CITY OF SANTEE

PRIORITY DEVELOPMENT PROJECT (PDP)

STORM WATER QUALITY MANAGEMENT PLAN (SWQMP)

FOR

ALL RIGHT STORAGE INC.
CUP 2019-5

8708 Cottonwood Ave
SANTEE CA 92071

ASSESSOR'S PARCEL NUMBER(S):
APN 384-370-25
ENGINEER OF WORK:

____

ROBERT D. DENTINO, P.E NUMBER 45629

PREPARED FOR:

MICHAEL DEUTSCH
111 C ST. SUITE 200
ENCINITAS, CA92024

PDP SWQMP & PLAN PREPARED BY:

EXCEL ENGINEERING
440 STATE PLACE
ESCONDIDO, CA 92029
PHONE: 760 745 8118

DATE OF SWQMP:
03/04/2020

0	03.04.2020	Third Submittal	Excel Engineering
REVISION	**SUBMITTAL DATE**	**DESCRIPTION**	**ISSUED BY**

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TABLE OF CONTENTS

ACRONYMS

APN	Assessor's Parcel Number
BMP	Best Management Practice
HMP	Hydromodification Management Plan
HSG	Hydrologic Soil Group
MS4	Municipal Separate Storm Sewer System
N/A	Not Applicable
NRCS	Natural Resources Conservation Service
PDP	Priority Development Project
PE	Professional Engineer
SC	Source Control
SD	Site Design
SDRWQCB	San Diego Regional Water Quality Control Board
SIC	Standard Industrial Classification
SWQMP	Storm Water Quality Management Plan

SWQMP PREPARER'S
CERTIFICATION PAGE

Project Name: ALL RIGHT SELF STORAGE
Permit Application Number: [Insert Permit Application Number]

PREPARER'S CERTIFICATION

I hereby declare that I am the Engineer in Responsible Charge of design of storm water best management practices (BMPs) for this project, and that I have exercised responsible charge over the design of the BMPs as defined in Section 6703 of the Business and Professions Code, and that the design is consistent with the PDP requirements of the City of Santee BMP Design Manual, which is a design manual for compliance with local [INSERT AGENCY NAME] and regional MS4 Permit (California Regional Water Quality Control Board San Diego Region Order No. R9-2015-0100) requirements for storm water management.

I have read and understand that the [City Engineer] has adopted minimum requirements for managing urban runoff, including storm water, from land development activities, as described in the BMP Design Manual. I certify that this PDP SWQMP has been completed to the best of my ability and accurately reflects the project being proposed and the applicable BMPs proposed to minimize the potentially negative impacts of this project's land development activities on water quality. I understand and acknowledge that the plan check review of this PDP SWQMP by the [City Engineer] is confined to a review and does not relieve me, as the Engineer in Responsible Charge of design of storm water BMPs for this project, of my responsibilities for project design.

REC 45629 / EXP. 12-31-2020
Engineer of Work's Signature, PE Number & Expiration Date

ROBERT D. DENTINO
Print Name

EXCEL ENGINEERING
Company

04/03/2020
Date

Engineer's Seal:

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SWQMP PROJECT OWNER'S
CERTIFICATION PAGE

Project Name: ALL RIGHT STORAGE INC
Permit Application Number: [Insert Permit Application Number]

PROJECT OWNER'S CERTIFICATION

This PDP SWQMP has been prepared for ALL RIGHT STORAGE INC by EXCEL ENGINEERING. The PDP SWQMP is intended to comply with the PDP requirements of the CITY OF SANTEE BMP Design Manual, which is a design manual for compliance with local [INSERT AGENCY NAME] and regional MS4 Permit (California Regional Water Quality Control Board San Diego Region Order No. R9-2015-0100) requirements for storm water management.

The undersigned, while it owns the subject property, is responsible for the implementation of the provisions of this plan. Once the undersigned transfers its interests in the property, its successor-in-interest shall bear the aforementioned responsibility to implement the best management practices (BMPs) described within this plan, including ensuring on-going operation and maintenance of structural BMPs. A signed copy of this document shall be available on the subject property into perpetuity.

M. Deutsch

Project Owner's Signature

MICHAEL DEUTSCH

Print Name

ALL RIGHT STORAGE INC.

Company

2/27/2020

Date

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SUBMITTAL RECORD

Use this Table to keep a record of submittals of this PDP SWQMP. Each time the PDP SWQMP is re-submitted, provide the date and status of the project. In column 4 summarize the changes that have been made or indicate if response to plancheck comments is included. When applicable, insert response to plancheck comments behind this page.

Submittal Number	Date	Project Status	Summary of Changes
1	09/07/18	☐ Preliminary Design / Planning/ CEQA ☐ Final Design	Initial Submittal
2	04/15/19	☐ Preliminary Design / Planning/ CEQA ☐ Final Design	Second Submittal
3	03/04/2020	☑ Preliminary Design / Planning/ CEQA ☐ Final Design	Third Submittal
4		☐ Preliminary Design / Planning/ CEQA ☐ Final Design	

March 4, 2020

Response to Comments All Right Self Storage

(MP 2019-05) date November 4, 2019

5. DRAINAGE STUDY

a. Drainage study –no offsite flows run on to project site.

b. updated

c. updated

d. updated – See Pre-Development Map

e. updated – see Post Development Map

f. updated – Run-off Coefficient used General Commercial

6. SWQMP

a. Ok & Updated.

b. Project owner's information provided

c. Updated.

d. Updated.

e. Updated.

f. Pollutants expected are one sheet 7 already. "Benthic Community Effects, Cadmium, Nitrogen, Phosphorus, Total Dissolved Solids, Toxicity."

g. Additional support has been provided in form I-6 and attachment 1-e now includes Bio Clean attachment for "GULD approval for basic, phosphorus and enhanced treatment under the TAPE approval."

h. DMA updated to show updated DMA areas, hatch added for buildings (phase 1 & 2), pervious area hatch added, existing and proposed contours added, and existing and proposed utilities shown.

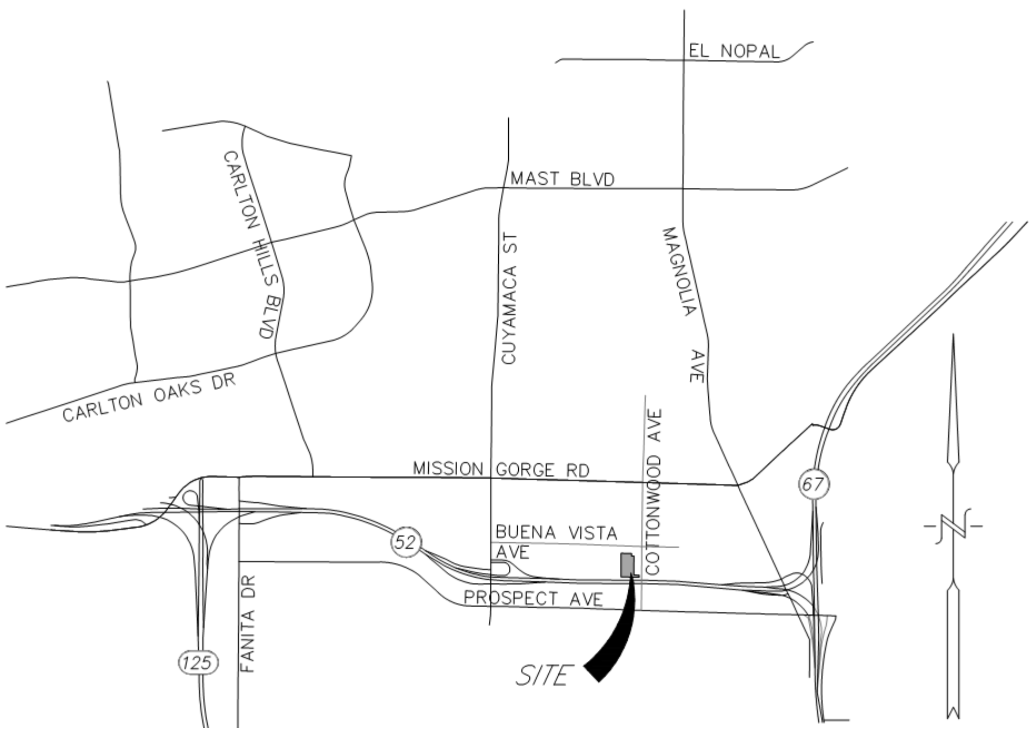
i. Tabs added.

j. Form I-8 filled in.

k. "Updated Geotechnical Investigation and Infiltration Testing" report dated March 28, 2018 was included in attachment 1c.

PROJECT VICINITY MAP

Project Name: All Right Self-Storage
Permit Application Number: [Insert Permit Application Number]



Applicability of Permanent, Post-Construction Storm Water BMP Requirements (Storm Water Intake Form for all Development Permit Applications)	**Form I-1** Model BMP Design Manual [August 31, 2015]

Project Identification	
Project Name: All Right Self-Storage	
Permit Application Number:	Date:
Project Address: 8708 Cottonwood Ave Santee CA 92071	

Determination of Requirements

The purpose of this form is to identify permanent, post-construction requirements that apply to the project. This form serves as a short summary of applicable requirements, in some cases referencing separate forms that will serve as the backup for the determination of requirements.

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

Refer to BMP Design Manual sections and/or separate forms referenced in each step below.

Step	Answer	Progression
Step 1: Is the project a "development project"? See Section 1.3 of the BMP Design Manual for guidance.	☑ Yes	Go to Step 2.
	☐ No	Stop. Permanent BMP requirements do not apply. No SWQMP will be required. Provide discussion below.
Discussion / justification if the project is not a "development project" (e.g., the project includes *only* interior remodels within an existing building):		
Step 2: Is the project a Standard Project, Priority Development Project (PDP), or exception to PDP definitions? To answer this item, see Section 1.4 of the BMP Design Manual *in its entirety* for guidance, AND complete Form I-2, Project Type Determination.	☐ Standard Project	Stop. Only Standard Project requirements apply, including Standard Project SWQMP.
	☑ PDP	Standard and PDP requirements apply, including PDP SWQMP. Go to Step 3.
	☐ Exception to PDP definitions	Stop. Standard Project requirements apply, and any additional requirements specific to the type of project. Provide discussion and list any additional requirements below. Prepare Standard Project SWQMP.

Form I-1 Page 2, Form Template Date: August 31, 2015		
[Step 2 Continued from Page 1] Discussion / justification, and additional requirements for exceptions to PDP definitions, if applicable:		
Step 3 (PDPs only). Is the project subject to earlier PDP requirements due to a prior lawful approval? See Section 1.10 of the BMP Design Manual for guidance.	☐ Yes	Consult the [City Engineer] to determine requirements. Provide discussion and identify requirements below. Go to Step 4.
	☑ No	BMP Design Manual PDP requirements apply. Go to Step 4.
Discussion / justification of prior lawful approval, and identify requirements (*not required if prior lawful approval does not apply*):		
Step 4 (PDPs only). Do hydromodification control requirements apply? See Section 1.6 of the BMP Design Manual for guidance.	☑ Yes	PDP structural BMPs required for pollutant control (Chapter 5) and hydromodification control (Chapter 6). Go to Step 5.
	☐ No	Stop. PDP structural BMPs required for pollutant control (Chapter 5) only. Provide brief discussion of exemption to hydromodification control below.
Discussion / justification if hydromodification control requirements do <u>not</u> apply:		
Step 5 (PDPs subject to hydromodification control requirements only). Does protection of critical coarse sediment yield areas apply based on review of WMAA Potential Critical Coarse Sediment Yield Area Map? See Section 6.2 of the BMP Design Manual for guidance.	☐ Yes	Management measures required for protection of critical coarse sediment yield areas (Chapter 6.2). Stop.
	☑ No	Management measures not required for protection of critical coarse sediment yield areas. Provide brief discussion below. Stop.

<table>
<tr><td colspan="4">Priority Determination Form</td><td>Form I-2
Model BMP Design Manual
[August 31, 2015]</td></tr>
<tr><td colspan="5">Project Information</td></tr>
<tr><td colspan="5">Project Name: All Right Self-Storage</td></tr>
<tr><td colspan="4">Permit Application Number:</td><td>Date:</td></tr>
<tr><td colspan="5">Project Address:
8708 Cottonwood Ave, Santee CA 92071</td></tr>
<tr><td colspan="5">Project Type Determination: Standard Project or Priority Development Project (PDP)</td></tr>
<tr><td colspan="5">The project is (select one): New Development ☑ Redevelopment</td></tr>
<tr><td colspan="5">The total proposed newly created or replaced impervious area is: 122520 ft^2 (2.81) acres</td></tr>
<tr><td colspan="5">Is the project in any of the following categories, (a) through (f)?</td></tr>
<tr><td>Yes</td><td>No
☑</td><td>(a)</td><td colspan="2">New development projects that create 10,000 square feet or more of impervious surfaces (collectively over the entire project site). This includes commercial, industrial, residential, mixed-use, and public development projects on public or private land.</td></tr>
<tr><td>Yes
☑</td><td>No</td><td>(b)</td><td colspan="2">Redevelopment projects that create and/or replace 5,000 square feet or more of impervious surface (collectively over the entire project site on an existing site of 10,000 square feet or more of impervious surfaces). This includes commercial, industrial, residential, mixed-use, and public development projects on public or private land.</td></tr>
<tr><td>Yes</td><td>No
☑</td><td>(c)</td><td colspan="2">New and redevelopment projects that create and/or replace 5,000 square feet or more of impervious surface (collectively over the entire project site), and support one or more of the following uses:
(i) Restaurants. This category is defined as a facility that sells prepared foods and drinks for consumption, including stationary lunch counters and refreshment stands selling prepared foods and drinks for immediate consumption (Standard Industrial Classification (SIC) code 5812).
(ii) Hillside development projects. This category includes development on any natural slope that is twenty-five percent or greater.
(iii) Parking lots. This category is defined as a land area or facility for the temporary parking or storage of motor vehicles used personally, for business, or for commerce.
(iv) Streets, roads, highways, freeways, and driveways. This category is defined as any paved impervious surface used for the transportation of automobiles, trucks, motorcycles, and other vehicles.</td></tr>
</table>

Form I-2 Page 2, Form Template Date: August 31, 2015			
Yes	No ☑	(d)	New or redevelopment projects that create and/or replace 2,500 square feet or more of impervious surface (collectively over the entire project site), and discharging directly to an Environmentally Sensitive Area (ESA). "Discharging directly to" includes flow that is conveyed overland a distance of 200 feet or less from the project to the ESA, or conveyed in a pipe or open channel any distance as an isolated flow from the project to the ESA (i.e. not commingled with flows from adjacent lands). *Note: ESAs are areas that include but are not limited to all Clean Water Act Section 303(d) impaired water bodies; areas designated as Areas of Special Biological Significance by the State Water Board and San Diego Water Board; State Water Quality Protected Areas; water bodies designated with the RARE beneficial use by the State Water Board and San Diego Water Board; and any other equivalent environmentally sensitive areas which have been identified by the Copermittees. See BMP Design Manual Section 1.4.2 for additional guidance.*
Yes	No ☑	(e)	New development projects, or redevelopment projects that create and/or replace 5,000 square feet or more of impervious surface, that support one or more of the following uses: (i) Automotive repair shops. This category is defined as a facility that is categorized in any one of the following SIC codes: 5013, 5014, 5541, 7532-7534, or 7536-7539. (ii) Retail gasoline outlets (RGOs). This category includes RGOs that meet the following criteria: (a) 5,000 square feet or more or (b) a projected Average Daily Traffic (ADT) of 100 or more vehicles per day.
Yes ☑	No	(f)	New or redevelopment projects that result in the disturbance of one or more acres of land and are expected to generate pollutants post construction. *Note: See BMP Design Manual Section 1.4.2 for additional guidance.*

Does the project meet the definition of one or more of the Priority Development Project categories (a) through (f) listed above?

No – the project is not a Priority Development Project (Standard Project).

☑ Yes – the project is a Priority Development Project (PDP).

The following is for redevelopment PDPs only:

The area of existing (pre-project) impervious area at the project site is: 85505 ft^2 (A)
The total proposed newly created or replaced impervious area is 122520 ft^2 (B)
Percent impervious surface created or replaced (B/A)*100: 143.2%
The percent impervious surface created or replaced is (select one based on the above calculation):

less than or equal to fifty percent (50%) – only new impervious areas are considered PDP

OR

☑ greater than fifty percent (50%) – the entire project site is a PDP

Site Design Checklist For PDPs	Form I-3B (PDPs) Model BMP Design Manual [August 31, 2015]
Project Summary Information	
Project Name:	All Right Self-Storage
Project Address:	8708 Cottonwood Ave, Santee CA 92071
Assessor's Parcel Number(s) (APN(s))	384-370-25
Permit Application Number	
Project Hydrologic Unit	Select One: ☐ Santa Margarita 902 ☐ San Luis Rey 903 ☐ Carlsbad 904 ☐ San Dieguito 905 ☐ Penasquitos 906 ☑ San Diego 907 ☐ Pueblo San Diego 908 ☐ Sweetwater 909 ☐ Otay 910 ☐ Tijuana 911
Project Watershed (Complete Hydrologic Unit, Area, and Subarea Name with Numeric Identifier)	HU 7, HANAME: Lower San Diego, HSANAME: Santee
Parcel Area (total area of Assessor's Parcel(s) associated with the project)	3 Acres (130,922 Square Feet)
Area to be Disturbed by the Project (Project Area)	3 Acres (130,922 Square Feet)
Project Proposed Impervious Area (subset of Project Area)	2.81 Acres (122,520 Square Feet)
Project Proposed Pervious Area (subset of Project Area)	0.19 Acres (8,402 Square Feet)
Note: Proposed Impervious Area + Proposed Pervious Area = Area to be Disturbed by the Project. This may be less than the Parcel Area.	

Form I-3B Page 2 of 10, Form Template Date: August 31, 2015
Description of Existing Site Condition
Current Status of the Site (select all that apply): ☐ Existing development ☐ Previously graded but not built out ☑ Demolition completed without new construction ☐ Agricultural or other non-impervious use ☐ Vacant, undeveloped/natural Description / Additional Information: The site was previously a mobile home park. The mobile home units were removed and left with concrete slabs, pavement, driveway and old drainage structure.
Existing Land Cover Includes (select all that apply): ☑ Vegetative Cover ☐ Non-Vegetated Pervious Areas ☑ Impervious Areas Description / Additional Information:
Underlying Soil belongs to Hydrologic Soil Group (select all that apply): ☐ NRCS Type A ☐ NRCS Type B ☐ NRCS Type C ☑ NRCS Type D
Approximate Depth to Groundwater (GW): ☐ GW Depth < 5 feet ☐ 5 feet < GW Depth < 10 feet ☐ 10 feet < GW Depth < 20 feet ☑ GW Depth > 20 feet

Existing Natural Hydrologic Features (select all that apply):

☐ Watercourses

☐ Seeps

☐ Springs

☐ Wetlands

☑ None

Description / Additional Information:

Form I-3B Page 3 of 10, Form Template Date: August 31, 2015
Description of Existing Site Drainage Patterns
How is storm water runoff conveyed from the site? At a minimum, this description should answer: (1) whether existing drainage conveyance is natural or urban; (2) Is runoff from offsite conveyed through the site? if yes, quantify all offsite drainage areas, design flows, and locations where offsite flows enter the project site, and summarize how such flows are conveyed through the site; (3)Provide details regarding existing project site drainage conveyance network, including any existing storm drains, concrete channels, swales, detention facilities, storm water treatment facilities, natural or constructed channels; and (4) Identify all discharge locations from the existing project site along with a summary of conveyance system size and capacity for each of the discharge locations. Provide summary of the pre-project drainage areas and design flows to each of the existing runoff discharge locations. Describe existing site drainage patterns: The project site resides in the location of a previous mobile home park. The mobile homes have been removed while the roads and drainage infrastructure remain. The existing infrastructure includes a single ribbon gutter at the center of the driveway and two inlets reside on the easterly and westerly portions of the property. The site run off is discharged through a 4” pipe at the north westerly corner of the site and then conveyed to the curb and gutter along Buena Vista Avenue. When the 4” pipe becomes overwhelmed, the flow is conveyed through an open joint on the boundary wall and then along the curb and gutter within the neighboring property where it outfalls to the same POC at Buena Vista Avenue.

Form I-3B Page 4 of 10, Form Template Date: August 31, 2015
Description of Proposed Site Development
Project Description / Proposed Land Use and/or Activities: Proposed The project is proposing to build five buildings, in two construction phases, to be used for self–storage. Phase 1 consists of a 3–story building (25,923 SF), a 1–story building (4,413 SF) and a 1–story building which includes a unit for the caretaker (5,920 SF). In addition to the three buildings, 50 open spaces are proposed for recreational vehicles, vehicle and boat storage. Associated improvements will include walkways, a single trash enclosure, 26 parking spaces, landscaping, and all necessary utilities (storm, sewer, water, dry, etc.). Phase 2 will replace the 50 open spaces from Phase 1 with a 3–story building (16,802 SF) and 1–story building (8,316 SF). In addition to the 26 parking spaces added in Phase 1, 3 more spaces will be adding totaling to 29 parking spaces.
List/describe proposed impervious features of the project (e.g., buildings, roadways, parking lots, courtyards, athletic courts, other impervious features): Buildings, parking lots
List/describe proposed pervious features of the project (e.g., landscape areas): Landscape strip surrounding the site and at parking lots
Does the project include grading and changes to site topography? ☑ Yes ☐ No Description / Additional Information:

Description of Proposed Site Drainage Patterns

Does the project include changes to site drainage (e.g., installation of new storm water conveyance systems)?

☑ Yes
☐ No

If yes, provide details regarding the proposed project site drainage conveyance network, including storm drains, concrete channels, swales, detention facilities, storm water treatment facilities, natural or constructed channels, and the method for conveying offsite flows through or around the proposed project site. Identify all discharge locations from the proposed project site along with a summary of the conveyance system size and capacity for each of the discharge locations. Provide a summary of pre- and post-project drainage areas and design flows to each of the runoff discharge locations. Reference the drainage study for detailed calculations.

Describe proposed site drainage patterns:

The project proposes to convey overland flow produced by storm runoff in inlets throughout the site. The runoff will be captured within an underground storage tank and then be pumped back to the surface at the same location the site currently outlets along the westerly boundary.

Form I-3B Page 6 of 10, Form Template Date: August 31, 2015
Identify whether any of the following features, activities, and/or pollutant source areas will be present (select all that apply): ☑ On-site storm drain inlets ☑ Interior floor drains and elevator shaft sump pumps ☐ Interior parking garages ☐ Need for future indoor & structural pest control ☑ Landscape/Outdoor Pesticide Use ☐ Pools, spas, ponds, decorative fountains, and other water features ☐ Food service ☐ Refuse areas ☐ Industrial processes ☐ Outdoor storage of equipment or materials ☐ Vehicle and Equipment Cleaning ☐ Vehicle/Equipment Repair and Maintenance ☐ Fuel Dispensing Areas ☐ Loading Docks ☑ Fire Sprinkler Test Water ☐ Miscellaneous Drain or Wash Water ☑ Plazas, sidewalks, and parking lots Description / Additional Information:

Form I-3B Page 7 of 10, Form Template Date: August 31, 2015
Identification and Narrative of Receiving Water and Pollutants of Concern
Describe flow path of storm water from the project site discharge location(s), through urban storm conveyance systems as applicable, to receiving creeks, rivers, and lagoons as applicable, and ultimate discharge to the Pacific Ocean (or bay, lagoon, lake or reservoir, as applicable): The project outlets storm flow via overland flow along the westerly property line. The runoff is then conveyed within the neighboring properties gutter into a public storm drain inlet. The public system conveys flows to the San Diego River, which ultimately outlets to the Pacific Ocean.
List any 303(d) impaired water bodies within the path of storm water from the project site to the Pacific Ocean (or bay, lagoon, lake or reservoir, as applicable), identify the pollutant(s)/stressor(s) causing impairment, and identify any TMDLs and/or Highest Priority Pollutants from the WQIP for the impaired water bodies:

303(d) Impaired Water Body	Pollutant(s)/Stressor(s)	TMDLs / WQIP Highest Priority Pollutant
San Diego River (Lower)	Benthic Community Effects, Cadmium, Nitrogen, Phosphorus, Total Dissolved Solids, Toxicity,	Required

Identification of Project Site Pollutants*
***Identification of project site pollutants is only required if flow-thru treatment BMPs are implemented onsite in lieu of retention or biofiltration BMPs (note the project must also participate in an alternative compliance program unless prior lawful approval to meet earlier PDP requirements is demonstrated)**
Identify pollutants expected from the project site based on all proposed use(s) of the site (see BMP Design Manual Appendix B.6):

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

Form I-3B Page 8 of 10, Form Template Date: August 31, 2015
Hydromodification Management Requirements
Do hydromodification management requirements apply (see Section 1.6 of the BMP Design Manual)? ☑ Yes, hydromodification management flow control structural BMPs required. ☐ No, the project will discharge runoff directly to existing underground storm drains discharging directly to water storage reservoirs, lakes, enclosed embayments, or the Pacific Ocean. ☐ No, the project will discharge runoff directly to conveyance channels whose bed and bank are concrete-lined all the way from the point of discharge to water storage reservoirs, lakes, enclosed embayments, or the Pacific Ocean. ☐ No, the project will discharge runoff directly to an area identified as appropriate for an exemption by the WMAA for the watershed in which the project resides. Description / Additional Information (to be provided if a 'No' answer has been selected above):
Critical Coarse Sediment Yield Areas* ***This Section only required if hydromodification management requirements apply**

Based on the maps provided within the WMAA, do potential critical coarse sediment yield areas exist within the project drainage boundaries?

☐ Yes
☑ No, No critical coarse sediment yield areas to be protected based on WMAA maps

If yes, have any of the optional analyses presented in Section 6.2 of the BMP Design Manual been performed?

☐ 6.2.1 Verification of Geomorphic Landscape Units (GLUs) Onsite

☐ 6.2.2 Downstream Systems Sensitivity to Coarse Sediment

☐ 6.2.3 Optional Additional Analysis of Potential Critical Coarse Sediment Yield Areas Onsite

☐ No optional analyses performed, the project will avoid critical coarse sediment yield areas identified based on WMAA maps

If optional analyses were performed, what is the final result?

☐ No critical coarse sediment yield areas to be protected based on verification of GLUs onsite

☐ Critical coarse sediment yield areas exist but additional analysis has determined that protection is not required. Documentation attached in Attachment 2.b of the SWQMP.

☐ Critical coarse sediment yield areas exist and require protection. The project will implement management measures described in Sections 6.2.4 and 6.2.5 as applicable, and the areas are identified on the SWQMP Exhibit.

Discussion / Additional Information:

Form I-3B Page 9 of 10, Form Template Date: August 31, 2015
Flow Control for Post-Project Runoff* *This Section only required if hydromodification management requirements apply
List and describe point(s) of compliance (POCs) for flow control for hydromodification management (see Section 6.3.1). For each POC, provide a POC identification name or number correlating to the project's HMP Exhibit and a receiving channel identification name or number correlating to the project's HMP Exhibit. The project contains a single POC along the westerly boundary and is named POC-1.
Has a geomorphic assessment been performed for the receiving channel(s)? ☑ No, the low flow threshold is 0.1Q2 (default low flow threshold) ☐ Yes, the result is the low flow threshold is 0.1Q2 ☐ Yes, the result is the low flow threshold is 0.3Q2 ☐ Yes, the result is the low flow threshold is 0.5Q2 If a geomorphic assessment has been performed, provide title, date, and preparer: Discussion / Additional Information: (optional)

Form I-3B Page 10 of 10, Form Template Date: August 31, 2015
Other Site Requirements and Constraints
When applicable, list other site requirements or constraints that will influence storm water management design, such as zoning requirements including setbacks and open space, or local codes governing minimum street width, sidewalk construction, allowable pavement types, and drainage requirements. N/A
Optional Additional Information or Continuation of Previous Sections As Needed
This space provided for additional information or continuation of information from previous sections as needed.

Source Control BMP Checklist for All Development Projects (Standard Projects and Priority Development Projects)			Form I-4 Model BMP Design Manual [August 31, 2015]
Project Identification			
Project Name All Right Self-Storage			
Permit Application Number			
Source Control BMPs			
All development projects must implement source control BMPs SC-1 through SC-6 where applicable and feasible. See Chapter 4 and Appendix E of the Model BMP Design Manual for information to implement source control BMPs shown in this checklist. Answer each category below pursuant to the following. • "Yes" means the project will implement the source control BMP as described in Chapter 4 and/or Appendix E of the Model BMP Design Manual. Discussion / justification is not required. • "No" means the BMP is applicable to the project but it is not feasible to implement. Discussion / justification must be provided. • "N/A" means the BMP is not applicable at the project site because the project does not include the feature that is addressed by the BMP (e.g., the project has no outdoor materials storage areas). Discussion / justification may be provided.			
Source Control Requirement	**Applied?**		
SC-1 Prevention of Illicit Discharges into the MS4	☑ Yes	☐ No	☐ N/A
Discussion / justification if SC-1 not implemented:			
SC-2 Storm Drain Stenciling or Signage	☑ Yes	☐ No	☐ N/A
Discussion / justification if SC-2 not implemented:			
SC-3 Protect Outdoor Materials Storage Areas from Rainfall, Run-On, Runoff, and Wind Dispersal	☐ Yes	☐ No	☑ N/A
Discussion / justification if SC-3 not implemented: Ultimate site build out contains no outdoor material storage areas			
SC-4 Protect Materials Stored in Outdoor Work Areas from Rainfall, Run-On, Runoff, and Wind Dispersal	☐ Yes	☐ No	☑ N/A
Discussion / justification if SC-4 not implemented: Ultimate site build out contains no outdoor work areas			

Form I-4 Page 2 of 2, Form Template Date: August 31, 2015			
Source Control Requirement	**Applied?**		
SC-5 Protect Trash Storage Areas from Rainfall, Run-On, Runoff, and Wind Dispersal	☑ Yes	☐ No	☐ N/A
Discussion / justification if SC-5 not implemented:			
SC-6 Additional BMPs Based on Potential Sources of Runoff Pollutants (must answer for each source listed below)			
☐ On-site storm drain inlets	☑ Yes	☐ No	☐ N/A
☐ Interior floor drains and elevator shaft sump pumps	☐ Yes	☐ No	☑N/A
☐ Interior parking garages	☐ Yes	☐ No	☑ N/A
☐ Need for future indoor & structural pest control	☐ Yes	☐ No	☑ N/A
☐ Landscape/Outdoor Pesticide Use	☑ Yes	☐ No	☐ N/A
☐ Pools, spas, ponds, decorative fountains, and other water features	☐ Yes	☐ No	☑ N/A
☐ Food service	☐ Yes	☐ No	☑ N/A
☐ Refuse areas	☐ Yes	☐ No	☑ N/A
☐ Industrial processes	☐ Yes	☐ No	☑ N/A
☐ Outdoor storage of equipment or materials	☐ Yes	☐ No	☑ N/A
☐ Vehicle and Equipment Cleaning	☐ Yes	☐ No	☑ N/A
☐ Vehicle/Equipment Repair and Maintenance	☐ Yes	☐ No	☑ N/A
☐ Fuel Dispensing Areas	☐ Yes	☐ No	☑ N/A
☐ Loading Docks	☐ Yes	☐ No	☐ N/A
☐ Fire Sprinkler Test Water	☐ Yes	☐ No	☑ N/A
☐ Miscellaneous Drain or Wash Water	☐ Yes	☐ No	☑ N/A
☐ Plazas, sidewalks, and parking lots	☑ Yes	☐ No	☐ N/A

Discussion / justification if SC-6 not implemented. Clearly identify which sources of runoff pollutants are discussed. Justification must be provided for <u>all</u> "No" answers shown above.

Site Design BMP Checklist for All Development Projects (Standard Projects and Priority Development Projects)			Form I-5 Model BMP Design Manual [August 31, 2015]
Project Identification			
Project Name: All Right Self-Storage			
Permit Application Number:			
Site Design BMPs			
All development projects must implement site design BMPs SD-1 through SD-8 where applicable and feasible. See Chapter 4 and Appendix E of the Model BMP Design Manual for information to implement site design BMPs shown in this checklist. Answer each category below pursuant to the following. • "Yes" means the project will implement the site design BMP as described in Chapter 4 and/or Appendix E of the Model BMP Design Manual. Discussion / justification is not required. • "No" means the BMP is applicable to the project but it is not feasible to implement. Discussion / justification must be provided. • "N/A" means the BMP is not applicable at the project site because the project does not include the feature that is addressed by the BMP (e.g., the project site has no existing natural areas to conserve). Discussion / justification may be provided.			
Site Design Requirement	**Applied?**		
SD-1 Maintain Natural Drainage Pathways and Hydrologic Features	☐ Yes	☐ No	☑ N/A
Discussion / justification if SD-1 not implemented:			
SD-2 Conserve Natural Areas, Soils, and Vegetation	☐ Yes	☐ No	☑ N/A
Discussion / justification if SD-2 not implemented:			
SD-3 Minimize Impervious Area	☑ Yes	☐ No	☐ N/A
Discussion / justification if SD-3 not implemented:			
SD-4 Minimize Soil Compaction	☐ Yes	☐ No	☑ N/A
Discussion / justification if SD-4 not implemented:			
SD-5 Impervious Area Dispersion	☐ Yes	☐ No	☑ N/A
Discussion / justification if SD-5 not implemented:			

Form I-5 Page 2 of 2, Form Template Date: August 31, 2015			
Site Design Requirement	**Applied?**		
SD-6 Runoff Collection	☐ Yes	☐ No	☑ N/A
Discussion / justification if SD-6 not implemented:			
SD-7 Landscaping with Native or Drought Tolerant Species	☑ Yes	☐ No	☐ N/A
Discussion / justification if SD-7 not implemented:			
SD-8 Harvesting and Using Precipitation	☐ Yes	☐ No	☑ N/A
Discussion / justification if SD-8 not implemented:			

Summary of PDP Structural BMPs	**Form I-6 (PDPs)** Model BMP Design Manual [August 31, 2015]
Project Identification	
Project Name: All Right Self-Storage	
Permit Application Number	
PDP Structural BMPs	
All PDPs must implement structural BMPs for storm water pollutant control (see Chapter 5 of the BMP Design Manual). Selection of PDP structural BMPs for storm water pollutant control must be based on the selection process described in Chapter 5. PDPs subject to hydromodification management requirements must also implement structural BMPs for flow control for hydromodification management (see Chapter 6 of the BMP Design Manual). Both storm water pollutant control and flow control for hydromodification management can be achieved within the same structural BMP(s). PDP structural BMPs must be verified by the local jurisdiction at the completion of construction. This may include requiring the project owner or project owner's representative and engineer of record to certify construction of the structural BMPs (see Section 1.12 of the BMP Design Manual). PDP structural BMPs must be maintained into perpetuity, and the local jurisdiction must confirm the maintenance (see Section 7 of the BMP Design Manual). Use this form to provide narrative description of the general strategy for structural BMP implementation at the project site in the box below. Then complete the PDP structural BMP summary information sheet (page 3 of this form) for each structural BMP within the project (copy the BMP summary information page as many times as needed to provide summary information for each individual structural BMP).	
Describe the general strategy for structural BMP implementation at the site. This information must describe how the steps for selecting and designing storm water pollutant control BMPs presented in Section 5.1 of the BMP Design Manual were followed, and the results (type of BMPs selected). For projects requiring hydromodification flow control BMPs, indicate whether pollutant control and flow control BMPs are integrated or separate. The project was evaluated at the DMA scale and determined to require BMPs to assist with pollutant removal. Harvest and use was analyzed investigated using form I-7 in attachment 1 and determined to be infeasible. A soils analysis was performed and form I-8 in attachment 1 was used to determine if infiltration is feasible. It has been determined that infiltration is not feasible. Due to the size of the site, it is infeasible to drain to a common biofiltration basin and a proprietary BMP is selected. Hydromodification will be analyzed within the same system as the BMP. (Continue on page 2 as necessary.)	

Form I-6 Page 2 of X, Form Template Date: August 31, 2015
(Page reserved for continuation of description of general strategy for structural BMP implementation at the site)
(Continued from page 1) The project was evaluated at the DMA scale and determined to require BMPs to assist with pollutant removal. Harvest and use was analyzed investigated using form I-7 in attachment 1 and determined to be infeasible. A soils analysis was performed and form I-8 in attachment 1 was used to determine if infiltration is feasible. It has been determined that infiltration is not feasible. The required footprint size of a standard biofiltration basin would not be accommodable to the project site with the proximity of the buildings and the proximity of where the basin would have to be next to an existing wall on the property line. For this reason, a proprietary BMP is selected and will detain 1.5 times the DCV prior to the Modular Wetlands Unit. The drawdown time of the Modular wetlands unit will still satisfy the standard 36 hour drawdown. Since a proprietary bmp is being used a smaller than 3% footprint is also allowed as long as the proprietary device also meets requirements under Appendix F (See Attachment 1e for manufacture documents). As stated in section B.5.2.2 "Acceptable alternative designs (such as proprietary systems meeting Appendix F criteria) typically include design features intended to allow acceptable performance with a smaller footprint and have undergone field scale testing to evaluate performance and required O&M frequency." The infiltration onsite is so small that retention in any appreciable amounts will be very little. The site does include a swale that will retain water but due to the infiltration limitation it can only hold approximately 2 inches within the drawdown allowable time. Since the site has limited infiltration capabilities it is infeasible to have large areas of water ponding since the area will not drain down in the allowed drawdown timeframe. Hydromodification will be analyzed within the same system as the BMP.

Form I-6 Page 3 of X (Copy as many as needed) , Form Template Date: August 31, 2015	
Structural BMP Summary Information **(Copy this page as needed to provide information for each individual proposed structural BMP)**	
Structural BMP ID No.	
Construction Plan Sheet No.	
Type of structural BMP: ☐ Retention by harvest and use (HU-1) ☐ Retention by infiltration basin (INF-1) ☐ Retention by bioretention (INF-2) ☐ Retention by permeable pavement (INF-3) ☐ Partial retention by biofiltration with partial retention (PR-1) ☐ Biofiltration (BF-1) ☐ Biofiltration with Nutrient Sensitive Media Design (BF-2) ☑ Proprietary Biofiltration (BF-3) meeting all requirements of Appendix F ☐ Flow-thru treatment control with prior lawful approval to meet earlier PDP requirements (provide BMP type/description in discussion section below) ☐ Flow-thru treatment control included as pre-treatment/forebay for an onsite retention or biofiltration BMP (provide BMP type/description and indicate which onsite retention or biofiltration BMP it serves in discussion section below) ☐ Flow-thru treatment control with alternative compliance (provide BMP type/description in discussion section below) ☐ Detention pond or vault for hydromodification management ☐ Other (describe in discussion section below)	
Purpose: ☐ Pollutant control only ☐ Hydromodification control only ☑ Combined pollutant control and hydromodification control ☐ Pre-treatment/forebay for another structural BMP ☐ Other (describe in discussion section below)	
Who will certify construction of this BMP? Provide name and contact information for the party responsible to sign BMP verification forms if required by the [City Engineer] (See Section 1.12 of the BMP Design Manual)	
Who will be the final owner of this BMP?	All Right Storage Inc.
Who will maintain this BMP into perpetuity?	All Right Storage Inc.
What is the funding mechanism for maintenance?	Private

Form I-6 Page 4 of X (Copy as many as needed) , Form Template Date: August 31, 2015
Structural BMP ID No.
Construction Plan Sheet No.
Discussion (as needed):

ATTACHMENT 1
BACKUP FOR PDP POLLUTANT CONTROL BMPS

This is the cover sheet for Attachment 1.

Indicate which Items are Included behind this cover sheet:

Attachment Sequence	**Contents**	**Checklist**
Attachment 1a	DMA Exhibit (Required) See DMA Exhibit Checklist on the back of this Attachment cover sheet.	☑ Included
Attachment 1b	Tabular Summary of DMAs Showing DMA ID matching DMA Exhibit, DMA Area, and DMA Type (Required)* *Provide table in this Attachment OR on DMA Exhibit in Attachment 1a	☑ Included on DMA Exhibit in Attachment 1a ☐ Included as Attachment 1b, separate from DMA Exhibit
Attachment 1c	Form I-7, Harvest and Use Feasibility Screening Checklist (Required unless the entire project will use infiltration BMPs) Refer to Appendix B.3-1 of the BMP Design Manual to complete Form I-7.	☑ Included ☐ Not included because the entire project will use infiltration BMPs
Attachment 1d	Form I-8, Categorization of Infiltration Feasibility Condition (Required unless the project will use harvest and use BMPs) Refer to Appendices C and D of the BMP Design Manual to complete Form I-8.	☑ Included ☐ Not included because the entire project will use harvest and use BMPs
Attachment 1e	Pollutant Control BMP Design Worksheets / Calculations (Required) Refer to Appendices B and E of the BMP Design Manual for structural pollutant control BMP design guidelines	☑ Included

Use this checklist to ensure the required information has been included on the DMA Exhibit:

The DMA Exhibit must identify:

☑ Underlying hydrologic soil group

☑ Approximate depth to groundwater

☑ Existing natural hydrologic features (watercourses, seeps, springs, wetlands)

☑ Critical coarse sediment yield areas to be protected

☑ Existing topography and impervious areas

☑ Existing and proposed site drainage network and connections to drainage offsite

☑ Proposed demolition

☑ Proposed grading

☑ Proposed impervious features

☑ Proposed design features and surface treatments used to minimize imperviousness

☑ Drainage management area (DMA) boundaries, DMA ID numbers, and DMA areas (square footage or acreage), and DMA type (i.e., drains to BMP, self-retaining, or self-mitigating)

☑ Potential pollutant source areas and corresponding required source controls (see Chapter 4, Appendix E.1, and Form I-3B)

☑ Structural BMPs (identify location, type of BMP, and size/detail)

ATTACHMENT 1a

SOURCE CONTROL BMPs

1. SC-1 EFFECTIVE IRRIGATION IMPLEMENTED TO PREVENT ILLEGAL DISCHARGE INTO THE STORM WATER CONVEYANCE SYSTEM
2. SC-2 INLET STENCILING ON ALL CATCH BASINS USED TO IDENTIFY THE STORM DRAIN SYSTEM
3. SC-5 TRASH ENCLOSURE DESIGNED TO PROTECT THE TRASH STORAGE AREA FROM RAINFALL, RUN-ON, RUNOFF AND WIND DISPERSAL
4. SC-6 ON SITE STORM DRAIN INLET PROTECTION
5. SC-6 SIDEWALK & PARKING LOT CLEANING
6. SC-6 MINIMIZE PESTICIDE USE WITHIN LANDSCAPE AREA

SITE DESIGN BMPs

1. SD-3 PARKING AND DRIVING AISLES ARE DESIGNED TO THE MINIMUM REQUIRED TO MINIMIZE IMPERVIOUS AREAS
2. SD-7 LANDSCAPING WITH NATIVE OR DROUGHT TOLERANCE SPECIES

LEGEND

- CONCRETE SURFACE
- PERVIOUS SURFACE
- ROOF SURFACE (PHASE 1)
- ROOF SURFACE (PHASE 2)

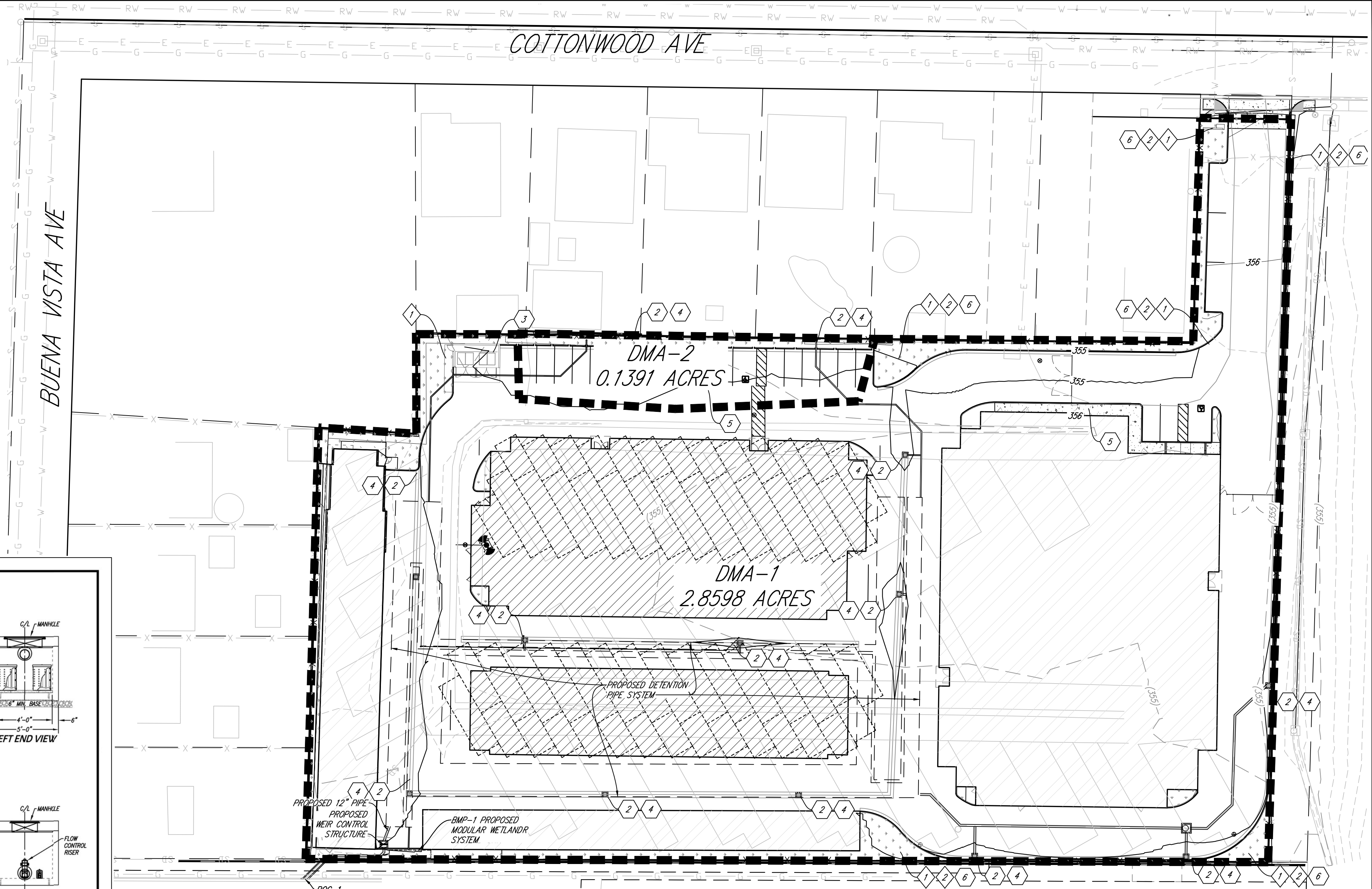
DRAINAGE MANAGEMENT CALCULATIONS

DMA ID	DMA TYPE	DRAINS TO BMP	POC	ROOF (SQFT)	CONCRETE (SQFT)	LANDSCAPE (SQFT)	TOTAL (SQFT)	TOTAL (ACRE)	%IMP (%)	DEPTH TO GROUND WATER (FT)	UNDERLYING SOIL TYPE
DMA-1	DRAINS TO BMP	BMP-1	POC-1	61375	56511	7118	125005	2.8700	94	>20 FT	D
DMA-2	DRAINS TO BMP	BMP-1	POC-1	0	5220	837	6057	0.1400	86	>20 FT	D

NOTE
NO CRITICAL COARSE SEDIMENT YIELD AREAS ON-SITE OR CONVEYED FROM OFF-SITE TO ON-SITE

BIO-BASIN SUMMARY TABLE

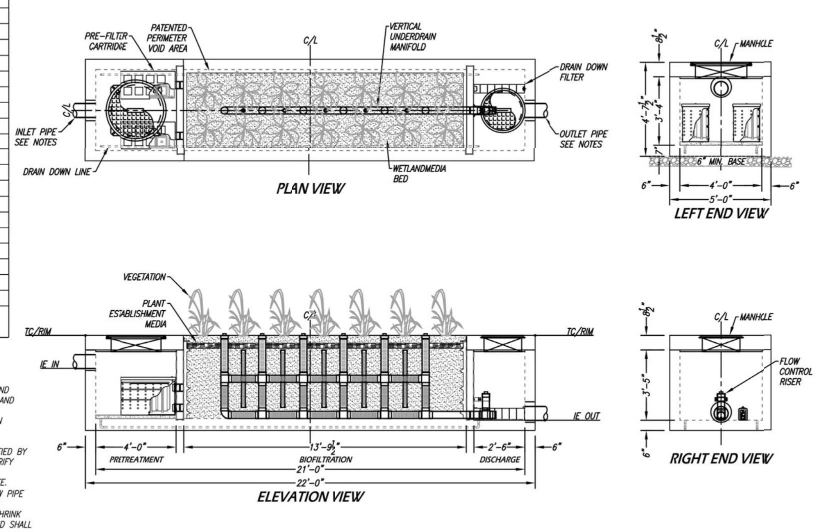
BMP ID	BMP TYPE	REQUIRED DCV (CUFT)	BMP STORAGE VOLUME (CUFT)	BMP MODEL
BMP - 1	BF-3	7998	45542	MWS-L-4-21-V



SCALE: 1"=30'
0 30 60 90 120

SITE SPECIFIC DATA

PROJECT NAME		Alright Self Storage	
PROJECT LOCATION		Cottonwood Ave	
STRUCTURE ID		MWS	
TREATMENT REQUIRED			
VOLUME BASED (CF)		FLOW BASED (CFS)	
7998			
TREATMENT HGL AVAILABLE (FT)			354.5
PEAK BYPASS REQUIRED (CFS) – IF APPLICABLE			
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	348.93	HDPE	6"
INLET PIPE 2		HDPE	
OUTLET PIPE	347.93	HDPE	4"
	PRETREATMENT	BIOFILTRATION	DISCHARGE
RIM ELEVATION	354.5	354.5	354.5
SURFACE LOAD	PARKWAY	OPEN PLANTER	PARKWAY
FRAME & COVER	ø30"	N/A	ø24"
WETLANDMEDIA VOLUME (CY)			7.63
WETLANDMEDIA DELIVERY METHOD			TBD
ORIFICE SIZE (DIA. INCHES)			ø1.08"
MAXIMUM PICK WEIGHT (LBS)			43000
NOTES:			



INSTALLATION NOTES

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

GENERAL NOTES

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

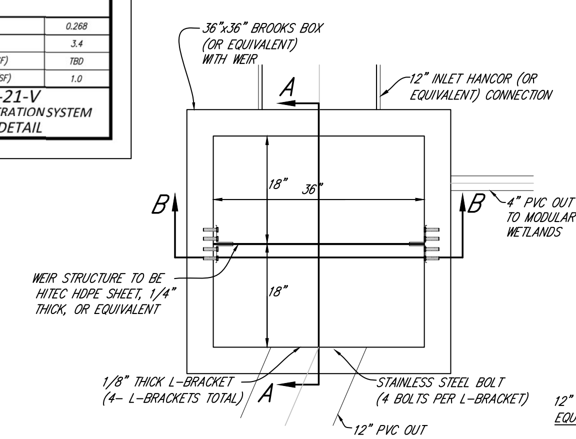
TREATMENT FLOW (CFS)	0.268
OPERATING HEAD (FT)	3.4
PRETREATMENT LOADING RATE (GPM/SF)	TBD
WETLAND MEDIA LOADING RATE (GPM/SF)	1.0

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

PROPRIETARY AND CONFIDENTIAL:
THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF MODULAR WETLANDS SYSTEMS. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF MODULAR WETLANDS SYSTEMS IS PROHIBITED.

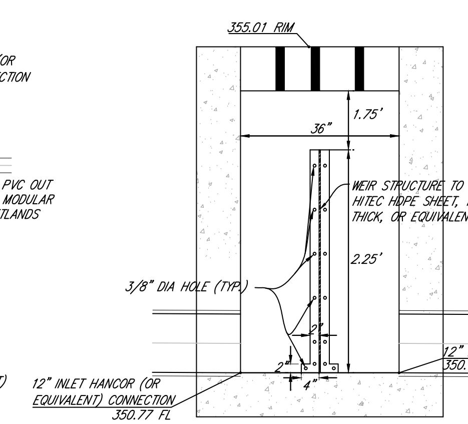
MODULAR WETLANDS
www.ModularWetlands.com | (855) 5MOD-WET

MWS-L-4-21-V
STORMWATER BIOFILTRATION SYSTEM STANDARD DETAIL

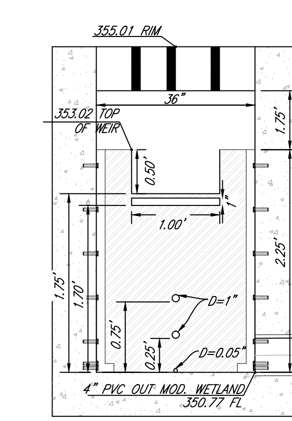


WEIR CONTROL STRUCTURE PLAN VIEW (SEE SHEET 1)
NOT TO SCALE

WEIR CONTROL NOTE:
THE PURPOSE OF THIS STRUCTURE IS FOR DETENTION FOR WATER QUALITY AND HYDROMODIFICATION FLOW CONTROL SEPARATE FROM TYPICAL BIOFILTRATION FLOW MODELING.



SECTION A-A
NOT TO SCALE



SECTION B-B
NOT TO SCALE

WEIR CONTROL STRUCTURE DETAIL
NOT TO SCALE

ENGINEER OF WORK
EXCEL ENGINEERING
LAND PLANNING • ENGINEERING • SURVEYING
440 STATE PLACE, ESCONDIDO, CA 92029
PH (760)745-8118 FAX (760)745-1890
ROBERT D. DENTINO
RCE: 45629 EXP:12/31/20

February 20, 2020
DATE

ALL RIGHT SELF-STORAGE
PROPOSED DMA EXHIBIT

V:\18\18005\Engineering\SDP\Storm-SDP\SWQMP\Attachment\Attachment 1\18005_DMA.dwg 3/4/2020 10:56 AM ORIGINAL PLOT SIZE: -----

ATTACHMENT 1b

Design Capture Volume		Worksheet B-2.1			
1	85th percentile 24-hr storm depth from Figure B.1-1	d=	0.58	0.58	inches
2	Area tributary to BMP (s)	A=	2.86	0.14	Acres
3	Area weighted runoff factor (estimate using Appendix B.1.1 and B.2.1)	C=	0.85	0.73	unitless
4	Street trees volume reduction	TCV=			cubic-feet
5	Rain barrels volume reduction	RCV=			cubic-feet
6	Calculate DCV= (3630 x C x d x A) - TCV -RCV	DCV=	5,118.00	214.00	cubic-feet
	1.5*DCV=Volume needed	(1.5*5118) = 7677		(1.5*214) = 321	cubic-feet

ATTACHMENT 1c

Harvest and Use Feasibility Checklist :		**Form I-7**
1. Is there a demand for harvested water (check all that apply) at the project site that is reliably present during the wet season? ✔ Toilet and urinal flushing ✔ Landscape irrigation Other:_____		
2. If there is a demand; estimate the anticipated average wet season demand over a period of 36 hours. Guidance for planning level demand calculations for toilet/urinal flushing and landscape irrigation is provided in Section B.3.2. Flushing: (371 employees)x(9.3 gal/emp) = 3,450 gallons ⇨(3,450 gal)(1.5 days)/(7.48 gal/cu. ft.)=692 cu. ft. Irrigation: 36-hr Mod. Water per Table B.3-3 = (1,470 gal days/acre)(0.60acres)/(7.48 gal/cu feet) = 1651 cu ft. Total Demand = 2,343 cu. ft.		
3. Calculate the DCV using worksheet B.2-1. DCV =__13,138____(cubic feet)		
3a. Is the 36 hour demand greater than or equal to the DCV? Yes / No ⇨	3b. Is the 36 hour demand greater than 0.25DCV but less than the full DCV? Yes / No ⇨	3c. Is the 36 hour demand less than 0.25DCV? Yes ⇩
Harvest and use appears to be feasible. Conduct more detailed evaluation and sizing calculations to confirm that DCV can be used at an adequate rate to meet drawdown criteria.	Harvest and use may be feasible. Conduct more detailed evaluation and sizing calculations to determine feasibility. Harvest and use may only be able to be used for a portion of the site, or (optionally) the storage may need to be upsized to meet long term capture targets while draining in longer than 36 hours.	Harvest and use is considered to be infeasible.
Is harvest and use feasible based on further evaluation? Yes, refer to Appendix E to select and size harvest and use BMPs. ✔ No, select alternate BMPs.		

ATTACHMENT 1d

Categorization of Infiltration Feasibility Condition		Form I-8	
Part 1 - Full Infiltration Feasibility Screening Criteria **Would infiltration of the full design volume be feasible from a physical perspective without any undesirable consequences that cannot be reasonably mitigated?**			
Criteria	Screening Question	Yes	No
1	**Is the estimated reliable infiltration rate below proposed facility locations greater than 0.5 inches per hour?** The response to this Screening Question shall be based on a comprehensive evaluation of the factors presented in Appendix C.2 and Appendix D.		X
Provide basis: The infiltration test results on the site at locations (INF-1 and INF-2) revealed infiltration rates ranging from 0.000 to 0.031 inches per hour, with a minimum factor of safety of 2 applied at both locations. Simple open pit testing was performed at 2 locations on the site in accordance with Appendix D of the City of Santee BMP design manual. In addition, a comprehensive evaluation of the site was conducted in accordance with Appendix C.2. Please refer to our report "Update Geotechnical Investigation and Infiltration Testing", dated March 28, 2018 for details of the comprehensive evaluation and investigation conducted, simple open pit test rates and simple open pit rate to infiltration rate calculations and maps representative of the study. Summarize findings of studies; provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability.			
2	**Can infiltration greater than 0.5 inches per hour be allowed without increasing risk of geotechnical hazards (slope stability, groundwater mounding, utilities, or other factors) that cannot be mitigated to an acceptable level?** The response to this Screening Question shall be based on a comprehensive evaluation of the factors presented in Appendix C.2.		X
Provide basis: Our infiltration test results on the site revealed inifiltration rates ranging from 0.000 to 0.031 inches per hour with a minimum factor of safety of 2 applied. Infiltration rates greater than 0.5 inches per hour were not encountered, therefore, the question is not applicable. Please refer to our report "Update Geotechnical Investigation and Infiltration Testing", dated March 28, 2018 for details of the comprehensive evaluation and investigation conducted, simple open pit test rates and simple open pit rate to infiltration rate calculations and maps representative of the study. Summarize findings of studies; provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability.			

"X" filled in by Excel Engineering

<table>
<tr><th colspan="4">Form I-8 Page 2 of 4</th></tr>
<tr><th>Criteria</th><th>Screening Question</th><th>Yes</th><th>No</th></tr>
<tr><td>3</td><td>Can infiltration greater than 0.5 inches per hour be allowed without increasing risk of groundwater contamination (shallow water table, storm water pollutants or other factors) that cannot be mitigated to an acceptable level? The response to this Screening Question shall be based on a comprehensive evaluation of the factors presented in Appendix C.3.</td><td></td><td>X</td></tr>
<tr><td colspan="4">Provide basis:
Our infiltration test results on the site revealed inifiltration rates ranging from 0.000 to 0.031 inches per hour with a minimum factor of safety of 2 applied. Infiltration rates greater than 0.5 inches per hour were not encountered, therefore, the question is not applicable.
Please refer to our report "Update Geotechnical Investigation and Infiltration Testing", dated March 28, 2018 for details of the comprehensive evaluation and investigation conducted, simple open pit test rates and simple open pit rate to infiltration rate calculations and maps representative of the study.

Summarize findings of studies; provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability.</td></tr>
<tr><td>4</td><td>Can infiltration greater than 0.5 inches per hour be allowed without causing potential water balance issues such as change of seasonality of ephemeral streams or increased discharge of contaminated groundwater to surface waters? The response to this Screening Question shall be based on a comprehensive evaluation of the factors presented in Appendix C.3.</td><td></td><td>X</td></tr>
<tr><td colspan="4">Provide basis:
Question to be answered by the design engineer.

Summarize findings of studies; provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability.</td></tr>
<tr><td>Part 1 Result *</td><td colspan="2">If all answers to rows 1 - 4 are "Yes" a full infiltration design is potentially feasible. The feasibility screening category is Full Infiltration

If any answer from row 1-4 is "No", infiltration may be possible to some extent but would not generally be feasible or desirable to achieve a "full infiltration" design. Proceed to Part 2</td><td>NO</td></tr>
</table>

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

"X" filled in by Excel Engineering

Form I-8 Page 3 of 4

Part 2 – Partial Infiltration vs. No Infiltration Feasibility Screening Criteria

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

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

Provide basis:

Our infiltration test results on the site revealed inifiltration rates ranging from 0.000 to 0.031 inches per hour with a minimum factor of safety of 2 applied. Based on our infiltration test rates and limited geotechnical investigation of the site, it is our opinion that the soil and geologic conditions do not allow for appreciable infiltration rates.
Please refer to our report "Update Geotechnical Investigation and Infiltration Testing", dated March 28, 2018 for details of the comprehensive evaluation and investigation conducted, simple open pit test rates and simple open pit rate to infiltration rate calculations and maps representative of the study.

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

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

Provide basis:

Our infiltration test results on the site revealed inifiltration rates ranging from 0.000 to 0.031 inches per hour with a minimum factor of safety of 2 applied. Appreciable infiltration rates were not encountered at either test location, therefore, the question is not applicable.
Please refer to our report "Update Geotechnical Investigation and Infiltration Testing", dated March 28, 2018 for details of the comprehensive evaluation and investigation conducted, simple open pit test rates and simple open pit rate to infiltration rate calculations and maps representative of the study.

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

"X" filled in by Excel Engineering

Form I-8 Page 4 of 4			
Criteria	Screening Question	Yes	No
7	**Can Infiltration in any appreciable quantity be allowed without posing significant risk for groundwater related concerns (shallow water table, storm water pollutants or other factors)?** The response to this Screening Question shall be based on a comprehensive evaluation of the factors presented in Appendix C.3.		X

Provide basis:

Our infiltration test results on the site revealed inifiltration rates ranging from 0.000 to 0.031 inches per hour with a minimum factor of safety of 2 applied. Appreciable infiltration rates were not encountered at either test location, therefore, the question is not applicable.
Please refer to our report "Update Geotechnical Investigation and Infiltration Testing", dated March 28, 2018 for details of the comprehensive evaluation and investigation conducted, simple open pit test rates and simple open pit rate to infiltration rate calculations and maps representative of the study.

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

8	**Can infiltration be allowed without violating downstream water rights?** The response to this Screening Question shall be based on a comprehensive evaluation of the factors presented in Appendix C.3.		X

Provide basis:

Question to be answered by the design engineer.

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

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

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

"X" filled in by Excel Engineering

Geotechnical Exploration, Inc.
SOIL AND FOUNDATION ENGINEERING • GROUNDWATER • ENGINEERING GEOLOGY

28 March 2018

All Right Storage, Inc.
11300 Sorrento Valley Road, Suite 250
San Diego, CA 92121
Attn: Mr. Olivier Andreu

Job No. 14-10558.1

Subject: **Update Geotechnical Investigation and Infiltration Testing**
Cottonwood Self Storage Project
Northwest of State Route 52 and Cottonwood Ave
Santee, California
APN Nos. 383-112-05-00 and 28-00

Dear Mr. Andreu:

In accordance with your request, ***Geotechnical Exploration, Inc.*** has performed an update geotechnical investigation and infiltration testing for the subject project (see Vicinity Map, Figure No. I). We previously performed a preliminary geotechnical investigation for a previously planned project at the site, the results of which were presented in our report dated July 10, 2014. It is our understanding, based on preliminary plans provided to us, that the presently proposed development of the currently vacant 6-acre site will include 3 single-story and 2 three-story self storage buildings with pavements and other associated improvements (see Figure Nos. II and III). The objectives of this update investigation were to evaluate the depth of existing undocumented fill soils along the western and northern property boundaries and to provide supplemental grading and foundation recommendations as needed. The objective of the infiltration testing was to evaluate the subsurface soil infiltration rates in an area that may be used for an infiltration basin.

SCOPE OF SERVICES

Based on the above information, the update geotechnical investigation and infiltration testing consisted of the following:

1. A field subsurface exploration program which consisted of the excavation of six exploratory test pits along the western and northern property boundaries and near the northeast corner of the property to evaluate the depth of existing undocumented fills that require removal and recompaction. The work was performed under the direction of our geologist who supervised, logged and sampled the excavations. In addition, two exploratory excavations were made to perform infiltration testing in a potential area for a storm water infiltration basin. The proposed infiltration testing was conducted in accordance with the City of Santee BMP Design Manual, Appendix C (Geotechnical and Groundwater Investigation Requirements) and Appendix D (Approved Infiltration Rate Assessment Methods).

2. Laboratory testing of samples obtained from the excavations to assist in classification of the materials and to help evaluate the index, strength, compressibility, and expansion properties of the soils encountered.

3. Geotechnical engineering analysis and evaluation of the resulting field and laboratory test data.

4. Preparation of this update geotechnical investigation report presenting the results of our study along with updated design and construction recommendations for the site grading, building foundations, and slab on-

grade construction as warranted. In addition, our infiltration rate findings are provided.

FIELD INVESTIGATION

The field investigation consisted of a surface reconnaissance and a subsurface exploration program using a rubber tired backhoe to investigate and sample the subsurface soils. On March 7, 2018, five exploratory test pits were excavated along the western and northern property boundaries where single-story buildings are planned close to those boundaries, and one exploratory test pit was excavated near the northeast corner of the property where a boring for the previous investigation (Boring B-2) had encountered debris-laden fill to a depth of about 8 feet. The test pits were excavated to a maximum depth of 5 feet. The soils encountered in the exploratory excavations were continuously logged in the field by our geologist and described in accordance with the Unified Soil Classification System (refer to Appendix A). The approximate locations of the exploratory excavations are shown on the Plot Plan, Figure No. IV.

In addition, two exploratory excavations were also made on March 7, 2018, to a maximum depth of 6½ feet in order to perform infiltration testing.

Representative samples were obtained from the exploratory excavations at selected depths appropriate to the investigation. All samples were returned to our laboratory for evaluation and testing.

Exploratory excavation logs have been prepared on the basis of our observations and laboratory test results. Logs of the exploratory test pits and infiltration testing excavations are attached as Figure Nos. Va-h.

SOIL DESCRIPTION

Existing fill soils consisting of loose to medium dense clayey sands were encountered in exploratory Test Pits 1 through 5 to depths of 1 to 3 feet. In Test Pit 6, the fill soils extended to a depth of 4 feet. Existing fill soils, consisting of loose to medium dense clayey sands were also encountered in the infiltration excavations to a depth of 2 feet. The fill soils encountered in Test Pits 1 through 3 appear to be retaining wall backfill along the western property boundary and it appears that the retaining wall is founded on older alluvial soils. The materials encountered beneath the fill soils in all of the exploratory excavations consisted of older alluvial materials, comprised of dense silty and clayey sands, to the maximum depth explored of 6½ feet.

The exploratory test pit and infiltration excavation logs and related information depict subsurface conditions only at the specific locations shown on the site plan and on the particular date designated on the logs. Subsurface conditions at other locations may differ from conditions occurring at these locations. Also, the passage of time may result in changes in the subsurface conditions due to environmental changes.

CONCLUSIONS AND RECOMMENDATIONS

Based on review of our previous investigation at the site, as well as the presently proposed development plans, it is our opinion that the conclusions and recommendations presented in our previous preliminary geotechnical investigation report dated July 10, 2014, remain applicable for the proposed site development with the following exceptions.

1. *Building Pad Grading:* We recommend that the grading for the building pads consist of removal and recompaction of the existing fill soils or to a depth of 3 feet below the pad subgrade levels, whichever is deeper.

2. *Building Foundations:* It is our understanding that the proposed buildings will be supported on mat foundations rather than shallow footing foundations. We recommend that a subgrade modulus (K_{v1}) of 160 tons per cubic foot be used for the mat designs.

3. *Seismic Design:* The seismic design parameters presented in our 2014 report cited the 2013 CBC and the presently proposed project will be constructed in accordance with the 2016 CBC. In that the 2013 and 2016 CBC both utilize ASCE 7-10 for the determination of seismic design parameters, the previously presented parameters remain applicable.

INFILTRATION TESTING

We performed simple open pit falling head testing at two locations on the property at depths of 78 inches at INF-1, and 54 inches at INF-2. Falling head measurements were collected at regular time intervals for a period of 3 hours. The tests were performed per the requirements of the City of Santee Storm Water Standards, BMP Design Manual, in accordance with Appendix D. Both tests were performed in the older alluvial materials underlying the site at shallow depths. Laboratory test results at infiltration test locations INF-1 and INF-2, indicate 42 percent and 56 percent of the soils passed the #200 sieve, respectively.

Testing at location INF-1 revealed a falling head rate of 480 minutes/inch. The testing at INF-2 showed no measurable head drop in the last hour. The simple open pit falling head test rate results for INF-1 and INF-2 have been converted to infiltration rates using the Porchet Method and indicate infiltration rates of 0.062- and 0.000-inch/hour, respectively, without a factor of safety applied. Refer to Appendix A for the simple open pit test rate results and simple open pit to infiltration rate calculations. Review of the USDA Web Soil Survey Map indicates the site has been assigned to hydrologic soil group (HSG) D. Refer to Appendix B for USDA Web Soil Survey Map.

Based on the results of our simple open pit falling head testing and evaluation of the infiltration rates, it is our professional opinion that the site is not suitable for infiltration BMPs. We also recommend that any bio remediation features be lined with an impermeable liner and drained to the storm drain system.

Our services consist of professional opinions and recommendations made in accordance with generally accepted geotechnical engineering principles and practices. This warranty is in lieu of all other warranties either expressed or implied.

This opportunity to be of service is sincerely appreciated. If you have any questions concerning this matter, please contact our office. Reference to our **Job No. 14-10558.1** will help to expedite a response to your inquiries.

Respectfully submitted,

GEOTECHNICAL EXPLORATION, INC.

Wm. D. Hespeler, G.E. 396
Senior Geotechnical Engineer

REGISTERED PROFESSIONAL ENGINEER
WM. DAVID HESPELER
No. 396
Exp. 3/31/20
GEOTECHNICAL
STATE OF CALIFORNIA

VICINITY MAP

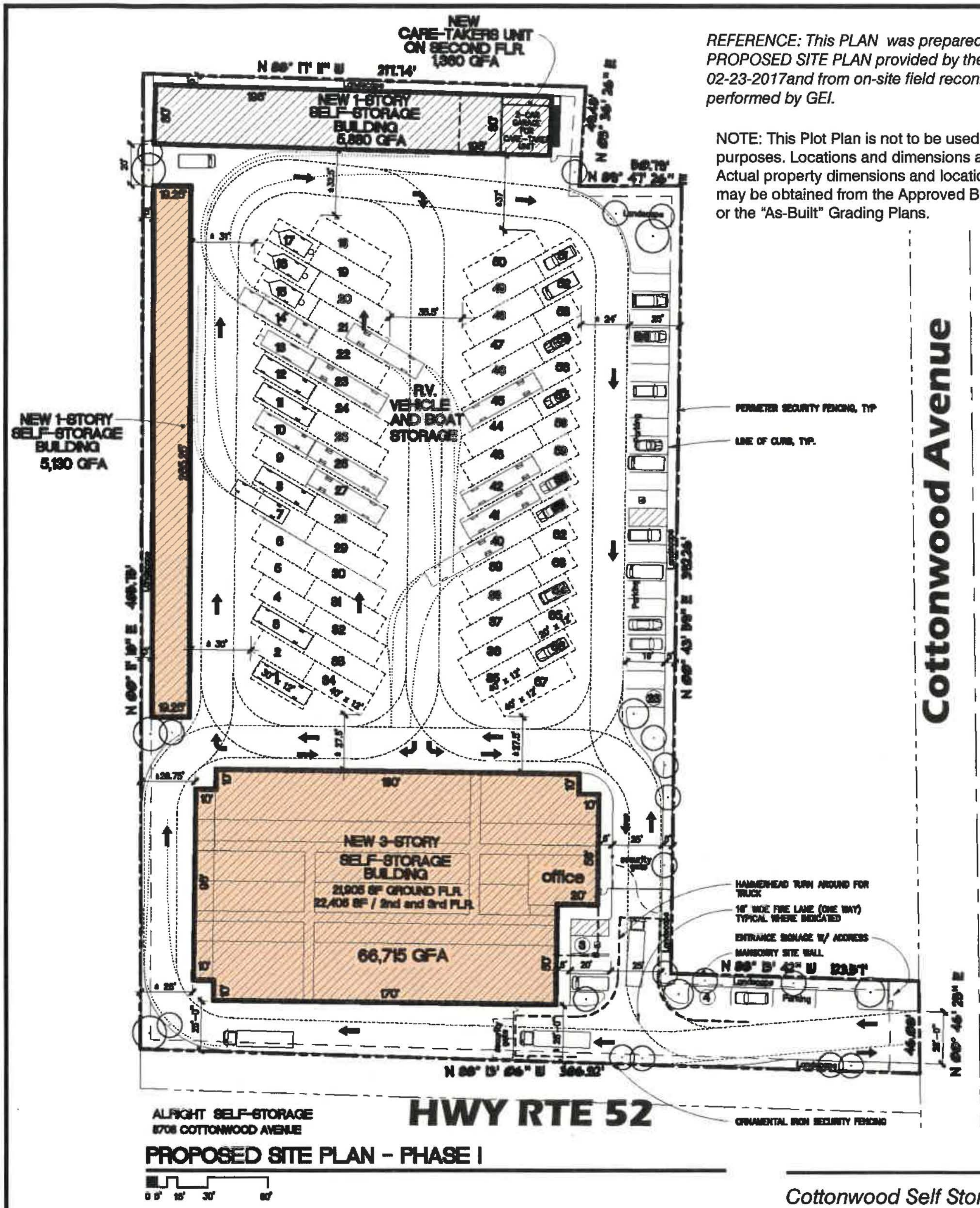
Thomas Bros Guide San Diego County pg 1231-E7

Cottonwood Self Storage
Northwest of State Route 52 and Cottonwood Avenue
Santee, CA.

Figure No. I
Job No. 14-10558.1

REFERENCE: This PLAN was prepared from an existing PROPOSED SITE PLAN provided by the client dated 02-23-2017and from on-site field reconnaissance performed by GEI.

NOTE: This Plot Plan is not to be used for legal purposes. Locations and dimensions are approximate. Actual property dimensions and locations of utilities may be obtained from the Approved Building Plans or the "As-Built" Grading Plans.



Scale (approximate)

PHAZE 1

SITE DEVELOPMENT PLAN

Cottonwood Self Storage
Northwest of State Route 52
and Cottonwood Avenue
Santee, CA.
Figure No. II
Job No. 14-10558.1

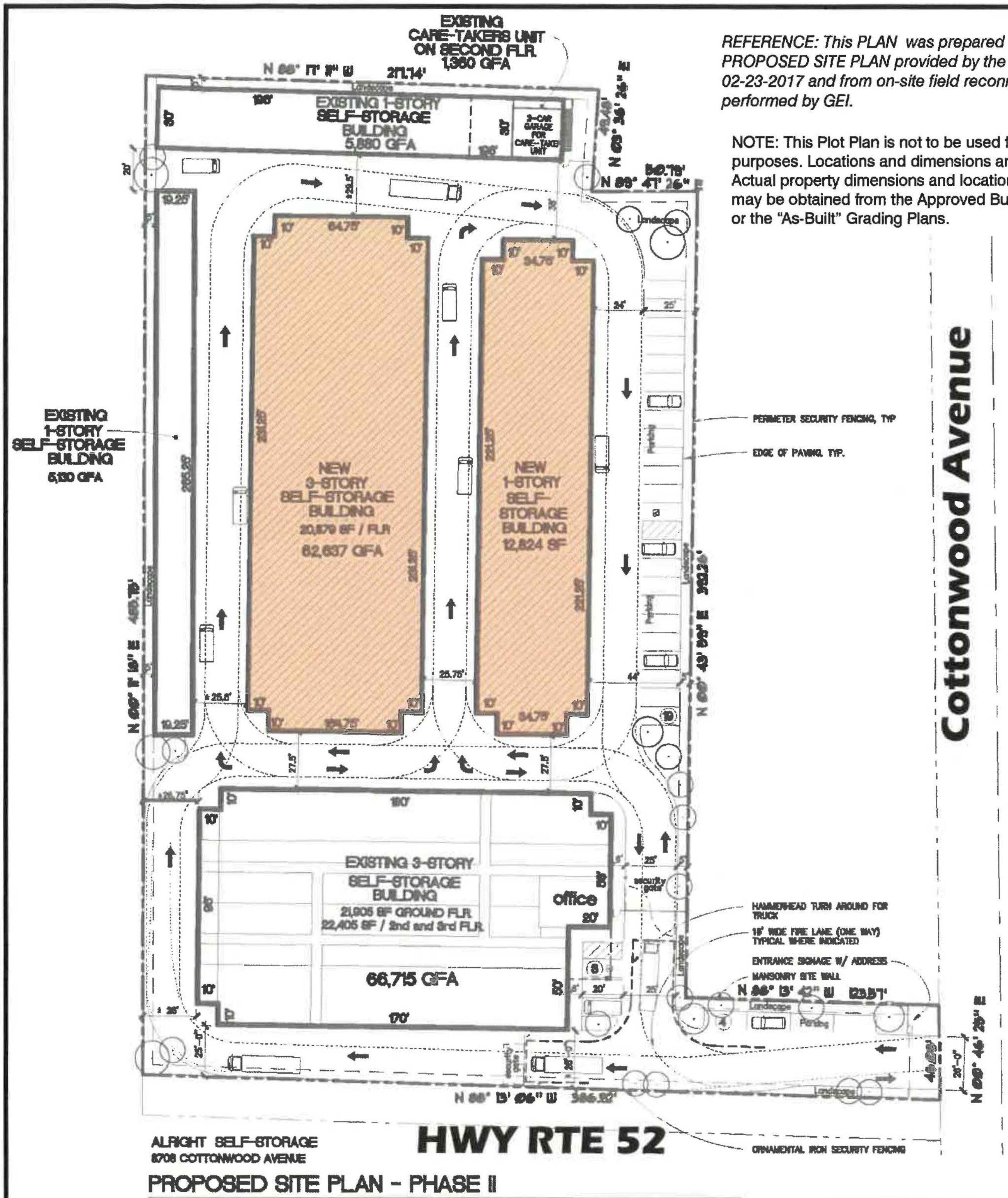
Geotechnical Exploration, Inc.

March 2018

14-10558.1-P1.ai

REFERENCE: This PLAN was prepared from an existing PROPOSED SITE PLAN provided by the client dated 02-23-2017 and from on-site field reconnaissance performed by GEI.

NOTE: This Plot Plan is not to be used for legal purposes. Locations and dimensions are approximate. Actual property dimensions and locations of utilities may be obtained from the Approved Building Plans or the "As-Built" Grading Plans.



ALRIGHT SELF-STORAGE
8708 COTTONWOOD AVENUE

PROPOSED SITE PLAN - PHASE II

0 5' 15' 30' 60'

Scale (approximate)

PHAZE 2

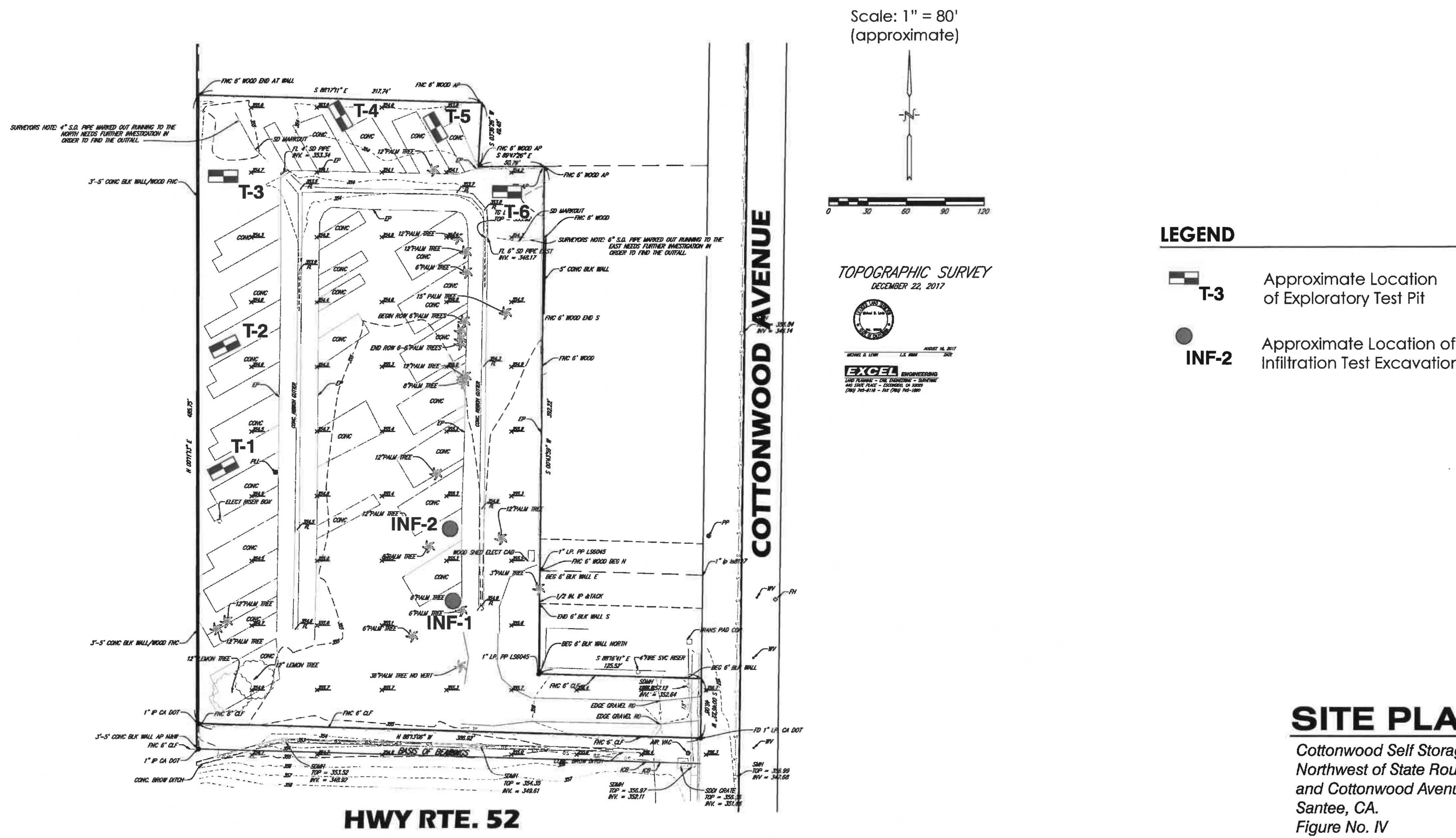
SITE DEVELOPMENT PLAN

Cottonwood Self Storage
Northwest of State Route 52
and Cottonwood Avenue
Santee, CA.
Figure No. III
Job No. 14-10558.1

Geotechnical Exploration, Inc.

March 2018

14-10558.1-P2.ai



SITE PLAN

Cottonwood Self Storage
Northwest of State Route 22
and Cottonwood Avenue
Santee, CA.
Figure No. IV
Job No. 14-10558.1

Geotechnical Exploration, Inc.

(March 2018)

NOTE: This Plot Plan is not to be used for legal purposes. Locations and dimensions are approximate. Actual property dimensions and locations of utilities may be obtained from the Approved Building Plans or the "As-Built" Grading Plans.

REFERENCE: This Plot Plan was prepared from an existing TOPOGRAPHIC SURVEY provided by EXCEL ENGINEERING dated December 22, 2017 and from on-site field reconnaissance performed by GEI.

14-10558.1-P-III.ai

EQUIPMENT	DIMENSION & TYPE OF EXCAVATION	DATE LOGGED
Rubber-tire Backhoe	**12' X 2' X 4' Trench**	**3-7-18**
SURFACE ELEVATION	GROUNDWATER/ SEEPAGE DEPTH	LOGGED BY
± 354.5' Mean Sea Level	**Not Encountered**	**JAB**

DEPTH (feet)	SYMBOL	SAMPLE	FIELD DESCRIPTION AND CLASSIFICATION — DESCRIPTION AND REMARKS (Grain size, Density, Moisture, Color)	U.S.C.S.	IN-PLACE MOISTURE (%)	IN-PLACE DRY DENSITY (pcf)	OPTIMUM MOISTURE (%)	MAXIMUM DRY DENSITY (pcf)	DENSITY (% of M.D.D.)	EXPAN. + CONSOL. - (%)	BLOW COUNTS/FT.	SAMPLE O.D. (INCHES)
0–1.5			**CLAYEY SAND** , fine- to medium-grained, some glass and concrete debris. Loose to medium dense. Moist. Dark red-brown. **FILL (Qaf)**	SC								
1.5–2.5			**SILTY SAND** , fine- to medium-grained. Medium dense. Slightly moist. Light brown. **OLDER ALLUVIUM (Qoa)**	SM								
2.5–4			**CLAYEY SAND** , fine- to medium-grained. Dense. Moist. Dark red-brown. **OLDER ALLUVIUM (Qoa)**	SC								
4			Bottom @ 4'									

Depth scale: 1, 2, 3, 4, 5

PERCHED WATER TABLE	JOB NAME **Cottonwood Self Storage Project**		
BULK BAG SAMPLE	SITE LOCATION **NW of SR 52 and Cottonwood Ave., Santee, CA**		
1 IN-PLACE SAMPLE	JOB NUMBER **14-10558.1**	REVIEWED BY **JAB/WDH**	LOG No. **T-1**
MODIFIED CALIFORNIA SAMPLE		Geotechnical Exploration, Inc.	
S NUCLEAR FIELD DENSITY TEST	FIGURE NUMBER **Va**		
STANDARD PENETRATION TEST			

EQUIPMENT	DIMENSION & TYPE OF EXCAVATION	DATE LOGGED
Rubber-tire Backhoe	**12' X 2' X 4' Trench**	**3-7-18**
SURFACE ELEVATION	GROUNDWATER/ SEEPAGE DEPTH	LOGGED BY
± 354.5' Mean Sea Level	**Not Encountered**	**JAB**

DEPTH (feet)	SYMBOL	SAMPLE	FIELD DESCRIPTION AND CLASSIFICATION: DESCRIPTION AND REMARKS (Grain size, Density, Moisture, Color)	U.S.C.S.	IN-PLACE MOISTURE (%)	IN-PLACE DRY DENSITY (pcf)	OPTIMUM MOISTURE (%)	MAXIMUM DRY DENSITY (pcf)	DENSITY (% of M.D.D.)	EXPAN. + CONSOL. - (%)	BLOW COUNTS/FT.	SAMPLE O.D. (INCHES)
0–2			**CLAYEY SAND** , fine- to medium-grained, some glass, brick, tile and concrete debris. Loose to medium dense. Moist. Dark red-brown. **FILL (Qaf)** -- @2'- electric, water and sewer throughout trench.	SC								
2–4			**CLAYEY SAND** , fine- to medium-grained. Dense. Slightly moist to moist. Dark red-brown. **OLDER ALLUVIUM (Qoa)**	SC								
4			Bottom @ 4'									

- PERCHED WATER TABLE
- BULK BAG SAMPLE
- 1 IN-PLACE SAMPLE
- MODIFIED CALIFORNIA SAMPLE
- S NUCLEAR FIELD DENSITY TEST
- STANDARD PENETRATION TEST

JOB NAME
Cottonwood Self Storage Project

SITE LOCATION
NW of SR 52 and Cottonwood Ave., Santee, CA

JOB NUMBER	REVIEWED BY	LOG No.
14-10558.1	**JAB/WDH**	**T-2**
FIGURE NUMBER	Geotechnical Exploration, Inc.	
Vb		

EQUIPMENT	DIMENSION & TYPE OF EXCAVATION	DATE LOGGED
Rubber-tire Backhoe	**12' X 2' X 4' Trench**	**3-7-18**
SURFACE ELEVATION	GROUNDWATER/ SEEPAGE DEPTH	LOGGED BY
± 354.5' Mean Sea Level	**Not Encountered**	**JAB**

DEPTH (feet)	SYMBOL	SAMPLE	FIELD DESCRIPTION AND CLASSIFICATION — DESCRIPTION AND REMARKS (Grain size, Density, Moisture, Color)	U.S.C.S.	IN-PLACE MOISTURE (%)	IN-PLACE DRY DENSITY (pcf)	OPTIMUM MOISTURE (%)	MAXIMUM DRY DENSITY (pcf)	DENSITY (% of M.D.D.)	EXPAN. + CONSOL. - (%)	BLOW COUNTS/FT.	SAMPLE O.D. (INCHES)
0–2			**CLAYEY SAND**, fine- to medium-grained, some roots. Loose to medium dense. Moist. Dark red-brown. **FILL (Qaf)** -- electrical conduit on west end of trench.	SC								
2–4			**CLAYEY SAND**, fine- to medium-grained, some caliche. Dense. Slightly moist to moist. Dark red-brown. **OLDER ALLUVIUM (Qoa)**	SC								
4			Bottom @ 4'									

Depth scale: 1, 2, 3, 4, 5

▼	PERCHED WATER TABLE
☒	BULK BAG SAMPLE
1	IN-PLACE SAMPLE
■	MODIFIED CALIFORNIA SAMPLE
S	NUCLEAR FIELD DENSITY TEST
▨	STANDARD PENETRATION TEST

JOB NAME: **Cottonwood Self Storage Project**		
SITE LOCATION: **NW of SR 52 and Cottonwood Ave., Santee, CA**		
JOB NUMBER: **14-10558.1**	REVIEWED BY: **JAB/WDH**	LOG No. **T-3**
FIGURE NUMBER: **Vc**	Geotechnical Exploration, Inc.	

EQUIPMENT	DIMENSION & TYPE OF EXCAVATION	DATE LOGGED
Rubber-tire Backhoe	**10' X 2' X 4' Trench**	**3-7-18**
SURFACE ELEVATION	GROUNDWATER/ SEEPAGE DEPTH	LOGGED BY
± 354' Mean Sea Level	**Not Encountered**	**JAB**

DEPTH (feet)	SYMBOL	SAMPLE	FIELD DESCRIPTION AND CLASSIFICATION: DESCRIPTION AND REMARKS (Grain size, Density, Moisture, Color)	U.S.C.S.	IN-PLACE MOISTURE (%)	IN-PLACE DRY DENSITY (pcf)	OPTIMUM MOISTURE (%)	MAXIMUM DRY DENSITY (pcf)	DENSITY (% of M.D.D.)	EXPAN. + CONSOL. - (%)	BLOW COUNTS/FT.	SAMPLE O.D. (INCHES)
0–3			**CLAYEY SAND**, fine- to medium-grained, some trash debris. Loose to medium dense. Moist. Dark red-brown. **FILL (Qaf)**	SC								
3–4			**CLAYEY SAND**, fine- to medium-grained, some caliche. Dense. Moist. Dark red-brown. **OLDER ALLUVIUM (Qoa)** -- gas/water line @ 3.5' on north end of trench.	SC								
4			Bottom @ 4'									
5												

▼ PERCHED WATER TABLE
☒ BULK BAG SAMPLE
1 IN-PLACE SAMPLE
■ MODIFIED CALIFORNIA SAMPLE
S NUCLEAR FIELD DENSITY TEST
▨ STANDARD PENETRATION TEST

JOB NAME
Cottonwood Self Storage Project

SITE LOCATION
NW of SR 52 and Cottonwood Ave., Santee, CA

JOB NUMBER	REVIEWED BY	LOG No.
14-10558.1	**JAB/WDH**	**T-4**
FIGURE NUMBER **Vd**	Geotechnical Exploration, Inc.	

EQUIPMENT	DIMENSION & TYPE OF EXCAVATION	DATE LOGGED
Rubber-tire Backhoe	11' X 2' X 3' Trench	3-7-18
SURFACE ELEVATION	GROUNDWATER/ SEEPAGE DEPTH	LOGGED BY
± 354' Mean Sea Level	Not Encountered	JAB

DEPTH (feet)	SYMBOL	SAMPLE	FIELD DESCRIPTION AND CLASSIFICATION: DESCRIPTION AND REMARKS (Grain size, Density, Moisture, Color)	U.S.C.S.	IN-PLACE MOISTURE (%)	IN-PLACE DRY DENSITY (pcf)	OPTIMUM MOISTURE (%)	MAXIMUM DRY DENSITY (pcf)	DENSITY (% of M.D.D.)	EXPAN. + CONSOL. - (%)	BLOW COUNTS/FT.	SAMPLE O.D. (INCHES)
0–1			**CLAYEY SAND** , fine- to medium-grained. Loose to medium dense. Moist. Dark red-brown. **FILL (Qaf)**	SC								
1–3			**CLAYEY SAND** , fine- to medium-grained, some pinhole voids, some caliche. Dense. Slightly moist to moist. Dark red-brown. **OLDER ALLUVIUM (Qoa)** -- electric line @ 2.5' on south end of trench.	SC								
3			Bottom @ 3'									
4												
5												

PERCHED WATER TABLE
BULK BAG SAMPLE
1 IN-PLACE SAMPLE
MODIFIED CALIFORNIA SAMPLE
S NUCLEAR FIELD DENSITY TEST
STANDARD PENETRATION TEST

JOB NAME		
Cottonwood Self Storage Project		
SITE LOCATION		
NW of SR 52 and Cottonwood Ave., Santee, CA		
JOB NUMBER: 14-10558.1	REVIEWED BY: JAB/WDH	LOG No.
FIGURE NUMBER: Ve	Geotechnical Exploration, Inc.	T-5

EQUIPMENT	DIMENSION & TYPE OF EXCAVATION	DATE LOGGED
Rubber-tire Backhoe	17' X 2' X 5' Trench	3-7-18
SURFACE ELEVATION	GROUNDWATER/ SEEPAGE DEPTH	LOGGED BY
± 354' Mean Sea Level	Not Encountered	JAB

DEPTH (feet)	SYMBOL	SAMPLE	FIELD DESCRIPTION AND CLASSIFICATION — DESCRIPTION AND REMARKS (Grain size, Density, Moisture, Color)	U.S.C.S.	IN-PLACE MOISTURE (%)	IN-PLACE DRY DENSITY (pcf)	OPTIMUM MOISTURE (%)	MAXIMUM DRY DENSITY (pcf)	DENSITY (% of M.D.D.)	EXPAN. + CONSOL. - (%)	BLOW COUNTS/FT.	SAMPLE O.D. (INCHES)
			ASPHALT CONCRETE PAVEMENT , 3" thick.									
1			**CLAYEY SAND** , fine- to medium-grained, trace gravel, some brick and metal pipe debris. Medium dense. Moist. Dark red-brown. **FILL (Qaf)**	SC								
2												
3												
4			**CLAYEY SAND** , fine- to medium-grained. Dense. Slightly moist to moist. Red-brown. **OLDER ALLUVIUM (Qoa)**	SC								
5			Bottom @ 5'									
6												

PERCHED WATER TABLE
BULK BAG SAMPLE
1 IN-PLACE SAMPLE
MODIFIED CALIFORNIA SAMPLE
S NUCLEAR FIELD DENSITY TEST
STANDARD PENETRATION TEST

JOB NAME		
Cottonwood Self Storage Project		
SITE LOCATION		
NW of SR 52 and Cottonwood Ave., Santee, CA		
JOB NUMBER 14-10558.1	REVIEWED BY JAB/WDH	LOG No. T-6
FIGURE NUMBER Vf	Geotechnical Exploration, Inc.	

EXPLORATION LOG 10558.1 COTTONWOOD.GPJ GEO_EXPL.GDT 3/27/18

EQUIPMENT	DIMENSION & TYPE OF EXCAVATION	DATE LOGGED
Rubber-tire Backhoe	**12' X 4' X 6.5' Trench**	**3-7-18**
SURFACE ELEVATION	GROUNDWATER/ SEEPAGE DEPTH	LOGGED BY
± 355' Mean Sea Level	**Not Encountered**	**JAB**

DEPTH (feet)	SYMBOL	SAMPLE	FIELD DESCRIPTION AND CLASSIFICATION — DESCRIPTION AND REMARKS (Grain size, Density, Moisture, Color)	U.S.C.S.	IN-PLACE MOISTURE (%)	IN-PLACE DRY DENSITY (pcf)	OPTIMUM MOISTURE (%)	MAXIMUM DRY DENSITY (pcf)	DENSITY (% of M.D.D.)	EXPAN. + CONSOL. - (%)	BLOW COUNTS/FT.	SAMPLE O.D. (INCHES)
0–2			**CLAYEY SAND** , fine- to medium-grained, trace asphalt and concrete debris. Medium dense. Slightly moist to moist. Dark red-brown. **FILL (Qaf)** -- electric lines exposed in northwest corner of trench. -- sewer line exposed in southwest corner of trench.	SC								
2–6.5			**CLAYEY SAND** , fine- to medium-grained. Dense. Slightly moist to moist. Red-brown. **OLDER ALLUVIUM (Qoa)** Infiltration test conducted from 6' to 6.5'.	SC								
		1	-- 42% passing #200 sieve.									
7			Bottom @ 6.5'									

PERCHED WATER TABLE
BULK BAG SAMPLE
1 IN-PLACE SAMPLE
MODIFIED CALIFORNIA SAMPLE
S NUCLEAR FIELD DENSITY TEST
STANDARD PENETRATION TEST

JOB NAME		
Cottonwood Self Storage Project		
SITE LOCATION		
NW of SR 52 and Cottonwood Ave., Santee, CA		
JOB NUMBER **14-10558.1**	REVIEWED BY **JAB/WDH**	LOG No. **INF-1**
FIGURE NUMBER **Vg**	Geotechnical Exploration, Inc.	

EXPLORATION LOG 10558.1 COTTONWOOD.GPJ GEO_EXPL.GDT 3/27/18

EQUIPMENT	DIMENSION & TYPE OF EXCAVATION	DATE LOGGED
Rubber-tire Backhoe	**12' X 4' X 4' Trench**	**3-7-18**
SURFACE ELEVATION	GROUNDWATER/ SEEPAGE DEPTH	LOGGED BY
± 355' Mean Sea Level	**Not Encountered**	**JAB**

DEPTH (feet)	SYMBOL	SAMPLE	FIELD DESCRIPTION AND CLASSIFICATION — DESCRIPTION AND REMARKS (Grain size, Density, Moisture, Color)	U.S.C.S.	IN-PLACE MOISTURE (%)	IN-PLACE DRY DENSITY (pcf)	OPTIMUM MOISTURE (%)	MAXIMUM DRY DENSITY (pcf)	DENSITY (% of M.D.D.)	EXPAN. + CONSOL. - (%)	BLOW COUNTS/FT.	SAMPLE O.D. (INCHES)
			SILTY SAND, fine- to medium-grained. Loose. Slightly moist. Gray. **FILL (Qaf)**	SM								
1			**CLAYEY SAND**, fine- to medium-grained, trace asphalt and concrete debris. Medium dense. Slightly moist to moist. Red-brown. **FILL (Qaf)**	SC								
2			**CLAYEY SAND/ SANDY CLAY**, fine- to medium-grained, some manganese staining, some pinhole voids, some caliche. Dense/ very stiff. Slightly moist to moist. Dark red-brown. **OLDER ALLUVIUM (Qoa)**	SC/ CL								
3		☒	Infiltration test conducted from 3.5' to 4'. -- 56% passing #200 sieve.									
4			Bottom @ 4'									
5												

- PERCHED WATER TABLE
- ☒ BULK BAG SAMPLE
- 1 IN-PLACE SAMPLE
- ■ MODIFIED CALIFORNIA SAMPLE
- S NUCLEAR FIELD DENSITY TEST
- ▨ STANDARD PENETRATION TEST

JOB NAME		
Cottonwood Self Storage Project		
SITE LOCATION		
NW of SR 52 and Cottonwood Ave., Santee, CA		
JOB NUMBER: **14-10558.1**	REVIEWED BY: **JAB/WDH**	LOG No.
FIGURE NUMBER: **Vh**	Geotechnical Exploration, Inc.	**INF-2**

EXPLORATION LOG 10558.1 COTTONWOOD.GPJ GEO_EXPL.GDT 3/27/18

APPENDIX A

Simple Open Pit Falling Head Test Sheet

Project Name: Cottonwood Self Storage
Project No. 14-10558.1
Date Excavated: 3/7/18
Test Hole No: INF-1

Tested By: JAB
Soil Classification: SC/CL
Depth of Test Hole: 78"
Test Hole Dia: 24"

Initial Time (Minutes)	Final Time (Minutes)	Time interval (minutes)	Initial Water Level (inches)	Final Water Level (inches)	Change in water (inches)	Falling Head Rate (min/inches)
925	1025	60	71.500	71.750	0.250	240.000
1025	1125	60	71.750	71.875	0.125	480.000
1125	1225	60	71.875	72.000	0.125	480.000

Simple Open Pit Falling Head Test Sheet

Project Name: Cottonwood Self Storage
Project No. 14-10558.1
Date Excavated: 3/7/18
Test Hole No: INF-2

Tested By: JAB
Soil Classification: SC/CL
Depth of Test Hole: 54"
Test Hole Dia: 24"

Initial Time (Minutes)	Final Time (Minutes)	Time interval (minutes)	Initial Water Level (inches)	Final Water Level (inches)	Change in water (inches)	Falling Head Rate (min/inches)
942	1042	60	47.125	47.375	0.250	240.000
1042	1142	60	47.375	47.500	0.125	480.000
1142	1242	60	47.500	47.500	0.000	#DIV/0!

Simple Open Pit Rate to Infiltration Rate Conversion (Porchet Method)

Project Name: Cottonwood Self Storage
Project No. 14-10558.1
Test Hole No: INF-1

Calculated By: JAB
Checked By:
Test Hole Dia: 24"

Date: 3/19/2018
Date:
Depth of Test Hole: 78"

Porchet Corrections

Infiltration rate=((delta h*60r)/(delta t*(r+2 h avg))

Test No.	EB Depth (inches)	Delta T (min)	Water Depth 1 (inches)	Water Depth 2 (inches)	h 1 (inches)	h 2 (inches)	delta h (inches)	h avg (inches)	r (radius) (inches)	delta h*60r	delta t*(r+2 h avg)	Infiltration rate (in/hr)
1	78	60	71.500	71.750	6.500	6.250	0.250	6.375	12	180	1485	0.121
2	78	60	71.750	71.875	6.250	6.125	0.125	6.188	12	90	1462.5	0.062
3	78	60	71.875	72.000	6.125	6.000	0.125	6.063	12	90	1447.5	0.062
4												
5												
6												
7												
8												
9												

Simple Open Pit Rate to Infiltration Rate Conversion (Porchet Method)

Project Name: Cottonwood Self Storage
Project No. 14-10558.1
Test Hole No: INF-2

Calculated By: JAB
Checked By:
Test Hole Dia: 24"

Date: 3/19/2018
Date:
Depth of Test Hole: 54"

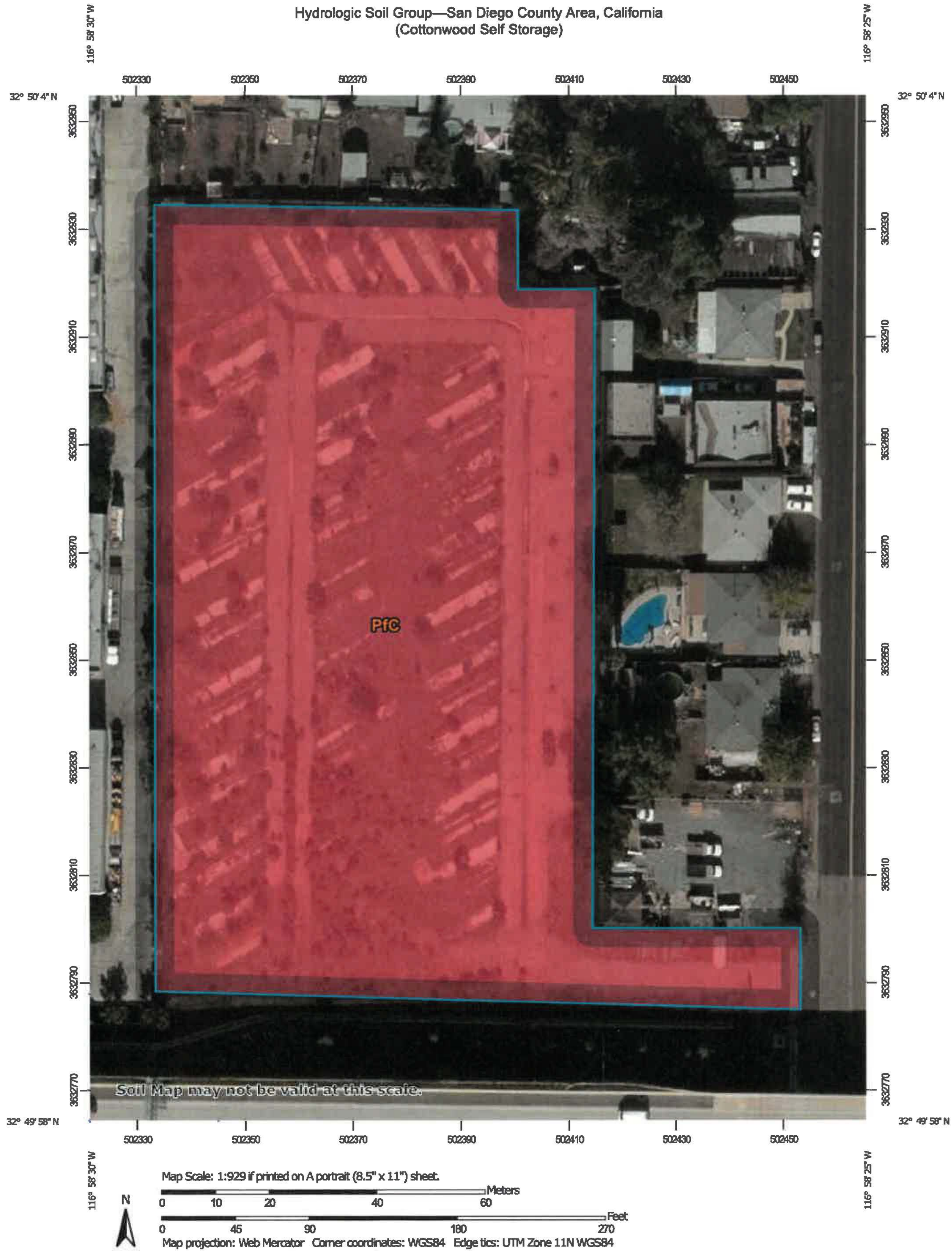
Porchet Corrections

Infiltration rate=((delta h*60r)/(delta t*(r+2 h avg))

Test No.	EB Depth (inches)	Delta T (min)	Water Depth 1 (inches)	Water Depth 2 (inches)	h 1 (inches)	h 2 (inches)	delta h (inches)	h avg (inches)	r (radius) (inches)	delta h*60r	delta t*(r+2 h avg)	Infiltration rate (in/hr)
1	54	60	47.125	47.375	6.875	6.625	0.250	6.750	12	180	1530	0.118
2	54	60	47.375	47.500	6.625	6.500	0.125	6.563	12	90	1507.5	0.060
3	54	60	47.500	47.500	6.500	6.500	0.000	6.500	12	0	1500	0.000
4												
5												
6												
7												
8												
9												

APPENDIX B

Hydrologic Soil Group—San Diego County Area, California
(Cottonwood Self Storage)



MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Lines

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Points

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: San Diego County Area, California
Survey Area Data: Version 12, Sep 13, 2017

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Dec 7, 2014—Jan 4, 2015

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
PfC	Placentia sandy loam, thick surface, 2 to 9 percent slo pes	D	3.0	100.0%
Totals for Area of Interest			**3.0**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

ATTACHMENT 1e

Design Capture Volume			Worksheet B-2.1		
1	85th percentile 24-hr storm depth from Figure B.1-1	d=	0.58	0.58	inches
2	Area tributary to BMP (s)	A=	2.86	0.14	Acres
3	Area weighted runoff factor (estimate using Appendix B.1.1 and B.2.1)	C=	0.85	0.73	unitless
4	Street trees volume reduction	TCV=			cubic-feet
5	Rain barrels volume reduction	RCV=			cubic-feet
6	Calculate DCV= (3630 x C x d x A) - TCV -RCV	DCV=	5,118.00	214.00	cubic-feet
	1.5*DCV=Volume needed	(1.5*5118) = 7677		(1.5*214) = 321	cubic-feet

Automated Worksheet B.2: Retention Requirements (V2.0)

Category	#	Description	*ii*	Units
Basic Analysis	1	Drainage Basin ID or Name	DMA-2	unitless
	2	85th Percentile Rainfall Depth	0.58	inches
	3	Predominant NRCS Soil Type Within BMP Location	D	unitless
	4	Is proposed BMP location Restricted or Unrestricted for Infiltration Activities?	Unrestricted	unitless
	5	Nature of Restriction	n/a	unitless
	6	Do Minimum Retention Requirements Apply to this Project?	Yes	yes/no
	7	Are Habitable Structures Greater than 9 Stories Proposed?	No	yes/no
Advanced Analysis	8	Has Geotechnical Engineer Performed an Infiltration Analysis?	Yes	yes/no
	9	Design Infiltration Rate Recommended by Geotechnical Engineer	0.062	in/hr
Result	10	Design Infiltration Rate Used To Determine Retention Requirements	0.062	in/hr
	11	Percent of Average Annual Runoff that Must be Retained within DMA	16.6%	percentage
	12	Fraction of DCV Requiring Retention	0.11	ratio
	13	Required Retention Volume	24	cubic-feet

No Warning Messages

BIO CLEAN
ENVIRONMENTAL SERVICES, INC.

April 20th, 2016

Project: All Related

Subject: MWS Linear BMP Classification Per San Diego Manual

To Whom It May Concern:

It is the intention of this document to use the MWS Linear as a biofiltration BMP. Based upon definitions of Biofiltration as found in Section 2.2.1 and Appendix F of the manual the MWS Linear meets the criteria to be classified as biofiltration and therefore is not flow through treatment and thus does not trigger the need for alternative compliance. The MWS Linear has GULD approval for basic, phosphorus and enhanced treatment under the TAPE approval. The system is certified under the TAPE approval at a loading rate of 1 gpm/sq ft for all three pollutant categories. This is consistent with the performance criteria related to the performance of Appendix F.

Let us first address the comment regarding the MWS (referring to the Modular Wetland System Linear) being flow through treatment. To do so let us look at the definition of biofiltration as provided by the Design Manual which states:

> *"For situations where onsite retention of the 85th percentile storm volume is not feasible, biofiltration must be provided to satisfy specific "biofiltration standards" i.e. a set of selection, sizing, design and operation and maintenance (O&M) criteria that must be met for a BMP to be considered a "biofiltration BMP" – see Section 2.2.1 and Appendix F."*

If we look at section 2.2.2 Storm Water Pollutant Control Performance Standard it states:

> *"(i) If it is not technically feasible to implement retention BMPs for the full DCV onsite for a PDP, then the PDP shall utilize biofiltration BMPs for the remaining volume not reliably retained. Biofiltration BMPs must be designed as described in Appendix F to have an appropriate hydraulic loading rate to maximize storm water retention and pollutant removal, as well as to prevent erosion, scour, and channeling within the BMP, and must be sized to:*
>
> > *[a]. Treat 1.5 times the DCV not reliably retained onsite, OR*
> >
> > *[b]. Treat the DCV not reliably retained onsite with a flow-thru design that has a total volume, including pore spaces and pre-filter detention volume, sized to hold at least 0.75 times the portion of the DCV not reliably retained onsite."*

As the manual states Biofiltration BMPs must be designed as described in Appendix F which states:

> *"A project applicant must be able to affirmatively demonstrate that a given BMP is designed and sized in a manner consistent with this definition to be considered as a "biofiltration BMP" as part of a compliant storm water management plan."*
>
> *"This appendix contains a checklist of the key underlying criteria that must be met for a BMP to be considered a biofiltration BMP. The purpose of this checklist is to facilitate consistent review and approval of biofiltration BMPs that meet the "biofiltration standard" defined by the MS4 Permit."*
>
> *"This checklist includes specific design criteria that are essential to defining a system as a biofiltration BMP; however it does not present a complete design basis. This checklist was used to develop BMP Fact Sheets for PR-1 biofiltration with partial retention and BF-1 biofiltration, which do present a complete design basis. Therefore, biofiltration BMPs that substantially meet all aspects of the Fact sheets PR-1 or BF-1 should be able to complete this checklist without additional documentation beyond what would already be required for a project submittal."*
>
> *"Other biofiltration BMP designs (including both non-proprietary and proprietary designs) may also meet the underlying MS4 Permit requirements to be considered biofiltration BMPs. These BMPs may be classified as biofiltration BMPs if they (1) meet the minimum design criteria listed in this appendix, including the pollutant treatment performance standard in Appendix F.1, (2) are designed and maintained in a manner consistent with their performance certifications (See explanation in Appendix F.2), if applicable, and (3) are acceptable at the discretion of the [City Engineer]. The applicant may be required to provide additional studies and/or required to meet additional design criteria beyond the scope of this document in order to demonstrate that these criteria are met."*

As stated the Biofiltration BMP must meet three objectives. The following outlines how the Modular Wetland System Linear meets these criteria.

Minimum Design Criteria

1. Biofiltration BMPs shall be allowed only as described in the BMP selection process in this manual (i.e., retention feasibility hierarchy).

    a. The Modular Wetland System Linear (MWS Linear) is only being proposed on plans when retention via infiltration or reuse is proven infeasible. Conditions such as soils with little to no infiltration rate or sites in which insufficient landscaping warrant to successful implementation of reuse systems.

2. Biofiltration BMPs must be sized using acceptable sizing methods described in this manual.

    a. Section B.5.2 Basis for Minimum Sizing Factor for Biofiltration BMPs states:

    "The MS4 Permit describes conceptual performance goals for biofiltration BMPs and specifies numeric criteria for sizing biofiltration BMPs (See Section 2.2.1 of this Manual). However, the MS4 Permit does not define a specific footprint sizing factor or design profile that must be provided for the BMP to be considered "biofiltration."

    "Additionally, it does not apply to alternative biofiltration designs that utilize the checklist in Appendix F (Biofiltration Standard and Checklist). Acceptable alternative designs (such as proprietary systems meeting Appendix F criteria) typically include design features intended to allow acceptable performance with a smaller footprint and have undergone field scale testing to evaluate performance and required O&M frequency."

    As stated in the Manual alternative biofiltration designs are allowed. The MWS Linear therefore qualifies as a biofiltration BMP under this definition as it has both undergone field scale testing (TAPE tested and approved with a GULD) and provides requirements on O&M frequency. In addition, the MWS Linear can be sized to treat either 1.5 times the DCV not reliably retained onsite OR 1.0 times the portion of the DCV not reliably retained onsite; and additionally check that the system has a total static (i.e. non-routed) storage volume, including pore spaces and pre-filter detention volume to at least 0.75 times the portion of the DCV not reliably retained onsite.

3. Biofiltration BMPs must be sited and designed to achieve maximum feasible infiltration and evapotranspiration.

    a. The MWS Linear is utilized and placed in the same manner as other types of biofiltration systems. As with other biofiltration systems the MWS Linear includes and underdrain for the remaining portion of the DCV that is not retained via incidental infiltration (as biofiltration if infiltration is not feasible due to poor soils) and evapotranspiration. The MWS Linear can be designed with an open bottom to maximize this incidental infiltration. The only exception to this, as with other biofiltration BMPs, is when the geotechnical consultant recommends an impervious liner be used due to specific soil conditions such as expansive clays. Additionally, the MWS Linear utilizes an amended media that is much more porous than the standard prescribed biofiltration media which is a mix of sand and compost. 100% of the media used in the MWS Linear has interparticle voids of 48% plus and 24% internal void space for each media particle. This is much greater than the sand which has interparticle voids of 35% and internal voids of 0%. As such, the MWS Linear retains greater moisture which allows for greater volume retention and ultimately evapotranspiration via respiration of the contained vegetation.

4. Biofiltration BMPs must be designed with a hydraulic loading rate to maximize pollutant retention, preserve pollutant control/sequestration processes, and minimize potential for pollutant washout.

    a. The manual states:

    "Alternatively, for proprietary designs and custom media mixes not meeting the media specifications contained in the City or County LID Manual, field scale testing data are provided to demonstrate that proposed media meets the pollutant treatment performance criteria in Section F.1 below."

    The MWS Linear has been tested under the Washington State TAPE protocol which is full scale field testing and has received General Use Level Designation under that protocol. Table F.1-1, as shown below, requires a biofiltration BMP to have Basic Treatment, Phosphorus Treatment, and Enhanced Treatment under this protocol. The MWS Linear has GULD approval for all three and therefore meets this minimum requirement 4. A copy of the TAPE approval has been attached to this document.

Table F.1-1: Required Technology Acceptance Protocol-Ecology Certifications for Polltuants of Concern for Biofiltration Performance Standard

Project Pollutant of Concern	Required Technology Acceptance Protocol-Ecology Certification for Biofiltration Performance Standard
Trash	Basic Treatment, Phosphorus Treatment, Enhanced Treatment
Sediments	Basic Treatment, Phosphorus Treatment, Enhanced Treatment
Oil and Grease	Basic Treatment, Phosphorus Treatment, Enhanced Treatment
Nutrients	Phosphorus Treatment[1]
Metals	Enhanced Treatment
Pesticides	Basic Treatment (including filtration)[2] Phosphorus Treatment, Enhanced Treatment
Organics	Basic Treatment (including filtration)[2] Phosphorus Treatment, Enhanced Treatment
Bacteria and Viruses	Basic Treatment (including bacteria removal processes)[3] , Phosphorus Treatment, Enhanced Treatment
Basic Treatment (including filtration)[2] Phosphorus Treatment, Enhanced Treatment	Basic Treatment (including filtration)[2] Phosphorus Treatment, Enhanced Treatment

5. Biofiltration BMPs must be designed to promote appropriate biological activity to support and maintain treatment processes.

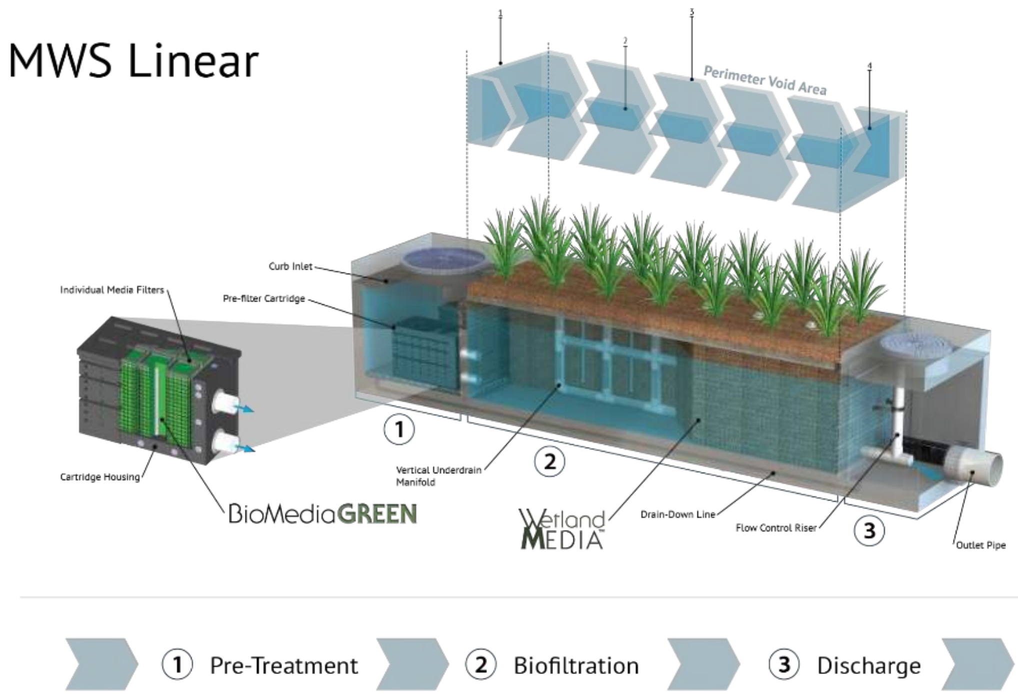
    a. The MWS Linear an advanced vegetated biofiltration promotes biological processes found in both upland bioretention systems and wetlands. The system utilizes an advanced horizontal flow design to ensure maximum contact with the vegetation root mass. Bacterial growth, supported by the root system in the wetland chamber, performs a number of treatment processes. These vary as a function of moisture, temperature, pH, salinity, and pollutant concentrations. Biologically available forms of nitrogen, phosphorus, and carbon are actively taken into the cells of vegetation and bacteria, and used for metabolic processes (i.e., energy production and growth). Nitrogen and phosphorus are actively taken up as nutrients that are vital for a number of cell functions, growth, and energy production. These processes remove metabolites from the media during and between storm events, making the media available to capture more nutrients from subsequent storms.

    b. Soil organisms in the wetland chamber can break down a wide array of organic compounds into less toxic forms or completely break them down into carbon dioxide and water (Means and Hinchee 1994). Bacteria can also cause metals to precipitate out as salts, bind them within organic material, and accumulate metals in nodules within the cells. Finally, plant growth may metabolize many pollutants, sequester them or rendering them less toxic (Reeves and Baker 2000).

    c. Following are pictures from the plants pulled from a MWS Linear after only 14 months of growth. The media used in the system is designed to maximize biological activity:


6. Biofiltration BMPs must be designed to prevent erosion, scour, and channeling within the BMP.

    a. The MWS Linear is a self-contained system with a pre-treatment chamber. Unlike other biofiltration BMPs erosion, scour, and channeling with in the BMP is not an issue. Following is a diagram of the BMP. The system pre-treatment chamber prevent any erosion or scour. The system downstream orifice control prevents channeling of the media:



7. Biofiltration BMP must include operations and maintenance design features and planning considerations to provide for continued effectiveness of pollutant and flow control functions.

    a. The MWS Linear provides activation along with the first year of maintenance and inspection free on all installation in the county of San Diego. Unlike other biofiltration BMPs the City and Co-permitees can be assured the system is being properly installed and maintained. The first year of inspections is used to gauge the amount of loading in the system and this information is used to set appropriate maintenance interval for subsequent years. Attached is a copy of the maintenance manual for the MWS Linear.

Designed & Maintained Consistent with their Performance Certifications

We are in agreement that all BMPs should be designed in a manner consistent with the TAPE certification. The MWS Linear is sized in accordance with the TAPE GULD approval which provides certification at a loading rate of 1 gpm/sq ft (100 in/hr) for Basic, Phosphorus and Enhanced treatment. In addition, as stated previously, Modular Wetland System, Inc. provide activation of all system installed in San Diego County along with the first year of inspections and maintenance to ensure appropriate function. As previously stated, a copy of the TAPE GULD approval is attached to support this claim.

Additionally, it should be noted that the manual allows for biofiltration BMPs to be sized in either volume based (DCV) or flow based design. The manual states in section F.2.2 Sizing of Flow-Based Biofiltration *BMPs:*

> *"This sizing method is only available when the BMP meets the pollutant treatment performance standard in Appendix F.1."*
>
> *"Proprietary biofiltration BMPs are typically designed as a flow-based BMPs (i.e., a constant treatment capacity with negligible storage volume). Additionally, proprietary biofiltration is only acceptable if no infiltration is feasible and where site-specific documentation demonstrates that the use of larger footprint biofiltration BMPs would be infeasible. The applicable sizing method for biofiltration is therefore reduced to: Treat 1.5 times the DCV."*
>
> *"The following steps should be followed to demonstrate that the system is sized to treat 1.5 times the DCV."*
>
> > *1. Calculate the flow rate required to meet the pollutant treatment performance standard without scaling for the 1.5 factor. Options include either:*
> >
> > - *Calculate the runoff flow rate from a 0.2 inch per hour uniform intensity precipitation event (See methodology Appendix B.6.3), or*
> >
> > - *Conduct a continuous simulation analysis to compute the size required to capture and treat 80 percent of average annual runoff; for small catchments, 5-minute precipitation data should be used to account for short time of concentration. Nearest rain gage with 5-minute precipitation data is allowed for this analysis.*

2. Multiply the flow rate from Step 1 by 1.5 to compute the design flow rate for the biofiltration system.

3. Based on the conditions of certification/verification (discussed above), establish the design capacity, as a flow rate, of a given sized unit.

4. Demonstrates that an appropriate unit size and number of units is provided to provide a flow rate that meets the required flow rate from Step 2.

In conclusion, we have closely followed the process and protocol for showing the MWS Linear meets all the criteria to be accepted as Biofiltration as found in Appendix F.

If you have any questions please feel free to contact us directly.

Sincerely,

Zachariha J. Kent

Director of Engineering

Bio Clean Environmental Services, Inc.

WASHINGTON STATE DEPARTMENT OF ECOLOGY

April 2014

GENERAL USE LEVEL DESIGNATION FOR BASIC, ENHANCED, AND PHOSPHORUS TREATMENT

For the

MWS-Linear Modular Wetland

Ecology's Decision:

Based on Modular Wetland Systems, Inc. application submissions, including the Technical Evaluation Report, dated April 1, 2014, Ecology hereby issues the following use level designation:

1. General use level designation (GULD) for the MWS-Linear Modular Wetland Stormwater Treatment System for Basic treatment
   - Sized at a hydraulic loading rate of 1 gallon per minute (gpm) per square foot (sq ft) of wetland cell surface area. For moderate pollutant loading rates (low to medium density residential basins), size the Prefilters at 3.0 gpm/sq ft of cartridge surface area. For high loading rates (commercial and industrial basins), size the Prefilters at 2.1 gpm/sq ft of cartridge surface area.
2. General use level designation (GULD) for the MWS-Linear Modular Wetland Stormwater Treatment System for Phosphorus treatment
   - Sized at a hydraulic loading rate of 1 gallon per minute (gpm) per square foot (sq ft) of wetland cell surface area. For moderate pollutant loading rates (low to medium density residential basins), size the Prefilters at 3.0 gpm/sq ft of cartridge surface area. For high loading rates (commercial and industrial basins), size the Prefilters at 2.1 gpm/sq ft of cartridge surface area.
3. General use level designation (GULD) for the MWS-Linear Modular Wetland Stormwater Treatment System for Enhanced treatment
   - Sized at a hydraulic loading rate of 1 gallon per minute (gpm) per square foot (sq ft) of wetland cell surface area. For moderate pollutant loading rates (low to medium density residential basins), size the Prefilters at 3.0 gpm/sq ft of cartridge surface area. For high loading rates (commercial and industrial basins), size the Prefilters at 2.1 gpm/sq ft of cartridge surface area.
4. Ecology approves monitoring for the MWS - Linear Modular Wetland Stormwater Treatment System units for Basic, Phosphorus, and Enhanced treatment at the hydraulic

loading rate listed above. Designers shall calculate the water quality design flow rates using the following procedures:

- Western Washington: For treatment installed upstream of detention or retention, the water quality design flow rate is the peak 15-minute flow rate as calculated using the latest version of the Western Washington Hydrology Model or other Ecology-approved continuous runoff model.
- Eastern Washington: For treatment installed upstream of detention or retention, the water quality design flow rate is the peak 15-minute flow rate as calculated using one of the three methods described in Chapter 2.2.5 of the Stormwater Management Manual for Eastern Washington (SWMMEW) or local manual.
- Entire State: For treatment installed downstream of detention, the water quality design flow rate is the full 2-year release rate of the detention facility.

5. These use level designations have no expiration date but may be revoked or amended by Ecology, and are subject to the conditions specified below.

Ecology's Conditions of Use:

Applicants shall comply with the following conditions:

1. Design, assemble, install, operate, and maintain the MWS – Linear Modular Wetland Stormwater Treatment System units, in accordance with Modular Wetland Systems, Inc. applicable manuals and documents and the Ecology Decision.
2. Each site plan must undergo Modular Wetland Systems, Inc. review and approval before site installation. This ensures that site grading and slope are appropriate for use of a MWS – Linear Modular Wetland Stormwater Treatment System unit.
3. MWS – Linear Modular Wetland Stormwater Treatment System media shall conform to the specifications submitted to, and approved by, Ecology.
4. Maintenance: The required maintenance interval for stormwater treatment devices is often dependent upon the degree of pollutant loading from a particular drainage basin. Therefore, Ecology does not endorse or recommend a "one size fits all" maintenance cycle for a particular model/size of manufactured filter treatment device.

- Typically, Modular Wetland Systems, Inc. designs MWS - Linear Modular Wetland systems for a target prefilter media life of 6 to 12 months.
- Indications of the need for maintenance include effluent flow decreasing to below the design flow rate or decrease in treatment below required levels.
- Owners/operators must inspect MWS - Linear Modular Wetland systems for a minimum of twelve months from the start of post-construction operation to determine site-specific maintenance schedules and requirements. You must conduct inspections monthly during the wet season, and every other month during the dry season. (According to the SWMMWW, the wet season in western Washington is October 1 to April 30. According to SWMMEW, the wet season in eastern Washington is October 1 to June 30). After the first year of operation, owners/operators must conduct inspections based on the findings during the first year of inspections.

- Conduct inspections by qualified personnel, follow manufacturer's guidelines, and use methods capable of determining either a decrease in treated effluent flowrate and/or a decrease in pollutant removal ability.
- When inspections are performed, the following findings typically serve as maintenance triggers:
    - Standing water remains in the vault between rain events, or
    - Bypass occurs during storms smaller than the design storm.
    - If excessive floatables (trash and debris) are present (but no standing water or excessive sedimentation), perform a minor maintenance consisting of gross solids removal, not prefilter media replacement.
    - Additional data collection will be used to create a correlation between pretreatment chamber sediment depth and pre-filter clogging (see *Issues to be Addressed by the Company* section below)

6. Discharges from the MWS - Linear Modular Wetland Stormwater Treatment System units shall not cause or contribute to water quality standards violations in receiving waters.

Applicant: Modular Wetland Systems, Inc.
Applicant's Address: *PO. Box 869*
Oceanside, CA 92054

Application Documents:

- *Original Application for Conditional Use Level Designation*, Modular Wetland System, Linear Stormwater Filtration System Modular Wetland Systems, Inc., January 2011
- *Quality Assurance Project Plan*: Modular Wetland system – Linear Treatment System performance Monitoring Project, draft, January 2011.
- *Revised Application for Conditional Use Level Designation*, Modular Wetland System, Linear Stormwater Filtration System Modular Wetland Systems, Inc., May 2011
- *Memorandum: Modular Wetland System-Linear GULD Application Supplementary Data, April 2014*
- *Technical Evaluation Report: Modular Wetland System Stormwater Treatment System Performance Monitoring, April 2014.*

Applicant's Use Level Request:

General use level designation as a Basic, Enhanced, and Phosphorus treatment device in accordance with Ecology's Guidance for Evaluating Emerging Stormwater Treatment Technologies Technology Assessment Protocol – Ecology (TAPE) January 2011 Revision.

Applicant's Performance Claims:

- The MWS – Linear Modular wetland is capable of removing a minimum of 80-percent of TSS from stormwater with influent concentrations between 100 and 200 mg/l.

- The MWS – Linear Modular wetland is capable of removing a minimum of 50-percent of Total Phosphorus from stormwater with influent concentrations between 0.1 and 0.5 mg/l.
- The MWS – Linear Modular wetland is capable of removing a minimum of 30-percent of dissolved Copper from stormwater with influent concentrations between 0.005 and 0.020 mg/l.
- The MWS – Linear Modular wetland is capable of removing a minimum of 60-percent of dissolved Zinc from stormwater with influent concentrations between 0.02 and 0.30 mg/l.

Ecology Recommendations:

- Modular Wetland Systems, Inc. has shown Ecology, through laboratory and field-testing, that the MWS - Linear Modular Wetland Stormwater Treatment System filter system is capable of attaining Ecology's Basic, Total phosphorus, and Enhanced treatment goals.

Findings of Fact:

<u>Laboratory Testing</u>

The MWS-Linear Modular wetland has the:

- Capability to remove 99 percent of total suspended solids (using Sil-Co-Sil 106) in a quarter-scale model with influent concentrations of 270 mg/L.
- Capability to remove 91 percent of total suspended solids (using Sil-Co-Sil 106) in laboratory conditions with influent concentrations of 84.6 mg/L at a flow rate of 3.0 gpm per square foot of media.
- Capability to remove 93 percent of dissolved Copper in a quarter-scale model with influent concentrations of 0.757 mg/L.
- Capability to remove 79 percent of dissolved Copper in laboratory conditions with influent concentrations of 0.567 mg/L at a flow rate of 3.0 gpm per square foot of media.
- Capability to remove 80.5-percent of dissolved Zinc in a quarter-scale model with influent concentrations of 0.95 mg/L at a flow rate of 3.0 gpm per square foot of media.
- Capability to remove 78-percent of dissolved Zinc in laboratory conditions with influent concentrations of 0.75 mg/L at a flow rate of 3.0 gpm per square foot of media.

<u>Field Testing</u>

- Modular Wetland Systems, Inc. conducted monitoring of an MWS-Linear (Model # MWS-L-4-13) from April 2012 through May 2013, at a transportation maintenance facility in Portland, Oregon. The manufacturer collected flow-weighted composite samples of the system's influent and effluent during 28 separate storm events. The system treated approximately 75 percent of the runoff from 53.5 inches of rainfall during the monitoring period. The applicant sized the system at 1 gpm/sq ft. (wetland media) and 3gpm/sq ft. (prefilter).

- Influent TSS concentrations for qualifying sampled storm events ranged from 20 to 339 mg/L. Average TSS removal for influent concentrations greater than 100 mg/L (n=7) averaged 85 percent. For influent concentrations in the range of 20-100 mg/L (n=18), the upper 95 percent confidence interval about the mean effluent concentration was 12.8 mg/L.
- Total phosphorus removal for 17 events with influent TP concentrations in the range of 0.1 to 0.5 mg/L averaged 65 percent. A bootstrap estimate of the lower 95 percent confidence limit (LCL95) of the mean total phosphorus reduction was 58 percent.
- The lower 95 percent confidence limit of the mean percent removal was 60.5 percent for dissolved zinc for influent concentrations in the range of 0.02 to 0.3 mg/L (n=11). The lower 95 percent confidence limit of the mean percent removal was 32.5 percent for dissolved copper for influent concentrations in the range of 0.005 to 0.02 mg/L (n=14) at flow rates up to 28 gpm (design flow rate 41 gpm). Laboratory test data augmented the data set, showing dissolved copper removal at the design flow rate of 41 gpm (93 percent reduction in influent dissolved copper of 0.757 mg/L).

Issues to be addressed by the Company:

1. Modular Wetland Systems, Inc. should collect maintenance and inspection data for the first year on all installations in the Northwest in order to assess standard maintenance requirements for various land uses in the region. Modular Wetland Systems, Inc. should use these data to establish required maintenance cycles.
2. Modular Wetland Systems, Inc. should collect pre-treatment chamber sediment depth data for the first year of operation for all installations in the Northwest. Modular Wetland Systems, Inc. will use these data to create a correlation between sediment depth and pre-filter clogging.

Technology Description:
Download at http://www.modularwetlands.com/

Contact Information:

Applicant: Greg Kent
Modular Wetland Systems, Inc.
P.O. Box 869
Oceanside, CA 92054
gkent@biocleanenvironmental.net

Applicant website: http://www.modularwetlands.com/

Ecology web link: http://www.ecy.wa.gov/programs/wg/stormwater/newtech/index.html

Ecology: Douglas C. Howie, P.E.
Department of Ecology
Water Quality Program
(360) 407-6444
douglas.howie@ecy.wa.gov

Revision History

Date	Revision
June 2011	Original use-level-designation document
September 2012	Revised dates for TER and expiration
January 2013	Modified Design Storm Description, added Revision Table, added maintenance discussion, modified format in accordance with Ecology standard
December 2013	Updated name of Applicant
April 2014	Approved GULD designation for Basic, Phosphorus, and Enhanced treatment

TAPE PERFORMANCE SUMMARY

MWS-LINEAR 2.0

Application: Stand Alone Stormwater Treatment Best Management Practice
Type of Treatment: High Flow Rate Media Filtration and Biofiltration (dual-stage)

DESCRIPTION

Modular Wetland System Linear 2.0 (MWS-L 2.0) is an advanced dual-stage high flow rate media and biofiltration system for the treatment of urban stormwater runoff. Superior pollutant removal efficiencies are achieved by treating runoff through a pre-treatment chamber containing a screening device for trash and larger debris, a separation chamber for larger TSS and a series of media filter cartridges for removal of fine TSS and other particulate pollutants. Pre-treated runoff is transferred to the biofiltration chamber which contains an engineered ion exchange media designed to support an abundant plant and microbe community that captures, absorbs, transforms and uptakes pollutants through an array of physical, chemical, and biological mechanisms.

MWS-L 2.0 is a self-contained treatment train that is supplied to the job site completely assembled and ready for use. Once installed, stormwater runoff drains directly from impervious surfaces through an built-in curb inlet, drop in, or via pipe from upstream inlets or downspouts. Treated runoff is discharged from the system through an orifice control riser to assure the proper amount of flow is treated. The treated water leaving the system is connected to the storm drain system, infiltration basins, or to be re-used on site for irrigation or other uses.

TAPE PERFORMANCE

Modular Wetland System Linear 2.0 (MWS-L 2.0) completed its TAPE field testing in the spring of 2013. The Washington DOE has approved the system under the TAPE protocol. The MWS-Linear has met the performance benchmarks for the three major pollutant categories as defined by TAPE: Basic Treatment (TSS), Phosphorus and Enhanced (dissolved zinc and copper). It is the first system tested under the protocol to meet the benchmarks for all three categories.

Pollutant	Avg. Influent (mg/L)	Avg. Effluent (mg/L)	Removal Efficiency	Notes
Total Suspended Solids	75.0	15.7	85%	Summary of all data meeting TAPE parameters pertaining to this pollutant. Mean of 8 microns.
Total Phosphorus	0.227	0.074	64%	Summary of all data meeting TAPE parameters pertaining to this pollutant.
Ortho Phosphorus	0.093	0.031	67%	Summary of all data meeting TAPE parameters for total phosphorus.
Nitrogen	1.40	0.77	45%	Utilizing the Kjeldahl method (Total Kjeldahl nitrogen). Summary of all data during testing.
Dissolved Zinc	0.062	0.024	66%	Summary of all data meeting TAPE parameters pertaining to this pollutant.
Dissolved Copper	0.0086	0.0059	38%	Summary of all data meeting TAPE parameters pertaining to this pollutant.
Total Zinc	0.120	0.038	69%	Summary of all data during testing.
Total Copper	0.017	0.009	50%	Summary of all data during testing.
Motor Oil	24.157	1.133	95%	Summary of all data during testing.

NOTES:
1. The MWS-Linear was proven effective at infiltration rates of up to 121 in/hr.
2. A minimum of 10 aliquots were collected for each event.
3. Sampling was targeted to capture at least 75 percent of the hydrograph.

Modular Wetland System, Inc.
2972 San Luis Rey Rd
Oceanside, CA 92058

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PERFORMANCE SUMMARY

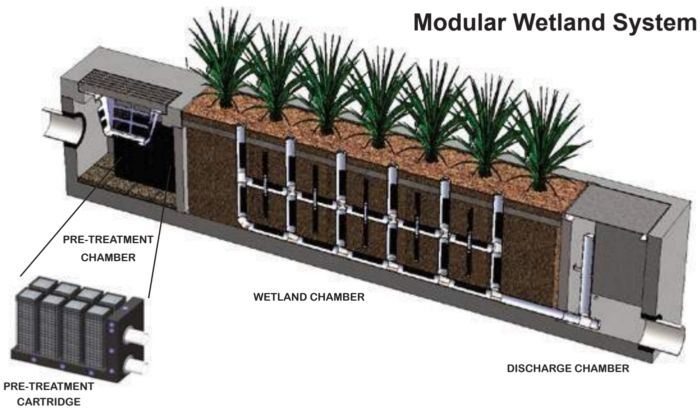
MWS-LINEAR 2.0

Application: Stand Alone Stormwater Treatment Best Management Practice
Type of Treatment: High Flow Rate Media Filtration and Biofiltration (dual-stage)

DESCRIPTION

Modular Wetland System Linear 2.0 (MWS-L 2.0) is an advanced dual-stage high flow rate media and biofiltration system for the treatment of urban stormwater runoff. Superior pollutant removal efficiencies are achieved by treating runoff through a pre-treatment chamber containing a screening device for trash and larger debris, a separation chamber for larger TSS and a series of media filter cartridges for removal of fine TSS and other particulate pollutants. Pre-treated runoff is transferred to the biofiltration chamber which contains an engineered ion exchange media designed to support an abundant plant and microbe community that captures, absorbs, transforms and uptakes pollutants through an array of physical, chemical, and biological mechanisms.

MWS-L 2.0 is a self-contained treatment train that is supplied to the job site completely assembled and ready for use. Once installed, stormwater runoff drains directly from impervious surfaces through an built-in curb inlet, drop in, or via pipe from upstream inlets or downspouts. Treated runoff is discharged from the system through an orifice control riser to assure the proper amount of flow is treated. The treated water leaving the system is connected to the storm drain system, infiltration basins, or to be re-used on site for irrigation or other uses.



Modular Wetland System Linear 2.0 (MWS-L 2.0) has been independently tested in laboratory and field conditions since 2008.

Oceanside Test Site

Portland Test Site

HEAVY METALS: Copper / Zinc

Description	Type	Avg. Influent (mg/L)	Avg. Effluent (mg/L)	Removal Efficiency	Notes
Waves Environmental - 1/4 Scale Lab Testing - 2007	Lab	.76 / .95	.06 / .19	92% / 80%	Majority Dissolved Fraction
City of Oceanside Boat Wash / Waves Environmental - 2008	Field	.04 / .24	< .02 / < .05	>50% / >79%	Effluent Concentrations Below Detectable Limits
Recycling Facility, Kileen, TX / CERL - 2011-2012	Field	.058 / .425	.032 / .061	44% / 86%	Test Unit 2
TAPE Field Testing / Portland, OR 2011/2012	Field	.017/ .120	.009 / .038	50% / 69%	Total Metals

TOTAL SUSPENDED SOLIDS:

Description	Type	Avg. Influent (mg/L)	Avg. Effluent (mg/L)	Removal Efficiency	Notes
Waves Environmental - 1/4 Scale Lab Testing - 2007	Lab	270	3	99%	Sil-co-sil 106 - 20 micron mean particle size
City of Oceanside Boat Wash / Waves Environmental - 2008	Field	45.67	8.24	82%	Mean Particle Size by Count < 8 Microns
Recycling Facility, Kileen, TX / CERL - 2011-2012	Field	676	39	94%	Test Unit 2
TAPE Field Testing / Portland, OR 2011/2012	Field	75.0	15.7	85%	Means particle size of 8 microns

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PERFORMANCE SUMMARY

MWS-LINEAR 2.0

PHOSPHORUS:

Description	Type	Avg. Influent (mg/L)	Avg. Effluent (mg/L)	Removal Efficiency	Notes
TAPE Field Testing / Portland, OR 2011/2012	Field	.227	.074	64%	TOTAL P
TAPE Field Testing / Portland, OR 2011/2012	Field	.093	.031	67%	ORTHO P

BACTERIA:

Description	Type	Avg. Influent (MPN)	Avg. Effluent (MPN)	Removal Efficiency	Notes
Waves Environmental - 1/4 Scale Lab Testing - 2007	Lab	1600 / 1600	535 / 637	67% / 60%	Fecal / E. Coli
City of Oceanside Boat Wash / Waves Environmental - 2008	Field	31666 / 6280	8667 / 1058	73% / 83%	Fecal / E. Coli

LEAD:

Description	Type	Avg. Influent (mg/L)	Avg. Effluent (mg/L)	Removal Efficiency	Notes
Waves Environmental - 1/4 Scale Lab Testing - 2007	Lab	.54	.10	82%	Total
Recycling Facility, Kileen, TX / CERL - 2011-2012	Field	.01 / .043	.004 / .014	60% / 68%	Both Test Units
TAPE Field Testing / Portland, OR 2011/2012	Field	.011	.003	70%	Total

All removal efficiencies and concentrations rounded up for easy viewing. Please call us for more information, including full copies of the reports reference above.

NITROGEN:

Description	Type	Avg. Influent (mg/L)	Avg. Effluent (mg/L)	Removal Efficiency	Notes
City of Oceanside Boat Wash / Waves Environmental - 2008	Field	.85	.21	75%	NITRATE
TAPE Field Testing / Portland, OR 2011/2012	Field	1.40	0.77	45%	TKN

HYDROCARBONS:

Description	Type	Avg. Influent (mg/L)	Avg. Effluent (mg/L)	Removal Efficiency	Notes
Waves Environmental - 1/4 Scale Lab Testing - 2007	Lab	10	1.625	84%	Oils & Grease
City of Oceanside Boat Wash / Waves Environmental - 2008	Field	.83	0	100%	TPH Motor Oil
TAPE Field Testing / Portland, OR 2011/2012	Field	24.157	1.133	95%	Motor Oil

TURBIDITY:

Description	Type	Avg. Influent (NTU)	Avg. Effluent (NTU)	Removal Efficiency	Notes
Waves Environmental - 1/4 Scale Lab Testing - 2007	Lab	21	1.575	93%	Field Measurement
City of Oceanside Boat Wash / Waves Environmental - 2008	Field	21	6	71%	Field Measurement

COD:

Description	Type	Avg. Influent (mg/L)	Avg. Effluent (mg/L)	Removal Efficiency	Notes
Recycling Facility, Kileen, TX / CERL - 2011-2012	Field	516 / 1450	90 / 356	83% / 75%	Both Test Units

ATTACHMENT 2
BACKUP FOR PDP HYDROMODIFICATION CONTROL MEASURES

This is the cover sheet for Attachment 2.

☐ Mark this box if this attachment is empty because the project is exempt from PDP hydromodification management requirements.

Indicate which Items are Included behind this cover sheet:

Attachment Sequence	**Contents**	**Checklist**
Attachment 2a	Hydromodification Management Exhibit (Required)	☑ Included See Hydromodification Management Exhibit Checklist on the back of this Attachment cover sheet.
Attachment 2b	Management of Critical Coarse Sediment Yield Areas (WMAA Exhibit is required, additional analyses are optional) See Section 6.2 of the BMP Design Manual.	☑ Exhibit showing project drainage boundaries marked on WMAA Critical Coarse Sediment Yield Area Map (Required) Optional analyses for Critical Coarse Sediment Yield Area Determination ☐ 6.2.1 Verification of Geomorphic Landscape Units Onsite ☐ 6.2.2 Downstream Systems Sensitivity to Coarse Sediment ☐ 6.2.3 Optional Additional Analysis of Potential Critical Coarse Sediment Yield Areas Onsite
Attachment 2c	Geomorphic Assessment of Receiving Channels (Optional) See Section 6.3.4 of the BMP Design Manual.	☑ Not performed ☐ Included ☐ Submitted as separate stand-alone document
Attachment 2d	Flow Control Facility Design, including Structural BMP Drawdown Calculations and Overflow Design Summary (Required) See Chapter 6 and Appendix G of the BMP Design Manual	☑ Included ☐ Submitted as separate stand-alone document
Attachment 2e	Vector Control Plan (Required when structural BMPs will not drain in 96 hours)	☐ Included ☑ Not required because BMPs will drain in less than 96 hours

Use this checklist to ensure the required information has been included on the Hydromodification Management Exhibit:

The Hydromodification Management Exhibit must identify:

☑ Underlying hydrologic soil group
☑ Approximate depth to groundwater
☑ Existing natural hydrologic features (watercourses, seeps, springs, wetlands)
☑ Critical coarse sediment yield areas to be protected
☑ Existing topography
☑ Existing and proposed site drainage network and connections to drainage offsite
☑ Proposed grading
☑ Proposed impervious features
☑ Proposed design features and surface treatments used to minimize imperviousness
☑ Point(s) of Compliance (POC) for Hydromodification Management
☑ Existing and proposed drainage boundary and drainage area to each POC (when necessary, create separate exhibits for pre-development and post-project conditions)
☑ Structural BMPs for hydromodification management (identify location, type of BMP, and size/detail)

ATTACHMENT 2a

BIO-BASIN SUMMARY TABLE				
BMP ID	BMP TYPE	REQUIRED DCV (CUFT)	BMP STORAGE VOLUME (CUFT)	BMP MODEL
BMP – 1	BF–3	7998	45542	MWS–6–4–21–V

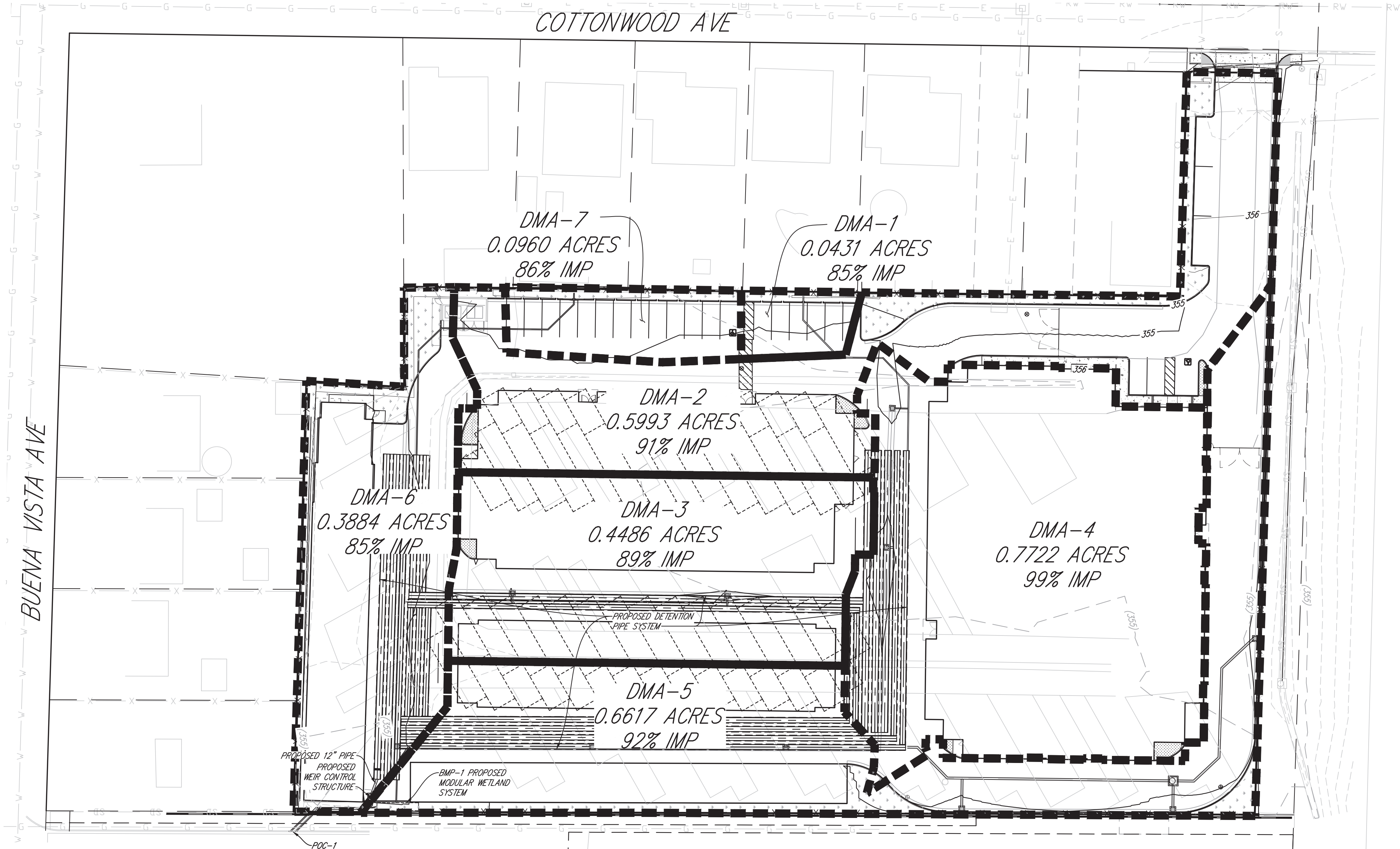
NOTE
- NO CRITICAL COARSE SEDIMENT YIELD AREAS ON–SITE OR CONVEYED FROM OFF–SITE TO ON–SITE
- SOIL TYPE: D
- DEPTH TO GROUND WATER: >20 FT

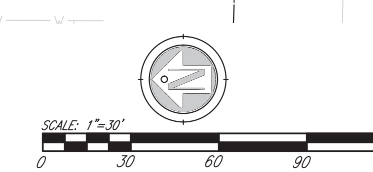
LEGEND

IMPERVIOUS SURFACE

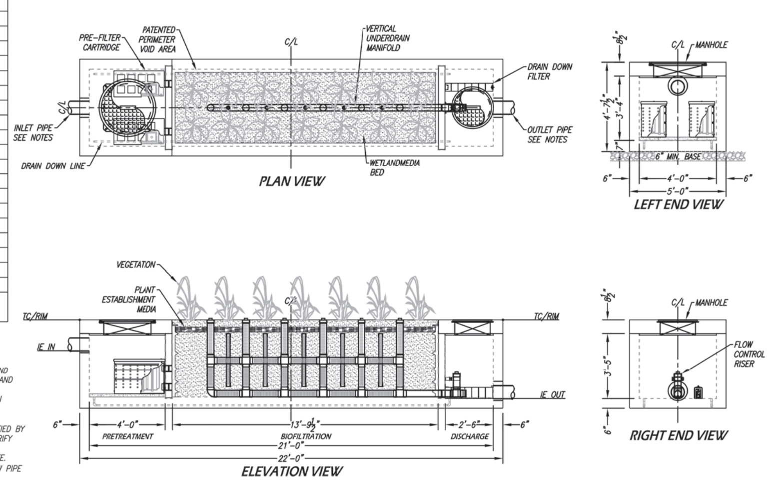
PERVIOUS SURFACE

*HYDROMOD DMA AREAS ARE SPECIFICALLY FOR THIS HYDROMOD EXHIBIT. DMA EXHIBIT AREAS ARE NOT THE SAME.





SITE SPECIFIC DATA			
PROJECT NAME		Alright Self Storage	
PROJECT LOCATION		Cottonwood Ave	
STRUCTURE ID		MWS	
TREATMENT REQUIRED			
VOLUME BASED (CF)		FLOW BASED (CFS)	
7998			
TREATMENT HGL AVAILABLE (FT)			354.5
PEAK BYPASS REQUIRED (CFS) – IF APPLICABLE			
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	348.93	HDPE	6"
INLET PIPE 2		HDPE	
OUTLET PIPE	347.93	HDPE	4"
	PRETREATMENT	BIOFILTRATION	DISCHARGE
RIM ELEVATION	354.5	354.5	354.5
SURFACE LOAD	PARKWAY	OPEN PLANTER	PARKWAY
FRAME & COVER	ø30"	N/A	ø24"
WETLANDMEDIA VOLUME (CY)			7.63
WETLANDMEDIA DELIVERY METHOD			TBD
ORIFICE SIZE (DIA. INCHES)			ø1.08"
MAXIMUM PICK WEIGHT (LBS)			43000
NOTES:			



INSTALLATION NOTES

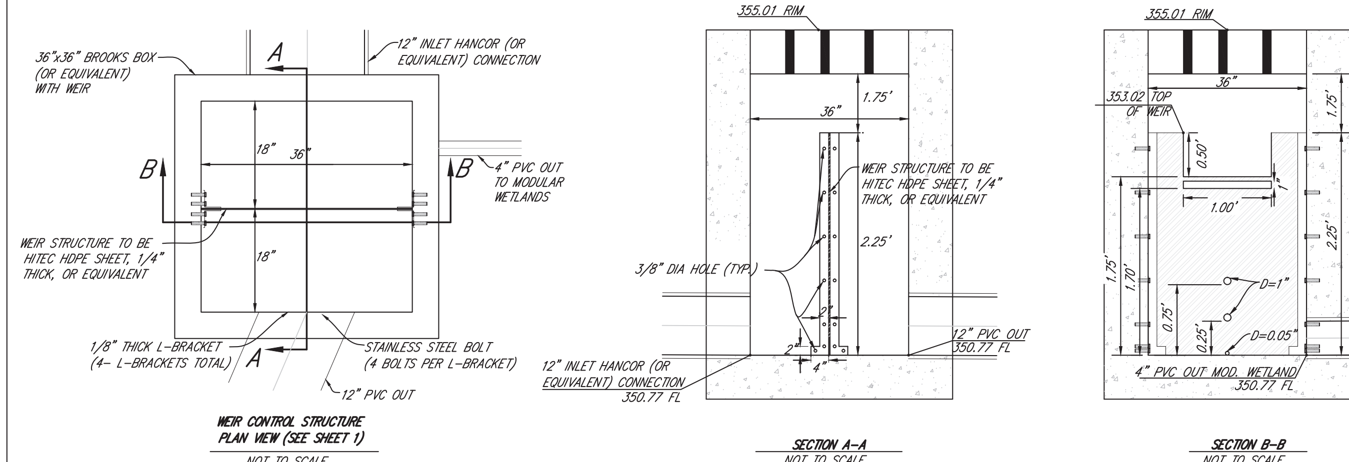
1. CONTRACTOR TO PROVIDE ALL LABOR, EQUIPMENT, MATERIALS AND INCIDENTALS REQUIRED TO OFFLOAD AND INSTALL THE SYSTEM AND APPURTENANCES IN ACCORDANCE WITH THIS DRAWING AND THE MANUFACTURERS SPECIFICATIONS, UNLESS OTHERWISE STATED IN MANUFACTURERS CONTRACT.
2. UNIT MUST BE INSTALLED ON LEVEL BASE. MANUFACTURER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

GENERAL NOTES

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

TREATMENT FLOW (CFS)	0.268
OPERATING HEAD (FT)	3.4
PRETREATMENT LOADING RATE (GPM/SF)	TBD
WETLAND MEDIA LOADING RATE (GPM/SF)	1.0

MWS-L-4-21-V
STORMWATER BIOFILTRATION SYSTEM
STANDARD DETAIL



WEIR CONTROL STRUCTURE DETAIL
NOT TO SCALE

WEIR CONTROL NOTE:
THE PURPOSE OF THIS STRUCTURE IS FOR DETENTION FOR WATER QUALITY AND HYDROMODIFICATION FLOW CONTROL SEPARATE FROM TYPICAL BIOFILTRATION FLOW MODELING.

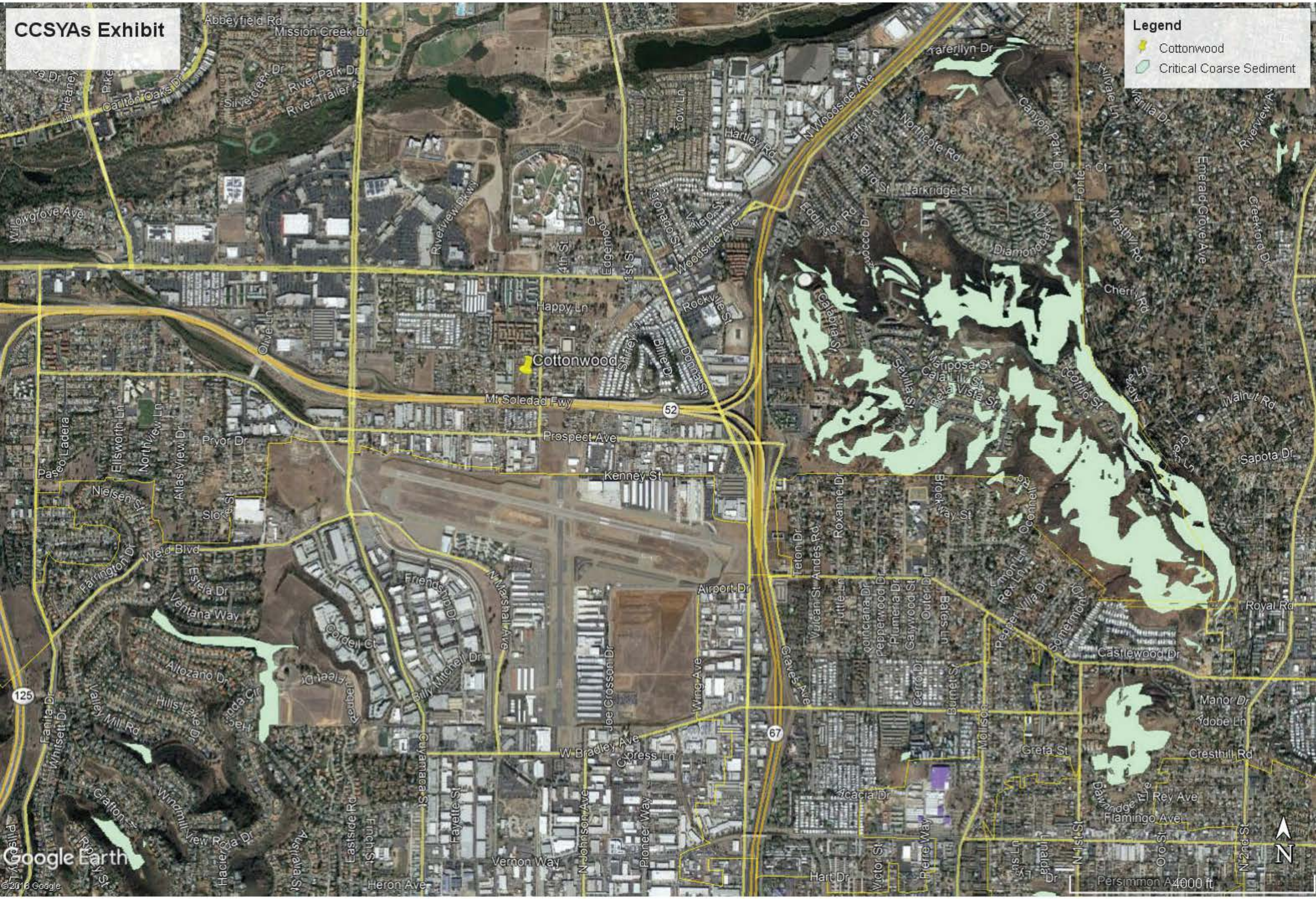
ENGINEER OF WORK
EXCEL ENGINEERING
LAND PLANNING• ENGINEERING • SURVEYING
440 STATE PLACE, ESCONDIDO, CA 92029
PH (760)745-8118 FAX (760)745-1890

ROBERT D. DENTINO
RCE: 45629 EXP:12/31/20
February 20, 2020
DATE

REGISTERED PROFESSIONAL ENGINEER
ROBERT D. DENTINO
No. 45629
Exp. 12-31-20
CIVIL
STATE OF CALIFORNIA

ALL RIGHT SELF-STORAGE
PROPOSED HYDROMOD EXHIBIT

ATTACHMENT 2b



CCSYAs Exhibit
Legend
Cottonwood
Critical Coarse Sediment
Cottonwood
Mt Soledad Fwy
52
67
125
Prospect Ave
Kenney St
Happy Ln
Airport Dr
W Bradley Ave
Weld Blvd
Royal Rd
Castlewood Dr
Larkridge St
N Woodside Ave
Mission Creek Dr
Abbeyfield Rd
Carlton Oaks Dr
Riverview Pkwy
Pryor Dr
Ventana Way
Joe Crosson Dr
Wing Ave
Greta St
Cresthill Rd
Acacia Dr
Vernon Way
Heron Ave
Hart Dr
N
4000 ft
Google Earth
©2018 Google

ATTACHMENT 2c

No, the low flow threshold is $0.1Q2$ (default low flow threshold)

ATTACHMENT 2d

SWMM MODELING TO DETERMINE LID SIZES FOR HYDROMODIFICATION COMPLIANCE

ALL RIGHT STORAGE INC.
8708 COTTONWOOD AVE, SANTEE
CA 92071

DATE: February 28, 2020

Prepared For:

All Right Storage Inc.
11300 Sorrento Valley Road, Ste. 250
San Diego, CA 92121

Prepared By:

EXCEL ENGINEERING
440 STATE PLACE
ESCONDIDO, CA 92029
TEL: (760)745-8118

Hydromodification Analysis

Table of Contents

INTRODUCTION

This report provides Hydromodification and Water Quality design based on LID (Low Impact Development) principles for a proposed self-storage facility located at 8708 Cottonwood Ave in the City of Santee, San Diego County, California.

The Hydromodification and Water Quality calculations were performed utilizing continuous simulation analysis to size the storm water treatment and control facilities. Storm Water Management Model (SWMM) version 5.1 distributed by USEPA is the basis of all calculations within this report. SWMM output file was used to generate peak flow recurrence frequencies and flow duration series statistics based on an assigned rain gauge for pre-development, unmitigated post-development flows and post-development mitigated flows to determine compliance with the State Water Resources Control Board Order 2009-0009-DWQ and the County wide Model BMP design Manual dated February 2016 and Hydromodification Management Plan (HMP) requirements.

The proposed tributary area is approximately 3 acres and this project is planned for storage facility serviced by private driveways and parking lots. There is one point of compliance (POC) in the analysis located at the North-West corner of the site.

The Hydromodification and Water Quality system proposed for this project is 1 proprietary bio filtration unit (modular Wetland unit) with one point of compliance; located near the North-West corner of the site. This system detains storm water in the detention tanks under the driveway before entering a proprietary bio filtration device for water quality treatment. The proprietary bio-filtration, filters storm water through plant roots and a biologically active soil mix (see attachment 1-f of SWQMP), and then releases it into the existing storm drain system which currently collects the sites storm flows. The resulting mitigated outflows are shown to be equal to or less than all continuously simulated storms based on the historical data collected from the Santee rain gage.

Low Flow Threshold

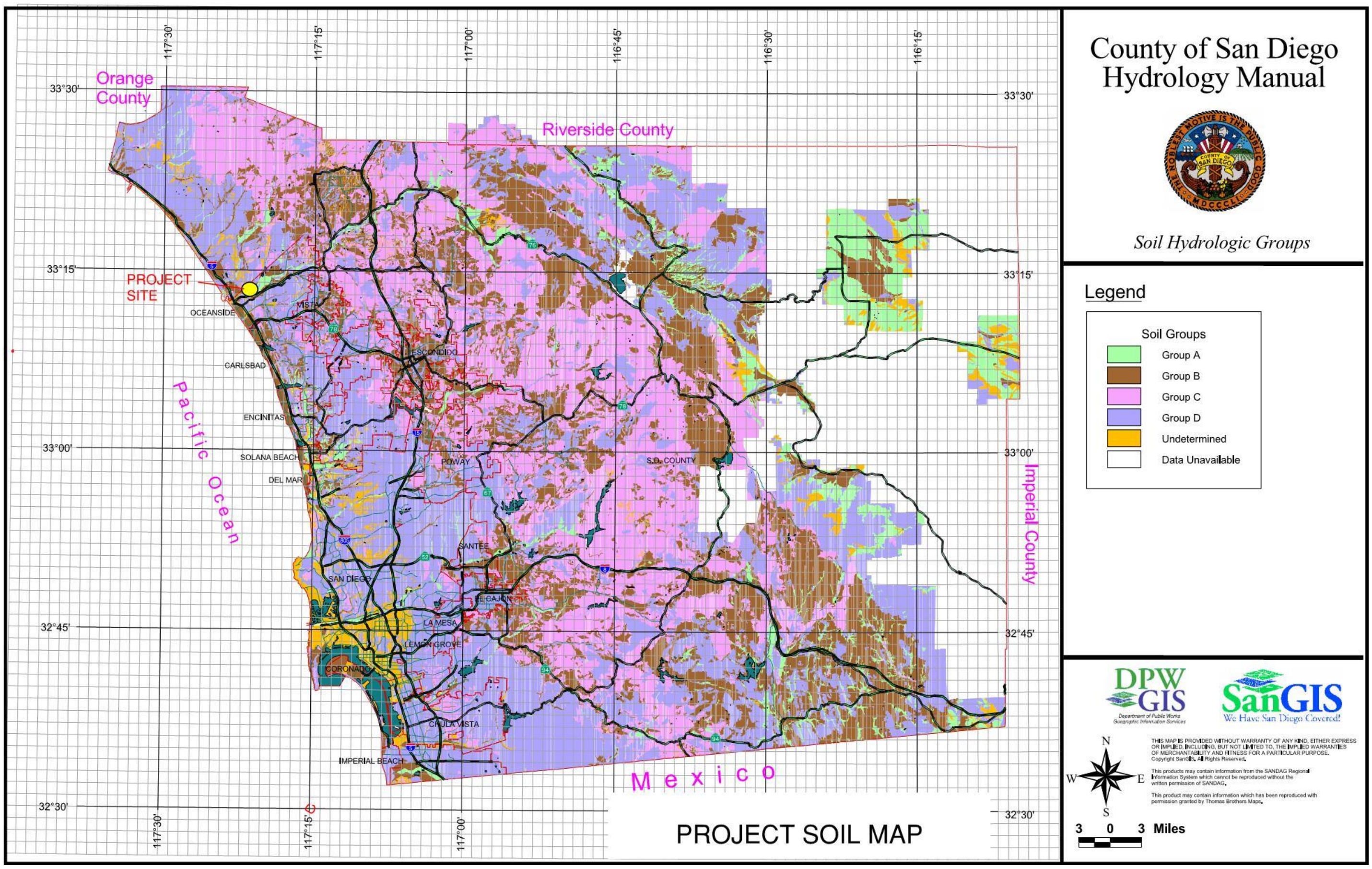
A downstream channel assessment has not been completed for this project and therefore the low flow threshold utilized for the system analysis is 10% of 2-year storm event (0.1Q2). This will be used as the low flow threshold to meet peak flow frequency and flow duration controls.

Soil type

Based on Figure C.1 taken from Model BMP Design Manual San Diego Region Appendices dated June 2015, the soil type of this project is soil type D. See Figure 1 below.

Therefore, the SWMM sub-catchments were based on infiltration rate of soil type D. The original grading for the site and the overexcavation areas for the pad the deep over excavation areas that were created will minimize the native's soil infiltration rate for the pervious area.

Figure-1. Hydrologic Soil Group Map



SECTION I. MODEL SETUP

Pre-development Model Setup

The SWMM model for this projects pre-development site is analyzed using historical rain gauge data. The Santee gauge is utilized for this project. That data provides continuous precipitation input to a sub-catchment with its outfall based on the contributing basins imperviousness.

The imperviousness parameter in SWMM is the amount of effective or directly connected impervious area. The effective impervious area is the impervious area that drains directly to the Stormwater conveyance system. The pre-development condition is a vacant pad with poor cover of some grasses with no trees. No other impervious surface exists on site of the on-site area has been disturbed (the site is padded and has been compacted).

Post-Development Model Setup

Figure 3 illustrates each contributing basin discharging its overland flow directly into the detention pipe system before it is conveyed to a proprietary biofiltration system (Modular Wetland System/ Bioclean product). The proprietary bio-filtration is not model in the SWMM model since the loading rate of the proprietary biofilter's is higher than the weir control of the detention pipe. There is no actual elevation entered in the program. The bottom elevation of the surface storage is assumed at 0 ft.

Figure-2. Typical
Proprietary Biofiltration Section

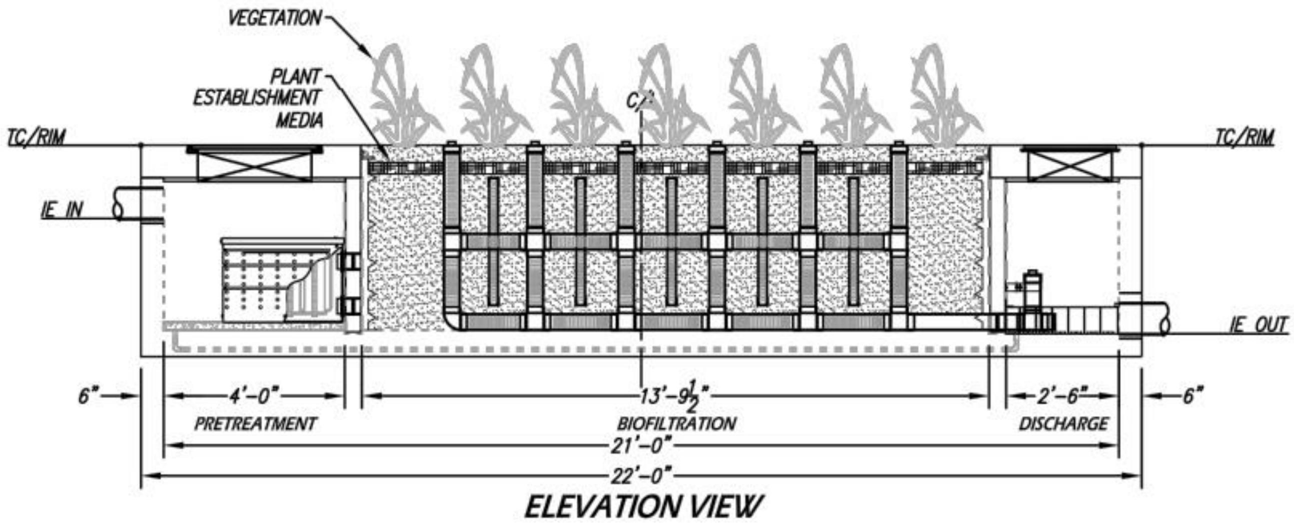


Fig.3 – SWMM Post-Development with Mitigation Model

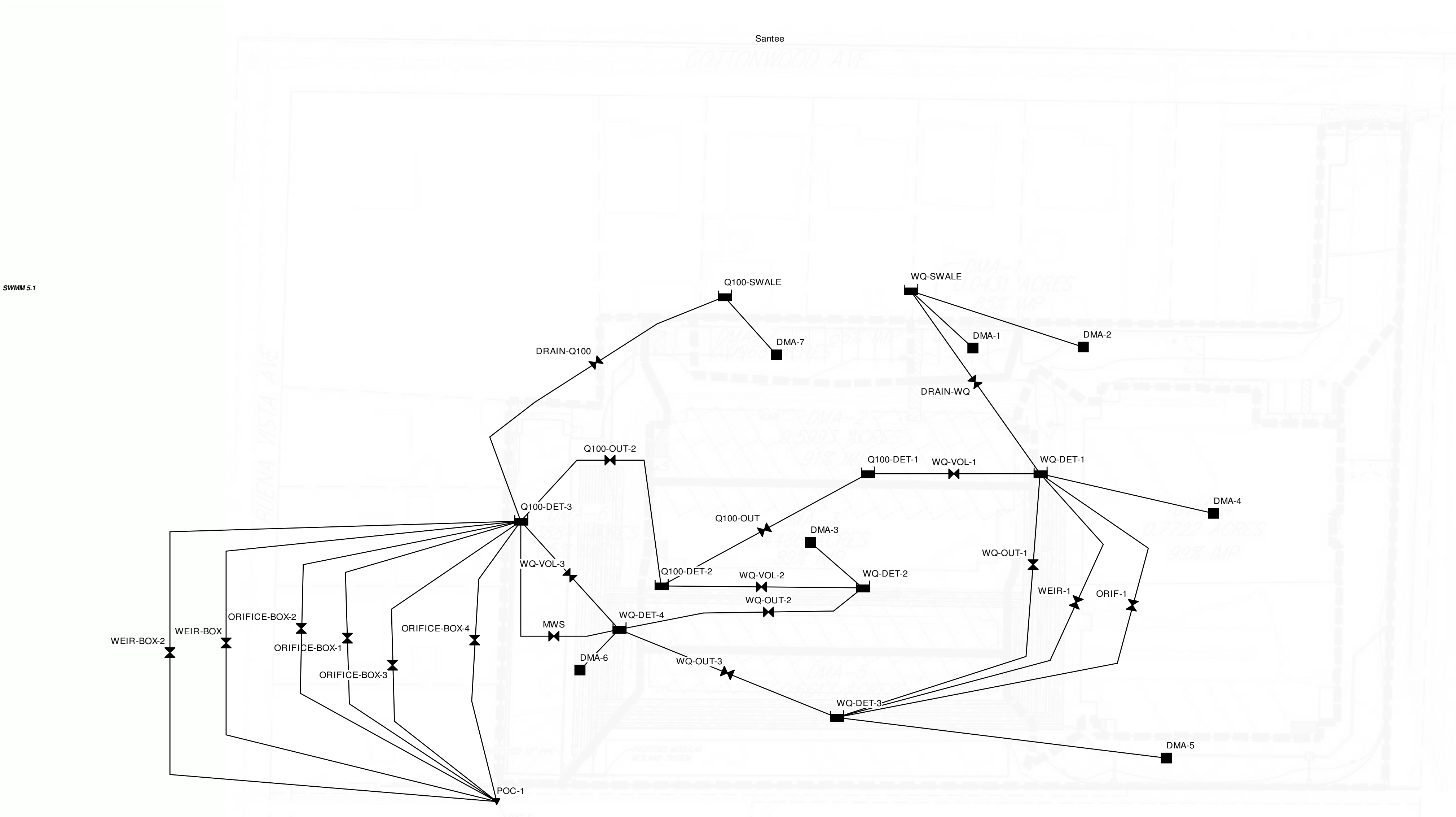


Fig.4 – SWMM Pre-Development Model

SECTION II. SYSTEM REPRESENTATION

SWMM is a distributed model, which means that a study area can be subdivided into any number of irregular sub-catchments to best capture the effect that spatial variability in topography, drainage pathways, land cover, and soil characteristics have on runoff generation. For modeling of Hydromodification calculations, there are four main system representations: Rain gage, Sub-catchment (contributing basin or LID area), Nodes and Links.

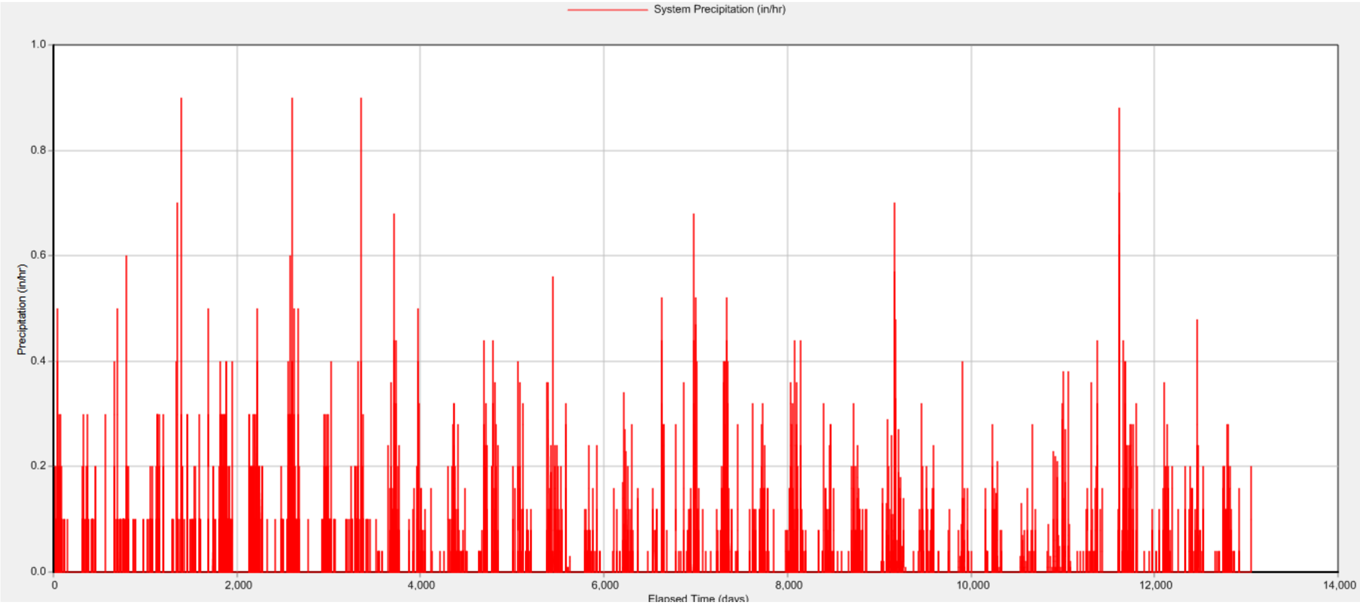


Fig. 5 – Time series rain data, which corresponds to runoff estimates for each of the 508,080 time steps (each date and hour) of the 35-year simulation period. (Inches/hour vs. elapsed time)

Rain Gauge

The properties of a rain gauge describe the source and format of the precipitation data that are applied to the study area. In this project, the rainfall data consist of a long-term rainfall record stored in a user-defined Time Series labeled as “Santee” rain gauge station. The Santee rain station was chosen due to its data quality and its location to the project site.

The rain gauge supplies precipitation data for one or more sub-catchment areas in a study region taken from the Project Clean Water website (www.projectcleanwater.org). This data file contains rainfall intensity, hourly-recorded time interval, and the dates of recorded precipitation each hour. The Santee rain data has approximately 35 years of hourly precipitation data from 01/03/1973 to 09/26/2008 and generates 35 years of hourly runoff estimates, which corresponds to runoff estimates for each of the 508,080 time steps (each date and hour) of the 35 year simulation period.

Sub-catchment (contributing basin or LID area)
A basin is modeled using a sub-catchment object, which contains some of the following properties:

The rate of stormwater runoff and volume depends directly on the precipitation magnitude and its spatial and temporal distribution over the catchment. Each sub-catchment in SWMM is linked to a rain gauge object that describes the format and source of the rainfall input for the sub-catchment.

Area

This area is bounded by the sub-catchment boundary. Its value is determined directly from maps or field surveys of the site or by using SWMM's Auto-length tool when the sub-catchment is drawn to scale on SWMM's study area map. This Project is divided into several sub-catchments based on its outfall.

Width

Width can be defined as the sub-catchment's area divided by the length of the longest overland flow path that water can travel. When there are several such paths, one would use an average of their lengths to compute a width. If overland flow is visualized as running down –slope off an idealized, rectangular catchment, then the width of the sub-catchment is the physical width of overland flow.

In natural areas, true overland flow can only occur for distances of about 500 feet before it begins to consolidate into a small stream flow. In post-development, the true overland flow can be very short before it is collected into open channels. A maximum overland flow of 500 ft is appropriate for a non-urban catchment, while the typical overland flow length is appropriate for non-urban catchments; the typical overland flow length is the length from the back of a representative lot to the center of the street for urban catchments. If the overland flow length varies greatly within a sub-catchment, then an area-weighted average should be used.

Slope

This is the slope of the land surface over which runoff flows and is the same for both the pervious and impervious surfaces. It is the slope of what one considers being the overland flow path or its area-weighted average if there are several paths in the sub-catchment.

Imperviousness

This is the percentage of sub-catchment area covered by impervious surfaces such as sidewalks and roadways or whatever surfaces that rainfall cannot infiltrate.

Roughness Coefficient

The roughness coefficient N-Pervious default number =0.1 for Pre- and Post-development was used for this calculation. This value results in a more conservative approach than the actual N-value.

Fig.6- Typical surface on the existing condition moderate bare packed soil N-pervious = 0.1

Infiltration Model

The pre-development condition is primarily empty land with moderate vegetation cover. In the model, clay soil was used for the post-development condition and the pre-development condition for a conservative approach (yield to a higher runoff). Infiltration of rainfall from the pervious area of a sub-catchment into the unsaturated upper soil zone can be described using three different infiltration models: Horton, Green-Ampt, and Curve Number. The Green-Ampt method was chosen to calculate the infiltration of the pervious areas based on the availability of data for this project. It is invoked when editing the infiltration property of a sub-catchment.

The conductivity in the Post-Project is reduced by 25% due to compaction.

Table 1 – Soil Infiltration Parameter

SWMM Parameter Name	Unit	Range	Use in San Diego
Infiltration	Method	HORTON GREEN_AMPT CURVE_NUMBER	GREEN_AMPT
Suction Head (Green-Ampt)	Inches	1.93 – 12.60 presented in Table A.2 of SWMM Manual	Hydrologic Soil Group A: 1.5 Hydrologic Soil Group B: 3.0 Hydrologic Soil Group C: 6.0 Hydrologic Soil Group D: 9.0
Conductivity (Green-Ampt)	Inches per hour	0.01 – 4.74 presented in Table A.2 of SWMM Manual by soil texture class 0.00 – Ç0.45 presented in Table A.3 of SWMM Manual by hydrologic soil group	Hydrologic Soil Group A: 0.3 Hydrologic Soil Group B: 0.2 Hydrologic Soil Group C: 0.1 Hydrologic Soil Group D: 0.025 Note: reduce conductivity by 25% in the post-project condition when native soils will be compacted. For fill soils in post-project condition, see Section G.1.4.3.
Initial Deficit (Green-Ampt)		The difference between soil porosity and initial moisture content. Based on the values provided in Table A.2 of SWMM Manual, the range for completely dry soil would be 0.097 to 0.375	Hydrologic Soil Group A: 0.30 Hydrologic Soil Group B: 0.31 Hydrologic Soil Group C: 0.32 Hydrologic Soil Group D: 0.33 Note: in long-term continuous simulation, this value is not important as the soil will reach equilibrium after a few storm events regardless of the initial moisture content specified.
Groundwater	yes/no	yes/no	NO
LID Controls			Project Specific
Snow Pack Land Uses Initial Buildup Curb Length			Not applicable to hydromodification management studies

Source: Model BMP Design Manual San Diego Region Appendices, February 26, 2016

LID controls

Utilizing LID controls within a SWMM project is a two-step process that:

- Creates a set of scale-independent LID controls that can be deployed throughout the study area,
- Assign any desired mix and sizing of these controls to designated sub-catchments.

The LID for this project is a Modular Wetlands system unit. That unit is handled by the SWQMP and will not be modeled in this SWMM model.

SECTION III. CONTINUOUS SIMULATION OPTIONS

Simulation Dates

These dates determine the starting and ending dates/times of a simulation and are chosen based on the rain data availability.

Start analysis on 01/03/1973
Start Reporting on 01/03/1973
End Analysis on 09/26/2008

Time Steps

The Time Steps establish the length of the time steps used for runoff computation, routing computation and results reporting. Time steps are specified in days and hours: minutes: seconds except for flow routing which is entered as decimal seconds.

Climatology

-Evaporation Data

The available monthly evaporation data for project area was obtained from the California Irrigation Management Information System “Reference Evapotranspiration Zones” brochure and map (CIMIS ETo Zone Map), prepared by California Department of Water Resources, dated January 2012. Project site falls in “Zone 4” South Coast Inland Plains based on CIMIS ETo Zone map.

Table 2 – Zone 4 Monthly Evaporation data (in/day)

January	February	March	April	May	June
0.05	0.09	0.13	0.19	0.25	0.29
July	August	September	October	November	December
0.30	0.270	0.210	0.140	0.080	0.050

SECTION IV. RUNNING THE SIMULATION

In general, the Run time will depend on the complexity of the watershed being modeled, the routing method used, and the size of the routing time step used. The larger the time steps, the faster the simulation, but the less detailed the results.

Model Results

SWMM's Status Report summarizes overall results for the 35-yr simulation. The runoff continuity error is -4.28 % and the flow routing continuity error is 0.01%. When a run completes successfully, the mass continuity errors for runoff, flow routing, and pollutant routing will be displayed in the Run Status window. These errors represent the percent difference between initial storage + total inflow and final storage + total outflow for the entire drainage system. If they exceed some reasonable level, such as 10 percent, then the validity of the analysis results must be questioned. The most common reasons for an excessive continuity error are computational time steps that are too long or conduits that are too short.

In addition to the system continuity error, the Status Report produced by a run will list those nodes of the drainage network that have the largest flow continuity errors. If the error for a node is excessive, then one should first consider if the node in question is of importance to the purpose of the simulation. If it is, then further study is warranted to determine how the error might be reduced.

The SWMM program ranks the partial duration series, the exceedance frequency and the return period. They are computed using the Weibull formula for plotting position. See the flow duration curve and peak flow frequency on the following pages.

SECTION V. RESULT ANALYSIS

Development of the Flow Duration Statistics

The flow duration statistics are also developed directly from the SWMM binary output file. It should be noted right from the start that the "durations" that we are talking about in this section have nothing to do with the "storm durations" presented in the peak flow statistics section. Other than using the same sequence of letters for the word, the two concepts have nothing to do with each other and the reader is cautioned not to confuse the two. The goal of the flow duration statistics is to determine, for the flow rates that fall within the hydromorphologicaly significant range, the length of time that each of those flow rates occur. Since the amount of sediment transported by a river or stream is proportional to the velocity of the water flowing and the length of time that velocity of flow acts on the sediment, knowing the velocity and length of time for each flow rate is very useful.

Methodology

The methodology for determining the flow duration curves comes from a document developed by the U.S. Geological Survey (USGS). The first stop on the journey to find this document was a link to the USGS water site (http://www.usgs.gov/water/). This link is found in Appendix E (SDHMP Continuous

Simulation Modeling Primer), found in the County Hydromodification Management Plan[1]. On this web site a search for "Flow Duration Curves" leads to USGS Publication 1542-A, Flow-duration curves, by James K. Searcy 1959 (http://pubs.er.usgs.gov/publication/wsp1542A). In this publication the development of the flow duration curves is discussed in detail.

In Pub 1542-A, beginning on page 7 an example problem is used to illustrate the compilation of data used to create the flow duration plots. A completed form 9-217-c form shows the monthly tabulation of flow rates for Bowie Creek near Hattiesburg, Miss. For each flow range the number of readings is tabulated and then the total number of each flow rate is totaled for the year. It should be noted that while this example is for a stream with a minimum flow rate of 100cfs, for the purposes of run-off studies in Southern California the minimum flow rate of zero (0) cfs is the common low flow value. Once each of the year's data has been compiled the summary numbers from each year are transferred to form 9-217-d. On this form the total number of each flow rate is again totaled and the percentage of time exceeded calculated (as will be explained later under the discussion of our calculations). Once the data has been compiled a graph of Discharge Rate vs. Percent Time Exceeded is developed. As will be explained in the next section, the use of these curves leads to the amount of time each particular flow can be expected to occur (based on historical data).

How to Read the Graphs[2]

Figure 1 shows a flow duration curve for a hypothetical development. The three curves show what percentage of the time a range of flow rates are exceeded for three different conditions: pre-project, post-project and post-project with storm water mitigation. Under pre-project conditions the minimum geomorphically significant flow rate is 0.10cfs (assumed) and as read from the graph, flows would equal or exceed this value about 0.14% of the time (or about 12 hours per year) (0.0014 x 365days x 24 hour/day). For post-project conditions, this flow rate would occur more often – about 0.38% of the time (or about 33 hours per year) (0.0038 x 365days x 24 hour/day). This increase in the duration of the geomorphically significant flow after development illustrates why duration control is closely linked to

[1] FINAL HYDROMODIFICATION MANAGEMENT PLAN, Prepared for County of San Diego, California, March 2011, by Brown and Caldwell Engineering of San Diego.
(http://www.projectcleanwater.org/images/stories/Docs/LDS/HMP/0311_SD_HMP_wAppendices.pdf)
[2] The graph and the explanation were taken directly from Appendix E of the Hydromodification Plan

protecting creeks from accelerated erosion.

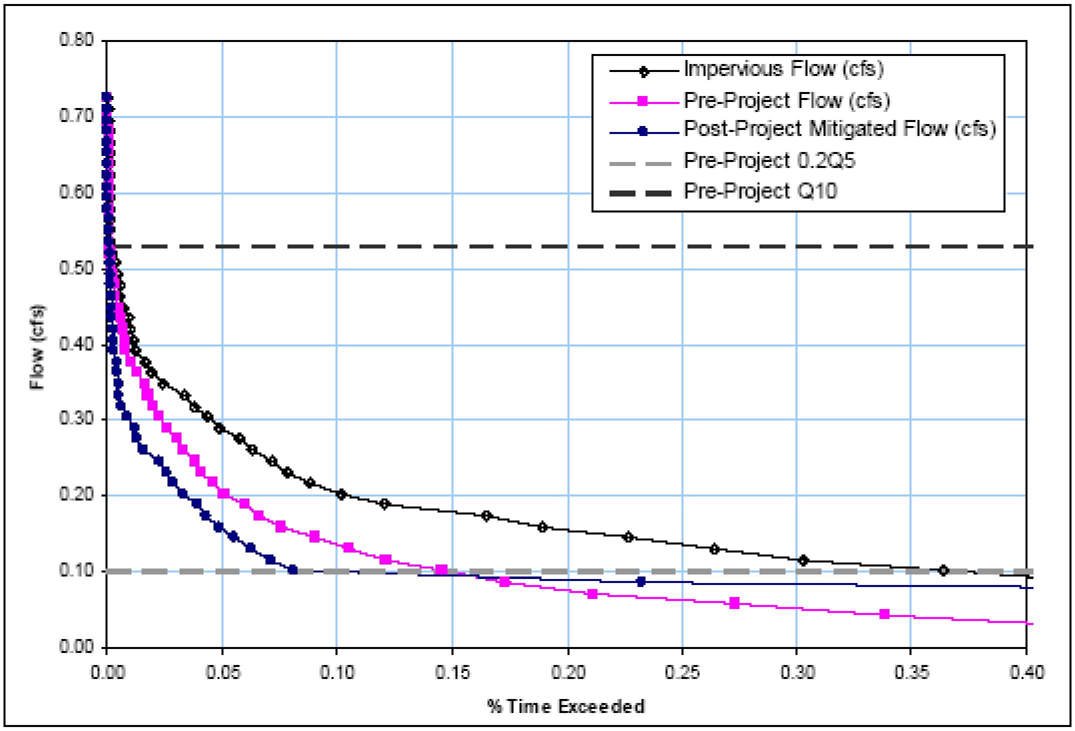


Figure 1. Flow Duration Series Statistics for a Hypothetical Development Scenario

Development of Flow Duration Curves

The first step in developing the flow duration curves is to count the number of occurrences of each flow rate. This is done by first rounding every non-zero flow value to an appropriate number of decimal places (say two places). This in effect groups each flow into closely related values or "bins" as they are referred to in publication 9-217d. Then the entire runoff record is queried for each value and the number of each value counted. The next step is to enter the results of the query into a grid patterned after form 9-217d. The data is entered in ascending order starting with the lowest flow first. The grid is composed of four columns. They are (from left to right) Discharge Rate, Number of **Periods (count),** Total Periods Exceeding (the total number of periods equal to or exceeding this value), and Percent Time Exceeded. Starting at the top row (row 1), the flow rate (which is often times zero) is entered with the corresponding number of times that value was found. The next column is the total number of values greater than or equal to that flow rate. For the first flow rate point, by definition all flow rate values are greater than or equal to this value, therefore the total number of runoff records of the rainfall record is entered here. The final column which is the percent of time exceeded is calculated by dividing the total periods exceeded by the total number of periods in the study. For the first row this number should be 100%

For the next row (row 2), the flow rate, and the flow rate count are entered. The total number of periods exceeding for row 2 is calculated by subtracting Number of Periods of row 1 from the Total Periods Exceeding of line 1. This result is entered in the Total Periods Exceeding on row 2. As was the case for line 1, the final column is calculated by dividing the total periods exceeded by the total number of periods in the study. For the second row this number should be something less than 100% and continually decrease as we move down the chart. If all the calculations are correct, then everything should zero out on the last line of the calculations.

The final step in developing the flow duration curves is to make a plot of the Discharge Rate vs. the Percent Time Exceeded. For the purposes of this report, the first value corresponding to the zero flow rate is not plotted allowing the graph to be focused on the actual flow rate values.

The Flow Duration Analysis

The Peak Flow Statistics analysis is composed of the following series of files:

1. The Flow Duration Plot
2. Comparison of the Un-Mitigated Flow Duration Curve to the Pre-Development Curve (Pass/Fail)
3. Comparison of the Mitigated Flow Duration Curve to the Pre-Development Curve (Pass/Fail)
4. The calculations for the Pre-Development flow duration curve development (USGS9217d)
5. The calculations for the Post-Development flow duration curve development (USGS9217d)
6. The calculations for the Mitigated flow duration curve development (USGS9217d)

The Flow Duration Plot

The Flow Duration Curves Plot is the plotting of all three (pre, un-mitigated and mitigated) sets of Discharge Rate vs. the Percent Time Exceeded data point pair lists. In addition to these curves horizontal lines are plotted corresponding to the Q_{10} and Q_{lf} (low flow threshold) values. Within the geomorphically significant range (Q_{10} – Q_{lf}) one can see a visual representation of the relative positions of the flow duration curves. The flow duration curves are compared in an East/West (horizontal) direction to compare post development Discharge Rates to pre-development Discharge Rates. The pre-development curve is plotted in blue, the unmitigated curve is plotted in red, and the mitigated curve is plotted in green. As long as the post development curve lies to the left of the pre-development curve (mostly[3]), the project meets the peak flow hydromodification requirements.

Pass/Fail comparison of the curves

The next two sets of data are the point by point comparison of the post-development curve(s) and the pre-development curve. The Pass/Fail table is helpful in determining compliance since the plotted lines can be difficult to see at the scales suitable for use in a report. Each point on the post- development curve has a corresponding "Y" value (Flow Rate), and "X" value (% Time Exceeded). For each point on the post development curve, the "Y" value is used to interpolate the corresponding Percent Time Exceeded (X) value from the pre-development curve. Then the Post-development Percent Time Exceeded value is compared to the pre-development Percent Time Exceeded value. Based on the relative values of each point, pass/fail criteria are determined point by point.

For each set of data, the upper right hand header value shows the name of the file being displayed (ex. flowDurationPassFailMitigated.TXT). The first line of the file shows the name of the SWMM output file (*.out). The next line shows the time stamp of the SWMM file that is being analyzed. The time stamps of all of the report files should be within a minute or two of each other, otherwise there may have been

[3] See hydromodification limits for exceedance of pre-development values

tampering with the files. Each report run creates and prints all of the files and reports at one time so all the time stamps should be very close.

The first column is the zero based number of the point. The next two columns show the post development “X” and “Y” values. The next column shows the value interpolated between the two bounding points on the pre-development curve. The next three columns show the true or false values of the comparison of the two “X” values. The last column shows the resultant pass or fail status of the point. There are three ways a point can pass. They are:

1. Q_{post} being outside of the geomorphically significant range Q_{lf} to Q_{10}
2. Q_{post} being less than Q_{pre}
3. Q_{post} being less than 110% of the value of Q_{pre} if the point is between Q_{lf} and Q_{10}

There are two ways that a point can fail. They are:

1. Q_{post} being greater than 110% of Q_{pre} if the point is between Q_{lf} and Q_{10}
2. If more than 10% of the points are between 100% and 110% of Q_{pre} for the points between Q_{lf} and Q_{10}

A quick scan down the last column will quickly tell if there are any points that fail.

At the bottom of each set of data are the date stamp of the report to the left, and to the right is the page number/number of pages for the specific set of data (not the pages of the report!). Each new set of data has its own page numbering. Between the file name in the header row and the page numbering in the footer row, the engineer can readily scan the document for the data of interest.

Plan Check Suggestions

As was described under the peak flow section, is the responsibility of the reviewing agency to confirm that the data sets presented are valid results from consistent calculations, and that any and all results can be duplicated by manual methods and achieve the same results. In light of these goals, the plan checker is invited to consider the following tasks as part of the plan check process.

Compare the Data Stamps for Each of the Statistics Files Used In This Analysis.

As was described in the Peak Flows section, all report files should have time stamps that are nearly identical. If the time values are more than a few minutes apart then the potential for inconsistent results files should be investigated.

Verify the Flow Rate Counts

For each of the pre, un-mitigate and mitigated flow duration tables, a few randomly selected flow value counts should be checked against the values taken directly from the SWMM file. This can be done by opening the corresponding SWMM file, selecting the outfall node, selecting Report>Table>By Object, Setting the time format to Date/Time, selecting the appropriate node value, and clicking the OK button to generate a table of the date/time/Total Inflow values. Next step is to click in the left most header row of the SWMM table which will select the entire table. Now from the main menu select Edit>Copy To>Clipboard. Now open a new blank sheet in MS Excel (or suitable spread sheet program) select cell

A1 and paste the results from the clipboard into the spread sheet. Now sort the values based on the Total Inflow column. This will group all the flow values together enabling the number of occurrences of each value to be counted. At this point the a few (or all) of the counts on the various USGS9217d.txt files can be verified.

Manually Verify That the Percent Exceeded Values (form USGS9217d) are Correctly Calculated

The discharge rates and counts are confirmed as was described above. The top row should be the smallest runoff value (0.00cfs usually). Total Periods Exceeding of the first line should be the total number of rainfall records in the study. The percentage of Time Exceeding should be the total periods Exceeding divided by the total number of rainfall records in the study (100% for the first line). For each successive discharge rate, the total periods exceeding for the current line should be the total periods exceeding from the line above minus the number of periods from the line above. The number of periods and the number of periods exceeding should zero out at the last line.

Compare Plotted Curves to Table Data
Randomly check a few of the plotted points against the values verified above.
Verify by Observation that the plotted values of Q_{10} and Q_{lf} are reasonable.
Verify that the correct values for each of these return periods are plotted correctly on the graph.

Development of the Peak Flow Statistics

The peak flow statistics are developed directly from the binary output file produced by the SWMM program. The site is modeled three ways, Pre-Development, Post-Development-Unmitigated, and Post-Development-Mitigated. For each of these files a specific time period differentiating distinct storms is chosen. The SWMM results are extracted and each flow value is queried. The majority of the values for Southern California sites are zero flow. As each successive record is read, as soon as a non-zero value is read the time and flow value of that record are recorded as the beginning of an event. The first record is automatically recorded as the “tentative” peak value. As each successive non-zero value is read and the successive flow value is compared to the peak value and the greater value is retained as the peak value of the storm. As soon as a successive number of zero values equal to the predetermined storm separation value, then the time value of the last non-zero value is recorded as the end of the storm, the duration of the storm is the difference between the end time and the start time, and the peak value is recorded as the highest flow value between the start and end times.

Once the entire SWMM output file is read all of the distinct storm events will have been recorded in a special list. The storms will be in the order of their occurrence. To develop the peak flow statistics table the first step is to sort the storms in descending order of the peak flow value. Once the list is sorted then the relative rank of each storm is assigned with the highest ranking storm being the storm with the highest peak flow. There are several methods that can be used to determine which storm should be ranked above another equally valued storm. For the purposes of these studies an Ordinal ranking is used so that each storm has a unique rank number. Where two or more storms have equal flow values, the earlier storm is assigned the higher rank. This is done consistently throughout the storm record. Since we are only looking at peak flow statistics, it is assumed that the relative ranking of individual (but equal) storms is irrelevant to the calculations.

The exceedance frequency and return period are both computed using the Weibull formula for plotting position. Therefore, for a specific event the exceedance frequency F and the return period in years T are calculated using the following equations[4]:

$F=m/(n_R+1)$ and $T=n+1/m$

where m is the event's rank, n_R is the total number of events and n is the number of years under analysis.

Once the Peak flow statistics table is complete, a plot of Return Frequency vs. peak flow is created. All three conditions (pre, post and mitigated) are plotted on the same plot.

The Peak Flow Statistics Analysis

The Peak Flow Statistics analysis is composed of the following series of files:

1. The Peak Flow Frequency Plot
2. The Comparison of the Un-Mitigated Peak Flow Curve to the Pre-Development Curve (Pass/Fail)
3. The Comparison of the Mitigated Conditions Curve to the Pre-Development Curve (Pass/Fail)
4. The Peak Flow Statistics Calculation for the Pre-Development Curve.
5. The Peak Flow Statistics Calculation for the Un-Mitigated Curve.
6. The Peak Flow Statistics Calculation for the Mitigated Curve.

The Peak Flow Frequency Plot

The Peak Flow Frequency Curves are the plotting of all three (Pre, Un-Mitigated and Mitigated) sets of return Period vs peak flow data point pair lists. In addition to these curves horizontal lines are plotted corresponding to the Q_{10}, Q_5, Q_2 and Q_{lf} (low flow threshold) values. Within the geomorphically significant range ($Q_{10} – Q_{lf}$) one can see a visual representation of the relative positions of the peak flow curves. The peak flow curves are compared in a North/South (vertical) direction to compare post development peak flows to pre-development flows. The Pre-Development curve is plotted in blue, the unmitigated curve is plotted in red, and the mitigated curve is plotted in green. As long as the post development curve lies below the pre-development curve (mostly[5]), the project meets the peak flow hydromodification requirements.

Pass/Fail comparison of the curves

The next two sets of data are the point by point comparison of the post-development curve(s) and the pre-development curve. The Pass/Fail table is helpful in determining compliance since the plotted lines can be difficult to see at the scales suitable for use in a report. Each point on the post- development curve has a corresponding "X" value (Recurrence Interval), and "Y" value (Peak Flow). For each point on the post development curve, the "X" value is used to interpolate the corresponding peak flow value from the pre-development curve. Then the Post-development peak flow value is compared to the pre-development peak flow value. Based on the relative values of each point, pass/fail criteria are determined point by point.

[4] Pg 169-170 STORM WATER MANAGEMENT MODEL APPLICATIONS MANUAL, EPA/600/R-09/000 July 2009
[5] See hydromodification limits for exceedance of pre-development values

For each set of data, the upper right hand header value shows the name of the file being displayed (ex. peakFlowPassFailMitigated.TXT). The first line of the file also shows this value. The next line shows the time stamp of the file that is being analyzed. The time stamps of all of the report files should be within a minute or two of each other, otherwise there may have been tampering with the files. Each report run creates and prints all of the files and reports at one time so all the time stamps should be very close. It should be noted that the SWMM.out files will not have related time stamps since each file is developed independently.

The first column is the zero based number of the point. The next two columns show the post development "X" and "Y" values. The next column shows the value interpolated between the two bounding points on the pre-development curve. The next three columns show the true or false values of the comparison of the two "Y" values. The last column shows the resultant pass or fail status of the point. There are three ways a point can pass. They are:

1. Point is outside of the geomorphically significant range $Q_{10} – Q_{lf}$
2. Q_{post} being less than Q_{pre}
3. Q_{post} being less than 110% of the value of Q_{pre} if the point is between Q_5 and Q_{10}[6]

There are four ways that a point can fail. They are:

1. Q_{post} being greater than Q_{pre} if the point is between Q_{lf} and Q_5
2. Q_{post} being greater than 110% of Q_{pre} if the point is between Q_{lf} and Q_{10}
3. If more than 10% of the points are between 100% and 110% of Q_{pre} for the points between Q_5 and Q_{10}
4. If the frequency interval for points > 100% of Q_{pre} is greater than 1 year for the points between Q_5 and Q_{10}

A quick scan down the last column will quickly tell if there are any points that fail.

At the bottom of each set of data are the date stamp of the report to the left, and to the right is the page number/number of pages for the specific set of data (not the pages of the report!). Each new set of data has its own page numbering. Between the file name in the header row and the page numbering in the footer row, the engineer can readily scan the document for the data of interest.

The Peak Flow Statistics Calculations

There are three sets of data for the Peak Flow Statistics calculations (Pre-Development, Un-Mitigated, and Mitigated). As was the case for the pass/fail data, the upper right hand corner of each sheet has the file name. The first row of the data is the SWMM file name. The second row is the SWMM file time stamp of the file being analyzed. The 4th, 5th, and 6th rows are the calculated values for Q_{10}, Q_5, and Q_2. These values are derived by linear interpolation between the nearest bounding points in the listing. While the relationship between the points in the peak flow analysis is not technically a linear relationship, the error introduced in using linear interpolation between such relatively close data points is assumed to be irrelevant. Finally, the footer row shows the report time and the page/number of pages of the data set.

[6] See section on how a point can fail point number 3 hereon

As was previously discussed, each storm listed was determined by reading the flow values directly from the binary output file from the SWMM program. The storms were then sorted in descending order of peak flow values. Then each storm was assigned a unique rank, then the Frequency and Return Period were calculated using Weibull formulas. Every discharge value for the entire rainfall record is listed in each of these lists. It should be noted that the derivation of these peak flow statistics values use full precision (i.e. no rounding off) of the SWMM output values. Since the precision of the calculations may not be the same as the SWMM program uses, and also the assignment of rank to values of equal peak flow value may differ slightly from the way SWMM calculates the tables, minor variances in the data values and/or the order of storms can be expected.

Finally, as was previously stated, the values of the Return Period were plotted vs. the peak flow values to develop the peak flow frequency curves.

Plan Check Suggestions

As is the responsibility of the reviewing agency, any and all methods should be considered to verify that the SWMM analysis adequately models the site as far as hydrologic discharge is concerned, and that the data sets presented are valid results from consistent calculations, and that any and all results can be duplicated by manual methods and achieve the same results. In light of these goals, the plan checker is invited to consider the following tasks as part of the plan check process.

Compare the Data Stamps for Each of the Statistics Files Used In This Analysis.

For each set of calculations and report files, the first step of the process is to list out all the files in the report folder and delete those files. The very first step leaves the reports folder completely empty. Then as each successive step is performed, the results file is placed in the reports folder. Once all of the results files are complete, then the report file is compiled using the data directly from the files placed in the results folder. This means that the time stamps on each of the report files in the report should be within a minute or two depending on the speed of the computer. If the time values are more than a few minutes apart then the potential for inconsistent results files should be investigated.

Verify A Few Random Storm Statistics

For each of the Pre, Un-mitigate and Mitigated peak flow statics tables, a few randomly selected storms should be checked against the values taken directly from the SWMM file. This can be done by opening the corresponding SWMM file, selecting the outfall node, selecting Report>Table>By Object, Setting the time format to Date/Time, selecting the appropriate node value, and clicking the OK button to generate a table of the date/time/Total Inflow values. Now scroll down the list to the start date and time of the randomly selected storm. Verify that the start date, end date, and the highest flow value between the start and end date correspond to the values shown in the statistics table. Do this for a few storm to verify that the data corresponds to the SWMM output file. Verify by hand a few of the frequency and return period values.

Compare Plotted Curves to Table Data

Randomly check a few of the plotted points against the values found in the Peak Flow Frequency Tables.

Verify by Observation that the values of Q_{10}, Q_5, Q_2 and Q_{lf} are reasonable.

For each value shown on the reports, verify that the value shown for say Q10 is in between the next higher return period and the next lower period. Also verify that the correct values for each of these return periods are plotted correctly on the peak flow frequency graph.

Manually Verify That the Pass-Fail Table Is Correctly Calculated

Select at random several points on each of the pass-fail tables to verify that the values for post X/Y and interpolated Y look reasonable. Also check that the various test results are shown accurately in the chart and also the final pass-fail result looks accurate.

VI. SUMMARY AND CONCLUSIO`N

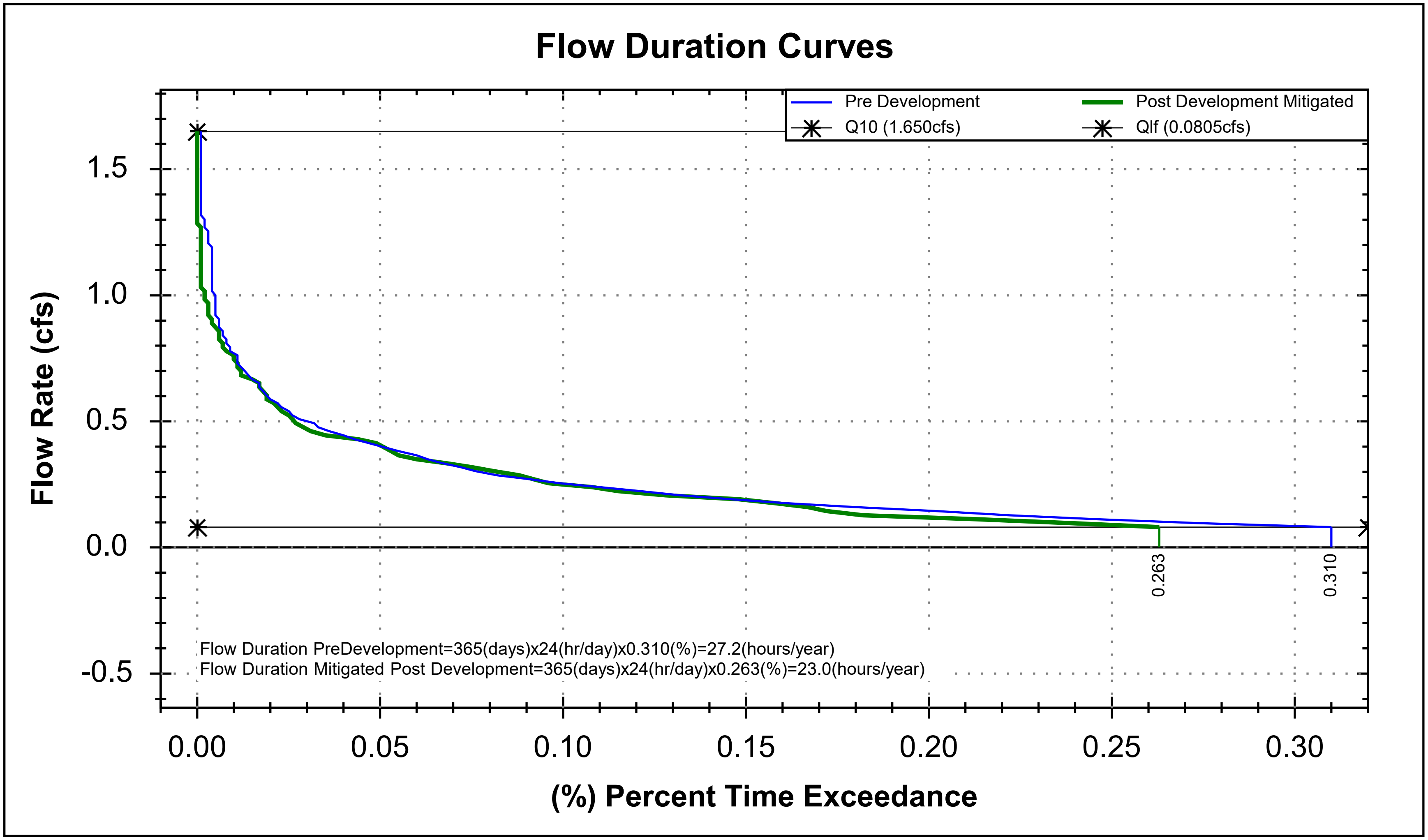
Hydromodification calculations were performed utilizing continuous simulation to size storm water control facilities. SWMM (Storm Water Management Model) version 5.1 distributed by USEPA was used to generate computed peak flow recurrence and flow duration series statistics.

There are tributary areas with each stored by a detention pipe storage and then treated by 1 modular wetland systems (MWS). The detention pipes with hydromodification storage were labeled as with a total tributary area of approximately 3.0 acres. The areas were grouped based on its outfall and were analyzed for pre−development and mitigated post−development conditions.

The analyzed SWMM runs attached show that the proposed proprietary bio−filtration (MWS) facilities provide variety of orifice flow control sizes at the base of the gravel storage configured as shown in Figure 1 is in compliance with the latest BMP Manual City of Oceanside.

On the Two Point of Compliance (POC)

For POC 1−With the proposed square footage of LID areas and orifices acting as the low flow restrictor configured as shown in Figure 7, the duration of the flow is 14.5 hours (0.166%×365days×24 hour/day =14.5 hours/year), with an existing flow duration of 25.7 hours (0.293%x365daysx24 hour/day =25.7(hours/year).


Flow Duration Curves
Pre Development
Post Development Mitigated
Q10 (1.650cfs)
Qlf (0.0805cfs)
Flow Rate (cfs)
1.5
1.0
0.5
0.0
-0.5
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.263
0.310
Flow Duration PreDevelopment=365(days)x24(hr/day)x0.310(%)=27.2(hours/year)
Flow Duration Mitigated Post Development=365(days)x24(hr/day)x0.263(%)=23.0(hours/year)
(%) Percent Time Exceedance

Attachment A

SWMM STATISTICS ANALYSIS, FLOW DURATION CURVE AND PASS/FAIL TABLE

STATISTICS ANALYSIS OF THE SWMM FILES FOR:

DISCHARGE NODE: POC-1

ANALYSIS DETAILS

Statistics Selection: Nodes/Total Inflow
Stream Susceptibility to Channel Erosion: High (Qlf = (0.1)Q2)
Assumed time between storms (hours): 24

PRE-DEVELOPMENT SWMM FILE

SWMM file name: V:\18\18005\Engineering\SDP\Storm-SDP\SWMM\JEN\SWMM FILES\ITERATIONS\60\18005ex.out
SWMM file time stamp: 2/27/2020 10:08:27 AM
Selected Node to Analyze: POC-1

POST-DEVELOPMENT MITIGATED SWMM FILE

SWMM file name: V:\18\18005\Engineering\SDP\Storm-SDP\SWMM\JEN\SWMM FILES\ITERATIONS\60\Stormchamber-alt.out
SWMM file time stamp: 2/28/2020 3:41:05 PM
Selected Node to Analyze: POC-1

MITIGATED CONDITIONS RESULTS

For the Mitigated Conditions:
Peak Flow Conditions PASS
Flow Duration Conditions PASS

The Mitigated Conditions peak flow frequency curve is composed of 390 points. Of the points, 0 point(s) are above the flow control upper limit (Q10), 287 point(s) are below the low flow threshold value (Qlf). Of the points within the flow control range (Qlf to Q10), 103 point(s) have a lower peak flow rate than pre-development conditions. These points all pass. There are no points that failed, therefore the unmitigated conditions peak flow requirements have been met.

The Mitigated Conditions flow duration curve is composed of 100 flow bins (points) between the upper flow threshold (cfs) and lower flow threshold (cfs). Each point represents the number of hours where the discharge was equal to or greater than the discharge value, but less than the next greater flow value. Comparing the post-development flow duration curve to the pre-development curve, 92 point(s) have a lower duration than pre-development conditions, and 8 point(s) have a duration that exceeds the pre-development by less than 10%, and for less than 10% of the curve length. These points all pass. There are no points that failed, therefore the unmitigated conditions flow duration requirements have been met.

Development of the Peak Flow Statistics

The peak flow statistics are developed directly from the binary output file produced by the SWMM program. The site is modeled for the Pre-Development, and Post-Development-Mitigated conditions. For each of these files a specific time period differentiating distinct storms is chosen. The SWMM results are extracted and each flow value is queried. The majority of the values for Southern California sites are zero flow. As each successive record is read, as soon as a non-zero value is read the time and flow value of that record are recorded as the beginning of an event. The first record is automatically recorded as the "tentative" peak value. As each successive non-zero value is read and the successive flow value is compared to the peak value and the greater value is retained as the peak value of the storm. As soon as a successive number of zero values equal to the chosen storm separation value (generally assumed to be 24 hours), then the time value of the last non-zero value is recorded as the end of the storm, the duration of the storm is the difference between the end time and the start time, and the peak value is recorded as the highest flow value between the start and end times.

Once the entire SWMM output file is read all of the distinct storm events will have been recorded in a special list. The storms will be in the order of their occurrence. To develop the peak flow statistics table the first step is to sort the storms in descending order of the peak flow value. Once the list is sorted then the relative rank of each storm is assigned with the highest ranking storm being the storm with the highest peak flow. There are several methods that can be used to determine which storm should be ranked above another equally valued storm. For the purposes of these studies an Ordinal ranking is used so that each storm has a unique rank number. Where two or more storms have equal flow values, the earlier storm is assigned the higher rank. This is done consistently throughout the storm record. Since we are only looking at peak flow statistics, it is assumed that the relative ranking of individual (but equal) storms is irrelevant to the calculations.

The exceedance frequency and return period are both computed using the Weibull formula for plotting position. Therefore, for a specific event the exceedance frequency F and the return period in years T are calculated using the following equations[1]:

$F=m/(n_R+1)$ and $T=n+1/m$

where m is the event's rank, n_R is the total number of events and n is the number of years under analysis.

Once the Peak flow statistics table is complete, a plot of Return Frequency vs. peak flow is created. All three conditions (pre, post and mitigated) are plotted on the same plot.

[1] Pg 169-170 STORM WATER MANAGEMENT MODEL APPLICATIONS MANUAL, EPA/600/R-09/000 July 2009

The Peak Flow Statistics Analysis

The Peak Flow Statistics analysis is composed of the following series of files:

1. The Peak Flow Frequency Plot
2. The Comparison of the Un-Mitigated Peak Flow Curve to the Pre-Development Curve (Pass/Fail)
3. The Comparison of the Mitigated Conditions Curve to the Pre-Development Curve (Pass/Fail)
4. The Peak Flow Statistics Calculation for the Pre-Development Curve.
5. The Peak Flow Statistics Calculation for the Un-Mitigated Curve.
6. The Peak Flow Statistics Calculation for the Mitigated Curve.

The Peak Flow Frequency Plot

The Peak Flow Frequency Curves are the plotting of all three (Pre, Un-Mitigated and Mitigated) sets of return Period vs peak flow data point pair lists. In addition to these curves horizontal lines are plotted corresponding to the Q_{10}, Q_5, Q_2 and Q_{lf} (low flow threshold) values. Within the geomorphically significant range (Q_{10} – Q_{lf}) one can see a visual representation of the relative positions of the peak flow curves. The peak flow curves are compared in a North/South (vertical) direction to compare post development peak flows to pre-development flows. The Pre-Development curve is plotted in blue, the unmitigated curve is plotted in red, and the mitigated curve is plotted in green. As long as the post development curve lies below the pre-development curve (mostly[2]), the project meets the peak flow hydromodification requirements.

Pass/Fail comparison of the curves

The next two sets of data are the point by point comparison of the post-development curve(s) and the pre-development curve. The Pass/Fail table is helpful in determining compliance since the plotted lines can be difficult to see at the scales suitable for use in a report. Each point on the post- development curve has a corresponding "X" value (Recurrence Interval), and "Y" value (Peak Flow). For each point on the post development curve, the "X" value is used to interpolate the corresponding peak flow value from the pre-development curve. Then the Post-development peak flow value is compared to the pre-development peak flow value. Based on the relative values of each point, pass/fail criteria are determined point by point.

For each set of data, the upper right hand header value shows the name of the file being displayed (ex. peakFlowPassFailMitigated.TXT). The first line of the file also shows this value. The next line shows the time stamp of the file that is being analyzed. The time stamps of all of the report files should be within a minute or two of each other, otherwise there may have been tampering with the files. Each report run creates and prints all of the files and reports at one time so all the time stamps should be very close. It

[2] See hydromodification limits for exceedance of pre-development values

should be noted that the SWMM.out files will not have related time stamps since each file is developed independently.

The first column is the zero based number of the point. The next two columns show the post development “X” and “Y” values. The next column shows the value interpolated between the two bounding points on the pre-development curve. The next three columns show the true or false values of the comparison of the two “Y” values. The last column shows the resultant pass or fail status of the point. There are three ways a point can pass. They are:

1. Point is outside of the geomorphically significant range Q_{10} – Q_{lf}
2. Q_{post} being less than Q_{pre}
3. Q_{post} being less than 110% of the value of Q_{pre} if the point is between Q_5 and Q_{10}[3]

There are four ways that a point can fail. They are:

1. Q_{post} being greater than Q_{pre} if the point is between Q_{lf} and Q_5
2. Q_{post} being greater than 110% of Q_{pre} if the point is between Q_{lf} and Q_{10}
3. If more than 10% of the points are between 100% and 110% of Q_{pre} for the points between Q_5 and Q_{10}
4. If the frequency interval for points > 100% of Q_{pre} is greater than 1 year for the points between Q_5 and Q_{10}

A quick scan down the last column will quickly tell if there are any points that fail.

At the bottom of each set of data are the date stamp of the report to the left, and to the right is the page number/number of pages for the specific set of data (not the pages of the report!). Each new set of data has its own page numbering. Between the file name in the header row and the page numbering in the footer row, the engineer can readily scan the document for the data of interest.

The Peak Flow Statistics Calculations

There are three sets of data for the Peak Flow Statistics calculations (Pre-Development, Un-Mitigated, and Mitigated). As was the case for the pass/fail data, the upper right hand corner of each sheet has the file name. The first row of the data is the SWMM file name. The second row is the SWMM file time stamp of the file being analyzed. The 4th, 5th, and 6th rows are the calculated values for Q_{10}, Q_5, and Q_2. These values are derived by linear interpolation between the nearest bounding points in the listing. While the relationship between the points in the peak flow analysis is not technically a linear relationship, the error introduced in using linear interpolation between such relatively close data points is assumed to be irrelevant. Finally, the footer row shows the report time and the page/number of pages of the data set.

[3] See section on how a point can fail point number 3 hereon

As was previously discussed, each storm listed was determined by reading the flow values directly from the binary output file from the SWMM program. The storms were then sorted in descending order of peak flow values. Then each storm was assigned a unique rank, then the Frequency and Return Period were calculated using Weibull formulas. Every discharge value for the entire rainfall record is listed in each of these lists. It should be noted that the derivation of these peak flow statistics values use full precision (i.e. no rounding off) of the SWMM output values. Since the precision of the calculations may not be the same as the SWMM program uses, and also the assignment of rank to values of equal peak flow value may differ slightly from the way SWMM calculates the tables, minor variances in the data values and/or the order of storms can be expected.

Finally, as was previously stated, the values of the Return Period were plotted vs. the peak flow values to develop the peak flow frequency curves.

Plan Check Suggestions

As is the responsibility of the reviewing agency, any and all methods should be considered to verify that the SWMM analysis adequately models the site as far as hydrologic discharge is concerned, and that the data sets presented are valid results from consistent calculations, and that any and all results can be duplicated by manual methods and achieve the same results. In light of these goals, the plan checker is invited to consider the following tasks as part of the plan check process.

Compare the Data Stamps for Each of the Statistics Files Used In This Analysis.

For each set of calculations and report files, the first step of the process is to list out all the files in the report folder and delete those files. The very first step leaves the reports folder completely empty. Then as each successive step is performed, the results file is placed in the reports folder. Once all of the results files are complete, then the report file is compiled using the data directly from the files placed in the results folder. This means that the time stamps on each of the report files in the report should be within a minute or two depending on the speed of the computer. If the time values are more than a few minutes apart then the potential for inconsistent results files should be investigated.

Verify A Few Random Storm Statistics

For each of the Pre, Un-mitigate and Mitigated peak flow statics tables, a few randomly selected storms should be checked against the values taken directly from the SWMM file. This can be done by opening the corresponding SWMM file, selecting the outfall node, selecting Report>Table>By Object, Setting the time format to Date/Time, selecting the appropriate node value, and clicking the OK button to generate a table of the date/time/Total Inflow values. Now scroll down the list to the start date and time of the randomly selected storm. Verify that the start date, end date, and the highest flow value between the start and end date correspond to the values shown in the statistics table. Do this for a few storm to verify that the data corresponds to the SWMM output file. Verify by hand a few of the frequency and return period values.

Compare Plotted Curves to Table Data

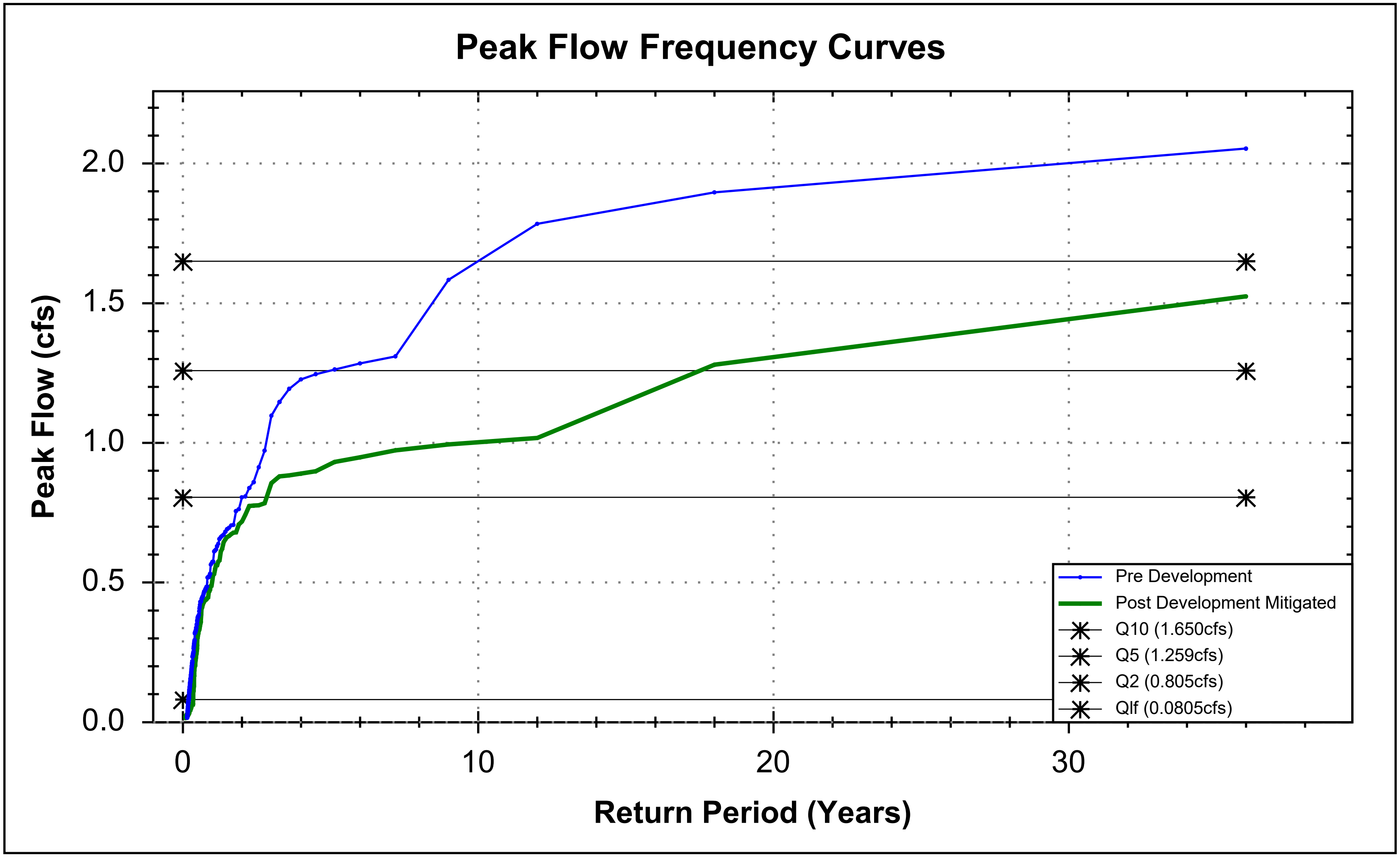
Randomly check a few of the plotted points against the values found in the Peak Flow Frequency Tables.

Verify by Observation that the values of Q_{10}, Q_5, Q_2 and Q_{lf} are reasonable.

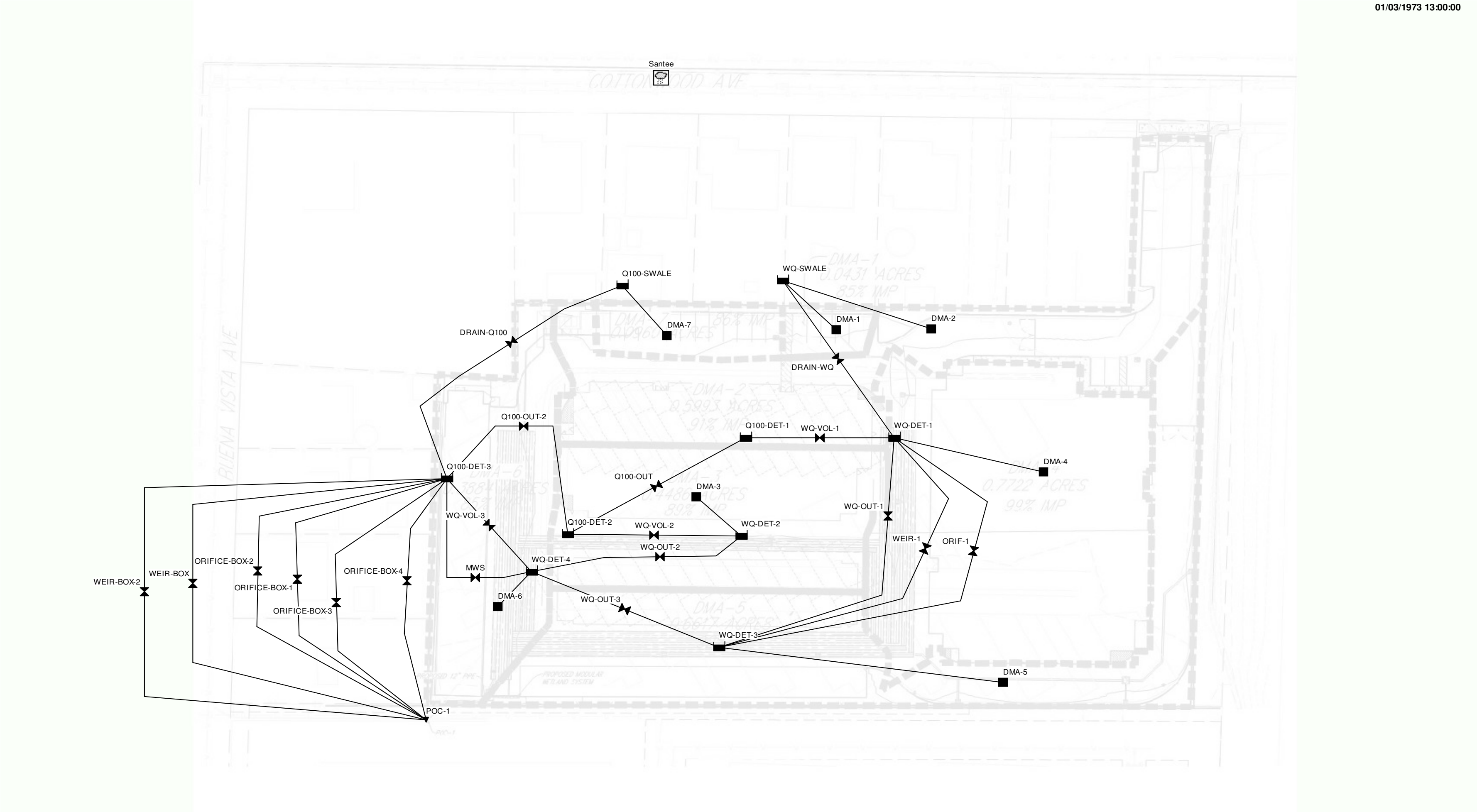
For each value shown on the reports, verify that the value shown for say Q10 is in between the next higher return period and the next lower period. Also verify that the correct values for each of these return periods are plotted correctly on the peak flow frequency graph.

Manually Verify That the Pass Fail Table Is Correctly Calculated

Select at random several points on each of the pass/fail tables to verify that the values for post X/Y and interpolated Y look reasonable. Also check that the various test results are shown accurately in the chart and also the final pass/fail result looks accurate.


Peak Flow Frequency Curves
Peak Flow (cfs)
2.0
1.5
1.0
0.5
0.0
0
10
20
30
Return Period (Years)
Pre Development
Post Development Mitigated
Q10 (1.650cfs)
Q5 (1.259cfs)
Q2 (0.805cfs)
Qlf (0.0805cfs)

01/03/1973 13:00:00



Compare Post-Development Curve to Pre-Development Curve

post-development SWMM file: V:\18\18005\Engineering\SDP\Storm-SDP\SWMM\JEN\SWMM FILES\ITERATIONS\60\Stormchamber-alt.out
post-development time stamp: 2/28/2020 3:41:05 PM
Compared to:
pre-development SWMM file: V:\18\18005\Engineering\SDP\Storm-SDP\SWMM\JEN\SWMM FILES\ITERATIONS\60\18005ex.out
pre-development time stamp: 2/27/2020 10:08:27 AM

Post PT #	Rtn Prd (yrs)	Post Dev Q	Pre Dev Q	Qpost < Qpre	Qpost > Qpre	Qpost > 110% Qpre	Pass/Fail
0	36.00	1.52	2.05	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
1	18.00	1.28	1.90	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
2	12.00	1.02	1.78	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
3	9.00	0.99	1.58	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
4	7.20	0.97	1.31	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
5	6.00	0.95	1.28	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
6	5.14	0.93	1.26	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
7	4.50	0.90	1.25	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
8	4.00	0.89	1.23	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
9	3.60	0.88	1.19	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
10	3.27	0.88	1.15	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
11	3.00	0.86	1.10	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
12	2.77	0.78	0.97	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
13	2.57	0.78	0.91	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
14	2.40	0.78	0.86	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
15	2.25	0.77	0.84	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
16	2.12	0.74	0.81	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
17	2.00	0.72	0.81	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
18	1.90	0.71	0.76	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
19	1.80	0.68	0.76	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
20	1.71	0.68	0.71	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
21	1.64	0.67	0.70	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
22	1.57	0.67	0.70	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
23	1.50	0.66	0.69	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
24	1.44	0.65	0.68	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
25	1.39	0.64	0.67	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
26	1.33	0.62	0.67	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
27	1.29	0.61	0.66	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
28	1.24	0.58	0.66	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
29	1.20	0.57	0.64	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
30	1.16	0.56	0.63	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
31	1.13	0.56	0.62	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
32	1.09	0.55	0.61	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
33	1.06	0.53	0.61	TRUE	FALSE	FALSE	Pass- Qpost < Qpre

Post PT #	Rtn Prd (yrs)	Post Dev Q	Pre Dev Q	Qpost < Qpre	Qpost > Qpre	Qpost > 110% Qpre	Pass/Fail
34	1.03	0.53	0.57	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
35	1.00	0.51	0.57	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
36	0.97	0.49	0.57	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
37	0.95	0.49	0.56	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
38	0.92	0.47	0.53	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
39	0.90	0.47	0.52	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
40	0.88	0.46	0.52	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
41	0.86	0.45	0.52	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
42	0.84	0.45	0.52	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
43	0.82	0.44	0.49	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
44	0.80	0.44	0.48	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
45	0.78	0.44	0.48	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
46	0.77	0.44	0.48	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
47	0.75	0.44	0.47	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
48	0.74	0.43	0.47	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
49	0.72	0.43	0.47	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
50	0.71	0.43	0.46	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
51	0.69	0.43	0.45	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
52	0.68	0.42	0.45	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
53	0.67	0.42	0.45	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
54	0.66	0.41	0.45	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
55	0.64	0.41	0.44	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
56	0.63	0.40	0.44	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
57	0.62	0.38	0.43	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
58	0.61	0.36	0.43	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
59	0.60	0.35	0.43	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
60	0.59	0.35	0.43	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
61	0.58	0.34	0.42	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
62	0.57	0.34	0.41	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
63	0.56	0.33	0.41	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
64	0.55	0.33	0.40	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
65	0.55	0.33	0.38	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
66	0.54	0.33	0.38	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
67	0.53	0.32	0.38	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
68	0.52	0.32	0.38	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
69	0.51	0.31	0.38	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
70	0.51	0.31	0.37	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
71	0.50	0.30	0.37	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
72	0.49	0.30	0.37	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
73	0.49	0.28	0.36	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
74	0.48	0.26	0.35	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
75	0.47	0.26	0.35	TRUE	FALSE	FALSE	Pass- Qpost < Qpre

Post PT #	Rtn Prd (yrs)	Post Dev Q	Pre Dev Q	Qpost < Qpre	Qpost > Qpre	Qpost > 110% Qpre	Pass/Fail
76	0.47	0.25	0.35	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
77	0.46	0.24	0.34	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
78	0.46	0.24	0.34	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
79	0.45	0.24	0.34	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
80	0.44	0.23	0.33	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
81	0.44	0.23	0.33	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
82	0.43	0.22	0.33	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
83	0.43	0.22	0.32	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
84	0.42	0.21	0.32	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
85	0.42	0.21	0.32	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
86	0.41	0.21	0.32	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
87	0.41	0.20	0.32	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
88	0.40	0.20	0.32	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
89	0.40	0.20	0.29	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
90	0.40	0.19	0.29	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
91	0.39	0.18	0.29	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
92	0.39	0.17	0.29	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
93	0.38	0.17	0.28	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
94	0.38	0.16	0.28	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
95	0.38	0.13	0.27	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
96	0.37	0.12	0.27	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
97	0.37	0.12	0.26	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
98	0.36	0.11	0.25	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
99	0.36	0.11	0.25	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
100	0.36	0.11	0.25	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
101	0.35	0.10	0.24	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
102	0.35	0.08	0.24	TRUE	FALSE	FALSE	Pass- Qpost < Qpre
103	0.35	0.07	0.24	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
104	0.34	0.07	0.24	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
105	0.34	0.07	0.24	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
106	0.34	0.06	0.24	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
107	0.33	0.06	0.24	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
108	0.33	0.06	0.23	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
109	0.33	0.06	0.23	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
110	0.32	0.06	0.22	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
111	0.32	0.06	0.21	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
112	0.32	0.06	0.21	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
113	0.32	0.06	0.21	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
114	0.31	0.06	0.21	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
115	0.31	0.06	0.20	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
116	0.31	0.06	0.20	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
117	0.31	0.06	0.20	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold

Post PT #	Rtn Prd (yrs)	Post Dev Q	Pre Dev Q	Qpost < Qpre	Qpost > Qpre	Qpost > 110% Qpre	Pass/Fail
118	0.30	0.06	0.20	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
119	0.30	0.06	0.19	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
120	0.30	0.06	0.19	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
121	0.30	0.06	0.19	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
122	0.29	0.06	0.19	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
123	0.29	0.06	0.19	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
124	0.29	0.06	0.18	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
125	0.29	0.06	0.18	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
126	0.28	0.06	0.17	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
127	0.28	0.06	0.17	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
128	0.28	0.06	0.17	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
129	0.28	0.06	0.17	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
130	0.28	0.05	0.16	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
131	0.27	0.05	0.16	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
132	0.27	0.05	0.16	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
133	0.27	0.05	0.16	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
134	0.27	0.05	0.16	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
135	0.27	0.05	0.16	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
136	0.26	0.05	0.16	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
137	0.26	0.05	0.15	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
138	0.26	0.05	0.15	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
139	0.26	0.05	0.15	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
140	0.26	0.05	0.15	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
141	0.25	0.05	0.14	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
142	0.25	0.05	0.14	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
143	0.25	0.05	0.14	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
144	0.25	0.05	0.14	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
145	0.25	0.04	0.14	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
146	0.25	0.04	0.14	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
147	0.24	0.04	0.13	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
148	0.24	0.04	0.13	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
149	0.24	0.04	0.13	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
150	0.24	0.04	0.13	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
151	0.24	0.04	0.13	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
152	0.24	0.04	0.13	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
153	0.23	0.04	0.12	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
154	0.23	0.04	0.12	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
155	0.23	0.04	0.12	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
156	0.23	0.04	0.12	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
157	0.23	0.04	0.12	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
158	0.23	0.04	0.12	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
159	0.23	0.04	0.12	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold

Post PT #	Rtn Prd (yrs)	Post Dev Q	Pre Dev Q	Qpost < Qpre	Qpost > Qpre	Qpost > 110% Qpre	Pass/Fail
160	0.22	0.04	0.11	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
161	0.22	0.04	0.11	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
162	0.22	0.04	0.11	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
163	0.22	0.04	0.11	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
164	0.22	0.04	0.11	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
165	0.22	0.04	0.11	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
166	0.22	0.04	0.11	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
167	0.21	0.04	0.10	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
168	0.21	0.04	0.10	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
169	0.21	0.04	0.10	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
170	0.21	0.04	0.09	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
171	0.21	0.04	0.09	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
172	0.21	0.04	0.09	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
173	0.21	0.04	0.09	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
174	0.21	0.04	0.09	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
175	0.21	0.04	0.09	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
176	0.20	0.04	0.09	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
177	0.20	0.04	0.09	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
178	0.20	0.03	0.08	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
179	0.20	0.03	0.08	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
180	0.20	0.03	0.08	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
181	0.20	0.03	0.08	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
182	0.20	0.03	0.08	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
183	0.20	0.03	0.08	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
184	0.20	0.03	0.08	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
185	0.19	0.03	0.08	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
186	0.19	0.03	0.08	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
187	0.19	0.03	0.08	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
188	0.19	0.03	0.07	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
189	0.19	0.03	0.07	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
190	0.19	0.03	0.07	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
191	0.19	0.03	0.07	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
192	0.19	0.03	0.07	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
193	0.19	0.03	0.07	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
194	0.19	0.03	0.07	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
195	0.18	0.03	0.07	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
196	0.18	0.03	0.07	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
197	0.18	0.03	0.07	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
198	0.18	0.03	0.07	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
199	0.18	0.03	0.07	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
200	0.18	0.03	0.07	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
201	0.18	0.03	0.06	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold

Post PT #	Rtn Prd (yrs)	Post Dev Q	Pre Dev Q	Qpost < Qpre	Qpost > Qpre	Qpost > 110% Qpre	Pass/Fail
202	0.18	0.03	0.06	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
203	0.18	0.03	0.06	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
204	0.18	0.03	0.06	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
205	0.18	0.03	0.05	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
206	0.17	0.03	0.05	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
207	0.17	0.03	0.05	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
208	0.17	0.03	0.05	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
209	0.17	0.03	0.05	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
210	0.17	0.03	0.05	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
211	0.17	0.03	0.04	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
212	0.17	0.03	0.04	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
213	0.17	0.03	0.04	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
214	0.17	0.03	0.04	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
215	0.17	0.03	0.04	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
216	0.17	0.03	0.04	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
217	0.17	0.03	0.04	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
218	0.16	0.03	0.04	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
219	0.16	0.03	0.04	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
220	0.16	0.03	0.03	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
221	0.16	0.03	0.03	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
222	0.16	0.03	0.03	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
223	0.16	0.03	0.03	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
224	0.16	0.03	0.03	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
225	0.16	0.03	0.03	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
226	0.16	0.03	0.03	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
227	0.16	0.03	0.03	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
228	0.16	0.03	0.03	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
229	0.16	0.03	0.03	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
230	0.16	0.03	0.02	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
231	0.16	0.03	0.02	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
232	0.16	0.03	0.02	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
233	0.15	0.03	0.02	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
234	0.15	0.03	0.02	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
235	0.15	0.03	0.02	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
236	0.15	0.03	0.02	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
237	0.15	0.03	0.02	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
238	0.15	0.03	0.02	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
239	0.15	0.03	0.02	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
240	0.15	0.03	0.02	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
241	0.15	0.03	0.02	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
242	0.15	0.02	0.01	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
243	0.15	0.02	0.01	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold

Post PT #	Rtn Prd (yrs)	Post Dev Q	Pre Dev Q	Qpost < Qpre	Qpost > Qpre	Qpost > 110% Qpre	Pass/Fail
244	0.15	0.02	0.01	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
245	0.15	0.02	0.01	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
246	0.15	0.02	0.01	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
247	0.15	0.02	0.01	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
248	0.15	0.02	0.01	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
249	0.14	0.02	0.01	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
250	0.14	0.02	0.01	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
251	0.14	0.02	0.01	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
252	0.14	0.02	0.01	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
253	0.14	0.02	0.01	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
254	0.14	0.02	0.01	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
255	0.14	0.02	0.01	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
256	0.14	0.02	0.01	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
257	0.14	0.02	0.01	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
258	0.14	0.02	0.00	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
259	0.14	0.02	0.00	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
260	0.14	0.02	0.00	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
261	0.14	0.02	0.00	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
262	0.14	0.02	0.00	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
263	0.14	0.02	0.00	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
264	0.14	0.02	0.00	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
265	0.14	0.02	0.00	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
266	0.14	0.02	0.00	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
267	0.13	0.02	0.00	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
268	0.13	0.02	0.00	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
269	0.13	0.02	0.00	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
270	0.13	0.02	0.00	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
271	0.13	0.02	0.00	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
272	0.13	0.02	0.00	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
273	0.13	0.02	-0.01	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
274	0.13	0.02	-0.01	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
275	0.13	0.02	-0.01	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
276	0.13	0.02	-0.01	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
277	0.13	0.02	-0.01	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
278	0.13	0.02	-0.01	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
279	0.13	0.02	-0.01	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
280	0.13	0.02	-0.01	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
281	0.13	0.02	-0.01	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
282	0.13	0.02	-0.01	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
283	0.13	0.02	-0.01	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
284	0.13	0.02	-0.01	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
285	0.13	0.02	-0.01	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold

Post PT #	Rtn Prd (yrs)	Post Dev Q	Pre Dev Q	Qpost < Qpre	Qpost > Qpre	Qpost > 110% Qpre	Pass/Fail
286	0.13	0.02	-0.01	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
287	0.13	0.02	-0.01	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
288	0.13	0.02	-0.01	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
289	0.12	0.02	-0.01	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
290	0.12	0.02	-0.01	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
291	0.12	0.02	-0.02	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
292	0.12	0.02	-0.02	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
293	0.12	0.02	-0.02	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
294	0.12	0.02	-0.02	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
295	0.12	0.02	-0.02	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
296	0.12	0.02	-0.02	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
297	0.12	0.02	-0.02	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
298	0.12	0.02	-0.02	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
299	0.12	0.02	-0.02	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
300	0.12	0.02	-0.02	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
301	0.12	0.02	-0.02	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
302	0.12	0.02	-0.02	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
303	0.12	0.02	-0.02	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
304	0.12	0.02	-0.02	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
305	0.12	0.02	-0.02	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
306	0.12	0.02	-0.02	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
307	0.12	0.02	-0.02	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
308	0.12	0.02	-0.02	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
309	0.12	0.02	-0.02	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
310	0.12	0.02	-0.02	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
311	0.12	0.02	-0.02	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
312	0.12	0.02	-0.02	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
313	0.12	0.02	-0.02	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
314	0.11	0.02	-0.03	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
315	0.11	0.02	-0.03	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
316	0.11	0.02	-0.03	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
317	0.11	0.02	-0.03	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
318	0.11	0.02	-0.03	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
319	0.11	0.02	-0.03	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
320	0.11	0.02	-0.03	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
321	0.11	0.02	-0.03	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
322	0.11	0.02	-0.03	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
323	0.11	0.02	-0.03	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
324	0.11	0.02	-0.03	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
325	0.11	0.02	-0.03	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
326	0.11	0.02	-0.03	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
327	0.11	0.02	-0.03	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold

Post PT #	Rtn Prd (yrs)	Post Dev Q	Pre Dev Q	Qpost < Qpre	Qpost > Qpre	Qpost > 110% Qpre	Pass/Fail
328	0.11	0.02	-0.03	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
329	0.11	0.02	-0.03	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
330	0.11	0.02	-0.03	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
331	0.11	0.02	-0.03	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
332	0.11	0.02	-0.03	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
333	0.11	0.02	-0.03	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
334	0.11	0.02	-0.03	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
335	0.11	0.02	-0.03	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
336	0.11	0.02	-0.03	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
337	0.11	0.02	-0.03	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
338	0.11	0.02	-0.04	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
339	0.11	0.02	-0.04	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
340	0.11	0.02	-0.04	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
341	0.11	0.02	-0.04	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
342	0.11	0.02	-0.04	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
343	0.11	0.02	-0.04	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
344	0.10	0.02	-0.04	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
345	0.10	0.02	-0.04	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
346	0.10	0.02	-0.04	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
347	0.10	0.02	-0.04	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
348	0.10	0.02	-0.04	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
349	0.10	0.02	-0.04	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
350	0.10	0.02	-0.04	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
351	0.10	0.02	-0.04	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
352	0.10	0.02	-0.04	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
353	0.10	0.02	-0.04	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
354	0.10	0.02	-0.04	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
355	0.10	0.02	-0.04	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
356	0.10	0.02	-0.04	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
357	0.10	0.02	-0.04	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
358	0.10	0.02	-0.04	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
359	0.10	0.02	-0.04	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
360	0.10	0.02	-0.04	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
361	0.10	0.02	-0.04	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
362	0.10	0.02	-0.04	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
363	0.10	0.02	-0.04	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
364	0.10	0.02	-0.04	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
365	0.10	0.02	-0.05	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
366	0.10	0.02	-0.05	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
367	0.10	0.02	-0.05	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
368	0.10	0.02	-0.05	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
369	0.10	0.02	-0.05	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold

Post PT #	Rtn Prd (yrs)	Post Dev Q	Pre Dev Q	Qpost < Qpre	Qpost > Qpre	Qpost > 110% Qpre	Pass/Fail
370	0.10	0.02	-0.05	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
371	0.10	0.02	-0.05	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
372	0.10	0.02	-0.05	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
373	0.10	0.02	-0.05	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
374	0.10	0.02	-0.05	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
375	0.10	0.02	-0.05	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
376	0.10	0.02	-0.05	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
377	0.10	0.02	-0.05	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
378	0.10	0.02	-0.05	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
379	0.10	0.02	-0.05	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
380	0.09	0.02	-0.05	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
381	0.09	0.02	-0.05	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
382	0.09	0.02	-0.05	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
383	0.09	0.02	-0.05	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
384	0.09	0.02	-0.05	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
385	0.09	0.02	-0.05	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
386	0.09	0.02	-0.05	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
387	0.09	0.02	-0.05	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
388	0.09	0.02	-0.05	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold
389	0.09	0.02	-0.05	FALSE	FALSE	FALSE	Pass- Qpost Below Flow Control Threshold

SWMM.out file name: V:\18\18005\Engineering\SDP\Storm-SDP\SWMM\JEN\SWMM FILES\ITERATIONS\60\18005ex.out
SWMM.out time stamp: 2/27/2020 10:08:27 AM

Q10: 1.650
Q5: 1.259
Q2: 0.805

Peak Flow Statistics Table Values

Rank	Start Date	End Date	Duration	Peak	Frequency	Return Period
1	1976/10/22 16:00:00	1976/10/22 19:00:00	4	2.053	0.41%	36
2	1980/02/16 19:00:00	1980/02/21 07:00:00	109	1.897	0.83%	18
3	2004/10/27 05:00:00	2004/10/28 17:00:00	37	1.784	1.24%	12
4	1998/02/07 05:00:00	1998/02/08 03:00:00	23	1.584	1.65%	9
5	1976/09/10 09:00:00	1976/09/10 17:00:00	9	1.31	2.07%	7.2
6	1983/03/01 15:00:00	1983/03/04 23:00:00	81	1.284	2.48%	6
7	1979/01/31 06:00:00	1979/02/01 05:00:00	24	1.263	2.89%	5.14
8	1982/03/12 16:00:00	1982/03/12 18:00:00	3	1.246	3.31%	4.5
9	1992/02/06 17:00:00	1992/02/07 00:00:00	8	1.227	3.72%	4
10	1980/01/28 22:00:00	1980/01/30 05:00:00	32	1.193	4.13%	3.6
11	1998/02/02 12:00:00	1998/02/03 02:00:00	15	1.146	4.55%	3.27
12	1991/02/27 19:00:00	1991/03/01 11:00:00	41	1.097	4.96%	3
13	1998/02/13 08:00:00	1998/02/14 02:00:00	19	0.972	5.37%	2.77
14	1974/12/04 10:00:00	1974/12/04 15:00:00	6	0.913	5.79%	2.57
15	1995/01/04 17:00:00	1995/01/05 05:00:00	13	0.859	6.20%	2.4
16	1983/11/20 12:00:00	1983/11/20 23:00:00	12	0.838	6.61%	2.25
17	1973/02/11 08:00:00	1973/02/11 22:00:00	15	0.808	7.02%	2.12
18	1977/08/17 01:00:00	1977/08/17 07:00:00	7	0.805	7.44%	2
19	2007/02/19 11:00:00	2007/02/19 20:00:00	10	0.762	7.85%	1.9
20	1986/02/15 03:00:00	1986/02/15 13:00:00	11	0.755	8.26%	1.8
21	1978/02/10 04:00:00	1978/02/11 16:00:00	37	0.706	8.68%	1.71
22	1976/02/08 17:00:00	1976/02/09 05:00:00	13	0.704	9.09%	1.64
23	1982/02/10 15:00:00	1982/02/11 04:00:00	14	0.696	9.50%	1.57
24	1974/10/28 11:00:00	1974/10/29 12:00:00	26	0.691	9.92%	1.5
25	1978/01/14 19:00:00	1978/01/15 09:00:00	15	0.682	10.33%	1.44
26	1993/01/31 01:00:00	1993/01/31 04:00:00	4	0.672	10.74%	1.39
27	1993/02/18 17:00:00	1993/02/19 23:00:00	31	0.667	11.16%	1.33
28	1992/02/15 14:00:00	1992/02/15 21:00:00	8	0.663	11.57%	1.29
29	1975/03/06 11:00:00	1975/03/06 14:00:00	4	0.656	11.98%	1.24
30	1980/01/09 13:00:00	1980/01/11 17:00:00	53	0.639	12.40%	1.2
31	2005/03/04 18:00:00	2005/03/05 06:00:00	13	0.63	12.81%	1.16
32	2004/10/19 16:00:00	2004/10/20 18:00:00	27	0.619	13.22%	1.13
33	1995/02/14 10:00:00	1995/02/14 13:00:00	4	0.614	13.64%	1.09
34	1983/03/24 04:00:00	1983/03/24 09:00:00	6	0.611	14.05%	1.06
35	1998/02/16 12:00:00	1998/02/17 01:00:00	14	0.574	14.46%	1.03
36	1993/01/12 15:00:00	1993/01/14 06:00:00	40	0.573	14.88%	1
37	2005/02/20 12:00:00	2005/02/23 07:00:00	68	0.569	15.29%	0.97
38	2004/12/28 10:00:00	2004/12/29 08:00:00	23	0.564	15.70%	0.95
39	1993/01/06 05:00:00	1993/01/08 13:00:00	57	0.531	16.12%	0.92

Rank	Start Date	End Date	Duration	Peak	Frequency	Return Period
40	1995/03/05 10:00:00	1995/03/06 03:00:00	18	0.524	16.53%	0.9
41	1982/03/14 16:00:00	1982/03/14 20:00:00	5	0.519	16.94%	0.88
42	1978/03/04 18:00:00	1978/03/05 18:00:00	25	0.519	17.36%	0.86
43	1981/03/01 05:00:00	1981/03/02 03:00:00	23	0.518	17.77%	0.84
44	1979/01/05 09:00:00	1979/01/06 13:00:00	29	0.486	18.18%	0.82
45	1993/01/15 13:00:00	1993/01/18 23:00:00	83	0.484	18.60%	0.8
46	2000/02/21 17:00:00	2000/02/21 23:00:00	7	0.477	19.01%	0.78
47	1973/02/13 04:00:00	1973/02/13 08:00:00	5	0.477	19.42%	0.77
48	1974/01/04 20:00:00	1974/01/05 13:00:00	18	0.471	19.83%	0.75
49	1984/12/18 14:00:00	1984/12/20 05:00:00	40	0.468	20.25%	0.74
50	1992/03/06 22:00:00	1992/03/07 00:00:00	3	0.468	20.66%	0.72
51	2003/02/11 17:00:00	2003/02/13 01:00:00	33	0.461	21.07%	0.71
52	1978/03/11 23:00:00	1978/03/12 13:00:00	15	0.455	21.49%	0.69
53	1983/02/27 17:00:00	1983/02/28 03:00:00	11	0.451	21.90%	0.68
54	1991/03/26 02:00:00	1991/03/27 11:00:00	34	0.45	22.31%	0.67
55	2004/02/22 13:00:00	2004/02/23 05:00:00	17	0.446	22.73%	0.66
56	1978/02/27 22:00:00	1978/03/02 19:00:00	70	0.442	23.14%	0.64
57	1980/03/06 05:00:00	1980/03/06 14:00:00	10	0.441	23.55%	0.63
58	1985/11/11 11:00:00	1985/11/11 21:00:00	11	0.432	23.97%	0.62
59	2004/12/09 14:00:00	2004/12/09 16:00:00	3	0.432	24.38%	0.61
60	1982/04/01 11:00:00	1982/04/01 19:00:00	9	0.431	24.79%	0.6
61	2005/01/09 09:00:00	2005/01/10 03:00:00	19	0.431	25.21%	0.59
62	1978/05/01 05:00:00	1978/05/01 07:00:00	3	0.421	25.62%	0.58
63	1987/01/04 18:00:00	1987/01/04 23:00:00	6	0.413	26.03%	0.57
64	1980/04/23 04:00:00	1980/04/23 06:00:00	3	0.407	26.45%	0.56
65	1996/03/13 07:00:00	1996/03/13 12:00:00	6	0.397	26.86%	0.55
66	1977/12/28 08:00:00	1977/12/28 23:00:00	16	0.385	27.27%	0.55
67	1981/02/09 00:00:00	1981/02/09 13:00:00	14	0.382	27.69%	0.54
68	1991/03/19 00:00:00	1991/03/21 07:00:00	56	0.38	28.10%	0.53
69	1978/01/16 23:00:00	1978/01/17 07:00:00	9	0.379	28.51%	0.52
70	1995/03/11 04:00:00	1995/03/11 10:00:00	7	0.377	28.93%	0.51
71	1997/01/01 10:00:00	1997/01/02 16:00:00	31	0.374	29.34%	0.51
72	1993/02/08 01:00:00	1993/02/08 19:00:00	19	0.373	29.75%	0.5
73	2003/04/13 17:00:00	2003/04/13 22:00:00	6	0.367	30.17%	0.49
74	1974/04/02 02:00:00	1974/04/02 10:00:00	9	0.362	30.58%	0.49
75	1982/03/17 10:00:00	1982/03/18 05:00:00	20	0.351	30.99%	0.48
76	1985/11/25 01:00:00	1985/11/25 21:00:00	21	0.351	31.40%	0.47
77	1984/12/11 05:00:00	1984/12/11 18:00:00	14	0.349	31.82%	0.47
78	1998/02/22 16:00:00	1998/02/24 00:00:00	33	0.339	32.23%	0.46
79	1978/11/24 03:00:00	1978/11/24 17:00:00	15	0.338	32.64%	0.46
80	1992/03/02 15:00:00	1992/03/02 21:00:00	7	0.338	33.06%	0.45
81	2003/02/24 17:00:00	2003/02/24 22:00:00	6	0.33	33.47%	0.44
82	1987/12/16 15:00:00	1987/12/16 23:00:00	9	0.326	33.88%	0.44
83	1988/04/20 08:00:00	1988/04/20 14:00:00	7	0.326	34.30%	0.43
84	2001/01/11 06:00:00	2001/01/12 16:00:00	35	0.325	34.71%	0.43
85	1978/02/12 23:00:00	1978/02/14 02:00:00	28	0.323	35.12%	0.42
86	1983/01/29 01:00:00	1983/01/29 05:00:00	5	0.32	35.54%	0.42

Rank	Start Date	End Date	Duration	Peak	Frequency	Return Period
87	1986/12/07 15:00:00	1986/12/07 17:00:00	3	0.32	35.95%	0.41
88	1976/02/05 02:00:00	1976/02/07 09:00:00	56	0.32	36.36%	0.41
89	1995/04/18 12:00:00	1995/04/18 13:00:00	2	0.318	36.78%	0.4
90	1977/05/08 23:00:00	1977/05/09 03:00:00	5	0.294	37.19%	0.4
91	1995/01/25 10:00:00	1995/01/26 03:00:00	18	0.292	37.60%	0.4
92	1992/02/12 21:00:00	1992/02/13 08:00:00	12	0.288	38.02%	0.39
93	2005/01/11 03:00:00	2005/01/11 11:00:00	9	0.286	38.43%	0.39
94	1987/12/04 22:00:00	1987/12/04 23:00:00	2	0.281	38.84%	0.38
95	1987/11/04 20:00:00	1987/11/05 17:00:00	22	0.275	39.26%	0.38
96	1994/02/17 12:00:00	1994/02/17 15:00:00	4	0.272	39.67%	0.38
97	1996/11/22 03:00:00	1996/11/22 07:00:00	5	0.27	40.08%	0.37
98	1974/01/07 14:00:00	1974/01/08 09:00:00	20	0.264	40.50%	0.37
99	2008/01/27 02:00:00	2008/01/27 10:00:00	9	0.252	40.91%	0.36
100	1990/01/14 04:00:00	1990/01/14 07:00:00	4	0.251	41.32%	0.36
101	2005/01/03 08:00:00	2005/01/04 09:00:00	26	0.249	41.74%	0.36
102	1983/03/21 05:00:00	1983/03/21 06:00:00	2	0.245	42.15%	0.35
103	1983/03/18 15:00:00	1983/03/18 23:00:00	9	0.244	42.56%	0.35
104	1978/02/05 15:00:00	1978/02/05 21:00:00	7	0.242	42.98%	0.35
105	1978/02/07 18:00:00	1978/02/07 23:00:00	6	0.238	43.39%	0.34
106	1992/01/05 15:00:00	1992/01/06 08:00:00	18	0.237	43.80%	0.34
107	2004/10/18 13:00:00	2004/10/18 14:00:00	2	0.236	44.21%	0.34
108	1979/10/20 14:00:00	1979/10/20 17:00:00	4	0.236	44.63%	0.33
109	2008/01/07 01:00:00	2008/01/07 05:00:00	5	0.235	45.04%	0.33
110	2004/02/26 09:00:00	2004/02/26 11:00:00	3	0.233	45.45%	0.33
111	1975/03/10 13:00:00	1975/03/11 16:00:00	28	0.218	45.87%	0.32
112	1981/12/30 13:00:00	1981/12/30 18:00:00	6	0.213	46.28%	0.32
113	1978/12/17 15:00:00	1978/12/19 11:00:00	45	0.213	46.69%	0.32
114	1979/03/28 10:00:00	1979/03/28 22:00:00	13	0.211	47.11%	0.32
115	1973/03/08 14:00:00	1973/03/08 19:00:00	6	0.211	47.52%	0.31
116	1999/01/26 14:00:00	1999/01/27 01:00:00	12	0.205	47.93%	0.31
117	1983/11/25 00:00:00	1983/11/25 03:00:00	4	0.203	48.35%	0.31
118	1976/12/29 14:00:00	1976/12/30 03:00:00	14	0.201	48.76%	0.31
119	1988/04/21 19:00:00	1988/04/22 02:00:00	8	0.2	49.17%	0.3
120	1988/12/25 00:00:00	1988/12/25 03:00:00	4	0.193	49.59%	0.3
121	1979/01/16 02:00:00	1979/01/16 03:00:00	2	0.192	50.00%	0.3
122	1973/01/19 00:00:00	1973/01/19 04:00:00	5	0.188	50.41%	0.3
123	1997/01/26 00:00:00	1997/01/26 08:00:00	9	0.186	50.83%	0.29
124	1973/11/23 00:00:00	1973/11/23 06:00:00	7	0.186	51.24%	0.29
125	1978/01/09 19:00:00	1978/01/10 20:00:00	26	0.18	51.65%	0.29
126	1993/11/14 09:00:00	1993/11/14 10:00:00	2	0.176	52.07%	0.29
127	1990/01/17 03:00:00	1990/01/17 05:00:00	3	0.172	52.48%	0.28
128	1983/02/08 06:00:00	1983/02/08 09:00:00	4	0.17	52.89%	0.28
129	1992/12/07 13:00:00	1992/12/07 16:00:00	4	0.169	53.31%	0.28
130	1995/01/10 20:00:00	1995/01/11 01:00:00	6	0.168	53.72%	0.28
131	1973/03/11 14:00:00	1973/03/11 19:00:00	6	0.163	54.13%	0.28
132	1983/01/27 08:00:00	1983/01/27 18:00:00	11	0.163	54.55%	0.27
133	1979/01/18 08:00:00	1979/01/18 21:00:00	14	0.158	54.96%	0.27

Rank	Start Date	End Date	Duration	Peak	Frequency	Return Period
134	1974/03/08 08:00:00	1974/03/08 12:00:00	5	0.158	55.37%	0.27
135	1980/02/14 04:00:00	1980/02/14 18:00:00	15	0.157	55.79%	0.27
136	1998/01/08 17:00:00	1998/01/08 21:00:00	5	0.156	56.20%	0.27
137	1978/04/07 05:00:00	1978/04/07 06:00:00	2	0.156	56.61%	0.26
138	1991/10/26 23:00:00	1991/10/27 03:00:00	5	0.155	57.02%	0.26
139	1980/03/10 18:00:00	1980/03/10 19:00:00	2	0.15	57.44%	0.26
140	1980/01/19 03:00:00	1980/01/19 05:00:00	3	0.148	57.85%	0.26
141	1983/12/03 17:00:00	1983/12/03 19:00:00	3	0.148	58.26%	0.26
142	2005/01/28 17:00:00	2005/01/28 19:00:00	3	0.143	58.68%	0.25
143	1994/02/08 08:00:00	1994/02/08 10:00:00	3	0.143	59.09%	0.25
144	1976/03/01 19:00:00	1976/03/01 21:00:00	3	0.142	59.50%	0.25
145	1981/03/19 23:00:00	1981/03/20 06:00:00	8	0.141	59.92%	0.25
146	1994/02/18 17:00:00	1994/02/18 19:00:00	3	0.141	60.33%	0.25
147	1981/03/05 18:00:00	1981/03/05 20:00:00	3	0.137	60.74%	0.25
148	1994/03/24 23:00:00	1994/03/25 03:00:00	5	0.133	61.16%	0.24
149	2006/02/28 00:00:00	2006/02/28 03:00:00	4	0.131	61.57%	0.24
150	1976/04/15 21:00:00	1976/04/15 22:00:00	2	0.13	61.98%	0.24
151	1973/03/22 02:00:00	1973/03/22 06:00:00	5	0.128	62.40%	0.24
152	2006/04/04 23:00:00	2006/04/05 03:00:00	5	0.126	62.81%	0.24
153	1986/03/15 23:00:00	1986/03/17 02:00:00	28	0.126	63.22%	0.24
154	1987/10/11 18:00:00	1987/10/11 19:00:00	2	0.124	63.64%	0.23
155	1984/12/27 02:00:00	1984/12/27 09:00:00	8	0.121	64.05%	0.23
156	1978/11/11 22:00:00	1978/11/12 00:00:00	3	0.12	64.46%	0.23
157	1973/03/06 14:00:00	1973/03/07 05:00:00	16	0.118	64.88%	0.23
158	2008/02/14 17:00:00	2008/02/14 18:00:00	2	0.117	65.29%	0.23
159	1983/02/02 14:00:00	1983/02/02 17:00:00	4	0.116	65.70%	0.23
160	1984/11/24 19:00:00	1984/11/24 23:00:00	5	0.116	66.12%	0.23
161	1973/03/28 21:00:00	1973/03/28 22:00:00	2	0.113	66.53%	0.22
162	1996/10/30 16:00:00	1996/10/30 18:00:00	3	0.112	66.94%	0.22
163	2003/12/25 19:00:00	2003/12/25 20:00:00	2	0.112	67.36%	0.22
164	1982/01/01 12:00:00	1982/01/02 12:00:00	25	0.107	67.77%	0.22
165	1995/01/12 10:00:00	1995/01/12 16:00:00	7	0.107	68.18%	0.22
166	2007/02/28 04:00:00	2007/02/28 06:00:00	3	0.106	68.60%	0.22
167	1992/03/20 16:00:00	1992/03/20 17:00:00	2	0.106	69.01%	0.22
168	1977/01/01 14:00:00	1977/01/01 16:00:00	3	0.103	69.42%	0.21
169	2007/12/09 00:00:00	2007/12/09 01:00:00	2	0.097	69.83%	0.21
170	1984/12/08 00:00:00	1984/12/08 02:00:00	3	0.095	70.25%	0.21
171	1977/12/26 08:00:00	1977/12/26 20:00:00	13	0.095	70.66%	0.21
172	2003/03/14 17:00:00	2003/03/15 17:00:00	25	0.089	71.07%	0.21
173	2005/03/22 22:00:00	2005/03/23 00:00:00	3	0.088	71.49%	0.21
174	1998/03/24 17:00:00	1998/03/24 18:00:00	2	0.087	71.90%	0.21
175	1975/03/08 13:00:00	1975/03/08 15:00:00	3	0.087	72.31%	0.21
176	2002/12/19 17:00:00	2002/12/19 22:00:00	6	0.086	72.73%	0.21
177	1999/04/12 03:00:00	1999/04/12 05:00:00	3	0.085	73.14%	0.2
178	1979/03/01 14:00:00	1979/03/01 16:00:00	3	0.085	73.55%	0.2
179	1974/11/01 23:00:00	1974/11/02 01:00:00	3	0.085	73.97%	0.2
180	2007/02/22 22:00:00	2007/02/22 23:00:00	2	0.082	74.38%	0.2

Rank	Start Date	End Date	Duration	Peak	Frequency	Return Period
181	2005/01/07 15:00:00	2005/01/07 18:00:00	4	0.081	74.79%	0.2
182	1982/01/21 08:00:00	1982/01/21 14:00:00	7	0.08	75.21%	0.2
183	1994/03/07 02:00:00	1994/03/07 06:00:00	5	0.079	75.62%	0.2
184	1985/11/29 15:00:00	1985/11/29 18:00:00	4	0.078	76.03%	0.2
185	1984/12/16 05:00:00	1984/12/16 06:00:00	2	0.077	76.45%	0.2
186	1983/03/22 23:00:00	1983/03/23 01:00:00	3	0.077	76.86%	0.19
187	2008/01/23 21:00:00	2008/01/23 22:00:00	2	0.077	77.27%	0.19
188	2008/02/03 12:00:00	2008/02/03 13:00:00	2	0.075	77.69%	0.19
189	1995/01/08 02:00:00	1995/01/08 05:00:00	4	0.075	78.10%	0.19
190	1976/09/03 17:00:00	1976/09/03 17:00:00	1	0.074	78.51%	0.19
191	1985/02/02 10:00:00	1985/02/02 10:00:00	1	0.073	78.93%	0.19
192	2006/03/28 23:00:00	2006/03/29 01:00:00	3	0.073	79.34%	0.19
193	1986/03/12 13:00:00	1986/03/12 14:00:00	2	0.072	79.75%	0.19
194	1995/01/16 10:00:00	1995/01/16 11:00:00	2	0.07	80.17%	0.19
195	2005/02/12 11:00:00	2005/02/12 16:00:00	6	0.07	80.58%	0.19
196	1999/04/07 10:00:00	1999/04/07 10:00:00	1	0.068	80.99%	0.18
197	1980/05/02 00:00:00	1980/05/02 00:00:00	1	0.068	81.40%	0.18
198	1973/03/20 10:00:00	1973/03/20 13:00:00	4	0.068	81.82%	0.18
199	1996/01/31 21:00:00	1996/02/01 05:00:00	9	0.066	82.23%	0.18
200	1998/12/05 07:00:00	1998/12/05 07:00:00	1	0.066	82.64%	0.18
201	1981/04/18 22:00:00	1981/04/18 23:00:00	2	0.065	83.06%	0.18
202	1975/02/03 15:00:00	1975/02/03 16:00:00	2	0.06	83.47%	0.18
203	1991/12/29 18:00:00	1991/12/29 19:00:00	2	0.056	83.88%	0.18
204	1987/10/31 21:00:00	1987/10/31 21:00:00	1	0.056	84.30%	0.18
205	1998/03/27 17:00:00	1998/03/27 19:00:00	3	0.054	84.71%	0.18
206	1973/03/13 23:00:00	1973/03/13 23:00:00	1	0.049	85.12%	0.18
207	1994/12/25 05:00:00	1994/12/25 06:00:00	2	0.049	85.54%	0.17
208	1980/02/22 17:00:00	1980/02/22 17:00:00	1	0.049	85.95%	0.17
209	1989/03/25 17:00:00	1989/03/25 17:00:00	1	0.049	86.36%	0.17
210	1998/12/06 07:00:00	1998/12/06 07:00:00	1	0.045	86.78%	0.17
211	2006/03/12 22:00:00	2006/03/12 23:00:00	2	0.043	87.19%	0.17
212	1992/01/07 20:00:00	1992/01/07 22:00:00	3	0.043	87.60%	0.17
213	2001/01/26 19:00:00	2001/01/26 21:00:00	3	0.043	88.02%	0.17
214	1980/04/28 16:00:00	1980/04/29 01:00:00	10	0.042	88.43%	0.17
215	2008/02/22 07:00:00	2008/02/22 08:00:00	2	0.042	88.84%	0.17
216	1976/03/03 01:00:00	1976/03/03 07:00:00	7	0.042	89.26%	0.17
217	2000/03/05 17:00:00	2000/03/05 19:00:00	3	0.039	89.67%	0.17
218	2001/03/06 17:00:00	2001/03/06 17:00:00	1	0.038	90.08%	0.17
219	1986/09/25 06:00:00	1986/09/25 06:00:00	1	0.038	90.50%	0.16
220	1990/04/04 08:00:00	1990/04/04 09:00:00	2	0.036	90.91%	0.16
221	1993/02/24 00:00:00	1993/02/24 00:00:00	1	0.035	91.32%	0.16
222	1975/03/26 04:00:00	1975/03/26 04:00:00	1	0.034	91.74%	0.16
223	1973/02/06 19:00:00	1973/02/06 19:00:00	1	0.033	92.15%	0.16
224	2007/11/30 22:00:00	2007/12/01 00:00:00	3	0.033	92.56%	0.16
225	2001/02/26 17:00:00	2001/02/27 19:00:00	27	0.032	92.98%	0.16
226	1998/04/10 17:00:00	1998/04/10 18:00:00	2	0.03	93.39%	0.16
227	1997/12/05 17:00:00	1997/12/05 17:00:00	1	0.029	93.80%	0.16

Rank	Start Date	End Date	Duration	Peak	Frequency	Return Period
228	1975/03/22 12:00:00	1975/03/22 12:00:00	1	0.026	94.21%	0.16
229	1994/04/26 18:00:00	1994/04/26 18:00:00	1	0.026	94.63%	0.16
230	2006/03/21 03:00:00	2006/03/21 03:00:00	1	0.023	95.04%	0.16
231	1988/01/17 20:00:00	1988/01/17 20:00:00	1	0.022	95.45%	0.16
232	1976/11/11 00:00:00	1976/11/11 00:00:00	1	0.022	95.87%	0.16
233	1978/01/05 22:00:00	1978/01/05 22:00:00	1	0.02	96.28%	0.16
234	1986/11/18 01:00:00	1986/11/18 01:00:00	1	0.019	96.69%	0.15
235	1975/03/14 03:00:00	1975/03/14 03:00:00	1	0.019	97.11%	0.15
236	1998/03/30 17:00:00	1998/03/30 17:00:00	1	0.019	97.52%	0.15
237	1998/04/14 17:00:00	1998/04/14 17:00:00	1	0.018	97.93%	0.15
238	1973/01/17 00:00:00	1973/01/17 00:00:00	1	0.018	98.35%	0.15
239	2005/02/18 07:00:00	2005/02/18 07:00:00	1	0.018	98.76%	0.15
240	1998/05/11 17:00:00	1998/05/11 17:00:00	1	0.017	99.17%	0.15
241	2001/02/23 17:00:00	2001/02/23 17:00:00	1	0.016	99.59%	0.15
--End of Data-----------------						

SWMM.out file name: V:\18\18005\Engineering\SDP\Storm-SDP\SWMM\JEN\SWMM FILES\ITERATIONS\60\Stormchamber-alt.out
SWMM.out time stamp: 2/28/2020 3:41:05 PM

Q10: 0.000
Q5: 0.000
Q2: 0.000

Peak Flow Statistics Table Values

Rank	Start Date	End Date	Duration	Peak	Frequency	Return Period
1	1976/10/22 16:00:00	1976/10/27 01:00:00	106	1.524	0.26%	36
2	1980/02/13 18:00:00	1980/02/29 11:00:00	378	1.28	0.51%	18
3	2004/10/27 06:00:00	2004/11/03 21:00:00	184	1.017	0.77%	12
4	1979/01/31 06:00:00	1979/02/07 09:00:00	172	0.995	1.02%	9
5	1998/02/02 10:00:00	1998/02/27 04:00:00	595	0.973	1.28%	7.2
6	1992/02/06 15:00:00	1992/02/18 01:00:00	275	0.948	1.53%	6
7	1982/03/12 05:00:00	1982/03/23 20:00:00	280	0.931	1.79%	5.14
8	1976/09/10 09:00:00	1976/09/14 02:00:00	90	0.898	2.05%	4.5
9	1974/12/04 10:00:00	1974/12/07 18:00:00	81	0.89	2.30%	4
10	1983/02/24 13:00:00	1983/03/11 11:00:00	359	0.884	2.56%	3.6
11	1975/03/06 10:00:00	1975/03/16 06:00:00	237	0.88	2.81%	3.27
12	2007/02/19 08:00:00	2007/02/24 12:00:00	125	0.855	3.07%	3
13	1974/10/26 16:00:00	1974/11/04 11:00:00	212	0.784	3.32%	2.77
14	1991/02/27 18:00:00	1991/03/07 06:00:00	181	0.777	3.58%	2.57
15	1977/08/16 20:00:00	1977/08/20 15:00:00	92	0.775	3.84%	2.4
16	1995/01/03 17:00:00	1995/01/15 01:00:00	273	0.774	4.09%	2.25
17	1995/02/14 02:00:00	1995/02/17 18:00:00	89	0.743	4.35%	2.12
18	1986/02/15 04:00:00	1986/02/18 22:00:00	91	0.718	4.60%	2
19	1993/01/31 02:00:00	1993/02/02 13:00:00	60	0.708	4.86%	1.9
20	1980/01/28 14:00:00	1980/02/04 15:00:00	170	0.68	5.12%	1.8
21	1976/02/04 04:00:00	1976/02/15 08:00:00	269	0.678	5.37%	1.71
22	1982/02/08 20:00:00	1982/02/14 14:00:00	139	0.673	5.63%	1.64
23	2004/12/28 10:00:00	2005/01/15 00:00:00	423	0.666	5.88%	1.57
24	1973/02/11 09:00:00	1973/02/16 20:00:00	132	0.662	6.14%	1.5
25	1985/11/11 08:00:00	1985/11/16 07:00:00	120	0.654	6.39%	1.44
26	1978/02/05 15:00:00	1978/02/18 10:00:00	308	0.644	6.65%	1.39
27	2004/10/17 15:00:00	2004/10/25 09:00:00	187	0.621	6.91%	1.33
28	1987/01/04 18:00:00	1987/01/09 18:00:00	121	0.611	7.16%	1.29
29	1993/02/18 18:00:00	1993/02/26 09:00:00	184	0.579	7.42%	1.24
30	2005/03/04 22:00:00	2005/03/08 02:00:00	77	0.575	7.67%	1.2
31	1978/01/09 20:00:00	1978/01/21 21:00:00	290	0.562	7.93%	1.16
32	1980/01/07 21:00:00	1980/01/21 12:00:00	328	0.562	8.18%	1.13
33	1983/11/20 13:00:00	1983/11/23 11:00:00	71	0.548	8.44%	1.09
34	1995/03/05 10:00:00	1995/03/10 03:00:00	114	0.53	8.70%	1.06
35	1993/01/06 06:00:00	1993/01/25 03:00:00	454	0.527	8.95%	1.03
36	2000/02/21 12:00:00	2000/02/27 09:00:00	142	0.506	9.21%	1
37	2005/02/18 07:00:00	2005/02/28 01:00:00	235	0.489	9.46%	0.97
38	2004/02/22 13:00:00	2004/02/29 06:00:00	162	0.487	9.72%	0.95
39	2003/02/24 12:00:00	2003/03/01 05:00:00	114	0.474	9.97%	0.92

Rank	Start Date	End Date	Duration	Peak	Frequency	Return Period
40	1977/05/08 20:00:00	1977/05/13 21:00:00	122	0.469	10.23%	0.9
41	2003/04/13 09:00:00	2003/04/17 04:00:00	92	0.465	10.49%	0.88
42	1991/03/19 02:00:00	1991/03/30 20:00:00	283	0.446	10.74%	0.86
43	1978/02/27 22:00:00	1978/03/15 21:00:00	384	0.445	11.00%	0.84
44	1974/01/04 21:00:00	1974/01/13 01:00:00	197	0.443	11.25%	0.82
45	1997/01/01 09:00:00	1997/01/06 18:00:00	130	0.439	11.51%	0.8
46	1980/03/06 06:00:00	1980/03/13 00:00:00	163	0.439	11.76%	0.78
47	1981/02/09 01:00:00	1981/02/13 01:00:00	97	0.437	12.02%	0.77
48	1976/12/29 12:00:00	1977/01/04 09:00:00	142	0.435	12.28%	0.75
49	1987/12/16 15:00:00	1987/12/21 09:00:00	115	0.434	12.53%	0.74
50	1981/12/30 12:00:00	1982/01/06 17:00:00	174	0.431	12.79%	0.72
51	1979/10/20 07:00:00	1979/10/23 07:00:00	73	0.427	13.04%	0.71
52	2003/02/10 22:00:00	2003/02/17 06:00:00	153	0.427	13.30%	0.69
53	1985/11/25 00:00:00	1985/12/05 07:00:00	248	0.421	13.55%	0.68
54	1981/02/26 01:00:00	1981/03/08 06:00:00	246	0.418	13.81%	0.67
55	1992/03/02 15:00:00	1992/03/09 20:00:00	174	0.412	14.07%	0.66
56	1996/11/21 20:00:00	1996/11/25 06:00:00	83	0.408	14.32%	0.64
57	1979/01/05 15:00:00	1979/01/10 02:00:00	108	0.405	14.58%	0.63
58	2008/01/05 07:00:00	2008/01/10 18:00:00	132	0.385	14.83%	0.62
59	1993/02/08 01:00:00	1993/02/12 01:00:00	97	0.359	15.09%	0.61
60	1994/02/17 13:00:00	1994/02/21 09:00:00	93	0.354	15.35%	0.6
61	1977/12/25 16:00:00	1978/01/01 10:00:00	163	0.348	15.60%	0.59
62	1984/12/08 01:00:00	1984/12/14 16:00:00	160	0.343	15.86%	0.58
63	1978/12/17 05:00:00	1978/12/23 18:00:00	158	0.337	16.11%	0.57
64	1984/12/16 07:00:00	1984/12/23 00:00:00	162	0.331	16.37%	0.56
65	1982/03/26 04:00:00	1982/04/04 11:00:00	224	0.329	16.62%	0.55
66	1996/03/12 23:00:00	1996/03/16 21:00:00	95	0.329	16.88%	0.55
67	1976/03/01 19:00:00	1976/03/06 18:00:00	120	0.326	17.14%	0.54
68	1978/11/11 04:00:00	1978/11/15 22:00:00	115	0.319	17.39%	0.53
69	1974/04/02 05:00:00	1974/04/04 17:00:00	61	0.316	17.65%	0.52
70	1995/03/11 04:00:00	1995/03/14 23:00:00	92	0.314	17.90%	0.51
71	1978/11/21 22:00:00	1978/11/27 10:00:00	133	0.309	18.16%	0.51
72	2007/11/30 12:00:00	2007/12/04 01:00:00	86	0.301	18.41%	0.5
73	2001/01/11 07:00:00	2001/01/15 15:00:00	105	0.301	18.67%	0.49
74	1992/12/07 12:00:00	1992/12/10 10:00:00	71	0.275	18.93%	0.49
75	1986/11/17 22:00:00	1986/11/20 08:00:00	59	0.264	19.18%	0.48
76	1986/12/06 09:00:00	1986/12/10 14:00:00	102	0.255	19.44%	0.47
77	1979/03/27 18:00:00	1979/04/01 21:00:00	124	0.247	19.69%	0.47
78	1995/01/25 09:00:00	1995/01/28 22:00:00	86	0.245	19.95%	0.46
79	2006/04/04 21:00:00	2006/04/08 03:00:00	79	0.242	20.20%	0.46
80	1999/01/25 12:00:00	1999/01/30 06:00:00	115	0.236	20.46%	0.45
81	2008/01/27 01:00:00	2008/01/30 09:00:00	81	0.231	20.72%	0.44
82	1976/11/11 00:00:00	1976/11/13 15:00:00	64	0.228	20.97%	0.44
83	1994/03/06 22:00:00	1994/03/10 04:00:00	79	0.224	21.23%	0.43
84	1988/04/20 09:00:00	1988/04/25 10:00:00	122	0.22	21.48%	0.43
85	1987/11/04 20:00:00	1987/11/08 13:00:00	90	0.211	21.74%	0.42
86	1981/03/20 00:00:00	1981/03/22 12:00:00	61	0.207	21.99%	0.42

Rank	Start Date	End Date	Duration	Peak	Frequency	Return Period
87	1982/01/20 21:00:00	1982/01/24 13:00:00	89	0.206	22.25%	0.41
88	1974/03/07 23:00:00	1974/03/11 01:00:00	75	0.202	22.51%	0.41
89	1997/01/26 01:00:00	1997/01/28 20:00:00	68	0.201	22.76%	0.4
90	1984/12/27 02:00:00	1984/12/30 14:00:00	85	0.197	23.02%	0.4
91	1992/01/05 16:00:00	1992/01/10 17:00:00	122	0.192	23.27%	0.4
92	2005/02/11 03:00:00	2005/02/16 07:00:00	125	0.184	23.53%	0.39
93	1983/03/17 15:00:00	1983/03/27 03:00:00	229	0.166	23.79%	0.39
94	1989/03/25 17:00:00	1989/03/28 01:00:00	57	0.165	24.04%	0.38
95	1987/12/04 23:00:00	1987/12/07 03:00:00	53	0.155	24.30%	0.38
96	1983/01/27 09:00:00	1983/01/31 13:00:00	101	0.128	24.55%	0.38
97	1988/01/17 13:00:00	1988/01/20 14:00:00	74	0.124	24.81%	0.37
98	1980/04/22 13:00:00	1980/04/25 08:00:00	68	0.122	25.06%	0.37
99	1990/01/14 05:00:00	1990/01/19 02:00:00	118	0.112	25.32%	0.36
100	1973/03/05 10:00:00	1973/03/16 06:00:00	261	0.111	25.58%	0.36
101	1976/04/12 11:00:00	1976/04/17 21:00:00	131	0.108	25.83%	0.36
102	1987/10/11 18:00:00	1987/10/14 18:00:00	73	0.1	26.09%	0.35
103	1991/10/27 00:00:00	1991/10/29 04:00:00	53	0.085	26.34%	0.35
104	2008/02/14 17:00:00	2008/02/16 21:00:00	53	0.065	26.60%	0.35
105	1975/11/27 22:00:00	1975/12/01 08:00:00	83	0.065	26.85%	0.34
106	1980/04/28 17:00:00	1980/05/03 13:00:00	117	0.065	27.11%	0.34
107	1978/05/01 05:00:00	1978/05/03 05:00:00	49	0.065	27.37%	0.34
108	1981/04/18 23:00:00	1981/04/21 05:00:00	55	0.064	27.62%	0.33
109	1992/03/20 17:00:00	1992/03/25 01:00:00	105	0.064	27.88%	0.33
110	1979/01/15 22:00:00	1979/01/21 06:00:00	129	0.064	28.13%	0.33
111	1986/09/25 05:00:00	1986/09/27 15:00:00	59	0.064	28.39%	0.32
112	1973/11/23 02:00:00	1973/11/27 07:00:00	102	0.063	28.64%	0.32
113	2006/02/28 01:00:00	2006/03/02 23:00:00	71	0.063	28.90%	0.32
114	1994/03/25 00:00:00	1994/03/27 17:00:00	66	0.063	29.16%	0.32
115	2004/12/05 02:00:00	2004/12/14 10:00:00	225	0.061	29.41%	0.31
116	1973/11/17 21:00:00	1973/11/21 10:00:00	86	0.061	29.67%	0.31
117	1979/03/01 15:00:00	1979/03/03 17:00:00	51	0.06	29.92%	0.31
118	1977/12/18 11:00:00	1977/12/20 19:00:00	57	0.06	30.18%	0.31
119	1986/03/08 20:00:00	1986/03/19 18:00:00	263	0.06	30.43%	0.3
120	2008/09/25 06:00:00	2008/09/26 15:00:00	34	0.059	30.69%	0.3
121	1995/04/16 10:00:00	1995/04/21 04:00:00	115	0.059	30.95%	0.3
122	2003/03/14 15:00:00	2003/03/18 19:00:00	101	0.058	31.20%	0.3
123	1998/03/24 15:00:00	1998/04/03 00:00:00	226	0.058	31.46%	0.29
124	1998/01/08 14:00:00	1998/01/12 07:00:00	90	0.057	31.71%	0.29
125	2003/12/25 15:00:00	2003/12/28 00:00:00	58	0.057	31.97%	0.29
126	1976/09/03 18:00:00	1976/09/05 15:00:00	46	0.057	32.23%	0.29
127	1986/02/08 01:00:00	1986/02/10 21:00:00	69	0.056	32.48%	0.28
128	1996/10/30 17:00:00	1996/11/01 19:00:00	51	0.056	32.74%	0.28
129	1993/11/14 10:00:00	1993/11/16 10:00:00	49	0.056	32.99%	0.28
130	1992/12/27 23:00:00	1992/12/31 04:00:00	78	0.055	33.25%	0.28
131	1988/12/25 01:00:00	1988/12/27 13:00:00	61	0.053	33.50%	0.28
132	1973/03/20 11:00:00	1973/03/24 08:00:00	94	0.053	33.76%	0.27
133	1988/02/02 09:00:00	1988/02/05 02:00:00	66	0.052	34.02%	0.27

Rank	Start Date	End Date	Duration	Peak	Frequency	Return Period
134	2007/12/07 11:00:00	2007/12/11 20:00:00	106	0.051	34.27%	0.27
135	1994/12/24 21:00:00	1994/12/27 04:00:00	56	0.051	34.53%	0.27
136	1973/01/17 00:00:00	1973/01/21 03:00:00	100	0.051	34.78%	0.27
137	1983/02/02 15:00:00	1983/02/05 08:00:00	66	0.05	35.04%	0.26
138	2008/02/03 13:00:00	2008/02/05 23:00:00	59	0.049	35.29%	0.26
139	1994/03/19 07:00:00	1994/03/22 09:00:00	75	0.049	35.55%	0.26
140	1983/11/25 01:00:00	1983/11/27 00:00:00	48	0.048	35.81%	0.26
141	2006/03/29 00:00:00	2006/03/31 07:00:00	56	0.047	36.06%	0.26
142	1977/10/06 07:00:00	1977/10/08 15:00:00	57	0.046	36.32%	0.25
143	1995/03/21 15:00:00	1995/03/25 00:00:00	82	0.045	36.57%	0.25
144	1984/11/24 20:00:00	1984/11/26 21:00:00	50	0.045	36.83%	0.25
145	2006/05/22 06:00:00	2006/05/24 03:00:00	46	0.045	37.08%	0.25
146	1983/02/08 03:00:00	1983/02/10 06:00:00	52	0.044	37.34%	0.25
147	2005/04/28 10:00:00	2005/04/30 12:00:00	51	0.044	37.60%	0.25
148	2002/11/07 15:00:00	2002/11/11 02:00:00	84	0.043	37.85%	0.24
149	1977/03/25 07:00:00	1977/03/28 05:00:00	71	0.043	38.11%	0.24
150	1975/02/03 15:00:00	1975/02/07 04:00:00	86	0.043	38.36%	0.24
151	1999/04/12 03:00:00	1999/04/14 02:00:00	48	0.042	38.62%	0.24
152	1981/01/28 10:00:00	1981/02/02 03:00:00	114	0.042	38.87%	0.24
153	1997/09/25 11:00:00	1997/09/27 15:00:00	53	0.041	39.13%	0.24
154	1991/07/31 05:00:00	1991/08/02 04:00:00	48	0.041	39.39%	0.23
155	2007/04/20 19:00:00	2007/04/22 20:00:00	50	0.04	39.64%	0.23
156	1978/04/07 06:00:00	1978/04/09 08:00:00	51	0.04	39.90%	0.23
157	2001/02/23 19:00:00	2001/03/02 07:00:00	157	0.039	40.15%	0.23
158	2002/11/28 15:00:00	2002/12/01 02:00:00	60	0.039	40.41%	0.23
159	1996/01/31 12:00:00	1996/02/03 14:00:00	75	0.039	40.66%	0.23
160	1986/01/30 07:00:00	1986/02/02 16:00:00	82	0.039	40.92%	0.23
161	2001/01/26 19:00:00	2001/01/29 08:00:00	62	0.039	41.18%	0.22
162	1983/12/25 00:00:00	1983/12/28 18:00:00	91	0.038	41.43%	0.22
163	2003/11/12 08:00:00	2003/11/14 07:00:00	48	0.038	41.69%	0.22
164	1988/04/15 01:00:00	1988/04/17 00:00:00	48	0.038	41.94%	0.22
165	2002/12/15 16:00:00	2002/12/22 19:00:00	172	0.038	42.20%	0.22
166	1975/03/22 12:00:00	1975/03/24 07:00:00	44	0.037	42.46%	0.22
167	1983/11/12 06:00:00	1983/11/15 14:00:00	81	0.037	42.71%	0.22
168	2006/01/01 03:00:00	2006/01/04 18:00:00	88	0.037	42.97%	0.21
169	1981/11/27 07:00:00	1981/12/01 10:00:00	100	0.036	43.22%	0.21
170	2001/03/06 16:00:00	2001/03/09 00:00:00	57	0.036	43.48%	0.21
171	1990/11/20 02:00:00	1990/11/22 14:00:00	61	0.036	43.73%	0.21
172	1997/12/05 16:00:00	1997/12/09 04:00:00	85	0.036	43.99%	0.21
173	1979/02/22 08:00:00	1979/02/25 04:00:00	69	0.035	44.25%	0.21
174	1978/03/31 01:00:00	1978/04/03 06:00:00	78	0.035	44.50%	0.21
175	1987/10/31 11:00:00	1987/11/03 03:00:00	65	0.035	44.76%	0.21
176	1975/02/09 17:00:00	1975/02/12 06:00:00	62	0.035	45.01%	0.21
177	1993/06/05 17:00:00	1993/06/07 15:00:00	47	0.035	45.27%	0.2
178	1998/12/05 08:00:00	1998/12/08 00:00:00	65	0.035	45.52%	0.2
179	1994/02/07 15:00:00	1994/02/10 06:00:00	64	0.034	45.78%	0.2
180	1983/12/03 18:00:00	1983/12/05 13:00:00	44	0.034	46.04%	0.2

Rank	Start Date	End Date	Duration	Peak	Frequency	Return Period
181	2005/03/22 23:00:00	2005/03/25 12:00:00	62	0.033	46.29%	0.2
182	1973/03/26 20:00:00	1973/03/30 16:00:00	93	0.033	46.55%	0.2
183	1998/11/28 09:00:00	1998/12/02 22:00:00	110	0.033	46.80%	0.2
184	1994/01/25 08:00:00	1994/01/29 02:00:00	91	0.033	47.06%	0.2
185	1974/01/01 09:00:00	1974/01/03 05:00:00	45	0.033	47.31%	0.2
186	1983/04/20 14:00:00	1983/04/23 08:00:00	67	0.032	47.57%	0.19
187	1978/01/05 08:00:00	1978/01/08 15:00:00	80	0.031	47.83%	0.19
188	1990/12/20 01:00:00	1990/12/22 12:00:00	60	0.031	48.08%	0.19
189	1993/03/26 07:00:00	1993/03/29 09:00:00	75	0.031	48.34%	0.19
190	1985/12/09 23:00:00	1985/12/13 07:00:00	81	0.031	48.59%	0.19
191	1991/12/28 08:00:00	1992/01/01 01:00:00	90	0.031	48.85%	0.19
192	1991/01/03 21:00:00	1991/01/06 04:00:00	56	0.03	49.10%	0.19
193	2000/04/17 21:00:00	2000/04/19 21:00:00	49	0.03	49.36%	0.19
194	2005/01/28 18:00:00	2005/01/30 19:00:00	50	0.03	49.62%	0.19
195	1990/02/17 23:00:00	1990/02/20 14:00:00	64	0.03	49.87%	0.19
196	1996/01/22 02:00:00	1996/01/24 06:00:00	53	0.03	50.13%	0.18
197	1987/09/22 06:00:00	1987/09/24 11:00:00	54	0.03	50.38%	0.18
198	2007/02/27 23:00:00	2007/03/02 00:00:00	50	0.03	50.64%	0.18
199	1999/04/01 19:00:00	1999/04/03 16:00:00	46	0.029	50.90%	0.18
200	1995/01/16 11:00:00	1995/01/18 16:00:00	54	0.029	51.15%	0.18
201	1982/01/11 00:00:00	1982/01/13 00:00:00	49	0.029	51.41%	0.18
202	1988/11/25 13:00:00	1988/11/27 12:00:00	48	0.029	51.66%	0.18
203	1992/03/26 22:00:00	1992/03/29 05:00:00	56	0.028	51.92%	0.18
204	1998/04/10 18:00:00	1998/04/12 16:00:00	47	0.028	52.17%	0.18
205	1990/03/28 16:00:00	1990/03/30 12:00:00	45	0.028	52.43%	0.18
206	1996/02/25 12:00:00	1996/02/29 09:00:00	94	0.028	52.69%	0.18
207	2006/03/11 05:00:00	2006/03/14 08:00:00	76	0.028	52.94%	0.17
208	1978/01/30 21:00:00	1978/02/01 19:00:00	47	0.028	53.20%	0.17
209	1982/01/29 01:00:00	1982/01/31 02:00:00	50	0.028	53.45%	0.17
210	2008/02/22 09:00:00	2008/02/25 09:00:00	73	0.028	53.71%	0.17
211	1994/02/04 04:00:00	1994/02/06 04:00:00	49	0.028	53.96%	0.17
212	1995/12/23 13:00:00	1995/12/25 04:00:00	40	0.028	54.22%	0.17
213	1975/03/25 21:00:00	1975/03/27 21:00:00	49	0.028	54.48%	0.17
214	2008/01/23 23:00:00	2008/01/25 18:00:00	44	0.028	54.73%	0.17
215	1999/02/04 18:00:00	1999/02/06 19:00:00	50	0.028	54.99%	0.17
216	1985/02/02 11:00:00	1985/02/04 10:00:00	48	0.027	55.24%	0.17
217	1996/04/18 05:00:00	1996/04/19 21:00:00	41	0.027	55.50%	0.17
218	2006/10/14 07:00:00	2006/10/16 00:00:00	42	0.027	55.75%	0.17
219	1988/03/01 05:00:00	1988/03/03 15:00:00	59	0.027	56.01%	0.16
220	1998/01/02 20:00:00	1998/01/05 04:00:00	57	0.027	56.27%	0.16
221	1981/03/26 12:00:00	1981/03/28 10:00:00	47	0.027	56.52%	0.16
222	2005/10/18 04:00:00	2005/10/20 02:00:00	47	0.027	56.78%	0.16
223	1975/12/12 18:00:00	1975/12/15 04:00:00	59	0.027	57.03%	0.16
224	1994/04/24 13:00:00	1994/04/28 19:00:00	103	0.027	57.29%	0.16
225	2000/03/05 19:00:00	2000/03/07 13:00:00	43	0.027	57.54%	0.16
226	1996/03/05 02:00:00	1996/03/06 20:00:00	43	0.027	57.80%	0.16
227	2007/01/30 05:00:00	2007/02/01 03:00:00	47	0.026	58.06%	0.16

Rank	Start Date	End Date	Duration	Peak	Frequency	Return Period
228	1990/01/02 08:00:00	1990/01/04 00:00:00	41	0.026	58.31%	0.16
229	1983/04/29 11:00:00	1983/05/02 00:00:00	62	0.026	58.57%	0.16
230	1984/10/17 11:00:00	1984/10/19 01:00:00	39	0.026	58.82%	0.16
231	1987/02/24 07:00:00	1987/02/27 13:00:00	79	0.026	59.08%	0.16
232	2006/03/21 05:00:00	2006/03/22 21:00:00	41	0.026	59.34%	0.16
233	1977/02/24 15:00:00	1977/02/26 08:00:00	42	0.026	59.59%	0.16
234	1998/11/08 16:00:00	1998/11/10 07:00:00	40	0.026	59.85%	0.15
235	1997/11/13 15:00:00	1997/11/15 07:00:00	41	0.026	60.10%	0.15
236	1990/04/04 10:00:00	1990/04/05 23:00:00	38	0.026	60.36%	0.15
237	1996/12/06 06:00:00	1996/12/07 22:00:00	41	0.026	60.61%	0.15
238	1997/02/28 05:00:00	1997/03/01 22:00:00	42	0.025	60.87%	0.15
239	2006/02/18 15:00:00	2006/02/20 21:00:00	55	0.025	61.13%	0.15
240	1990/06/09 19:00:00	1990/06/11 19:00:00	49	0.025	61.38%	0.15
241	1980/03/26 05:00:00	1980/03/27 20:00:00	40	0.025	61.64%	0.15
242	2002/01/28 18:00:00	2002/01/30 18:00:00	49	0.025	61.89%	0.15
243	1999/03/15 19:00:00	1999/03/17 12:00:00	42	0.025	62.15%	0.15
244	1977/05/24 11:00:00	1977/05/26 01:00:00	39	0.025	62.40%	0.15
245	1998/04/14 13:00:00	1998/04/16 07:00:00	43	0.025	62.66%	0.15
246	1997/11/26 17:00:00	1997/11/28 09:00:00	41	0.025	62.92%	0.15
247	1977/03/17 00:00:00	1977/03/18 14:00:00	39	0.025	63.17%	0.15
248	1999/04/07 10:00:00	1999/04/09 00:00:00	39	0.025	63.43%	0.15
249	1998/05/11 21:00:00	1998/05/13 22:00:00	50	0.025	63.68%	0.15
250	1989/02/09 15:00:00	1989/02/11 05:00:00	39	0.024	63.94%	0.14
251	1999/03/25 21:00:00	1999/03/27 09:00:00	37	0.024	64.19%	0.14
252	1973/02/06 11:00:00	1973/02/08 16:00:00	54	0.024	64.45%	0.14
253	1997/01/15 08:00:00	1997/01/17 07:00:00	48	0.024	64.71%	0.14
254	1986/04/06 11:00:00	1986/04/07 23:00:00	37	0.024	64.96%	0.14
255	2005/05/06 02:00:00	2005/05/07 15:00:00	38	0.024	65.22%	0.14
256	1979/01/25 11:00:00	1979/01/27 01:00:00	39	0.024	65.47%	0.14
257	1974/03/02 20:00:00	1974/03/05 00:00:00	53	0.024	65.73%	0.14
258	1991/12/18 02:00:00	1991/12/20 05:00:00	52	0.024	65.98%	0.14
259	1974/12/28 18:00:00	1974/12/30 11:00:00	42	0.023	66.24%	0.14
260	1996/12/10 00:00:00	1996/12/13 01:00:00	74	0.023	66.50%	0.14
261	1990/01/31 07:00:00	1990/02/01 16:00:00	34	0.023	66.75%	0.14
262	1997/12/20 20:00:00	1997/12/22 06:00:00	35	0.023	67.01%	0.14
263	1993/12/11 23:00:00	1993/12/13 08:00:00	34	0.023	67.26%	0.14
264	2006/12/17 05:00:00	2006/12/18 13:00:00	33	0.023	67.52%	0.14
265	2000/10/30 05:00:00	2000/10/31 14:00:00	34	0.023	67.77%	0.14
266	2001/11/23 20:00:00	2001/11/25 05:00:00	34	0.023	68.03%	0.14
267	1974/07/23 18:00:00	1974/07/25 02:00:00	33	0.023	68.29%	0.14
268	1993/12/15 02:00:00	1993/12/16 10:00:00	33	0.023	68.54%	0.13
269	2004/02/18 22:00:00	2004/02/20 05:00:00	32	0.022	68.80%	0.13
270	1998/01/28 20:00:00	1998/01/30 04:00:00	33	0.022	69.05%	0.13
271	2002/03/18 05:00:00	2002/03/19 12:00:00	32	0.022	69.31%	0.13
272	1985/03/27 23:00:00	1985/03/29 08:00:00	34	0.022	69.57%	0.13
273	1983/11/18 08:00:00	1983/11/19 13:00:00	30	0.022	69.82%	0.13
274	1986/12/20 17:00:00	1986/12/21 23:00:00	31	0.022	70.08%	0.13

Rank	Start Date	End Date	Duration	Peak	Frequency	Return Period
275	1987/10/29 02:00:00	1987/10/30 08:00:00	31	0.022	70.33%	0.13
276	1973/02/28 12:00:00	1973/03/01 17:00:00	30	0.022	70.59%	0.13
277	1992/04/01 11:00:00	1992/04/02 17:00:00	31	0.022	70.84%	0.13
278	1978/04/16 04:00:00	1978/04/17 09:00:00	30	0.022	71.10%	0.13
279	2004/02/03 06:00:00	2004/02/04 15:00:00	34	0.022	71.36%	0.13
280	1981/04/02 17:00:00	1981/04/03 21:00:00	29	0.022	71.61%	0.13
281	1975/06/18 11:00:00	1975/06/19 15:00:00	29	0.022	71.87%	0.13
282	1982/05/11 20:00:00	1982/05/12 23:00:00	28	0.021	72.12%	0.13
283	1992/12/04 06:00:00	1992/12/05 12:00:00	31	0.021	72.38%	0.13
284	1992/10/23 10:00:00	1992/10/24 14:00:00	29	0.021	72.63%	0.13
285	1973/01/10 06:00:00	1973/01/11 09:00:00	28	0.021	72.89%	0.13
286	1983/04/18 11:00:00	1983/04/19 13:00:00	27	0.021	73.15%	0.13
287	1985/01/07 19:00:00	1985/01/08 22:00:00	28	0.021	73.40%	0.13
288	2006/12/10 08:00:00	2006/12/11 09:00:00	26	0.021	73.66%	0.13
289	1991/03/14 01:00:00	1991/03/15 02:00:00	26	0.021	73.91%	0.13
290	1983/01/01 16:00:00	1983/01/02 16:00:00	25	0.021	74.17%	0.12
291	1973/01/03 23:00:00	1973/01/05 18:00:00	44	0.021	74.42%	0.12
292	1988/12/16 06:00:00	1988/12/17 12:00:00	31	0.021	74.68%	0.12
293	1988/11/14 16:00:00	1988/11/15 16:00:00	25	0.021	74.94%	0.12
294	1988/01/06 00:00:00	1988/01/07 00:00:00	25	0.02	75.19%	0.12
295	1983/01/19 12:00:00	1983/01/20 12:00:00	25	0.02	75.45%	0.12
296	2000/02/12 20:00:00	2000/02/13 21:00:00	26	0.02	75.70%	0.12
297	1990/03/11 09:00:00	1990/03/12 09:00:00	25	0.02	75.96%	0.12
298	2004/03/02 10:00:00	2004/03/03 10:00:00	25	0.02	76.21%	0.12
299	1990/02/04 18:00:00	1990/02/05 18:00:00	25	0.02	76.47%	0.12
300	1991/12/09 02:00:00	1991/12/10 02:00:00	25	0.02	76.73%	0.12
301	2004/04/17 20:00:00	2004/04/18 19:00:00	24	0.02	76.98%	0.12
302	2008/05/23 23:00:00	2008/05/24 21:00:00	23	0.02	77.24%	0.12
303	2004/04/02 06:00:00	2004/04/03 04:00:00	23	0.02	77.49%	0.12
304	2006/12/27 17:00:00	2006/12/28 16:00:00	24	0.02	77.75%	0.12
305	1991/01/09 21:00:00	1991/01/10 19:00:00	23	0.02	78.01%	0.12
306	2000/10/27 20:00:00	2000/10/28 21:00:00	26	0.02	78.26%	0.12
307	1989/01/06 04:00:00	1989/01/07 01:00:00	22	0.02	78.52%	0.12
308	1981/01/12 12:00:00	1981/01/13 11:00:00	24	0.02	78.77%	0.12
309	1987/04/04 03:00:00	1987/04/05 01:00:00	23	0.019	79.03%	0.12
310	2001/12/20 22:00:00	2001/12/21 20:00:00	23	0.019	79.28%	0.12
311	2000/01/01 22:00:00	2000/01/02 20:00:00	23	0.019	79.54%	0.12
312	2001/04/21 13:00:00	2001/04/22 09:00:00	21	0.019	79.80%	0.12
313	1978/12/06 06:00:00	1978/12/07 01:00:00	20	0.019	80.05%	0.12
314	2004/01/03 06:00:00	2004/01/04 02:00:00	21	0.019	80.31%	0.12
315	1992/12/18 10:00:00	1992/12/19 05:00:00	20	0.019	80.56%	0.11
316	1989/09/19 18:00:00	1989/09/20 13:00:00	20	0.019	80.82%	0.11
317	1997/01/23 16:00:00	1997/01/24 11:00:00	20	0.019	81.07%	0.11
318	2006/11/27 20:00:00	2006/11/28 15:00:00	20	0.019	81.33%	0.11
319	1995/05/06 18:00:00	1995/05/07 15:00:00	22	0.019	81.59%	0.11
320	1994/11/10 21:00:00	1994/11/11 16:00:00	20	0.019	81.84%	0.11
321	2000/11/10 21:00:00	2000/11/11 22:00:00	26	0.019	82.10%	0.11

Rank	Start Date	End Date	Duration	Peak	Frequency	Return Period
322	1983/10/07 16:00:00	1983/10/08 11:00:00	20	0.019	82.35%	0.11
323	1977/01/29 08:00:00	1977/01/30 02:00:00	19	0.019	82.61%	0.11
324	1975/01/31 01:00:00	1975/01/31 19:00:00	19	0.019	82.86%	0.11
325	1973/12/02 01:00:00	1973/12/02 19:00:00	19	0.019	83.12%	0.11
326	1985/01/29 02:00:00	1985/01/29 21:00:00	20	0.019	83.38%	0.11
327	1973/01/30 22:00:00	1973/01/31 17:00:00	20	0.019	83.63%	0.11
328	1973/02/04 08:00:00	1973/02/05 02:00:00	19	0.019	83.89%	0.11
329	1979/11/08 05:00:00	1979/11/08 23:00:00	19	0.019	84.14%	0.11
330	1984/11/08 21:00:00	1984/11/09 15:00:00	19	0.019	84.40%	0.11
331	1980/03/22 07:00:00	1980/03/23 00:00:00	18	0.018	84.65%	0.11
332	1981/10/29 07:00:00	1981/10/30 00:00:00	18	0.018	84.91%	0.11
333	1974/01/21 07:00:00	1974/01/22 01:00:00	19	0.018	85.17%	0.11
334	1975/05/20 15:00:00	1975/05/21 09:00:00	19	0.018	85.42%	0.11
335	2002/12/28 23:00:00	2002/12/29 18:00:00	20	0.018	85.68%	0.11
336	2006/03/18 12:00:00	2006/03/19 14:00:00	27	0.018	85.93%	0.11
337	1978/12/02 07:00:00	1978/12/03 00:00:00	18	0.018	86.19%	0.11
338	1975/09/07 09:00:00	1975/09/08 02:00:00	18	0.018	86.45%	0.11
339	1977/11/06 07:00:00	1977/11/07 00:00:00	18	0.018	86.70%	0.11
340	1981/10/01 10:00:00	1981/10/02 03:00:00	18	0.018	86.96%	0.11
341	1995/11/01 16:00:00	1995/11/02 10:00:00	19	0.018	87.21%	0.11
342	1993/11/11 14:00:00	1993/11/12 22:00:00	33	0.018	87.47%	0.11
343	1996/01/17 06:00:00	1996/01/18 00:00:00	19	0.018	87.72%	0.11
344	1977/04/02 16:00:00	1977/04/03 09:00:00	18	0.018	87.98%	0.11
345	1992/10/31 03:00:00	1992/10/31 19:00:00	17	0.018	88.24%	0.1
346	1998/01/15 00:00:00	1998/01/16 07:00:00	32	0.018	88.49%	0.1
347	2001/12/03 00:00:00	2001/12/03 16:00:00	17	0.018	88.75%	0.1
348	1980/03/19 02:00:00	1980/03/19 18:00:00	17	0.018	89.00%	0.1
349	2001/11/29 00:00:00	2001/11/29 16:00:00	17	0.018	89.26%	0.1
350	2002/09/07 00:00:00	2002/09/07 15:00:00	16	0.018	89.51%	0.1
351	2006/12/22 17:00:00	2006/12/23 07:00:00	15	0.017	89.77%	0.1
352	1989/02/04 20:00:00	1989/02/05 12:00:00	17	0.017	90.03%	0.1
353	1986/10/10 21:00:00	1986/10/11 10:00:00	14	0.017	90.28%	0.1
354	2007/03/21 17:00:00	2007/03/22 06:00:00	14	0.017	90.54%	0.1
355	1985/04/18 08:00:00	1985/04/18 21:00:00	14	0.017	90.79%	0.1
356	1984/04/06 17:00:00	1984/04/07 06:00:00	14	0.017	91.05%	0.1
357	1993/11/23 10:00:00	1993/11/23 23:00:00	14	0.017	91.30%	0.1
358	1984/01/05 18:00:00	1984/01/06 07:00:00	14	0.017	91.56%	0.1
359	1993/01/02 22:00:00	1993/01/03 10:00:00	13	0.017	91.82%	0.1
360	1980/04/10 08:00:00	1980/04/10 22:00:00	15	0.017	92.07%	0.1
361	1983/08/18 20:00:00	1983/08/19 10:00:00	15	0.017	92.33%	0.1
362	2007/12/19 12:00:00	2007/12/20 00:00:00	13	0.017	92.58%	0.1
363	2002/04/24 22:00:00	2002/04/25 10:00:00	13	0.017	92.84%	0.1
364	1982/09/26 15:00:00	1982/09/27 05:00:00	15	0.017	93.09%	0.1
365	1999/09/24 21:00:00	1999/09/25 08:00:00	12	0.017	93.35%	0.1
366	1981/05/16 18:00:00	1981/05/17 07:00:00	14	0.017	93.61%	0.1
367	1987/02/14 09:00:00	1987/02/14 20:00:00	12	0.016	93.86%	0.1
368	1980/04/02 04:00:00	1980/04/02 15:00:00	12	0.016	94.12%	0.1

Rank	Start Date	End Date	Duration	Peak	Frequency	Return Period
369	1995/01/21 15:00:00	1995/01/22 00:00:00	10	0.016	94.37%	0.1
370	2003/05/03 03:00:00	2003/05/03 12:00:00	10	0.016	94.63%	0.1
371	2005/03/20 10:00:00	2005/03/20 19:00:00	10	0.016	94.88%	0.1
372	2000/03/09 03:00:00	2000/03/09 11:00:00	9	0.016	95.14%	0.1
373	1992/01/04 02:00:00	1992/01/04 10:00:00	9	0.016	95.40%	0.1
374	1995/06/16 09:00:00	1995/06/16 21:00:00	13	0.016	95.65%	0.1
375	1991/10/24 09:00:00	1991/10/24 16:00:00	8	0.016	95.91%	0.1
376	1998/03/06 03:00:00	1998/03/06 11:00:00	9	0.016	96.16%	0.1
377	2001/04/08 04:00:00	2001/04/08 11:00:00	8	0.016	96.42%	0.1
378	1990/04/24 06:00:00	1990/04/24 13:00:00	8	0.016	96.68%	0.1
379	1995/05/13 19:00:00	1995/05/14 01:00:00	7	0.016	96.93%	0.1
380	2001/02/15 03:00:00	2001/02/15 10:00:00	8	0.016	97.19%	0.1
381	1983/10/01 18:00:00	1983/10/02 00:00:00	7	0.016	97.44%	0.09
382	1990/11/26 15:00:00	1990/11/26 21:00:00	7	0.016	97.70%	0.09
383	1978/03/23 13:00:00	1978/03/23 19:00:00	7	0.015	97.95%	0.09
384	1998/12/20 07:00:00	1998/12/20 12:00:00	6	0.015	98.21%	0.09
385	1984/01/17 04:00:00	1984/01/17 09:00:00	6	0.015	98.47%	0.09
386	1997/04/04 05:00:00	1997/04/04 09:00:00	5	0.015	98.72%	0.09
387	1991/03/16 07:00:00	1991/03/16 11:00:00	5	0.015	98.98%	0.09
388	1992/05/23 06:00:00	1992/05/23 10:00:00	5	0.015	99.23%	0.09
389	1988/12/21 20:00:00	1988/12/21 22:00:00	3	0.015	99.49%	0.09
390	1999/03/12 03:00:00	1999/03/12 04:00:00	2	0.015	99.74%	0.09
--End of Data-----------------						

Development of the Flow Duration Statistics

Similar to the Peak Flow Statistics, the flow duration statistics are also developed directly from the SWMM binary output file. It should be noted right from the start that the "durations" that we are talking about in this section have nothing to do with the "storm durations" presented in the peak flow statistics section. Other than using the same sequence of letters for the word, the two concepts have nothing to do with each other and the reader is cautioned not to confuse the two. The goal of the flow duration statistics is to determine, for the flow rates that fall within the hydromorphologicaly significant range, the length of time that each of those flow rates occur. Since the amount of sediment transported by a river or stream is proportional to the velocity of the water flowing and the length of time that velocity of flow acts on the sediment, knowing the velocity and length of time for each flow rate is very useful.

Methodology

The methodology for determining the flow duration curves comes from a document developed by the U.S. Geological Survey (USGS). The first stop on the journey to find this document was a link to the USGS water site (http://www.usgs.gov/water/). This link is found in Appendix E (SDHMP Continuous Simulation Modeling Primer), found in the County Hydromodification Management Plan[1]. On this web site a search for "Flow Duration Curves" leads to USGS Publication 1542-A, Flow-duration curves, by James K. Searcy 1959 (http://pubs.er.usgs.gov/publication/wsp1542A). In this publication the development of the flow duration curves is discussed in detail.

In Pub 1542-A, beginning on page 7 an example problem is used to illustrate the compilation of data used to create the flow duration plots. On page 8 a completed form 9-217-c form shows the monthly tabulation of flow rates for Bowie Creek near Hattiesburg, Miss. For each flow range the number of readings is tabulated and then the total number of each flow rate is totaled for the year. It should be noted that while this example is for a stream with a minimum flow rate of 100cfs, for the purposes of run-off studies in Southern California the minimum flow rate of zero (0) cfs is the common low flow value. Once each of the year's data has been compiled the summary numbers from each year are transferred to form 9-217-d. On this form the total number of each flow rate is again totaled and the percentage of time exceeded calculated (as will be explained later under the discussion of our calculations). Once the data has been compiled a graph of Discharge Rate vs. Percent Time Exceeded is developed. As will be explained in the next section, the use of these curves leads to the amount of time each particular flow can be expected to occur (based on historical data).

[1] FINAL HYDROMODIFICATION MANAGEMENT PLAN, Prepared for County of San Diego, California, March 2011, by Brown and Caldwell Engineering of San Diego. (http://www.projectcleanwater.org/images/stories/Docs/LDS/HMP/0311_SD_HMP_wAppendices.pdf)

How to Read the Graphs[2]

Figure 1 shows a flow duration curve for a hypothetical development. The three curves show what percentage of the time a range of flow rates are exceeded for three different conditions: pre-project, post-project and post-project with storm water mitigation. Under pre-project conditions the minimum geomorphically significant flow rate is 0.10cfs (assumed) and as read from the graph, flows would equal or exceed this value about 0.14% of the time (or about 12 hours per year) (0.0014 x 365days x 24 hour/day). For post-project conditions, this flow rate would occur more often – about 0.38% of the time (or about 33 hours per year) (0.0038 x 365days x 24 hour/day). This increase in the duration of the geomorphically significant flow after development illustrates why duration control is closely linked to protecting creeks from accelerated erosion.

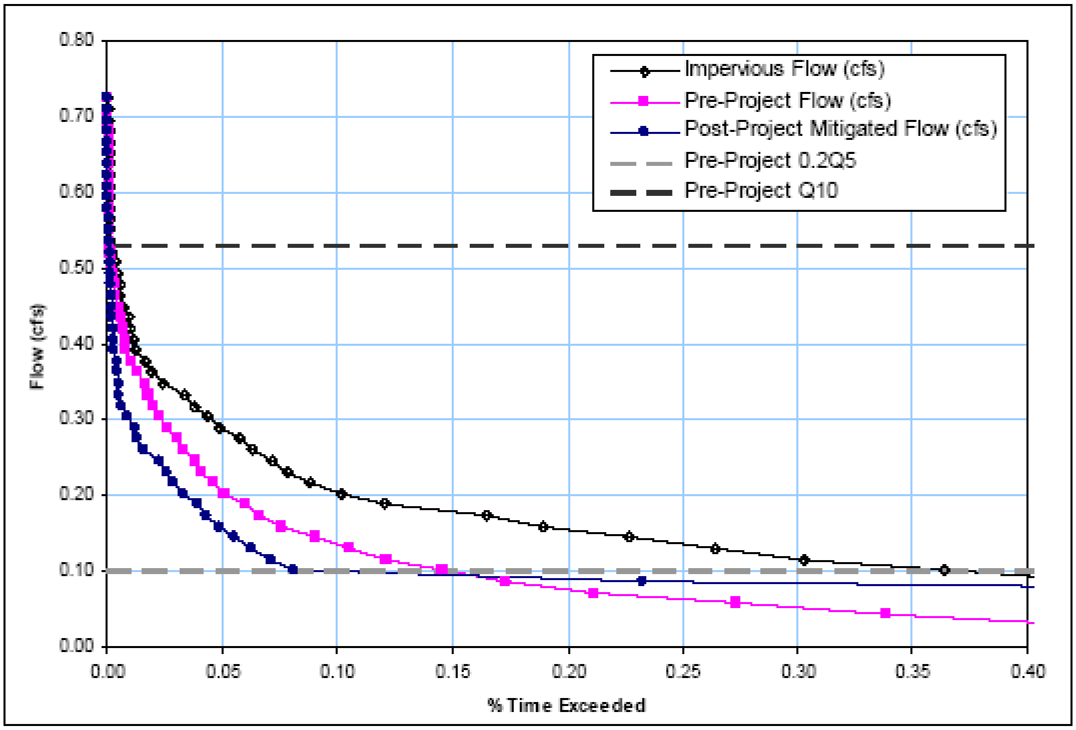


Figure 1. Flow Duration Series Statistics for a Hypothetical Development Scenario

Development of Flow Duration Curves

The first step in developing the flow duration curves is to count the number of occurrences of each flow rate. This is done by first rounding every non-zero flow value to an appropriate number of decimal places (say two places). This in effect groups each flow into closely related values or "bins" as they are referred to in publication 9-217d. Then the entire runoff record is queried for each value and the number of each value counted. The next step is to enter the results of the query into a grid patterned after form 9-217d. The data is entered in ascending order starting with the lowest flow first. The grid is composed of four columns. They are (from left to right) Discharge Rate, Number of Periods (count), Total Periods

[2] The graph and the explanation were taken directly from Appendix E of the Hydromodification Plan

Exceeding (the total number of periods equal to or exceeding this value), and Percent Time Exceeded. Starting at the top row (row 1), the flow rate (which is often times zero) is entered with the corresponding number of times that value was found. The next column is the total number of values greater than or equal to that flow rate. For the first flow rate point, by definition all flow rate values are greater than or equal to this value, therefore the total number of runoff records of the rainfall record is entered here. The final column which is the percent of time exceeded is calculated by dividing the total periods exceeded by the total number of periods in the study. For the first row this number should be 100%

For the next row (row 2), the flow rate, and the flow rate count are entered. The total number of periods exceeding for row 2 is calculated by subtracting Number of Periods of row 1 from the Total Periods Exceeding of line 1. This result is entered in the Total Periods Exceeding on row 2. As was the case for line 1, the final column is calculated by dividing the total periods exceeded by the total number of periods in the study. For the second row this number should be something less than 100% and continually decrease as we move down the chart. If all the calculations are correct, then everything should zero out on the last line of the calculations.

The final step in developing the flow duration curves is to make a plot of the Discharge Rate vs. the Percent Time Exceeded. For the purposes of this report, the first value corresponding to the zero flow rate is not plotted allowing the graph to be focused on the actual flow rate values.

The Flow Duration Analysis

The Flow Duration analysis is composed of the following series of files:

1. The Flow Duration Plot
2. Comparison of the Mitigated Flow Duration Curve to the Pre-Development Curve (Pass/Fail)
3. The calculations for the Pre-Development flow duration curve development (USGS9217d)
4. The calculations for the Mitigated flow duration curve development (USGS9217d)

The Flow Duration Plot

The Flow Duration Curves Plot is the plotting of both the pre-development and mitigated post-development sets of Discharge Rate vs. the Percent Time Exceeded data point pair lists. Only that portion of the flow range within the geomorphically significant range (Q_{10} – Q_{lf}) is summarized. With these curves one can see a visual representation of the relative positions of the respective flow duration curves. The flow duration curves are compared in an East/West (horizontal) direction to compare post development Discharge Rates to pre-development Discharge Rates. The pre-development curve is plotted in blue, and the mitigated curve is plotted in green. As long as the post development curve lies to the left of the pre-development curve (mostly[3]), the project meets the peak flow hydromodification requirements.

[3] See hydromodification limits for exceedance of pre-development values

Pass/Fail comparison of the curves

The next two sets of data are the point by point comparison of the post-development curve(s) and the pre-development curve. The Pass/Fail table is helpful in determining compliance since the plotted lines can be difficult to see at the scales suitable for use in a report. Each point on the post- development curve has a corresponding "Y" value (Flow Rate), and "X" value (% Time Exceeded). For each point on the post development curve, the "Y" value is used to interpolate the corresponding Percent Time Exceeded (X) value from the pre-development curve. Then the Post-development Percent Time Exceeded value is compared to the pre-development Percent Time Exceeded value. Based on the relative values of each point, pass/fail criteria are determined point by point.

For each set of data, the upper right hand header value shows the name of the file being displayed (ex. flowDurationPassFailMitigated.TXT). The first line of the file shows the name of the SWMM output file (*.out). The next line shows the time stamp of the SWMM file that is being analyzed. The time stamps of all of the report files should be within a minute or two of each other, otherwise there may have been tampering with the files. Each report run creates and prints all of the files and reports at one time so all the time stamps should be very close.

The first column is the zero based number of the point. The next two columns show the post development "X" and "Y" values. The next column shows the value interpolated between the two bounding points on the pre-development curve. The next three columns show the true or false values of the comparison of the two "X" values. The last column shows the resultant pass or fail status of the point. There are three ways a point can pass. They are:

1. Q_{post} being outside of the geomorphically significant range Q_{lf} to Q_{10}
2. Q_{post} being less than Q_{pre}
3. Q_{post} being less than 110% of the value of Q_{pre} if the point is between Q_{lf} and Q_{10}

There are two ways that a point can fail. They are:

1. Q_{post} being greater than 110% of Q_{pre} if the point is between Q_{lf} and Q_{10}
2. If more than 10% of the points are between 100% and 110% of Q_{pre} for the points between Q_{lf} and Q_{10}

A quick scan down the last column will quickly tell if there are any points that fail.

At the bottom of each set of data are the date stamp of the report to the left, and to the right is the page number/number of pages for the specific set of data (not the pages of the report!). Each new set of data has its own page numbering. Between the file name in the header row and the page numbering in the footer row, the engineer can readily scan the document for the data of interest.

Plan Check Suggestions

As was described under the peak flow section, is the responsibility of the reviewing agency to confirm that the data sets presented are valid results from consistent calculations, and that any and all results can be duplicated by manual methods and achieve the same results. In light of these goals, the plan checker is invited to consider the following tasks as part of the plan check process.

Compare the Data Stamps for Each of the Statistics Files Used In This Analysis.

As was described in the Peak Flows section, all report files should have time stamps that are nearly identical. If the time values are more than a few minutes apart then the potential for inconsistent results files should be investigated.

Verify the Flow Rate Counts

For each of the pre, and mitigated flow duration tables, a few randomly selected flow value counts should be checked against the values taken directly from the SWMM file. This can be done by opening the corresponding SWMM file, selecting the outfall node, selecting Report>Table>By Object, Setting the time format to Date/Time, selecting the appropriate node value, and clicking the OK button to generate a table of the date/time/Total Inflow values. Next step is to click in the left most header row of the SWMM table which will select the entire table. Now from the main menu select Edit>Copy To>Clipboard. Now open a new blank sheet in MS Excel (or suitable spread sheet program) select cell A1 and paste the results from the clipboard into the spread sheet. Now sort the values based on the Total Inflow column. This will group all the flow values together enabling the number of occurrences of each value to be counted. At this point the a few (or all) of the counts on the various USGS9217d.txt files can be verified.

Manually Verify That the Percent Exceeded Values (form USGS9217d) are Correctly Calculated

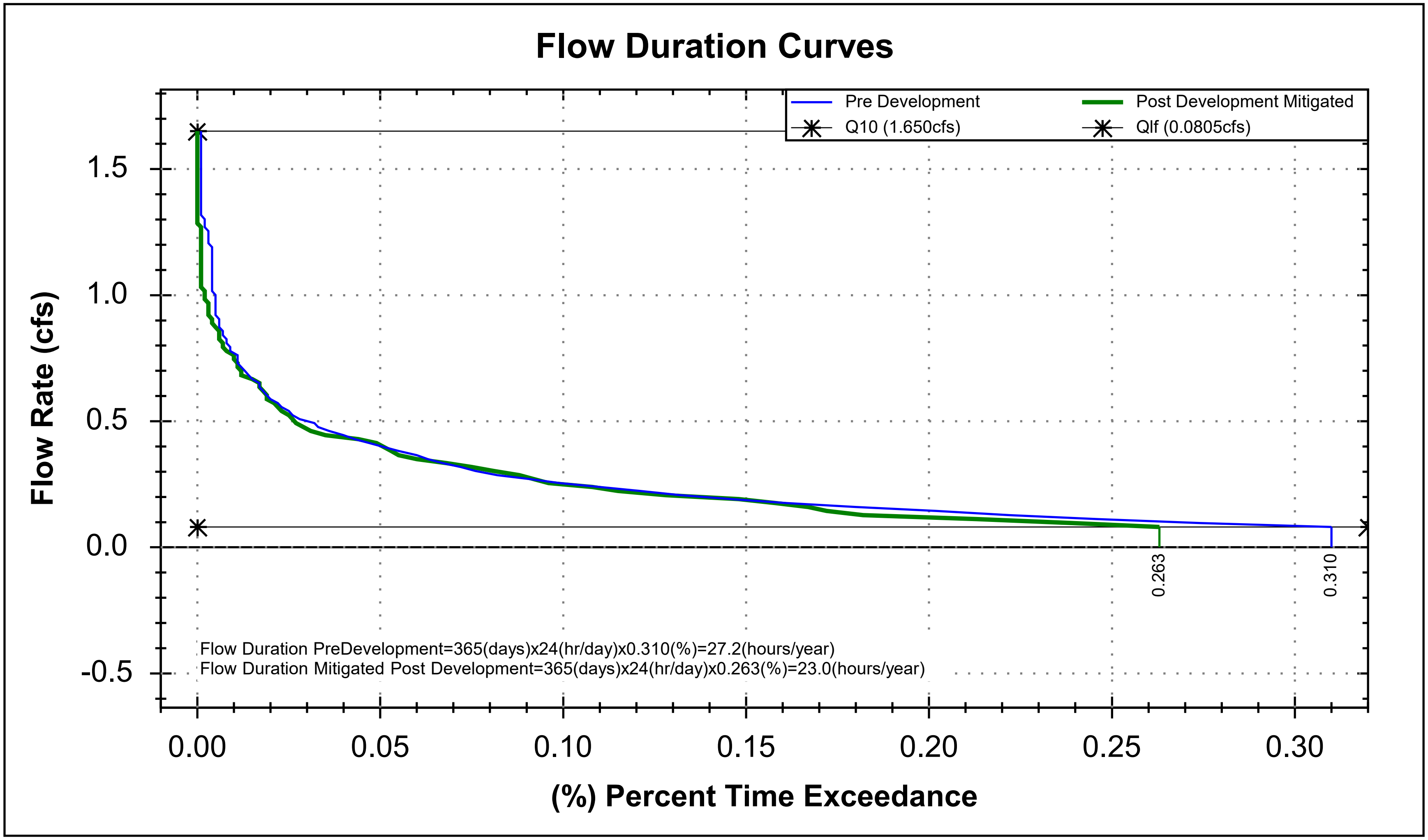
The discharge rates and counts are confirmed as was described above. The top row should be just above the low flow rate (Qlf) value. Total Periods Exceeding of the first line should be the total number of rainfall records between Q10 and Qlf. The percentage of Time Exceeding should be the total periods exceeding divided by the total number of rainfall records between Q10 and Qlf. (100% for the first line). For each successive discharge rate, the total periods exceeding for the current line should be the total periods exceeding from the line above minus the number of periods from the line above. The number of periods and the number of periods exceeding should zero out at the last line.

Compare Plotted Curves to Table Data

Randomly check a few of the plotted points against the values verified above.

Verify by Observation that the plotted values of Q_{10} and Q_{lf} are reasonable.

Verify that the correct values for each of these return periods are plotted correctly on the graph.


Flow Duration Curves
Pre Development
Post Development Mitigated
Q10 (1.650cfs)
Qlf (0.0805cfs)
Flow Rate (cfs)
1.5
1.0
0.5
0.0
-0.5
0.263
0.310
Flow Duration PreDevelopment=365(days)x24(hr/day)x0.310(%)=27.2(hours/year)
Flow Duration Mitigated Post Development=365(days)x24(hr/day)x0.263(%)=23.0(hours/year)
0.00
0.05
0.10
0.15
0.20
0.25
0.30
(%) Percent Time Exceedance

Compare Post-Development Curve to Pre-Development Curve

post-development SWMM file: V:\18\18005\Engineering\SDP\Storm-SDP\SWMM\JEN\SWMM FILES\ITERATIONS\60\Stormchamber-alt.out
post-development time stamp: 2/28/2020 3:41:05 PM
Compared to:
pre-development SWMM file: V:\18\18005\Engineering\SDP\Storm-SDP\SWMM\JEN\SWMM FILES\ITERATIONS\60\18005ex.out
pre-development time stamp: 2/27/2020 10:08:27 AM

Post PT #	Flow Rate	Post Dev % Exceed	Pre Dev % Exceed	%Ex post < %Ex pre	%Ex post > %Ex pre	%Ex post > 110% %Ex pre	Pass/Fail
0	0.08	0.26	0.31	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
1	0.10	0.24	0.27	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
2	0.11	0.21	0.25	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
3	0.13	0.18	0.22	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
4	0.14	0.17	0.20	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
5	0.16	0.17	0.18	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
6	0.18	0.16	0.16	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
7	0.19	0.15	0.15	FALSE	TRUE	FALSE	Pass: Post Duration <10% Over Pre Duration
8	0.21	0.13	0.13	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
9	0.22	0.12	0.12	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
10	0.24	0.11	0.11	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
11	0.26	0.10	0.10	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
12	0.27	0.09	0.09	FALSE	TRUE	FALSE	Pass: Post Duration <10% Over Pre Duration
13	0.29	0.09	0.08	FALSE	TRUE	FALSE	Pass: Post Duration <10% Over Pre Duration
14	0.30	0.08	0.08	FALSE	TRUE	FALSE	Pass: Post Duration <10% Over Pre Duration
15	0.32	0.08	0.07	FALSE	TRUE	FALSE	Pass: Post Duration <10% Over Pre Duration
16	0.33	0.07	0.07	FALSE	TRUE	FALSE	Pass: Post Duration <10% Over Pre Duration
17	0.35	0.06	0.06	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
18	0.37	0.06	0.06	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
19	0.38	0.05	0.06	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
20	0.40	0.05	0.05	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
21	0.41	0.05	0.05	FALSE	TRUE	FALSE	Pass: Post Duration <10% Over Pre Duration
22	0.43	0.04	0.04	FALSE	TRUE	FALSE	Pass: Post Duration <10% Over Pre Duration
23	0.45	0.04	0.04	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
24	0.46	0.03	0.04	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
25	0.48	0.03	0.03	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
26	0.49	0.03	0.03	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
27	0.51	0.03	0.03	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
28	0.53	0.03	0.03	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
29	0.54	0.02	0.03	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
30	0.56	0.02	0.02	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
31	0.57	0.02	0.02	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration

Post PT #	Flow Rate	Post Dev % Exceed	Pre Dev % Exceed	%Ex post < %Ex pre	%Ex post > %Ex pre	%Ex post > 110% %Ex pre	Pass/Fail
32	0.59	0.02	0.02	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
33	0.60	0.02	0.02	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
34	0.62	0.02	0.02	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
35	0.64	0.02	0.02	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
36	0.65	0.02	0.02	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
37	0.67	0.02	0.02	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
38	0.68	0.01	0.01	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
39	0.70	0.01	0.01	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
40	0.72	0.01	0.01	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
41	0.73	0.01	0.01	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
42	0.75	0.01	0.01	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
43	0.76	0.01	0.01	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
44	0.78	0.01	0.01	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
45	0.79	0.01	0.01	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
46	0.81	0.01	0.01	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
47	0.83	0.01	0.01	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
48	0.84	0.01	0.01	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
49	0.86	0.01	0.01	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
50	0.87	0.01	0.01	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
51	0.89	0.00	0.01	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
52	0.91	0.00	0.01	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
53	0.92	0.00	0.01	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
54	0.94	0.00	0.01	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
55	0.95	0.00	0.01	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
56	0.97	0.00	0.01	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
57	0.98	0.00	0.01	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
58	1.00	0.00	0.01	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
59	1.02	0.00	0.00	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
60	1.03	0.00	0.00	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
61	1.05	0.00	0.00	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
62	1.06	0.00	0.00	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
63	1.08	0.00	0.00	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
64	1.10	0.00	0.00	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
65	1.11	0.00	0.00	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
66	1.13	0.00	0.00	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
67	1.14	0.00	0.00	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
68	1.16	0.00	0.00	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
69	1.18	0.00	0.00	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
70	1.19	0.00	0.00	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
71	1.21	0.00	0.00	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration

Post PT #	Flow Rate	Post Dev % Exceed	Pre Dev % Exceed	%Ex post < %Ex pre	%Ex post > %Ex pre	%Ex post > 110% %Ex pre	Pass/Fail
72	1.22	0.00	0.00	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
73	1.24	0.00	0.00	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
74	1.25	0.00	0.00	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
75	1.27	0.00	0.00	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
76	1.29	0.00	0.00	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
77	1.30	0.00	0.00	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
78	1.32	0.00	0.00	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
79	1.33	0.00	0.00	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
80	1.35	0.00	0.00	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
81	1.37	0.00	0.00	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
82	1.38	0.00	0.00	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
83	1.40	0.00	0.00	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
84	1.41	0.00	0.00	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
85	1.43	0.00	0.00	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
86	1.44	0.00	0.00	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
87	1.46	0.00	0.00	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
88	1.48	0.00	0.00	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
89	1.49	0.00	0.00	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
90	1.51	0.00	0.00	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
91	1.52	0.00	0.00	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
92	1.54	0.00	0.00	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
93	1.56	0.00	0.00	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
94	1.57	0.00	0.00	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
95	1.59	0.00	0.00	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
96	1.60	0.00	0.00	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
97	1.62	0.00	0.00	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
98	1.64	0.00	0.00	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration
99	1.65	0.00	0.00	TRUE	FALSE	FALSE	Pass: Post Duration < Pre Duration

Duration Table Summary at Project Discharge Point				
file name: V:\18\18005\Engineering\SDP\Storm-SDP\SWMM\JEN\SWMM FILES\ITERATIONS\60\18005ex.out				
time stamp: 2/27/2020 10:08:27 AM				
DISCHARGE		Number of periods when discharge was equal to or greater than DISCHARGE column but less than that shown on the next line		
Bin Number	Discharge Rate	Number of Periods	Total Periods Exceeding	Percent Time Exceeded
1	0.08	113	972	0.310
2	0.10	88	859	0.274
3	0.11	75	771	0.246
4	0.13	64	696	0.222
5	0.14	69	632	0.202
6	0.16	59	563	0.180
7	0.18	47	504	0.161
8	0.19	45	457	0.146
9	0.21	34	412	0.132
10	0.22	33	378	0.121
11	0.24	36	345	0.110
12	0.25	24	309	0.099
13	0.27	27	285	0.091
14	0.29	19	258	0.082
15	0.30	15	239	0.076
16	0.32	15	224	0.072
17	0.33	13	209	0.067
18	0.35	8	196	0.063
19	0.37	15	188	0.060
20	0.38	14	173	0.055
21	0.40	13	159	0.051
22	0.41	10	146	0.047
23	0.43	10	136	0.043
24	0.45	12	126	0.040
25	0.46	11	114	0.036
26	0.48	4	103	0.033
27	0.49	10	99	0.032
28	0.51	8	89	0.028
29	0.52	4	81	0.026
30	0.54	4	77	0.025
31	0.56	3	73	0.023
32	0.57	7	70	0.022
33	0.59	4	63	0.020
34	0.60	4	59	0.019
35	0.62	2	55	0.018
36	0.64	1	53	0.017
37	0.65	4	52	0.017
38	0.67	4	48	0.015
39	0.68	3	44	0.014
40	0.70	4	41	0.013
41	0.71	1	37	0.012
42	0.73	0	36	0.011
43	0.75	1	36	0.011
44	0.76	6	35	0.011
45	0.78	1	29	0.009
46	0.79	3	28	0.009
47	0.81	0	25	0.008
48	0.83	2	25	0.008
49	0.84	0	23	0.007
50	0.86	3	23	0.007
51	0.87	0	20	0.006

Bin Number	Discharge Rate	Number of Periods	Total Periods Exceeding	Percent Time Exceeded
52	0.89	2	20	0.006
53	0.91	1	18	0.006
54	0.92	1	17	0.005
55	0.94	0	16	0.005
56	0.95	0	16	0.005
57	0.97	1	16	0.005
58	0.98	0	15	0.005
59	1.00	1	15	0.005
60	1.02	1	14	0.004
61	1.03	0	13	0.004
62	1.05	0	13	0.004
63	1.06	0	13	0.004
64	1.08	0	13	0.004
65	1.10	1	13	0.004
66	1.11	0	12	0.004
67	1.13	0	12	0.004
68	1.14	1	12	0.004
69	1.16	0	11	0.004
70	1.17	0	11	0.004
71	1.19	1	11	0.004
72	1.21	0	10	0.003
73	1.22	1	10	0.003
74	1.24	1	9	0.003
75	1.25	1	8	0.003
76	1.27	1	7	0.002
77	1.29	0	6	0.002
78	1.30	2	6	0.002
79	1.32	0	4	0.001
80	1.33	0	4	0.001
81	1.35	0	4	0.001
82	1.36	0	4	0.001
83	1.38	0	4	0.001
84	1.40	0	4	0.001
85	1.41	0	4	0.001
86	1.43	0	4	0.001
87	1.44	0	4	0.001
88	1.46	0	4	0.001
89	1.48	0	4	0.001
90	1.49	0	4	0.001
91	1.51	0	4	0.001
92	1.52	0	4	0.001
93	1.54	0	4	0.001
94	1.56	0	4	0.001
95	1.57	1	4	0.001
96	1.59	0	3	0.001
97	1.60	0	3	0.001
98	1.62	0	3	0.001
99	1.63	0	3	0.001
100	1.65	0	3	0.001
---------End of Data-----------------				

Duration Table Summary at Project Discharge Point				
file name: V:\18\18005\Engineering\SDP\Storm-SDP\SWMM\JEN\SWMM FILES\ITERATIONS\60\Stormchamber-alt.out				
time stamp: 2/28/2020 3:41:05 PM				
DISCHARGE		Number of periods when discharge was equal to or greater than DISCHARGE column but less than that shown on the next line		
Bin Number	Discharge Rate	Number of Periods	Total Periods Exceeding	Percent Time Exceeded
1	0.08	74	824	0.263
2	0.10	82	750	0.239
3	0.11	98	668	0.213
4	0.13	32	570	0.182
5	0.14	16	538	0.172
6	0.16	26	522	0.167
7	0.18	32	496	0.158
8	0.19	62	464	0.148
9	0.21	43	402	0.128
10	0.22	21	359	0.115
11	0.24	36	338	0.108
12	0.25	14	302	0.096
13	0.27	11	288	0.092
14	0.29	23	277	0.088
15	0.30	18	254	0.081
16	0.32	23	236	0.075
17	0.33	25	213	0.068
18	0.35	17	188	0.060
19	0.37	5	171	0.055
20	0.38	5	166	0.053
21	0.40	9	161	0.051
22	0.41	14	152	0.049
23	0.43	29	138	0.044
24	0.45	13	109	0.035
25	0.46	4	96	0.031
26	0.48	8	92	0.029
27	0.49	3	84	0.027
28	0.51	2	81	0.026
29	0.52	7	79	0.025
30	0.54	2	72	0.023
31	0.56	5	70	0.022
32	0.57	5	65	0.021
33	0.59	1	60	0.019
34	0.60	3	59	0.019
35	0.62	3	56	0.018
36	0.64	1	53	0.017
37	0.65	4	52	0.017
38	0.67	9	48	0.015
39	0.68	0	39	0.012
40	0.70	3	39	0.012
41	0.71	3	36	0.011
42	0.73	2	33	0.011
43	0.75	1	31	0.010
44	0.76	5	30	0.010
45	0.78	2	25	0.008
46	0.79	1	23	0.007
47	0.81	2	22	0.007
48	0.83	0	20	0.006
49	0.84	2	20	0.006
50	0.86	2	18	0.006
51	0.87	2	16	0.005

Bin Number	Discharge Rate	Number of Periods	Total Periods Exceeding	Percent Time Exceeded
52	0.89	2	14	0.004
53	0.91	2	12	0.004
54	0.92	1	10	0.003
55	0.94	1	9	0.003
56	0.95	0	8	0.003
57	0.97	2	8	0.003
58	0.98	1	6	0.002
59	1.00	0	5	0.002
60	1.02	1	5	0.002
61	1.03	0	4	0.001
62	1.05	0	4	0.001
63	1.06	0	4	0.001
64	1.08	0	4	0.001
65	1.10	1	4	0.001
66	1.11	1	3	0.001
67	1.13	0	2	0.001
68	1.14	0	2	0.001
69	1.16	0	2	0.001
70	1.17	0	2	0.001
71	1.19	0	2	0.001
72	1.21	0	2	0.001
73	1.22	0	2	0.001
74	1.24	0	2	0.001
75	1.25	0	2	0.001
76	1.27	1	2	0.001
77	1.29	0	1	0.000
78	1.30	0	1	0.000
79	1.32	0	1	0.000
80	1.33	0	1	0.000
81	1.35	0	1	0.000
82	1.36	0	1	0.000
83	1.38	0	1	0.000
84	1.40	0	1	0.000
85	1.41	0	1	0.000
86	1.43	0	1	0.000
87	1.44	0	1	0.000
88	1.46	0	1	0.000
89	1.48	0	1	0.000
90	1.49	0	1	0.000
91	1.51	0	1	0.000
92	1.52	1	1	0.000
93	1.54	0	0	0.000
94	1.56	0	0	0.000
95	1.57	0	0	0.000
96	1.59	0	0	0.000
97	1.60	0	0	0.000
98	1.62	0	0	0.000
99	1.63	0	0	0.000
100	1.65	0	0	0.000
---------End of Data-----------------				

END OF STATISTICS ANALYSIS

Attachment B

SWMM INPUT DATA SUMMARY AND DETAIL

PRE-DEVELOPMENT INP

```
[TITLE]
;;Project Title/Notes

[OPTIONS]
;;Option             Value
FLOW_UNITS           CFS
INFILTRATION         GREEN_AMPT
FLOW_ROUTING         KINWAVE
LINK_OFFSETS         DEPTH
MIN_SLOPE            0
ALLOW_PONDING        NO
SKIP_STEADY_STATE    NO

START_DATE           01/03/1973
START_TIME           12:00:00
REPORT_START_DATE    01/03/1973
REPORT_START_TIME    12:00:00
END_DATE             09/26/2008
END_TIME             16:00:00
SWEEP_START          01/01
SWEEP_END            12/31
DRY_DAYS             0
REPORT_STEP          01:00:00
WET_STEP             01:00:00
DRY_STEP             01:00:00
ROUTING_STEP         0:01:00
RULE_STEP            00:00:00

INERTIAL_DAMPING     PARTIAL
NORMAL_FLOW_LIMITED  BOTH
FORCE_MAIN_EQUATION  H-W
VARIABLE_STEP        0.75
LENGTHENING_STEP     0
MIN_SURFAREA         12.557
MAX_TRIALS           8
HEAD_TOLERANCE       0.005
SYS_FLOW_TOL         5
LAT_FLOW_TOL         5
MINIMUM_STEP         0.5
THREADS              1

[EVAPORATION]
;;Data Source    Parameters
;;-------------- ----------------
MONTHLY          0.06   0.08   0.11   0.16   0.18   0.21   0.21   0.20   0.16   0.12   0.008  0.06
DRY_ONLY         NO

[RAINGAGES]
;;Name           Format    Interval SCF      Source
;;-------------- --------- ------ ------ ----------
```

```
Santee           INTENSITY 1:00     1.0      FILE       "R:\Rain gage dat\Santee ALERT Station.dat" Santee     IN

[SUBCATCHMENTS]
;;Name           Rain Gage        Outlet           Area     %Imperv  Width    %Slope   CurbLen  SnowPack
;;-------------- ---------------- ---------------- -------- -------- -------- -------- -------- ----------------
DMA-1            Santee           POC-1            3.006    0        256      1.0      0

[SUBAREAS]
;;Subcatchment   N-Imperv   N-Perv     S-Imperv   S-Perv     PctZero    RouteTo    PctRouted
;;-------------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
DMA-1            .012       0.15       0.05       0.1        25         OUTLET

[INFILTRATION]
;;Subcatchment   Suction    Ksat       IMD
;;-------------- ---------- ---------- ----------
DMA-1            9.0        0.01875    0.33

[OUTFALLS]
;;Name           Elevation  Type       Stage Data       Gated    Route To
;;-------------- ---------- ---------- ---------------- -------- ----------------
POC-1            0          FREE                        NO

[REPORT]
;;Reporting Options
SUBCATCHMENTS ALL
NODES ALL
LINKS ALL

[TAGS]

[MAP]
DIMENSIONS -2500.000 0.000 12500.000 10000.000
Units      None

[COORDINATES]
;;Node           X-Coord            Y-Coord
;;-------------- ------------------ ------------------
POC-1            1595.745           932.118

[VERTICES]
;;Link           X-Coord            Y-Coord
;;-------------- ------------------ ------------------

[Polygons]
;;Subcatchment   X-Coord            Y-Coord
;;-------------- ------------------ ------------------
DMA-1            7320.162           4690.983

[SYMBOLS]
;;Gage           X-Coord            Y-Coord
```

```
;;-------------- ------------------ ------------------
Santee           -55.724            7811.550


[BACKDROP]
FILE       "V:\18\18005\Engineering\SDP\Storm-SDP\SWMM\18005_EX_CivilD-Existing.jpg"
DIMENSIONS -2500.000 0.000 12500.000 10000.000
```

PRE-DEVELOPMENT RPT

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.013)
--------------------------------------------------------------


*********************
Rainfall File Summary
*********************
Station    First        Last         Recording   Periods    Periods    Periods
ID         Date         Date         Frequency  w/Precip    Missing    Malfunc.
-------------------------------------------------------------------------------
Santee     01/03/1973   09/26/2008      60 min      6203          0          0


*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... NO
  Water Quality .......... NO
Infiltration Method ...... GREEN_AMPT
Starting Date ............ 01/03/1973 12:00:00
Ending Date .............. 09/26/2008 16:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 01:00:00
Wet Time Step ............ 01:00:00
Dry Time Step ............ 01:00:00


**************************        Volume         Depth
Runoff Quantity Continuity     acre-feet        inches
**************************     ---------       -------
Total Precipitation ......       116.958       466.900
Evaporation Loss .........         4.477        17.871
Infiltration Loss ........        91.145       363.851
Surface Runoff ...........        23.570        94.093
Final Storage ............         0.000         0.000
Continuity Error (%) .....        -1.909
```

```
**************************        Volume         Volume
Flow Routing Continuity         acre-feet       10^6 gal
**************************      ---------      ---------
Dry Weather Inflow .......          0.000          0.000
Wet Weather Inflow .......         23.570          7.681
Groundwater Inflow .......          0.000          0.000
RDII Inflow ..............          0.000          0.000
External Inflow ..........          0.000          0.000
External Outflow .........         23.570          7.681
Flooding Loss ............          0.000          0.000
Evaporation Loss .........          0.000          0.000
Exfiltration Loss ........          0.000          0.000
Initial Stored Volume ....          0.000          0.000
Final Stored Volume ......          0.000          0.000
Continuity Error (%) .....          0.000
```

```
***************************
Subcatchment Runoff Summary
***************************
```

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Imperv Runoff in	Perv Runoff in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
DMA-1	466.90	0.00	17.87	363.85	0.00	94.09	94.09	7.68	2.07	0.202

```
Analysis begun on:  Thu Feb 27 10:08:04 2020
Analysis ended on:  Thu Feb 27 10:08:27 2020
Total elapsed time: 00:00:23
```

POST-DEVELOPMENT INP

```
[TITLE]
;;Project Title/Notes

[OPTIONS]
;;Option             Value
FLOW_UNITS           CFS
INFILTRATION         GREEN_AMPT
FLOW_ROUTING         KINWAVE
LINK_OFFSETS         DEPTH
MIN_SLOPE            0
ALLOW_PONDING        NO
SKIP_STEADY_STATE    NO

START_DATE           01/03/1973
START_TIME           12:00:00
REPORT_START_DATE    01/03/1973
REPORT_START_TIME    12:00:00
END_DATE             09/26/2008
END_TIME             16:00:00
SWEEP_START          01/01
SWEEP_END            12/31
DRY_DAYS             0
REPORT_STEP          01:00:00
WET_STEP             01:00:00
DRY_STEP             01:00:00
ROUTING_STEP         0:01:00
RULE_STEP            00:00:00

INERTIAL_DAMPING     PARTIAL
NORMAL_FLOW_LIMITED  BOTH
FORCE_MAIN_EQUATION  H-W
VARIABLE_STEP        0.75
LENGTHENING_STEP     0
MIN_SURFAREA         12.557
MAX_TRIALS           8
HEAD_TOLERANCE       0.005
SYS_FLOW_TOL         5
LAT_FLOW_TOL         5
MINIMUM_STEP         0.5
THREADS              1

[EVAPORATION]
;;Data Source    Parameters
;;-------------- ----------------
MONTHLY          0.06   0.08   0.11   0.16   0.18   0.21   0.21   0.20   0.16   0.12   0.08   0.06
DRY_ONLY         NO

[RAINGAGES]
;;Name           Format    Interval SCF      Source
;;-------------- --------- ------ ------ ----------
```

```
Santee           INTENSITY 1:00     1.0      FILE       "R:\Rain gage dat\Santee ALERT Station.dat" Santee     IN

[SUBCATCHMENTS]
;;Name           Rain Gage        Outlet           Area     %Imperv  Width    %Slope   CurbLen  SnowPack
;;-------------- ---------------- ---------------- -------- -------- -------- -------- -------- ----------------
DMA-1            Santee           WQ-SWALE         0.0431   86       56       2        0
DMA-2            Santee           WQ-SWALE         0.5993   91       210.67   1        0
DMA-3            Santee           WQ-DET-2         0.4486   89       200      1        0
DMA-4            Santee           WQ-DET-1         0.7722   99       181.23   1        0
DMA-5            Santee           WQ-DET-3         0.6617   92       75.5     1        0
DMA-6            Santee           WQ-DET-4         0.3884   85       75       0.5      0
DMA-7            Santee           Q100-SWALE       0.096    86       118.8    0.5      0

[SUBAREAS]
;;Subcatchment   N-Imperv   N-Perv     S-Imperv   S-Perv     PctZero    RouteTo    PctRouted
;;-------------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
DMA-1            .012       0.15       0.05       0.1        25         OUTLET
DMA-2            0.012      0.15       0.05       0.10       25         OUTLET
DMA-3            0.012      0.15       0.05       0.10       25         OUTLET
DMA-4            0.012      0.15       0.05       0.10       25         OUTLET
DMA-5            0.012      0.15       0.05       0.10       25         OUTLET
DMA-6            0.012      0.15       0.05       0.10       25         OUTLET
DMA-7            0.012      0.15       0.05       0.10       25         OUTLET

[INFILTRATION]
;;Subcatchment   Suction    Ksat       IMD
;;-------------- ---------- ---------- ----------
DMA-1            9          .01875     0.30
DMA-2            9.0        0.01875    0.30
DMA-3            9.0        0.01875    0.30
DMA-4            9.0        0.01875    0.30
DMA-5            9.0        0.01875    0.30
DMA-6            9.0        0.01875    0.30
DMA-7            9.0        0.01875    0.30

[OUTFALLS]
;;Name           Elevation  Type       Stage Data       Gated    Route To
;;-------------- ---------- ---------- ---------------- -------- ----------------
POC-1            0          FREE                        NO

[STORAGE]
;;Name           Elev.    MaxDepth   InitDepth  Shape      Curve Name/Params            N/A      Fevap    Psi      Ksat
IMD
;;-------------- -------- ---------- ----------- ---------- ---------------------------- -------- --------          --------
--------
WQ-SWALE         0        0.33       0          TABULAR    WQ-SWALE                     0        1        9.0      0.062
0.30
Q100-DET-1       0        3          0          TABULAR    Q100-DET-1                   0        0
WQ-DET-1         0        3          0          TABULAR    WQ-DET-1                     0        0
Q100-DET-2       0        3          0          TABULAR    Q100-DET-2                   0        0
```

```
WQ-DET-2         0        3          0          TABULAR    WQ-DET-2                     0        0
Q100-DET-3       0        3          0          TABULAR    Q100-DET-3                   0        0
WQ-DET-4         0        3          0          TABULAR    WQ-DET-4                     0        0
WQ-DET-3         0        3          0          TABULAR    WQ-DET-3                     0        0
Q100-SWALE       0        0.33       0          TABULAR    Q100-SWALE                   0        1        9.0      0.062
0.30

[ORIFICES]
;;Name           From Node        To Node          Type         Offset     Qcoeff     Gated    CloseTime
;;-------------- ---------------- ---------------- ------------ ---------- ---------- -------- ----------
MWS              WQ-DET-4         Q100-DET-3       SIDE         0          0.61       NO       0
WQ-VOL-1         WQ-DET-1         Q100-DET-1       SIDE         1.583      0.61       NO       0
WQ-OUT-1         WQ-DET-1         WQ-DET-3         SIDE         0          0.61       NO       0
WQ-VOL-2         WQ-DET-2         Q100-DET-2       SIDE         1.25       0.61       NO       0
WQ-OUT-3         WQ-DET-3         WQ-DET-4         SIDE         0          0.61       NO       0
Q100-OUT-2       Q100-DET-2       Q100-DET-3       SIDE         0          0.61       NO       0
Q100-OUT         Q100-DET-1       Q100-DET-2       SIDE         0          0.65       NO       0
WQ-VOL-3         WQ-DET-4         Q100-DET-3       SIDE         1.25       0.61       NO       0
WQ-OUT-2         WQ-DET-2         WQ-DET-4         SIDE         0          0.65       NO       0
ORIF-1           WQ-DET-1         WQ-DET-3         SIDE         0.25       0.61       NO       0
ORIFICE-BOX-1    Q100-DET-3       POC-1            SIDE         0          0.61       NO       0
ORIFICE-BOX-2    Q100-DET-3       POC-1            SIDE         1.7        0.61       NO       0
ORIFICE-BOX-3    Q100-DET-3       POC-1            SIDE         0.25       0.61       NO       0
ORIFICE-BOX-4    Q100-DET-3       POC-1            SIDE         0.75       0.61       NO       0

[WEIRS]
;;Name           From Node        To Node          Type         CrestHt    Qcoeff     Gated    EndCon   EndCoeff   Surcharge
RoadWidth  RoadSurf   Coeff. Curve
;;-------------- ---------------- ---------------- ------------ ---------- ---------- -------- -------- ---------- ----------
---------- ---------- ----------------
DRAIN-WQ         WQ-SWALE         WQ-DET-1         TRANSVERSE   0.166      3.33       NO       0        0          YES
DRAIN-Q100       Q100-SWALE       Q100-DET-3       TRANSVERSE   0.166      3.33       NO       0        0          YES
WEIR-1           WQ-DET-1         WQ-DET-3         SIDEFLOW     2          3.33       NO       0        0          YES
WEIR-BOX         Q100-DET-3       POC-1            SIDEFLOW     2.25       3.33       NO       0        0          YES
WEIR-BOX-2       Q100-DET-3       POC-1            SIDEFLOW     1.75       3.33       NO       0        0          YES

[XSECTIONS]
;;Link           Shape        Geom1            Geom2      Geom3      Geom4      Barrels    Culvert
;;-------------- ------------ ---------------- ---------- ---------- ---------- ---------- ----------
MWS              CIRCULAR     0.09             0          0          0
WQ-VOL-1         CIRCULAR     0.67             0          0          0
WQ-OUT-1         CIRCULAR     0.04167          0          0          0
WQ-VOL-2         CIRCULAR     1                0          0          0
WQ-OUT-3         CIRCULAR     0.083            0          0          0
Q100-OUT-2       CIRCULAR     0.5              0          0          0
Q100-OUT         CIRCULAR     0.5              0          0          0
WQ-VOL-3         CIRCULAR     1                0          0          0
WQ-OUT-2         CIRCULAR     0.04167          0          0          0
ORIF-1           CIRCULAR     0.083            0          0          0
ORIFICE-BOX-1    CIRCULAR     0.04167          0          0          0
```

```
ORIFICE-BOX-2    RECT_CLOSED  0.083            1          0          0
ORIFICE-BOX-3    CIRCULAR     0.083            0          0          0
ORIFICE-BOX-4    CIRCULAR     0.083            0          0          0
DRAIN-WQ         RECT_OPEN    0.166            2.828      0          0
DRAIN-Q100       RECT_OPEN    0.16             2.828      0          0
WEIR-1           RECT_OPEN    1                2.828427125 0          0
WEIR-BOX         RECT_OPEN    0.75             3          0          0
WEIR-BOX-2       RECT_OPEN    0.5              1          0          0

[CURVES]
;;Name           Type       X-Value    Y-Value
;;-------------- ---------- ---------- ----------
Q100-DET-1       Storage    0          0
Q100-DET-1                  0.3        1046.666667
Q100-DET-1                  0.6        760
Q100-DET-1                  0.9        1440
Q100-DET-1                  1.2        986.6666667
Q100-DET-1                  1.5        1546.666667
Q100-DET-1                  1.8        986.6666667
Q100-DET-1                  2.1        1440
Q100-DET-1                  2.4        760
Q100-DET-1                  2.7        1046.666667
Q100-DET-1                  3          6.666666667
;
Q100-DET-2       Storage    0          0
Q100-DET-2                  0.3        564.6666667
Q100-DET-2                  0.6        415.3333333
Q100-DET-2                  0.9        778
Q100-DET-2                  1.2        535.3333333
Q100-DET-2                  1.5        831.3333333
Q100-DET-2                  1.8        535.3333333
Q100-DET-2                  2.1        778
Q100-DET-2                  2.4        408.6666667
Q100-DET-2                  2.7        571.3333333
Q100-DET-2                  3          8.666666667
;
Q100-DET-3       Storage    0          0
Q100-DET-3                  0.3        1226.666667
Q100-DET-3                  0.6        900
Q100-DET-3                  0.9        1686.666667
Q100-DET-3                  1.2        1160
Q100-DET-3                  1.5        1813.333333
Q100-DET-3                  1.8        1160
Q100-DET-3                  2.1        1686.666667
Q100-DET-3                  2.4        900
Q100-DET-3                  2.7        1226.666667
Q100-DET-3                  3          6.666666667
;
WQ-DET-1         Storage    0          0
WQ-DET-1                    0.3        713.3333333
```

```
WQ-DET-1                         0.6         526.6666667
WQ-DET-1                         0.9         986.6666667
WQ-DET-1                         1.2         680
WQ-DET-1                         1.5         1060
WQ-DET-1                         1.8         680
WQ-DET-1                         2.1         986.6666667
WQ-DET-1                         2.4         526.6666667
WQ-DET-1                         2.7         713.3333333
WQ-DET-1                         3           3.18323E-12
;
WQ-DET-2          Storage        0           0
WQ-DET-2                         0.3         686.6666667
WQ-DET-2                         0.6         493.3333333
WQ-DET-2                         0.9         946.6666667
WQ-DET-2                         1.2         640
WQ-DET-2                         1.5         1020
WQ-DET-2                         1.8         640
WQ-DET-2                         2.1         946.6666667
WQ-DET-2                         2.4         493.3333333
WQ-DET-2                         2.7         693.3333333
WQ-DET-2                         3           13.33333333
;
WQ-DET-3          Storage        0           0
WQ-DET-3                         0.3         1993.333333
WQ-DET-3                         0.6         3453.333333
WQ-DET-3                         0.9         6193.333333
WQ-DET-3                         1.2         8080
WQ-DET-3                         1.5         11033.33333
WQ-DET-3                         1.8         12913.33333
WQ-DET-3                         2.1         15666.66667
WQ-DET-3                         2.4         17113.33333
WQ-DET-3                         2.7         19120
WQ-DET-3                         3           19093.33333
;
WQ-DET-4          Storage        0           0
WQ-DET-4                         0.3         634.6666667
WQ-DET-4                         0.6         465.3333333
WQ-DET-4                         0.9         874.6666667
WQ-DET-4                         1.2         598.6666667
WQ-DET-4                         1.5         941.3333333
WQ-DET-4                         1.8         598.6666667
WQ-DET-4                         2.1         874.6666667
WQ-DET-4                         2.4         465.3333333
WQ-DET-4                         2.7         634.6666667
WQ-DET-4                         3           2
;
WQ-SWALE          Storage        0           0
WQ-SWALE                         0.167       419.1377246
WQ-SWALE                         0.33        133.0095147
;
```

```
Q100-SWALE       Storage    0          0
Q100-SWALE                  0.167      894.1317365
Q100-SWALE                  0.33       283.7823739

[REPORT]
;;Reporting Options
SUBCATCHMENTS ALL
NODES ALL
LINKS ALL

[TAGS]

[MAP]
DIMENSIONS -2500.000 0.000 12500.000 10000.000
Units      None

[COORDINATES]
;;Node           X-Coord            Y-Coord
;;-------------- ------------------ ------------------
POC-1            1261.398           1236.069
WQ-SWALE         5445.795           6585.613
Q100-DET-1       5010.132           4670.719
WQ-DET-1         6752.786           4670.719
Q100-DET-2       2922.999           3495.441
WQ-DET-2         4959.473           3475.177
Q100-DET-3       1504.559           4174.265
WQ-DET-4         2497.467           3039.514
WQ-DET-3         4696.049           2117.528
Q100-SWALE       3561.297           6524.823

[VERTICES]
;;Link           X-Coord            Y-Coord
;;-------------- ------------------ ------------------
MWS              2173.252           2968.592
MWS              1504.559           2968.592
WQ-OUT-1         6610.942           2755.826
Q100-OUT-2       2750.760           4812.563
Q100-OUT-2       2071.935           4812.563
WQ-OUT-2         4665.653           3232.016
WQ-OUT-2         3348.531           3211.753
ORIF-1           7847.011           3890.578
ORIF-1           7532.928           2684.904
ORIFICE-BOX-1    -268.490           3637.285
ORIFICE-BOX-1    -227.964           2259.372
ORIFICE-BOX-2    -694.022           3718.338
ORIFICE-BOX-2    -724.417           2370.821
ORIFICE-BOX-3    197.568            3252.280
ORIFICE-BOX-3    227.964            2077.001
ORIFICE-BOX-4    1079.027           3566.363
ORIFICE-BOX-4    1008.105           2289.767
```

```
DRAIN-Q100       2882.472           6241.135
DRAIN-Q100       1646.403           5420.466
DRAIN-Q100       1190.476           5055.724
WEIR-1           7391.084           3931.104
WEIR-1           6854.103           2715.299
WEIR-BOX         -1474.164          3860.182
WEIR-BOX         -1474.164          1935.157
WEIR-BOX-2       -2041.540          4062.817
WEIR-BOX-2       -2041.540          1519.757

[Polygons]
;;Subcatchment   X-Coord            Y-Coord
;;-------------- ------------------ ------------------
DMA-1            6068.769           5987.842
DMA-1            6079.153           5987.842
DMA-2            7188.450           5997.974
DMA-2            7188.450           5997.974
DMA-3            4432.624           3951.368
DMA-4            8505.572           4255.319
DMA-5            8029.382           1691.996
DMA-6            2102.330           2613.982
DMA-7            4088.146           5916.920

[SYMBOLS]
;;Gage           X-Coord            Y-Coord
;;-------------- ------------------ ------------------
Santee           4027.356           9047.619


[BACKDROP]
FILE       "V:\18\18005\Engineering\SDP\Storm-SDP\SWMM\JEN\SWMM FILES\ITERATIONS\60\SWMM IMAGE.jpg"
DIMENSIONS -1470.588 0.000 11470.588 10000.000
```

POST-DEVELOPMENT RPT

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.013)
--------------------------------------------------------------


*********************
Rainfall File Summary
*********************
Station     First         Last          Recording   Periods    Periods    Periods
ID          Date          Date          Frequency  w/Precip    Missing    Malfunc.
-------------------------------------------------------------------------------------
Santee      01/03/1973   09/26/2008      60 min      6203          0          0


*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Infiltration Method ...... GREEN_AMPT
Flow Routing Method ...... KINWAVE
Starting Date ............ 01/03/1973 12:00:00
Ending Date .............. 09/26/2008 16:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 01:00:00
Wet Time Step ............ 01:00:00
Dry Time Step ............ 01:00:00
Routing Time Step ........ 60.00 sec


**************************        Volume         Depth
Runoff Quantity Continuity     acre-feet        inches
**************************     ---------       -------
Total Precipitation ......       117.087       466.900
Evaporation Loss .........        16.612        66.243
Infiltration Loss ........         6.876        27.421
Surface Runoff ...........       101.843       406.115
```

```
  Final Storage ...........         0.000          0.000
  Continuity Error (%) .....       -7.042


  **************************        Volume         Volume
  Flow Routing Continuity        acre-feet       10^6 gal
  **************************     ---------      ---------
  Dry Weather Inflow .......         0.000          0.000
  Wet Weather Inflow .......       101.843         33.187
  Groundwater Inflow .......         0.000          0.000
  RDII Inflow ..............         0.000          0.000
  External Inflow ..........         0.000          0.000
  External Outflow .........        98.785         32.191
  Flooding Loss ............         0.000          0.000
  Evaporation Loss .........         0.172          0.056
  Exfiltration Loss ........         2.753          0.897
  Initial Stored Volume ....         0.000          0.000
  Final Stored Volume ......         0.036          0.012
  Continuity Error (%) .....         0.096


  ********************************
  Highest Flow Instability Indexes
  ********************************
  All links are stable.


  *************************
  Routing Time Step Summary
  *************************
  Minimum Time Step           :    59.00 sec
  Average Time Step           :    60.00 sec
  Maximum Time Step           :    60.00 sec
  Percent in Steady State     :     0.00
  Average Iterations per Step :     1.00
  Percent Not Converging      :     0.00


  ***************************
  Subcatchment Runoff Summary
  ***************************


  --------------------------------------------------------------------------------------------------------------------------------
-
                          Total      Total      Total      Total     Imperv       Perv      Total       Total     Peak
 Runoff
                         Precip     Runon       Evap      Infil     Runoff     Runoff     Runoff      Runoff   Runoff
 Coeff
  Subcatchment               in         in         in         in         in         in         in    10^6 gal      CFS
```

DMA-1	466.90	0.00	59.72	47.15	373.00	21.44	394.44	0.46	0.04	0.845
DMA-2	466.90	0.00	64.25	30.64	392.24	13.21	405.46	6.60	0.54	0.868
DMA-3	466.90	0.00	62.74	37.45	384.20	16.14	400.34	4.88	0.40	0.857
DMA-4	466.90	0.00	69.99	3.37	425.08	1.53	426.61	8.95	0.70	0.914
DMA-5	466.90	0.00	68.74	27.32	391.61	11.18	402.79	7.24	0.60	0.863
DMA-6	466.90	0.00	63.86	51.68	363.28	19.93	383.21	4.04	0.35	0.821
DMA-7	466.90	0.00	60.34	47.62	372.40	20.78	393.18	1.02	0.09	0.842

****
Node Depth Summary
****

Node	Type	Average Depth Feet	Maximum Depth Feet	Maximum HGL Feet	Time of Max Occurrence days hr:min	Reported Max Depth Feet
POC-1	OUTFALL	0.00	0.00	0.00	0 00:00	0.00
WQ-SWALE	STORAGE	0.01	0.32	0.32	2604 07:01	0.32
Q100-DET-1	STORAGE	0.00	0.84	0.84	1388 05:08	0.83
WQ-DET-1	STORAGE	0.05	2.17	2.17	2604 07:03	2.17
Q100-DET-2	STORAGE	0.00	1.59	1.59	1388 05:18	1.52
WQ-DET-2	STORAGE	0.05	1.52	1.52	1388 05:02	1.52
Q100-DET-3	STORAGE	0.10	2.29	2.29	1388 05:10	2.28
WQ-DET-4	STORAGE	0.08	1.50	1.50	2604 07:08	1.50
WQ-DET-3	STORAGE	0.07	2.35	2.35	2604 18:35	2.35
Q100-SWALE	STORAGE	0.01	0.21	0.21	1388 05:02	0.21

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CFS	Maximum Total Inflow CFS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 gal	Total Inflow Volume 10^6 gal	Flow Balance Error Percent

POC-1	OUTFALL	0.00	1.55	1388	05:10	0	32.2	0.000
WQ-SWALE	STORAGE	0.58	0.58	2604	07:01	7.06	7.06	0.005
Q100-DET-1	STORAGE	0.00	0.82	2604	07:03	0	5.16	0.110
WQ-DET-1	STORAGE	0.70	1.28	2604	07:01	8.95	15.6	0.078
Q100-DET-2	STORAGE	0.00	1.17	1388	05:04	0	6.47	0.054
WQ-DET-2	STORAGE	0.40	0.40	2604	07:01	4.88	4.88	0.017
Q100-DET-3	STORAGE	0.00	1.56	1388	05:06	0	32.2	0.026
WQ-DET-4	STORAGE	0.35	0.40	2604	07:01	4.04	25.3	0.003
WQ-DET-3	STORAGE	0.60	1.04	1388	05:01	7.24	17.7	0.000
Q100-SWALE	STORAGE	0.09	0.09	2604	07:01	1.02	1.02	-0.000

****
Node Flooding Summary
****

No nodes were flooded.

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 ft3	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 ft3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow CFS
WQ-SWALE	0.002	3	0	5	0.079	99	2604 07:01	0.58
Q100-DET-1	0.000	0	0	0	0.678	23	1388 05:08	0.79
WQ-DET-1	0.027	1	0	0	1.607	78	2604 07:03	1.27
Q100-DET-2	0.000	0	0	0	0.887	55	1388 05:17	1.11
WQ-DET-2	0.024	1	0	0	1.005	51	1388 05:02	0.39
Q100-DET-3	0.088	2	0	0	2.912	83	1388 05:09	1.55
WQ-DET-4	0.042	2	0	0	0.914	50	2604 07:07	0.38
WQ-DET-3	0.208	1	0	0	19.456	62	2604 18:34	0.04
Q100-SWALE	0.003	2	3	52	0.109	64	1388 05:01	0.08

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CFS	Max Flow CFS	Total Volume 10^6 gal
POC-1	15.28	0.02	1.55	32.188

System	15.28	0.02	1.55	32.188

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CFS	Time of Max Occurrence days hr:min	Maximum |Veloc| ft/sec	Max/ Full Flow	Max/ Full Depth
MWS	ORIFICE	0.04	2604 07:08			0.00
WQ-VOL-1	ORIFICE	0.82	2604 07:03			0.00
WQ-OUT-1	ORIFICE	0.01	2604 07:03			0.00
WQ-VOL-2	ORIFICE	0.39	1388 05:02			0.00
WQ-OUT-3	ORIFICE	0.04	2604 18:35			0.00
Q100-OUT-2	ORIFICE	1.11	1388 05:18			0.00
Q100-OUT	ORIFICE	0.79	1388 05:08			0.00
WQ-VOL-3	ORIFICE	0.34	2604 07:08			0.00
WQ-OUT-2	ORIFICE	0.01	1388 05:02			0.00
ORIF-1	ORIFICE	0.04	2604 07:03			0.00
ORIFICE-BOX-1	ORIFICE	0.01	1388 05:10			0.00
ORIFICE-BOX-2	ORIFICE	0.30	1388 05:10			0.00
ORIFICE-BOX-3	ORIFICE	0.04	1388 05:10			0.00
ORIFICE-BOX-4	ORIFICE	0.03	1388 05:10			0.00
DRAIN-WQ	WEIR	0.58	2604 07:01			0.00
DRAIN-Q100	WEIR	0.08	1388 05:02			0.00
WEIR-1	WEIR	0.40	2604 07:03			0.00
WEIR-BOX	WEIR	0.04	1388 05:10			0.00
WEIR-BOX-2	WEIR	1.13	1388 05:10			0.00

****
Conduit Surcharge Summary
****

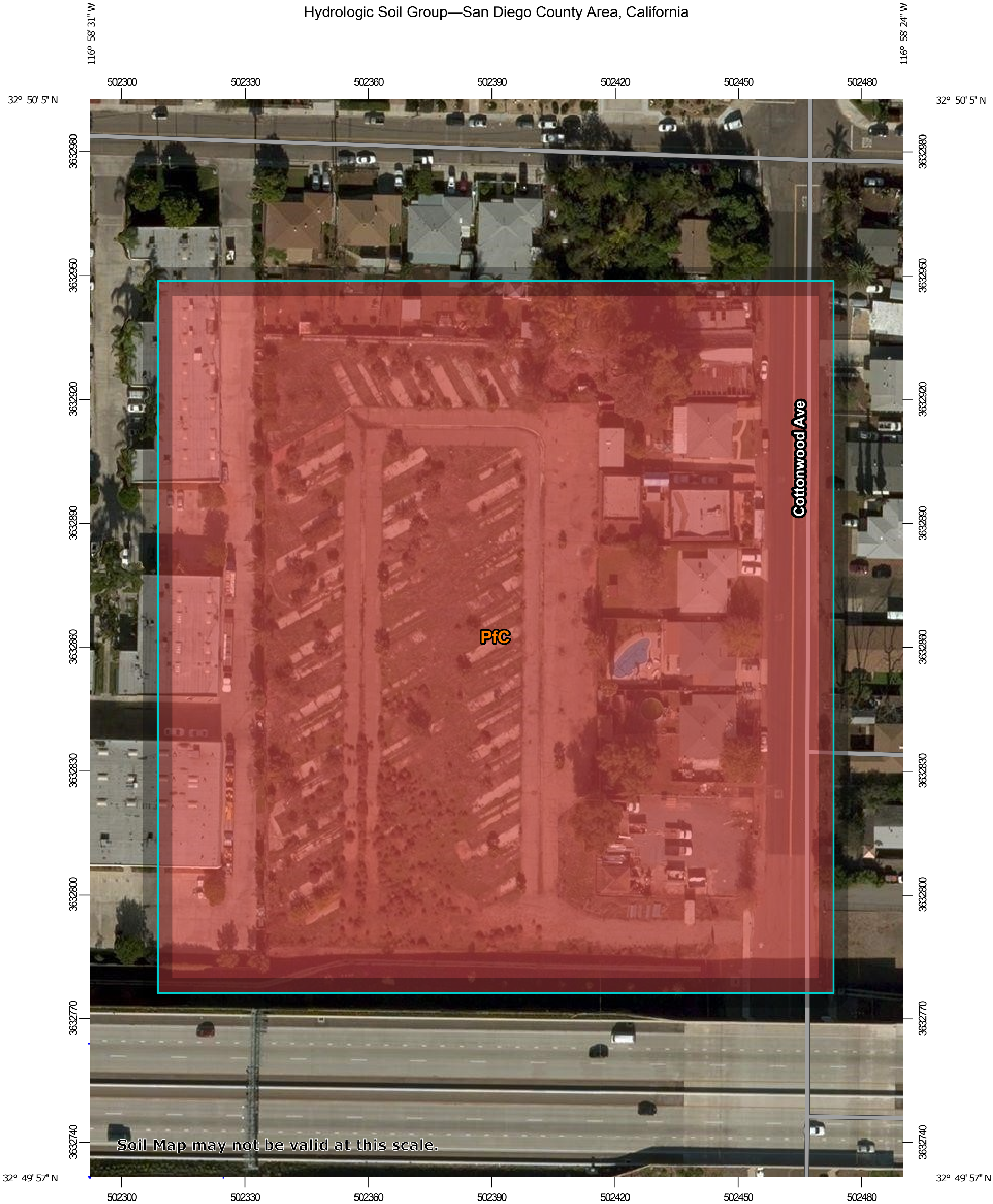
No conduits were surcharged.

Analysis begun on: Fri Feb 28 15:39:43 2020
Analysis ended on: Fri Feb 28 15:41:05 2020
Total elapsed time: 00:01:22

Attachment C

USDA NRCS CUSTOM SOIL RESOURCE REPORT

Hydrologic Soil Group—San Diego County Area, California



Map Scale: 1:1,270 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0, 15, 30, 60, 90

Feet: 0, 50, 100, 200, 300

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 11N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: San Diego County Area, California
Survey Area Data: Version 12, Sep 13, 2017

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Dec 7, 2014—Jan 4, 2015

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
PfC	Placentia sandy loam, thick surface, 2 to 9 percent slo pes	D	7.0	100.0%
Totals for Area of Interest			**7.0**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

ATTACHMENT 3
Structural BMP Maintenance Information

This is the cover sheet for Attachment 3.

Indicate which Items are Included behind this cover sheet:

Attachment Sequence	**Contents**	**Checklist**
Attachment 3a	Structural BMP Maintenance Thresholds and Actions (Required)	☑ Included See Structural BMP Maintenance Information Checklist on the back of this Attachment cover sheet.
Attachment 3b	Draft Maintenance Agreement (when applicable)	☐ Included ☑ Not Applicable

Use this checklist to ensure the required information has been included in the Structural BMP Maintenance Information Attachment:

☐ **Preliminary Design / Planning / CEQA level submittal:**

Attachment 3a must identify:

☑ Typical maintenance indicators and actions for proposed structural BMP(s) based on Section 7.7 of the BMP Design Manual

Attachment 3b is not required for preliminary design / planning / CEQA level submittal.

☐ **Final Design level submittal:**

Attachment 3a must identify:

☐ Specific maintenance indicators and actions for proposed structural BMP(s). This shall be based on Section 7.7 of the BMP Design Manual and enhanced to reflect actual proposed components of the structural BMP(s)

☐ How to access the structural BMP(s) to inspect and perform maintenance

☐ Features that are provided to facilitate inspection (e.g., observation ports, cleanouts, silt posts, or other features that allow the inspector to view necessary components of the structural BMP and compare to maintenance thresholds)

☐ Manufacturer and part number for proprietary parts of structural BMP(s) when applicable

☐ Maintenance thresholds specific to the structural BMP(s), with a location-specific frame of reference (e.g., level of accumulated materials that triggers removal of the materials, to be identified based on viewing marks on silt posts or measured with a survey rod with respect to a fixed benchmark within the BMP)

☐ Recommended equipment to perform maintenance

☐ When applicable, necessary special training or certification requirements for inspection and maintenance personnel such as confined space entry or hazardous waste management

Attachment 3b: For private entity operation and maintenance, Attachment 3b shall include a draft maintenance agreement in the local jurisdiction's standard format (PDP applicant to contact the [City Engineer] to obtain the current maintenance agreement forms).

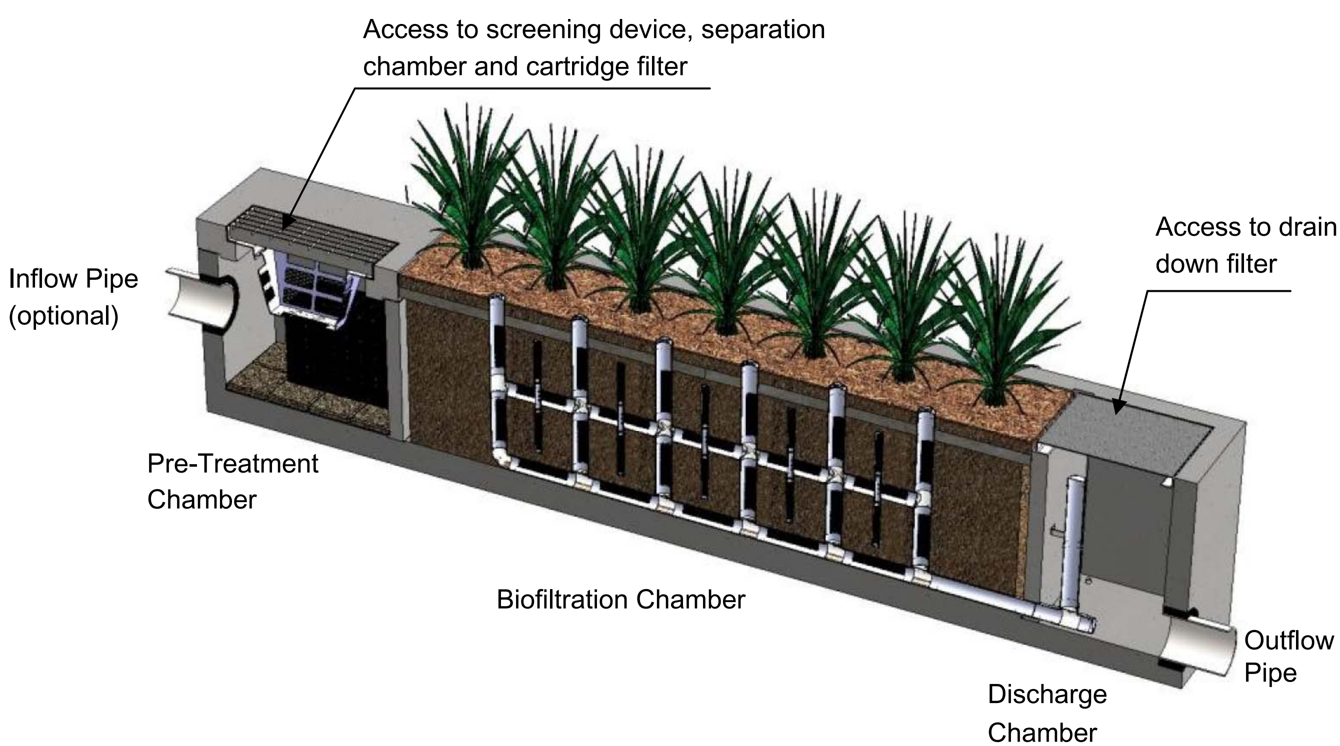
ATTACHMENT 3a

Maintenance Guidelines for Modular Wetland System - Linear

Maintenance Summary

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

System Diagram



Maintenance Procedures

Screening Device

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

Separation Chamber

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

Cartridge Filters

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

Drain Down Filter

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

Maintenance Notes

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

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

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

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

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

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

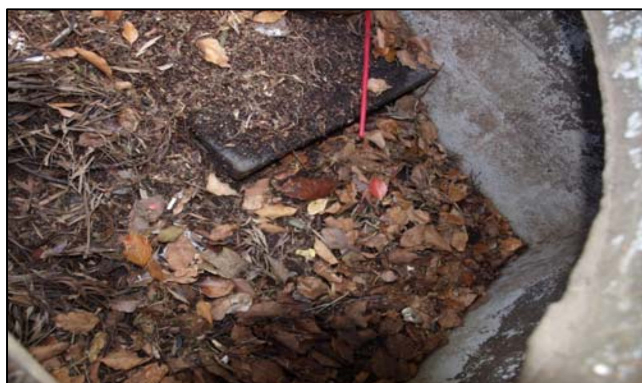
Maintenance Procedure Illustration

Screening Device

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

Separation Chamber

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



Cartridge Filters

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

Drain Down Filter

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

Trim Vegetation

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

Inspection Form

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

www.modularwetlands.com

BIO CLEAN ENVIRONMENTAL SERVICES, INC.

Inspection Report
Modular Wetlands System

MODULAR WETLANDS

Project Name ____________________

Project Address ____________________
(city) (Zip Code)

Owner / Management Company ____________________

Contact ____________________ Phone ( ) –

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

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

Weather Condition ____________________ Additional Notes ____________________

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

Inspection Checklist

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

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

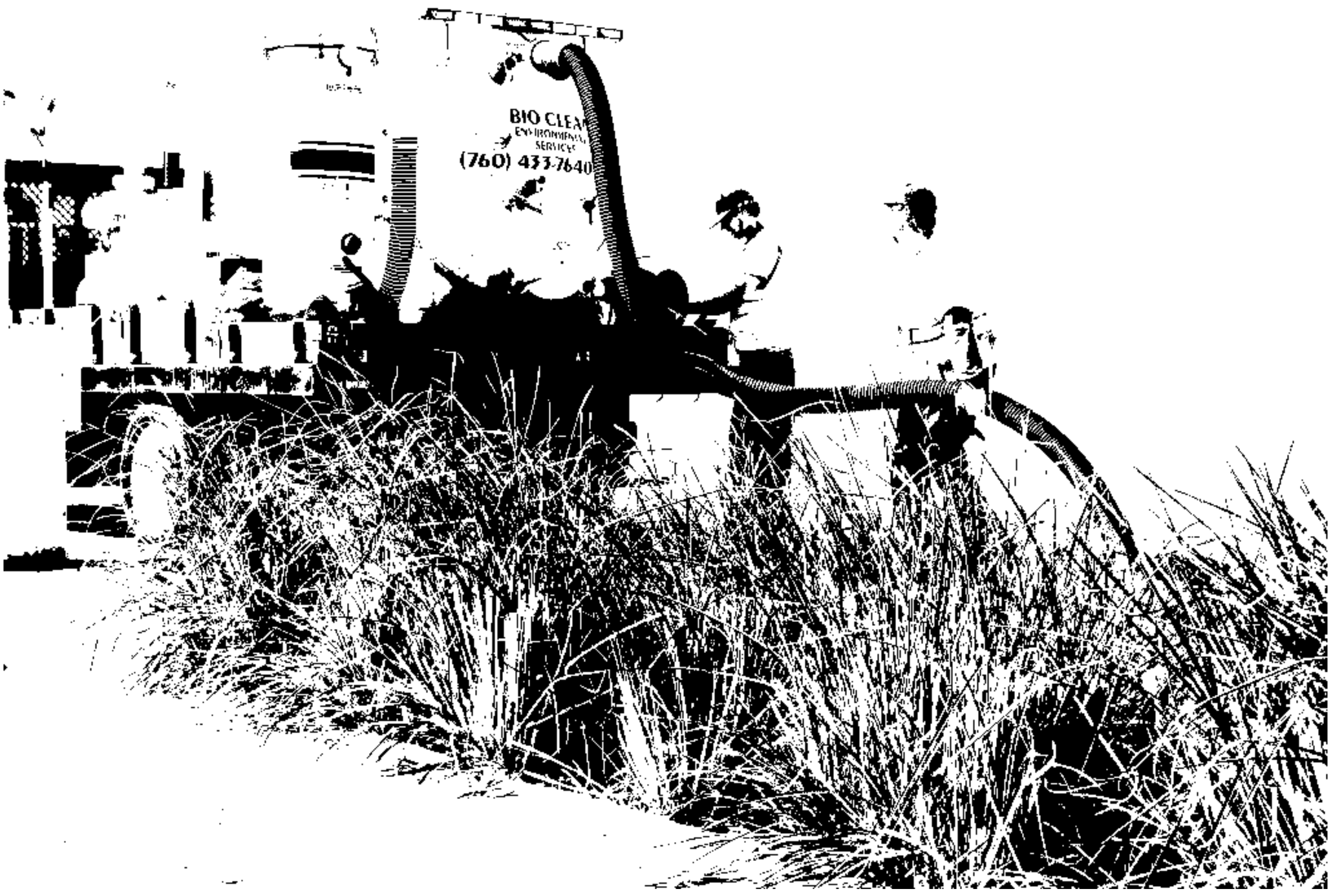
Waste:	Yes	No
Sediment / Silt / Clay		
Trash / Bags / Bottles		
Green Waste / Leaves / Foliage		

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

Plant Information	
Damage to Plants	
Plant Replacement	
Plant Trimming	

Additional Notes: ____________________

Maintenance Report



Modular Wetland System, Inc.
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E. Info@modularwetlands.com

www.modularwetlands.com

Cleaning and Maintenance Report
Modular Wetlands System

BIO CLEAN ENVIRONMENTAL SERVICES, INC.

MODULAR WETLANDS

Project Name ______________________

Project Address ______________________ (city) (Zip Code)

Owner / Management Company ______________________

Contact ______________________ Phone ( ) –

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

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

Weather Condition ______________________ Additional Notes ______________________

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

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

Comments:

MAINTENANCE

MWS – Linear

Hybrid Stormwater Filtration System

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

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

MAINTENANCE –

Maintenance Summary –

- Clean screening filter device a least twice per year (*15 minute service time*).
- Clean separation (sediment) chamber once a year (*30 minute service time*).
- Evaluate and replace primary filtration media (BioMediaGREEN blocks) as needed. Typically replacement occurs once every 12 to 18 months (*60 minute service time*).
- Evaluate condition of wetland media. Replacement of media occurs once every 5 to 20 years (*4 hours*).
- Replace drain down filter media (*BioMediaGREEN block*) once every year (*5 minute service time*).
- Trim vegetation as needed (*15 minute service time*).

Maintenance Procedures –

A. Every installed MWS – Linear unit is to be maintained by the Supplier, or a Supplier approved contractor. The cost of this service varies among providers.

B. The MWS – Linear is a multi-stage self-contained treatment train. Each stage protects subsequent stages from clogging. These stages include: screening, separation, primary filtration, and biological remediation. The biological remediation stage contains plants and therefore requires ongoing landscape maintenance, similar to that of other landscaped areas.

1. Screening is provided by Bio Clean Catch Basin Insert Filters. This screening filter has a capacity of 2 or 4 cubic feet (curb type and grate type respectively). This filter targets gross solids, including litter, and sediments greater than 200 microns. It is recommended that this screening filter be cleaned at least two times per year. Cleaning of this device is relatively inexpensive. *This procedure takes approximately 15 minutes.*

2. Separation is provided by a 3’ x 3’ settling chamber. This chamber has a capacity of approximately 21 cubic feet. This chamber targets smaller sediments, larger TSS, and particulate metals and nutrients. This chamber protects the following filtration stages from premature clogging. **It is recommended that this separation chamber be cleaned out once a year.** This procedure can be performed with a standard vac truck. *This procedure takes approximately 30 minutes.*

3. Primary filtration is provided by a horizontal flow perimeter filter utilizing BioMediaGREEN. The perimeter filter has a default media surface area of 28 square feet. This surface area can also be doubled to 56 square feet, upon request, by a simple physical modification to the media blocks. The greater the surface area, the longer the media will maintain appropriate flow rates before clogging. This perimeter filter and the revolutionary BioMediaGREEN media targets fine TSS, dissolved metals, nutrients, and bacteria. **It is recommended that the filter media be evaluated once per year and recharged if necessary.** Media life depends on local loading conditions and can easily be replaced and disposed of without any equipment. *Replacement of media takes approximately 60 minutes.*

4. Biological remediation (natural filtration) is provided by a 4th generation enhanced sub-surface flow vegetated gravel wetland. This natural filter is 14 feet long and contains 248 cubic feet of filter media and plant material. It targets the finest TSS, nutrients, dissolved metals, and bacteria. This filter provides the final polishing step of treatment. If prior treatment stages are properly maintained, the life of this media can be more than 5 years. **It is recommended the wetland and its plants be inspected once a year.** Replacement of the rock media may be needed as soon as five years or as long as 20 years. *Inspection takes approximately 15 minutes. Replacement of rock media takes approximately 4 hours and requires a vac truck.*

5. A drain down filter, similar in function to the perimeter filter is located in the discharge chamber. This filter allows standing water to be drained and filtered out

of the separation chamber. This addresses any vector issues, by eliminating all standing water within this system. **It is recommended the media of the drain down filter be replaced one a year.** *Replacement of media takes approximately 5 minutes and is performed without any equipment.*

The MWS – Linear catch basin filter, separation chamber, and wetland filter are designed to allow for the use of vacuum removal of captured materials in the filter screens and sediment and wetland chambers, serviceable by centrifugal compressor vacuum units without causing damage to the filter or during normal cleaning and maintenance. Filters can be cleaned and vacuumed from the standard manhole access or at grade.

Maintenance Notes:

1. Modular Wetland Systems, Inc. recommends the **catch basin filter** be inspected and cleaned a minimum of once every six months and replacement of hydrocarbon booms once a year. The procedure is easily done with the use of any standard vacuum truck.

    - Remove grate or manhole to gain access to catch basin filter insert. Remove the deflector shield (grate type only) with the hydrocarbon boom attached. Where possible the maintenance should be performed from the ground surface. Note: entry into an underground stormwater vault such as an inlet vault requires certification in confined space training.
    - Remove all trash, debris, organics, and sediments collected by the inlet filter insert. Removal of the trash and debris can be done manually or with the use of a vactor truck. The hose of the vactor truck will not damage the screen of the filter.
    - Evaluation of the hydrocarbon boom shall be performed at each cleaning. If the boom is filled with hydrocarbons and oils it should be replaced. Attach new boom to basket with plastic ties through pre-drilled holes in basket. Place the deflector shield (grate type only) back into the filter.

- Transport all debris, trash, organics and sediments to approved facility for disposal in accordance with local and state requirements.
- The hydrocarbon boom may be classified as hazardous material and will have to be picked up and disposed of as hazardous waste. Hazardous material can only be handled by a certified hazardous waste trained person (minimum 24-hour hazwoper).

2. Modular Wetland Systems, Inc. recommends the **separation chamber** be inspected and cleaned a minimum of once a year. The procedure is easily done with the use of any standard vacuum truck. Remove grate or manhole, remove catch basin filter, spray down pollutants accumulated on fiberglass media panels (do not spray media directly, doing so can damage the media), vacuum out separation chamber, replace catch basin filter, replace grate or manhole cover.

3. Modular Wetland Systems, Inc. recommends the **perimeter filter's** media be inspected and cleaned a minimum of once a year. The procedure will require prior maintenance of separation chamber. Remove grate, remove catch basin filter, enter separation chamber, unlatch top and bottom of each media protection panel, remove media protection panels to expose media, power wash surface, evaluate media condition, replace if necessary. New media blocks can be ordered from Modular Wetland Systems, Inc. Replace media protection panels, replace catch basin filter, replace grate or manhole cover.

4. Modular Wetland Systems, Inc. recommends the **drain down filter** be inspected and maintained a minimum of once a year. Open hatch of discharge chamber, enter chamber, unlatch fiberglass cover, remove media block, replace with new block, replace and latch cover. Exit chamber, close and lock down the hatch.

5. Modular Wetland Systems, Inc. recommends the **wetland filter** and its plants/vegetation be inspected and maintained a minimum of once a year. It is also recommended that the plants receive the same care as other landscaped areas. **Note: No fertilizer is to be used on this area.**

6. Following maintenance and/or inspection, the maintenance operator shall prepare a maintenance/inspection record. The record shall include any maintenance activities performed, amount and description of debris collected, and condition of the system and its various filter mechanism. .

7. The owner shall retain the maintenance/inspection record for a minimum of five years from the date of maintenance. These records shall be made available to the governing municipality for inspection upon request at any time.

8. Any person performing maintenance activities must have completed a minimum of OSHA 24-hour hazardous waste worker (hazwoper) training.

9. Remove access manhole lid or grate to gain access to filter screens and sediment chambers. Where possible the maintenance should be performed from the ground surface. Note: entry into an underground stormwater vault such as an inlet vault requires certification in confined space training.

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

11. The hydrocarbon boom is classified as hazardous material and will have to be picked up and disposed of as hazardous waste. Hazardous material can only be handled by a certified hazardous waste trained person (minimum 24-hour hazwoper).

Maintenance Sequence

Service Crews Arrive On Site And Remove Access Manhole To Perform Maintenance Service.

Assess Condition and Pollutant Loading. A Few Gallons Of Water Are Sprayed Into Sediment Chamber To Allow Sediment To Be Vacuumed.

Catch Basin Filters Are Completely Vacuumed Free Of All Pollutants.

Cleaned Catch Basin Filters Are Removed Through Access Manhole To Allow For Unimpeded Access To Sediment Chamber.

Sediment Chamber Is Vacuumed Clean Of All Accumulated Sediment And Associated Pollutants.

Filter Media Shields Are Removed To Expose BioMediaGREEN Filter Media To Be Cleaned Or Replaced.

Exposed Filter Media Will Be Evaluated For Clogging And Loading Condition.

Media To Be Power Washed To Reveal Extent Of Clogging. If Only Surface Is Clogged, Media Can Be Re-Used Once. If Clogged Replace With New Media Blocks. Remove and Replace.

Washed Or New Media Is Now Ready For Use. If Media Was Replaced, Old Media Will Need To Be Properly Disposed Of Properly.

Replace Media Filter Panels And Lock Into Position.

Replace Catch Basin Filters.

Replace Access Manhole. Check Plants For Growth, Trim If Necessary. Service Is Complete. Total Service Time = 45 Minutes.

ATTACHMENT 4
Copy of Plan Sheets Showing Permanent Storm Water BMPs

This is the cover sheet for Attachment 4.

Use this checklist to ensure the required information has been included on the plans:

The plans must identify:

☑ Structural BMP(s) with ID numbers matching Form I-6 Summary of PDP Structural BMPs

☑ The grading and drainage design shown on the plans must be consistent with the delineation of DMAs shown on the DMA exhibit

☑ Details and specifications for construction of structural BMP(s)

☑ Signage indicating the location and boundary of structural BMP(s) as required by the [City Engineer]

☑ How to access the structural BMP(s) to inspect and perform maintenance

☑ Features that are provided to facilitate inspection (e.g., observation ports, cleanouts, silt posts, or other features that allow the inspector to view necessary components of the structural BMP and compare to maintenance thresholds)

☑ Manufacturer and part number for proprietary parts of structural BMP(s) when applicable

☑ Maintenance thresholds specific to the structural BMP(s), with a location-specific frame of reference (e.g., level of accumulated materials that triggers removal of the materials, to be identified based on viewing marks on silt posts or measured with a survey rod with respect to a fixed benchmark within the BMP)

☑ Recommended equipment to perform maintenance

☑ When applicable, necessary special training or certification requirements for inspection and maintenance personnel such as confined space entry or hazardous waste management

☑ Include landscaping plan sheets showing vegetation requirements for vegetated structural BMP(s)

☑ All BMPs must be fully dimensioned on the plans

☑ When proprietary BMPs are used, site-specific cross section with outflow, inflow, and model number shall be provided. Photocopies of general brochures are not acceptable.

END OF REPORT