This form is provided for example purposes only.
Check with your local permitting agency for copies of forms and procedures appropriate for your project site.

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1) Project Information

Applicant Name: Sutter & Associates   Phone Number: 916-123-4567

Address: 1234 1st Street, Sacramento, CA 95818

Project Contact: Jim Anderson   Phone Number: 916-987-6543

Project name: Sutter Memorial   Assessor Parcel Number(s): 004-0010-006

Site Address: 5105 F Street, Sacramento, CA 95818

Project Category (check all that apply):   ***Refer to Design Manual Table 3-2 for Priority Project Categories***

- ☒ Residential (Single Family)
- ☐ Residential (Multi-Family)
- ☐ Commercial Development
- ☐ Automotive Repair Shop
- ☐ Retail Gasoline Outlet
- ☐ Restaurant
- ☐ Industrial Development
- ☒ Street/Road
- ☐ Hillside Development
- ☐ Parking Lot

Project Gross Acres: 20   Project Net Acres: 20

Existing Impervious Surface Area: 0   Proposed Impervious Surface Area: 10

Project Density (Residential Only): 7 DUA   Proposed Pervious Surface Area: 10

Watershed or Receiving Water: Laguna Creek

303(d) Listed Water Bodies: none

TMDLs: none

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2) Source Controls (check source control measure or applicable pollutant sources, check Design Manual Chapter 4 for more information on source control measures)

Refer to Design Manual Table 3-2 for Requirements

- ☒ Storm Drain Message and Signage
- ☐ Fueling Areas
- ☐ Loading/Unloading Areas
- ☐ Outdoor Storage Areas
- ☐ Outdoor Work Areas
- ☐ Vehicle/Equipment Wash Areas
- ☐ Waste Management Areas
- ☐ Other. Describe: ____________

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3) Low Impact Development Measures

Refer to Design Manual Table 3-2 for Requirements

Will LID measures be utilized for this project? ☒ Yes ☐ No

If yes, check selected LID measures below; attach completed worksheet (Design Manual Appendix D).

- ☐ Alternative Driveway Design
- ☒ Disconnected Roof Drains
- ☒ Disconnected Pavement
- ☐ Green Roof
- ☒ Interceptor Trees
- ☐ Porous Pavement
- ☐ Other. Describe: ____________________

4) Stormwater Quality Treatment Requirements

Refer to Design Manual Table 3-2 for Requirements

Is treatment required? ☒ Yes ☐ No

If no, form is complete with signature. If yes, complete this section.

Indicate number of drainage subwatersheds for the site: 1

Early consideration of stormwater quality during site planning may reduce the overall cost of treatment controls. Low Impact Development (LID) methods and innovative design options can reduce the size of treatment options. In addition, early consideration allows for non-proprietary treatment options that can significantly reduce construction and maintenance costs.

5) Attach Project Overview and Stormwater Quality Narrative

☒ Include Project description indicating nature of project (e.g., is it a newly developing site, replacement of a previously developed site, is it an infill site). Describe activities planned for site that may impact water quality such as a retail gasoline outlet as part of a development. Describe selected treatment options. Developers should keep in mind that proprietary devices require extensive maintenance by the owners of the property and do not qualify for LID credit, and should consider alternative treatment measures first. Project description should be no more than 1 page relating to stormwater quality.

☒ Include annotated copy of Figure 3-1 of the Design Manual demonstrating applicability of stormwater quality requirements.

☐ Include a copy of the discretionary level conditions of approval (if applicable).

6) Attach Site Plans* and/or Drawings Showing:

- ☒ Existing and natural hydrologic features
- ☒ Existing and proposed drainage system (including material, size, slope, and invert elevations)
- ☒ Locations where site discharges to municipal storm drain system and/or receiving waters
- ☒ Proposed grades/contours (agency may specify contour interval)
- ☒ Proposed drainage subwatersheds including (**Refer to item #4, if treatment is required)**
  - Name of subwatershed
  - Existing amount of pervious and impervious areas
  - Proposed amount of pervious and impervious areas
  - Proposed treatment option(s) for each subwatershed
  - WQV or WQF to be treated
- ☒ Pollutant source areas including loading docks, food service areas, refuse areas, outdoor processes and storage, vehicle cleaning, repair or maintenance, fuel dispensing, equipment washing, etc.
- ☒ Proposed design features to minimize impervious areas, applicable runoff reduction techniques, innovative design, and all treatment options selected.
- ☒ Details for post-construction control measures, including the following information, where applicable:
  - Dimensions and setbacks from property lines and structures
  - Profile view, including typical cross-sections and dimensions
  - Water surface elevations/freeboard
  - Inlets, outlet structures, and release points
  - Vegetation & growing medium specifications, including provisions for temporary irrigation if needed
  - Specifications for construction materials, such as filter fabric and infiltration materials
  - Installation requirements

*Note: Plans will not be checked for adequacy of treatment options until design review of drainage system. For information related to correct sizing and other requirements refer to *Stormwater Quality Design Manual for the Sacramento Region.*

7) Attach HMP Calculations (SAHM Output Report):

- ☒ Include SAHM output summary report demonstrating compliance with HMP flow duration criteria.

8) Attach LID Credit Backup:

- ☒ Include LID credit worksheet for either Residential or Commercial development (as applicable), or other backup documentation of LID credits.

9) Attach Treatment Calculations:

- ☐ Include miscellaneous treatment calculations for any BMPs that are not already included in item 7 (HMP calculations) or item 8 (LID Credit Worksheet) above.

10) List Subwatersheds and Selected Stormwater Quality Measures (as required)

Subwatershed Name	Total Subwatershed Area		Flow (cfs) or Volume (ft^3)	Control Measures Selected (for Hydromodification Management, LID, and/or Treatment)
	Impervious Area	Pervious Area		
1	14		32,525 ft^3	Bioretention
	10	4		

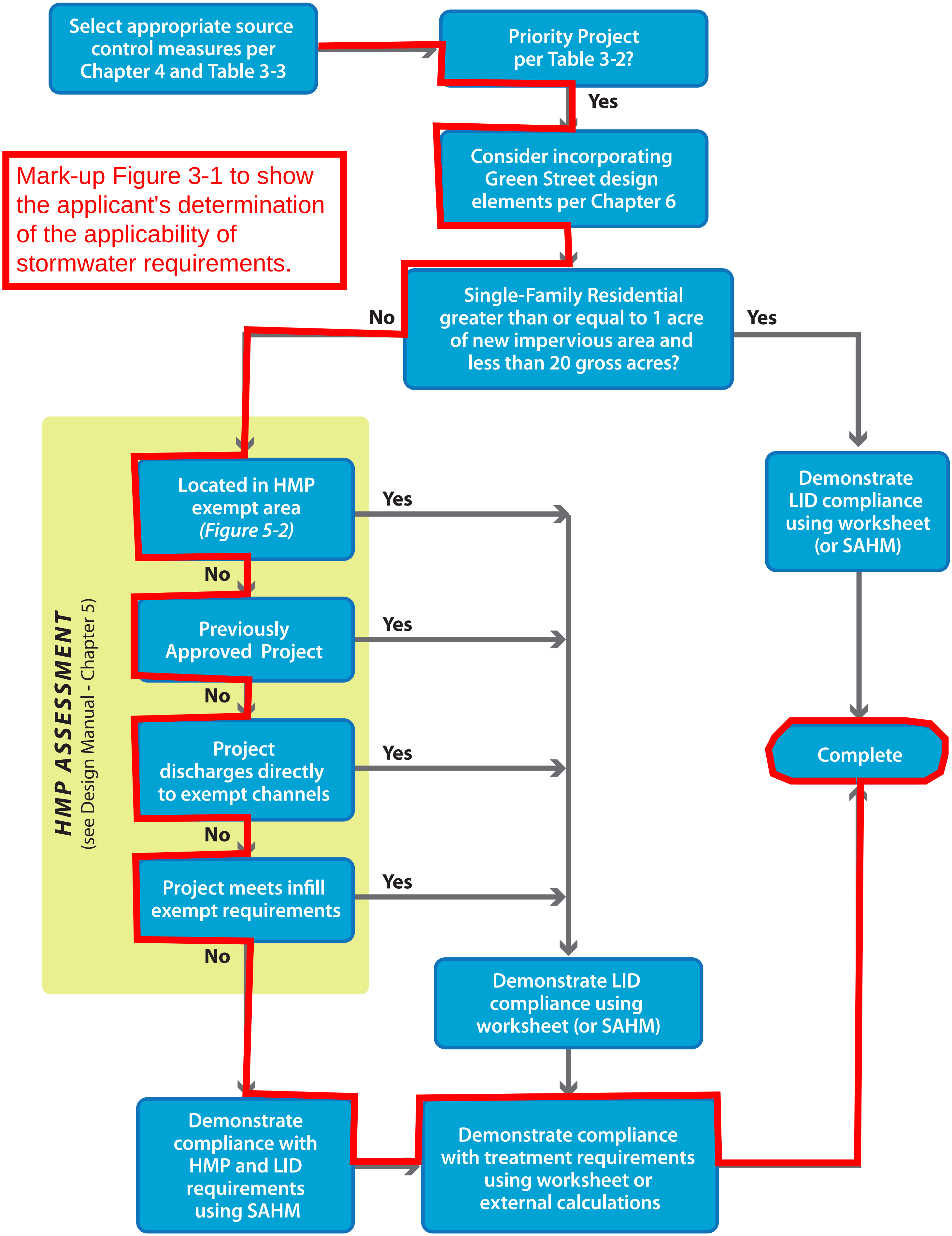
11) Signature

Print Name: Jim Anderson Indicate Owner or Title: Owner

Signature: Jim Anderson Date: 8-14-2013

*Control measures may be those included in the *Stormwater Quality Design Manual for the Sacramento Region* or alternative measures. For projects proposing use of control measures not specified in the Design Manual, the review and approval process may take longer. Also, slight variations to design criteria stated in the manual may be approved on occasion, provided the agency determines that performance of the facility itself or other site structures/features is not compromised. For agencies in Sacramento County, proposals of alternative proprietary structural devices may be accepted if the manufacturer can satisfy the agencies' protocol or the property owner agrees to conduct a pilot scale monitoring study.

To avoid delays, all alternative proposals should be discussed with the stormwater quality staff at the permitting agency as early as possible in the planning stages of the project, preferably at the pre-application meeting.


Select appropriate source control measures per Chapter 4 and Table 3-3
Priority Project per Table 3-2?
Yes
Consider incorporating Green Street design elements per Chapter 6
Mark-up Figure 3-1 to show the applicant's determination of the applicability of stormwater requirements.
No
Single-Family Residential greater than or equal to 1 acre of new impervious area and less than 20 gross acres?
Yes
HMP ASSESSMENT
(see Design Manual - Chapter 5)
Located in HMP exempt area (Figure 5-2)
Yes
No
Previously Approved Project
Yes
No
Project discharges directly to exempt channels
Yes
No
Project meets infill exempt requirements
Yes
No
Demonstrate LID compliance using worksheet (or SAHM)
Complete
Demonstrate LID compliance using worksheet (or SAHM)
Demonstrate compliance with HMP and LID requirements using SAHM
Demonstrate compliance with treatment requirements using worksheet or external calculations

NOTE: All roofs and sidewalks must be disconnected

Bioretention - 43,848 SF

SCALE: 1" = 60'

SHEET INDEX:

TENTATIVE MAP:	
TITLE SHEET	TM-1
PROPOSED SUBDIVISION LAYOUT	TM-2
EXISTING CONDITIONS	TM-3
PUD SCHEMATIC PLAN	PUD-1
REZONE EXHIBIT	R-1
GENERAL PLAN AMENDMENT	GP-1
PRELIMINARY GRADING AND UTILITY EXHIBIT	GU-1
COLOR PHOTOGRAPHS EXHIBIT	P-1

DESIGNED BY DF
DRAWN BY LE
CHECKED BY DF
SCALE AS SHOWN

SWA — Sausalito, Laguna Beach, Houston, Dallas, San Francisco, Los Angeles

STONEBRIDGE PROPERTIES, LLC

CECWEST.COM
Project Planning ■ Civil Engineering ■ Landscape Architecture
■ Sacramento Office 2120 20th Street, Suite Three Sacramento, CA 95818 (916) 455-2026
■ Davis Office 2940 Spafford Street, Suite 200 Davis, CA 95618 (530) 758-2026

CUNNINGHAM ENGINEERING

TENTATIVE SUBDIVISION MAP
FOR
SUTTER MEMORIAL SITE
PROPOSED SUBDIVISION LAYOUT

SACRAMENTO CALIFORNIA

SHEET TM-2 OF 3

DATE: 07/27/12
JOB NO: 1186.03

SAHM

PROJECT REPORT

General Model Information

Project Name:	Sutter
Site Name:	
Site Address:	
City:	
Report Date:	4/8/2014
Gage:	RANCHO C
Data Start:	1961/10/01
Data End:	2004/09/30
Timestep:	Hourly
Precip Scale:	0.94
Version:	2013/12/06

POC Thresholds

Low Flow Threshold for POC1:	25 Percent of the 2 Year
High Flow Threshold for POC1:	10 Year

Landuse Basin Data

Pre-Project Land Use

Pre Development

Bypass:	No
GroundWater:	No
Pervious Land Use	Acres
C,Grass,Mod (1-2%)	20
Pervious Total	20
Impervious Land Use	Acres
Impervious Total	0
Basin Total	20

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Bypass Open Space

Bypass:	Yes
GroundWater:	No
Pervious Land Use	Acres
C,Grass,Mod (1-2%)	6
Pervious Total	6
Impervious Land Use	Acres
Impervious Total	0
Basin Total	6

Element Flows To:

Surface	Interflow	Groundwater

Rooftops and Sidewalks

Bypass:	No
Impervious Land Use	Acres
Imperv,Mod (1-2%) LAT	3.22

Element Flows To:

Outlet 1	Outlet 2
Pervious Disconnection Landscaping	

Pervious Disconnection Landscaping

Bypass:	No
GroundWater:	No

Pervious Land Use	Acres
C,Grass,Mod (1-2%)	3.3

Element Flows To:

Surface	Interflow	Groundwater
Surface ention Areas	Surface ention Areas	

Streets Imp and Trees

Bypass:	No
GroundWater:	No
Pervious Land Use	Acres
C,Trees,Mod (1-2%)	0.7
Pervious Total	0.7
Impervious Land Use	Acres
Imperv,Mod (1-2%)	6.78
Impervious Total	6.78
Basin Total	7.48

Element Flows To:

Surface	Interflow	Groundwater
Surface ention Areas	Surface ention Areas	

Mitigated Routing

All Bioretention Areas

Bottom Length:	209.40 ft.
Bottom Width:	209.40 ft.
Material thickness of first layer:	0.5
Material type for first layer:	Loam
Material thickness of second layer:	1.5
Material type for second layer:	Sand
Material thickness of third layer:	0.75
Material type for third layer:	GRAVEL
Infiltration On	
Infiltration rate:	0.17
Infiltration safety factor:	1
Total Volume Infiltrated (ac-ft):	471.189
Total Volume Through Riser (ac-ft):	35.237
Total Volume Through Facility (ac-ft):	506.426
Percent Infiltrated:	93.04
Underdrain used	
Underdrain Diameter (ft):	0.25
Orifice Diameter (in):	1
Offset (in):	6
Flow Through Underdrain (ac-ft):	0.936
Total Outflow (ac-ft):	506.426
Percent Through Underdrain:	0.18

Discharge Structure

Riser Height:	1 ft.
Riser Diameter:	10 in.
Notch Type:	Rectangular
Notch Width:	0.000 ft.
Notch Height:	0.000 ft.

Element Flows To:

Outlet 1 Outlet 2

Landscape Swale Hydraulic Table

Stage(ft)	Area(ac)	Volume(ac-ft)	Discharge(cfs)	Infilt(cfs)
0.0000	1.0066	0.0000	0.0000	0.0000
0.0522	1.0066	0.0235	0.0000	0.0000
0.1044	1.0066	0.0470	0.0000	0.0000
0.1566	1.0066	0.0705	0.0000	0.0000
0.2088	1.0066	0.0939	0.0000	0.0000
0.2610	1.0066	0.1174	0.0000	0.0000
0.3132	1.0066	0.1409	0.0000	0.0000
0.3654	1.0066	0.1644	0.0000	0.0000
0.4176	1.0066	0.1879	0.0000	0.0000
0.4698	1.0066	0.2114	0.0000	0.0000
0.5220	1.0066	0.2324	0.0000	0.0000
0.5742	1.0066	0.2534	0.0000	0.0000
0.6264	1.0066	0.2744	0.0000	0.0000
0.6786	1.0066	0.2955	0.0000	0.0000
0.7308	1.0066	0.3165	0.0000	0.0000
0.7830	1.0066	0.3375	0.0000	0.0000
0.8352	1.0066	0.3585	0.0000	0.0000
0.8874	1.0066	0.3795	0.0000	0.0000
0.9396	1.0066	0.4005	0.0000	0.0000

0.9918	1.0066	0.4216	0.0000	0.0000
1.0440	1.0066	0.4426	0.0748	0.0000
1.0962	1.0066	0.4636	0.2420	0.0000
1.1484	1.0066	0.4846	0.4637	0.0000
1.2005	1.0066	0.5056	0.7289	0.0000
1.2527	1.0066	0.5266	1.0312	0.0000
1.3049	1.0066	0.5477	1.3667	0.0000
1.3571	1.0066	0.5687	1.7322	0.0000
1.4093	1.0066	0.5897	2.1255	0.0000
1.4615	1.0066	0.6107	2.5447	0.0000
1.5137	1.0066	0.6317	2.9884	0.0000
1.5659	1.0066	0.6527	3.4553	0.0000
1.6181	1.0066	0.6738	3.9442	0.0000
1.6703	1.0066	0.6948	4.4542	0.0000
1.7225	1.0066	0.7158	4.9844	0.0000
1.7747	1.0066	0.7368	5.5342	0.0000
1.8269	1.0066	0.7578	6.1028	0.0000
1.8791	1.0066	0.7788	6.6897	0.0000
1.9313	1.0066	0.7999	7.2942	0.0000
1.9835	1.0066	0.8209	7.9160	0.0000
2.0357	1.0066	0.8427	8.5545	0.0000
2.0879	1.0066	0.8645	9.2092	0.0000
2.1401	1.0066	0.8863	9.8799	0.0000
2.1923	1.0066	0.9081	10.566	0.0000
2.2445	1.0066	0.9299	11.268	0.0000
2.2967	1.0066	0.9517	11.984	0.0000
2.3489	1.0066	0.9735	12.715	0.0000
2.4011	1.0066	0.9953	13.460	0.0000
2.4533	1.0066	1.0171	14.219	0.0000
2.5055	1.0066	1.0389	14.992	0.0000
2.5577	1.0066	1.0607	15.778	0.0019
2.6099	1.0066	1.0826	16.578	0.0045
2.6621	1.0066	1.1044	17.391	0.0070
2.7143	1.0066	1.1262	18.216	0.0091
2.7500	1.0066	1.1411	19.054	0.0393

Landscape Swale Hydraulic Table

Stage(ft)	Area(ac)	Volume(ac-ft)	Discharge(cfs)	To Amended()cfs)	Infilt(cfs)
2.7500	1.0066	1.1411	0.0000	0.5826	0.0000
2.8022	1.0066	1.1936	0.0000	0.5826	0.0000
2.8544	1.0066	1.2462	0.0000	0.6376	0.0000
2.9066	1.0066	1.2987	0.0000	0.6927	0.0000
2.9588	1.0066	1.3513	0.0000	0.7478	0.0000
3.0110	1.0066	1.4038	0.0000	0.8028	0.0000
3.0632	1.0066	1.4563	0.0000	0.8579	0.0000
3.1154	1.0066	1.5089	0.0000	0.9130	0.0000
3.1676	1.0066	1.5614	0.0000	0.9680	0.0000
3.2198	1.0066	1.6140	0.0000	1.0231	0.0000
3.2720	1.0066	1.6665	0.0000	1.0782	0.0000
3.3242	1.0066	1.7191	0.0000	1.1332	0.0000
3.3764	1.0066	1.7716	0.0000	1.1883	0.0000
3.4286	1.0066	1.8241	0.0000	1.2434	0.0000
3.4808	1.0066	1.8767	0.0000	1.2984	0.0000
3.5330	1.0066	1.9292	0.0000	1.3535	0.0000
3.5852	1.0066	1.9818	0.0000	1.4086	0.0000
3.6374	1.0066	2.0343	0.0000	1.4636	0.0000
3.6896	1.0066	2.0869	0.0000	1.5187	0.0000
3.7418	1.0066	2.1394	0.0000	1.5738	0.0000

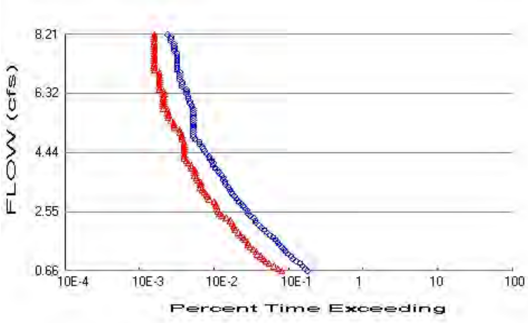
3.7940	1.0066	2.1919	0.0748	1.6288	0.0000
3.8462	1.0066	2.2445	0.2420	1.6839	0.0000
3.8984	1.0066	2.2970	0.4637	1.7390	0.0000
3.9505	1.0066	2.3496	0.7289	1.7940	0.0000
4.0027	1.0066	2.4021	1.0312	1.8491	0.0000
4.0549	1.0066	2.4547	1.3667	1.9042	0.0000
4.1071	1.0066	2.5072	1.7322	1.9592	0.0000
4.1593	1.0066	2.5598	2.1255	2.0143	0.0000
4.2115	1.0066	2.6123	2.5447	2.0694	0.0000
4.2637	1.0066	2.6648	2.9884	2.1244	0.0000
4.3159	1.0066	2.7174	3.4553	2.1795	0.0000
4.3681	1.0066	2.7699	3.9442	2.2346	0.0000
4.4203	1.0066	2.8225	4.4542	2.2896	0.0000
4.4725	1.0066	2.8750	4.9844	2.3447	0.0000
4.5247	1.0066	2.9276	5.5342	2.3998	0.0000
4.5769	1.0066	2.9801	6.1028	2.4548	0.0000
4.6291	1.0066	3.0326	6.6897	2.5099	0.0000
4.6813	1.0066	3.0852	7.2942	2.5650	0.0000
4.7335	1.0066	3.1377	7.9160	2.6200	0.0000
4.7500	1.0066	3.1543	8.5545	2.6374	0.0000

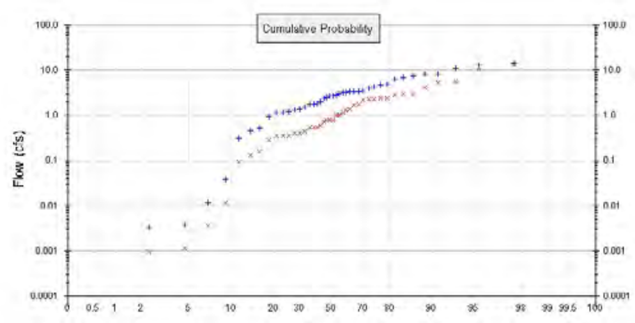
Surface ention Areas

Element Flows To:

Outlet 1	Outlet 2
	All Bioretention Areas

Analysis Results
POC 1





+ Pre-Project x Mitigated

Pre-Project Landuse Totals for POC #1
Total Pervious Area: 20
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 10
Total Impervious Area: 10

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Pre-Project. POC #1

Return Period	**Flow(cfs)**
2 year	2.65473
5 year	5.161155
10 year	8.210895
25 year	13.451809

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0.798734
5 year	2.455523
10 year	4.853076
25 year	11.014309

Annual Peaks

Annual Peaks for Pre-Project and Mitigated. POC #1

Year	**Pre-Project**	**Mitigated**
1962	2.989	1.293
1963	1.164	0.349
1964	0.038	0.011
1965	2.658	0.799
1966	0.012	0.004
1967	3.275	2.333
1968	0.525	0.158
1969	3.240	2.375
1970	2.492	0.804
1971	3.509	2.373
1972	0.004	0.001
1973	7.615	2.285
1974	1.996	0.599
1975	2.410	0.723

1976	0.003	0.001
1977	0.002	0.001
1978	3.336	1.002
1979	1.350	0.405
1980	4.647	1.394
1981	0.305	0.093
1982	6.241	2.914
1983	8.184	5.429
1984	2.797	1.731
1985	1.474	0.442
1986	13.356	10.637
1987	0.446	0.134
1988	1.829	0.549
1989	3.939	1.182
1990	2.655	0.796
1991	1.783	0.537
1992	4.403	1.772
1993	3.330	2.219
1994	1.342	0.403
1995	14.059	13.403
1996	8.233	2.819
1997	10.828	4.162
1998	7.056	5.479
1999	1.785	0.537
2000	4.921	2.967
2001	1.189	0.357
2002	1.151	0.345
2003	0.938	0.282
2004	3.343	1.003

Ranked Annual Peaks

Ranked Annual Peaks for Pre-Project and Mitigated. POC #1

Rank	Pre-Project	Mitigated
1	14.0586	13.4033
2	13.3560	10.6371
3	10.8277	5.4785
4	8.2335	5.4293
5	8.1838	4.1616
6	7.6153	2.9665
7	7.0565	2.9141
8	6.2415	2.8193
9	4.9211	2.3747
10	4.6470	2.3732
11	4.4030	2.3330
12	3.9388	2.2846
13	3.5095	2.2185
14	3.3429	1.7716
15	3.3358	1.7308
16	3.3303	1.3941
17	3.2751	1.2930
18	3.2398	1.1817
19	2.9893	1.0029
20	2.7965	1.0022
21	2.6579	0.8041
22	2.6547	0.7987
23	2.4919	0.7964
24	2.4104	0.7231
25	1.9956	0.5987

26	1.8293	0.5488
27	1.7851	0.5369
28	1.7829	0.5366
29	1.4743	0.4423
30	1.3496	0.4049
31	1.3422	0.4027
32	1.1885	0.3566
33	1.1636	0.3491
34	1.1509	0.3453
35	0.9385	0.2815
36	0.5255	0.1576
37	0.4459	0.1338
38	0.3049	0.0929
39	0.0382	0.0115
40	0.0118	0.0036
41	0.0037	0.0011
42	0.0032	0.0010
43	0.0024	0.0007

Duration Flows
The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.6637	681	307	45	Pass
0.7399	623	274	43	Pass
0.8162	584	241	41	Pass
0.8924	536	207	38	Pass
0.9686	482	187	38	Pass
1.0449	433	172	39	Pass
1.1211	409	159	38	Pass
1.1973	373	145	38	Pass
1.2736	345	138	40	Pass
1.3498	330	127	38	Pass
1.4260	304	115	37	Pass
1.5023	285	109	38	Pass
1.5785	270	107	39	Pass
1.6547	252	98	38	Pass
1.7310	234	93	39	Pass
1.8072	211	85	40	Pass
1.8834	195	80	41	Pass
1.9597	179	72	40	Pass
2.0359	164	71	43	Pass
2.1121	153	69	45	Pass
2.1884	138	66	47	Pass
2.2646	135	63	46	Pass
2.3408	127	55	43	Pass
2.4171	117	48	41	Pass
2.4933	109	45	41	Pass
2.5695	106	43	40	Pass
2.6458	101	42	41	Pass
2.7220	93	41	44	Pass
2.7982	87	40	45	Pass
2.8745	81	38	46	Pass
2.9507	76	33	43	Pass
3.0270	71	31	43	Pass
3.1032	67	30	44	Pass
3.1794	65	28	43	Pass
3.2557	61	26	42	Pass
3.3319	59	25	42	Pass
3.4081	54	25	46	Pass
3.4844	53	25	47	Pass
3.5606	51	23	45	Pass
3.6368	51	22	43	Pass
3.7131	48	21	43	Pass
3.7893	44	21	47	Pass
3.8655	43	21	48	Pass
3.9418	39	19	48	Pass
4.0180	37	19	51	Pass
4.0942	37	17	45	Pass
4.1705	35	16	45	Pass
4.2467	33	15	45	Pass
4.3229	32	15	46	Pass
4.3992	30	15	50	Pass
4.4754	28	15	53	Pass
4.5516	27	15	55	Pass
4.6279	26	15	57	Pass

4.7041	24	15	62	Pass
4.7803	24	15	62	Pass
4.8566	21	14	66	Pass
4.9328	20	14	70	Pass
5.0090	20	14	70	Pass
5.0853	20	13	65	Pass
5.1615	20	13	65	Pass
5.2378	20	11	55	Pass
5.3140	20	11	55	Pass
5.3902	20	11	55	Pass
5.4665	20	10	50	Pass
5.5427	20	9	45	Pass
5.6189	20	9	45	Pass
5.6952	20	9	45	Pass
5.7714	20	9	45	Pass
5.8476	20	8	40	Pass
5.9239	19	8	42	Pass
6.0001	18	8	44	Pass
6.0763	18	8	44	Pass
6.1526	17	8	47	Pass
6.2288	17	8	47	Pass
6.3050	16	8	50	Pass
6.3813	16	8	50	Pass
6.4575	16	7	43	Pass
6.5337	14	7	50	Pass
6.6100	14	7	50	Pass
6.6862	14	7	50	Pass
6.7624	13	7	53	Pass
6.8387	13	7	53	Pass
6.9149	13	7	53	Pass
6.9911	13	7	53	Pass
7.0674	12	6	50	Pass
7.1436	12	6	50	Pass
7.2198	12	6	50	Pass
7.2961	12	6	50	Pass
7.3723	12	6	50	Pass
7.4486	12	6	50	Pass
7.5248	12	6	50	Pass
7.6010	12	6	50	Pass
7.6773	11	6	54	Pass
7.7535	11	6	54	Pass
7.8297	11	6	54	Pass
7.9060	11	6	54	Pass
7.9822	10	6	60	Pass
8.0584	10	6	60	Pass
8.1347	10	6	60	Pass
8.2109	9	6	66	Pass

Drawdown Time Results

Model Default Modifications

Total of 0 changes have been made.

PERLND Changes

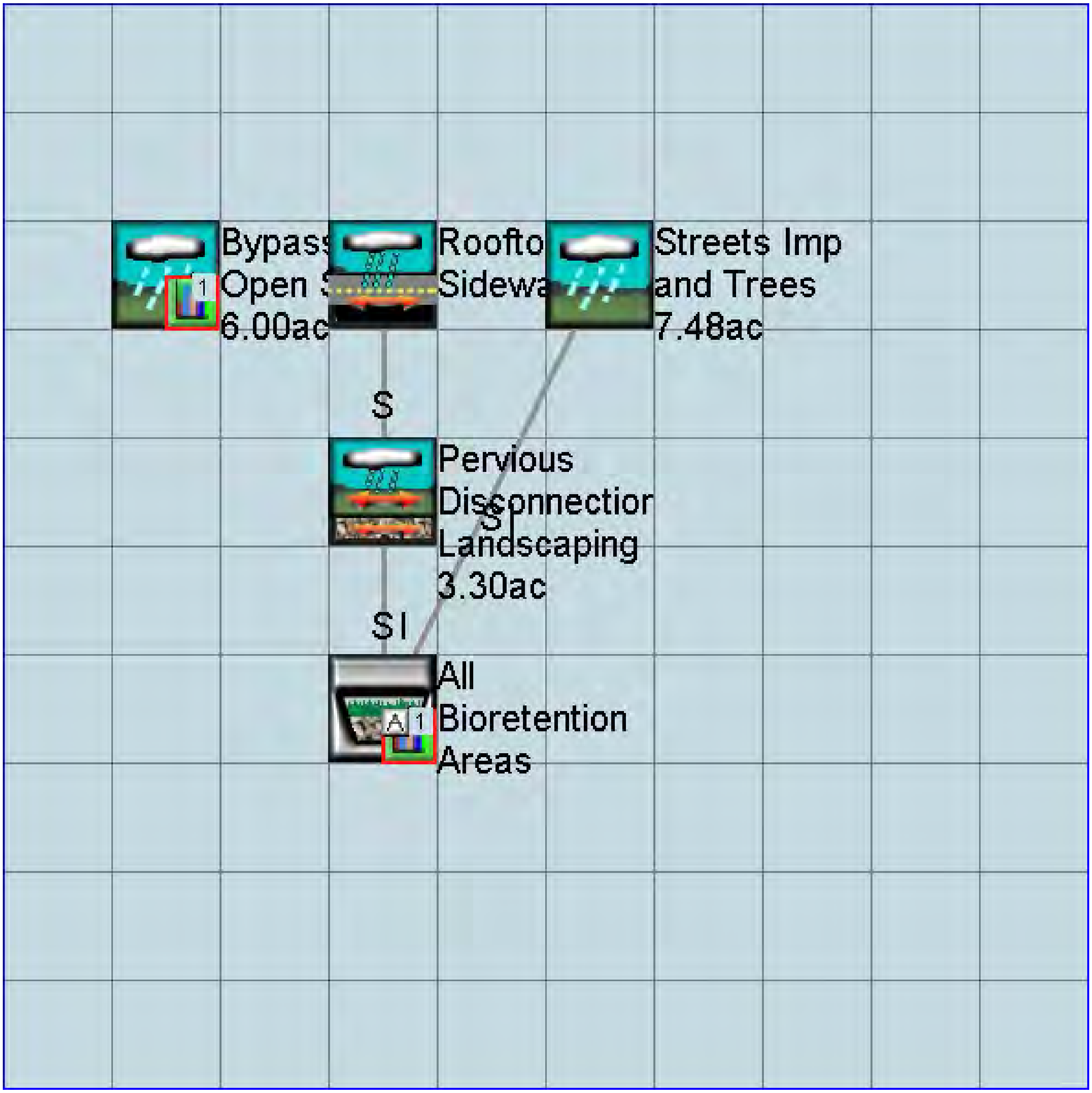
No PERLND changes have been made.

IMPLND Changes

No IMPLND changes have been made.

Appendix
Pre-Project Schematic

Mitigated Schematic



Pre-Project UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1961 10 01        END    2004 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                   UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                             ***
WDM        26   Sutter.wdm
MESSU      25   PreSutter.MES
           27   PreSutter.L61
           28   PreSutter.L62
           30   POCSutter1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:60
      PERLND      34
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Pre Development             MAX                     1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                            User  t-series Engl Metr ***
                                             in  out           ***
   34     C,Grass,Mod (1-2%)      1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   34         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ***************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
   34         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO
```

```
  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   34         0    0    0    1    0    0    0    0    1    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   34              0      4.45     0.043       400      0.02         3      0.92
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   34             40        35         2         2         0         0      0.05
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                                     ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   34              0      0.28      0.25      0.65      0.48         0
  END PWAT-PARM4
  MON-LZETPARM
    <PLS >      PWATER input info: Part 3         ***
    # -  #  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC  ***
   34       0.4  0.4  0.4 0.45  0.5 0.55 0.55 0.55 0.55 0.55 0.45  0.4
  END MON-LZETPARM
  MON-INTERCEP
    <PLS >      PWATER input info: Part 3         ***
    # -  #  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC  ***
   34      0.12 0.12 0.12 0.11  0.1  0.1  0.1  0.1  0.1  0.1 0.11 0.12
  END MON-INTERCEP

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
             ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
   34              0         0      0.15         0         4      0.05         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                      in  out           ***
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
  END IWAT-PARM2
```

```
  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Pre Development***
PERLND  34                          20     COPY   501     12
PERLND  34                          20     COPY   501     13

******Routing******
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   12.1        DISPLY   1     INPUT  TIMSER 1



<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                 ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG            ***
                                           in  out                           ***
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ****************** PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                      ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *       *  *  *  *  *         ***
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                         ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit       for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
  END HYDR-INIT
END RCHRES
```

```
SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    0.944          PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    0.944          IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    1              PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    1              IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
COPY   501 OUTPUT MEAN   1 1     12.1      WDM    501 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>      <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>               <Name> # #***
  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY          INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY          INPUT  MEAN
  END MASS-LINK   13


END MASS-LINK

END RUN
```

Mitigated UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1961 10 01        END    2004 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                    UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                             ***
WDM        26   Sutter.wdm
MESSU      25   MitSutter.MES
           27   MitSutter.L61
           28   MitSutter.L62
           30   POCSutter1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:60
      PERLND      34
      IMPLND       6
      PERLND      46
      IMPLND       2
      PERLND      66
      GENER        2
      RCHRES       1
      RCHRES       2
      COPY         1
      COPY       501
      COPY       601
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1         Surface ention Areas        MAX                      1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  601         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
    2        24
  END OPCODE
  PARM
    #    #         K ***
    2             0.
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                          in  out           ***
   34      C,Grass,Mod (1-2%)      1    1    1    1   27    0
   46      C,Trees,Mod (1-2%)      1    1    1    1   27    0
   66      C,Grass,Mod (1-2%)      1    1    1    1   27    0
  END GEN-INFO
```

```
*** Section PWATER***

ACTIVITY
  <PLS > ************* Active Sections *****************************
  # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
 34         0    0    1    0    0    0    0    0    0    0    0    0
 46         0    0    1    0    0    0    0    0    0    0    0    0
 66         0    0    1    0    0    0    0    0    0    0    0    0
END ACTIVITY

PRINT-INFO
  <PLS > ***************** Print-flags ***************************** PIVL  PYR
  # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
 34         0    0    4    0    0    0    0    0    0    0    0    0    1    9
 46         0    0    4    0    0    0    0    0    0    0    0    0    1    9
 66         0    0    4    0    0    0    0    0    0    0    0    0    1    9
END PRINT-INFO

PWAT-PARM1
  <PLS >  PWATER variable monthly parameter value flags  ***
  # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
 34         0    0    0    1    0    0    0    0    1    0    0
 46         0    0    0    1    0    0    0    0    1    0    0
 66         0    0    0    1    0    0    0    0    1    0    0
END PWAT-PARM1

PWAT-PARM2
  <PLS >      PWATER input info: Part 2         ***
  # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
 34              0      4.45     0.043       400      0.02         3      0.92
 46              0       4.9      0.05       400      0.02         3      0.92
 66              0      4.45     0.043       400      0.02         3      0.92
END PWAT-PARM2

PWAT-PARM3
  <PLS >      PWATER input info: Part 3         ***
  # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
 34             40        35         2         2         0         0      0.05
 46             40        35         2         2         0         0      0.05
 66             40        35         2         2         0         0      0.05
END PWAT-PARM3
PWAT-PARM4
  <PLS >     PWATER input info: Part 4                               ***
  # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
 34              0      0.28      0.25      0.65      0.48         0
 46              0      0.33      0.35      0.78      0.58         0
 66              0      0.28      0.25      0.65      0.48         0
END PWAT-PARM4
MON-LZETPARM
  <PLS >      PWATER input info: Part 3         ***
  # -  #  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC  ***
 34        0.4  0.4  0.4 0.45  0.5 0.55 0.55 0.55 0.55 0.55 0.45  0.4
 46        0.6  0.6  0.6  0.7 0.75 0.75 0.75 0.75 0.75 0.75 0.65  0.6
 66        0.4  0.4  0.4 0.45  0.5 0.55 0.55 0.55 0.55 0.55 0.45  0.4
END MON-LZETPARM
MON-INTERCEP
  <PLS >      PWATER input info: Part 3         ***
  # -  #  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC  ***
 34       0.12 0.12 0.12 0.11  0.1  0.1  0.1  0.1  0.1  0.1 0.11 0.12
 46       0.15 0.15 0.15  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2 0.18
 66       0.12 0.12 0.12 0.11  0.1  0.1  0.1  0.1  0.1  0.1 0.11 0.12
END MON-INTERCEP

PWAT-STATE1
  <PLS > *** Initial conditions at start of simulation
            ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
  # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
 34              0         0      0.15         0         4      0.05         0
 46              0         0      0.15         0         4      0.05         0
 66              0         0      0.15         0         4      0.05         0
```

```
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name-------> Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                       in  out          ***
    6     Imperv,Mod (1-2%) LAT   1    1    1   27    0
    2     Imperv,Mod (1-2%)       1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    6         0    0    1    0    0    0
    2         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    6         0    0    4    0    0    0    1    9
    2         0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
    6         0    0    0    0    0
    2         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    6            100      0.02      0.05       0.1
    2            100      0.02      0.05       0.1
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    6              0         0
    2              0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    6              0         0
    2              0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Rooftops and Sidewalks***
IMPLND   6                      0.9758     PERLND  66     50
Pervious Disconnection Landscaping***
PERLND  66                         3.3     RCHRES   1      2
PERLND  66                         3.3     RCHRES   1      3
Streets Imp and Trees***
PERLND  46                         0.7     RCHRES   1      2
PERLND  46                         0.7     RCHRES   1      3
IMPLND   2                        6.78     RCHRES   1      5
```

```
Bypass Open Space***
PERLND  34                          6     COPY   501     12
PERLND  34                          6     COPY   601     12
PERLND  34                          6     COPY   501     13
PERLND  34                          6     COPY   601     13

******Routing******
PERLND  66                        3.3     COPY     1     12
PERLND  66                        3.3     COPY     1     13
PERLND  46                        0.7     COPY     1     12
IMPLND   2                       6.78     COPY     1     15
PERLND  46                        0.7     COPY     1     13
RCHRES   1                          1     COPY     1     18
RCHRES   1                                RCHRES   2      8
RCHRES   2                          1     COPY   501     17
RCHRES   1                          1     COPY   501     17
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   12.1        DISPLY   1     INPUT  TIMSER 1
GENER    2 OUTPUT TIMSER      .0002778     RCHRES   1     EXTNL  OUTDGT 1


<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                 ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG            ***
                                           in  out                           ***
    1     Surface ention A-009    3    1    1    1   28    0    1
    2     All Bioretention-008    2    1    1    1   28    0    1
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
    1         1    0    0    0    0    0    0    0    0    0
    2         1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ******************* PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
    1         4    0    0    0    0    0    0    0    0    0    1    9
    2         4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                      ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *       *  *  *  *  *         ***
    1        0  1  0  0    4  5  6  0  0       0  1  0  0  0       2  1  2  2  2
    2        0  1  0  0    4  5  0  0  0       0  0  0  0  0       2  2  2  2  2
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
    1             1      0.01       0.0       0.0       0.5       0.0
    2             2      0.04       0.0       0.0       0.5       0.0
  END HYDR-PARM2
  HYDR-INIT
```

```
    RCHRES  Initial conditions for each HYDR section                         ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit       for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
    1        0            4.0  5.0  6.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
    2        0            4.0  5.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
*** User-Defined Variable Quantity Lines
***                          addr
***                        <------>
*** kwd  varnam optyp  opn  vari  s1 s2 s3 tp multiply  lc ls ac as agfn ***
  <****> <----> <----> <-> <----><-><-><-><-><--------> <><-> <><-> <--> ***
  UVQUAN vol2   RCHRES   2 VOL              4
  UVQUAN v2m2   GLOBAL     WORKSP  1        3
  UVQUAN vpo2   GLOBAL     WORKSP  2        3
  UVQUAN v2d2   GENER    2 K       1        3
*** User-Defined Target Variable Names
***                  addr or                        addr or
***                 <------>                       <------>
*** kwd   varnam ct  vari  s1 s2 s3  frac oper     vari  s1 s2 s3  frac oper
  <****>  <----><-> <----><-><-><-> <---> <-->    <----><-><-><-> <---> <-->
  UVNAME  v2m2    1 WORKSP  1         1.0 QUAN
  UVNAME  vpo2    1 WORKSP  2         1.0 QUAN
  UVNAME  v2d2    1 K       1         1.0 QUAN
*** opt foplop dcdts  yr mo dy hr mn d t   vnam  s1 s2 s3 ac quantity  tc  ts rp
  <****><-><--><><-><--> <> <> <> <><><>  <----><-><-><-><-><--------> <> <-><->
  GENER   2                               v2m2            =  46602.
*** Compute remaining available pore space
  GENER   2                               vpo2            =  v2m2
  GENER   2                               vpo2           -=  vol2
*** Check to see if VPORA goes negative; if so set VPORA = 0.0
IF (vpo2 < 0.0) THEN
  GENER   2                               vpo2            =  0.0
END IF
*** Infiltration volume
  GENER   2                               v2d2            =  vpo2
END SPEC-ACTIONS
FTABLES
  FTABLE      2
   54    5
     Depth      Area    Volume  Outflow1  Outflow2  Velocity  Travel Time***
      (ft)   (acres) (acre-ft)   (cfs)     (cfs)   (ft/sec)    (Minutes)***
  0.000000  1.006620  0.000000  0.000000  0.000000
  0.052198  1.006620  0.023487  0.000000  0.000000
  0.104396  1.006620  0.046974  0.000000  0.000000
  0.156593  1.006620  0.070461  0.000000  0.000000
  0.208791  1.006620  0.093947  0.000000  0.000000
  0.260989  1.006620  0.117434  0.000000  0.003269
  0.313187  1.006620  0.140921  0.000000  0.014306
  0.365385  1.006620  0.164408  0.000000  0.019017
  0.417582  1.006620  0.187895  0.000000  0.023854
  0.469780  1.006620  0.211382  0.000000  0.035570
  0.521978  1.006620  0.232399  0.000000  0.036548
  0.574176  1.006620  0.253417  0.000000  0.052689
  0.626374  1.006620  0.274434  0.000000  0.064870
  0.678571  1.006620  0.295451  0.000000  0.084749
  0.730769  1.006620  0.316469  0.000000  0.096400
  0.782967  1.006620  0.337486  0.000000  0.124470
  0.835165  1.006620  0.358503  0.000000  0.135901
  0.887363  1.006620  0.379521  0.000000  0.167534
  0.939560  1.006620  0.400538  0.000000  0.172551
  0.991758  1.006620  0.421555  0.000000  0.172551
  1.043956  1.006620  0.442573  0.000000  0.172551
  1.096154  1.006620  0.463590  0.000000  0.172551
  1.148352  1.006620  0.484607  0.000000  0.172551
  1.200549  1.006620  0.505625  0.000000  0.172551
  1.252747  1.006620  0.526642  0.000000  0.172551
```

1.304945	1.006620	0.547659	0.000000	0.172551
1.357143	1.006620	0.568677	0.000000	0.172551
1.409341	1.006620	0.589694	0.000000	0.172551
1.461538	1.006620	0.610711	0.000000	0.172551
1.513736	1.006620	0.631729	0.000000	0.172551
1.565934	1.006620	0.652746	0.000000	0.172551
1.618132	1.006620	0.673763	0.000000	0.172551
1.670330	1.006620	0.694781	0.000000	0.172551
1.722527	1.006620	0.715798	0.000000	0.172551
1.774725	1.006620	0.736815	0.000000	0.172551
1.826923	1.006620	0.757833	0.000000	0.172551
1.879121	1.006620	0.778850	0.000000	0.172551
1.931319	1.006620	0.799867	0.000000	0.172551
1.983516	1.006620	0.820885	0.000000	0.172551
2.035714	1.006620	0.842690	0.000000	0.172551
2.087912	1.006620	0.864496	0.000000	0.172551
2.140110	1.006620	0.886301	0.000000	0.172551
2.192308	1.006620	0.908107	0.000000	0.172551
2.244505	1.006620	0.929912	0.000000	0.172551
2.296703	1.006620	0.951718	0.000000	0.172551
2.348901	1.006620	0.973523	0.000000	0.172551
2.401099	1.006620	0.995329	0.000000	0.172551
2.453297	1.006620	1.017134	0.000000	0.172551
2.505495	1.006620	1.038940	0.000000	0.172551
2.557692	1.006620	1.060745	0.001874	0.172551
2.609890	1.006620	1.082550	0.004511	0.172551
2.662088	1.006620	1.104356	0.006957	0.172551
2.714286	1.006620	1.126161	0.009105	0.172551
2.750000	1.006620	2.396270	0.039321	0.172551

END FTABLE 2
FTABLE 1
40 6

Depth (ft)	Area (acres)	Volume (acre-ft)	Outflow1 (cfs)	Outflow2 (cfs)	outflow 3 (cfs)	Velocity (ft/sec)	Travel Time*** (Minutes)***
0.000000	1.006620	0.000000	0.000000	0.039321	0.000000		
0.052198	1.006620	0.052543	0.000000	0.582552	0.000000		
0.104396	1.006620	0.105087	0.000000	0.637619	0.000000		
0.156593	1.006620	0.157630	0.000000	0.692686	0.000000		
0.208791	1.006620	0.210173	0.000000	0.747754	0.000000		
0.260989	1.006620	0.262717	0.000000	0.802821	0.000000		
0.313187	1.006620	0.315260	0.000000	0.857888	0.000000		
0.365385	1.006620	0.367803	0.000000	0.912955	0.000000		
0.417582	1.006620	0.420347	0.000000	0.968022	0.000000		
0.469780	1.006620	0.472890	0.000000	1.023089	0.000000		
0.521978	1.006620	0.525433	0.000000	1.078156	0.000000		
0.574176	1.006620	0.577977	0.000000	1.133223	0.000000		
0.626374	1.006620	0.630520	0.000000	1.188291	0.000000		
0.678571	1.006620	0.683063	0.000000	1.243358	0.000000		
0.730769	1.006620	0.735607	0.000000	1.298425	0.000000		
0.782967	1.006620	0.788150	0.000000	1.353492	0.000000		
0.835165	1.006620	0.840693	0.000000	1.408559	0.000000		
0.887363	1.006620	0.893237	0.000000	1.463626	0.000000		
0.939560	1.006620	0.945780	0.000000	1.518693	0.000000		
0.991758	1.006620	0.998324	0.000000	1.573760	0.000000		
1.043956	1.006620	1.050867	0.074793	1.628828	0.000000		
1.096154	1.006620	1.103410	0.241982	1.683895	0.000000		
1.148352	1.006620	1.155954	0.463737	1.738962	0.000000		
1.200549	1.006620	1.208497	0.728896	1.794029	0.000000		
1.252747	1.006620	1.261040	1.031247	1.849096	0.000000		
1.304945	1.006620	1.313584	1.366676	1.904163	0.000000		
1.357143	1.006620	1.366127	1.732192	1.959230	0.000000		
1.409341	1.006620	1.418670	2.125497	2.014297	0.000000		
1.461538	1.006620	1.471214	2.544749	2.069364	0.000000		
1.513736	1.006620	1.523757	2.988433	2.124432	0.000000		
1.565934	1.006620	1.576300	3.455269	2.179499	0.000000		
1.618132	1.006620	1.628844	3.944163	2.234566	0.000000		
1.670330	1.006620	1.681387	4.454160	2.289633	0.000000		
1.722527	1.006620	1.733930	4.984420	2.344700	0.000000		

```
  1.774725  1.006620  1.786474  5.534198  2.399767  0.000000
  1.826923  1.006620  1.839017  6.102823  2.454834  0.000000
  1.879121  1.006620  1.891560  6.689690  2.509901  0.000000
  1.931319  1.006620  1.944104  7.294249  2.564969  0.000000
  1.983516  1.006620  1.996647  7.915996  2.620036  0.000000
  2.000000  1.006620  2.013240  8.554469  2.637425  0.000000
  END FTABLE  1
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    0.944          PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    0.944          IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    1              PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    1              IMPLND   1 999 EXTNL  PETINP
WDM      2 PREC     ENGL    0.944          RCHRES   1     EXTNL  PREC
WDM      1 EVAP     ENGL    0.5            RCHRES   1     EXTNL  POTEV
WDM      1 EVAP     ENGL    0.7            RCHRES   2     EXTNL  POTEV

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
COPY     1 OUTPUT MEAN   1 1     12.1      WDM    701 FLOW     ENGL      REPL
COPY   501 OUTPUT MEAN   1 1     12.1      WDM    801 FLOW     ENGL      REPL
COPY   601 OUTPUT MEAN   1 1     12.1      WDM    901 FLOW     ENGL      REPL
RCHRES   2 HYDR   RO     1 1        1      WDM   1000 FLOW     ENGL      REPL
RCHRES   2 HYDR   O      1 1        1      WDM   1001 FLOW     ENGL      REPL
RCHRES   2 HYDR   O      2 1        1      WDM   1002 FLOW     ENGL      REPL
RCHRES   2 HYDR   STAGE  1 1        1      WDM   1003 STAG     ENGL      REPL
RCHRES   1 HYDR   STAGE  1 1        1      WDM   1004 STAG     ENGL      REPL
RCHRES   1 HYDR   O      1 1        1      WDM   1005 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK        2
PERLND     PWATER SURO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    2

  MASS-LINK        3
PERLND     PWATER IFWO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    3

  MASS-LINK        5
IMPLND     IWATER SURO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    5

  MASS-LINK        8
RCHRES     OFLOW  OVOL   2                 RCHRES         INFLOW IVOL
  END MASS-LINK    8

  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13

  MASS-LINK       15
IMPLND     IWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   15

  MASS-LINK       17
RCHRES     OFLOW  OVOL   1                 COPY           INPUT  MEAN
  END MASS-LINK   17
```

```
  MASS-LINK        18
RCHRES     OFLOW  OVOL   2                  COPY          INPUT  MEAN
  END MASS-LINK   18

  MASS-LINK        50
IMPLND     IWATER SURO                      PERLND        EXTNL  SURLI
  END MASS-LINK   50

END MASS-LINK

END RUN
```

```
ERROR/WARNING ID:   341   6

DATE/TIME: 1986/ 2/18 23: 0

RCHRES:     1

The volume of water in this reach/mixed reservoir is greater than the value
in the "volume" column of the last row of RCHTAB().  To continue the
simulation the table has been extrapolated, based on information contained
in the last two rows.  This will usually result in some loss of accuracy.
If depth is being calculated it will also cause an error condition.
Relevant data are:

NROWS         V1         V2        VOL
40 8.6974E+04 8.7697E+04 8.8512E+04
```

```
ERROR/WARNING ID:   341   5

DATE/TIME: 1986/ 2/18 23: 0

RCHRES:     1

Calculation of relative depth, using Newton's method of successive
approximations, converged to an invalid value (not in range 0.0 to 1.0).
Probably ftable was extrapolated.  If extrapolation was small, no problem.
Remedy; extend ftable.  Relevant data are:

A          B          C      RDEP1      RDEP2  COUNT
0.0000E+00 8.7697E+04 -1.866E+05    2.1275     2.1275       2
```

```
ERROR/WARNING ID:   341   6

DATE/TIME: 1995/ 1/10  9: 0

RCHRES:     1

The volume of water in this reach/mixed reservoir is greater than the value
in the "volume" column of the last row of RCHTAB().  To continue the
simulation the table has been extrapolated, based on information contained
in the last two rows.  This will usually result in some loss of accuracy.
If depth is being calculated it will also cause an error condition.
Relevant data are:

NROWS         V1         V2        VOL
40 8.6974E+04 8.7697E+04 9.1323E+04
```

```
ERROR/WARNING ID:   341   5

DATE/TIME: 1995/ 1/10  9: 0

RCHRES:     1

Calculation of relative depth, using Newton's method of successive
approximations, converged to an invalid value (not in range 0.0 to 1.0).
Probably ftable was extrapolated.  If extrapolation was small, no problem.
Remedy; extend ftable.  Relevant data are:

A          B          C      RDEP1      RDEP2  COUNT
0.0000E+00 8.7697E+04 -5.276E+05    6.0164  6.0164E+00      2
```

Disclaimer

Legal Notice

Clear Creek Solutions, Inc.
6200 Capitol Blvd. Ste F
Olympia, WA. 98501
Toll Free 1(866)943-0304
Local (360)943-0304

www.clearcreeksolutions.com

Appendix D-1: Residential Sites: Low Impact Development (LID) Credits and Treatment BMP Sizing Calculations

Name of Drainage Shed: Sutter Memorial Subdivision   Fill in Blue Highlighted boxes

Location of project: Sacramento

Step 1 - Open Space and Pervious Area Credits

Is your project within the drainage area of a common drainage plan that includes open space? If not, skip to 1 b.

1 a. Common Drainage Plan Area	0.00	acres	A_{CDP}	
Common Drainage Plan Open Space (Off-project)	0	acres	A_{OS}	see area example below
a. Natural storage reservoirs and drainage corridors	0	acres		
b. Buffer zones for natural water bodies	0	acres		
c. Natural areas including existing trees, other vegetation, and soil	0	acres		
d. Common landscape area/park	0	acres		
e. Regional Flood Control/Drainage basins	0	acres		
1 b. Project Drainage Shed Area (Total)	20.00	acres	A	
Project-Specific Open Space (In-project, communal)**	1.27	acres	A_{PSOS}	see area example below
a. Natural storage reservoirs and drainage corridors	0.00	acres		
b. Buffer zones for natural water bodies	0.00	acres		
c. Natural areas including existing trees, other vegetation, and soil	0.00	acres		
d. Landscape area/park	1.27	acres		
e. Flood Control/Drainage basins	0.00	acres		

** Doesn't include impervious areas within individual lots and surrounding individual units. That is accounted for below using Form D-1a in Step 2.

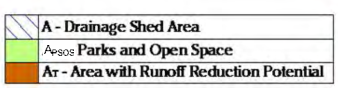
Area with Runoff Reduction Potential	$A - A_{PSOS}$ =	18.73	acres	A_T
Number of Units in A_T		125		
Number of units per acre in A_T	DU/A_T =	7		DUA
Assumed Initial Impervious Fraction of A_T (determined using Table D-1a)		0.5		I

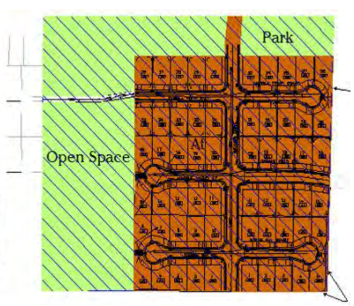
Open Space & Pervious Area LID Credit (Step 1)

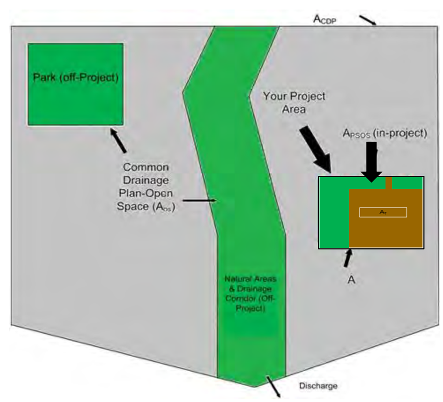
$(A_{OS}/A_{CDP}+A_{PSOS}/A)x100$ = 6 pts

Table D-1a

Dwelling units per acre	Imperviousness
1	0.17
2	0.25
3,4	0.35
5,6	0.40
7	0.50
8,9	0.55
10-14	0.60
15-20	0.70







Step 2 - Runoff Reduction Credits

Runoff Reduction Measures		Effective Area Managed (A_C)	
Disconnected Roof Drains (see Fact Sheet)	use Form D-1a for credits →	1.48	acres
Disconnected Pavement (see Fact Sheet)	use Form D-1b for credits →	0.45	acres
Interceptor Trees (see Fact Sheet)	use Form D-1c for credits →	0.14	acres
Alternative Driveway Design (see Fact Sheet)	use Form D-1d for credits →	0.00	acres
Total Effective Area Managed (Credit Area)	A_C	2.08	acres EAM

Runoff Reduction Credit (Step 2) $(A_C / A_T)*100$ = 11 pts

Form D-1a: Disconnected Roof Drains Worksheet

See Fact Sheet for more information regarding Disconnected Roof Drain credit guidelines

Effective Area Managed (A_C)

1. Determine efficiency Multiplier

Runoff is directed to a dispersal trench or dry well (Type A and B soils only)		1.00
Runoff is directed across landscaping, determine setback		
25 ft +	Use multiplier of	1.00
≥ 20 and < 25 ft	Use multiplier of	0.90
≥ 15 and < 20 ft	Use multiplier of	0.70
≥ 10 and < 15 ft	Use multiplier of	0.45
≥ 5 and < 10 ft	Use multiplier of	0.25

Efficiency Multiplier → 0.45 Box J1

2. Determine percentage of roof drains disconnected → 100.0% Box J2

3. Select project density in dwelling units per acre:

1	Use reduction factor of	0.08
2	Use reduction factor of	0.13
3,4	Use reduction factor of	0.19
5,6	Use reduction factor of	0.23
7	Use reduction factor of	0.29
8,9	Use reduction factor of	0.33
10-14	Use reduction factor of	0.37
15-20	Use reduction factor of	0.44

Reduction Factor → 0.29 Box J3

4. Determine Area Managed

Multiply Box J3 by A_T, and enter the result in Box J4 — 5.5 acres Box J4

5. Multiply Boxes J1, J2 and J4, and enter 60% of the result in Box J — 1.5 acres Box J

This is the amount of area credit to enter into the "Disconnected Roof Drains" Box of Form D-1

Form D-1b: Disconnected Pavement Worksheet

See Fact Sheet for more information regarding NDC Pavement credit guidelines

Effective Area Managed (A_C)

Divided Sidewalks

1. Determine percentage of units with divided Sidewalks — 100.0% Box K1

Multiply Box K1, A_T, and 0.04 and enter 60% of the result in Box K — 0.45 acres Box K

This is the amount of area credit to enter into the "Disconnected Pavement" Box of Form D-1

Form D-1c: Interceptor Tree Worksheet

See Fact Sheet for more information regarding Interceptor Tree credit guidelines

Effective Area Managed (A_C)

New Evergreen Trees

1. Enter number of new evergreen trees that qualify as Interceptor Trees in Box L1.	0	trees	Box L1
2. Multiply Box L1 by 200 and enter result in Box L2	0	sq. ft.	Box L2

New Deciduous Trees

3. Enter number of new deciduous trees that qualify as Interceptor Trees in Box L3.	275	trees	Box L3
4. Multiply Box L3 by 100 and enter result in Box L4	27500	sq. ft.	Box L4

Existing Tree Canopy

5. Enter square footage of existing tree canopy that qualifies as Existing Tree canopy in Box L5.	8000	sq. ft.	Box L5
6. Multiply Box L5 by 0.5 and enter the result in Box L6	4000	sq. ft.	Box L6

Total Interceptor Tree Credits

Add Boxes L2, L4, and L6 and enter it into Box L7	31500	sq. ft.	Box L7
Divide Box L7 by 43,560 and multiply by 20% to get effective area managed and enter the result in Box L8	0.14	acres	Box L8

This is the amount of area credit to enter into the "Interceptor Trees" Box of Form D-1

Form D-1d: Alternative Driveway Design

See Fact Sheet for more information regarding Alternative Driveway Design credit guidelines

1. Select type of driveway

Pervious Driveway:	Multiplier:
Cobblestone Block P	0.40
Pervious Concrete/A	0.60
Porous Pavement Porous Gravel Pavement &	0.75
Not Directly-connected I	1.00

0.4 Box M1

2. Determine percentage of units with Alternative Driveways: 0% Box M2

4. Multiply Boxes M1, M2, A_T and 0.04, and enter the result in Box M
This is the amount of area credit to enter into the "Alternative Driveway Design" Box of Form D-1

0.00 acres

Step 3 - Runoff Management Credits

Capture and Use Credits

Impervious Area Managed by Rain barrels, Cisterns, and automatically-emptied systems

(see Fact Sheet) - enter gallons, for simple rain barrels 0.00 acres

Automated-Control Capture and Use System

(see Fact Sheet, then enter impervious area managed by the system) 0.00 acres

Bioretention/Infiltration Credits

Impervious Area Managed by Bioretention BMPs

(see Fact Sheet)

Bioretention Area 43,848 sq ft
Subdrain Elevation 6 inches
Ponding Depth, inches 12.0 inches 15.01 acres

Impervious Area Managed by Infiltration BMPs

(see Fact Sheet)

Drawdown Time, hrs 12 drawdown_hrs_inf
Soil Infiltration Rate, in/hr 0.50 soil_inf_rate

Sizing Option 1: Capture Volume, acre-ft 0.00 capture_vol_inf 0.00 acres

Sizing Option 2: Infiltration BMP surface area, sq ft 0 soil_surface_area 0.00 acres

Basin or trench? Basin approximate BMP depth 0.50 ft

Impervious Area Managed by Amended Soil or Mulch Beds

(see Fact Sheet) Mulched Infiltration Area, sq ft - mulch_area 0.00 acres

Total Effective Area Managed by Capture-and-Use/Bioretention/Infiltration BMPs 15.01 A_{LIDc}

Runoff Management Credit (Step 3) A_{LIDC}/A_T*200 = 160.3 pts

Total LID Credits (Step 1+2+3) LID compliant, check for treatment sizing in Step 4 177.7

Does project require hydromodification management? If yes, proceed to using SacHM.

Adjusted Area for Flow-Based, Non-LID Treatment $A_T - A_C - A_{LIDC}$ = 1.64 A_{AT}

Adjusted Impervious Fraction of A for Volume-Based, Non-LID Treatment $(A_T*I-A_C-A_{LIDC}) / A$ = 0.000 I_A

STOP: No additional treatment needed

Step 4a Treatment - Flow-Based (Rational Method)

Form D-1e

Calculate treatment flow (cfs): Flow = Runoff Coefficient x Rainfall Intensity x Adjusted Treatment Area

Determine C Factor using Table D-1b 0.50 C

Determine i using Table D-1c (Rainfall Intensity) 0.18 i

A_{AT} from Step 2 1.64 A_{AT}

Flow = C * i * A_{AT} 0.15 cfs

TABLE D-1b

Development Type	Runoff Coefficient (Rational), C
Single-family areas	0.50
Multi-units, detached	0.60
Apartment dwelling areas	0.70
Multi-units, attached	0.75
User Specified	0.00

Table D-1c

Rainfall Intensity			
Roseville	i =	0.20	in/hr
Sacramento	i =	0.18	in/hr
Folsom	i =	0.20	in/hr

Step 4b Treatment - Volume-Based (ASCE-WEF)

Calculate water quality volume (Acre-Feet):	WQV = Area x Maximized Detention Volume (P_0)			
Obtain A from Step 1	20.00	A	12 hrs	Specified Draw Down time
Obtain P_0: Maximized Detention Volume from figures E-1 to E-4 in Appendix E of this manual using I_A from Step 2.	0.00	P_0		
Calculate treatment volume (acre-ft): **Treatment volume = A x (P_0 / 12)**	0.00	Acre-Feet		

v06232012

Table SP-3. Design Data Summary Sheet for Stormwater Planter

Designer: John Smith Date: 3/17/2014

Company: ABCD Engineering

Project: Sutter Memorial

Location: Lots B, C, D, and E (designed and modeled as one combined BMP)

1a. Determine Design Water Quality Volume

a. Tributary drainage area	Area =	609,840	ft^2
b. Water Quality Volume	WQV =	32,525	ft^3

1b. Adjust Volume Up for Hydromodification Management (If Applicable) Based upon SAHM Modeling

a. Water Quality Volume based on SAHM modeling	V =	43,848	ft^3
b. SAHM Model Demonstrates Compliance with Flow Duration Standards	(Yes or No)	Yes	

2. Design average surcharge depth (d_s)

d_s = 6-12 inches (0.5-1 foot)	d_s =	1.0	ft

3. Design Planter Surface Area (A_s)

$A_s = WQV/d_s$	A_s =	43,848	ft^2

4. Base Course Layers

a. Topsoil (6 in. minimum)	6	in
b. Sand/Peat Layer (18 in. minimum)	18	in
c. Gravel Layer (9 in. minimum)	9	in

5. Planter Type (check type used)

☐ Infiltration without underdrain

☒ Infiltration with underdrain

☐ Flow-through with impermeable liner

6. Vegetation (describe) Grass

7. Overflow Device (check type used or describe "Other")

☐ Drop inlet

☐ Standpipe

☒ Other 10" Riser

Notes:

Sample (Commercial) - Stormwater Quality Compliance Package
(Sacramento County)

The following information is presented for *<u>example purposes only</u>*
and may not be the current version. The other
permitting agencies in the region may use different forms.
Contact the local permitting agency for their submittal requirements.

Notes to Reader Regarding Auburn Blvd. Example Project:

Design and Modeling Assumptions

1. Project Site is assumed 4.34 acres of Type D Grass in Pre Development.
2. Hydromodification analysis has been performed for demonstration purposes only. The physical address for the project is in an area that is exempt from hydromodification analysis.
3. Water quality mitigation for the asphalt parking area (2.8 acres) is provided by the use of permeable pavement for the perimeter parking stalls, which total collectively approximately 0.80 acres. Water quality mitigation for the building footprint area (0.44 acres) is provided by means of a 90' bioswale and underground storage chamber connected in series.
4. The storage area underneath the porous pavement section is assumed 24" thick, with a native infiltration rate of 0.07" per hour (Type D Soils). A 3" perforated subdrain system is elevated 1' off the bottom of the pavement subgrade.
5. The porous pavement subgrade is assumed to be constructed flat
6. Point of compliance #2 is a duplicate of POC #1. It is used only to generate an unmitigated post development condition for use in the LID points tabulation within SAHM. In SAHM, LID points are determined based on the calculated volume reduction compared with the unmitigated condition (see Chapter 5 for more information regarding SAHM LID points).

Results

1. Project "passes" hydromodification compliance standard for POC #1. Reader should disregard "failing" results for POC #2. (That refers only to the unmitigated condition, which we intuitively would expect not to "pass.")
2. Computed LID points are found at the back of the report. A total of 207 points have been earned with the proposed design. The project exceeds the 100 point minimum for LID compliance. Separate Design Data Summary Sheets are provided to demonstrate compliance with treatment requirements for the 85th percentile event.

Sacramento County Supplemental Application:
Preliminary Stormwater Quality Compliance Form

This form is provided for example purposes only.
Check with your local permitting agency for copies of forms and procedures appropriate for your project site.

---

1) Project Information

Applicant Name: Auto Dealer
Phone Number: 916-867-5309
Address: 123 Elm Road
Project Contact: Jim Anderson
Phone Number: 916-867-5309
Project name: Auto Dealership
Assessor Parcel Number(s): 123-4567-890
Site Address: 360 Auburn Blvd., Sacramento, CA 95818

Project Category (check all that apply):

Refer to Design Manual Table 3-2 for Priority Project Categories

- ☐ Residential (Single Family)
- ☐ Residential (Multi-Family)
- ☒ Commercial Development
- ☐ Automotive Repair Shop
- ☐ Retail Gasoline Outlet
- ☐ Restaurant
- ☐ Industrial Development
- ☐ Street/Road
- ☐ Hillside Development
- ☒ Parking Lot

Project Gross Acres: 4.34
Project Net Acres: 4.34
Existing Impervious Surface Area: 0.00
Proposed Impervious Surface Area: 3.24
Project Density (Residential Only): N/A
Proposed Pervious Surface Area: 1.10
Watershed or Receiving Water: Arcade Creek
303(d) Listed Water Bodies: Arcade Creek
TMDLs: Chlorpyrifos and Diazinon

---

2) Source Controls (check source control measure or applicable pollutant sources, check Design Manual Chapter 4 for more information on source control measures)

Refer to Design Manual Table 3-2 for Requirements

- ☒ Storm Drain Message and Signage
- ☐ Fueling Areas
- ☒ Loading/Unloading Areas
- ☐ Outdoor Storage Areas
- ☐ Outdoor Work Areas
- ☐ Vehicle/Equipment Wash Areas
- ☒ Waste Management Areas
- ☐ Other. Describe: ______________________

---

3) Low Impact Development Measures

Refer to Design Manual Table 3-2 for Requirements

Will LID measures be utilized for this project? ☒ Yes ☐ No

If yes, check selected LID measures below; attach completed worksheet (Design Manual Appendix D).

- ☐ Alternative Driveway Design
- ☒ Disconnected Roof Drains
- ☐ Disconnected Pavement
- ☐ Green Roof
- ☐ Interceptor Trees
- ☒ Porous Pavement
- ☐ Other. Describe: ____________________

4) Stormwater Quality Treatment Requirements

Refer to Design Manual Table 3-2 for Requirements

Is treatment required? ☒ Yes ☐ No

If no, form is complete with signature. If yes, complete this section.

Indicate number of drainage subwatersheds for the site: 2

Early consideration of stormwater quality during site planning may reduce the overall cost of treatment controls. Low Impact Development (LID) methods and innovative design options can reduce the size of treatment options. In addition, early consideration allows for non-proprietary treatment options that can significantly reduce construction and maintenance costs.

5) Attach Project Overview and Stormwater Quality Narrative

☒ Include Project description indicating nature of project (e.g., is it a newly developing site, replacement of a previously developed site, is it an infill site). Describe activities planned for site that may impact water quality such as a retail gasoline outlet as part of a development. Describe selected treatment options. <u>Developers should keep in mind that proprietary devices require extensive maintenance by the owners of the property and do not qualify for LID credit, and should consider alternative treatment measures first.</u> Project description should be no more than 1 page relating to stormwater quality.

Auto Dealership – Project Description

The auto dealership development is located within the County of Sacramento. The project is 4.34 acres and includes one large building and an associated parking lot. Approximately 0.8 acres of porous pavement is proposed in the perimeter parking spaces. A bioswale and underground storage chamber are also proposed to mitigated rooftop runoff from the proposed building.

The existing property is undeveloped.

The project is not located in an HMP exempt area, it is not a previously approved project, it does not discharge directly to an exempt channel, and it does not meet the infill exemption requirements.

☒ Include annotated copy of Figure 3-1 of the Design Manual demonstrating applicability of stormwater quality requirements.

☐ Include a copy of the discretionary level conditions of approval (if applicable).

6) Attach Site Plans* and/or Drawings Showing:

☒ Existing and natural hydrologic features

☒ Existing and proposed drainage system (including material, size, slope, and invert elevations)

☒ Locations where site discharges to municipal storm drain system and/or receiving waters

☒ Proposed grades/contours (agency may specify contour interval)

☒ Proposed drainage subwatersheds including (**Refer to item #4, if treatment is required)**

- Name of subwatershed
- Existing amount of pervious and impervious areas
- Proposed amount of pervious and impervious areas
- Proposed treatment option(s) for each subwatershed
- WQV or WQF to be treated

☒ Pollutant source areas including loading docks, food service areas, refuse areas, outdoor processes and storage, vehicle cleaning, repair or maintenance, fuel dispensing, equipment washing, etc.

☒ Proposed design features to minimize impervious areas, applicable LID techniques, innovative design, and all treatment options selected.

☒ Details for post-construction control measures, including the following information, where applicable:

- Dimensions and setbacks from property lines and structures
- Profile view, including typical cross-sections and dimensions
- Water surface elevations/freeboard
- Inlets, outlet structures, and release points
- Vegetation & growing medium specifications, including provisions for temporary irrigation if needed
- Specifications for construction materials, such as filter fabric and infiltration materials
- Installation requirements

*Note: Plans will not be checked for adequacy of treatment options until design review of drainage system. For information related to correct sizing and other requirements refer to *Stormwater Quality Design Manual for the Sacramento Region.*

7) Attach HMP Calculations (SAHM Output Report):

☒ Include SAHM output summary report demonstrating compliance with HMP flow duration criteria.

8) Attach LID Credit Backup:

☒ Include LID credit worksheet for either Residential or Commercial development (as applicable), or other backup documentation of LID credits.

9) Attach Design Data Summary Sheets:

☒ Include miscellaneous treatment calculations for any BMPs that are not already included in item 7 (HMP calculations) or item 8 (LID Credit Spreadsheet) above.

10) List Subwatersheds and Selected Stormwater Quality Measures (as required)

Subwatershed Name	Total Subwatershed Area		Flow (cfs) or Volume (ft^3)	Control Measures Selected (for Hydromodification Management, LID, and/or Treatment)
	Impervious Area	Pervious Area		
1	0.44		.08 cfs	90' Bioswale and Underground Storage
	0.44	0.00		
2	3.90		7,786 ft^3	Porous pavement and subsurface storage
	2.80	1.10		

11) Signature

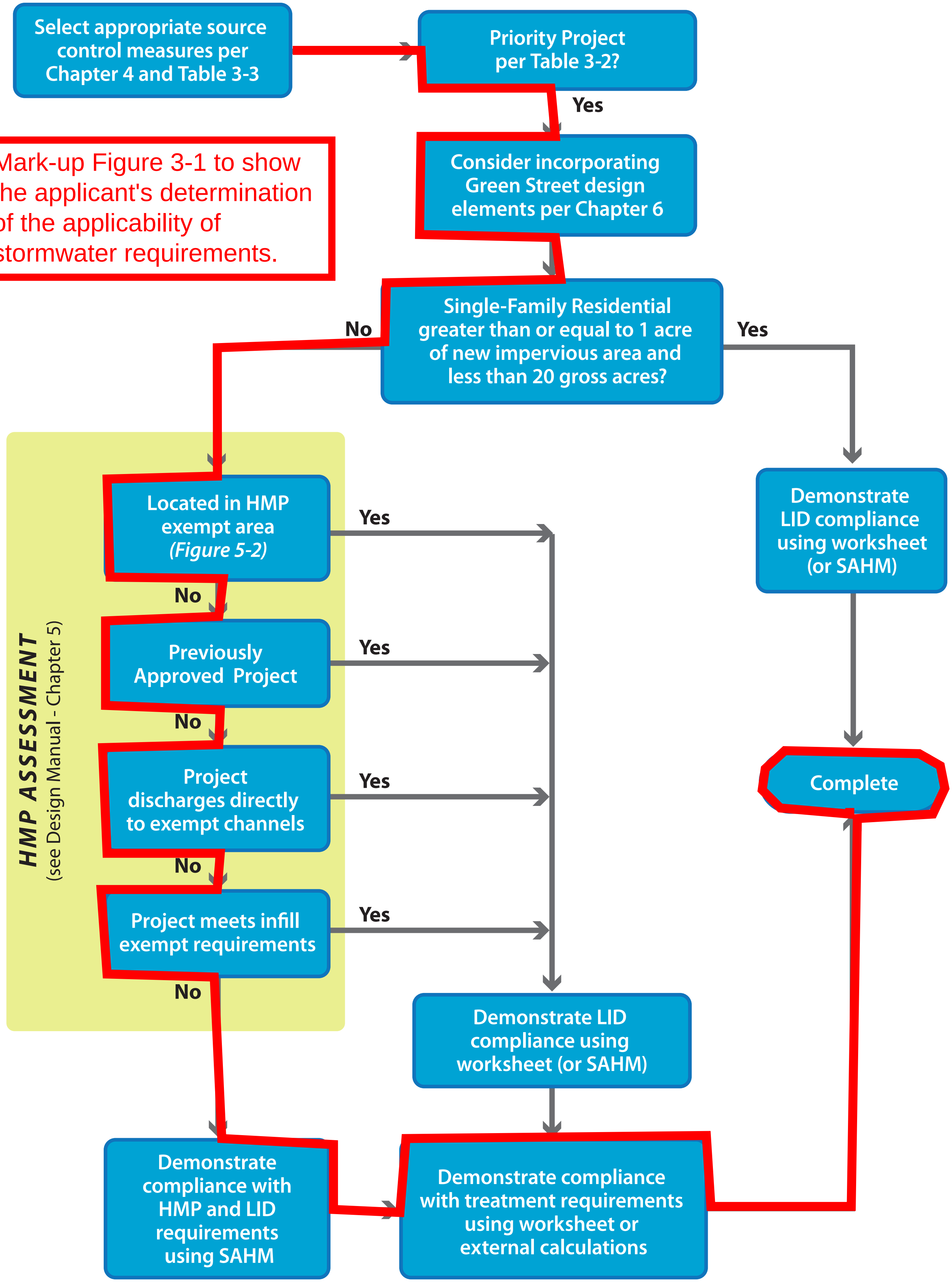
Print Name: Jim Anderson   Indicate Owner or Title: Owner

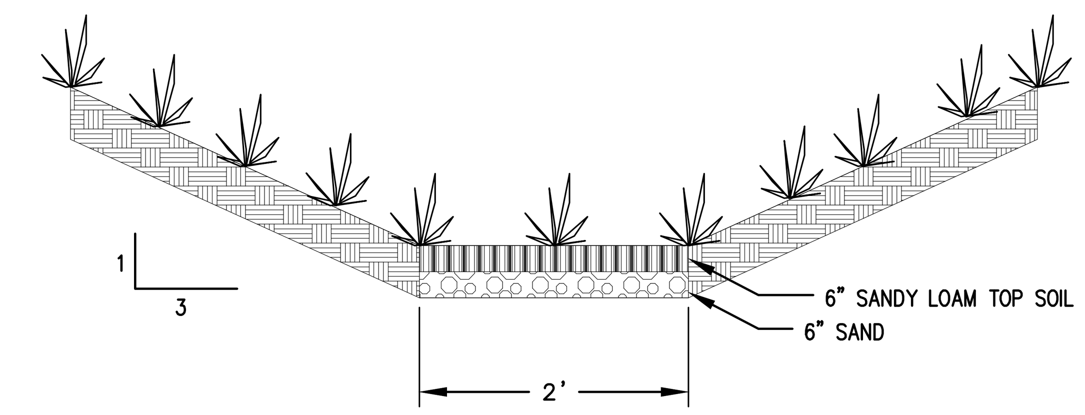
Signature: ______________________   Date: March 17, 2014

*Control measures may be those included in the *Stormwater Quality Design Manual for the Sacramento Region* or alternative measures. For projects proposing use of control measures not specified in the Design Manual, the review and approval process may take longer. Also, slight variations to design criteria stated in the manual may be approved on occasion, provided the agency determines that performance of the facility itself or other site structures/features is not compromised. For agencies in Sacramento County, proposals of alternative proprietary structural devices may be accepted if the manufacturer can satisfy the agencies' protocol or the property owner agrees to conduct a pilot scale monitoring study.

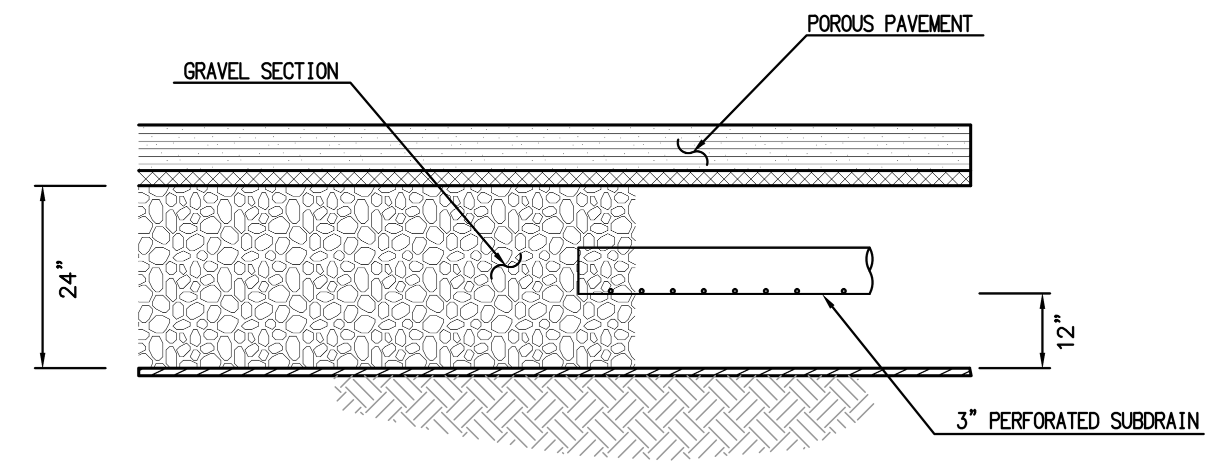
To avoid delays, all alternative proposals should be discussed with the stormwater quality staff at the permitting agency as early as possible in the planning stages of the project, preferably at the pre-application meeting.

Mark-up Figure 3-1 to show the applicant's determination of the applicability of stormwater requirements.





VEGETATED SWALE
N.T.S.



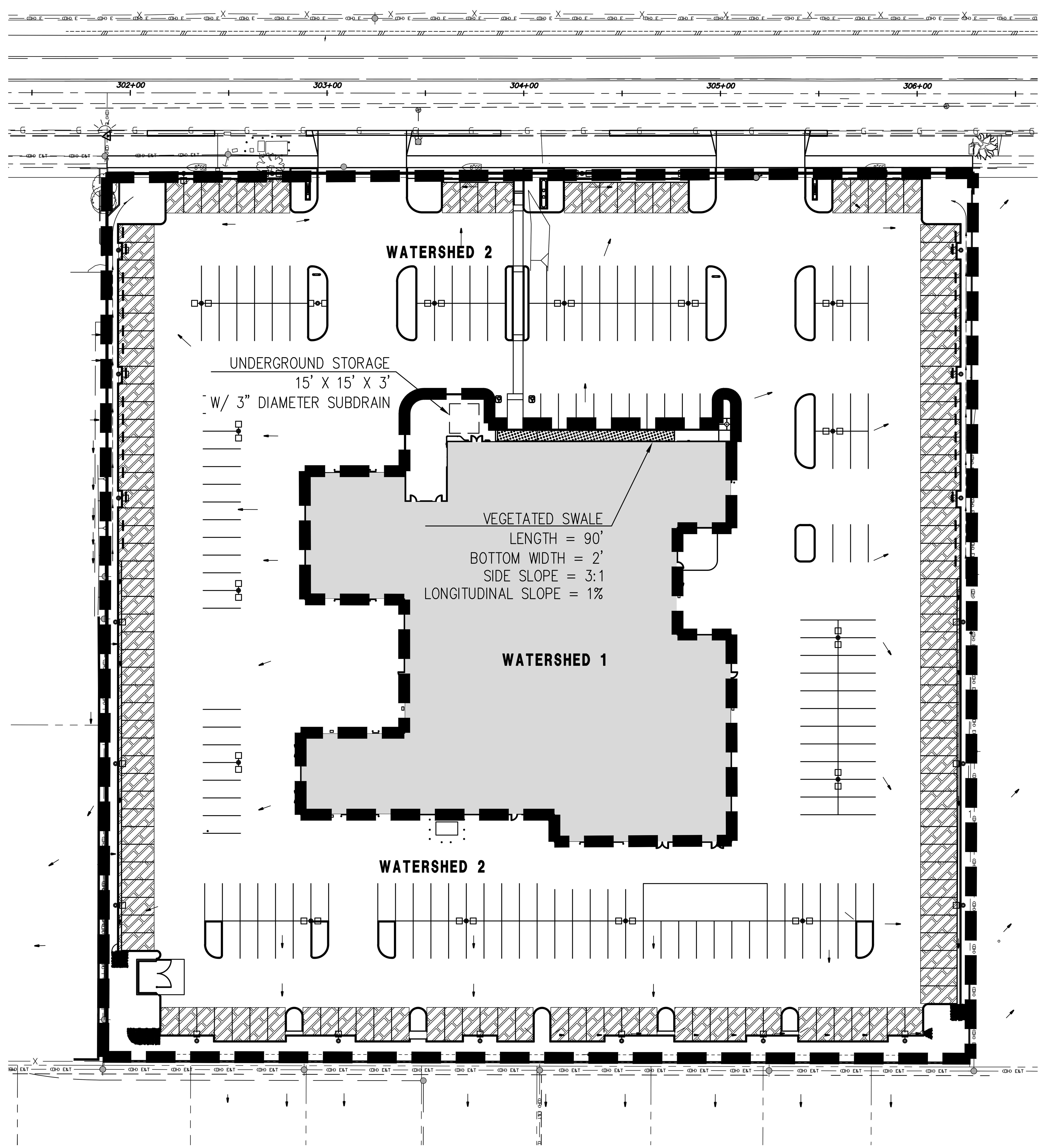
POROUS PAVEMENT SECTION
N.T.S.

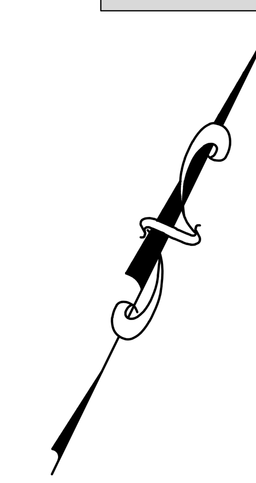
POST CONSTRUCTION MEASURES

SHED	EXISTING PERVIOUS	EXISTING IMPERVIOUS	PROPOSED PERVIOUS	PROPOSED IMPERVIOUS	TOTAL AREA	WQF/WQV	TREATMENT
#1	0.44 ACRES	0.00 ACRES	0.00 ACRES	0.44 ACRES	0.44 ACRES	0.08 CFS	VEGETATED SWALE
#2	3.90 ACRES	0.00 ACRES	1.10 ACRES	2.80 ACRES	3.90 ACRES	7,786 CF	POROUS PAVEMENT SUBGRADE

LEGEND

- POROUS PAVEMENT (0.80 ACRES TOTAL)
- VEGETATED SWALE (90 FEET)
- UNDERGROUND STORAGE (675 CUBIC FEET)
- DRAINAGE BASIN
- FLOW DIRECTION
- PROPOSED BUILDING





GRAPHIC SCALE
1 inch = 30' ft.

Post Construction Control Measure Compliance

I herby certify that the Post Construction Control Measures were constructed as shown on the plans approved by the County of Sacramento.

Project Engineer: ____________ R.C.E. : ________ Date ________

NUMBER	DESCRIPTION	ENGR INIT	COUNTY APPROVAL BY	DATE
7				
6				
5				
4				
3				
2				
1				

REVISION BLK.

DRAWN BY:
DESIGNED BY:
CHECKED BY:
SCALE: 1" = 30'
DATE: F.B. REF.

BENCH MARK
BM: ELEV : –
DATUM: –
(SEE SHEET 1)

PREPARED UNDER THE DIRECTION OF
DATE

IMPROVEMENT PLANS FOR:
AUTO DEALERSHIP
POST-CONSTRUCTION STORM WATER QUALITY PLAN
COUNTY OF SACRAMENTO, CALIFORNIA

JOB NUMBER

SAHM

PROJECT REPORT

General Model Information

Project Name:	Auburn Blvd Sample
Site Name:	
Site Address:	3830 Auburn BLVD
City:	sacramento, ca
Report Date:	3/17/2014
Gage:	RANCHO C
Data Start:	1961/10/01
Data End:	2004/09/30
Timestep:	Hourly
Precip Scale:	0.94
Version:	2013/12/06

POC Thresholds

Low Flow Threshold for POC1:	25 Percent of the 2 Year
High Flow Threshold for POC1:	10 Year
Low Flow Threshold for POC2:	25 Percent of the 2 Year
High Flow Threshold for POC2:	10 Year

Landuse Basin Data
Pre-Project Land Use

Pre Development

Bypass:	No
GroundWater:	No
Pervious Land Use	Acres
D,Grass,Mod (1-2%)	4.34
Pervious Total	4.34
Impervious Land Use	Acres
Impervious Total	0
Basin Total	4.34

Element Flows To:

Surface	Interflow	Groundwater

Duplicate Pre Develop

Bypass:	No
GroundWater:	No
Pervious Land Use	Acres
D,Grass,Mod (1-2%)	4.34
Pervious Total	4.34
Impervious Land Use	Acres
Impervious Total	0
Basin Total	4.34

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Traditional Asphalt Parking

Bypass:	No
Impervious Land Use	Acres
Imperv,Flat(0-1%) LAT	2.8

Element Flows To:

Outlet 1	Outlet 2
Porous Pavement 1	

Perimeter Landscape

Bypass:	No
GroundWater:	No
Pervious Land Use	Acres
D,Grass,Mod (1-2%)	.3

Element Flows To:

Surface	Interflow	Groundwater

Unmitigated Post

Bypass:	No
GroundWater:	No
Pervious Land Use	Acres
D,Grass,Mod (1-2%)	0.3
Pervious Total	0.3
Impervious Land Use	Acres
Imperv,Mod (1-2%)	4.04
Impervious Total	4.04
Basin Total	4.34

Element Flows To:

Surface	Interflow	Groundwater

Rooftop Area

Bypass:	No
Impervious Land Use	Acres
Imperv,Flat(0-1%) LAT	0.44

Element Flows To:

Outlet 1	Outlet 2
90 Foot Bioswale Building Front	

Routing Elements

Pre-Project Routing

Mitigated Routing

Porous Pavement 1

Pavement Area:0.7998 ac.Pavement Length: 1742.00 ft.
Pavement Width: 20.00 ft.
Pavement slope 1:0 To 1
Pavement thickness: 2
Pour Space of Pavement: 0.4
Material thickness of second layer: 0
Pour Space of material for second layer: 0
Material thickness of third layer: 0
Pour Space of material for third layer: 0
Infiltration On
Infiltration rate: 0.07
Infiltration safety factor: 1
Total Volume Infiltrated (ac-ft): 163.63
Total Volume Through Riser (ac-ft): 17.041
Total Volume Through Facility (ac-ft): 180.672
Percent Infiltrated: 90.57
Element Flows To:
Outlet 1 Outlet 2
Perimeter Landscape

Porous Pavement Hydraulic Table

Stage(ft)	Area(ac)	Volume(ac-ft)	Discharge(cfs)	Infilt(cfs)
0.0000	0.799	0.000	0.000	0.000
0.0278	0.800	0.008	0.000	0.056
0.0556	0.802	0.017	0.000	0.056
0.0833	0.803	0.026	0.000	0.056
0.1111	0.804	0.035	0.000	0.056
0.1389	0.805	0.044	0.000	0.056
0.1667	0.806	0.053	0.000	0.056
0.1944	0.807	0.062	0.000	0.056
0.2222	0.808	0.071	0.000	0.056
0.2500	0.809	0.080	0.000	0.056
0.2778	0.810	0.089	0.000	0.056
0.3056	0.812	0.098	0.000	0.056
0.3333	0.813	0.107	0.000	0.056
0.3611	0.814	0.116	0.000	0.056
0.3889	0.815	0.125	0.000	0.056
0.4167	0.816	0.134	0.000	0.056
0.4444	0.817	0.143	0.000	0.056
0.4722	0.818	0.152	0.000	0.056
0.5000	0.819	0.162	0.000	0.056
0.5278	0.820	0.171	0.000	0.056
0.5556	0.822	0.180	0.000	0.056
0.5833	0.823	0.189	0.000	0.056
0.6111	0.824	0.198	0.000	0.056
0.6389	0.825	0.207	0.000	0.056
0.6667	0.826	0.216	0.000	0.056
0.6944	0.827	0.226	0.000	0.056
0.7222	0.828	0.235	0.000	0.056
0.7500	0.829	0.244	0.000	0.056
0.7778	0.830	0.253	0.000	0.056
0.8056	0.832	0.262	0.000	0.056
0.8333	0.833	0.272	0.000	0.056

0.8611	0.834	0.281	0.000	0.056
0.8889	0.835	0.290	0.000	0.056
0.9167	0.836	0.300	0.000	0.056
0.9444	0.837	0.309	0.000	0.056
0.9722	0.838	0.318	0.000	0.056
1.0000	0.839	0.327	0.000	0.056
1.0278	0.840	0.337	0.039	0.056
1.0556	0.842	0.346	0.055	0.056
1.0833	0.843	0.356	0.068	0.056
1.1111	0.844	0.365	0.078	0.056
1.1389	0.845	0.374	0.088	0.056
1.1667	0.846	0.384	0.096	0.056
1.1944	0.847	0.393	0.104	0.056
1.2222	0.848	0.403	0.111	0.056
1.2500	0.849	0.412	0.118	0.056
1.2778	0.850	0.421	0.124	0.056
1.3056	0.852	0.431	0.130	0.056
1.3333	0.853	0.440	0.136	0.056
1.3611	0.854	0.450	0.142	0.056
1.3889	0.855	0.459	0.147	0.056
1.4167	0.856	0.469	0.152	0.056
1.4444	0.857	0.478	0.157	0.056
1.4722	0.858	0.488	0.162	0.056
1.5000	0.859	0.497	0.167	0.056
1.5278	0.860	0.507	0.171	0.056
1.5556	0.862	0.517	0.176	0.056
1.5833	0.863	0.526	0.180	0.056
1.6111	0.864	0.536	0.184	0.056
1.6389	0.865	0.545	0.188	0.056
1.6667	0.866	0.555	0.193	0.056
1.6944	0.867	0.565	0.197	0.056
1.7222	0.868	0.574	0.200	0.056
1.7500	0.869	0.584	0.204	0.056
1.7778	0.870	0.594	0.208	0.056
1.8056	0.872	0.603	0.212	0.056
1.8333	0.873	0.613	0.215	0.056
1.8611	0.874	0.623	0.219	0.056
1.8889	0.875	0.632	0.222	0.056
1.9167	0.876	0.642	0.226	0.056
1.9444	0.877	0.652	0.229	0.056
1.9722	0.878	0.662	0.233	0.056
2.0000	0.879	0.671	0.236	0.056
2.0278	0.880	0.696	0.316	0.056
2.0556	0.882	0.720	0.460	0.056
2.0833	0.883	0.745	0.646	0.056
2.1111	0.884	0.769	0.865	0.056
2.1389	0.885	0.794	1.114	0.056
2.1667	0.886	0.819	1.388	0.056
2.1944	0.887	0.843	1.685	0.056
2.2222	0.888	0.868	2.005	0.056
2.2500	0.889	0.893	2.345	0.056
2.2778	0.890	0.917	2.704	0.056
2.3056	0.892	0.942	3.082	0.056
2.3333	0.893	0.967	3.477	0.056
2.3611	0.894	0.992	3.888	0.056
2.3889	0.895	1.017	4.316	0.056
2.4167	0.896	1.041	4.759	0.056
2.4444	0.897	1.066	5.217	0.056

2.4722	0.898	1.091	5.689	0.056
2.5000	0.899	1.116	6.176	0.056

90 Foot Bioswale Building Front

Bottom Length: 90.00 ft.
Bottom Width: 2.00 ft.
Manning's n: 0.1
Channel bottom slope 1: 0.01 To 1
Channel Left side slope 0: 3 To 1
Channel right side slope 2: 3 To 1
Discharge Structure
Riser Height: 0 ft.
Riser Diameter: 0 in.
Element Flows To:
Outlet 1 Outlet 2
Vault 1

Channel Hydraulic Table

Stage(ft)	**Area(ac)**	**Volume(ac-ft)**	**Discharge(cfs)**	**Infilt(cfs)**
0.0000	0.004	0.000	0.000	0.000
0.0056	0.004	0.000	0.000	0.000
0.0111	0.004	0.000	0.001	0.000
0.0167	0.004	0.000	0.003	0.000
0.0222	0.004	0.000	0.005	0.000
0.0278	0.004	0.000	0.007	0.000
0.0333	0.004	0.000	0.010	0.000
0.0389	0.004	0.000	0.013	0.000
0.0444	0.004	0.000	0.017	0.000
0.0500	0.004	0.000	0.020	0.000
0.0556	0.004	0.000	0.024	0.000
0.0611	0.004	0.000	0.029	0.000
0.0667	0.005	0.000	0.033	0.000
0.0722	0.005	0.000	0.038	0.000
0.0778	0.005	0.000	0.043	0.000
0.0833	0.005	0.000	0.049	0.000
0.0889	0.005	0.000	0.055	0.000
0.0944	0.005	0.000	0.061	0.000
0.1000	0.005	0.000	0.067	0.000
0.1056	0.005	0.000	0.074	0.000
0.1111	0.005	0.000	0.080	0.000
0.1167	0.005	0.000	0.088	0.000
0.1222	0.005	0.000	0.095	0.000
0.1278	0.005	0.000	0.103	0.000
0.1333	0.005	0.000	0.111	0.000
0.1389	0.005	0.000	0.119	0.000
0.1444	0.005	0.000	0.127	0.000
0.1500	0.006	0.000	0.136	0.000
0.1556	0.006	0.000	0.145	0.000
0.1611	0.006	0.000	0.155	0.000
0.1667	0.006	0.000	0.164	0.000
0.1722	0.006	0.000	0.174	0.000
0.1778	0.006	0.000	0.184	0.000
0.1833	0.006	0.001	0.194	0.000
0.1889	0.006	0.001	0.205	0.000
0.1944	0.006	0.001	0.216	0.000
0.2000	0.006	0.001	0.227	0.000
0.2056	0.006	0.001	0.239	0.000
0.2111	0.006	0.001	0.250	0.000
0.2167	0.006	0.001	0.262	0.000

0.2222	0.006	0.001	0.275	0.000
0.2278	0.007	0.001	0.287	0.000
0.2333	0.007	0.001	0.300	0.000
0.2389	0.007	0.001	0.313	0.000
0.2444	0.007	0.001	0.327	0.000
0.2500	0.007	0.001	0.340	0.000
0.2556	0.007	0.001	0.354	0.000
0.2611	0.007	0.001	0.369	0.000
0.2667	0.007	0.001	0.383	0.000
0.2722	0.007	0.001	0.398	0.000
0.2778	0.007	0.001	0.413	0.000
0.2833	0.007	0.001	0.429	0.000
0.2889	0.007	0.001	0.444	0.000
0.2944	0.007	0.001	0.460	0.000
0.3000	0.007	0.001	0.477	0.000
0.3056	0.007	0.001	0.493	0.000
0.3111	0.008	0.001	0.510	0.000
0.3167	0.008	0.001	0.527	0.000
0.3222	0.008	0.002	0.545	0.000
0.3278	0.008	0.002	0.562	0.000
0.3333	0.008	0.002	0.580	0.000
0.3389	0.008	0.002	0.599	0.000
0.3444	0.008	0.002	0.617	0.000
0.3500	0.008	0.002	0.636	0.000
0.3556	0.008	0.002	0.656	0.000
0.3611	0.008	0.002	0.675	0.000
0.3667	0.008	0.002	0.695	0.000
0.3722	0.008	0.002	0.715	0.000
0.3778	0.008	0.002	0.736	0.000
0.3833	0.008	0.002	0.757	0.000
0.3889	0.009	0.002	0.778	0.000
0.3944	0.009	0.002	0.799	0.000
0.4000	0.009	0.002	0.821	0.000
0.4056	0.009	0.002	0.843	0.000
0.4111	0.009	0.002	0.865	0.000
0.4167	0.009	0.002	0.888	0.000
0.4222	0.009	0.002	0.911	0.000
0.4278	0.009	0.002	0.934	0.000
0.4333	0.009	0.003	0.958	0.000
0.4389	0.009	0.003	0.982	0.000
0.4444	0.009	0.003	1.006	0.000
0.4500	0.009	0.003	1.031	0.000
0.4556	0.009	0.003	1.056	0.000
0.4611	0.009	0.003	1.081	0.000
0.4667	0.009	0.003	1.107	0.000
0.4722	0.010	0.003	1.133	0.000
0.4778	0.010	0.003	1.159	0.000
0.4833	0.010	0.003	1.185	0.000
0.4889	0.010	0.003	1.212	0.000
0.4944	0.010	0.003	1.240	0.000
0.5000	0.010	0.003	1.267	0.000
0.5056	0.010	0.003	1.295	0.000

Vault 1

Width: 15 ft.
Length: 15 ft.
Depth: 3 ft.
Discharge Structure
Riser Height: 0 ft.
Riser Diameter: 0 in.
Orifice 1 Diameter: 3 in. Elevation:0 ft.
Element Flows To:
Outlet 1 Outlet 2

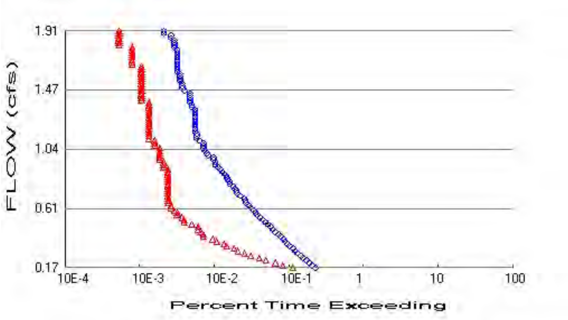
Vault Hydraulic Table

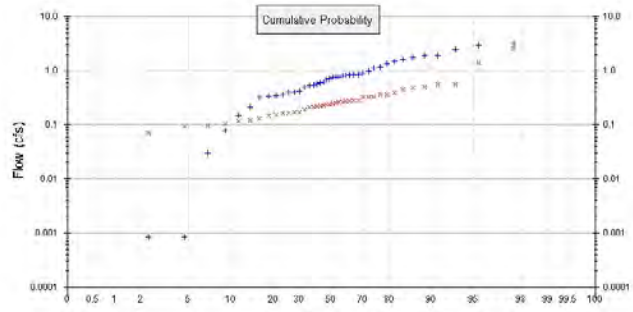
Stage(ft)	Area(ac)	Volume(ac-ft)	Discharge(cfs)	Infilt(cfs)
0.0000	0.005	0.000	0.000	0.000
0.0333	0.005	0.000	0.043	0.000
0.0667	0.005	0.000	0.061	0.000
0.1000	0.005	0.000	0.074	0.000
0.1333	0.005	0.000	0.086	0.000
0.1667	0.005	0.000	0.096	0.000
0.2000	0.005	0.001	0.105	0.000
0.2333	0.005	0.001	0.114	0.000
0.2667	0.005	0.001	0.122	0.000
0.3000	0.005	0.001	0.129	0.000
0.3333	0.005	0.001	0.136	0.000
0.3667	0.005	0.001	0.143	0.000
0.4000	0.005	0.002	0.149	0.000
0.4333	0.005	0.002	0.155	0.000
0.4667	0.005	0.002	0.161	0.000
0.5000	0.005	0.002	0.167	0.000
0.5333	0.005	0.002	0.172	0.000
0.5667	0.005	0.002	0.177	0.000
0.6000	0.005	0.003	0.183	0.000
0.6333	0.005	0.003	0.188	0.000
0.6667	0.005	0.003	0.193	0.000
0.7000	0.005	0.003	0.197	0.000
0.7333	0.005	0.003	0.202	0.000
0.7667	0.005	0.004	0.207	0.000
0.8000	0.005	0.004	0.211	0.000
0.8333	0.005	0.004	0.215	0.000
0.8667	0.005	0.004	0.220	0.000
0.9000	0.005	0.004	0.224	0.000
0.9333	0.005	0.004	0.228	0.000
0.9667	0.005	0.005	0.232	0.000
1.0000	0.005	0.005	0.236	0.000
1.0333	0.005	0.005	0.240	0.000
1.0667	0.005	0.005	0.244	0.000
1.1000	0.005	0.005	0.247	0.000
1.1333	0.005	0.005	0.251	0.000
1.1667	0.005	0.006	0.255	0.000
1.2000	0.005	0.006	0.258	0.000
1.2333	0.005	0.006	0.262	0.000
1.2667	0.005	0.006	0.266	0.000
1.3000	0.005	0.006	0.269	0.000
1.3333	0.005	0.006	0.272	0.000
1.3667	0.005	0.007	0.276	0.000

1.4000	0.005	0.007	0.279	0.000
1.4333	0.005	0.007	0.283	0.000
1.4667	0.005	0.007	0.286	0.000
1.5000	0.005	0.007	0.289	0.000
1.5333	0.005	0.007	0.292	0.000
1.5667	0.005	0.008	0.295	0.000
1.6000	0.005	0.008	0.299	0.000
1.6333	0.005	0.008	0.302	0.000
1.6667	0.005	0.008	0.305	0.000
1.7000	0.005	0.008	0.308	0.000
1.7333	0.005	0.009	0.311	0.000
1.7667	0.005	0.009	0.314	0.000
1.8000	0.005	0.009	0.317	0.000
1.8333	0.005	0.009	0.320	0.000
1.8667	0.005	0.009	0.322	0.000
1.9000	0.005	0.009	0.325	0.000
1.9333	0.005	0.010	0.328	0.000
1.9667	0.005	0.010	0.331	0.000
2.0000	0.005	0.010	0.334	0.000
2.0333	0.005	0.010	0.337	0.000
2.0667	0.005	0.010	0.339	0.000
2.1000	0.005	0.010	0.342	0.000
2.1333	0.005	0.011	0.345	0.000
2.1667	0.005	0.011	0.347	0.000
2.2000	0.005	0.011	0.350	0.000
2.2333	0.005	0.011	0.353	0.000
2.2667	0.005	0.011	0.355	0.000
2.3000	0.005	0.011	0.358	0.000
2.3333	0.005	0.012	0.361	0.000
2.3667	0.005	0.012	0.363	0.000
2.4000	0.005	0.012	0.366	0.000
2.4333	0.005	0.012	0.368	0.000
2.4667	0.005	0.012	0.371	0.000
2.5000	0.005	0.012	0.373	0.000
2.5333	0.005	0.013	0.376	0.000
2.5667	0.005	0.013	0.378	0.000
2.6000	0.005	0.013	0.381	0.000
2.6333	0.005	0.013	0.383	0.000
2.6667	0.005	0.013	0.386	0.000
2.7000	0.005	0.013	0.388	0.000
2.7333	0.005	0.014	0.390	0.000
2.7667	0.005	0.014	0.393	0.000
2.8000	0.005	0.014	0.395	0.000
2.8333	0.005	0.014	0.397	0.000
2.8667	0.005	0.014	0.400	0.000
2.9000	0.005	0.015	0.402	0.000
2.9333	0.005	0.015	0.404	0.000
2.9667	0.005	0.015	0.407	0.000
3.0000	0.005	0.015	0.409	0.000
3.0333	0.005	0.015	0.411	0.000
3.0667	0.000	0.000	0.413	0.000

Analysis Results

POC 1





+ Pre-Project x Mitigated

Pre-Project Landuse Totals for POC #1
Total Pervious Area: 4.34
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 0.3
Total Impervious Area: 4.039816

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Pre-Project. POC #1

Return Period	**Flow(cfs)**
2 year	0.699992
5 year	1.368109
10 year	1.907045
25 year	2.975886

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0.234126
5 year	0.366218
10 year	0.521446
25 year	1.546302

Annual Peaks

Annual Peaks for Pre-Project and Mitigated. POC #1

Year	**Pre-Project**	**Mitigated**
1962	0.764	0.284
1963	0.356	0.234
1964	0.078	0.155
1965	0.811	0.324
1966	0.030	0.096
1967	0.843	0.358
1968	0.211	0.106
1969	0.764	0.280
1970	0.612	0.231
1971	0.911	0.362
1972	0.001	0.071
1973	1.773	0.326
1974	0.561	0.164
1975	0.689	0.216

1976	0.001	0.094
1977	0.001	0.070
1978	0.849	0.260
1979	0.394	0.170
1980	1.343	0.320
1981	0.148	0.149
1982	1.483	0.482
1983	1.874	0.494
1984	0.700	0.245
1985	0.402	0.213
1986	2.954	1.398
1987	0.324	0.114
1988	0.589	0.168
1989	0.984	0.256
1990	0.748	0.187
1991	0.528	0.273
1992	1.101	0.273
1993	0.847	0.208
1994	0.414	0.129
1995	3.114	2.484
1996	1.935	0.450
1997	2.421	0.544
1998	1.594	0.545
1999	0.498	0.224
2000	1.165	0.384
2001	0.342	0.119
2002	0.338	0.167
2003	0.524	0.261
2004	0.820	0.220

Ranked Annual Peaks

Ranked Annual Peaks for Pre-Project and Mitigated. POC #1

Rank	Pre-Project	Mitigated
1	3.1143	2.4841
2	2.9540	1.3982
3	2.4206	0.5447
4	1.9348	0.5442
5	1.8737	0.4941
6	1.7727	0.4818
7	1.5943	0.4500
8	1.4829	0.3844
9	1.3426	0.3622
10	1.1647	0.3580
11	1.1010	0.3262
12	0.9836	0.3236
13	0.9106	0.3195
14	0.8490	0.2840
15	0.8467	0.2799
16	0.8425	0.2732
17	0.8198	0.2727
18	0.8112	0.2607
19	0.7642	0.2598
20	0.7639	0.2558
21	0.7476	0.2451
22	0.7000	0.2341
23	0.6893	0.2310
24	0.6118	0.2237
25	0.5891	0.2204

26	0.5608	0.2164
27	0.5277	0.2126
28	0.5240	0.2077
29	0.4980	0.1868
30	0.4136	0.1703
31	0.4018	0.1683
32	0.3939	0.1673
33	0.3564	0.1636
34	0.3420	0.1547
35	0.3376	0.1487
36	0.3241	0.1291
37	0.2111	0.1192
38	0.1484	0.1145
39	0.0776	0.1056
40	0.0303	0.0959
41	0.0008	0.0941
42	0.0008	0.0711
43	0.0008	0.0697

Duration Flows

The Facility PASSED

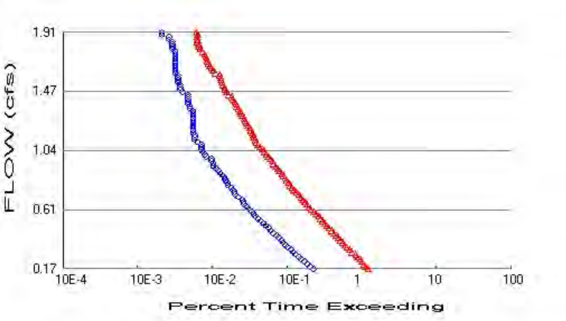
Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.1750	862	430	49	Pass
0.1925	770	313	40	Pass
0.2100	708	251	35	Pass
0.2275	653	187	28	Pass
0.2450	593	151	25	Pass
0.2625	549	116	21	Pass
0.2800	498	97	19	Pass
0.2975	462	79	17	Pass
0.3150	432	69	15	Pass
0.3325	388	56	14	Pass
0.3500	362	51	14	Pass
0.3674	340	41	12	Pass
0.3849	322	36	11	Pass
0.4024	296	27	9	Pass
0.4199	272	27	9	Pass
0.4374	250	25	10	Pass
0.4549	231	23	9	Pass
0.4724	215	23	10	Pass
0.4899	198	19	9	Pass
0.5074	185	15	8	Pass
0.5249	169	15	8	Pass
0.5424	155	14	9	Pass
0.5599	142	12	8	Pass
0.5774	136	12	8	Pass
0.5949	128	11	8	Pass
0.6124	115	10	8	Pass
0.6299	111	10	9	Pass
0.6474	102	9	8	Pass
0.6649	99	9	9	Pass
0.6824	96	9	9	Pass
0.6999	85	9	10	Pass
0.7174	77	9	11	Pass
0.7349	75	9	12	Pass
0.7523	72	9	12	Pass
0.7698	68	9	13	Pass
0.7873	61	9	14	Pass
0.8048	60	9	15	Pass
0.8223	57	9	15	Pass
0.8398	55	9	16	Pass
0.8573	52	9	17	Pass
0.8748	49	9	18	Pass
0.8923	46	9	19	Pass
0.9098	43	8	18	Pass
0.9273	39	8	20	Pass
0.9448	39	8	20	Pass
0.9623	37	7	18	Pass
0.9798	37	7	18	Pass
0.9973	31	7	22	Pass
1.0148	30	7	23	Pass
1.0323	28	7	25	Pass
1.0498	27	7	25	Pass
1.0673	27	6	22	Pass
1.0848	27	6	22	Pass

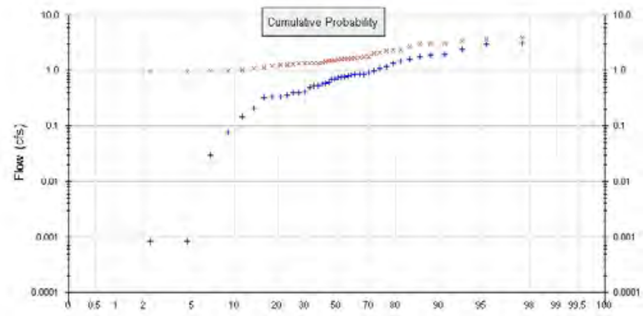
1.1023	24	6	25	Pass
1.1198	22	5	22	Pass
1.1372	22	5	22	Pass
1.1547	22	5	22	Pass
1.1722	21	5	23	Pass
1.1897	21	5	23	Pass
1.2072	21	5	23	Pass
1.2247	21	5	23	Pass
1.2422	21	5	23	Pass
1.2597	21	5	23	Pass
1.2772	21	5	23	Pass
1.2947	21	5	23	Pass
1.3122	21	5	23	Pass
1.3297	21	5	23	Pass
1.3472	19	5	26	Pass
1.3647	19	5	26	Pass
1.3822	18	5	27	Pass
1.3997	18	4	22	Pass
1.4172	18	4	22	Pass
1.4347	18	4	22	Pass
1.4522	18	4	22	Pass
1.4697	15	4	26	Pass
1.4872	14	4	28	Pass
1.5047	14	4	28	Pass
1.5221	14	4	28	Pass
1.5396	13	4	30	Pass
1.5571	13	4	30	Pass
1.5746	13	4	30	Pass
1.5921	13	4	30	Pass
1.6096	12	4	33	Pass
1.6271	12	4	33	Pass
1.6446	12	4	33	Pass
1.6621	12	3	25	Pass
1.6796	12	3	25	Pass
1.6971	12	3	25	Pass
1.7146	12	3	25	Pass
1.7321	12	3	25	Pass
1.7496	12	3	25	Pass
1.7671	12	3	25	Pass
1.7846	11	3	27	Pass
1.8021	11	2	18	Pass
1.8196	11	2	18	Pass
1.8371	11	2	18	Pass
1.8546	10	2	20	Pass
1.8721	10	2	20	Pass
1.8895	8	2	25	Pass
1.9070	8	2	25	Pass

Water Quality

Drawdown Time Results

POC 2





+ Pre-Project x Mitigated

Pre-Project Landuse Totals for POC #2

Total Pervious Area:	4.34
Total Impervious Area:	0

Mitigated Landuse Totals for POC #2

Total Pervious Area:	0.3
Total Impervious Area:	4.04

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Pre-Project. POC #2

Return Period	Flow(cfs)
2 year	0.699992
5 year	1.368109
10 year	1.907045
25 year	2.975886

Flow Frequency Return Periods for Mitigated. POC #2

Return Period	Flow(cfs)
2 year	1.50648
5 year	2.312765
10 year	3.065784
25 year	3.634603

Annual Peaks

Annual Peaks for Pre-Project and Mitigated. POC #2

Year	Pre-Project	Mitigated
1962	0.764	1.345
1963	0.356	1.615
1964	0.078	2.319
1965	0.811	1.334
1966	0.030	1.361
1967	0.843	1.682
1968	0.211	0.944
1969	0.764	1.097
1970	0.612	1.128
1971	0.911	1.626
1972	0.001	0.964
1973	1.773	2.913
1974	0.561	1.506
1975	0.689	1.696
1976	0.001	0.827

1977	0.001	0.972
1978	0.849	2.025
1979	0.394	0.989
1980	1.343	3.042
1981	0.148	1.304
1982	1.483	2.311
1983	1.874	2.677
1984	0.700	1.360
1985	0.402	1.658
1986	2.954	3.584
1987	0.324	1.033
1988	0.589	1.219
1989	0.984	1.752
1990	0.748	1.644
1991	0.528	2.263
1992	1.101	1.506
1993	0.847	1.361
1994	0.414	1.407
1995	3.114	3.958
1996	1.935	3.346
1997	2.421	3.085
1998	1.594	2.133
1999	0.498	1.231
2000	1.165	1.763
2001	0.342	1.242
2002	0.338	1.609
2003	0.524	1.461
2004	0.820	1.439

Ranked Annual Peaks

Ranked Annual Peaks for Pre-Project and Mitigated. POC #2

Rank	Pre-Project	Mitigated
1	3.1143	3.9578
2	2.9540	3.5836
3	2.4206	3.3456
4	1.9348	3.0854
5	1.8737	3.0423
6	1.7727	2.9133
7	1.5943	2.6767
8	1.4829	2.3186
9	1.3426	2.3115
10	1.1647	2.2631
11	1.1010	2.1330
12	0.9836	2.0253
13	0.9106	1.7631
14	0.8490	1.7520
15	0.8467	1.6961
16	0.8425	1.6819
17	0.8198	1.6584
18	0.8112	1.6443
19	0.7642	1.6256
20	0.7639	1.6151
21	0.7476	1.6087
22	0.7000	1.5065
23	0.6893	1.5055
24	0.6118	1.4611
25	0.5891	1.4393
26	0.5608	1.4073

27	0.5277	1.3613
28	0.5240	1.3606
29	0.4980	1.3605
30	0.4136	1.3449
31	0.4018	1.3344
32	0.3939	1.3040
33	0.3564	1.2419
34	0.3420	1.2305
35	0.3376	1.2185
36	0.3241	1.1281
37	0.2111	1.0966
38	0.1484	1.0330
39	0.0776	0.9890
40	0.0303	0.9716
41	0.0008	0.9635
42	0.0008	0.9440
43	0.0008	0.8269

Duration Flows

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.1750	862	4655	540	Fail
0.1925	770	4282	556	Fail
0.2100	708	4033	569	Fail
0.2275	653	3807	583	Fail
0.2450	593	3614	609	Fail
0.2625	549	3340	608	Fail
0.2800	498	3172	636	Fail
0.2975	462	2840	614	Fail
0.3150	432	2621	606	Fail
0.3325	388	2418	623	Fail
0.3500	362	2261	624	Fail
0.3674	340	2121	623	Fail
0.3849	322	1992	618	Fail
0.4024	296	1851	625	Fail
0.4199	272	1742	640	Fail
0.4374	250	1606	642	Fail
0.4549	231	1498	648	Fail
0.4724	215	1381	642	Fail
0.4899	198	1291	652	Fail
0.5074	185	1226	662	Fail
0.5249	169	1148	679	Fail
0.5424	155	1074	692	Fail
0.5599	142	1012	712	Fail
0.5774	136	928	682	Fail
0.5949	128	862	673	Fail
0.6124	115	799	694	Fail
0.6299	111	745	671	Fail
0.6474	102	702	688	Fail
0.6649	99	662	668	Fail
0.6824	96	620	645	Fail
0.6999	85	583	685	Fail
0.7174	77	543	705	Fail
0.7349	75	507	676	Fail
0.7523	72	468	650	Fail
0.7698	68	445	654	Fail
0.7873	61	418	685	Fail
0.8048	60	394	656	Fail
0.8223	57	374	656	Fail
0.8398	55	358	650	Fail
0.8573	52	339	651	Fail
0.8748	49	326	665	Fail
0.8923	46	301	654	Fail
0.9098	43	286	665	Fail
0.9273	39	267	684	Fail
0.9448	39	252	646	Fail
0.9623	37	240	648	Fail
0.9798	37	224	605	Fail
0.9973	31	213	687	Fail
1.0148	30	201	670	Fail
1.0323	28	191	682	Fail
1.0498	27	179	662	Fail
1.0673	27	165	611	Fail
1.0848	27	154	570	Fail
1.1023	24	148	616	Fail

1.1198	22	142	645	Fail
1.1372	22	134	609	Fail
1.1547	22	134	609	Fail
1.1722	21	130	619	Fail
1.1897	21	123	585	Fail
1.2072	21	120	571	Fail
1.2247	21	114	542	Fail
1.2422	21	108	514	Fail
1.2597	21	104	495	Fail
1.2772	21	101	480	Fail
1.2947	21	96	457	Fail
1.3122	21	93	442	Fail
1.3297	21	89	423	Fail
1.3472	19	84	442	Fail
1.3647	19	80	421	Fail
1.3822	18	79	438	Fail
1.3997	18	76	422	Fail
1.4172	18	71	394	Fail
1.4347	18	69	383	Fail
1.4522	18	62	344	Fail
1.4697	15	59	393	Fail
1.4872	14	56	400	Fail
1.5047	14	56	400	Fail
1.5221	14	53	378	Fail
1.5396	13	51	392	Fail
1.5571	13	49	376	Fail
1.5746	13	49	376	Fail
1.5921	13	48	369	Fail
1.6096	12	42	350	Fail
1.6271	12	39	325	Fail
1.6446	12	37	308	Fail
1.6621	12	35	291	Fail
1.6796	12	34	283	Fail
1.6971	12	32	266	Fail
1.7146	12	32	266	Fail
1.7321	12	31	258	Fail
1.7496	12	30	250	Fail
1.7671	12	28	233	Fail
1.7846	11	26	236	Fail
1.8021	11	25	227	Fail
1.8196	11	25	227	Fail
1.8371	11	24	218	Fail
1.8546	10	24	240	Fail
1.8721	10	24	240	Fail
1.8895	8	24	300	Fail
1.9070	8	23	287	Fail

The development has an increase in flow durations for more than a 10% increase from the 2 year to the 10 year flow.
The development has an increase in flow durations for more than 10% of the flows for the range of the duration analysis.

Drawdown Time Results

Model Default Modifications

Total of 0 changes have been made.

PERLND Changes

No PERLND changes have been made.

IMPLND Changes

No IMPLND changes have been made.

Appendix
Pre-Project Schematic

Mitigated Schematic

Pre-Project UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1961 10 01        END    2004 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                   UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                              ***
WDM        26   Auburn Blvd Sample.wdm
MESSU      25   PreAuburn Blvd Sample.MES
           27   PreAuburn Blvd Sample.L61
           28   PreAuburn Blvd Sample.L62
           30   POCAuburn Blvd Sample1.dat
           31   POCAuburn Blvd Sample2.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:60
      PERLND      50
      COPY       501
      COPY       502
      DISPLY       1
      DISPLY       2
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Pre Development             MAX                    1    2   30    9
    2        Duplicate Pre Develop       MAX                    1    2   31    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1        1    1
  501        1    1
  502        1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                          in  out           ***
   50     D,Grass,Mod (1-2%)      1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   50         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
```

```
    <PLS > ***************** Print-flags ***************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
   50         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   50         0    0    0    1    0    0    0    0    1    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   50              0      4.35     0.028       400      0.02         3      0.92
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   50             40        35         2         2         0         0      0.05
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                                     ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   50              0      0.28      0.25      0.65      0.48         0
  END PWAT-PARM4
  MON-LZETPARM
    <PLS >      PWATER input info: Part 3         ***
    # -  #  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC  ***
   50       0.4  0.4  0.4 0.45  0.5 0.55 0.55 0.55 0.55 0.55 0.45  0.4
  END MON-LZETPARM
  MON-INTERCEP
    <PLS >      PWATER input info: Part 3         ***
    # -  #  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC  ***
   50      0.12 0.12 0.12 0.11  0.1  0.1  0.1  0.1  0.1  0.1 0.11 0.12
  END MON-INTERCEP

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
              ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
   50              0         0      0.15         0         4      0.05         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name-------->   Unit-systems   Printer ***
    # -  #                      User  t-series Engl Metr ***
                                       in  out           ***
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
  END IWAT-PARM1
```

```
  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Pre Development***
PERLND  50                        4.34     COPY   501     12
PERLND  50                        4.34     COPY   501     13
Duplicate Pre Develop***
PERLND  50                        4.34     COPY   502     12
PERLND  50                        4.34     COPY   502     13

******Routing******
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   12.1        DISPLY   1     INPUT  TIMSER 1
COPY   502 OUTPUT MEAN   1 1   12.1        DISPLY   2     INPUT  TIMSER 1



<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                 ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG            ***
                                         in  out                             ***
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ******************* PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                      ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *       *  *  *  *  *         ***
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
```

```
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                         ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit       for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    0.944          PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    0.944          IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    1              PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    1              IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
COPY   501 OUTPUT MEAN   1 1      12.1     WDM    501 FLOW     ENGL      REPL
COPY   502 OUTPUT MEAN   1 1      12.1     WDM    502 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13


END MASS-LINK

END RUN
```

Mitigated UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1961 10 01        END    2004 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                   UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                              ***
WDM        26   Auburn Blvd Sample.wdm
MESSU      25   MitAuburn Blvd Sample.MES
           27   MitAuburn Blvd Sample.L61
           28   MitAuburn Blvd Sample.L62
           30   POCAuburn Blvd Sample1.dat
           31   POCAuburn Blvd Sample2.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:60
      IMPLND       6
      PERLND      50
      IMPLND       2
      IMPLND       9
      IMPLND       8
      RCHRES       1
      RCHRES       2
      PERLND      66
      RCHRES       3
      COPY       502
      COPY       501
      COPY         1
      DISPLY       2
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    2         Unmitigated Post            MAX                    1    2   31    9
    1         Perimeter Landscape         MAX                    1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  502         1    1
  501         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                         in  out          ***
   50     D,Grass,Mod (1-2%)      1    1    1    1   27    0
   66     D,Grass,Mod (1-2%)      1    1    1    1   27    0
```

```
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   50         0    0    1    0    0    0    0    0    0    0    0    0
   66         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ***************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
   50         0    0    4    0    0    0    0    0    0    0    0    0    1    9
   66         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   50         0    0    0    1    0    0    0    0    1    0    0
   66         0    0    0    1    0    0    0    0    1    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   50               0      4.35     0.028       400      0.02         3      0.92
   66               0      4.35     0.028       400      0.02         3      0.92
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   50              40        35         2         2         0         0      0.05
   66              40        35         2         2         0         0      0.05
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                               ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   50               0      0.28      0.25      0.65      0.48         0
   66               0      0.28      0.25      0.65      0.48         0
  END PWAT-PARM4
  MON-LZETPARM
    <PLS >      PWATER input info: Part 3         ***
    # -  #  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC  ***
   50       0.4  0.4  0.4 0.45  0.5 0.55 0.55 0.55 0.55 0.55 0.45  0.4
   66       0.4  0.4  0.4 0.45  0.5 0.55 0.55 0.55 0.55 0.55 0.45  0.4
  END MON-LZETPARM
  MON-INTERCEP
    <PLS >      PWATER input info: Part 3         ***
    # -  #  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC  ***
   50      0.12 0.12 0.12 0.11  0.1  0.1  0.1  0.1  0.1  0.1 0.11 0.12
   66      0.12 0.12 0.12 0.11  0.1  0.1  0.1  0.1  0.1  0.1 0.11 0.12
  END MON-INTERCEP

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
              ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
   50               0         0      0.15         0         4      0.05         0
   66               0         0      0.15         0         4      0.05         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
```

```
                                         in  out           ***
    6     Imperv,Flat(0-1%) LAT   1    1    1   27    0
    2     Imperv,Mod (1-2%)       1    1    1   27    0
    9     Imperv,Flat(0-1%) LAT   1    1    1   27    0
    8     Porous Pavement         1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    6         0    0    1    0    0    0
    2         0    0    1    0    0    0
    9         0    0    1    0    0    0
    8         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    6         0    0    4    0    0    0    1    9
    2         0    0    4    0    0    0    1    9
    9         0    0    4    0    0    0    1    9
    8         0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
    6         0    0    0    0    0
    2         0    0    0    0    0
    9         0    0    0    0    0
    8         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    6            100      0.01      0.05       0.1
    2            100      0.02      0.05       0.1
    9            100      0.01      0.05       0.1
    8            100      0.01      0.05       0.1
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    6              0         0
    2              0         0
    9              0         0
    8              0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    6              0         0
    2              0         0
    9              0         0
    8              0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Traditional Asphalt Parking***
IMPLND   6                      3.5008     IMPLND   8     53
IMPLND   8                      0.7998     RCHRES   1      5
```

```
Rooftop Area***
IMPLND   9                        0.44     RCHRES   2      5
Perimeter Landscape***
PERLND  66                         0.3     COPY   501     12
PERLND  66                         0.3     COPY   501     13
Unmitigated Post***
PERLND  50                         0.3     COPY   502     12
PERLND  50                         0.3     COPY   502     13
IMPLND   2                        4.04     COPY   502     15

******Routing******
RCHRES   1                      3.3333     PERLND  66     63
RCHRES   1                      3.3333     COPY     1     73
RCHRES   2                           1     RCHRES   3      6
RCHRES   2                                 COPY     1     16
RCHRES   3                           1     COPY   501     16
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   502 OUTPUT MEAN   1 1   12.1        DISPLY   2     INPUT  TIMSER 1
COPY   501 OUTPUT MEAN   1 1   12.1        DISPLY   1     INPUT  TIMSER 1



<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                 ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG            ***
                                           in  out                           ***
    1     Porous Pavement -009    2    1    1    1   28    0    1
    2     90 Foot Bioswale-013    1    1    1    1   28    0    1
    3     Vault  1                1    1    1    1   28    0    1
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
    1         1    0    0    0    0    0    0    0    0    0
    2         1    0    0    0    0    0    0    0    0    0
    3         1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ******************* PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
    1         4    0    0    0    0    0    0    0    0    0    1    9
    2         4    0    0    0    0    0    0    0    0    0    1    9
    3         4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                      ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible   exit *** possible   exit     possible   exit
             *  *  *  *    *  *  *  *  *       *  *  *  *  *         ***
    1        0  1  0  0    4  5  0  0  0       0  0  0  0  0       2  2  2  2  2
    2        0  1  0  0    4  0  0  0  0       0  0  0  0  0       2  2  2  2  2
    3        0  1  0  0    4  0  0  0  0       0  0  0  0  0       2  2  2  2  2
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
```

```
    1              1      0.33       0.0       0.0       0.5       0.0
    2              2      0.02       0.0       0.0       0.5       0.0
    3              3      0.01       0.0       0.0       0.5       0.0
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                         ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit       for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
    1         0            4.0  5.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
    2         0            4.0  0.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
    3         0            4.0  0.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
  FTABLE      1
   92    5
     Depth      Area    Volume  Outflow1  Outflow2  Velocity  Travel Time***
      (ft)   (acres) (acre-ft)     (cfs)     (cfs)  (ft/sec)    (Minutes)***
  0.000000  0.799816  0.000000  0.000000  0.000000
  0.027473  0.800915  0.008795  0.000000  0.056454
  0.054945  0.802014  0.017603  0.000000  0.056454
  0.082418  0.803112  0.026422  0.000000  0.056454
  0.109890  0.804211  0.035253  0.000000  0.056454
  0.137363  0.805310  0.044097  0.000000  0.056454
  0.164835  0.806408  0.052952  0.000000  0.056454
  0.192308  0.807507  0.061820  0.000000  0.056454
  0.219780  0.808606  0.070700  0.000000  0.056454
  0.247253  0.809704  0.079592  0.000000  0.056454
  0.274725  0.810803  0.088496  0.000000  0.056454
  0.302198  0.811901  0.097412  0.000000  0.056454
  0.329670  0.813000  0.106340  0.000000  0.056454
  0.357143  0.814099  0.115280  0.000000  0.056454
  0.384615  0.815197  0.124232  0.000000  0.056454
  0.412088  0.816296  0.133196  0.000000  0.056454
  0.439560  0.817395  0.142172  0.000000  0.056454
  0.467033  0.818493  0.151161  0.000000  0.056454
  0.494505  0.819592  0.160161  0.000000  0.056454
  0.521978  0.820691  0.169174  0.000000  0.056454
  0.549451  0.821789  0.178198  0.000000  0.056454
  0.576923  0.822888  0.187235  0.000000  0.056454
  0.604396  0.823987  0.196284  0.000000  0.056454
  0.631868  0.825085  0.205345  0.000000  0.056454
  0.659341  0.826184  0.214418  0.000000  0.056454
  0.686813  0.827283  0.223503  0.000000  0.056454
  0.714286  0.828381  0.232600  0.000000  0.056454
  0.741758  0.829480  0.241709  0.000000  0.056454
  0.769231  0.830579  0.250830  0.000000  0.056454
  0.796703  0.831677  0.259963  0.000000  0.056454
  0.824176  0.832776  0.269109  0.000000  0.056454
  0.851648  0.833874  0.278266  0.000000  0.056454
  0.879121  0.834973  0.287436  0.000000  0.056454
  0.906593  0.836072  0.296617  0.000000  0.056454
  0.934066  0.837170  0.305811  0.000000  0.056454
  0.961538  0.838269  0.315016  0.000000  0.056454
  0.989011  0.839368  0.324234  0.000000  0.056454
  1.016484  0.840466  0.333464  0.030348  0.056454
  1.043956  0.841565  0.342706  0.049558  0.056454
  1.071429  0.842664  0.351960  0.063174  0.056454
  1.098901  0.843762  0.361226  0.074336  0.056454
  1.126374  0.844861  0.370504  0.084029  0.056454
  1.153846  0.845960  0.379794  0.092714  0.056454
  1.181319  0.847058  0.389097  0.100652  0.056454
  1.208791  0.848157  0.398411  0.108008  0.056454
  1.236264  0.849256  0.407738  0.114895  0.056454
  1.263736  0.850354  0.417076  0.121391  0.056454
  1.291209  0.851453  0.426427  0.127557  0.056454
```

1.318681	0.852551	0.435789	0.133438	0.056454
1.346154	0.853650	0.445164	0.139071	0.056454
1.373626	0.854749	0.454551	0.144484	0.056454
1.401099	0.855847	0.463950	0.149702	0.056454
1.428571	0.856946	0.473361	0.154744	0.056454
1.456044	0.858045	0.482784	0.159626	0.056454
1.483516	0.859143	0.492219	0.164364	0.056454
1.510989	0.860242	0.501666	0.168969	0.056454
1.538462	0.861341	0.511125	0.173452	0.056454
1.565934	0.862439	0.520597	0.177822	0.056454
1.593407	0.863538	0.530080	0.182086	0.056454
1.620879	0.864637	0.539575	0.186254	0.056454
1.648352	0.865735	0.549083	0.190330	0.056454
1.675824	0.866834	0.558603	0.194320	0.056454
1.703297	0.867933	0.568134	0.198231	0.056454
1.730769	0.869031	0.577678	0.202065	0.056454
1.758242	0.870130	0.587234	0.205828	0.056454
1.785714	0.871229	0.596802	0.209524	0.056454
1.813187	0.872327	0.606382	0.213156	0.056454
1.840659	0.873426	0.615974	0.216726	0.056454
1.868132	0.874524	0.625578	0.220239	0.056454
1.895604	0.875623	0.635194	0.223697	0.056454
1.923077	0.876722	0.644822	0.227102	0.056454
1.950549	0.877820	0.654463	0.230456	0.056454
1.978022	0.878919	0.664115	0.233763	0.056454
2.005495	0.880018	0.688276	0.243805	0.056454
2.032967	0.881116	0.712468	0.339903	0.056454
2.060440	0.882215	0.736689	0.490811	0.056454
2.087912	0.883314	0.760941	0.680544	0.056454
2.115385	0.884412	0.785223	0.902223	0.056454
2.142857	0.885511	0.809535	1.151711	0.056454
2.170330	0.886610	0.833877	1.426156	0.056454
2.197802	0.887708	0.858250	1.723440	0.056454
2.225275	0.888807	0.882653	2.041906	0.056454
2.252747	0.889906	0.907086	2.380216	0.056454
2.280220	0.891004	0.931549	2.737254	0.056454
2.307692	0.892103	0.956042	3.112077	0.056454
2.335165	0.893201	0.980565	3.503869	0.056454
2.362637	0.894300	1.005119	3.911919	0.056454
2.390110	0.895399	1.029703	4.335597	0.056454
2.417582	0.896497	1.054317	4.774342	0.056454
2.445055	0.897596	1.078961	5.227649	0.056454
2.472527	0.898695	1.103635	5.695062	0.056454
2.500000	0.899793	1.128340	6.176163	0.056454

END FTABLE 1
FTABLE 2
91 4

Depth (ft)	Area (acres)	Volume (acre-ft)	Outflow1 (cfs)	Velocity (ft/sec)	Travel Time*** (Minutes)***
0.000000	0.004132	0.000000	0.000000		
0.005556	0.004201	0.000023	0.000520		
0.011111	0.004270	0.000047	0.001656		
0.016667	0.004339	0.000071	0.003263		
0.022222	0.004408	0.000095	0.005284		
0.027778	0.004477	0.000120	0.007683		
0.033333	0.004545	0.000145	0.010439		
0.038889	0.004614	0.000170	0.013533		
0.044444	0.004683	0.000196	0.016952		
0.050000	0.004752	0.000222	0.020686		
0.055556	0.004821	0.000249	0.024727		
0.061111	0.004890	0.000276	0.029068		
0.066667	0.004959	0.000303	0.033703		
0.072222	0.005028	0.000331	0.038627		
0.077778	0.005097	0.000359	0.043838		
0.083333	0.005165	0.000387	0.049330		
0.088889	0.005234	0.000416	0.055103		
0.094444	0.005303	0.000446	0.061152		
0.100000	0.005372	0.000475	0.067477		
0.105556	0.005441	0.000505	0.074077		
0.111111	0.005510	0.000536	0.080948		

0.116667	0.005579	0.000566	0.088092
0.122222	0.005648	0.000598	0.095506
0.127778	0.005716	0.000629	0.103191
0.133333	0.005785	0.000661	0.111145
0.138889	0.005854	0.000693	0.119369
0.144444	0.005923	0.000726	0.127862
0.150000	0.005992	0.000759	0.136625
0.155556	0.006061	0.000793	0.145657
0.161111	0.006130	0.000827	0.154959
0.166667	0.006199	0.000861	0.164530
0.172222	0.006267	0.000896	0.174372
0.177778	0.006336	0.000931	0.184485
0.183333	0.006405	0.000966	0.194869
0.188889	0.006474	0.001002	0.205525
0.194444	0.006543	0.001038	0.216454
0.200000	0.006612	0.001074	0.227655
0.205556	0.006681	0.001111	0.239131
0.211111	0.006750	0.001149	0.250881
0.216667	0.006819	0.001186	0.262907
0.222222	0.006887	0.001224	0.275209
0.227778	0.006956	0.001263	0.287789
0.233333	0.007025	0.001302	0.300647
0.238889	0.007094	0.001341	0.313784
0.244444	0.007163	0.001381	0.327201
0.250000	0.007232	0.001420	0.340900
0.255556	0.007301	0.001461	0.354881
0.261111	0.007370	0.001502	0.369145
0.266667	0.007438	0.001543	0.383693
0.272222	0.007507	0.001584	0.398527
0.277778	0.007576	0.001626	0.413648
0.283333	0.007645	0.001668	0.429057
0.288889	0.007714	0.001711	0.444754
0.294444	0.007783	0.001754	0.460742
0.300000	0.007852	0.001798	0.477021
0.305556	0.007921	0.001841	0.493592
0.311111	0.007990	0.001886	0.510458
0.316667	0.008058	0.001930	0.527618
0.322222	0.008127	0.001975	0.545074
0.327778	0.008196	0.002020	0.562828
0.333333	0.008265	0.002066	0.580880
0.338889	0.008334	0.002112	0.599232
0.344444	0.008403	0.002159	0.617885
0.350000	0.008472	0.002206	0.636841
0.355556	0.008541	0.002253	0.656100
0.361111	0.008610	0.002301	0.675665
0.366667	0.008678	0.002349	0.695535
0.372222	0.008747	0.002397	0.715713
0.377778	0.008816	0.002446	0.736200
0.383333	0.008885	0.002495	0.756997
0.388889	0.008954	0.002545	0.778106
0.394444	0.009023	0.002594	0.799527
0.400000	0.009092	0.002645	0.821263
0.405556	0.009161	0.002695	0.843314
0.411111	0.009229	0.002747	0.865681
0.416667	0.009298	0.002798	0.888367
0.422222	0.009367	0.002850	0.911371
0.427778	0.009436	0.002902	0.934697
0.433333	0.009505	0.002955	0.958344
0.438889	0.009574	0.003008	0.982315
0.444444	0.009643	0.003061	1.006611
0.450000	0.009712	0.003115	1.031232
0.455556	0.009781	0.003169	1.056181
0.461111	0.009849	0.003224	1.081459
0.466667	0.009918	0.003278	1.107066
0.472222	0.009987	0.003334	1.133005
0.477778	0.010056	0.003389	1.159277
0.483333	0.010125	0.003445	1.185882
0.488889	0.010194	0.003502	1.212823
0.494444	0.010263	0.003559	1.240101
0.500000	0.010332	0.003616	1.267716

END FTABLE 2
FTABLE 3
92 4

Depth (ft)	Area (acres)	Volume (acre-ft)	Outflow1 (cfs)	Velocity (ft/sec)	Travel Time*** (Minutes)***
0.000000	0.005165	0.000000	0.000000		
0.033333	0.005165	0.000172	0.043156		
0.066667	0.005165	0.000344	0.061032		
0.100000	0.005165	0.000517	0.074748		
0.133333	0.005165	0.000689	0.086312		
0.166667	0.005165	0.000861	0.096500		
0.200000	0.005165	0.001033	0.105710		
0.233333	0.005165	0.001205	0.114180		
0.266667	0.005165	0.001377	0.122064		
0.300000	0.005165	0.001550	0.129468		
0.333333	0.005165	0.001722	0.136471		
0.366667	0.005165	0.001894	0.143132		
0.400000	0.005165	0.002066	0.149497		
0.433333	0.005165	0.002238	0.155601		
0.466667	0.005165	0.002410	0.161475		
0.500000	0.005165	0.002583	0.167142		
0.533333	0.005165	0.002755	0.172624		
0.566667	0.005165	0.002927	0.177937		
0.600000	0.005165	0.003099	0.183095		
0.633333	0.005165	0.003271	0.188113		
0.666667	0.005165	0.003444	0.192999		
0.700000	0.005165	0.003616	0.197766		
0.733333	0.005165	0.003788	0.202419		
0.766667	0.005165	0.003960	0.206969		
0.800000	0.005165	0.004132	0.211420		
0.833333	0.005165	0.004304	0.215780		
0.866667	0.005165	0.004477	0.220053		
0.900000	0.005165	0.004649	0.224245		
0.933333	0.005165	0.004821	0.228360		
0.966667	0.005165	0.004993	0.232402		
1.000000	0.005165	0.005165	0.236375		
1.033333	0.005165	0.005337	0.240282		
1.066667	0.005165	0.005510	0.244127		
1.100000	0.005165	0.005682	0.247912		
1.133333	0.005165	0.005854	0.251640		
1.166667	0.005165	0.006026	0.255314		
1.200000	0.005165	0.006198	0.258936		
1.233333	0.005165	0.006371	0.262508		
1.266667	0.005165	0.006543	0.266031		
1.300000	0.005165	0.006715	0.269509		
1.333333	0.005165	0.006887	0.272942		
1.366667	0.005165	0.007059	0.276333		
1.400000	0.005165	0.007231	0.279683		
1.433333	0.005165	0.007404	0.282993		
1.466667	0.005165	0.007576	0.286264		
1.500000	0.005165	0.007748	0.289499		
1.533333	0.005165	0.007920	0.292698		
1.566667	0.005165	0.008092	0.295862		
1.600000	0.005165	0.008264	0.298993		
1.633333	0.005165	0.008437	0.302092		
1.666667	0.005165	0.008609	0.305159		
1.700000	0.005165	0.008781	0.308195		
1.733333	0.005165	0.008953	0.311202		
1.766667	0.005165	0.009125	0.314180		
1.800000	0.005165	0.009298	0.317130		
1.833333	0.005165	0.009470	0.320053		
1.866667	0.005165	0.009642	0.322950		
1.900000	0.005165	0.009814	0.325820		
1.933333	0.005165	0.009986	0.328666		
1.966667	0.005165	0.010158	0.331487		
2.000000	0.005165	0.010331	0.334285		
2.033333	0.005165	0.010503	0.337059		
2.066667	0.005165	0.010675	0.339810		
2.100000	0.005165	0.010847	0.342540		
2.133333	0.005165	0.011019	0.345248		

```
  2.166667  0.005165  0.011191  0.347935
  2.200000  0.005165  0.011364  0.350601
  2.233333  0.005165  0.011536  0.353247
  2.266667  0.005165  0.011708  0.355873
  2.300000  0.005165  0.011880  0.358480
  2.333333  0.005165  0.012052  0.361069
  2.366667  0.005165  0.012225  0.363639
  2.400000  0.005165  0.012397  0.366191
  2.433333  0.005165  0.012569  0.368725
  2.466667  0.005165  0.012741  0.371242
  2.500000  0.005165  0.012913  0.373742
  2.533333  0.005165  0.013085  0.376225
  2.566667  0.005165  0.013258  0.378692
  2.600000  0.005165  0.013430  0.381143
  2.633333  0.005165  0.013602  0.383579
  2.666667  0.005165  0.013774  0.385999
  2.700000  0.005165  0.013946  0.388404
  2.733333  0.005165  0.014118  0.390794
  2.766667  0.005165  0.014291  0.393170
  2.800000  0.005165  0.014463  0.395531
  2.833333  0.005165  0.014635  0.397878
  2.866667  0.005165  0.014807  0.400212
  2.900000  0.005165  0.014979  0.402532
  2.933333  0.005165  0.015152  0.404839
  2.966667  0.005165  0.015324  0.407133
  3.000000  0.005165  0.015496  0.409414
  3.033333  0.005165  0.015668  0.411682
  END FTABLE  3
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC      ENGL    0.944         PERLND   1 999 EXTNL  PREC
WDM      2 PREC      ENGL    0.944         IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP      ENGL    1             PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP      ENGL    1             IMPLND   1 999 EXTNL  PETINP
WDM      1 EVAP      ENGL    1             RCHRES   1     EXTNL  POTEV

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
COPY     1 OUTPUT MEAN   1 1     12.1      WDM    701 FLOW     ENGL      REPL
COPY   501 OUTPUT MEAN   1 1     12.1      WDM    801 FLOW     ENGL      REPL
COPY     2 OUTPUT MEAN   1 1     12.1      WDM    702 FLOW     ENGL      REPL
COPY   502 OUTPUT MEAN   1 1     12.1      WDM    802 FLOW     ENGL      REPL
RCHRES   3 HYDR   RO     1 1        1      WDM   1000 FLOW     ENGL      REPL
RCHRES   3 HYDR   STAGE  1 1        1      WDM   1001 STAG     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK        5
IMPLND     IWATER SURO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    5

  MASS-LINK        6
RCHRES     ROFLOW                          RCHRES         INFLOW
  END MASS-LINK    6

  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13
```

```
  MASS-LINK        15
IMPLND      IWATER SURO        0.083333      COPY           INPUT  MEAN
  END MASS-LINK    15

  MASS-LINK        16
RCHRES      ROFLOW                           COPY           INPUT  MEAN
  END MASS-LINK    16

  MASS-LINK        53
IMPLND      IWATER SURO                      IMPLND         EXTNL  SURLI
  END MASS-LINK    53

  MASS-LINK        63
RCHRES      OFLOW  OVOL   1    12.00000      PERLND         EXTNL  SURLI
  END MASS-LINK    63

  MASS-LINK        73
RCHRES      OFLOW  OVOL   1                  COPY           INPUT  MEAN
  END MASS-LINK    73

END MASS-LINK

END RUN
```

Pre-Project HSPF Message File

Mitigated HSPF Message File

Disclaimer

Legal Notice

Clear Creek Solutions, Inc.
6200 Capitol Blvd. Ste F
Olympia, WA. 98501
Toll Free 1(866)943-0304
Local (360)943-0304

www.clearcreeksolutions.com

LID Points Tabulation									
LID Measures	Pre Time Series	Pre Volume (ac-ft)	Post Unmit. Element Name	Post Unmit. Time Series	Post Unmit. Volume (ac-ft)	Post Mitigated Element Name	Post Mitigated Time Series	Post Mit. Volume (ac-ft)	LID Pts
Porous Pavement, 90 Foot Bioswale Building Front	501	49	Unmitigated Post	802	215.3	Porous Pavement 1, 90 Foot Bioswale Building Front	801	42.7	207.58
								Total	**207.58**

Channel Report

90 Foot Swale at Building Front

Trapezoidal

Bottom Width (ft)	= 2.00
Side Slopes (z:1)	= 3.00, 3.00
Total Depth (ft)	= 0.50
Invert Elev (ft)	= 100.00
Slope (%)	= 1.00
N-Value	= 0.200

Calculations

Compute by:	Known Q
Known Q (cfs)	= 0.08

Highlighted

Depth (ft)	= 0.17
Q (cfs)	= 0.080
Area (sqft)	= 0.43
Velocity (ft/s)	= 0.19
Wetted Perim (ft)	= 3.08
Crit Depth, Yc (ft)	= 0.04
Top Width (ft)	= 3.02
EGL (ft)	= 0.17

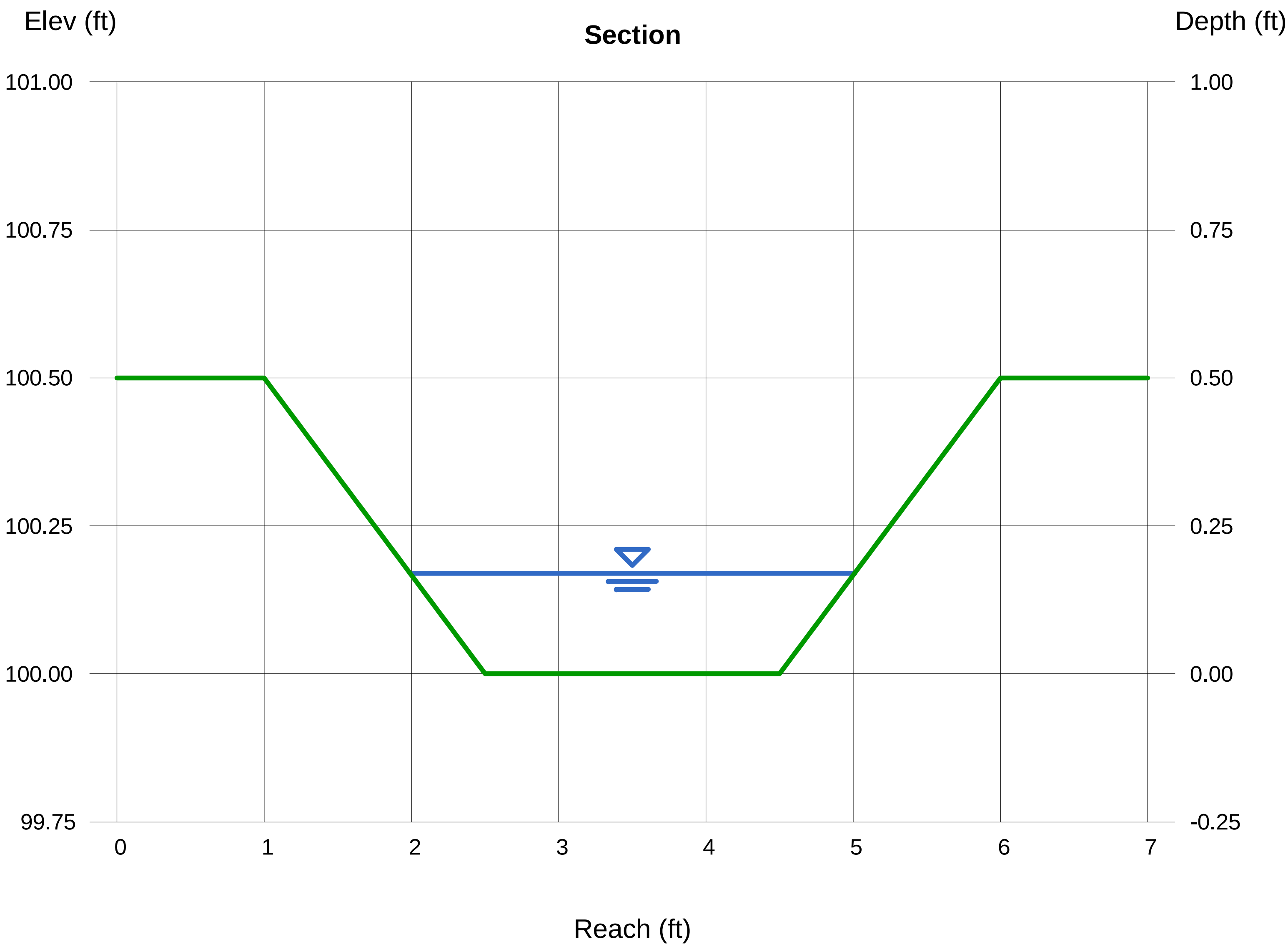


Table VS-3. Design Data Summary Sheet for Vegetated Swale

Designer: John Smith Date: 3/17/2014

Company: ABCD Engineering

Project: Auto Dealership

Location: Along front side of proposed building

1. Design Flow: WQF = I x C x A	WQF =	0.08	cfs
I = Design Intensity = 0.18 in/hr	I =	0.18	in/hr
C = Runoff Coefficient	C =	1.0	
A = Tributary Area	A =	0.44	acres
2. Swale Geometry			
Swale Bottom Width (b)	b =	2.0	Ft
Side slope (Z)	Z =	3:1	
3. Depth of flow (d) at WQF (3" to 5" with Manning's n=0.20)	d =	2.04	in
4. Design Slope			
s = 1% minimum without underdrains, 4% maximum without grade controls	s =	1.0	%
Number of grade controls required		N/A	
5. Design flow velocity (Manning's n=0.20)	v =	0.19	ft/sec
6. Contact Time (t_c = 7 minutes minimum)	t_c =	7.9	Minutes
7. Design Length, L = (t_c) x (flow velocity) x 60	L =	90	ft

8. Vegetation (describe): 4" to 6" high grass

9. Outflow Collection (Check type used or describe "Other")

☐ Grated Inlet ☐ Infiltration Trench ☐ Underdrain Used

☒ Other Discharge to adjacent underground vault.

Notes:

Porous Pavement Subgrade Storage Volume

169,884 sf	Tributary Drainage Area
7,786 cf	Water Quality Volume
13,939 cf	Volume Provided

Volume provided in void space of porous pavement subgrade exceed WQV.

Appendix B. Maintenance Requirements

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Appendix B Maintenance Requirements

State Mandated Requirement

Verification of long-term maintenance provisions for post-construction structural and treatment control measures is mandated by the agencies' State-issued stormwater permits. For example, the Sacramento Areawide NPDES Municipal Stormwater Permit (No. CAS082597) specifies:

22. Maintenance Agreement and Transfer: Each Permittee shall require that all developments subject to Development Standards and site specific plan requirements provide verification of maintenance provisions for Structural Treatment Control BMPs, including but not limited to legal agreements, covenants, California Environmental Quality Act (CEQA) mitigation requirements, and or conditional use permits. Verification at a minimum shall include:

a. The developer's signed statement accepting responsibility for maintenance until the responsibility is legally transferred; or

b. Written conditions in the sales or lease agreement, which requires the recipient to assume responsibility for maintenance; or

c. Written text in project conditions, covenants and restrictions for residential properties assigning maintenance responsibilities to the Home Owners Association for maintenance of Structural Treatment Control BMPs; or

d. Any other legally enforceable agreement that assigns responsibility for the maintenance of post-construction Structural Treatment Control BMPs.

Maintenance Agreements, Covenants or Permits

In compliance with this regulation, the local permitting agencies in the Sacramento area have decided that they will require execution of a maintenance agreement, covenant or permit with the property owner for projects using any of the following control measures (refer to Chapter 5):

- Underground Storage
- Porous Pavement
- Green Roof
- Constructed Wetland Basin
- Water Quality Detention Basin
- Infiltration Basin

- Infiltration Trench
- Sand Filter
- Bioretention Planter
- Vegetated Swale
- Proprietary Devices
- Trash Capture Devices

Typically, maintenance agreements and covenants are recorded with the deed for the property and follow property ownership. The agreements generally include provisions for the permitting agency to recover costs for maintenance in the event that the property owner fails to fulfill their obligations. Check with the local permitting agency about the timing for execution of the agreement.

Recommended Inspection and Maintenance Procedures

A stand-alone table listing recommended inspection and maintenance procedures is provided at the end of the fact sheet for each of the above control measures. The intent is for the applicable table(s) to be incorporated into the maintenance agreement for the project with amendments as needed by the project designer and property owner to pertain to the unique project conditions. It is the responsibility of the project designer to inform the permitting agency of the complete set of necessary inspection and maintenance requirements that will provide long-term continued performance and sustainability of the measures.

Reconstruction or Replacement of Failed Facilities

In addition to inspecting and performing maintenance on the stormwater quality control measure(s), the property owner will be required by the maintenance agreement or permit to reconstruct or replace the measure when it ceases to function properly. For informational purposes, the table on the next page summarizes projected life span information for the various stormwater quality control measures, based on available literature.

Example Maintenance Agreements

Each agency will likely use a different format for the maintenance verification. For example purposes, two standard maintenance covenants/agreements are provided at the end of this appendix, for the County of Sacramento and City of Sacramento, respectively. The contents of each form are basically the same.

Resources for Additional Guidance

Maintaining Your Stormwater Management Facility: Homeowner Handbook, City of Portland, OR. http://www.portlandonline.com/shared/cfm/image.cfm?id=65926

Expected Life for Selected Stormwater Quality Control Measures (Based on Published Literature)

Control Measure	Average Life Expectancy[1]	Source/Reference
Underground Storage		
Porous Pavement[2]	20 years	Maintaining Your Stormwater Management Facility: Homeowner Handbook, City of Portland, OR. http://www.portlandonline.com/shared/cfm/image.cfm?id=65926
	30 years	http://www.seattle.gov/dpd/static/GF_RainGardens_1_37427_DPDP_019875.pdf
Disconnected Pavement		
Alternative Driveway		
Disconnected Roof Drains		
Interceptor Trees		
Green Roof	10-40 years	http://www.ecoroofsystems.com/cost_files/c_cost.html
Capture and Re-Use		
Compost Amended Soil		
Constructed Wetland Detention Basin	20 years	http://www.epa.gov/superfund/programs/aml/tech/cuwetlands.pdf
Water Quality Detention Basin	25 years and more	http://www.abe.msstate.edu/csd/p-dm/all-chapters/chapter4/chapter4/det-basin.pdf
Infiltration Basin	NA	Information to be provided in a future update.
Infiltration Trench	30 years	http://www.portlandonline.com/shared/cfm/image.cfm?id=65926
	5-15 years	http://www.epa.gov/owmitnet/mtb/infiltrenc.pdf
Sand Filter	5-20 years	http://www.fhwa.dot.gov/environment/ultraurb/3fs7.htm
Bioretention Planter	NA	Information to be provided in a future update.
Vegetated Filter Strip	50 years	http://www.portlandonline.com/shared/cfm/image.cfm?id=65926
Vegetated Swale	20 years	http://www.highwaybmp.dfwinfo.com/FHWA_PDF/Grassed%20Swale.pdf
	No known limit	http://www.epa.gov/nrmrl/pubs/600r04121/600r04121asect6.pdf

NA: Not available

1: Information is based on cited references/sources and assuming proper design, installation and long term maintenance. Life expectancy may vary depending on the design. The studies cited in this table may not have used the same design criteria as specified in this design manual.

2: Expected life estimated to increase with increased pavement depth.

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Sample Agreements

The following “Stormwater Treatment Measure Access and Maintenance Agreement” and “Declaration of Covenants (Device Maintenance and Access)” are sample agreements for reference only.

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Recorded at the request of:
CITY OF SACRAMENTO
DEPARTMENT OF UTILITIES
No Fee per Government Code 6130

____
After recording, return to:
Office of the City Clerk
Historic City Hall
915 "I" Street, 1st Floor
Sacramento CA 95814

STORMWATER TREATMENT MEASURE
ACCESS AND MAINTENANCE AGREEMENT

OWNER: ____

PROPERTY ADDRESS: ____

APN: __________________

THIS AGREEMENT is made and entered into in Sacramento, California, this _______ day of _______________ 20___, by and between ______________________________(“Owner”), and the CITY OF SACRAMENTO, a municipal corporation (“City”).

WHEREAS, the Owner owns real property (the "Property") in the City of Sacramento, County of Sacramento, State of California, more specifically described in Exhibit “A” and depicted in Exhibit “B”, each of which exhibits is attached hereto and incorporated herein by this reference; and

WHEREAS, at the time of initial approval of the development project on the Property known as ________________________________, the City’s conditions of approval included a requirement for the Project to employ on-site control measures to minimize pollutants in urban runoff; and

WHEREAS, the Owner has chosen to install ________________________________ (collectively referred to herein as the “Measure”), as the on-site control measure to minimize pollutants in urban runoff; and

WHEREAS, the Measure has been installed in accordance with plans and specifications accepted by the City; and

WHEREAS, the Measure, with installation on private property and draining only private property, is a private facility and all maintenance or replacement of the Measure is the sole responsibility of the Owner in accordance with the terms of this Agreement; and

WHEREAS, the Owner is aware and agrees that periodic and continuous maintenance, including, but not necessarily limited to, removal of sediment, trash and debris, maintenance of vegetation, and repairs to any ruts or holes, is required to assure peak performance of the Measure and that, furthermore, such maintenance activity will require compliance with all local, State, or Federal laws and regulations, including those pertaining to waste disposal methods, in effect at the time such maintenance occurs.

NOW THEREFORE, it is mutually stipulated and agreed as follows:

1. The foregoing recitals are incorporated herein by this reference.

2. Owner hereby provides the City or City's designee complete access to the Measure and its immediate vicinity at any time and for any duration, upon twenty-four (24) hour advance notice in writing, for the purpose of inspection, sampling and testing of the Measure. City shall make every effort at all times to minimize or avoid interference with Owner's use of the Property.

3. Owner shall use its best efforts diligently to maintain the Measure in a manner assuring peak performance at all times, including but not necessarily limited to performance of the maintenance and repair measures specified on Exhibit "C", attached hereto and incorporated herein by this reference. All reasonable precautions shall be exercised by Owner and Owner's representative or contractor in the maintenance of vegetation, the removal and extraction of material(s) from the Measure and the ultimate disposal of the material(s) in a manner consistent with all relevant laws and regulations in effect at the time. As may be requested from time to time by the City, the Owner shall provide the City with documentation identifying the material(s) removed, the quantity, and disposal destination. In addition, Owner shall provide maintenance reports to the City on an annual basis, not later than 60 days after receiving City's maintenance report request.

4. If Owner, or its successors or assigns, fails to accomplish the necessary maintenance contemplated by this Agreement, within five (5) days of being given written notice by the City, the City is hereby authorized (but shall not have any obligation) to cause any maintenance necessary to be done and charge the entire cost to the Owner or Owner's successors or assigns, including administrative costs and interest thereon at the maximum rate authorized by the Civil Code from the date of notice of the cost until paid in full.

5. The City may require the Owner to post security in a form and for a time period satisfactory to the City, to guarantee performance of the obligations stated herein. Should the Owner fail to perform its obligations as required under this Agreement, the City may, in the case of a cash deposit or letter of credit, use the proceeds to pay costs incurred by the City to take any action(s) authorized by this Agreement, or in the case of a surety bond, the City may require the sureties to perform the Owner's obligations under the Agreement.

6. This Agreement shall be recorded in the Office of the Recorder of Sacramento County, California, at the expense of the Owner and shall constitute notice to all successors and assigns of the title to the Property of the obligations herein set forth, and also a lien in such amount as will fully reimburse the City for costs incurred pursuant to Section 4, above, including interest as hereinabove set forth, subject to foreclosure in event of default in payment.

7. In the event of legal action occasioned by any uncured default of the Owner, or its successors or assigns, then the prevailing party shall recover all costs incurred, including reasonable attorney's fees and costs.

8. It is the intent of the parties hereto that burdens and benefits herein undertaken shall

constitute covenants that run with the Property and constitute a lien against the Property.

9. The obligations herein undertaken shall be binding upon the heirs, successors, executors, administrators and assigns of the parties hereto. The term “Owner” shall include not only the present Owner, but also its heirs, successors, executors, administrators, and assigns. Owner shall notify any successor to title of all or any part of the Property of the existence of this Agreement. Owner shall provide such notice prior to such successor obtaining an interest in all or part of the Property. Owner shall provide a copy of such notice to the City at the same time such notice is provided to the successor. If an Owner shall convey all of its interest in the Property, the Owner shall be released from any obligations arising under this Agreement in connection with the maintenance of or failure to maintain the Measure occurring after the date of such conveyance.

10. Time is of the essence in the performance of this Agreement.

11. Any notice to a party required or called for in this Agreement shall be served in person, or by deposit in the U.S. Mail, first class postage prepaid, to the address set forth below. Notice(s) shall be deemed effective upon receipt, or seventy-two (72) hours after deposit in the U.S. Mail, whichever is earlier. A party may change a notice address only by providing written notice thereof to the other party.

    IF TO CITY:

    Director of Utilities – Stormwater Program
    City of Sacramento, Department of Utilities
    1395 35th Avenue
    Sacramento, CA 95822

    IF TO OWNER:

    ____
    ____
    ____
    ____

12. If Owner consists of more than one party, each person, entity or other party described as the “Owner” in the first paragraph of this Agreement and/or executing this Agreement for Owner shall be jointly and severally liable for each and every obligation and requirement imposed on Owner herein.

13. The Owner acknowledges and agrees that nothing contained in this Agreement reduces or otherwise affects Owner’s responsibility to comply with all applicable provisions of the City of Sacramento’s Stormwater Management and Discharge Control Code, set forth in Chapter 13.16 of the Sacramento City Code, and nothing contained in this Agreement shall in any way limit the City’s right to enforce any provisions of the Stormwater Management and Discharge Control Code in accordance with the provisions of that Code.

IN WITNESS THEREOF, the parties hereto have affixed their signatures as of the date first written above.

APPROVED AS TO FORM:

____
City Attorney

CITY OF SACRAMENTO:

____
William O. Busath
Director, Department of Utilities

ATTEST:

____
City Clerk Date

OWNER:

____
Signature of Authorized Person

Print Name: ____________________

Title: ___________________________

NOTARIES ON FOLLOWING PAGE

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EXHIBIT A

[Legal Description of Parcel]

EXHIBIT B
[Map/Illustration]

EXHIBIT C

[Inspection and Maintenance Guidelines]

RECORDING REQUESTED BY and for the BENEFIT OF:

NAME Sacramento County
Department of Water Resources

MAILING ADDRESS 827 7th Street, Rm. 301

CITY, STATE ZIP CODE Sacramento, CA 95814

INTEROFFICE MAIL: Mail Code 01-301

NO FEE DOCUMENT
Gov. Code § 6103

(rev. 8-13)

SPACE ABOVE THIS LINE RESERVED FOR RECORDER'S USE

DECLARATION OF COVENANTS
(Device Maintenance and Access)

THIS DECLARATION OF COVENANTS ("Declaration") is executed as of ______________, 201___, by ____, a _______________________, (hereinafter the "Declarant") with reference to the following facts:

A. Declarant is the owner of that certain real property, commonly referred to as Assessor's Parcel Number ("APN"), and more particularly described in Exhibit "A" and the plat thereof on Exhibit "B," attached hereto and incorporated by reference herein (hereinafter, the "Subject Property"). Subject Property is located within the County of Sacramento, California, a political subdivision of the State of California (hereinafter, "Sacramento County").

B. At the time of Sacramento County's initial approval of the development project known as ____ wherein the Subject Property is located, Sacramento County required installation of onsite control measures to minimize pollutants in urban runoff.

C. Declarant has chosen to install ____ ____, hereinafter referred to as the "Device," as the on-site control measure to minimize pollutants in urban runoff.

D. The Device has been installed in accordance with plans and specifications accepted by Sacramento County.

E. The Device, being installed on private property and draining only private property, is a private facility, and all maintenance or replacement of the Device is the sole responsibility of the Declarant in accordance with the terms of this Declaration.

F. The Declarant is aware that periodic and continuous maintenance, including, but not necessarily limited to, filter material replacement and sediment removal, is required to assure peak performance of the Device in accordance with the maintenance procedures prepared for the Device which maintenance procedures are attached hereto as Exhibit “C” and incorporated herein.

G. Maintenance of the Device will require compliance with all Local, State, or Federal laws and regulations, including those pertaining to confined space and waste disposal methods, in effect at the time such maintenance occurs.

H. In the event a Device failure results in pollutants being discharged into the County storm drain system, the Declarant shall be responsible for all costs of cleanup. The terms ‘pollutants’ and ‘County storm drain system’ are used herein as defined in Sacramento County Code Chapter15.12.

NOW THEREFORE, in consideration of the foregoing benefits, as well as the benefits obtained by the Declarant and other valuable consideration, the receipt and adequacy of which is hereby acknowledged, Declarant hereby declares as follows:

1. **Covenant Running with Land**. The Declarant does hereby covenant that the burdens and benefits herein made and undertaken shall constitute covenants running with the Subject Property and constitute an encumbrance on said Subject Property which shall bind successors.

2. **Declarant Responsibility to Maintain:** Declarant, its successors or assigns, shall at all times maintain the Device in accordance with requirements stated in Exhibit “C” and in a manner assuring the Device’s peak performance at all times. All reasonable precautions shall be exercised by Declarant and Declarant’s representatives in the removal and extraction of material(s) from the Device. Disposal of the material(s) shall be performed in a manner consistent with all relevant laws and regulations in effect at the time of removal. For a time period of the most recent three (3) years, Declarant shall maintain written documentation verifying all material(s) removed from the Device, including identifying the material(s) removed, quantity, and manner and place of disposal thereof. Such documentation shall be provided to Sacramento County annually by May 1.

3. **Failure to Maintain:** In the event Declarant, or its successors or assigns, fails to maintain the Device as required by this Declaration, after thirty (30) days written notice thereof, Sacramento County may and is hereby authorized to cause, at the Declarant’s expense, any and all maintenance to the Device necessary under the requirements specified in Exhibit “C.” In addition to the actual costs of such maintenance, the Declarant shall reimburse Sacramento County for an additional fifteen percent (15%) thereof to cover costs of administration. All such actual and administrative costs shall accrue interest from the date incurred by Sacramento County at the maximum rate authorized by law until paid in full. In addition, failure to maintain the Device as required may result in enforcement actions consisting of administrative civil penalties (SCC § 15.12.560) and or criminal penalties (SCC § 15.12.570). The notice provided herein shall be effective on the date sent by U.S. Mail, registered or certified mail, to the record owner of the Subject Property as shown on the last equalized assessment roll.

4. **Security:** If the Declarant fails to maintain the Device as required by the standards specified in Exhibit “C”, Sacramento County may require the Declarant, at the Declarant’s sole cost, to post security in a form, for a time period, and in an amount satisfactory to Sacramento County, to guarantee the Declarant’s performance of the obligations set forth herein. Should the Declarant fail to perform the obligations under this Declaration, Sacramento County may realize against said security, and in the case of a cash bond, act for the Declarant using the proceeds from it, or in the case of a surety bond, require the sureties to perform the obligations of this Declaration. Said security shall be available to Sacramento

County to satisfy the Declarant's reimbursement obligation under paragraph 3.

5. **Access by County:** Declarant grants Sacramento County or the County's designee the unrestricted right of access to the Device, including its immediate vicinity as well as ingress and egress to and from said Device over Subject Property, at any time, upon twenty-four (24) hour advance notice in writing, of any duration for the purpose of inspection, sampling and testing of the Device. Sacramento County shall make reasonable efforts at all times to minimize or avoid interference with Declarant's use of the Subject Property.

6. **Successors and Assigns Bound**: Declarant hereby agrees and acknowledges that maintenance of the Device as set forth herein, the costs of Device maintenance, Sacramento County's access to the Device, Sacramento County's rights of ingress and egress to the Device, and Sacramento County's rights to recovery of costs if Declarant fails to maintain the Device are a burden and restriction on the use of the Subject Property. The provisions of this Declaration shall be enforceable as an equitable servitude and as conditions, restrictions and covenants running with the land, and shall be binding upon the Declarant and upon each an all of its respective heirs, devisees, successors, and assigns, officers, directors, employees, agents, representatives, executors, trustees, successor trustees, beneficiaries and administrators, and upon any future owners of the Subject Property and each of them.

7. **Enforcement**: It is the express intent of the Declarant that the terms and provisions of this Declaration shall be enforceable as an equitable servitude. To the extent necessary to do so, Declarant and its successors and assigns hereby confer and assign rights to enforce the terms and conditions of this Declaration to Sacramento County.

8. **Recording of Agreement:** This Declaration shall be recorded in the Office of the Recorder of Sacramento County, California and shall constitute notice to all successors and assigns of the title to the Subject Property of the rights and obligations herein set forth.

9. **Amendment**: This Declaration may be amended by Declarant, but only if in writing, and only after written approval of Sacramento County.

IN WITNESS WHEREOF, Declarant has executed this Declaration as of the day and year written above.

DECLARANT:

By: ______________________________

Its: ______________________________

[*attach*]

DECLARANT'S ACKNOWLEGEMENT

Exhibit "A" Legal Description of Subject Property
Exhibit "B" Plat of Subject Property (with device locations)
Exhibit "C" Device Maintenance Requirements

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Appendix C. Connecting to the Sanitary Sewer System General Requirements

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Appendix C Connecting to the Sanitary Sewer System: General Information

Unincorporated Sacramento County and the Cities of Citrus Heights, Elk Grove, Folsom and Rancho Cordova

Sanitary sewer collection service is provided by County Sanitation District 1 (CSD-1); all wastewater is treated by the Sacramento Regional County Sanitation District (SRCSD) at the Sacramento Regional Wastewater Treatment Plant (SRWTP) in Elk Grove.[1]

To install or replace sewer pipelines for new business or residence, both a building permit and a sewer impact (connection) permit will be required. If public right of way or publicly owned property will be used, an encroachment permit will be required. Building and encroachment permits are issued by the County for the unincorporated area or by the applicable city. The sewer connection permit is issued by CSD-1. The purposes of these permits are to ensure that plumbing is installed safely and legally and that everyone pays their fair share of the cost to construct the wastewater collection and treatment system (pipelines and treatment plant). Permits are not required for "spot repairs" (such as line replacement under 10 feet in length, or cleanout installation).

Sewer impact (connection) fees must be calculated by the CSD-1/SRCSD Permit Services Unit. Refer to CSD-1's web site (www.csd-1.com) or SRCSD's website at www.srcsd.com and call 876-6100 for a fee quote.

A $45 inspection fee will be collected at the time of permit issuance for all pipes within the County of Sacramento.

City of Sacramento

Sanitary sewer collection service is either provided by the City of Sacramento or CSD-1, depending on the service area. Within the City's service area, the City operates a combined sewer system (CSS) that collects both sewage and drainage for the area. Wastewater treatment for these areas is provided by the SRCSD.

All development projects within the City will be charged sewer impact fees:

- For projects served by the City-owned collection system, the project will be charged a City sewer/CSS development fee and must pay the SRCSD sewer impact fee (connection fee). The City's development fee will be charged through the City's building permit process.

[1] CSD-1 covers sewer service from a residence or business (via what CSD calls the "little pipes") to SRCSD's "Interceptor System" (the "big pipes") that connect to the Sacramento Regional Wastewater Treatment Plant.

- For projects served by CSD-1, the project must pay the CSD-1 and SRCSD sewer impact (connection) fees.

City of Folsom

The City of Folsom owns and operates its own sanitary sewer collection system which eventually ties into to SRCSD's interceptor system and is treated by the SRCSD at their plant in Elk Grove.

Development projects in Folsom will be charged a City connection/impact fee and the SRCSD treatment fee.

City of Galt

Sanitary sewer collection service and wastewater treatment is provided by the City of Galt. Proposed sanitary sewer connections must be identified during the project application stage and will be reviewed on a case by case basis by the City's Public Works Department. Contact the City of Galt Public Works Department at (209) 366-7280.

Appendix D. Low Impact Development Credits and Calculation Worksheets

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Appendix D

LID Credit Calculation Worksheets

Appendix D-1 Worksheet for Residential Projects
Appendix D-2 Worksheet for Commercial Projects
Appendix D-3 Runoff Reduction Credit Criteria
Appendix D-4 Background Report and References

Appendix D-1: Residential Sites: Low Impact Development (LID) Credits and Treatment BMP Sizing Calculations

Name of Drainage Shed:

Location of project: Sacramento

Fill in Blue Highlighted boxes

Step 1 - Open Space and Pervious Area Credits

Is your project within the drainage area of a common drainage plan that includes open space? If not, skip to 1 b.

1 a. Common Drainage Plan Area — acres — A_{CDP}

Common Drainage Plan Open Space (Off-project) — 0 acres — A_{OS}

see area example below

a. Natural storage reservoirs and drainage corridors — 0 acres
b. Buffer zones for natural water bodies — 0 acres
c. Natural areas including existing trees, other vegetation, and soil — 0 acres
d. Common landscape area/park — 0 acres
e. Regional Flood Control/Drainage basins — 0 acres

1 b. Project Drainage Shed Area (Total) — acres — A

Project-Specific Open Space (In-project, communal)** — acres — A_{PSOS}

see area example below

a. Natural storage reservoirs and drainage corridors — 0.00 acres
b. Buffer zones for natural water bodies — 0.00 acres
c. Natural areas including existing trees, other vegetation, and soil — 0.00 acres
d. Landscape area/park — 0.00 acres
e. Flood Control/Drainage basins — 0.00 acres

** Doesn't include impervious areas within individual lots and surrounding individual units. That is accounted for below using Form D-1a in Step 2.

Area with Runoff Reduction Potential — $A - A_{PSOS} =$ 0.00 acres — A_T

Number of Units in A_T

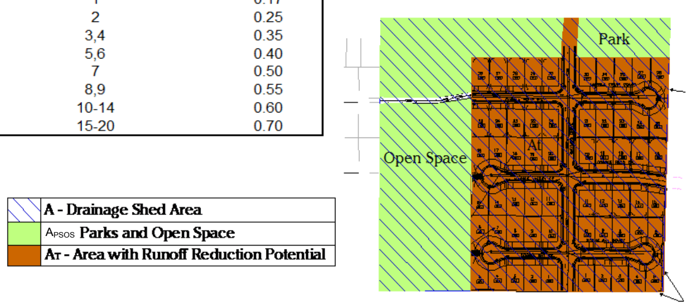
Number of units per acre in A_T — $DU/A_T =$ 0 — DUA

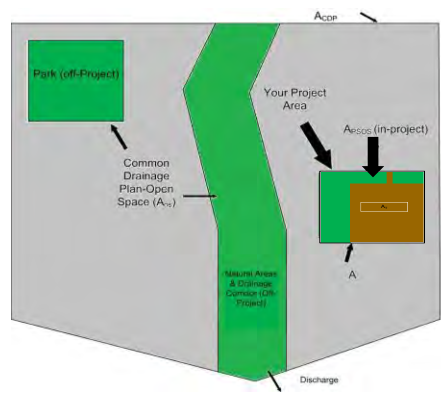
Assumed Initial Impervious Fraction of A_T — #N/A — I
(determined using Table D-1a)

Open Space & Pervious Area LID Credit (Step 1)
$(A_{OS}/A_{CDP}+A_{PSOS}/A)x100 =$ #DIV/0! pts

Table D-1a

Dwelling units per acre	Imperviousness
1	0.17
2	0.25
3,4	0.35
5,6	0.40
7	0.50
8,9	0.55
10-14	0.60
15-20	0.70





Step 2 - Runoff Reduction Credits

Runoff Reduction Measures		Effective Area Managed (A_C)	
Disconnected Roof Drains (see Fact Sheet)	use Form D-1a for credits →	0.00	acres
Disconnected Pavement (see Fact Sheet)	use Form D-1b for credits →	0.00	acres
Interceptor Trees (see Fact Sheet)	use Form D-1c for credits →	0.00	acres
Alternative Driveway Design (see Fact Sheet)	use Form D-1d for credits →	0.00	acres
Total Effective Area Managed (Credit Area)	A_C	0.00	acres EAM

Runoff Reduction Credit (Step 2) — $(A_C / A_T)*100 =$ #DIV/0! pts

Form D-1a: Disconnected Roof Drains Worksheet

See Fact Sheet for more information regarding Disconnected Roof Drain credit guidelines

Effective Area Managed (A_C)

1. Determine efficiency Multiplier

Runoff is directed to a dispersal trench or dry well (Type A and B soils only)		1.00
Runoff is directed across landscaping, determine setback		
25 ft +	Use multiplier of	1.00
≥ 20 and < 25 ft	Use multiplier of	0.90
≥ 15 and < 20 ft	Use multiplier of	0.70
≥ 10 and < 15 ft	Use multiplier of	0.45
≥ 5 and < 10 ft	Use multiplier of	0.25

Efficiency Multiplier → [ ] Box J1

2. Determine percentage of roof drains disconnected → [ ] Box J2

3. Select project density in dwelling units per acre:

1	Use reduction factor of	0.08
2	Use reduction factor of	0.13
3,4	Use reduction factor of	0.19
5,6	Use reduction factor of	0.23
7	Use reduction factor of	0.29
8,9	Use reduction factor of	0.33
10-14	Use reduction factor of	0.37
15-20	Use reduction factor of	0.44

Reduction Factor → 0.00 Box J3

4. Determine Area Managed

Multiply Box J3 by A_T, and enter the result in Box J4 — 0.0 acres Box J4

5. Multiply Boxes J1, J2 and J4, and enter 60% of the Result in Box J — 0.0 acres Box J

This is the amount of area credit to enter into the "Disconnected Roof Drains" Box of Form D-1

Form D-1b: Disconnected Pavement Worksheet

See Fact Sheet for more information regarding NDC Pavement credit guidelines

Effective Area Managed (A_C)

Divided Sidewalks

1. Determine percentage of units with divided Sidewalks [ ] Box K1

Multiply Box K1, A_T, and 0.04 and enter 60% of the result in Box K — 0.00 acres Box K

This is the amount of area credit to enter into the "Disconnected Pavement" Box of Form D-1

Form D-1c: Interceptor Tree Worksheet

See Fact Sheet for more information regarding Interceptor Tree credit guidelines

Effective Area Managed (A_C)

New Evergreen Trees

1. Enter number of new evergreen trees that qualify as Interceptor Trees in Box L1.		trees	Box L1
2. Multiply Box L1 by 200 and enter result in Box L2	0	sq. ft.	Box L2

New Deciduous Trees

3. Enter number of new deciduous trees that qualify as Interceptor Trees in Box L3.		trees	Box L3
4. Multiply Box L3 by 100 and enter result in Box L4	0	sq. ft.	Box L4

Existing Tree Canopy

5. Enter square footage of existing tree canopy that qualifies as Existing Tree canopy in Box L5.		sq. ft.	Box L5
6. Multiply Box L5 by 0.5 and enter the result in Box L6	0	sq. ft.	Box L6

Total Interceptor Tree Credits

Add Boxes L2, L4, and L6 and enter it into Box L7	0	sq. ft.	Box L7
Divide Box L7 by 43,560 and multiply by 20% to get effective area managed and enter the result in Box L8	0.00	acres	Box L8

This is the amount of area credit to enter into the "Interceptor Trees" Box of Form D-1

Form D-1d: Alternative Driveway Design

See Fact Sheet for more information regarding Alternative Driveway Design credit guidelines

1. Select type of driveway

Pervious Driveway:	Multiplier:
Cobblestone Block P	0.40
Pervious Concrete/A	0.60
Modular Block Porous Pavement Porous Gravel	0.75
Not Directly-connected I	1.00

Box M1

2. Determine percentage of units with Alternative Driveways: Box M2

4. Multiply Boxes M1, M2, A_T and 0.04, and enter the result in Box M
This is the amount of area credit to enter into the "Alternative Driveway Design" Box of Form D-1 — 0.00 acres

Step 3 - Runoff Management Credits

Capture and Use Credits

Impervious Area Managed by Rain barrels, Cisterns, and automatically-emptied systems

(see Fact Sheet) — enter gallons, for simple rain barrels — 0.00 acres

Automated-Control Capture and Use System

(see Fact Sheet, then enter impervious area managed by the system) — 0.00 acres

Bioretention/Infiltration Credits

Impervious Area Managed by Bioretention BMPs

(see Fact Sheet)

Bioretention Area — sq ft
Subdrain Elevation — inches
Ponding Depth, inches — inches — 0.00 acres

Impervious Area Managed by Infiltration BMPs

(see Fact Sheet)

Drawdown Time, hrs — drawdown_hrs_inf
Soil Infiltration Rate, in/hr — soil_inf_rate

Sizing Option 1: Capture Volume, acre-ft — capture_vol_inf — 0.00 acres

Sizing Option 2: Infiltration BMP surface area, sq ft — soil_surface_area — 0.00 acres

Basin or trench? Basin — approximate BMP depth 0.00 ft

Impervious Area Managed by Amended Soil or Mulch Beds

(see Fact Sheet) — Mulched Infiltration Area, sq ft — mulch_area — 0.00 acres

Total Effective Area Managed by Capture-and-Use/Bioretention/Infiltration BMPs — 0.00 — A_{LIDc}

Runoff Management Credit (Step 3) — $A_{LIDC}/A_T*200 =$ #DIV/0! pts

Total LID Credits (Step 1+2+3) — #DIV/0! — #DIV/0!

Does project require hydromodification management? If yes, proceed to using SacHM.

Adjusted Area for Flow-Based, Non-LID Treatment — $A_T - A_C - A_{LIDC} =$ 0.00 — A_{AT}

Adjusted Impervious Fraction of A for Volume-Based, Non-LID Treatment — $(A_T*I-A_C-A_{LIDC}) / A =$ 0.000 — I_A

STOP: No additional treatment needed

Step 4a Treatment - Flow-Based (Rational Method)

Form D-1e

Calculate treatment flow (cfs): Flow = Runoff Coefficient x Rainfall Intensity x Adjusted Treatment Area

Determine C Factor using Table D-1b — C

Determine i using Table D-1c (Rainfall Intensity) — 0.18 — i

A_{AT} from Step 2 — 0.00 — A_{AT}

Flow = C * i * A_{AT} — 0.00 — cfs

TABLE D-1b

Development Type	Runoff Coefficient (Rational), C
Single-family areas	0.50
Multi-units, detached	0.60
Apartment dwelling areas	0.70
Multi-units, attached	0.75
User Specified	0.00

Table D-1c

Rainfall Intensity			
Roseville	i =	0.20	in/hr
Sacramento	i =	0.18	in/hr
Folsom	i =	0.20	in/hr

Step 4b Treatment - Volume-Based (ASCE-WEF)

Calculate water quality volume (Acre-Feet):	WQV = Area x Maximized Detention Volume (P_0)			
Obtain A from Step 1	0.00	A	hrs	Specified Draw Down time
Obtain P_0: Maximized Detention Volume from figures E-1 to E-4 in Appendix E of this manual using I_A from Step 2.	0.00	P_0		
Calculate treatment volume (acre-ft): **Treatment volume = A x (P_0 / 12)**	0.00	Acre-Feet		

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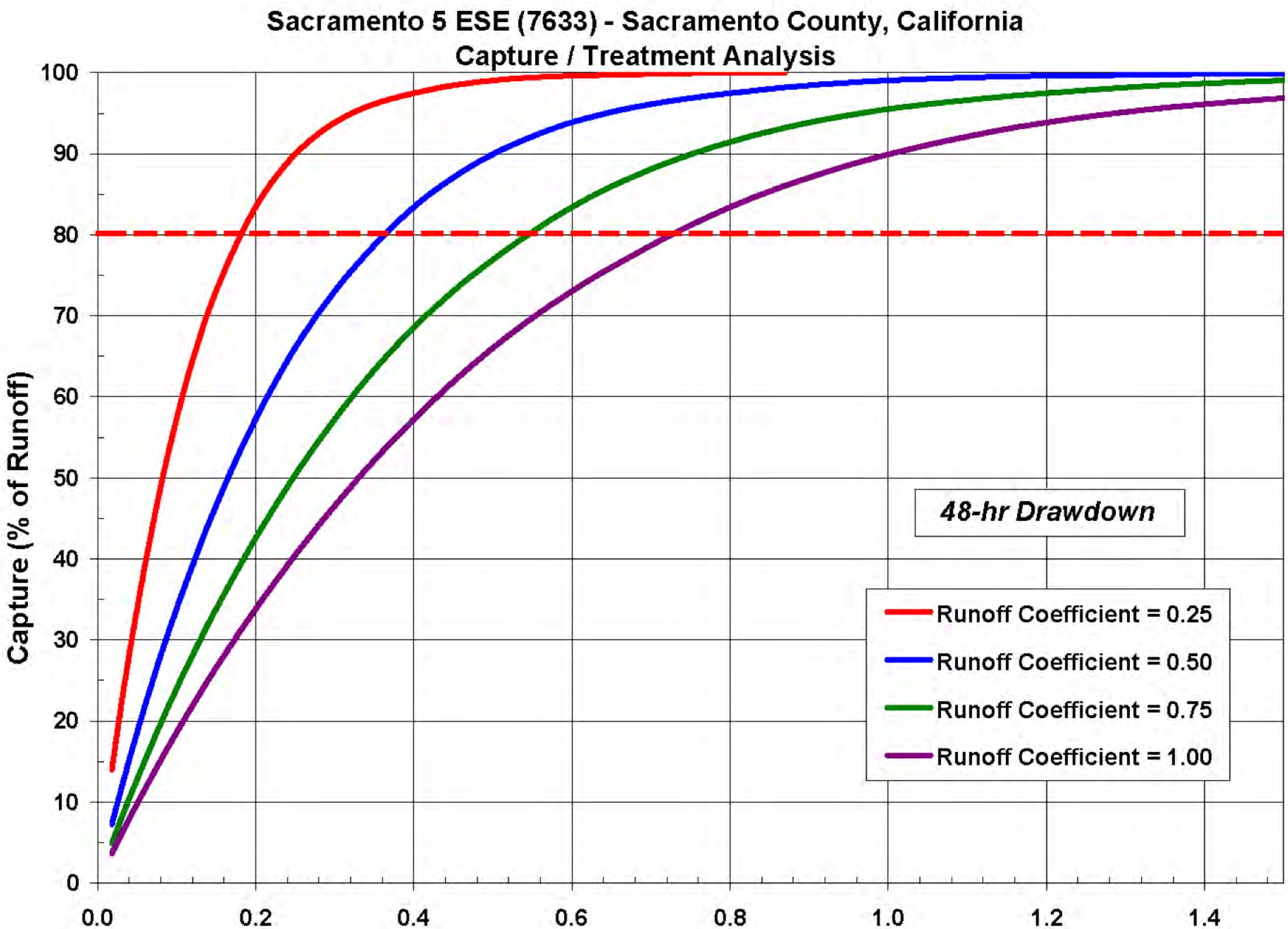


Figure D-1A. Unit Basin Storage Volume (inches)

Appendix D-2: Commercial Sites: Low Impact Development (LID) Credits and Treatment BMP Sizing Calculations

Name of Drainage Shed: ______ Fill in Blue Highlighted boxes

Location of project: ______

Step 1 - Open Space and Pervious Area Credits

Is your project within the drainage area of a common drainage plan that includes open space? If not, skip to 1 b.

1 a. Common Drainage Plan Area	0	acres	A_{CDP}
Common Drainage Plan Open Space (Off-project)	0	acres	A_{OS}
a. Natural storage reservoirs and drainage corridors	0	acres	
b. Buffer zones for natural water bodies	0	acres	
c. Natural areas including existing trees, other vegetation, and soil	0	acres	
d. Common landscape area/park	0	acres	
e. Regional Flood Control/Drainage basins	0	acres	

see area example below

1 b. Project Drainage Shed Area (Total)		acres	A
Project-Specific Open Space (In-project, communal)**	0.00	acres	A_{PSOS}
a. Natural storage reservoirs and drainage corridors	0.00	acres	
b. Buffer zones for natural water bodies	0.00	acres	
c. Natural areas including existing trees, other vegetation, and soil	0.00	acres	
d. Landscape area/park	0.00	acres	
e. Flood Control/Drainage basins	0.00	acres	

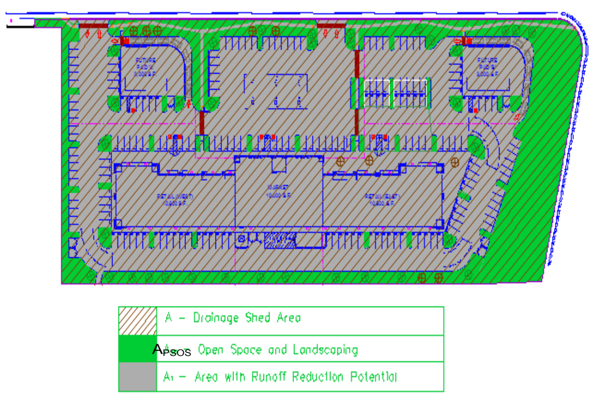
see area example below

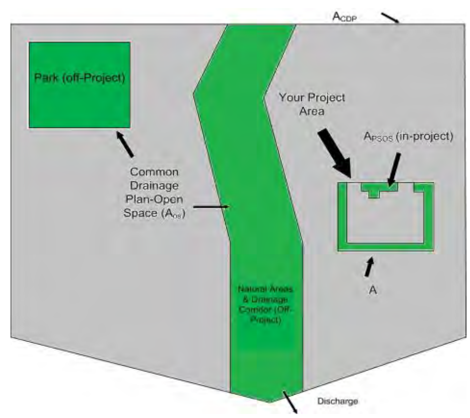
** Doesn't include impervious areas within individual lots and surrounding individual units. That is accounted for below using Form D-1a in Step 2.

Area with Runoff Reduction Potential	$A - A_{PSOS} =$	0.00	acres	A_T
Assumed Initial Impervious Fraction	$A_T / A =$	0.00		I

Open Space & Pervious Area LID Credit (Step 1)

$(A_{OS}/A_{CDP}+A_{PSOS}/A)x100 =$ #DIV/0! pts





Step 2 - Runoff Reduction Credits

Runoff Reduction Treatments	Impervious Area Managed			Efficiency Factor		Effective Area Managed (A_C)	
Porous Pavement:							
Option 1: Porous Pavement (see Fact Sheet, excludes porous pavement used in Option 2)	0	acres	x		=	0.000	acres
Option 2: Disconnected Pavement (see Fact Sheet, excludes porous pavement used in Option 1)	use Form D-2a for credits			→		0.00	acres
Landscaping used to Disconnect Pavement (see Fact Sheet)	0.0000	acres			=	0.00	acres
Disconnected Roof Drains (see Fact Sheet and/or Table D-2b for summary of requirements)	0	acres			=	0.00	acres
Ecoroof (see Fact Sheet)	0	acres			=	0.00	acres
Interceptor Trees (see Fact Sheet)	use Form D-2b for credits			→		0.00	acres
Total Effective Area Managed by Runoff Reduction Measures				A_C		0.00	acres
Runoff Reduction Credit (Step 2)				$(A_C / A_T)*100 =$		#DIV/0!	pts

Table D-2a

Porous Pavement Type	Efficiency Multiplier
Cobblestone Block Pavement	0.40
Pervious Concrete/Asphalt	0.60
Modular Block Pavement &	0.75
Reinforced Grass Pavement	1.00

Table D-2b

Maximum roof size	Minimum travel distance
≤ 3,500 sq ft	21 ft
≤ 5,000 sq ft	24 ft
≤ 7,500 sq ft	28 ft
≤ 10,000 sq ft	32 ft

Form D-2a: Disconnected Pavement Worksheet

See Fact Sheet for more information regarding Disconnected Pavement credit guidelines

Effective Area Managed (A_C)

Pavement Draining to Porous Pavement

2. Enter area draining onto Porous Pavement — 0.00 acres — Box K1

3. Enter area of Receiving Porous Pavement (excludes area entered in Step 2 under Porous Pavement) — 0.00 acres — Box K2

4. Ratio of Areas (Box K1 / Box K2) — 0.00 — Box K3

5. Select multiplier using ratio from Box K3 and enter into Box K4 — 1 — Box K4

Ratio (Box D)	Multiplier
Ratio is ≤ 0.5	1.00
Ratio is > 0.5 and < 1.0	0.83
Ratio is > 1.0 and < 1.5	0.71
Ratio is > 1.5 and < 2.0	0.55

6. Enter Efficiency of Porous Pavement (see table below) — Box K5

Porous Pavement Type	Efficiency Multiplier
Cobblestone Block Pavement	0.40
Pervious Concrete Asphalt Pavement	0.60
Modular Block Pavement Porous Gravel Pavement	0.75
Reinforced Grass Pavement	1.00

7. Multiply Box K2 by Box K5 and enter into Box K6 — 0.00 acres — Box K6

8. Multiply Boxes K1,K4, and K5 and enter the result in Box K7 — 0.00 acres — Box K7

9. Add Box K6 to Box K7 and multiply by 60%, and enter the Result in Box K8 — 0.00 acres — Box K8

This is the amount of area credit to enter into the "Disconnected Pavement" Box of Form D-2

Form D-2b: Interceptor Tree Worksheet

See Fact Sheet for more information regarding Interceptor Tree credit guidelines

New Evergreen Trees

1. Enter number of new evergreen trees that qualify as Interceptor Trees in Box L1.		trees	Box L1
2. Multiply Box L1 by 200 and enter result in Box L2	0	sq. ft.	Box L2

New Deciduous Trees

3. Enter number of new deciduous trees that qualify as Interceptor Trees in Box L3.		trees	Box L3
4. Multiply Box L3 by 100 and enter result in Box L4	0	sq. ft.	Box L4

Existing Tree Canopy

5. Enter square footage of existing tree canopy that qualifies as Existing Tree canopy in Box L5.	0	sq. ft.	Box L5
6. Multiply Box L5 by 0.5 and enter the result in Box L6	0	sq. ft.	Box L6

Total Interceptor Tree EAM Credits

Add Boxes L2, L4, and L6 and enter it into Box L7	0	sq. ft.	Box L7
Divide Box L7 by 43,560 and multiply by 20% to get effective area managed and enter result in Box L8 This is the amount of area credit to enter into the "Interceptor Trees" Box of Form D-2	0.00	acres	Box L8

Step 3 - Runoff Management Credits

Capture and Use Credits

Impervious Area Managed by Rain barrels, Cisterns, and automatically-emptied systems

(see Fact Sheet) - enter gallons, for simple rain barrels — 0.00 acres

Automated-Control Capture and Use System

(see Fact Sheet, then enter impervious area managed by the system) — 0.00 acres

Bioretention/Infiltration Credits

Impervious Area Managed by Bioretention BMPs

(see Fact Sheet)

Bioretention Area		sq ft		
Subdrain Elevation		inches		
Ponding Depth, inches		inches	0.00	acres

Impervious Area Managed by Infiltration BMPs

(see Fact Sheet)

	Drawdown Time, hrs		drawdown_hrs_inf		
	Soil Infiltration Rate, in/hr		soil_inf_rate		
Sizing Option 1:	Capture Volume, acre-ft	0.00	capture_vol_inf	0.00	acres
Sizing Option 2:	Infiltration BMP surface area, sq ft	0	soil_surface_area	0.00	acres

Basin or trench? — approximate BMP depth 0.00 ft

Impervious Area Managed by Amended Soil or Mulch Beds

(see Fact Sheet) — Mulched Infiltration Area, sq ft — mulch_area — 0.00 acres

Total Effective Area Managed by Capture-and-Use/Bioretention/Infiltration BMPs — 0.00 A_{LIDc}

Runoff Management Credit (Step 3) — A_{LIDC}/A_T*200 = #DIV/0! pts

Total LID Credits (Step 1+2+3) #DIV/0! #DIV/0!

Does project require hydromodification management? If yes, proceed to using SacHM.

Adjusted Area for Flow-Based, Non-LID Treatment — $A_T - A_C - A_{LIDC}$ = 0.00 A_{AT}

Adjusted Impervious Fraction of A for Volume-Based, Non-LID Treatment — A_{AT} / A = 0.00 I_A

STOP: No additional treatment needed

Step 4a Treatment - Flow-Based (Rational Method)

Calculate treatment flow (cfs): Flow = Runoff Coefficient x Rainfall Intensity x Area

Look up value for i in Table D-2c (Rainfall Intensity)	select a location or	i
Obtain A_{AT} from Step 3	0.00	A_{AT}
Use C = 0.95	0.95	C
Flow = 0.95 * i * A_{AT}	#VALUE!	cfs

Table D-2c

Rainfall Intensity			
Roseville	i =	0.20	in/hr
Sacramento	i =	0.18	in/hr
Folsom	i =	0.20	in/hr

Step 4b Treatment - Volume-Based (ASCE-WEF)

Calculate water quality volume (Acre-Feet):	WQV = Area x Maximized Detention Volume (P_0)			
Obtain A from Step 1	0.00	A	hrs	Specified Draw Down time
Obtain P_0: Maximized Detention Volume from figures E-1 to E-4 in Appendix E of this manual using I_A from Step 2.	0.00	P_0		
Calculate treatment volume (acre-ft): **Treatment volume = A x (P_0 / 12)**	0.00	Acre-Feet		

v06232012

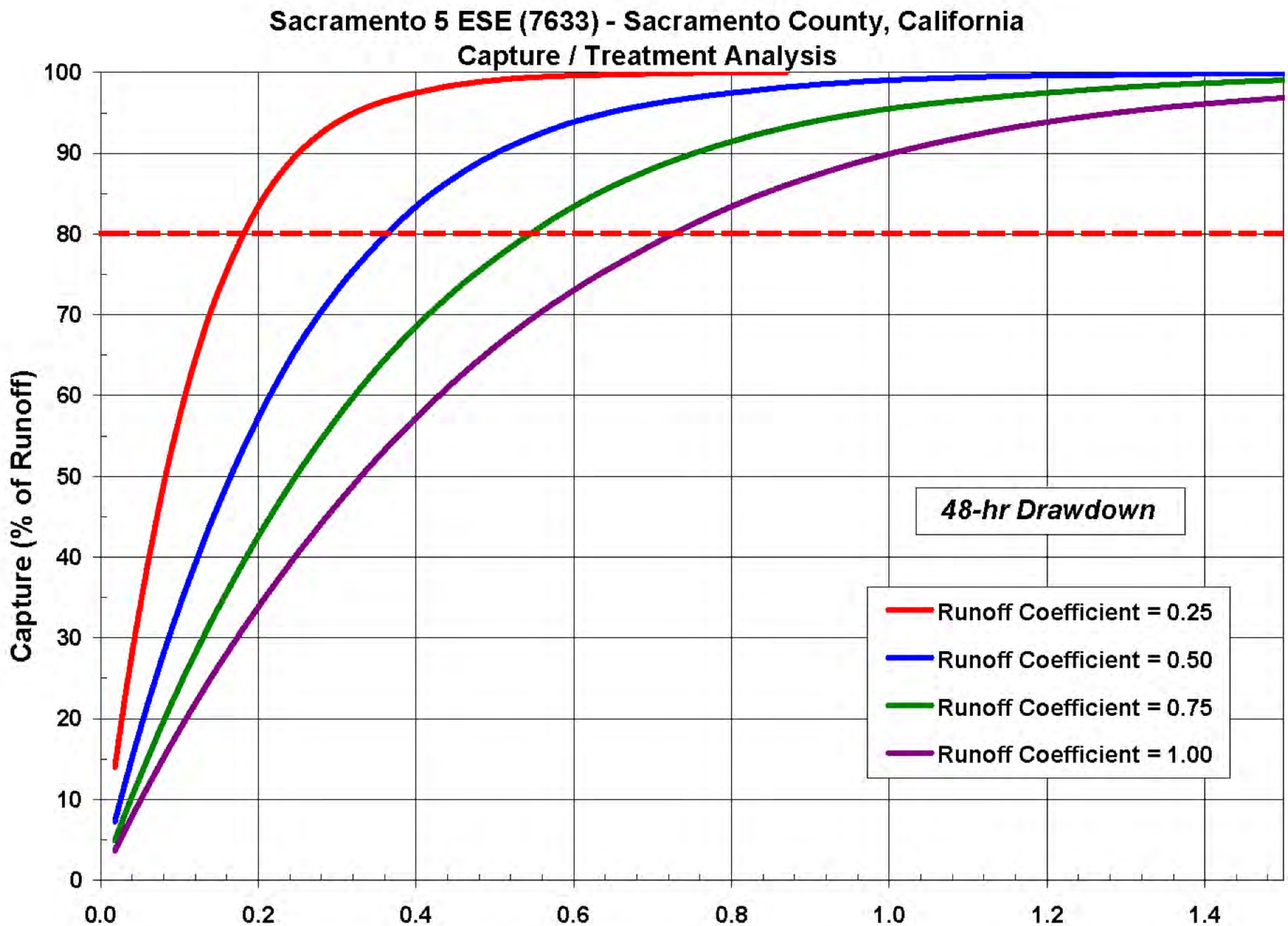


Figure D-2A. Unit Basin Storage Volume (inches)

Appendix D-3 Runoff Reduction Credit Criteria

The following series of tables presents information related to calculating runoff reduction credits for the control measures presented in Chapter 5 of the Design Manual.

Runoff Reduction Credits for Porous Pavement

This table refers to runoff reduction credit worksheets/forms which can be found in Appendix D-1 and D-2 of this Design Manual. Efficiency multipliers were taken from Denver manual.

Pavement Type	Applications and Runoff Reduction Credits
Pervious Concrete or Asphalt	Residential – Runoff Reduction Credits can be obtained for use of these materials in driveways (see Alternative Driveways Fact Sheet). The credit calculation is simplified in Appendix D-1.
	Commercial – Runoff Reduction Credits can be obtained for the use on any appropriate commercial surface. Credits are calculated using an efficiency multiplier of 60%. The credit calculation is simplified in Appendix D-2.
Modular Block Pavement	Residential – Runoff Reduction Credits can be obtained for use of modular block in driveways (see Alternative Driveways Fact Sheet). The credit calculation is simplified in Appendix D-1. Credits can be obtained for use of modular block in other areas of residential development where surfaces which would otherwise be impervious are substituted with MBP. Use an efficiency multiplier of 75%.
	Commercial – Runoff Reduction Credits can be obtained for the use of modular block on any appropriate commercial surface. Credits are calculated using an efficiency multiplier of 75%. The credit calculation is simplified in Appendix D-2.
Reinforced Grass Pavement	Residential – Runoff Reduction Credits can be obtained for use of reinforced grass pavement in residential development where surfaces which would otherwise be impervious are substituted with reinforced grass pavement. Use an efficiency multiplier of 100%.
	Commercial – Runoff Reduction Credits can be obtained for the use of reinforced grass pavement on any appropriate commercial surface. Credits are calculated using an efficiency multiplier of 100%. This calculation is simplified in Appendix D-2.
Cobblestone Block Pavement	Residential – Runoff Reduction Credits can be obtained for use of cobblestone block pavement in driveways (see Alternative Driveways Fact Sheet). The credit calculation is simplified in Appendix D-1. Credits can be obtained for use of cobblestone block pavement in other areas of residential development where surfaces which would otherwise be impervious are substituted with cobblestone block pavement. Use an efficiency multiplier of 40%.
	Commercial – Runoff Reduction Credits can be obtained for the use of cobblestone block pavement on any appropriate commercial surface. Credits are calculated using an efficiency multiplier of 40%. This calculation is simplified in Appendix D-2.

Pavement Type	Applications and Runoff Reduction Credits
Porous Gravel Pavement	Residential – Runoff Reduction Credits can be obtained for use of porous gravel pavement in residential development where surfaces which would otherwise be impervious are substituted with porous gravel pavement. Use an efficiency multiplier of 75%.
	Commercial – Runoff Reduction Credits can be obtained for the use of porous gravel pavement on any appropriate commercial surface. Credits are calculated using an efficiency multiplier of 75%. This calculation is simplified in Appendix D-2.

Runoff Reduction Credits for Disconnected Pavement

Efficiency multipliers were taken from Denver manual.

Variation/Application	Runoff Reduction Credits
Pavement Draining to Landscaping	
Residential	Runoff Reduction Credits can be obtained for disconnection of sidewalks (simplified in Appendix D-1, Form D-1b) and driveways (see Alternative Driveways Fact Sheet, simplified in Form D-1d).
Commercial	Runoff Reduction Credits can be obtained for use of landscaping to disconnect impervious surfaces. Credit can apply to 100% of up to 1000 square feet of pavement draining to each properly designed vegetated area. (Source: Contra Costa Clean Water Program)
Pavement Draining to Porous Pavement (Source: Denver)	
Commercial	Runoff Reduction Credits can be obtained for disconnected impervious surfaces with the amount of credit dependent on the ratio of impervious surfaces to pervious surfaces. More credit is given for lower ratios. If the impervious surface area equals no more than half the area of the porous surface, then credit is given for the entire impervious surface. As the ratio increases above 0.5, the treatment provided is decreased resulting in a lower infiltration factor. Credit is not given for ratios above 2.0. Credit allowed for specific impervious/pervious ratios are listed below:

Impervious Area/Porous Area Ratio	Efficiency Multiplier
≤ 0.5	1.00
0.5 – 1.0	0.83
1.0 – 1.5	0.71
1.5 – 2.0	0.55

The efficiency of the porous pavement in infiltrating sheet flow is dependent on the type of pavement used. The following are the efficiency factors for different

<table>
<tr><th>Variation/Application</th><th>Runoff Reduction Credits</th></tr>
<tr><td></td><td>pavement types:
<table>
<tr><th>Porous Pavement Type</th><th>Efficiency Multiplier</th></tr>
<tr><td>Modular Block Pavement</td><td>0.75</td></tr>
<tr><td>Cobblestone Block Pavement</td><td>0.40</td></tr>
<tr><td>Reinforced Grass Pavement</td><td>1.00</td></tr>
<tr><td>Poured Porous Concrete Pavement</td><td>0.60</td></tr>
<tr><td>Porous Gravel Pavement</td><td>0.75</td></tr>
</table>
</td></tr>
</table>

These tables refer to runoff reduction credit worksheets/forms which can be found in Appendix D-1 and D-2 of this Design Manual.

Runoff Reduction Credits for Alternative Driveways

Variation	Applications and Runoff Reduction Credits
Pervious Driveway	Residential – credits can be applied for the entire driveway surface when approved materials and specifications are used in accordance with the Design Requirements. Use Appendix D-1.
Hollywood Driveway	Residential – an efficiency multiplier of 75% of the driveway area when approved materials and specifications are used in accordance with the Design Requirements. Use Appendix D-1.
Disconnected Driveway	Residential – credits can be for the entire driveway surface when designed according to this fact sheet. Use Appendix D-1.
Shared Driveway	Residential – credits vary according to design. Consult municipal engineer.

Runoff Reduction Credits for Disconnected Roof Drains

Variation	Applications and Runoff Reduction Credits
Splash Block/Pop-up Drainage Emitter	
Residential	Credit may be given for each disconnected roof drain with the amount of credit dependent upon building set back. This calculation is simplified in Appendix D-1.
Commercial	Credit may be given for each disconnected roof drain meeting the design requirements. The credit calculation is simplified in Appendix D-2.
Dispersal Trench and Dry Well	
Residential	Credit may be given for each disconnected roof drain meeting the design

Variation	Applications and Runoff Reduction Credits
	requirements. The credit calculation is simplified in Appendix D-1.
Commercial	Credit may be given for each disconnected roof drain meeting the design requirements. The credit calculation is simplified in Appendix D-2.

Runoff Reduction Credits for Interceptor Trees

Variation	Applications and Runoff Reduction Credits
All Planted Trees	Residential - Credit may be given for each new tree planted in the municipal right-of-way. Consult municipality about the possibility of credits for trees outside of the municipal right-of-way. This calculation is simplified in Appendix D-1.
	Commercial - Credit may be given for each new tree planted within 25 feet of ground level impervious surfaces. 25% of trees already required by zoning can be used for Interceptor Tree credits. This calculation is simplified in Appendix D-2.
New Evergreen Trees	20 square feet of credit
New Deciduous Trees	100 square feet of credit
Existing Trees	The Runoff Reduction Credit, as applied to existing trees, is calculated by identifying the square-footage equal to one-half of the existing tree canopy, measured within the drip line. The resulting square footage divided by the total site square footage is equal to the IRP. This calculation is simplified in Appendix D-1 and D-2.
*Trees required by the municipality as mitigation for other trees lost on the project will not count toward Runoff Reduction Credit.	

Trees Qualifying for Interceptor Tree Runoff Reduction Credits*

			Mature Tree		
Common Name	**Botanical Name**	**Type****	**Shape**	**Canopy (dia.)**	**Height (max.)**
American Chestnut	*Castanea dentate*		Oval to rounded or wide spreading	40-60'	80-120'
American Hornbeam	*Carpinus caroliniana*		Vase-shaped	20-30'	25-30'
American Linden	*Tilia americana*		Oval and informal	30-60'	60-80' (100')
American Sweet Gum	*Liquidambar styraciflua*		Conical	20-40'	45-65'
Amur Maackia	*Maackia amurensis*		Vase-shaped	15-20'	20-30'
Amur Maple	*Acer tataricum ginnala*		Rounded	15-20'	20'
Arizona Cypress	*Cupressus arizonica*	E	Conical to vase	25-30'	40-50'
Atlas (Blue) Cedar	*Cedrus atlantica*	E	Flat-topped,	30-40'	40-60' (120')

Common Name	Botanical Name	Type**	Mature Tree		
			Shape	Canopy (dia.)	Height (max.)
			loose, open and spreading		
Autumn Blaze Maple	*Acer fremanii 'Autumn Blaze'*		Oval	50'	50'
Bald Cypress	*Taxodium distichum*		Oval at maturity, uniform	20-30'	50-70' (100')
Bechtel Crabapple	*Malus ioensis 'Plena'*		Broad-rounded	20'	25'
Bigleaf Maple	*Acer macrophyllum*	N	Broad-rounded	30-75'	45-75' (100')
Blue Oak	*Quercus douglasii*	N P	Rounded umbrella	50-80'	50-60'
Burr Oak	*Quercus macrocarpa*		Broad-rounded	75-85'	70-80'
California Bay	*Umbellularia californica*	EN	Round	30'	25'
California Black Oak[a]	*Quercus kelloggii*	N	Vase	30-60'	30-80'
Callery Pear	*Pyrus calleryana*		Columnar, Oval, Round	25'	40'
Canary Island Date Palm	*Phoenix canariensis*	E	Round head	25-30'	60'
Canary Island Pine	*Pinus canariensis*	E	Pyramidal	25-35'	60-80'
Canyon Live Oak	*Quercus chrysolepis*	E N	Broad-rounded	50-70'	50-75'
Carob	*Ceratonia siliqua*	E	Broad to wide-rounded	30-45'	30-40'
Carolina Laurel Cherry	*Prunus caroliniana*	E	Irregular rounded	15-25'	20-30' (40')
Chaste Tree	*Vitex agnus-castus*		Rounded	15-20'	20-25'
Chestnut-Leafed Oak	*Quercus castaneafolia*		Broad and rounded	50-60'	70-90'
Chinese Evergreen Elm	*Ulmus parvifolia*		Rounded	40-50'	40-50' (70')
Chinese Fringe Tree	*Chionanthus retusus*		Rounded	20-25'	20-25'
Chinese Hackberry	*Celtis sinensis*		Rounded	50-60'	40-80'
Chinese PIstache	*Pistacia chinensis*		Broad-rounded	25-35'	30-35' (50')
Chinese Wingnut	*Pterocarya stenoptera*		Broad-rounded	30-40'	40-90'
Coast Live Oak	*Quercus agrifolia*	EN	Rounded	60'	40'
Coast Redwood	*Sequoia sempervirens*	E	Narrow pyramidal to wide conical	50-60'	200-300'
Colorado Spruce	*Picea pungens*	E	Narrow pyramidal to broad conical	10-20'	30-60' (135')
Common Horsechestnut	*Aesculus hippocastanum*		Pyramidal to oval	40-70'	50-75' (100'+)

Common Name	Botanical Name	Type**	Mature Tree		
			Shape	Canopy (dia.)	Height (max.)
Coolibah	*Eucalyptus microtheca*		Round head	30'	25-50'
Cork Oak	*Quercus suber*	E	Rounded	35-45'	70-100'
Crabapple 'Prariefire'	*Malus ioensis 'Prariefire'*		Broad-rounded	15-20'	25'
Crape Myrtle (Tree Form, some are large shrubs)	*Lagerstroemia hybrids*		Broad-rounded	15-20'	15-30'
Crimson Sentry Maple	*Acer platanoides 'Crimson Sentry'*		Oval	40'	40'
Dawn Redwood	*Metasequoia glyptostroboides*		Conical to narrow pyramidal and formal	25-35'	80-90' (120')
Deodar Cedar	*Cedrus deodara*	E	Wide and slightly flat-topped	30-60'	40-70' (200')
Douglas Fir	*Pseudotsuga menziesii*	E N	Broadly cylindrical	30-40'	40-80' (200')
Eastern Dogwood	*Cornus florida*		Broad-rounded	15-20'	20-25'
Eastern Redbud	*Cercis canadensis*		Rounded	25-35'	20-30'
English Hawthord 'Paul's Scarlet'	*Crataegus laevigata 'Paul's Scarlet'*		Vase-shape	20-25'	18-25'
English Oak	*Quercus robur*			50'	50'
European Beech	*Fagus sylvatica*		Oval to rounded	35-45'	50-60' (100')
European Hackberry	*Celtis australis*		Rounded	50-60'	40-80'
European Hornbeam	*Carpinus betulus 'Fastigiata'*		Broad oval-vase shaped	20-30'	40'
Evergreen Ash	*Fraxinus uhdei*	E	Round head	70'	40'
Flannel Bush	*Fremontodendron californicum*	E	Flat-topped Vase	20-25'	20-25'
Forest Green Oak	*Quercus frainetto 'Forest Green'*		Rounded	30'	50'
Formosan Flame	*Koelreuteria elegans*		Broad rounded	35'	35'
Fragrant Snowbell	*Styrax obassia*		Rounded	15-20'	20-30'
Frontier Elm	*Ulmus 'Frontier'*			30'	40'
Ginkgo Biloba (Male Only)	*Ginkgo biloba*		Wide rounded-pyramidal	30-40'+	35-80' (100')
Golden Flame Tree	*Koelreuteria bipinnata*		Rounded	15-25'	20-40'
Goldenchain Tree	*Laburnum anagyroides*		Oval to round-headed	15-20'	20-30'
Goldenrain Tree	*Koelreuteria paniculata*		Rounded	30-40'+	30-40'
Grecian Laurel	*Laurus nobilis*	E	Irregular rounded	20-25'	15-40'
Green Ash	*Fraxinus pennsyvalnica 'Patmore', 'Leprichaun',*		Oval, irregular	30'	40'

Common Name	Botanical Name	Type**	Mature Tree		
			Shape	Canopy (dia.)	Height (max.)
	'Centerpoint'				
Hedge Maple	*Acer campestre*		Rounded	30-35'	30-70'
Holly Oak	*Quercus ilex*	E	Rounded	40-50'	40-70'
Honey Locust (thornless)	*Gleditsia triacanthos*		Rounded to wide-rounded	30-70'	35-70'
Incense Cedar	*Calocedrus decurrens*	E N	Conical	25-30'	30-50' (150')
Interior Live Oak	*Quercus wislizenii*	E N P	Irregular	30-60'	30-75'
Italian Stone Pine	*Pinus pinea*		Broad, flat topped	30-40'	40-80'
Japanese Maple	*Acer palmatum*		Broad-rounded	25'+	20'
Japanese Pagoda Tree	*Sophora japonica*		Rounded to broad-spreading	50-75'	50-75'
Japanese Red Pine	*Pinus densiflora*	E	Broad-pyramidal and irregular	40-60'	40-60' (100')
Japanese Snowdrop	*Styrax japnicus*		Rounded	15-20'	25-30'
Japanese White Birch	*Betula platyphylla japonica*		Oval	20-25'	40-50'
Jelecote Pine	*Pinu patula*	E		25'	30'
Kentucky Coffee Tree	*Gymnocladus dioica*		Oval with coarse branching	40-50'	60-75' (90')
Kobus Magnolia	*Magnloia kobus*		Rounded	15-25'	30'
Little-Leaf Linden	*Tilia cordata*		Rounded pyramidal	30-50'	60-70' (90')
Mexican Fan Palm	*Washingtonia robusta*	E	Round head	10-15'	100'
Norwegian Sunset Maple	*Acer truncatum 'Norwegian Sunset'*			25'	30'
Pin Oak	*Quercus palustris*		Uniformly pyramidal with a straight central leader	25-40'	50-80'
Ponderosa Pine	*Pinus ponderosa*	E N	Conical	30-50'	60-100' (230')
Prospector Elm	*Ulmus 'Prospector'*			30'	40'
Purple Leaf Plum	*Prunus cerasifera 'Krauter Vesuvius'*		Rounded	15-25'	15-30'
Red Maple	*Acer rubrum*		Oval to rounded	To 60'	40-60' (120')
Red Oak	*Quercus rubra*		Rounded	60-75'	60-75' (100')
Saucer Magnolia	*Magnloia x soulangeana*		Rounded	20-30'	25'
Scarlet Oak	*Quercus coccinea*		Oval to rounded with an open habit	40-50'	70-75' (100')
She-oak	*Casuarina stricta*	E	Oval/vase	15-25'	20-35'
Shumard Red Oak	*Quercus shumardii*		Oval	50'	70'

Common Name	Botanical Name	Type**	Mature Tree Shape	Canopy (dia.)	Height (max.)
'Seville' sour orange	*Citrus 'Seville'*	E	Rounded	15-20'	20-30'
Southern Live Oak	*Quercus virginiana*	E	Broad rounded, irregular	65'	60'
Southern Magnolia	*Magnolia grandiflora*	E	Broad pyramidal, rounded pyramidal and rounded	30-50'	60-80'
Southern Magnolia 'St. Mary'	*Magnolia grandiflora 'St. Mary'*	E	Rounded	15-20'	20'
Strawberry Tree	*Arbutus unedo*	E	Oval to rounded	15-35'	15-35'
Sugar Maple	*Acer saccharum*		Oval to rounded	40-60'	60-75' (120')
Sycamore	*Platanus* species	S	Oval to rounded	30-50'	40-100'
Texas Red Oak	*Quercus buckleyi*			25'	30'
Trident Maple	*Acer buergerianum*		Oval	20-25'	20-25'
Tulip Tree	*Liriodendron tulipifera*		Oval-rounded with a strong centra leader	35-50'	70-90' (150')
Tupelo / Sour Gum	*Nyssa sylvatica*		Rounded pyramidal	20-30'	30-50'
Valley Oak	*Quercus lobata*	N P	Broad-rounded	50-80'	70'+
Vine Maple	*Acer circinatum*	N	Rounded	25-35'	5-35'
Washington Hawthorn	*Crataegus phaenopyrum*		Rounded, vase-shaped	15-20'	25'
Western Red Cedar	*Thuja plicata*	E	Conical to wide conical	50-80'	50-70' (200')
Western Redbud	*Cercis occidentalis*		Rounded	10-18'	10-18'
White Alder	*Alnus rhombifolia*	N	Pyramidal to rounded	15-25'	30-45'
White Ash	*Fraxinus Americana 'Autum Purple', 'Chicago Regal'*		Oval	60'	40'
Willow Oak	*Quercus phellos*		Rounded	30-40'	40-60' (100')
Zelkova	*Zelkova serrate*		Vase-shaped and rounded	30-60'	50-80' (120')

*proposed tree's/landscaping plans are subject to the approval of the local permitting agency
[a]only allowed in foothills of Folsom
**E = Evergreen; N = Native; P = Protected Species (may vary by jurisdiction); S = Some Can Be Native

Appendix D-4 LID Credits Background Report

I. Introduction

Multiple environmental agencies, including the Central Valley Regional Water Quality Control Board, have recently adopted a strategy to encourage municipalities and developers to incorporate Low Impact Development (LID) into site planning and design. Low Impact Development includes a set of measures that reduce site imperviousness, thereby reducing storm water runoff, and/or provide filtration through vegetation or infiltration. In theory, use of LID controls within a given site results in a reduction of the amount of storm water requiring treatment, termed Runoff Reduction. The purpose of this report is to summarize an effort undertaken by local agencies to develop an LID, or Runoff Reduction, credit system. This system is being developed for use in the Stormwater Quality Design Manual for the Sacramento Region (Manual).

The NPDES Phase I and Phase II Municipal Stormwater Permits for the County of Sacramento (and copermittees) and the City of Roseville, respectively, require that treatment of storm water occur for development projects of various types: residential and commercial being the most common. Thresholds (by size of development) for treatment vary by permit, but all participating municipalities have an interest in achieving regional consistency in the application of storm water design standards.

This document and the resulting worksheets are an attempt to 1) quantify the benefit obtained through the incorporation of specific Runoff Reduction measures, and 2) provide a mechanism by which developers can calculate the benefit for using Runoff Reduction and the resulting reduction in size of treatment controls. This is achieved by assigning "credits" to the use of Runoff Reduction measures.

This document focuses on the two most common types of development, residential and commercial, but the concepts presented could be easily adapted to other types of development projects.

Assumptions

The Runoff Reduction credit system has been developed based on the following assumptions.

- Pavement/asphalt and roof tops are 100% impervious.
- Landscaped areas, lawns, and natural areas are pervious and any runoff generated from these areas is assumed to be clean with no further treatment needed.
- Runoff from porous pavements is partially infiltrated/reduced depending on how pervious the material is and on the permeability of native soils.
- Runoff from impervious surfaces that flows across pervious surfaces is partially reduced with the amount of reduction dependent on the type of receiving surface.

II. Residential Credits Calculation

Background Data

Research was conducted in 2005 by the City of Roseville and the County of Sacramento using studies of available maps of residential developments of various sizes and types within Sacramento and Placer County. These maps were used to calculate the aggregate area of features of interest: streets, rooftops, sidewalks, and driveways, as well as the total area of each development. A value was calculated for rooftops, sidewalks, driveways, streets, and total impervious surface as a percentage of the total area. This information was compiled to obtain local, accurate, empirical values for the average impervious fraction of different types of residential developments with differing densities (dwelling units per acre), as well as information about how the different features contribute to total site imperviousness. Data collected in the research effort for 29 sites is summarized in Attachment A.

The Sacramento/Roseville data was used to compute an average impervious fraction for each of eight categories of residential development classified by density, which ranged from one dwelling unit per acre to 20 dwelling units per acre. Average total impervious fraction and percent imperviousness by surface type has been identified in Table 1.

Table 1 Average Impervious Fraction by Surface Type for Eight Categories of Residential Development

Density in Dwelling Unites per acre (DU/A)	**1**	**2**	**3-4**	**5-6**	**7**	**8-9**	**10-14**	**15-20**
Total Impervious Fraction	0.17	0.25	0.35	0.40	0.50	0.55	0.60	0.70
Rooftop	0.08	0.13	0.19	0.23	0.29	0.33	0.37	0.44
Sidewalk	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Driveway	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Street	0.01	0.04	0.08	0.09	0.13	0.14	0.15	0.18

Appendix D-1 in Manual

The Residential Runoff Reduction Worksheet, Form D-1, allows a designer to calculate a reduced treatment requirement based on the incorporation of various Runoff Reduction measures into their project. To use Appendix D-1, the designer must obtain an accurate estimate of the project area, then estimate how much of that area will be 'open space and parks' as defined in the Manual. Open space and parks does not include landscaping within individual residential lots. The open space/parks acreage is subtracted from the total acreage to find the size of the area that will require treatment, At. These calculations are completed in Step 1 of the form.

The designer then proceeds through Step 2 to determine how much credit is earned for Runoff Reduction techniques incorporated into the project. Using predetermined impervious fraction factors and Forms D-1a-d, the designer calculates the size of each area that will be affected by various Runoff Reduction techniques, and these areas become "effectively managed" under the system. The total Effective Area Managed (Ac) equals the amount of credit allowed for the incorporation of Runoff Reduction measures.

For every technique, an *efficiency multiplier* is provided which reflects the fraction of runoff that is being reduced or treated from the area being considered. For example, a porous pavement driveway reduces runoff from the driveway by 60% while a Hollywood driveway reduces runoff by 75%, based on each driveway's ability to infiltrate stormwater. After an efficiency multiplier is determined, a *use multiplier* representing the percentage of units in the development that are using the technique is determined. So, if 50% of the units in the development use the Runoff Reduction measure, then 50% of possible reduction is achieved. Finally, a *reduction factor* is selected, which represents the fraction of land that the surface of interest represents. For example, in calculating the amount of credits allowed for an alternative driveway, the reduction factor reflects the area of driveway surface as a fraction of the total area requiring treatment (At); in all residential developments, driveways comprise 4% of the total area. These fractions are all multiplied together to get a fraction of total site area effectively managed. This is multiplied by the total acreage of AT to find the area of impervious surface that is effectively managed (Ac) by using the Runoff Reduction technique.

So the *effective area managed* is equal to:

efficiency multiplier * use multiplier * reduction factor * total acreage

Runoff Reduction measures for which credit can be obtained within residential development projects include *disconnected roof drains, disconnected pavement, interceptor trees, and alternative driveways*. All Runoff Reduction measures must be designed and installed in accordance with specifications and details provided in Fact Sheets included in the Manual. The basis for the credit allowed for each of the Runoff Reduction measures has been detailed below.

Disconnected Roof Drains (DRDs)

Disconnected roof drains (DRDs) can achieve the functional equivalent of reducing a large amount of imperviousness by directing rooftop runoff to a pervious surface, dispersal trench, or dry well, as allowed by the local permitting agency. Use of DRDs as a Runoff Reduction measure has been recommended in guidance manuals such as *Start at the Source* (1999) and *The Practice of Low Impact Development* (2003.) If the roof drainage is connected to a dispersal trench or a dry well that have been designed according to specifications provided in the fact sheet, then 100% of the impervious surface attributed to rooftop is considered treated for that unit, thus the *efficiency multiplier* is 1.00. Design standards for the dispersal trench and dry well are adapted from *High Point Community Site Drainage Technical Standards* (2004) and *Virginia Stormwater Management Program Handbook* (1999).

If the runoff, via the roof drain, is directed across the surface of the landscaping, then the amount of runoff that will be treated is dependent on the amount of vegetation the water will flow through before entering the storm drain system. The design specifications for Sacramento County require a 20-foot setback between the house and the sidewalk. Most new developments obtain variances to reduce their setback distances to 15 feet or 12.5 feet. The *efficiency multiplier* for disconnected roof drains draining to landscaping is then found using manning's equation to solve for hydraulic residence time. The manning's equation used is the equation described in *Filter Strip Worksheet 2005 Surface Water Design Manual Sizing Method* published in the King County Surface Water Design Manual published by King County Water and Land Resources Division.

$$L = t\frac{Q}{W}\left(\frac{1.49W\sqrt{s}}{Qn}\right)^{0.6}$$

Where

L = filter strip length (feet)

t = hydraulic residence time (seconds)

Q = design flow (cfs)

W = filter strip width (feet)

n = Manning's roughness coefficient

s = longitudinal slope along path

$$WQF = C\ i\ A$$

Where

WQF = design flow (cfs)

C = Rational Runoff coefficient

i = rainfall intensity (in/hr)

A = Area (acres)

The equation is solved for hydraulic residence time, using various setback lengths and the following assumptions:

Residential Disconnected Roof Drain Assumptions

W = 5 feet (recommended by local hydrologist as typical average)

s = 0.01

n = 0.35 (residential is likely to have short grasses)

C = 0.9 (rational C) (corresponds to rooftop's 100% imperviousness)

Rooftop area = 2,500 sq feet (average roof area for 5-7 DU/A)

The hydraulic residence time is then computed as a percentage of the value for full treatment, identified as being 7 minutes by many stormwater manuals. The results are summarized in Table 2, and multipliers are rounded to the nearest 0.05 in the form.

Table 2 DRD Efficiency Multipliers Based on Length of Front Yard Setback

Length of Setback (feet)	Residence Time (min)	Percent of 7 minutes	Efficiency Multiplier
25	8.6	123%	1
20	6.9	98%	0.98
15	5.2	74%	0.74
10	3.4	48%	0.48
5	1.7	24%	0.24

The designer must determine how many of the roof downspouts are to be disconnected, as a percentage of total roof downspouts. This determines the *use multiplier* for disconnected rooftops.

The form is used to determine the area of impervious surface accounted for by rooftops, dependent on site density (1-20 DU/A). This area is the maximum amount of impervious surface that can be effectively managed with DRDs and comprises the *reduction factor*. Reduction factors for DRDs range from 0.08 to 0.44 and are summarized in Table 1.

Example:

If a 20-acre residential site, 5 DU/A (23% rooftop impervious surface), includes the disconnection of all roof drains on 40% of houses with a setback of 12 feet (48% treatment) the Runoff Reduction measure would result in:

(0.48)(0.40)(0.23)(20 acres) = 0.044(20 acres) = 0.88 acres of effectively managed area (Ac).

Divided Sidewalks (DS)

Divided Sidewalks (DS) function to drain water runoff from sidewalks onto a strip of grass located between the sidewalk and the street. Divided Sidewalks are essentially a variation on Disconnected Pavement (DP) and the credits application method for DP was adapted from the *Urban Storm Drainage Criteria Manual Volume 3 – Best Management Practices* for Denver (2005). The landscaping strips are usually as wide as the sidewalks themselves, so the sidewalks are considered entirely treated. Sidewalks account for approximately 6% of the total area of most residential developments, so if all units use divided sidewalks the development will treat 6% of total site runoff. If a development chooses to use divided sidewalks on some areas, connector streets for example, the amount of credits applied will be scaled by the percentage of units using the design. A designer chooses the percentage of units using the design, and the number is multiplied by 0.04 to get the total credits obtained.

If a designer uses divided sidewalks on 30% of units in a 200 acre development, the credit allowed: use multiplier * reduction factor * total acreage

(0.30)(0.04)(200 acres) = 0.012(200 acres) =2.4 acres of effectively managed area (Ac).

Interceptor Trees (IT)

Interceptor trees can prevent and/or delay water from landing on an impervious surface. Much of the intercepted water runs down along the tree's leaves and branches and evaporates, or runs down into the root system. Properly located trees can reduce the effective impervious fraction by diverting rain that would otherwise fall on streets and sidewalks. The *City of Portland Stormwater Management Manual* (2004) and City of San Jose policy apply 100 sq. feet of credit for a deciduous tree and 200 sq. feet for an evergreen tree. Research results published by Q. Xiao (1998, 2000(2), 2003) provides evidence that this credit system is appropriate for the central valley climate. The number of trees is multiplied by the credit to obtain an area reduced by interceptor trees. Credits may be applied for existing trees as defined in Interceptor Trees Fact Sheet. To calculate the credits allowed for existing interceptor trees, the designer must identify the square footage equal to one half of the existing tree canopy. The resulting area is considered the area effectively managed by the existing interceptor trees.

Alternative Driveway Design (ADD)

Alternative driveways can be designed to incorporate a pervious or semi-pervious surface or to direct runoff into vegetation. Use of ADD as a Runoff Reduction measure has been recommended in guidance manuals such as *Start at the Source* (1999) and *The Practice of Low Impact Development* (2003.) The amount of runoff infiltrated on driveways depends on the type of porous pavement used (acceptable types of porous pavements are listed under the Porous Pavement Section), therefore *efficiency factors* vary from 0.40 to 1.00 (see below **Porous Pavement**). For Hollywood driveways, which reduce pavement area but do not necessarily utilize alternative pavement types, the reduction of paved surface and the redirection of stormwater into the unpaved section results in an *efficiency factor* of 0.75.

The designer must determine how many of the driveways are to be designed using the alternative method, as a percentage of total driveways. This determines the *use multiplier* for ADD. Reduction factor for ADD measures for all development densities are 0.04.as summarized in Table 1.

Example:

If 50% of the homes in a 100 acre residential site, 5 DU/A (4% driveway impervious surface), use Hollywood driveways, the Runoff Reduction measure would result in:

(0.50)(0.04)(0.75)(100 acres) = 0.015(100 acres) = 1.5 acres of effectively managed area (Ac).

Using the Effective Area Managed (Ac) in Calculating Treatment Requirement

After each Runoff Reduction measure has been addressed on the subforms, Forms D-1a through D-1d, the A_c is totaled. This managed area is subtracted from the Area Requiring Treatment (A_T) found in Step 1. The Adjusted Area Requiring Treatment (A_{AT}) is also used to find an Adjusted Impervious Fraction (I_A).

After the A_{AT} is calculated, the water quality flow and/or volume must be calculated for sizing treatment controls. Whether the designer needs to calculate flow-based treatment or volume-based treatment depends on the type of treatment planned.

Treatment flow(WQF) is found using the standard flow equation,

$$WQF = C\ i\ A$$

where C is the rational runoff coefficient based on the DU/A (Table D-1b in Form D-1), i is the rainfall intensity (varies by region, see Table D-1c in Form D-1), and A is the adjusted area requiring treatment (A_{AT}). This value is to be used when determining sizing criteria for structural treatment controls.

Treatment Volume is found using either the CASQA method (Roseville):

$$V = A \times SV / 12$$

where A = the total area of the drainage shed, SV = the Unit Basin Storage Volume; use C_A adjusted for credits earned (see Adjusted Runoff Coefficient, below).

Or the ASCE-WEF method (Sacramento):

$$WQV\ (ac\text{-}ft) = P_0 * A / 12$$

where A = the total area of the drainage shed, P_0 = maximized detention volume using the ASCE-WEF method.

Please refer to Chapter 5 and Appendix E for the selection of the treatment measures and design requirements. Then use form D-1f, Treatment – Volume Based (CASQA) for volume-based treatment controls within the City of Roseville, or form D-1g, Treatment – Volume Based, for treatment controls in areas outside of the City of Roseville.

Adjusted Runoff Coefficient

The Adjusted Impervious Fraction is converted to an Adjusted Runoff Coefficient, CA, using the empirical regression equation presented in the California Stormwater BMP Handbook (CASQA, 2003).

$$C = 0.858\ I^3 - 0.78\ I^2 + 0.774\ I + 0.04$$

where C = runoff coefficient, I = impervious fraction

The results of this equation for values of “I” between 0 and 1 are listed in Table D-1d, Form D-1.

III. Commercial and Multi-Family Credits Calculation

Appendix D-2 in Manual

The Commercial and Multifamily Runoff Reduction Worksheet, Appendix D-2, allows a designer to calculate a reduced treatment requirement based on the incorporation of various Runoff Reduction measures into their project. To use Appendix D-2, the designer must obtain an accurate estimate of the area, then estimate how much of that area will be 'open space and parks' as defined in the Manual. This includes all landscaping areas and areas left in a natural state. The open space acreage is subtracted from the total acreage to find the size of the area that will require treatment, A_T. This area (A_T) generally includes parking lots, rooftops, and driveways, which are assumed to be impervious. The designer then calculates the size of each area that will be affected by various Runoff Reduction techniques, and these areas become "effectively managed" under the system. The total Effective Area Managed (A_c) equals the amount of credit allowed for the incorporation of Runoff Reduction measures.

Runoff Reduction measures for which credit can be obtained within commercial and multi-family development projects include porous pavement, disconnected roof drains, green roofs, disconnected pavement, and interceptor trees. All Runoff Reduction measures must be designed and installed in accordance with specifications and details provided in Fact Sheets included in the Manual. The basis for the credit allowed for each of the Runoff Reduction measures has been detailed below.

Porous Pavement

The amount of credit applied for the use of porous pavement varies depending on the pavement type. The effective impervious fraction of these different types of porous pavement has been studied and reported in *Urban Storm Drainage Criteria Manual Volume 3 – Best Management Practices* for Denver (2005). This source was used to determine the impervious fraction of the following porous pavement types. Modular Block Pavement is concrete blocks with open voids occupying at least 20% of total surface area. The voids are filled with gravel and then filled in with sand. These surfaces have an effective impervious fraction of 25%, thus the *efficiency multiplier* is 0.75. Cobblestone Block Pavement consists of concrete blocks that look like cobblestone and create open voids between the blocks. These create an effective impervious fraction of 60%, and have an *efficiency multiplier* of 0.40. Reinforced Grass Pavement is a stabilized grass surface that infiltrates rainwater well. Because of this, it is given an *efficiency multiplier* of 1.00. Pervious Pavement is a concrete/asphalt that does not contain the normal fine sand and has 15-20% of its volume as void space. These are found to have an impervious fraction of 40%, and thus an *efficiency multiplier* of 0.60. Porous Gravel Pavement is a loose gravel paving and has an effective impervious fraction of 25%, and an *efficiency multiplier* of 0.75. The *efficiency multipliers* are listed in Table D-2a of Appendix D-2. For all pavement types, the *efficiency multiplier* is multiplied by the area of land utilizing the porous pavement type to determine total credits applied.

If Modular Block Pavement, which has an *efficiency multiplier* of 0.75, was used on 5,000 sq. ft of parking lot, the A_c would be:

5,000*0.75 = 3,750 square feet.

Disconnected Pavement (DP)

Disconnected Pavement is pavement designed to allow stormwater to sheet flow over vegetated areas or porous pavement prior to entry into a storm drain system. The efficiency of this method depends on both the impervious fraction of the receiving porous surface, as well as the ratio of contributing area to receiving area. These two factors taken together allow for the calculation of an effective impervious fraction for the not directly connected surface. These values are derived from Figure PP-1 of the *Urban Storm Drainage Criteria Manual Volume 3 – Best Management Practices* for Denver (2005). The designer begins by selecting the type of surface (landscaping or one of the porous pavements) that the disconnected pavement will run onto. If the pavement will be draining onto landscaping the entire pavement area is effectively treated, providing that the area draining onto the landscaping is not more than twice the area of landscaping.

If the pavement will be draining onto a porous pavement, first the ratio of contributing pavement to receiving pavement is calculated, then based on the resulting ratio, a multiplier is determined, as listed in Table 3. Porous pavement for which credit is obtained under Appendix D-2, Step 2, Porous Pavement Option, cannot be included in Disconnected Pavement calculations.

Table 3 Multipliers Based on Ratio of Contributing Pavement to Receiving Pavement

Ratio of Contributing Pavement to Receiving Pavement	Multiplier
<0.5	1.00
≥0.5 and <1.0	0.83
≥1.0 and <1.5	0.71
≥1.5 and <2.0	0.55

The efficiency multiplier for the selected porous pavement is selected from Table D-2a in Appendix D-2. The formula for calculating the A_c is as follows:

$$(\text{area of receiving pavement})(\text{efficiency multiplier}) + (\text{area of contributing pavement})(\text{ratio multiplier})(\text{efficiency multiplier}) = A_c$$

Disconnected Roof Drains (DRD)

Disconnected roof drains (DRDs) can achieve the functional equivalent of reducing a large amount of imperviousness by directing rooftop runoff to a pervious surface, dispersal trench, or dry well. Use of DRDs as a Runoff Reduction measure has been recommended in guidance manuals such as *Start at the Source* (1999) and *The Practice of Low Impact Development* (2003.) If the roof drainage is connected to a dispersal trench or a dry well that have been designed according to specifications provided in the fact sheet, then 100% of the impervious surface attributed to rooftop is considered treated for that unit, thus the *efficiency multiplier* is 1.00. Design standards for the dispersal trench and dry well are adapted from *High Point Community Site Drainage Technical Standards* (2004) and *Virginia Stormwater Management Program Handbook* (1999).

If the runoff, via the roof drain, is directed across the surface of the landscaping, then the amount of runoff that will be treated is dependent on the amount of vegetation the water will flow through before entering the storm drain system. In order to receive credits for DRDs on a commercial site, the runoff must be conveyed across a minimum length of landscaping or conveyance furrow. This minimum value is different for different rooftop sizes. The minimum values are calculated using a filter strip calculation which is a variation of manning's equation to solve for hydraulic residence time. The manning's equation used is the equation described in *Filter Strip Worksheet 2005 Surface Water Design Manual Sizing Method* published in the King County Surface Water Design Manual published by King County Water and Land Resources Division.

$$L = t\frac{Q}{W}\left(\frac{1.49W\sqrt{s}}{Qn}\right)^{0.6}$$

Where

L = filter strip length (feet)

t = hydraulic residence time (seconds)

Q = design flow (cfs)

W = filter strip width (feet)

n = Manning's roughness coefficient

s = longitudinal slope along path

$$WQF = C\ i\ A$$

Where

WQF = design flow (cfs)

C = Rational Runoff coefficient

i = rainfall intensity (in/hr)

A = Area (acres)

The equation is solved for hydraulic residence time, using various setback lengths and the following assumptions:

Commercial Disconnected Roof Drain Assumptions

W = 8 feet (recommended by local hydrologist as typical average)

s = 0.01

n = 0.3 (commercial planter strip, will contain some bushes and larger plants)

Rooftop C = 0.9 (rational C) (corresponds to 100% imperviousness)

T = 7 minutes (standard residence time for treatment)

This results in the following setback/travel distance values for commercial sites.

Table 4 Minimum Travel Distance for Disconnected Roof Drains in Commercial/Multi-family Development Projects

Area (maximum roof size)	Length (min travel distance)	Depth of flow
3,500 sq ft	21 feet	0.4 in
5,000 sq ft	24 feet	0.5 in
7,500 sq ft	28 feet	0.6 in
10,000 sq ft	32 feet	0.7 in

Interceptor Trees

Interceptor trees can prevent and/or delay water from landing on an impervious surface. Much of the intercepted water runs down along the tree's leaves and branches and evaporates, or runs down into the root system. Properly located trees can reduce the effective impervious fraction by diverting rain that would otherwise fall on streets and sidewalks. The *City of Portland Stormwater Management Manual* (2004) and City of San Jose policy apply 100 sq. ft of credit for a deciduous tree and 200 sq. feet for an evergreen tree. Research results published by Q. Xiao (1998, 2000(2), 2003) provides evidence that this credit system is appropriate. The number of trees is multiplied by the credit to obtain an area reduced by interceptor trees. Credits may be applied for existing trees as defined in Interceptor Trees Fact Sheet. To calculate the credits allowed for existing interceptor trees, the designer must identify the square footage equal to one half of the tree canopy. The resulting area is considered the area effectively managed by the existing interceptor trees.

Using the Effective Area Managed in Calculating Treatment Requirement

After each Runoff Reduction measure has been addressed on the subforms, forms D-2a and D-2b, the A_c is totaled. This managed area is subtracted from the Area Requiring Treatment (A_T) found in Step 1. The Adjusted Area Requiring Treatment (A_{AT}) is also used to find an Adjusted Impervious Fraction (I_A).

After the A_T, A_{AT}, and I_A have been calculated, the water quality flow and/or volume must be calculated for sizing treatment controls. Whether the designer needs to calculate flow-based treatment or volume-based treatment depends on the type of treatment planned.

Treatment flow (WQF) is found using the standard flow equation,

$$WQF = C\ i\ A$$

where C is the rational runoff coefficient for A_{AT} (assumed to be 0.95), i is the rainfall intensity, and A is the adjusted area requiring treatment (A_{AT}). This value is to be used when determining sizing criteria for structural treatment controls.

Treatment Volume (WQV) is found using either the CASQA method (Roseville):

$$V = A \times SV / 12$$

where A = the total area of the drainage shed, SV = the Unit Basin Storage Volume; use CA adjusted for credits earned (see Adjusted Runoff Coefficient, below).

Or the ASCE-WEF method (Sacramento):

$$WQV\ (ac\text{-}ft) = P_o * A / 12$$

where A = the total area of the drainage shed, P_o = maximized detention volume using the ASCE-WEF method.

Please refer to Chapter 5 and Appendix E for the selection of the treatment measures and design requirements. Then use form D-1f, Treatment – Volume Based (CASQA) for volume-based treatment controls within the City of Roseville, or form D-1g, Treatment – Volume Based, for treatment controls in areas outside of the City of Roseville.

Adjusted Runoff Coefficient

The *Adjusted Impervious Fraction* is converted to an *Adjusted Runoff Coefficient*, C_A, using the empirical regression equation presented in the *California Stormwater BMP Handbook* (CASQA, 2003).

$$C = 0.858\ I^3 - 0.78\ I^2 + 0.774\ I + 0.04$$

Where C = runoff coefficient, I = impervious fraction

The results of this equation for values of "I" between 0 and 1 are listed in Table D-2d of Appendix D-2.

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Appendix E. Design Requirements for Stormwater Quality Treatment Control Measures

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Appendix E Design Requirements for Stormwater Quality Treatment Control Measures (Volume and Flow-Based Measures)

The Sacramento Areawide NPDES Municipal Stormwater Permit contains provisions that require the local municipal agencies to establish and enforce stormwater quality treatment standards for many new and redevelopment projects. This appendix presents the minimum standards for sizing the treatment control measures.

General Methodology

Follow these steps:

- Refer to Table 3-2 in this Design Manual to determine if your project requires treatment control measures.
- Once you have made that determination, use the fact sheets in Chapter 6 to identify the type of control measures most appropriate for your project site and whether or not those measures are volume or flow-based.
- (Optional) Use Chapter 5 and the runoff reduction worksheets in Appendix D to select runoff reduction measures for your project which will reduce the runoff discharged; this may result in reduced treatment needs (and associated costs) for your project.
- Use the rest of the information in this appendix to size the treatment control facilities for your project.

The local Sacramento agencies have developed a presumptive approach, whereby, if project applicants follow the methodology presented herein, it is presumed that the project is reducing stormwater pollution in runoff to the "maximum extent practicable" NPDES municipal permit standard. A key principle here is that treatment control measures are most efficient and economical when they target small, frequent storm events that over time produce more total runoff than the larger, infrequent storms conventionally targeted for design of flood control facilities. Further, studies in other areas of the country have shown that much of the pollutant load is contained in the "first flush" of rainfall during a storm event, typically the first 0.5-inches. Targeting design storms larger than this may result in some improvements in pollutant removal effectiveness, but at considerable cost.

It is important to note that arbitrarily targeting large, infrequent storm events can actually reduce the pollutant removal capabilities of some treatment control measures. This occurs when outlet structures, detention times, and drain down times are designed to accommodate unusually large volumes and high flows. When over-designed in this way, the more frequent, small storms that produce the most annual runoff and a large part of the pollutant load pass quickly through the over-sized facility and therefore receive inadequate treatment. (CASQA, 2003).

Sizing Flow-Based Treatment Control Measures

Use this method for sizing flow-based control measures (e.g., vegetated swales).

Flow-based control measure design standards apply to control measures whose primary mode of pollutant removal depends on the rate of flow of runoff through the facility or device. Examples of control measures in this category include swales, sand filters, diversion structures for off-line control measures, and many proprietary products. Typically, flow-based design criteria calls for the capture and infiltration or treatment of the flow runoff produced by rain events of a specified magnitude. For the local area, the intensity of such a storm event is 0.20 inches/hour for the City of Folsom and 0.18 inches/hour for other cities in Sacramento County and unincorporated Sacramento County.

This method satisfies the provisions of the Sacramento Areawide NPDES Municipal Stormwater Permit, which requires that flow-based measures be designed for at least the maximum (peak) flow rate of runoff produced by the 85th percentile hourly precipitation intensity multiplied by a factor of two, referred to here as the flow-based 85th percentile method. (CDM, 2003). This criterion is the same as the one prescribed by the 2003 California BMP Handbook. From Appendix D of that handbook, the 85th percentile hourly precipitation intensity for the Sacramento gage is approximately 0.09 inches/hour. Multiplying by two, the required intensity is at least 0.18 inches/hour. The factor of two specified for this method by the municipal stormwater permits appears to be provided as a factor of safety: therefore, caution should be exercised when applying additional factors of safety during the design process so that over design can be avoided. (CASQA, 2003).

The flow-based BMP design criteria should be used in conjunction with the Rational Formula, a simplified, easy to apply formula that predicts flow rates based on rainfall intensity and drainage area characteristics. The Rational Formula is as follows:

$$WQF\ (cfs) = C\ i\ A$$

where

WQF = flow in ft^3/s

i = rain intensity in inches/hr

A = drainage area in acres

C = rational runoff coefficient

The Rational Formula is widely used for hydrologic calculations, but it does have a number of limitations. For stormwater treatment control measure design, a key limitation is the ability of the Rational Formula to predict runoff from undeveloped areas where runoff coefficients are highly variable with storm intensity and antecedent moisture conditions. This limitation is accentuated when predicting runoff from frequent, small storms used in stormwater quality treatment design because many of the runoff coefficients in common use were developed for predicting runoff for drainage design where larger, infrequent storms are of interest. Table 5-3 in the California BMP Handbook (May 2003) provides some general guidelines on use of the Rational Equation. In summary, the Rational Formula, when used with commonly tabulated runoff coefficients in undeveloped drainage areas, will likely result in predictions higher than will be experienced under actual field conditions. However, given the simplicity of the equation, its use remains practical and it is therefore the preferred method recommended by the local permitting agencies.

The following steps describe the approach for application of the flow-based design criteria. For simplicity, the worksheets presented in Appendix D (see Step 3 of Appendix D-1 and D-2) already incorporate these steps.

1. Identify and delineate the drainage shed that drains to the proposed control measure. This includes all areas that will contribute runoff to the proposed control measure, including pervious areas, impervious areas, and off-site areas, whether or not they are directly or indirectly connected to the control measure.

2. Select design rainfall intensity for the project area:
   0.20 inches/hour – projects in the City of Folsom
   0.18 inches/hour – projects located in other cities in Sacramento County and unincorporated Sacramento County

3. Calculate the composite runoff coefficient "C" for the drainage shed identified inStep 1 using table E-1. For contributing areas with multiple coefficients, use the weighted coefficient for the contributing area.

4. Apply the Rational Formula to calculated the water quality design flow (WQF).

$$WQF = C\ i\ A$$

Table E-1: Runoff coefficients for the Rational Formula

Type of Drainage Area	Runoff Coefficient, C
Business	
Downtown areas	0.95
Neighborhood areas	0.70
Residential	
Single-family areas	0.50
Multi-units, detached	0.60
Multi-units, attached	0.75
Apartment dwelling areas	0.70
Industrial	
Light areas	0.80
Heavy areas	0.90
Parks, cemeteries	0.25
Playgrounds	0.40
Railroad yard areas	0.40
Unimproved area	0.30
Lawns	
Sandy soil, flat, 2%	0.10
Sandy soil, average, 2-7%	0.15
Sandy soil, steep, 7%	0.20
Heavy soil, flat, 2%	0.17
Heavy soil, average, 2-7%	0.22
Heavy soil, steep, 7%	0.35
Streets	
Asphaltic	0.95
Concrete	0.95
Brick	0.85
Drives and Walks	0.85
Roofs	0.95

Sizing Volume-Based Treatment Control Measures

Volume-based design standards apply to control measures whose primary mode of pollutant removal depends on the volumetric capacity of the facility. Examples of control measures in this category include water quality detention basins, constructed wetlands, stormwater planters, and infiltration basins/trenches. Volume-based design criteria calls for the capture and infiltration or treatment of a certain percentage of the runoff from the project site, usually in the range of the 75th to 85th percentile average annual runoff volume.

The agencies in Sacramento County require use of the Urban Runoff Quality Management method for sizing volume-based control measures. This method is one of the three alternative design approaches allowed by the NPDES municipal stormwater permits.

Sacramento County Volume-Based Design Method

For projects in Sacramento County, volume-based control measures shall be designed to capture and treat the maximized stormwater quality capture volume for the area, based on historical rainfall records, determined using the formula and volume capture coefficients set forth in Urban Runoff Quality Management (WEF Manual of Practice No. 23/ASCE Manual of Practice No. 87, (1998), pages 175-178). The Urban Runoff Quality Management approach (also known as WEF/ASCE approach) is based on the translation of rainfall to runoff using two regression equations. The first regression equation relates rainfall to runoff. The rainfall to runoff regression equation was developed using 2 years of data from more than 60 urban watersheds nationwide. The second regression equation relates mean annual runoff-producing rainfall depths to the "Maximized Water Quality Capture Volume" which corresponds to the "knee of the cumulative probability curve". This second regression was based on analysis of long-term rainfall data from seven rain gages representing climatic zones across the country. The Maximized Water Quality Capture Volume corresponds to approximately the 85th percentile runoff event, and ranges from 82 to 88%.

The two regression equations that form the Urban Runoff Quality Management approach are as follows:

$$C = 0.858\, I^3 - 0.78\, I^2 + 0.774\, I + 0.04$$

$$P_o = (a \bullet C) \bullet P_6$$

Where

C = runoff coefficient;

I = watershed imperviousness ratio which is equal to the percent total imperviousness divided by 100;

P_o = Maximized Detention Volume, in watershed inches;

a = regression constant, a= 1.312 for 12 hrs, a=1.582 for 24 hrs, and a=1.963 for 48-hour draw down time.

P_6 = mean annual runoff-producing rainfall depths, in watershed inches.

The following steps describe the use of the approach. For simplicity, the worksheets presented in Appendix D (see Step 3 of Appendix D-1 and D-2) already incorporate these steps.

1. Identify the drainage shed (A in acres) that drains to the proposed control measure. This includes all areas that will contribute runoff to the proposed facility, including pervious areas, impervious areas (such as roofs, roads, parking lots, etc), and off-site areas, whether or not they are directly or indirectly connected to the control measure.

2. Determine the "Maximized Detention Volume" (P_0) in inches for the drainage shed. Please refer to the attached figures (figure E-1 though figure E-4).

3. Calculate the required water quality volume of the control measure by multiplying the drainage shed area from Step 1 by the "Maximized Detention Volume" from Step 2.

$$WQV\ (ac\text{-}ft) = P_0 \bullet A / 12$$

References

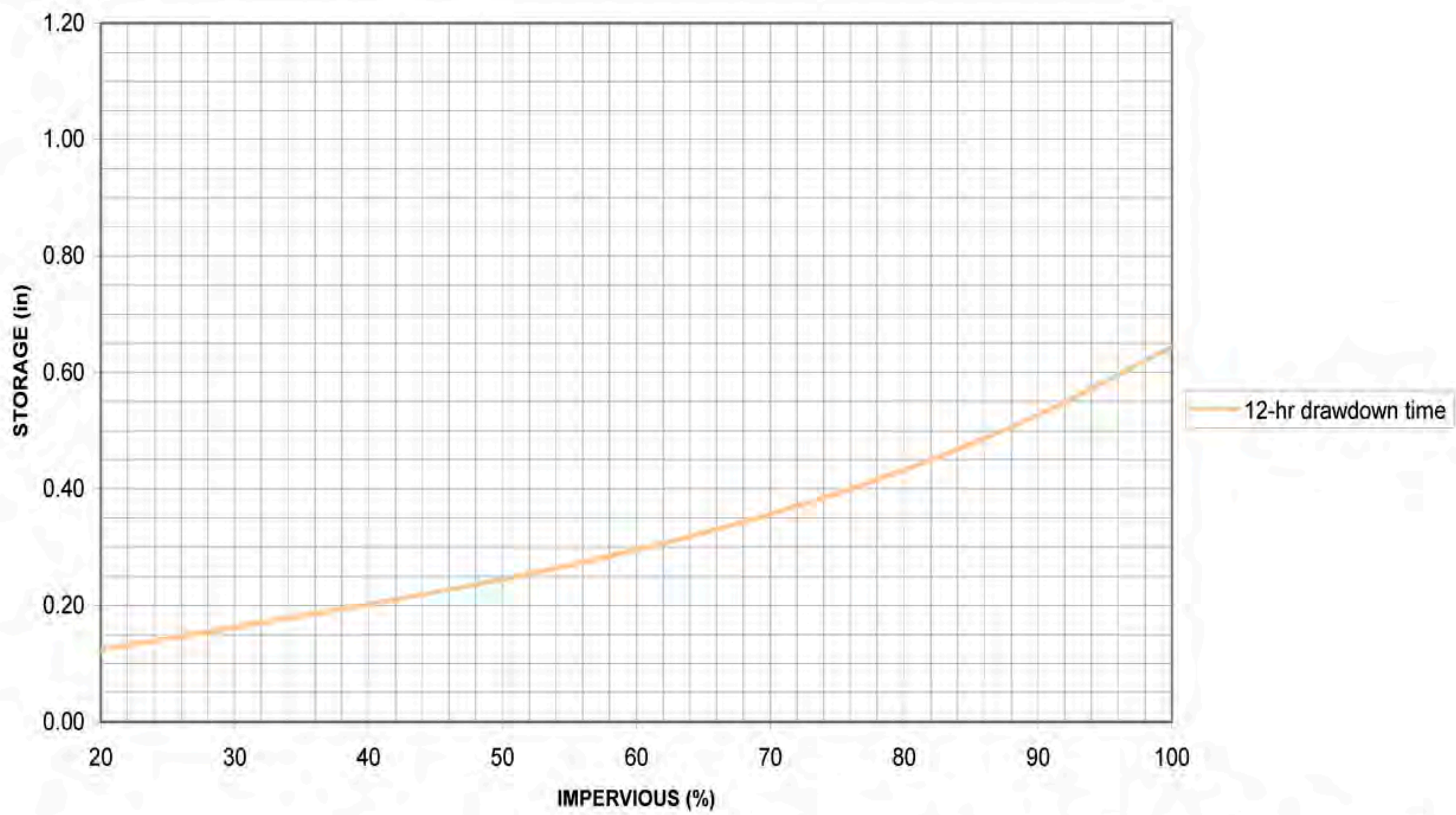
California Stormwater Quality Association (CASQA), 2003. *California Stormwater BMP Handbook for New Development and Redevelopment*, www.cabmphandbooks.com.

Development Standards Plan, Dec. 2003. *Appendix F: Technical Memorandum- Review of Design Criteria for Stormwater Quality Treatment Facilities for the Sacramento Stormwater Management Program.*

Placer Regional Stormwater Coordination Group (PRSCG). May 2005. *Guidance Document for Volume and Flow-Based Sizing of Permanent Post-Construction Best Management Practices for Stormwater Quality Protection.*

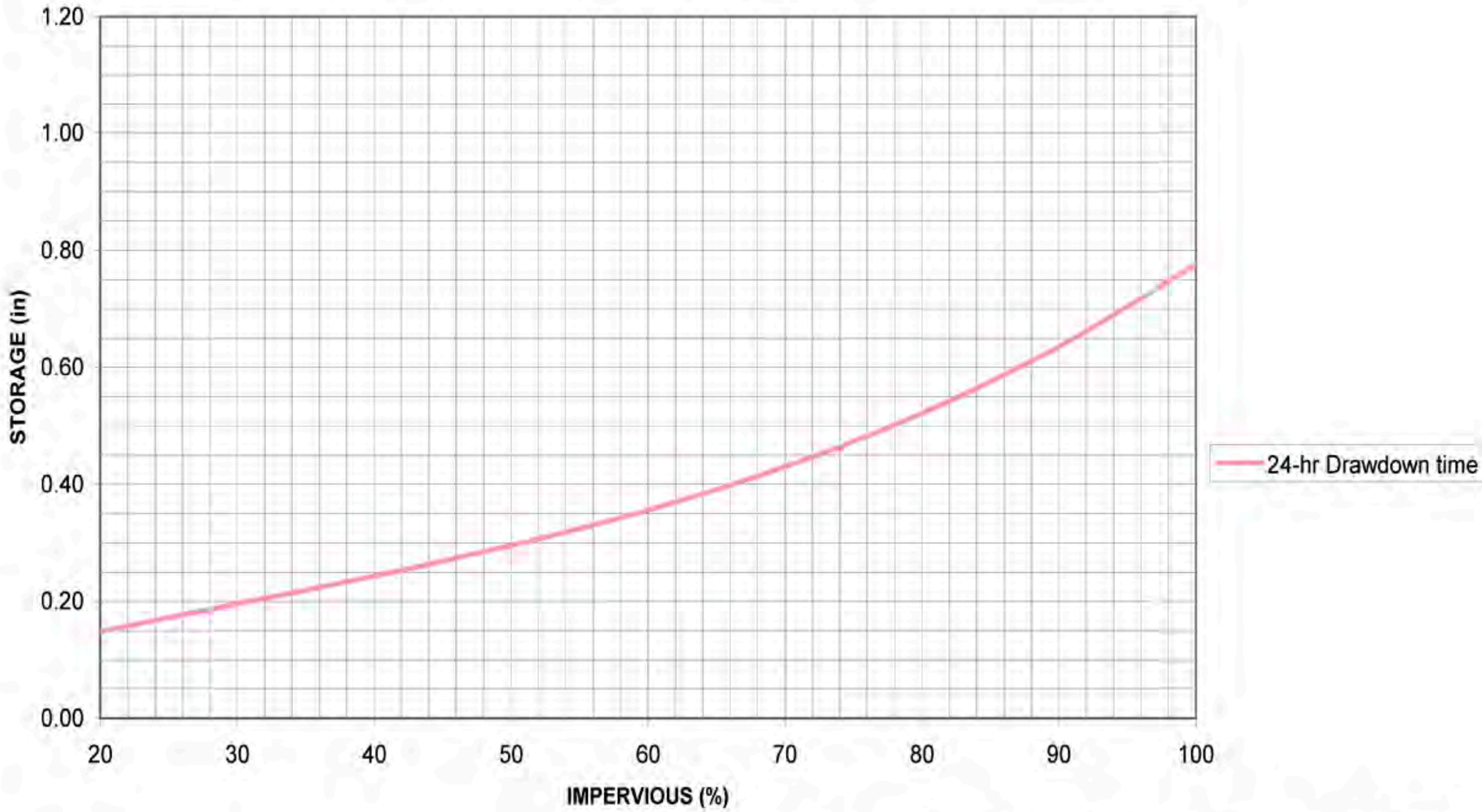
US Department of Transportation, Federal Highway Administration. November 1996. *Urban Drainage Design Manual, Hydraulic Engineering Circular No. 22*, FHWA-SA-96-078.

Water Environment Federation and American Society of Civil Engineers (WEF and ASCE). 1998. *Urban Runoff Quality Management*. WEF Manual of Practice No. 23 and ASCE Manual and Report on Engineering Practice No. 87.



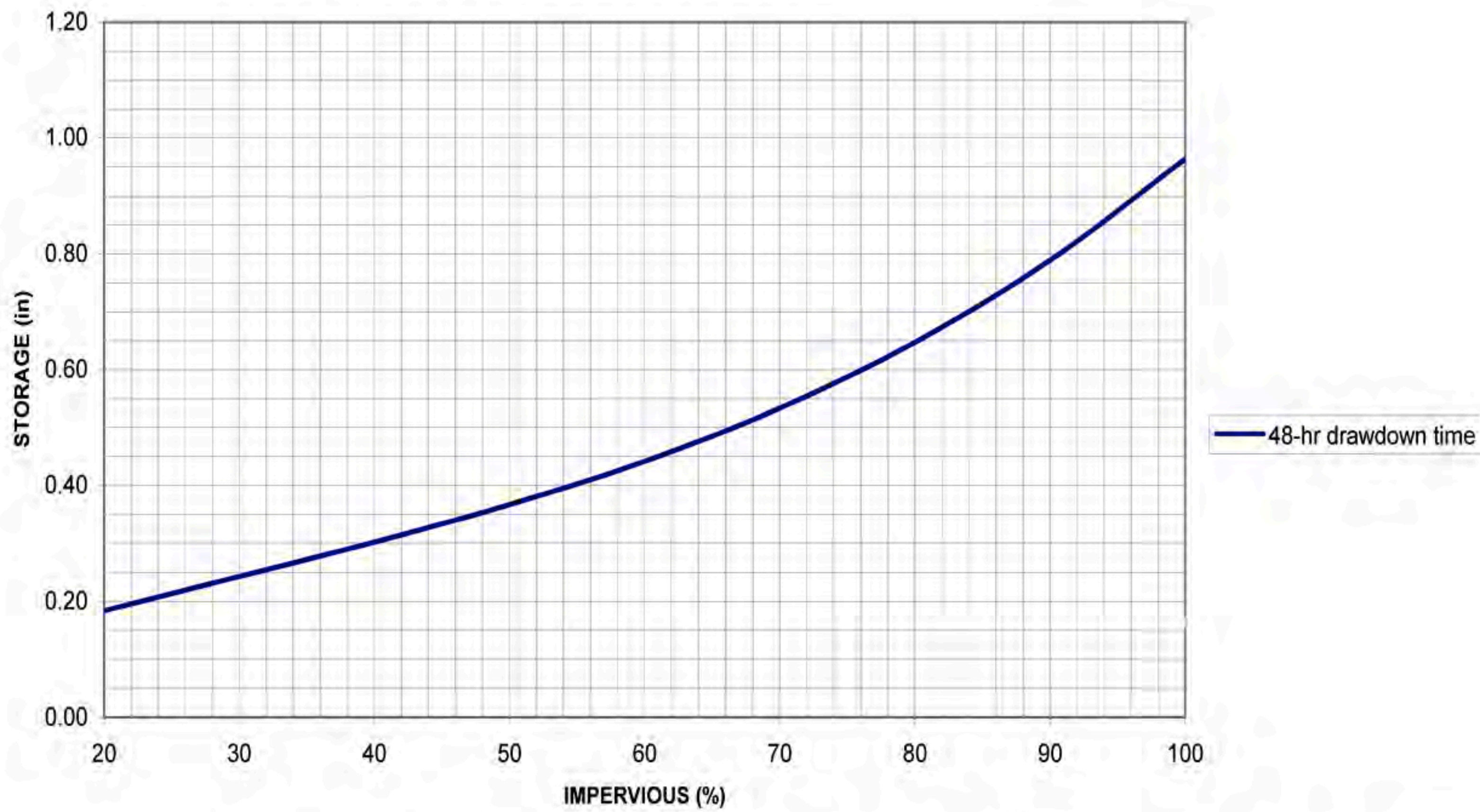
Souce: URBAN RUNOFF QUALITY MANAGEMENT: WEF Manual of Practice No. 23 and Report on Engineering Practice No. 87.

Curve for Maximized Detention Volume P_0	Date: August 2006
	Figure: E-1



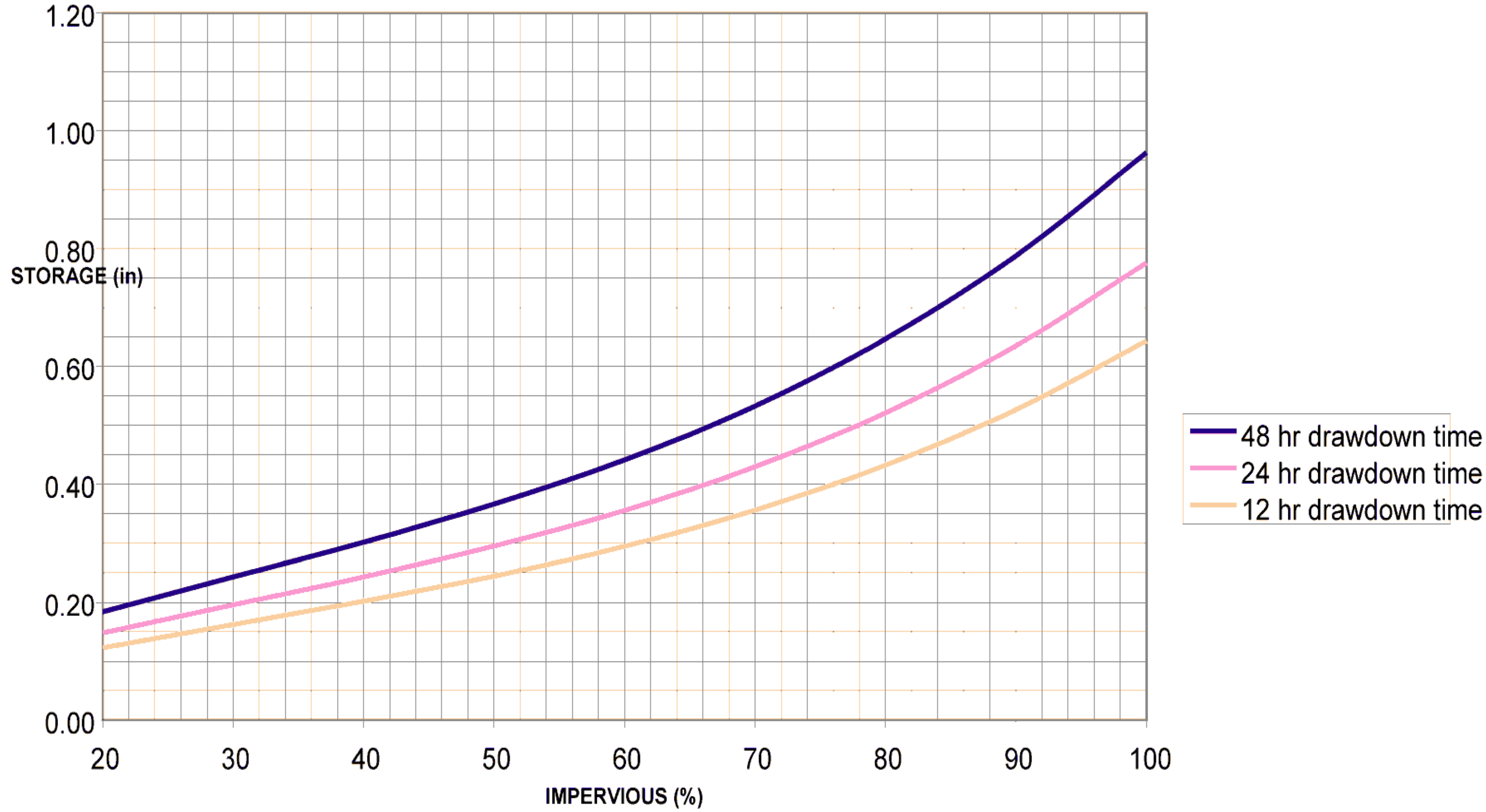
Source: URBAN RUNOFF QUALITY MANAGEMENT: WEF Manual of Practice No. 23 and Report on Engineering Practice No. 87.

Curve for Maximized Detention Volume P_0	Date: August 2006
	Figure: E-2



Source: URBAN RUNOFF QUALITY MANAGEMENT: WEF Manual of Practice No. 23 and Report on Engineering Practice No. 87.

Curve for Maximized Detention Volume P_0	Date: August 2006
	Figure: E-3



Souce: URBAN RUNOFF QUALITY MANAGEMENT: WEF Manual of Practice No. 23 and Report on Engineering Practice No. 87.

Curve for Maximized Detention Volume P_0	Date: August 2006
	Figure: E-4

Appendix F. Drainage Design and Stormwater Management Information Not Included in the Design Manual

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Appendix F Drainage Design and Stormwater Management Information Not Included in the Design Manual

Drainage/Flood Control Design Reference Documents

The design manual does not contain general drainage design standards and details. For that information refer to:

City and County of Sacramento Drainage Manual -Volume II Hydrology Standards can be downloaded at http://www.waterresources.saccounty.net/Pages/ReportsPublications.aspx or hard copy/CD can be purchased from Sacramento County. Contact the Sacramento County Dept. of Water Resources at (916) 874-6851 for ordering information.

City of Sacramento Department of Utilities Procedures Manual and Utility Standards – Electronic copies can be downloaded at http://www.cityofsacramento.org/Public-Works/Engineering-Services/Permits/Plan-Check . Hard copies can be purchased at the City Department of Utilities or one of the two City Permit Centers; call (916) 808-1400 for more information.

City of Folsom Design and Procedures Manual – Electronic copy can be downloaded at: https://www.folsom.ca.us/city_hall/depts/community/engineering/engineering_forms_n_information/default.asp . Or contact the City Department of Public Works for more information at (916) 355-7272.

Construction Erosion and Sediment Control Documents

Sacramento County Improvement Standards (Section 11: Erosion and Sediment Control). (Theses standard details area also used by cities in Sacramento; check with your local permitting agency for verification.) Electronic copies can be downloaded at http://www.engineering.saccounty.net/Pages/ImprovementStandards.aspx. Hard copies can be purchased at: 827 7th Street, Sacramento, CA 95814, at the cashier's office on first floor.

Industrial/Commercial Facility Operational BMP Guidance Documents

Sacramento County and Cities in Sacramento County: Guidance materials are published by the Sacramento County Environmental Management Department, which is responsible for conducting stormwater compliance inspections of many industrial/commercial facilities in the county. Visit http://www.emd.saccounty.net/EH/Pages/Stormwater.aspx for more information.

Statewide Guidance: California Stormwater Best Management Practice Handbook (Industrial and Commercial Edition), CASQA, 2003. https://www.casqa.org/resources/bmp-handbooks

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Appendix G. Inspection Checklist for Stormwater Control Measures

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Inspection Checklist for Stormwater Control Measures

The City/ County inspector is required to verify these listed items for Post Construction Stormwater Quality Measures before signing off on the project:

All Projects:

- ☐ BMPs are correctly and permanently installed (including any necessary vegetation), per the approved plans and/or maintenance agreement for the property.
- ☐ Landscaped areas are stabilized
- ☐ Inlets and curb-cuts are installed to provide smooth entry of runoff from adjoining pavement. Curb-cuts shall be 12-inch minimum
- ☐ Inflows from roof leaders and pipes are NOT directly connected to the underground drainage system
- ☐ Rock or other energy dissipation at piped discharge and curb-cuts is adequate
- ☐ Overflow outlets are configured to allow the facility to fill to near rim before overflow
- ☐ Plantings are healthy and becoming established
- ☐ Weeds and invasive plants have been removed
- ☐ Irrigation system is operable; there are no leaks or breaks in the system and the system does not overspray outside of the facility
- ☐ Site is graded and drains as designed; no surface ponding is evident
- ☐ Any accumulated construction debris, trash, or sediment is removed from all stormwater measures
- ☐ All gravel bags and inlet protection is removed
- ☐ Vegetated BMPs are free of erosion or scouring
- ☐ BMP is free of standing water and unpleasant odors
- ☐ Filter media pouches, booms, cartridges, etc. associated with a permanent BMP are completely secured, intact, and in working condition.

Vegetated Swale

- ☐ Energy dissipater or flow spreader at swale inlet is free and clear of sediment and is not blocked by overgrown vegetation
- ☐ Positive longitudinal slope to the swale outlet
- ☐ No bark mulch shall be placed in the vegetated swale
- ☐ The swale is vegetated as detailed in the approved improvement plans
- ☐ Underdrain is installed per approved improvement plans (if applicable)
- ☐ Filter fabric or filter layer is installed per approved improvement plans (not wrapped around underdrain!!)

Stormwater Planter

- ☐ Minimum of 6-inch storage depth
- ☐ Verify material for Top layer, 18-inch Sand/Peat layer and Gravel layer
- ☐ Overflow inlet grade is not below the minimum storage line.
- ☐ Underdrain for flow-through planter is installed per approved improvement plans
- ☐ Filter fabric or filter layer is installed per approved improvement plans (not wrapped around underdrain!!)

Proprietary Devices

- ☐ Completion of installation per Manufacturer’s specification
- ☐ Certification letter from manufacturer to verify the proper installation of the device.

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Appendix H. Amendment to the Water Quality Control Plan for Ocean Waters of California to Control Trash (Ocean Plan) and Certified Full Capture Systems List of Trash Treatment Control Devices

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Certified Trash Full Capture Systems List
Of Multi-Benefit Treatment Systems

The State Water Resources Control Board (State Water Board) promotes Low Impact Development (LID) designs to capture, reuse, treat, and/or infiltrate storm water runoff. The LID systems and individual treatment controls (Multi-Benefit Treatment Systems) listed below meet the Full Capture System definition and are certified for use by the State Water Board Executive Director, or designee, provided the Multi-Benefit Treatment System performs as follows:

1. Prohibits the discharge of particles 5 mm or greater to surface waters off site;
2. Contains a capacity greater than the volume collected during the region specific one-year, one-hour storm event from the applicable drainage area; or a capacity to carry at least the same flows as the corresponding storm drain;
3. Incorporates an operation and maintenance plan sufficient to ensure that the captured trash does not migrate from the site; and
4. Has stamped and signed design plans by a registered California licensed professional civil engineer (see Bus. & Prof. Code Section 6700, et seq.).

The Executive Director reserves the right to remove any Multi-Benefit System from this list.

System Description **(click links to access information sheets)**
Bioretention
Capture and Use Systems
Detention Basin
Infiltration Trench or Basin
Media Filter

Last Updated: 8/4/17

Bioretention
Trash Best Management Practices (BMP)
Minimum Specifications

Figure A: CA State University-Sacramento Bioretention BMP

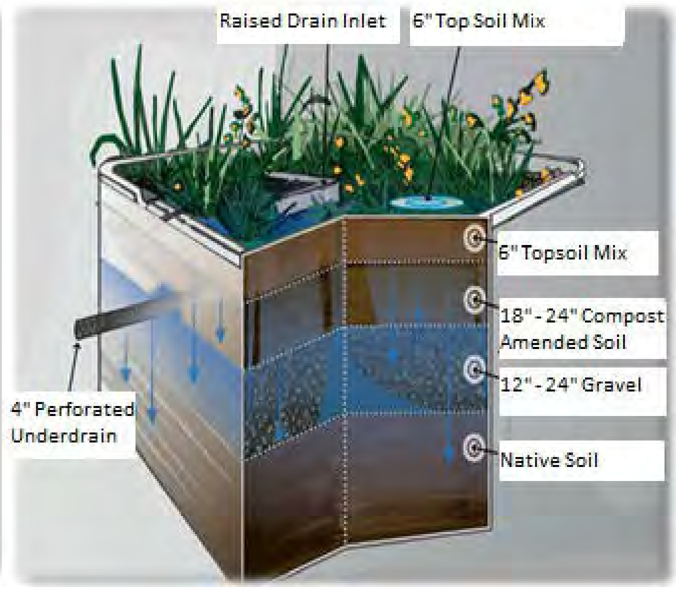

Figure B. American Common Bio-Swale Detail

Description

Bioretention BMPs, including bio-swales, remove pollutants from storm water runoff through physical filtration as storm water passes through media layers. The treatment area consists of: a ponding layer; vegetated, mulched, and engineered soil layer; and supporting bed layer of sand or gravel. Bioretention BMPs can be a variety of shapes and sizes. Storm water entering the treatment area evapotranspires or gradually passes through the mulch/soil/gravel layers where it then infiltrates into native soil or collects in an underdrain that conveys to a discharge point.

Performance and Design

The bioretention BMP must be designed to trap trash particles that are 5 mm or greater and prevent offsite migration, and the design must include:

1. A screen[1] that prohibits the discharge of particles 5 mm or greater at the BMP overflow or bypass outlet;
2. A treatment capacity equal to or greater than the volume collected during the region specific one-year, one-hour storm event from the applicable drainage area; or a capacity to carry at least the same flows of the corresponding storm drain; and
3. Stamped and signed design plans by a registered California licensed professional civil engineer (see Bus. & Prof. Code Section 6700, et seq.).

Maintenance

Regular maintenance is required to maintain adequate trash capture capacity and to ensure that trapped trash does not migrate offsite. The owner should establish a maintenance schedule based on site-specific factors, including the size of the bioretention BMP trench, storm frequency, and characterization of upstream trash and vegetation accumulation. Trash capture and maintenance may be improved by addition of various forms of pretreatment, such as upstream swales or forebays.

[1] Upon approval by the Regional Water Quality Control Board Executive Officer, an external design feature or up-gradient structure designed to bypass flows exceeding the region specific one-year, one-hour, storm event does not require a 5 mm screen.

Storm Water Capture and Use

Trash Best Management Practices (BMP) Minimum Specifications

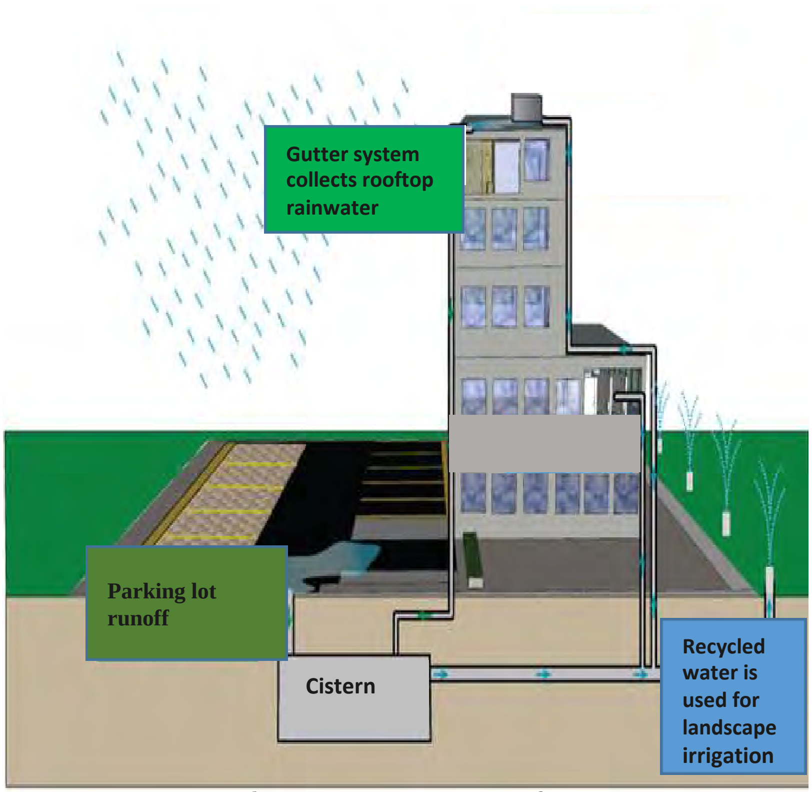

Figure A: Cistern used to capture storm water for onsite use
San Diego County LID Handbook Photo


Figure B: Large Scale Capture and Use Tank

Description

Storm Water Capture and Use BMPs capture and store runoff for use in a variety of applications including irrigation, toilet flushing, and other non-potable uses. There are numerous methods of capturing storm water for use including some of the other certified Multi-Benefit Treatment Systems.

Performance and Design

The Storm Water Capture and Use BMP design must include:

1. A screen[1] that prohibits the discharge of particles 5 mm or greater at the BMP overflow or bypass outlet;
2. A treatment capacity equal to or greater than the volume collected during the region specific one-year, one-hour storm event from the applicable drainage area; or a capacity to carry at least the same flows of the corresponding storm drain; and
3. Stamped and signed design plans by a registered California licensed professional civil engineer (see Bus. & Prof. Code Section 6700, et seq.).

Maintenance

Regular maintenance is required to maintain adequate trash capture capacity for the generated runoff of the anticipated storm. The owner should establish a maintenance schedule based on site-specific factors, including the size of the Storm Water Capture BMP, storm frequency, and characterization of upstream trash and vegetation accumulation.

[1] Upon approval by the Regional Water Quality Control Board Executive Officer, an external design feature or up-gradient structure designed to bypass flows exceeding the region specific one-year, one-hour, storm event does not require a 5 mm screen.

Detention Basin
Trash BMP Minimum Specifications

Figure A: Detention Basin BMP

Description
A detention basin BMP, or retarding basin, is a local topographic depression designed to reduce potential for flooding by reducing peak flow rates. These basins are also called "dry ponds," "holding ponds," or "dry detention basins," and are distinguishable from *retention basins* that are commonly known as "wet ponds" and designed to contain some water all-year-round. Detention basins may also be located underground in an array of pipe, chambers, concrete vaults, or other void structures.

Performance and Design
The detention basin BMP must be designed to trap trash that are 5 mm or greater and prevent offsite migration, and include:

1. A screen[1] that prohibits the discharge of particles 5 mm or greater at the BMP overflow or bypass outlet;
2. A capacity equal to or greater than the volume collected during the region specific one-year, one-hour storm event from the applicable drainage area; or the capacity to contain at least the same flows of the corresponding storm drain; and
3. Stamp and signed design plans by a registered California licensed professional civil engineer (see Bus. & Prof. Code Section 6700, et seq.).

Maintenance
Regular maintenance is required to maintain adequate trash capture capacity and ensure that trapped trash does not migrate offsite. The owner should establish a maintenance schedule based on site-specific factors, including the size of the detention basin BMP, storm frequency, and characterization of upstream trash and vegetation accumulation. Trash capture and maintenance may be improved by the addition of various forms of pretreatment, such as upstream swales or forebays.

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[1] Upon approval by the Regional Water Quality Control Board Executive Officer, an external design feature or up-gradient structure designed to bypass flows exceeding the region specific one-year, one-hour, storm event does not require a 5 mm screen.

Infiltration Trench or Basin

Trash Best Management Practices (BMP) Minimum Specifications

Figure A: Urban Infiltration Trench BMP

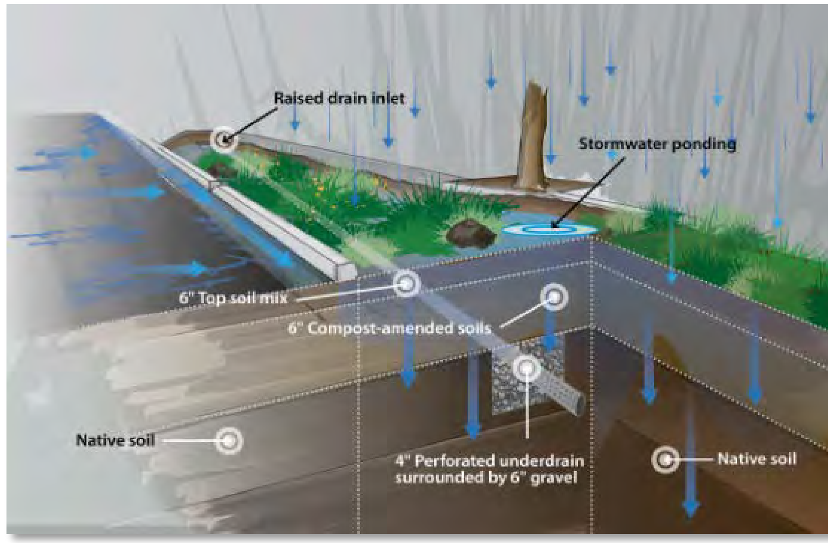

Figure B: CA State University-Sacramento Generic Urban Infiltration Trench BMP Detail

Description

An infiltration trench or basin BMP captures and infiltrates storm water runoff into native soils. Infiltration trench or basin BMPs come in a variety of shapes and sizes and the final appearance may vary substantially. Infiltration trenches may be backfilled with porous media such as gravel, sand, Cornell Soil, or various locally earthed rocks known not to generate pollutants of concern to the downstream waters. Subsurface designs may be comprised of perforated pipe, chambers, open bottom concrete galleries or other high voids structures. These trenches and basins store the design water quality volume for infiltration to underlying soils.

Performance and Design

The infiltration trench BMPs must be designed to trap trash particles that are 5 mm or greater and prevent offsite migration, and the design must include:

1. A screen[1] that prohibits the discharge of particles 5 mm or greater at the BMP overflow or bypass outlet;
2. A treatment capacity equal to or greater than the volume collected during the region specific one-year, one-hour storm event from the applicable drainage area, or a capacity to carry at least the same flows of the corresponding storm drain; and
3. Stamp and signed design plans by a registered California licensed professional civil engineer (see Bus. & Prof. Code Section 6700, et seq.).

Maintenance

Regular maintenance is required to maintain adequate trash capture capacity and to ensure that captured trash does not migrate offsite. The owner should establish a maintenance schedule based on site-specific factors, including the size of the infiltration trench BMP, storm frequency, and characterization of upstream trash and vegetation accumulation. Trash capture and maintenance may be improved by addition of various forms of pretreatment, such as upstream swales, forebays, or manufactured treatment systems.

[1] Upon approval by the Regional Water Quality Control Board Executive Officer, an external design feature or up-gradient structure designed to bypass flows exceeding the region specific one-year, one-hour, storm event does not require a 5 mm screen.

Media Filter
Trash Best Management Practices (BMP)
Minimum Specifications

Figure A: Media Filter BMP Image
County of San Diego LID Handbook BMP Image

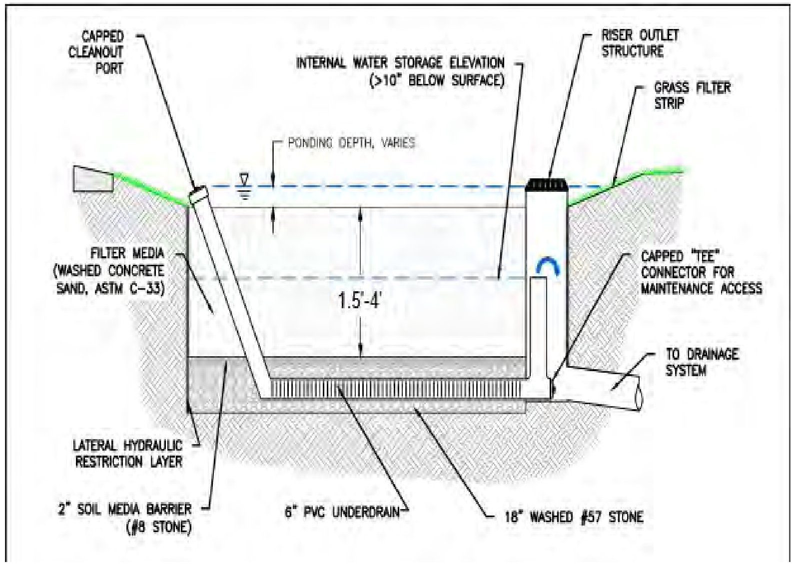

Figure B: Generic Media Filter BMP Detail
County of San Diego LID Handbook BMP Image

Description
A media filter BMP uses a bed of sand, peat, zeolite, anionic and/or cationic media, granite or other fine grained materials or fabrics to physically separate sediment and sediment-bound pollutants and/or electro-chemically remove dissolved constituents from storm water.

Performance and Design
The media filter BMP must be designed to trap trash particles 5 mm or greater and prevent offsite migration, and the design must include:

1. A screen[1] that prohibits the discharge of particles 5 mm or greater at the BMP overflow or bypass outlet;
2. A treatment capacity equal to or greater than the volume collected during a one-year, one-hour storm event from the applicable drainage area; or a capacity to carry at least the same flows as the corresponding storm drain; and
3. Stamped and signed design plans by a registered California licensed professional civil engineer (see Bus. & Prof. Code Section 6700, et seq.).

Maintenance
Regular maintenance is required to maintain adequate trash capture capacity and to ensure that captured trash does not migrate offsite. The owner should establish a maintenance schedule based on site-specific factors including the size of the media filter BMP, storm frequency, and characterization of upstream trash and vegetation accumulation. Trash capture and maintenance may be improved by addition of various forms of pretreatment, such as upstream swales or forebays.

[1] Upon approval by the Regional Water Quality Control Board Executive Officer, an external design feature or up-gradient structure designed to bypass flows exceeding the region specific one-year, one-hour, storm event does not require a 5 mm screen.

Appendix I. Bioretention Soil Media Specifications

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Appendix I Bioretention Soil Media Specifications

(Designs should follow these specifications unless otherwise specified by your local permitting agency.)

		Sandy Loam			
BSM Composition	**Sand**	**Sand**	**Silt**	**Clay**	**Compost**
Volume	65%	20%			15%
Weight	75-80%		10% max	3% max	9% max (9% compost by weight results in approximately 5% organic matter by weight)
General Notes: Bioretention Soil Media (BSM) should provide a long-term, in-place infiltration rate of 5 inches per hour. BSM should also support plant growth while providing pollutant treatment.					

<table>
<tr><th>BSM Component</th><th>Description</th></tr>
<tr><td rowspan="2">Sand</td><td>Quality: Sand should be thoroughly washed before delivery and should be free of wood, waste, and coatings such as clay, carbonate, stone dust, or other deleterious material. All aggregate passing the No. 200 sieve size should be non-plastic.</td></tr>
<tr><td>Texture: Sand should meet the following gradation:
<table>
<tr><th rowspan="2">Sieve Size</th><th colspan="2">Percent Passing (by weight)</th></tr>
<tr><th>Min.</th><th>Max.</th></tr>
<tr><td>3/8 inch</td><td>100</td><td>100</td></tr>
<tr><td>No. 4</td><td>90</td><td>100</td></tr>
<tr><td>No. 8</td><td>70</td><td>100</td></tr>
<tr><td>No. 16</td><td>40</td><td>95</td></tr>
<tr><td>No. 30</td><td>15</td><td>70</td></tr>
<tr><td>No. 40</td><td>5</td><td>55</td></tr>
<tr><td>No. 100</td><td>0</td><td>15</td></tr>
<tr><td>No. 200</td><td>0</td><td>5</td></tr>
<tr><td colspan="3">All sands complying with ASTM C33, Standard Specification for Concrete Aggregates, for fine aggregate also comply with the above gradation requirements.</td></tr>
</table></td></tr>
<tr><td rowspan="2">Sandy Loam Soil</td><td>Quality: Sandy loam shall be free of wood, waste, and coatings such as carbonate, stone dust, or other deleterious material. All aggregate passing the No. 200 sieve size shall be non-plastic.</td></tr>
<tr><td>Texture: Based on ASTM D422, sandy loam shall comply with the following specifications by weight:
A. 50-74 percent sand
B. 0-48 percent silt
C. 2-15 percent clay</td></tr>
</table>

<table>
<tr><th>BSM Component</th><th>Description</th></tr>
<tr><td rowspan="4">Compost Soil</td><td>Quality: Compost shall be well-decomposed, stable, weed-free organic matter source and shall be derived from waste materials such as wood waste, yard debris, or other organic materials. Compost shall not be derived from waste that includes manure or biosolids. Compost shall have a soil-like odor and be dark brown in color. Compost exhibiting a sour or putrid smell, containing recognizable grass or leaves, or measuring over 120 degrees Fahrenheit upon delivery or rewetting is unacceptable.</td></tr>
<tr><td>Source: Compost shall be produced from a facility inspected and regulated by the local enforcement agency for CalRecycle. Upon request, the past three inspection reports shall be submitted to verify testing compliance with CalRecycle Title 14 and EPA 40 CFS 503.</td></tr>
<tr><td>Texture: Compost shall be analyzed by a qualified lab using No. 200 and 1/2-inch sieves and meet the following gradation:
<table>
<tr><th rowspan="2">Sieve Size</th><th colspan="2">Percent Passing (by weight)</th></tr>
<tr><th>Min.</th><th>Max.</th></tr>
<tr><td>1/2 inch</td><td>97</td><td>100</td></tr>
<tr><td>No. 200</td><td>0</td><td>5</td></tr>
</table></td></tr>
<tr><td>Parameters: Compost should comply with the following requirements:
<table>
<tr><th>Parameter</th><th>Method</th><th>Requirement</th><th>Units</th></tr>
<tr><td>Bulk Density</td><td>-</td><td>400-600</td><td>dry lbs/cubic yd</td></tr>
<tr><td>Moisture Content</td><td>Gravimetric</td><td>30% - 60%</td><td>Dry solids</td></tr>
<tr><td>Organic Matter</td><td>ASTM F 1647 Standard Test Methods for Organic Matter Content of Athletic Field Rootzone Mixes or Testing Methods for the Examination of Compost and Composting (TMECC) 05.07A, “Loss-on-Ignition Organic Matter Method.”</td><td>65% - 75%</td><td>Dry weight</td></tr>
<tr><td>pH</td><td>Saturation Paste</td><td>6.0 – 8.0</td><td></td></tr>
<tr><td>Carbon to Nitrogen Ratio</td><td>-</td><td>15:1 to 25:1</td><td></td></tr>
<tr><td>Maturity/Stability</td><td>Solvita®</td><td>>5</td><td>Index value</td></tr>
<tr><td colspan="4">Metals</td></tr>
<tr><td colspan="2">Arsenic</td><td><20</td><td>mg/kg dry weight</td></tr>
<tr><td colspan="2">Cadmium</td><td><10</td><td>mg/kg dry weight</td></tr>
<tr><td colspan="2">Chromium</td><td><600</td><td>mg/kg dry weight</td></tr>
<tr><td colspan="2">Copper</td><td><750</td><td>mg/kg dry weight</td></tr>
<tr><td colspan="2">Lead</td><td><150</td><td>mg/kg dry weight</td></tr>
<tr><td colspan="2">Mercury</td><td><8</td><td>mg/kg dry weight</td></tr>
<tr><td colspan="2">Nickel</td><td><210</td><td>mg/kg dry weight</td></tr>
<tr><td colspan="2">Selenium</td><td><18</td><td>mg/kg dry weight</td></tr>
<tr><td colspan="2">Zinc</td><td><1400</td><td>mg/kg dry weight</td></tr>
<tr><td colspan="4">Pathogens</td></tr>
<tr><td colspan="2">Salmonella</td><td><3</td><td>MPN per 4 g</td></tr>
<tr><td colspan="2">Fecal Coliform</td><td><1000</td><td>MPN per 1 g</td></tr>
<tr><td colspan="4">Inert Material/Physical Contaminants</td></tr>
<tr><td colspan="2">Plastic, Metal, and Glass</td><td><1%</td><td>By weight</td></tr>
<tr><td colspan="2">Sharps (% >4 mm)</td><td>0%</td><td>By weight</td></tr>
</table></td></tr>
</table>

Appendix J. Local Agency Plant Selection Guidance

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Appendix J Local Agency Plant Selection Guidance

Some agencies within the Stormwater Quality Partnership have specific plant lists included in their agency guidelines; other agencies rely on project applicants to develop plant lists based on specific criteria. For those agencies that have approved plant lists or other specific guidelines, links are provided below.

City of Citrus Heights

Landscape Guidelines: https://www.citrusheights.net/DocumentCenter/View/4199

City of Elk Grove

Chapter 23.54 Landscaping, Section 23.54.040 Landscape development standards (http://www.codepublishing.com/CA/ElkGrove/html/ElkGrove23/ElkGrove2354.html#23.54.040)

Plant Type. Landscape planting shall include drought-tolerant, ornamental, and native species (especially along natural corridors), shall complement the architectural design of structures on the site, and shall be suitable for the soil and climatic conditions specific to the site.

City of Galt

Landscape Design Guidelines:
http://www.ci.galt.ca.us/home/showdocument?id=15839

City of Rancho Cordova

Refer to the UC Davis Arboretum (www.arboretum.ucdavis.edu) for a list of 100 affordable, water-wise plant options that thrive in California's Mediterranean climate.

City of Sacramento

River-Friendly Landscape Plant List:
http://www.cityofsacramento.org/-/media/Corporate/Files/DOU/Conservation/Cover-Letter-Plant-List.pdf?la=en

Other References

Alameda County Stormwater Technical Guidance

https://www.cleanwaterprogram.org/c3-guidance-table.html

Appendix B includes a table of recommended plant types and corresponding storm water measures.

California Native Plant Society

Sac Valley's Drought-Tolerant, California Native Plant List
https://sacvalleycnps.org/index.php?option=com_content&view=article&id=71&Itemid=237

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Appendix

B

Plant List and Planting Guidance for Landscape-Based Stormwater Measures

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B.1 Introduction

The purpose of this appendix is to provide guidance on the planting techniques and selection of appropriate plant materials for the stormwater measures described in this handbook.

The plant lists described in this appendix are not prescriptive, but should serve as a guide. In selecting plant materials, it is important to consider factors that influence plant establishment and success, such as microclimate, type of soil, water availability, proximity to saltwater and exposure to sun. Numerous resources are available to assist in selecting appropriate plant species in Alameda County, including Sunset's *Western Garden Book* and the East Bay Municipal Utility District's *Plants and Landscapes for Summer-Dry Climates of the San Francisco Bay Region.*

In addition, the function of the individual stormwater measure should be carefully considered when selecting plant materials. Factors to be considered include inundation period, expected flow of water, and access and maintenance requirements.

The plant lists described in this appendix are not prescriptive, but should ***serve as a guide.*** In selecting plant materials, it is important to consider factors that influence plant establishment and success, such as microclimate, type of soil, water availability, proximity to saltwater and exposure to sun.

B.2 General Recommendations

Avoid the use of invasive species. In selecting plants for stormwater measures, the use of invasive species should be avoided. A complete list of invasive plants can be found at www.cal-ipc.org, the California Invasive Plant Council's Invasive Plant Inventory.

Minimize or eliminate the use of irrigated turf. Effort should be made to minimize the use of irrigated turf, which has higher maintenance requirements and greater potential for polluted runoff.

Select California natives and/or drought tolerant plants. Planting appropriate, drought tolerant California natives or Mediterranean plants reduces water consumption for irrigations, and reduces mowing, fertilizing, and spraying. For the purposes of the plant list on the following pages, "drought tolerant" refers to plants that meet the following critieria:

- Are identified as drought tolerant as follows: California Native Plants for the Garden (Borstein, et al.).
- Are identified as requiring occasional or infrequent irrigation in Borstein, et al., or Plants and Landscapes for Summer Dry Climates (EBMUD).
- Are identified as requiring no summer water in EBMUD.
- Are identified as requiring little or no water in the Sunset Western Garden Book.
- Are identified as requiring low or very low irrigation in the Guide to Estimateing Irrigation Water Needs of Landscape Plantings in California (University of California Cooperative Extension).

Plants not listed in any of the above references will require that the design professional base selection upon successful experience with species on previous projects under similar horticultural conditions.

Site-specific Factors. Given Alameda County spans several Sunset climate zones, with variable humidity, heat, frost, and wind factors, as well as varying soil characteristics, plants need to be selected with an understanding of specific climate and microclimate conditions, and grouped in appropriate hydrozones.

Supplemental watering needs. Many plants listed as drought tolerant per the above references may require more supplemental watering in fast-draining, engineered soils.

B.3 Plants for Stormwater Measures

Plants play an important role in the function of landscape-based stormwater treatment measures:

- Infiltration and evapotranspiration. Plants aid in the reduction of stormwater runoff by both increasing infiltration, and by returning water to the atmosphere through evapotranspiration.
- Sedimentation. Some stormwater treatment measures, such as vegetated swales and vegetated buffer strips, are designed to remove coarse solids through sedimentation that is aided by dense, low-growing vegetation.
- Pollutant trapping. Vegetation helps to prevent the resuspension of pollutants associated with sediment particles. It is essential that pollutants removed during small storms are not remobilized during large storms.
- Phytoremediation. Plants for stormwater treatment measures are important for their role in phytoremediation, the uptake of nutrients and the ability to neutralize pollutants.
- Soil stabilization. As in any landscaped area, established plantings help control soil erosion. This is important both to keep sediment out of stormwater and to retain the surface soils, which help to remove pollutants from infiltrated runoff.
- Aesthetic benefits. Plants within or adjacent to stormwater facilities provide an aesthetic benefit.

Plants suitable for use in stormwater treatment measures are organized according to the following categories:

- **Emergent** refers to those species which occur on saturated soils or on soils covered with water for most of the growing season. The foliage of emergent aquatics is partly or entirely borne above the water surface.
- **Grasses** refer to those species that are monocotyledonous plants with slender-leaved herbage found in the in the Family Poaceae.
- **Herbaceous** refers to those species with soft upper growth rather than woody growth. Some species will die back to the roots at the end of the growing season and grow again at the start of the next season. Annuals, biennials and perennials may be herbaceous.
- **Shrub** is a horticultural distinction that refers to those species of woody plants which are distinguished from trees by their multiple stems and lower height. A large number of plants can be either shrubs or trees, depending on the growing conditions they experience.
- **Tree** refers to those species of woody plants with one main trunk and a rather distinct and elevated head.

Plants suitable for use in stormwater treatment measures are listed in two ways. First, a comprehensive list of all recommended plant species is provided in Table B-1, which lists the plants in alphabetical order by Latin name, in the categories described above. The columns in Table B-1 indicate stormwater treatment measures for which each plant species may be suitable. Following Table B-1 are brief descriptions of the stormwater measures for which technical guidance is included in this handbook, including the suitable plantings from Table B-1.

Invasive species. Under no circumstances shall any plants listed as invasive under www.cal-ipc.org/paf be specified.

Table B-1 Plant List for Stormwater Measures

Species	Common Name	Bioretention Area - including linear treatment measure	Flow-Through Planters	Tree Well Filters[2]	Vegetated Buffer Strip	Infiltration Trench	Extended Detention Basin - biotreatment soil	Extended Detention Basin - non-biotreatment soil	Turf Block Pavers	Green Roof - extensive	Green Roof - intensive	California Native	Drought Tolerant^
Emergent Species													
Artemisia douglasiana	mugwort						✓	✓				✓	
Carex barbarae	Santa Barbara sedge				✓		✓	✓		✓	✓	✓	✓
Carex densa	dense sedge						✓	✓				✓	
Carex obnupta	slough sedge						✓	✓				✓	
Eleocharis macrostachya	creeping spikerush					✓	✓	✓				✓	
Hydrocotyle ranunculoides	marsh pennywort		✓					✓				✓	
Juncus balitcus [1]	baltic rush						✓	✓				✓	
Juncus bufonius	toad rush						✓	✓				✓	
Juncus effusus [1]	Pacific rush						✓	✓				✓	
Juncus leseurii	common rush						✓	✓				✓	
Juncus mexicanus	Mexican rush						✓	✓				✓	
Juncus patens	blue rush	✓	✓		✓	✓	✓	✓			✓	✓	✓
Juncus xiphioides	iris-leaved rush						✓	✓				✓	
Limonium californicum	Marsh rosemary						✓	✓				✓	✓
Phragmites spp.	common reeds						✓	✓					
Scirpus actutus	tule						✓	✓				✓	
Scirpus americanus [1]	three square	✓					✓	✓				✓	
Scirpus californicus [1]	california bulrush						✓	✓				✓	
Spartina foliosa	California cordgrass						✓	✓				✓	
Typha angustifolia	narrowleaf cattail						✓	✓				✓	
Typha latifolia	cattail						✓	✓				✓	
Grass Species													
Agrostis exarata	spike bentgrass						✓	✓	✓			✓	
Alopecurus aequalis	shortawn foxtail						✓	✓				✓	
Alopecurus saccatus	Pacific foxtail						✓	✓				✓	
Aristida purpurea	Purple three-awn	✓	✓		✓						✓	✓	✓
Carex pansa	California meadow sedge			✓	✓		✓	✓	✓	✓	✓	✓	✓
Carex praegracilus	clustered field sedge						✓	✓				✓	
Carex divulsa (tumulicola)	Berkeley sedge							✓				✓	
Chondropetalum tectorum	cape rush	✓	✓		✓	✓	✓	✓			✓		✓
Danthonia californica	California oatgrass						✓	✓				✓	
Deschampsia cespitosa [1]	tufted hairgrass	✓			✓	✓	✓	✓			✓	✓	✓
Deschampsia cespitosa ssp. holciformis	Pacific hairgrass	✓			✓	✓	✓	✓			✓	✓	✓
Deschampsia danthonioides	annual hairgrass						✓	✓			✓	✓	
Distichlis spicata	salt grass						✓	✓				✓	
Eleocharis palustris	creeping spikerush						✓	✓				✓	
Elymus glaucus	blue wild rye	✓			✓			✓		✓	✓	✓	✓
Festuca californica	California fescue	✓	✓	✓	✓						✓	✓	✓
Festuca idahoensis	Idaho fescue		✓	✓	✓				✓		✓	✓	
Festuca rubra[1]	red fescue		✓	✓	✓				✓		✓	✓	✓
Festuca rubra 'molate'	Molate fescue		✓	✓	✓				✓		✓	✓	✓
Hordeum brachyantherum [1]	meadow barley	✓			✓		✓	✓				✓	✓
Leymus triticoides	creeping wildrye	✓			✓	✓		✓			✓	✓	✓
Linum usitatissimum [1]	flax	✓	✓										✓
Lolium perenne [1]	ryegrass	✓	✓			✓							
Melica californica	California melic				✓							✓	✓
Grass Species cont'd													
Melica imperfecta	coast range melic	✓	✓		✓							✓	✓
Muhlenbergia rigens	deergrass	✓	✓		✓	✓	✓	✓			✓	✓	✓

** Denotes riparian species with limited drought tolerance*
[1] Denotes species with phytoremediation capabilities
[2] Non-tree species to be used only with adequate planting surface and when infiltration rates are 5-10 inches/hour

Table B-1 Plant List for Stormwater Measures

		Bioretention Area - including linear treatment measure	Flow-Through Planters	Tree Well Filters[2]	Vegetated Buffer Strip	Infiltration Trench	Extended Detention Basin - biotreatment soil	Extended Detention Basin - non-biotreatment soil	Turf Block Pavers	Green Roof - extensive	Green Roof - intensive	California Native	Drought Toleran^
Nasella pulchra	purple needlegrass	✓		✓	✓	✓					✓	✓	✓
Nassella lepida	Foothill needlegrass			✓	✓	✓					✓	✓	✓
Panicum coloratum ¹	kleingrass	✓	✓		✓	✓							
Panicum virgatum ¹	switchgrass	✓	✓		✓	✓							
Phalaris californica	California canarygrass	✓			✓	✓						✓	
Pleuropogon californicus	semaphore grass				✓	✓						✓	
Sisyrinchium bellum	blue-eyed grass		✓		✓	✓				✓		✓	✓
Sisyrinchium douglasii	purple-eyed grass					✓				✓		✓	
Herbaceous Species													
Achillea millefolium ¹	common yarrow		✓	✓	✓					✓	✓	✓	✓
Allium spp.	wild onion	✓	✓		✓					✓	✓		
Anthemis nobilis (Chamaemelum nobile)	chamomile			✓					✓				✓
Armeria maritima	sea pink		✓	✓	✓					✓	✓	✓	✓
Clarkia spp.	Clarkia	✓			✓					✓	✓	✓	✓
Epilobium densiflorum	dense spike-primrose	✓	✓		✓	✓						✓	✓
Eriogonum latifolium	coast buckwheat			✓	✓							✓	✓
Eriogonum fasciculatum	flattop buckwheat			✓	✓							✓	✓
Eschscholzia californica	California poppy	✓	✓		✓				✓	✓	✓	✓	✓
Layia platyglossa	tidy tips				✓					✓	✓	✓	✓
Limonium californicum	marsh rosemary	✓	✓		✓	✓	✓	✓				✓	✓
Linanthus spp.	Linanthus	✓			✓					✓	✓	✓	✓
Lotus scoparius	deerweed	✓			✓					✓	✓	✓	✓
Mimulus aurantiacus	common monkeyflower	✓	✓		✓						✓	✓	✓
Mimulus cardinalis	scarlet monkeyflower	✓	✓	✓	✓		✓	✓			✓	✓	
Monardella spp.	coyote mint	✓			✓							✓	✓
Nepeta spp.	catmint	✓		✓	✓						✓		✓
Penstemon spp.	bearded tongue	✓		✓	✓						✓	✓	✓
Sedum spp.	stonecrop				✓					✓	✓		✓
Sempervivum spp.	hen and chicks				✓					✓	✓		✓
Solidago spp. ¹	goldenrod		✓		✓					✓	✓		
Thymus pseudolanuginosus	woolly thyme	✓	✓	✓	✓				✓	✓	✓		
Vigna unguiculata ¹	cowpea		✓		✓						✓		
Shrub Species													
Adenostoma fasciculatum	chamise				✓						✓	✓	✓
Arctostaphylos densiflora 'McMinn'	manzanita 'McMinn'	✓	✓		✓						✓	✓	✓
Arctostaphylos manzanita	common manzanita		✓		✓						✓	✓	✓
Arctostaphylos uva-ursi 'Emerald Carpet'	manzanita 'Emerald Carpet'	✓	✓	✓	✓						✓	✓	✓
Baccharis pilularis 'Twin Peaks'	coyote brush prostrate	✓	✓	✓	✓						✓	✓	✓
Baccharis salicifolia	mulefat				✓		✓	✓				✓	
Buddleia spp.	butterfly bush	✓			✓								✓
Calycanthus occidentalis	Spicebush	✓	✓		✓	✓						✓	✓
Carpenteria californica	bush anemone	✓	✓		✓							✓	✓
Shrub Species cont'd													
Ceanothus hearstiorum	ceanothus	✓			✓						✓	✓	✓
Ceanothus spp.	ceanothus	✓			✓						✓	✓	✓
Cercocarpus betuloides	mountain mahogany				✓							✓	✓
Cistus spp.	rockrose				✓								✓
Cornus sericea (same as C. stolonifera)	western dogwood	✓	✓		✓	✓	✓	✓				✓	
Garrya elliptica	coast silk tassle		✓		✓						✓	✓	✓
Echium candicans	pride-of-madeira		✓		✓						✓		✓
Heteromeles arbutifolia	toyon	✓	✓		✓						✓	✓	✓
Holodiscus sp.	oceanspray	✓			✓							✓	✓
Lavandula spp.	lavender		✓	✓	✓						✓		✓
Lavatera spp.	tree mallow				✓								✓

** Denotes riparian species with limited drought tolerance*
¹ Denotes species with phytoremediation capabilities
[2] Non-tree species to be used only with adequate planting surface and when infiltration rates are 5-10 inches/hour

Table B-1 Plant List for Stormwater Measures

Botanical Name	Common Name	Bioretention Area - including linear treatment measure	Flow-Through Planters	Tree Well Filters[2]	Vegetated Buffer Strip	Infiltration Trench	Extended Detention Basin - biotreatment soil	Extended Detention Basin - non-biotreatment soil	Turf Block Pavers	Green Roof - extensive	Green Roof - intensive	California Native	Drought Tolerant^
Lepechina calycina	pitcher sage				✓							✓	✓
Lupinus albifrons	bush lupine				✓							✓	✓
Mahonia aquifolium	Oregon grape	✓	✓		✓						✓	✓	✓
Mahonia repens	creeping Oregon grape	✓	✓	✓	✓						✓	✓	✓
Myrica californica	Pacific wax myrtle				✓						✓	✓	✓
Physocarpus capitatus	Pacific ninebark	✓		✓	✓		✓	✓			✓	✓	
Pittosporum tobira	mock orange		✓		✓								✓
Prunus ilicifolia	holleyleaf cherry				✓	✓						✓	✓
Rhamnus Californica	coffeeberry	✓	✓		✓						✓	✓	✓
Rhus integrifolia	lemonade berry				✓							✓	✓
Ribes aureum	golden currant	✓	✓		✓	✓						✓	✓
Ribes malvaceum	chaparral currant				✓							✓	✓
Ribes sanguineum	red-flowering currant				✓							✓	✓
Rosa californica	California wild rose	✓	✓		✓	✓						✓	✓
Rubus parviflorus	thimbleberry	✓	✓		✓	✓						✓	
Rubus spectabilis	salmonberry	✓	✓		✓	✓						✓	
Rubus ursinus	California blackberry	✓			✓							✓	✓
Salvia brandegii	black sage				✓							✓	✓
Salvia clevelandii	Cleveland sage	✓			✓							✓	✓
Salvia leucophylla	purple sage	✓			✓							✓	✓
Salvia melifera	black sage				✓							✓	✓
Salvia sonomensis	creeping sage	✓	✓	✓	✓							✓	✓
Sambucus mexicana	elderberry	✓	✓		✓							✓	✓
Santolina spp.	santolina	✓	✓		✓							✓	✓
Symphoricarpos albus	snowberry		✓		✓							✓	✓
Stachys spp.	lambs ear	✓		✓	✓					✓	✓		✓
Styrax officinalis redivivus	California snowdrop	✓			✓							✓	✓
Trichostema spp.	wooly blue curls	✓			✓						✓	✓	✓
Vaccinium ovatum	evergreen huckleberry	✓	✓		✓							✓	
Zauschneria californica (Epilobium c.)	California fuchsia			✓	✓						✓	✓	✓
Tree Species													
Acer circinatum	Vine Maple	✓		✓	✓	✓					✓	✓	
*Acer macrophyllum**	big leaf maple	✓			✓							✓	
Acer negundo v. Californicum*	box elder	✓		✓	✓	✓	✓	✓				✓	
Aesculus californica	buckeye				✓							✓	✓
*Alnus rhombifolia **	white alder	✓		✓	✓		✓	✓				✓	
*Alnus rubra**	red alder	✓		✓	✓	✓	✓	✓				✓	
Arbutus menziesii	Madrone				✓							✓	✓
Arbutus unedo	strawberry tree				✓						✓		✓
Betula nigra	river birch	✓		✓	✓	✓							
Calocedrus decurrens	incense cedar				✓							✓	
Celtis occidentalis	common hackberry				✓								✓
Cercidium floridum	Blue palo verde				✓							✓	✓
Cercis occidentalis	redbud				✓						✓	✓	✓
Chionanthus retusus	Chinese fringe tree				✓								

** Denotes riparian species with limited drought tolerance*
[1] Denotes species with phytoremediation capabilities
[2] Non-tree species to be used only with adequate planting surface and when infiltration rates are 5-10 inches/hour

Table B-1 Plant List for Stormwater Measures

Scientific Name	Common Name	Bioretention Area - including linear treatment measure	Flow-Through Planters	Tree Well Filters[2]	Vegetated Buffer Strip	Infiltration Trench	Extended Detention Basin - biotreatment soil	Extended Detention Basin - non-biotreatment soil	Turf Block Pavers	Green Roof - extensive	Green Roof - intensive	California Native	Drought Tolerant^
Corylus cornuta v. Californica	California hazelnut	✓		✓	✓							✓	✓
Crataegus	Hawthorn			✓							✓		✓
Fraxinus latifolia	Oregon ash	✓		✓	✓	✓	✓	✓				✓	
Geijera parviflora	Australian willow				✓								
Lagerstroemia spp.	crepe myrtle				✓						✓		✓
Lyanothamnus floribundus asplendifolius	Catalina Ironwood				✓							✓	✓
Morus alba (fruitless var.)[1]	white mulberry				✓								
Platanus acerifolia	london plane tree				✓								✓
*Platanus racemosa**	sycamore	✓			✓		✓	✓				✓	
*Populus fremontii** [1]	Fremont's cottonwood	✓		✓	✓	✓						✓	
Prunus, spp.	plum				✓								✓
Quercus agrifolia	California live oak				✓							✓	✓
Quercus kellogii	California black oak				✓							✓	✓
Quercus lobata	valley oak	✓			✓							✓	✓
Quercus palustris	pin oak				✓								
Quercus virginiana	Southern live oak			✓									
Salix laevigata[1]	red willow	✓			✓	✓	✓	✓				✓	
Salix lasiolepis[1]	arroyo willow	✓			✓	✓	✓	✓				✓	
Salix lucida ssp. lasiandra [1]	shining willow	✓			✓	✓	✓	✓				✓	
Sequoia sempervirens	coast redwood				✓		✓	✓				✓	
Umbellularia californica	California bay				✓							✓	

** Denotes riparian species with limited drought tolerance*
[1] Denotes species with phytoremediation capabilities
[2] Non-tree species to be used only with adequate planting surface and when infiltration rates are 5-10 inches/hour

A brief paragraph describing each stormwater measure is provided below, including the key factors that should influence planting techniques and plant selection. For suitable plantings, please refer to Table B-1.

Bioretention Area (including linear treatment measures)

Bioretention areas are intended to act as filters with plants. Plants in bioretention areas help with phytoremediation and infiltration. Therefore, nutrient uptake and the ability to neutralize pollutants are priorities for species selection. Plants for these areas should be able to withstand periods of inundation as well as extended periods of drought. Emergent, grass and herbaceous species can be planted in the bioretention area, while shrub and tree species should be concentrated on the outer edges. Grasses can also be planted along the exterior to slow the velocity of flow and allow the sedimentation of coarse solids, which helps minimize clogging of the bioretention area. Supplemental irrigation will be necessary to maintain emergent species during extremely dry conditions.

Flow-through planter

Plant species for flow-through planters will depend on the size of the planter. Shrubs and trees should be planted in planters only when there is sufficient space. Recommended minimum soil depth for shrubs is 18", and for small trees is 36". Plant species should be adapted to well-drained soils. Irrigation is typically required, but selecting plants adapted to extended dry periods can reduce irrigation requirements.

Tree well filter

Trees and shrubs planted in tree well filters should be an appropriate size for the space provided. Because plant roots are confined to the container, it is recommended that small trees and shrubs with shallow, fibrous roots be planted in the tree well filter. Provided that site conditions allow, it may be possible to work with the manufacturer to design a container that would allow for the planting of larger trees or shrubs. Plants for tree well filters should be tolerant of frequent, but temporary periods of inundation as well as adapted to extremely well-drained soils. Species with the ability to neutralize contaminants are preferred.

Vegetated buffer strips

Vegetated buffer strips should be designed to function and appear as natural vegetated areas adjacent to development. They treat surface runoff from adjacent impervious areas so a variety of trees, shrubs, and grass and herbaceous species should be included in order to maximize water and nutrient uptake, as well as to retain sediment.

Infiltration Trench

An infiltration trench is an aggregate filled trench that receives and stores stormwater runoff in the void spaces between the aggregate and allows it to infiltrate into the surrounding soil. Vegetated filter strips of grass species on either side of the trench can slow and pre-treat the runoff while the trench can physically remove fine sediment and other suspended solids.

Extended Detention Basin

Extended detention basins are intended to capture and detain water for much longer periods (up to 5 days) than bioretention areas. They are designed to drain completely between storms. Plants in extended detention basins increase pollutant removal and assist with soil stabilization;

therefore nutrient uptake and the ability to neutralize pollutants are priorities for species selection. Because extended detention basins are intended to capture and move large quantities of water, trees should not be planted in the basins, and shrubs are typically not specified for extended detention basins. Subject to approval by the municipality, trees and shrubs may be included on the outer perimeter (top of bank), provided that they do not interfere with detention. Species should be adapted to periodic inundation and saturation and extended periods of dry conditions. Emergent, grass and herbaceous species for extended detention basins should consists of species that are able withstand extended periods of inundation. Supplemental irrigation will be necessary to maintain emergent species during extremely dry conditions. Extended detention basins typically have typically not been constructed with special soil, and beginning December 1, 2011, basins designed without biotreatment soil (having a long-term infiltration rate of 5 to 10 inches per hour) may not be used as stand-alone treatment measures, although they could be used as part of a treatment train, along with biotreatment measures (more information in Section 6.6). Table B-1 includes two planting lists for extended detention basins: one for basins designed WITH biotreatment soil, and another for basins designed WITHOUT biotreatment soil.

Pervious paving – Turf Block Pavers

Some pervious paving systems can be planted with grass or herbaceous species in order to assist with erosion prevention as well as promote infiltration and pollutant uptake. Plant species should be tolerant of compaction, have the ability to neutralize contaminants, and should not interfere with maintenance and use of the paved surface. Most plant species cannot tolerate frequent vehicular compaction. Therefore, turf block pavers are best suited for areas requiring infrequent access, such as emergency vehicle access routes. Paver manufacturer should be consulted regarding recommended and acceptable plant species.

Green roof

A green roof is intended to capture precipitation and roof runoff. Green roofs utilize a lightweight, porous planting substrate as a medium for plant growth. The depth and composition of this substrate is extremely important in determining types of plants that will be successful as part of a green roof system. Intensive green roofs, which can have up to 48" of substrate, can support a wider variety of plant types. The list in Table B-1 is only a sample of plants that could be suitable for an intensive green roof. Please note that shrub species may be used only if the substrate has a minimum depth of 12 inches; a minimum dept of 36 inches is required for planting trees.

Extensive green roofs, which have a depth of 3" to 7" of planting medium, are suitable for a limited number of grass and herbaceous species. These roofs generally require little maintenance and should be designed to succeed with minimal irrigation. In addition to the species listed in Table B-1, pre-vegetated mats can be utilized on extensive green roofs. Information can be found at:: www.thehenryford.org/rouge/leedlivingroof.aspx.

B.4 Planting Specifications

Planting plans and specifications must be prepared by a qualified professional and coordinated with other site development details and specifications including earthwork, soil preparation and irrigation (if used). Plans indicating a planting layout, with species composition and density, should be prepared on a site-specific basis. Reference Alameda County's Bay Friendly Landscaping Guidelines prepared by Rescape California, also known as the Bay-Friendly Landscaping Coalition (available at www.rescapeca.org), which outline principles and practices to minimize waste, protect air and water quality, conserve energy and water, and protect natural ecosystems, including:

- Evaluate site and assess the soil;
- Consider potential for fire;
- Select plants for appropriate size upon maturity, do not over-plant;
- Irrigation, if required, should be designed as a high efficiency, water conserving system; and
- Utilize compost (see the specification in the Bay-Friendly Landscaping Guidelines) and mulch to build healthy soils and increase the water holding capacity of the soil.

Propagation and Planting Methods

The propagation methods for different species will vary, depending upon type of plant and stormwater adaptation. In general, container stock will be utilized most commonly for greenroofs, flow-through planters, tree well filters, vegetated swales and buffer strips and infiltration trenches. Bioretention areas and extended detention basins will generally utilize native plants available as transplants (plugs), pole cuttings and seed mixes.

Container Stock. Planting holes for container stock should be twice as wide and only as deep as the container size. Plant spacing should be determined on a site-specific basis. When planting, the root collar and base of the stem should be 1" above the adjacent soil surface. Soils should be backfilled and tamped down to assure contact with the roots. The planting should be watered-in promptly to promote the settling of soil. If appropriate, container plantings may receive a balanced time-released fertilizer tablet, quantity and placement per manufacturer's recommendation, placed in the planting hole prior to installation of the plant. Planting berms for water retention and mulch shall be used to enhance plant establishment. Trees shall be staked or guyed to provide interim support until established.

Transplants (Plugs). Transplanted plant divisions, referred to here as "plugs", should be planted during the fall dormant period, preferably between October 1 and November 15 after first soaking rain. Plugs should be collected from a suitable collection site in the vicinity of the constructed basins. Plugs are clumps of plant roots, rhizomes or tubers combined with associated soil that can be manually removed, or salvaged with an excavator or backhoe. The maximum recommended size is 1 foot x 1 foot. Whole plants or plant divisions can be utilized. The plugs should be from healthy specimens free of insects, weeds and disease. The plugs should be spaced from 1 foot to 6 feet apart, depending on the size of the plug. Smaller plugs can be planted at the minimum distance to promote faster spreading and cover. Larger plugs from cattail and bulrush species should be planted at 3-foot to 6-foot intervals.

To plant a plug, a hole slightly wider than the diameter of the plug should be prepared and the roots system of the plug placed in the hole. Do not over-excavate the hole depth or the plant will settle below grade. A shovel could be used to create the planting hole. Manual planting with a spade is recommended for wet soils. Power augers can be used for creating holes in dry soils. Alternatively, a trench could be created along the narrow axis of the extended detention basin, and planting material manually placed at specified elevations in relation to the proximity of permanently saturated soils. To plant a plug with an established root system, the base of the stem and top of the root collar should be level with the ground surface. Tubers should be secured to prevent floating. Rhizomes should be placed in the soil with a slight upward angle.

The hole or trench containing the plug(s) should be backfilled with soil and the soil tamped down to assure good soil contact and secure the plug. The vegetative portion of the plant should be cut back to prevent water loss and wilting, and encourage the growth of roots and new shoots. Plugs of wetland plants should be grown in saturated soil. The soil should not be allowed to dry out after planting. Plugs should be planted immediately, when possible. When necessary, plugs can be stored in a cool, moist, shaded location for a maximum of one day. Plants must be thoroughly watered.

Pole Cuttings. Pole cuttings should be collected from the 1-year old wood of dormant trees and have a minimum of 5 viable nodes. The parent material should be healthy and free of diseases. The basal area of the pole cutting should be a minimum of one to two inches in diameter; however, the diameter at the base should not exceed 2 inches. The optimum diameter width of the base is 1 inch. The length of the cutting should be a minimum of 2 feet and should not exceed a maximum of 4 feet in length. Generally, 75 percent of the length of the cutting should be planted beneath the soil surface.

Pole cuttings should be collected no more than 2 days prior to planting. Cuttings should be placed in cool water to promote swelling of the nodes. Water should be kept fresh by aeration and/or by daily replacement. The pole cuttings should be placed in a hole approximately 3 feet deep (as determined by the length of the cutting) and backfilled with native soil, or a rich organic medium mixed with native soil. Soil should be tamped down to remove air pockets and assure soil contact with the cutting.

Seeding. Seeding should be conducted after plugs, container stock and pole cuttings are installed. Hydroseeding or broadcast method shall be utilized as appropriate for the size and accessibility of the area. The soil surface should be scarified prior to seeding. Do not damage previously planted vegetation. The seeds should be planted in fall, ideally in October.

Seeds should be broadcast or hydroseeded over the specified planting area. With broadcast seeding, the seed should be applied with hand-held spreaders to scarified soil. The soil surface should then be raked to cover the seeds with about one-eighth to one-quarter inch of soil to discourage predation, and tamped or rolled to firm soil surface.

Seeds should be planted at the ratios and rates specified by the supplier. The seed should be free of weeds and diseases. The supplier should provide the certified germination percentage.

Water Level Management and Irrigation for Plant Establishment

All newly planted material needs careful attention to watering requirements to ensure proper establishment. As mentioned in the introduction, it is important to select plants based on specific site conditions, which will affect the availability of water for plant use. Also, grouping plants with similar water needs can help reduce irrigation demand. The specific approach will vary for irrigated and non-irrigated conditions, and for each stormwater application. In most cases, stormwater applications require a permanent irrigation system which shall be designed to maximize water conservation. Irrigation specifications and design plans shall be provided.

Plants such as shrubs and trees grown in naturalized areas that are not saturated to the surface or inundated shall be irrigated with drip irrigation. The irrigation system shall remain in place for a minimum of three years, and should continue until it is demonstrated that the plantings can survive on annual rainfall and/or groundwater. Seeded areas do not need irrigation in years of normal rainfall. If a period of drought occurs after seeding, supplemental watering may be needed for germination in the first year.

The plants on the bottom and edge of the constructed basins should be allowed to become established for one growing season prior to the onset of significant flooding that will inundate the plantings for extended periods. The types of plants recommended for these locations are rushes, sedges, grasses and herbaceous species. Initially, saturated soils are required for the bioretention areas and extended detention basins during the establishment period of the plantings. After the plants have become established, inundation with a surface depth of 1 cm to 2 cm alternating with short dry periods is recommended for the basins during the first year. Periodic shallow flooding of these basins can slow the growth of non-native weedy terrestrial species in the wetland system; however, the water depth should not be greater than the height of the plants. This initial irrigation regime will prevent plant mortality from dry periods or excessive flooding in the first year, and reduce the growth of non-native weedy species.

Emergent species should be planted in saturated soil so the plants will become established. For emergent species, the water level in the first year should be maintained to allow for soil saturation or shallow inundation around the base of the plants. Significant flooding and inundation of stems and leaves of the plants should be avoided the first year. Tall plugs and plantings can tolerate greater depths of inundation if a significant portion of the stems and leaves of the plantings remain above the water surface.

B.5 Monitoring and Maintenance

General Requirements

All planted areas shall be monitored and maintained as required to ensure proper establishment by a Contractor with a valid California C-27 contractor's license. Frequency of site visits and required maintenance practices will vary depending upon the stormwater measure and plant selection. Maintenance shall include watering, cultivation, weeding and pruning as necessary to maintain optimum growth conditions and, as appropriate to the specific stormwater measure, to keep the planted areas neat and attractive in appearance. In all instances, controlling weeds and unwanted growth with chemical applications is prohibited.

The contractor shall be familiar with the design and function of the specific stormwater measure(s) to ensure that the plantings are maintained appropriately and do not interfere with the efficient runoff drainage and filtration.

Ongoing management of invasive weed species is required in all applications. Monthly hand weeding will allow the naturalized vegetation to take hold, and will ultimately be less costly than less frequent, and more intensive clearing. Regular application of compost mulch, or other mulch material that will resist floating with surface runoff (such as pea gravel, rock, cobble, or large float-resistant wood mulches), will also help control weed growth. "Micro-bark" or "gorilla hair" mulches are not recommended.

Erosion Control

Particularly with landscapes that are not fully established, contractors will need to monitor and evaluate potential for erosion and sediment accumulation in the runoff, which will influence irrigation scheduling and as well as determine the need for additional erosion control measures. Soil can be protected from erosion by a number of methods including:

- Keep the soil covered with vegetation to the extent possible;
- Slow water runoff by using compost berms, blanket, socks or tubes along slopes;
- Cover bare soil with a minimum of 3 inches of mulch cover;
- Minimize the use of blowers in planting beds and on turf;
- On slopes use coarse shredded mulch that is not prone to washing into storms drains ("micro-bark" and "gorilla hair" mulches are not recommended for this application);
- Store leaf litter as additional much in planting beds as appropriate.

Irrigation Systems

Where irrigation systems have been installed for temporary or permanent irrigation, the contractor shall maintain the irrigation system for optimum performance, as per manufacturer's specifications. Contractor shall inspect the entire system on an ongoing basis, including cleaning and adjusting all sprinkler and bubbler heads, drip emitters and valves for proper coverage. Contractor shall monitor the irrigation system while operating to identify and correct problems with water runoff or standing water.

Monitor soil moisture within plant root zones using a soil probe or shovel and adjust irrigation schedules accordingly if a soil moisture sensor is not being utilized to signal the irrigation controller. If a Weather-Based Irrigation Controller (WBIC), otherwise known as a "Smart" Controller is not utilized on the project, irrigation shall be scheduled using a water budget approach, basing irrigation frequency on evapotranspiration data (ET) to avoid over-irrigation of plant material. Adjust irrigation frequency within each hydrozone area a minimum of every four weeks to respond to expected adjustments in ET data.

If a standard turf mix is used in lieu of a no-mow variety, implement grasscycling, where appropriate to the stormwater treatment measure. Grass clippings shall not be carried into the drainage structures. Refer to A Landscaper's Guide to Grasscycling available from Rescape California (also known as the Bay-Friendly Landscaping Coalition) at www.rescapeca.org.

Bioretention and Extended Detention Basins

In bioretention and extended detention basins, in particular, non-native invasive plant species should be carefully monitored and controlled to reduce competition with the native plantings and to assure the success of the revegetation activities. The establishment of weeds and invasive species in the bottom of the basins can be partially controlled during the establishment period by implementing the watering schedule of initial saturation followed by alternating periods of shallow inundation and dry soil. Manual methods of weed removal should be conducted on the bottom, edge and side of the basins when these areas are not inundated. Areas with hydroseeding on the banks of the basins should be weeded carefully to avoid removal of the native species.

Weeding should be conducted regularly the first two years to prevent the growth, flowering, and seed set of non-native weeds and invasive species. After the first two years, weeding frequency will be determined on a site-specific basis as determined by the type of weeds and seasonal growth cycle of the weed species. In general, weeding once a month will be necessary to avoid more extensive and costly eradication in the future.

Long-term maintenance tasks on the banks of the basins will include continued control of nonnative weeds and invasive plants, and control of erosion. Erosion could include gullies, rills and sheet erosion. Actions to control erosion should include redirecting or dissipating the water source. Recontouring and subsequent mulching and/or reseeding with erosion control species may be required in bare areas. In the event of extensive die-off of the native plant species, the bare areas should be replanted. Where the event that caused plant mortality was not a natural catastrophic occurrence, the site condition that resulted in the die-off should be investigated and remedial action to correct the problem should be undertaken prior to replanting.

B.6 Bay-Friendly Landscaping and IPM

This section provides a summary of Bay-Friendly landscaping and integrated pest management (IPM) techniques, based on Alameda County's Bay Friendly Landscaping Guidelines prepared by Rescape California, also known as the Bay-Friendly Landscaping Coalition (available at www.rescapeca.org).

Bay Friendly Landscaping

Bay-Friendly landscaping is a whole systems approach to the design, construction and maintenance of the landscape in order to support the integrity of the San Francisco Bay watershed. Project sponsors are encouraged to use landscape professionals who are familiar with and committed to implementing Bay-Friendly landscaping practices from the initial plant selection through the long-term maintenance of the site. This section summarizes Bay-Friendly Landscaping practices that may be implemented information that project sponsors need about how these practices canto benefit water quality of the Bay and its tributaries.

Bay-Friendly landscaping is based on 7 principles of sustainable landscaping and features the following practices:

1. **Landscape Locally.** Landscapes designed to be part of the larger ecosystem of the Bay Area can both protect the health, diversity and sustainability of this valuable resource while making the most of the natural processes of a well-functioning ecosystem. By selecting plants appropriate to the climate, exposure, soils, drainage and topography, plantings can be established more successfully with less consumption of resources and intensive maintenance. Landscape designers are also encouraged to use local, well-adapted plant communities as models and to consider the potential for fire when developing the plant palette for a project.

2. **Less to the Landfill.** Reducing waste –and thus conserving landfill space and fossil fuel for hauling this material to the landfill - starts with not generating it in the first place. Plant trimmings pruning can be reduced by selecting plants that can grow to their natural size is the space allotted them, by avoiding the use of sheared hedges as design elements and not specifying invasive species (see the list in Appendix B). Prune selectively, and avoid excessive plant growth by applying water and fertilizer judiciously..

   The second step is to recognize the value of plant debris, and to keep this organic matter on the site, using it as a gardening resource for mulching and composting.

3. **Nurture the Soil.** Returning organic matter to the soil, in the form of plant debris, is the link between protecting our watershed and protecting our watershed. Healthy soil that is rich in organic matter is full of life and can store water and actively cycle nutrients, regulate and partition water flow, neutralize pollutants, and resist pests. The following practices will encourage a complex soil community of microorganisms, worms, and other beneficial creatures. Base the landscape design on a soil analysis and understanding of soil texture, structure and drainage. The following practices are recommended Dduring construction:
   - Remove and store the topsoil for re-spreading after grading;
   - Limit construction traffic to areas that will not be landscaped;
   - Control soil erosion;
   - Amend the soils with compost before planting; and
   - Specify and maintain an adequate layer of organic mulch, taking into account water flow and designing to avoid the loss of mulch with runoff.

   Maintenance practices to benefit soils and the watershed include allowing grass clippings to remain on the lawn; feeding soils with naturally based products including compost and a water extract of mature compost, instead of synthetic, fast release fertilizers and avoiding pesticides.

4. **Conserve Water.** Amending the soil with compost and keeping it covered with composted mulch (or other mulch that resists floating) can increase soil permeability and water-holding capacity, reduce water loss through evaporation and decrease the need for irrigation. Planting appropriate, drought tolerant California natives or Mediterranean plants also reduces water consumption for irrigation, as well as consumption of other resources for mowing, fertilizing, and spraying. Minimize the use of turf grasses that require regular watering and fertilizing to remain green, particularly on slopes or in narrow, irregular hard to water shapes. Arrange plants in "hydrozones" of low, medium or high water demand. Onsite collection systems can allow the use of rainwater, or the reuse of "graywater" – uncontaminated wastewater from sinks, bathtubs, and washing machines. Specify, install and maintain high-efficiency irrigation systems, and train landscaping staff to manage irrigation according to need.

5. **Conserve Energy.** Conventional landscapes are very fossil fuel consumptive. Selecting plantings that do not require regular mowing or pruning, fertilizing and watering can help reduce this demand and restore our landscapes to those that are more productive than consumptive. Tree plantings can be used to moderate building temperatures, and to shade paved areas and air conditioners. Trees can also intercept significant amounts of rainfall each year and thus help control stormwater runoff. Specify as large a tree as possible but be sure that it will be allowed to grow to its natural shape and size in the

allotted space. Outdoor lighting should be designed to use less energy and minimize "light pollution." Choose and maintain energy-efficient landscaping equipment to conserve fuel. Specifying local products and suppliers reduces the energy needed to transport products and supports local economies.

6. **Protect Water and Air Quality.** Bay-Friendly landscaping can help protect water quality by increasing on-site infiltration and reducing runoff, reducing pollutants in runoff, and increasing the soil's ability to remove pollutants from runoff. It can help protect air quality by reducing fossil fuel consumption, recycling plant debris onsite, and planting trees to remove carbon dioxide and absorb air pollutants. Many of the practices described previously, such as minimizing high input decorative lawns, keeping soil covered with mulch and planting trees play a critical role in protecting water and air quality. An additional very important component of Bay-Friendly landscaping is reducing the use of pesticides through integrated pest management, which is described in a separate section, below.
7. **Create and Protect Wildlife Habitat.** Although we tend to rely on parks and open space to preserve wildlife habitat, developed landscapes can also provide food, water, shelter and nesting sites for birds, butterflies, beneficial insects, and other creatures. This can be accomplished by providing a diverse landscape that includes annuals, biennials and perennials of many different sizes, shapes, colors and textures; by choosing California natives first; providing appropriate water and shelter for wildlife; eliminating the use of pesticides; and planning sites to conserve or restore natural areas and wildlife corridors.

Integrated Pest Management

All creeks in the San Francisco Bay Area exceed water quality toxicity limits, primarily due to the pesticide Diazinon entering urban runoff. Although the residential use of Diazinon is currently being phased out, the use of a group of highly toxic chemicals, called pyrethroids, is increasing. Because all pesticides are toxins, integrated pest management (IPM) places a priority on avoiding their use. IPM is a holistic approach to mitigating insects, plant diseases, weeds, and other pests. Projects that require a landscaping plan as part of a development project application are required encouraged to use IPM, as indicated in each agency's source control measures list, which is based on the Clean Water Program's Source Control Model List. Avoiding pesticides and quick release synthetic fertilizers are particularly important when maintaining stormwater treatment measures, to protect water quality.

IPM encourages the use of many strategies to first prevent, and then control, but not eliminate, pests. It places a priority on fostering a healthy environment in which plants have the strength to resist diseases and insect infestations, and out-compete weeds. Using IPM requires an understanding of the life cycles of pests and beneficial organisms, as well as regular monitoring of their populations. When pest problems are identified, IPM considers all viable solutions and uses a combination of strategies to control pests, rather than relying on pesticides alone. The least toxic pesticides are used only as a last resort. IPM features the following practices:

- **Prevent Pest Problems.** Fostering a healthy soil and selecting appropriate plant communities for the site helps reduce the susceptibility to disease and other pests. Landscape designs should include a diversity of species that are well-suited to the site; specify resistant varieties and native species, including plants that attract beneficial insects; place plants a proper distance from buildings; avoid over-planting; and include compost in the soil specifications. Cultural methods of avoiding pests during construction and maintenance include the following:

- Selecting plant material that is free from disease and insects;
- Planting at the right depth;
- Watering thoroughly but not over-watering;
- Keeping mulch on the soil surface at all times, keeping it away from root crowns;
- Using slow release fertilizer, if necessary, and not over-fertilizing;
- Pruning judiciously;
- Eliminating noxious weeds before they go to seed or spread;
- Cleaning equipment after use on infected plants;
- Inspecting and removing invasive plant parts or seeds from clothing, tools and vehicle before leaving an infected site; and
- Cleaning up fruit and plant material that is infected with insects or diseases.

- **Watch for and Monitor Problems.** Landscaping firms should provide their staff with the time and resources to learn to identify both pest and beneficial organisms, and train residential clients to monitor and record pest problems. Plants should be checked often for vigor and signs of pests. Clarify which problems are the result of pests and not other environmental problems. Evaluate the results of any treatments, and check regularly with the Bio-Integral Resource Center (www.birc.org) or UC Davis (www.ipm.ucdavis.edu) for up-to-date resources and information.
- **Education is Key.** Many property owners have unrealistic standards of absolute pest control and need to learn how landscapes can tolerate a certain level of pests without resulting in significant, or even noticeable, damage. Landscape professionals should educate their clients and refer them to www.ourwaterourworld.org for fact sheets and information on alternative pest control strategies.
- **Use Physical and Mechanical Controls.** If pests are identified as causing unacceptable levels of damage, physical barriers or mechanical techniques are the first line of control. This can include the carefully timed and conducted pruning of infested plant material or removal of whole plants, spraying aphids with a strong jet of water, using pheromone or sticky traps to keep ants and other insects away or hand-picking large adult insect pests and larvae as they appear
- **Use Biological Controls.** Living organisms can also be used to keep pest populations under control. The most important biological controls appear naturally and will be abundant in a landscape that is not heavily treated with pesticides. Encourage beneficial insects by planting a wide range of plants that flower throughout the year (a list is provided in the Bay-Friendly Landscaping Guidelines), and introduce natural predators. Buy all biological controls from a reputable source, and do not use pesticides except as a last resort.
- **Least Toxic Pesticides are a Last Resort.** The least toxic and least persistent pesticide is used only when monitoring indicates that preventative and non-chemical methods are not keeping pests below acceptable levels. Pesticides are not used on a calendar basis. When used, their efficiency is maximized by understanding the pest and beneficial life cycles, by careful timing and targeted application.

B.7 Nursery Sources for Native Plants

It is recommended that the native plants used in treatment controls be grown by a qualified nursery. Seed collection should be conducted by a qualified botanist and/or nursery staff. Seed should be collected locally from selected sites to maintain the genetic integrity of the native plant species. The seeds shall be propagated by the nursery for planting during the fall dormant season. The appropriate container size for each species shall be used by the nursery.

Berkeley Horticultural Nursery*
1310 McGee Ave., Berkeley, CA
510-526-4704
http://www.berkeleyhort.com/

Clyde Robin Seed Company
Castro Valley, CA
510-785-0425
www.clyderobin.com

East Bay Nursery*
2332 San Pablo Ave., Berkeley, CA
510- 845-6490
http://www.eastbaynursery.com/

Larner Seeds
PO Box 407
Bolinas, California
415-868-9407, info@larnerseeds.com
www.larnerseeds.com/

Mines Road Natives
17505 Mines Road, Livermore, CA
925-371-0887 (Note: by appointment only)

Mostly Natives Nursery
27235 Highway 1, Tomales, CA
707-878-2009
www.mostlynatives.com

Native Here Nursery
101 Golf Course Road, Berkeley, CA
510-549-0211
www.ebcnps.org (click on "Native Here Nursery")

Oaktown Native Plant Nursery
1019 Bella Vista Ave., Oakland, CA
510-534-2552
http://www.oaktownnativenursery.info/

Pacific Coast Seed
533 Hawthorne Place
Livermore, CA
925- 373-4417
www.pcseed.com

Watershed Nursery
Berkeley, CA
510-548-4714
www.thewatershednursery.com
* Nurseries with a dedicated native plant section

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B. A Guide to Estimating Irrigation of Water Needs of Landscape Plantings, California Dept of Water Resources, http://cdec.water.ca.gov

C. Irrigation water audits, Irrigation Association, www.irrigation.org, and the Irrigation Technology Research Center, www.itrc.org.

D. California Irrigation Management Information System, www.cimis.water.ca.gov, Waste management and recycling, www.ciwmb.ca.gov.

E. The Weed Worker's Handbook, A Guide to Techniques for Removing Bay Area Invasive Plants, The Watershed Council (510) 231-5655 and the California Invasive Plant Council (510) 843-3902

F. Pests of Landscape Trees and Shrubs: An Integrated Pest Management Guide, 2nd ed., UC Publication 3359, http://www.ipm.ucdavis.edu

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L. East Bay Municipal Utility District (EBMUD), Plants and Landscapes for Summer Dry Climates

M. University of California Cooperative Extension, Guide to Estimating Irrigation Water Needs of Landscape Plantings in CA