

Appendix E-1

Mojave River Watershed
Water Quality Management Plan
Capstone Engineering
September 24, 2024

MOJAVE RIVER WATERSHED

Water Quality Management Plan

For:

GENERAL PUMP - HESPERIA , CA

A.P.N. 0414-072-06

Prepared for:

GENERAL PUMP

157 N ACACIA ST

SAN DIMAS, CA 91773

Prepared by:

CAPSTONE ENGINEERING

9711 Holland St, #8

Bakersfield, CA 93312

PH: (661) 230-9034

Submittal Date: 10/24/2024

Revision No. and Date: -

Revision No. and Date: Insert No and Current Revision Date

Revision No. and Date: Insert No and Current Revision Date

Revision No. and Date: Insert No and Current Revision Date

Revision No. and Date: Insert No and Current Revision Date

Final Approval Date: _____

Project Owner's Certification

This Mojave River Watershed Water Quality Management Plan (WQMP) has been prepared for GENERAL PUMP by CAPSTONE ENGINEERING . The WQMP is intended to comply with the requirements of the CITY OF HESPERIA and the Phase II Small MS4 General Permit for the Mojave River Watershed. The undersigned, while it owns the subject property, is responsible for the implementation of the provisions of this plan and will ensure that this plan is amended as appropriate to reflect up-to-date conditions on the site consistent with the Phase II Small MS4 Permit and the intent of San Bernardino County (unincorporated areas of Phelan, Oak Hills, Spring Valley Lake and Victorville) and the incorporated cities of Hesperia and Victorville and the Town of Apple Valley. Once the undersigned transfers its interest in the property, its successors in interest and the city/county/town shall be notified of the transfer. The new owner will be informed of its responsibility under this WQMP. A copy of the approved WQMP shall be available on the subject site in perpetuity.

"I certify under a penalty of law that the provisions (implementation, operation, maintenance, and funding) of the WQMP have been accepted and that the plan will be transferred to future successors."

Project Data			
Permit/Application Number(s):		Grading Permit Number(s):	
Tract/Parcel Map Number(s):	PORTION OF LOT D, BLOCK 382, TOWN OF HESPERIA	Building Permit Number(s):	
CUP, SUP, and/or APN (Specify Lot Numbers if Portions of Tract):			A.P.N. 0414-072-06
Owner's Signature			
Owner Name:			
Title	OWNER		
Company	I Ave Property Holdings (Hesperia, Ca) LLC		
Address	157 N Acacia St, San Dimas, CA 91773		
Email	info@genpump.com		
Telephone #	909-599-9606		
Signature		Date	10/24/2024

Preparer's Certification

Project Data			
Permit/Application Number(s):		Grading Permit Number(s):	
Tract/Parcel Map Number(s):	PORTION OF LOT D, BLOCK 382, TOWN OF HESPERIA	Building Permit Number(s):	
CUP, SUP, and/or APN (Specify Lot Numbers if Portions of Tract):			A.P.N. 0414-072-06

"The selection, sizing and design of stormwater treatment and other stormwater quality and quantity control measures in this plan were prepared under my oversight and meet the requirements of the California State Water Resources Control Board Order No. 2013-0001-DWQ.

Engineer: Andrew Bell		PE Stamp Below 
Title	Principal Engineer	
Company	CAPSTONE ENGINEERING	
Address	9711 Holland St, #8, Bakersfield, CA 93312	
Email	abell@capstoneengineering.com	
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Signature		
Date	10-24-2024	

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- COUNTY EDUCATION MATERIALS

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Section I – Introduction

This WQMP template has been prepared specifically for the Phase II Small MS4 General Permit in the Mojave River Watershed. This location is within the jurisdiction of the Lahontan Regional Water Quality Control Board (LRWQCB). This document should not be confused with the WQMP template for the Santa Ana Phase I area of San Bernardino County.

WQMP preparers must refer to the MS4 Permit for the Mojave Watershed WQMP template and Technical Guidance (TGD) document found at: <http://cms.sbcounty.gov/dpw/Land/NPDES.aspx> to find pertinent arid region and Mojave River Watershed specific references and requirements.

Section 1 Discretionary Permit(s)

Form 1-1 Project Information					
Project Name		GENERAL PUMP			
Project Owner Contact Name:		PETER BROOKS			
Mailing Address:	157 N ACACIA ST, SAN DIMAS, CA 91773	E-mail Address:	info@genpump.com	Telephone:	909-599-9606
Permit/Application Number(s):				Tract/Parcel Map Number(s):	
Additional Information/ Comments:		SW Corner of Hercules St and I Ave, Hesperia, CA 92345 Number of Drainage Areas (DA) = 1 Number of Drainage Management Areas (DMA) = 1 Existing Lot Area = 122,742 square-feet (2.82 acres) Existing Pervious Area = 122,742 square-feet Existing Impervious Area = 0 square-feet Proposed Lot Area (GROSS WQMP) = 122,742 square-feet (2.82 acres) Proposed Pervious Area = 12,832 square-feet Proposed Impervious Area = 109,910 square-feet # of Below Ground Infiltration System = 1 DA 1 DCV = 6,931 cubic-feet (14,343 cubic-feet – PROVIDED)			
Description of Project:		The existing land is vacant and will be developed into proposed storage and a 3,500 SF office building. FEMA reports the property is in Zone "X". The storage and office building will be on the east side of the site, along with offsite parking. Improvements will consist of curb gutter and sidewalk on the south side of Hercules St and west side of I Avenue with two drive approaches. An underground ADS Stormtech chamber is proposed to capture increased runoff volume.. There is approximately 1.6 acres at the southwest portion of the property that will not be utilized and will remain undisturbed.			

MOJAVE RIVER WATERSHED Water Quality Management Plan (WQMP)

Provide summary of Conceptual WQMP conditions (if previously submitted and approved). Attach complete copy.	N/A
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Section 2 Project Description

2.1 Project Information

The WQMP shall provide the information listed below. The information provided for Conceptual/Preliminary WQMP should give sufficient detail to identify the major proposed site design and LID BMPs and other anticipated water quality features that impact site planning. Final Project WQMP must specifically identify all BMP incorporated into the final site design and provide other detailed information as described herein.

The purpose of this information is to help determine the applicable development category, pollutants of concern, watershed description, and long term maintenance responsibilities for the project, and any applicable water quality credits. This information will be used in conjunction with the information in Section 3, Site Description, to establish the performance criteria and to select the LID BMP or other BMP for the project or other alternative programs that the project will participate in, which are described in Section 4.

2.1.1 Project Sizing Categorization

If the Project is greater than 5,000 square feet, and not on the excluded list as found on Section 1.4 of the TGD, the Project is a Regulated Development Project.

If the Project is creating and/or replacing greater than 2,500 square feet but less than 5,000 square feet of impervious surface area, then it is considered a Site Design Only project. This criterion is applicable to all development types including detached single family homes that create and/or replace greater than 2,500 square feet of impervious area and are not part of a larger plan of development.

Form 2.1-1 Description of Proposed Project

¹ Regulated Development Project Category (Select all that apply):

☒ #1 New development involving the creation of 5,000 ft ² or more of impervious surface collectively over entire site	☐ #2 Significant re-development involving the addition or replacement of 5,000 ft ² or more of impervious surface on an already developed site	☐ #3 Road Project – any road, sidewalk, or bicycle lane project that creates greater than 5,000 square feet of contiguous impervious surface	☐ #4 LUPs – linear underground/overhead projects that has a discrete location with 5,000 sq. ft. or more new constructed impervious surface
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☐ Site Design Only (Project Total Square Feet > 2,500 but < 5,000 sq.ft.) Will require source control Site Design Measures. Use the "PCMP" Template. Do not use this WQMP Template.

² Project Area (ft ²):	122,742	³ Number of Dwelling Units:	-	⁴ SIC Code:	4225
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⁵ Is Project going to be phased? Yes ☐ No ☒ If yes, ensure that the WQMP evaluates each phase as a distinct DA, requiring LID BMPs to address runoff at time of completion.

2.2 Property Ownership/Management

Describe the ownership/management of all portions of the project and site. State whether any infrastructure will transfer to public agencies (City, County, Caltrans, etc.) after project completion. State if a homeowners or property owners association will be formed and be responsible for the long-term maintenance of project stormwater facilities. Describe any lot-level stormwater features that will be the responsibility of individual property owners.

Form 2.2-1 Property Ownership/Management

Describe property ownership/management responsible for long-term maintenance of WQMP stormwater facilities:

GENERAL PUMP

159 N ACACIA ST

SAN DIMAS, CA 91773

PH: (909) 599-9606

A property owner's association (POA) will not be formed for long-term maintenance of project stormwater facility. Owner will maintain ownership of all units and they will be rental only.

The owner will be responsible for maintenance of the BMP's on the project site

2.3 Potential Stormwater Pollutants

Best Management Practices (BMP) measures for pollutant generating activities and sources shall be designed consistent with recommendations from the CASQA Stormwater BMP Handbook for New Development and Redevelopment (or an equivalent manual). Pollutant generating activities must be considered when determining the overall pollutants of concern for the Project as presented in Form 2.3-1.

Determine and describe expected stormwater pollutants of concern based on land uses and site activities (refer to Table 3-2 in the TGD for WQMP).

Form 2.3-1 Pollutants of Concern			
Pollutant	Please check: E=Expected, N=Not Expected		Additional Information and Comments
Pathogens (Bacterial / Virus)	E ☒	N ☐	Common runoff pollutant from pavement and landscape areas, including wild birds and animals together with garbage
Nutrients - Phosphorous	E ☒	N ☐	Common runoff pollutant from landscaping, including fertilizer, food waste, and garbage
Nutrients - Nitrogen	E ☒	N ☐	Common runoff pollutant from landscaping, including fertilizers, and food waste
Noxious Aquatic Plants	E ☒	N ☐	Runoff pollutant from landscaping
Sediment	E ☒	N ☐	Runoff pollutant from pavement, landscaping, graded slopes and rooftops
Metals	E ☒	N ☐	Runoff pollutant from vehicular traffic
Oil and Grease	E ☒	N ☐	Runoff pollutant from vehicular traffic, and a vehicle wash area
Trash/Debris	E ☒	N ☐	Runoff pollutant from poorly maintained trash containers and parking areas
Pesticides / Herbicides	E ☒	N ☐	Runoff pollutant from landscaping
Organic Compounds	E ☒	N ☐	Runoff pollutant from overuse of fertilizer
Other:	E ☐	N ☐	
Other:	E ☐	N ☐	
Other:	E ☐	N ☐	

Section 3 Site and Watershed Description

Describe the project site conditions that will facilitate the selection of BMPs through an analysis of the physical conditions and limitations of the site and its receiving waters. Identify distinct drainage areas (DA) that collect flow from a portion of the site and describe how runoff from each DA (and sub-watershed Drainage Management Areas (DMAs)) is conveyed to the site outlet(s). Refer to Section 3.2 in the TGD for WQMP. The form below is provided as an example. Then complete Forms 3.2 and 3.3 for each DA on the project site. ***If the project has more than one drainage area for stormwater management, then complete additional versions of these forms for each DA / outlet. A map presenting the DMAs must be included as an appendix to the WQMP document.***

Form 3-1 Site Location and Hydrologic Features			
Site coordinates take GPS measurement at approximate center of site	Latitude 34°28'46.7"N	Longitude 117°16'55.8"W	Thomas Bros Map page
1 San Bernardino County climatic region: ☒ Desert			
2 Does the site have more than one drainage area (DA): Yes ☐ No ☐ <i>If no, proceed to Form 3-2. If yes, then use this form to show a conceptual schematic describing DMAs and hydrologic feature connecting DMAs to the site outlet(s). An example is provided below that can be modified for proposed project or a drawing clearly showing DMA and flow routing may be attached</i>			
Conveyance	Briefly describe on-site drainage features to convey runoff that is not retained within a DMA		
DA1 DMA C flows to DA1 DMA A	Ex. Bioretention overflow to vegetated bioswale with 4' bottom width, 5:1 side slopes and bed slope of 0.01. Conveys runoff for 1000' through DMA 1 to existing catch basin on SE corner of property		
DA1 DMA A to Outlet 1	Vegeated swales drain to stormtech system. If that fills, a sidewalk drain to take overflow to the street		
DA1 DMA B to Outlet 1			
DA2 to Outlet 2			

Form 3-2 Existing Hydrologic Characteristics for Drainage Area 1				
For Drainage Area 1's sub-watershed DMA, provide the following characteristics	DMA A	DMA B	DMA C	DMA D
1 DMA drainage area (ft ²)	122,742			
2 Existing site impervious area (ft ²)	0			
3 Antecedent moisture condition <i>For desert areas, use http://www.sbcounty.gov/dpw/floodcontrol/pdf/20100412_map.pdf</i>	AMC II			
4 Hydrologic soil group <i>Refer to County Hydrology Manual Addendum for Arid Regions – http://www.sbcounty.gov/dpw/floodcontrol/pdf/20100412_addendum.pdf</i>	C			
5 Longest flowpath length (ft)	389			
6 Longest flowpath slope (ft/ft)	.0225			
7 Current land cover type(s) <i>Select from Fig C-3 of Hydrology Manual</i>	BARREN			
8 Pre-developed pervious area condition: <i>Based on the extent of wet season vegetated cover good >75%; Fair 50-75%; Poor <50% Attach photos of site to support rating</i>	POOR			

Form 3-2 Existing Hydrologic Characteristics for Drainage Area 1 (use only as needed for additional DMA w/in DA 1)				
For Drainage Area 1's sub-watershed DMA, provide the following characteristics	DMA E	DMA F	DMA G	DMA H
1 DMA drainage area (ft ²)				
2 Existing site impervious area (ft ²)				
3 Antecedent moisture condition <i>For desert areas, use</i> http://www.sbcounty.gov/dpw/floodcontrol/pdf/20100412_map.pdf				
4 Hydrologic soil group <i>County Hydrology Manual Addendum for Arid Regions –</i> http://www.sbcounty.gov/dpw/floodcontrol/pdf/20100412_addendum.pdf				
5 Longest flowpath length (ft)				
6 Longest flowpath slope (ft/ft)				
7 Current land cover type(s) <i>Select from Fig C-3 of Hydrology Manual</i>				
8 Pre-developed pervious area condition: <i>Based on the extent of wet season vegetated cover good >75%; Fair 50-75%; Poor <50% Attach photos of site to support rating</i>				

Form 3-3 Watershed Description for Drainage Area

Receiving waters

Refer to SWRCB site:

http://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2010.shtml

Mojave River

Applicable TMDLs

http://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2010.shtml

Mojave River: Fluoride

303(d) listed impairments

http://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2010.shtml

Mojave River: Fluoride, Sulfates, Total Dissolved Solids

Environmentally Sensitive Areas (ESA)

Refer to Watershed Mapping Tool –

<http://sbcounty.permitrack.com/WAP>

Desert Tortoise Habitate Cat 3

Hydromodification Assessment

☒ Yes Complete Hydromodification Assessment. Include Forms 4.2-2 through Form 4.2-5 and Hydromodification BMP Form 4.3-9 in submittal

☐ No

Section 4 Best Management Practices (BMP)

4.1 Source Control BMPs and Site Design BMP Measures

The information and data in this section are required for both Regulated Development and Site Design Only Projects. Source Control BMPs and Site Design BMP Measures are the basis of site-specific pollution management.

4.1.1 Source Control BMPs

Non-structural and structural source control BMP are required to be incorporated into all new development and significant redevelopment projects. Form 4.1-1 and 4.1-2 are used to describe specific source control BMPs used in the WQMP or to explain why a certain BMP is not applicable. Table 7-3 of the TGD for WQMP provides a list of applicable source control BMP for projects with specific types of potential pollutant sources or activities. The source control BMP in this table must be implemented for projects with these specific types of potential pollutant sources or activities.

The preparers of this WQMP have reviewed the source control BMP requirements for new development and significant redevelopment projects. The preparers have also reviewed the specific BMP required for project as specified in Forms 4.1-1 and 4.1-2. All applicable non-structural and structural source control BMP shall be implemented in the project.

The identified list of source control BMPs correspond to the CASQA Stormwater BMP Handbook for New Development and Redevelopment.

Form 4.1-1 Non-Structural Source Control BMPs				
Identifier	Name	Check One		Describe BMP Implementation OR, if not applicable, state reason
		Included	Not Applicable	
N1	Education of Property Owners, Tenants and Occupants on Stormwater BMPs	☒	☐	The owner will implement an education program for BMP information and maintenance. Material will be provided by owner to hired contractors regarding the protection of storm water quality. The provided materials will include, but not limited to, approved "County of San Bernardino Stormwater Pollution Prevention" education materials for residential sites and applicable maintenance specifications for proposed BMPs. BMP education material found in, but not limited to, Section 6.4 of this report and accessible for contractors and maintenance crews of the property. The property owner will maintain, enforce and revise the BMP education program as necessary.
N2	Activity Restrictions	☒	☐	Owner will be prohibited from any discharges into the on-site infiltration basins and paved areas. Other prohibited discharges listed in the City of Hesperia Ordinances will be restricted. Prohibition of these discharges will prevent comingling of on-site pollutants to the existing drainage system. The car was will have a rain sensor to allow stormwater into the drain, however car was runoff will drain to the sewer
N3	Landscape Management BMPs	☒	☐	Landscaped areas adjacent to curbs and sidewalks will be installed at a minimum of 1-inch below the finished surface. Landscape will be maintained in accordance with County of San Bernardino "Stormwater Pollution Prevention: Landscape Maintenance", located in Section 6.4 of this report.
N4	BMP Maintenance	☒	☐	BMP's will be maintained per Form 5-1 in this report
N5	Title 22 CCR Compliance (How development will comply)	☐	☒	No hazardous materials will be stored or generated on site
N6	Local Water Quality Ordinances	☒	☐	Owner will comply with all City of Hesperia Water Quality Ordinances. Stormwater runoff from the site will be treated in the infiltration basins prior to leaving the site
N7	Spill Contingency Plan	☒	☐	Spill kit and training available to staff

Form 4.1-1 Non-Structural Source Control BMPs				
N8	Underground Storage Tank Compliance	☒	☐	Per manufacturers recommendations
N9	Hazardous Materials Disclosure Compliance	☐	☒	No hazardous materials expeted on site

Form 4.1-1 Non-Structural Source Control BMPs				
Identifier	Name	Check One		Describe BMP Implementation OR, if not applicable, state reason
		Included	Not Applicable	
N10	Uniform Fire Code Implementation	☒	☐	All fire code requirements regarding products storage and safety from Article 80 of the Uniform Fire code shall be implemented
N11	Litter/Debris Control Program	☒	☐	Trash will be stored in City approved trash enclosure with approved trash bin with lid and will be picked up weekly via by waste company, will be put into effect at time of occupancy. Maintenance employees will pick up litter in parking lot and common areas on a weekly basis.
N12	Employee Training	☒	☐	Property owner will be provided a copy of this WQMP to train any hired contractors on post-construction storm water treatment management.
N13	Housekeeping of Loading Docks	☐	☒	No Loading Docks
N14	Catch Basin Inspection Program	☒	☐	Catch basin per manufacturers recommendations
N15	Vacuum Sweeping of Private Streets and Parking Lots	☒	☐	All landscape maintenance contractors will be required to sweep up all landscape cuttings, mowing and fertilizer materials off paved areas weekly and dispose of properly. Parking areas and drive ways will be swept monthly
N16	Other Non-structural Measures for Public Agency Projects	☐	☒	Not a public agency project
N17	Comply with all other applicable NPDES permits	☒	☐	Will comply with Construction General Permit

Form 4.1-2 Structural Source Control BMPs

Identifier	Name	Check One		Describe BMP Implementation OR, If not applicable, state reason
		Included	Not Applicable	
S1	Provide storm drain system stencilling and signage (CASQA New Development BMP Handbook SD-13)	☒	☐	All drainage inlets will be stenciled or signage will be provided that indicates "NO DUMPING-DRAINS TO RIVER". Stenciling shall be blue on a white background with lettering 2" in height. A fish or similar water dependent creature silhouette may be included subject to City approval. A catch basin curb marker, circular or rectangular, at least 4" in height or diameter, may be used. Legibility of stencils and signs must be maintained and will be inspected monthly.
S2	Design and construct outdoor material storage areas to reduce pollution introduction (CASQA New Development BMP Handbook SD-34)	☐	☒	No outdoor storage areas on site.
S3	Design and construct trash and waste storage areas to reduce pollution introduction (CASQA New Development BMP Handbook SD-32)	☒	☐	Trash will be stored in an approved trash bin with a lid of which will be held in a city approved trash enclosure
S4	Use efficient irrigation systems & landscape design, water conservation, smart controllers, and source control (Statewide Model Landscape Ordinance; CASQA New Development BMP Handbook SD-12)	☒	☐	Irrigation systems will be designed to supply just the right amount of water for the landscape to flourish and not overwater. Timed irrigation systems will be used. Rain sensors for automatic shut off of sprinklers when it is raining will be used. Shut-off valves triggered by a pressure drop to control water loss in the event of a broken sprinkler head or broken line will be used.
S5	Finish grade of landscaped areas at a minimum of 1-2 inches below top of curb, sidewalk, or pavement	☒	☐	Landscaped areas adjacent to curbs and sidewalks will be installed at a minimum of 1-inch below the finished hardscape surface. Inspection will occur before rainy season (October 1st).
S6	Protect slopes and channels and provide energy dissipation (CASQA New Development BMP Handbook SD-10)	☒	☐	A rip rap is provided to reduce the possibility of erosion caused by stormwater overflow from the infiltration system.
S7	Covered dock areas (CASQA New Development BMP Handbook SD-31)	☐	☒	No Dock Areas
S8	Covered maintenance bays with spill containment plans (CASQA New Development BMP Handbook SD-31)	☐	☒	No processing areas proposed.

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S9	Vehicle wash areas with spill containment plans (CASQA New Development BMP Handbook SD-33)	☒	☐	Vehicle wash area to have containment plan and educational materials
S10	Covered outdoor processing areas (CASQA New Development BMP Handbook SD-36)	☐	☒	No processing areas proposed.
Form 4.1-2 Structural Source Control BMPs				
Identifier	Name	Check One		Describe BMP Implementation OR, If not applicable, state reason
		Included	Not Applicable	
S11	Equipment wash areas with spill containment plans (CASQA New Development BMP Handbook SD-33)	☐	☒	No equipment wash areas proposed.
S12	Fueling areas (CASQA New Development BMP Handbook SD-30)	☒	☐	Fueling tank to be double walled. Spill plan to be implemented and educational materials provided
S13	Hillside landscaping (CASQA New Development BMP Handbook SD-10)	☐	☒	No significant hillsides.
S14	Wash water control for food preparation areas	☐	☒	No food preparation areas proposed.
S15	Community car wash racks (CASQA New Development BMP Handbook SD-33)	☐	☒	No community car wash racks proposed.

4.1.2 Site Design BMPs

As part of the planning phase of a project, the site design practices associated with new LID requirements in the Phase II Small MS4 Permit must be considered. Site design BMP measures can result in smaller Design Capture Volume (DCV) to be managed by both LID and hydromodification control BMPs by reducing runoff generation.

As is stated in the Permit, it is necessary to evaluate site conditions such as soil type(s), existing vegetation and flow paths will influence the overall site design.

Describe site design and drainage plan including:

- A narrative of site design practices utilized or rationale for not using practices
- A narrative of how site plan incorporates preventive site design practices
- Include an attached Site Plan layout which shows how preventative site design practices are included in WQMP

Refer to Section 5.2 of the TGD for WQMP for more details.

Form 4.1-3 Site Design Practices Checklist
Site Design Practices <i>If yes, explain how preventative site design practice is addressed in project site plan. If no, other LID BMPs must be selected to meet targets</i>
Minimize impervious areas: Yes ☒ No ☐ Explanation: The proposed site includes drive aisles and sidewalks that are designed to the minimum widths. Additional landscape is designed wherever possible, thus minimizing the impervious areas to their minimum areas.
Maximize natural infiltration capacity; Including improvement and maintenance of soil: Yes ☒ No ☐ Explanation: The stormtech chamber BMP utilizes the sites infiltration capacity to capture and treat stormwater.
Preserve existing drainage patterns and time of concentration: Yes ☒ No ☐ Explanation: The existing drainage pattern is being maintained by allowing flow from the southwest to northeast of the site.
Disconnect impervious areas. Including rerouting of rooftop drainage pipes to drain stormwater to storage or infiltration BMPs instead of to storm drain : Yes ☒ No ☐ Explanation: Downspouts drain to landscape areas
Use of Porous Pavement.: Yes ☐ No ☒ Explanation: Not ideal for this project
Protect existing vegetation and sensitive areas: Yes ☐ No ☒ Explanation: The entire site is being developed
Re-vegetate disturbed areas. Including planting and preservation of drought tolerant vegetation. : Yes ☒ No ☐ Explanation: Landscaping to be drought tolerant vegetation

Minimize unnecessary compaction in stormwater retention/infiltration basin/trench areas: Yes ☒ No ☐ Explanation: Stormtech chamber to be staked to avoid unnecessary compaction
Utilize naturalized/rock-lined drainage swales in place of underground piping or imperviously lined swales: Yes ☒ No ☐ Explanation: Swales are utilized where possible, and then landscape drains
Stake off areas that will be used for landscaping to minimize compaction during construction : Yes ☒ No ☐ Explanation: Landscape areas to be staked off
Use of Rain Barrels and Cisterns, Including the use of on-site water collection systems.: Yes ☐ No ☒ Explanation: Not suitable for this project
Stream Setbacks. Includes a specified distance from an adjacent stream: : Yes ☐ No ☒ Explanation: N/A

It is noted that, in the Phase II Small MS4 Permit, site design elements for green roofs and vegetative swales are required. Due to the local climatology in the Mojave River Watershed, proactive measures are taken to maximize the amount of drought tolerant vegetation. It is not practical in this region to have green roofs or vegetative swales. As part of site design the project proponent should utilize locally recommended vegetation types for landscaping. Typical landscaping recommendations are found in following local references:

San Bernardino County Special Districts:

Guide to High Desert Landscaping -

<http://www.specialdistricts.org/Modules/ShowDocument.aspx?documentid=795>

Recommended High-Desert Plants -

<http://www.specialdistricts.org/modules/showdocument.aspx?documentid=553>

Mojave Water Agency:

Desert Ranch: <http://www.mojavewater.org/files/desertranchgardenprototype.pdf>

Summertree: <http://www.mojavewater.org/files/Summertree-Native-Plant-Brochure.pdf>

Thornless Garden: <http://www.mojavewater.org/files/thornlessgardenprototype.pdf>

Mediterranean Garden: <http://www.mojavewater.org/files/mediterraneangardenprototype.pdf>

Lush and Efficient Garden: <http://www.mojavewater.org/files/lushandefficientgardenprototype.pdf>

Alliance for Water Awareness and Conservation (AWAC) outdoor tips – <http://hdawac.org/save-outdoors.html>

4.2 Treatment BMPs

After implementation and design of both Source Control BMPs and Site Design BMP measures, any remaining runoff from impervious DMAs must be directed to one or more on-site, treatment BMPs (LID or biotreatment) designed to infiltrate, evapotranspire, and/or bioretain the amount of runoff specified in Permit Section E.12.e (ii)(c) Numeric Sizing Criteria for Storm Water Retention and Treatment.

4.2.1 Project Specific Hydrology Characterization

The purpose of this section of the Project WQMP is to establish targets for post-development hydrology based on performance criteria specified in Section E.12.e.ii.c and Section E.12.f of the Phase II Small MS4 Permit. These targets include runoff volume for water quality control (referred to as LID design capture volume), and runoff volume, time of concentration, and peak runoff for protection from hydromodification.

If the project has more than one outlet for stormwater runoff, then complete additional versions of these forms for each DA / outlet.

It is noted that in the Phase II Small MS4 Permit jurisdictions, the LID BMP Design Capture Volume criteria is based on the 2-year rain event. The hydromodification performance criterion is based on the 10-year rain event.

Methods applied in the following forms include:

- For LID BMP Design Capture Volume (DCV), San Bernardino County requires use of the P_6 method (Form 4.2-1) For pre- and post-development hydrologic calculation, San Bernardino County requires the use of the Rational Method (San Bernardino County Hydrology Manual Section D). Forms 4.2-2 through Form 4.2-5 calculate hydrologic variables including runoff volume, time of concentration, and peak runoff from the project site pre- and post-development using the Hydrology Manual Rational Method approach. For projects greater than 640 acres (1.0 mi²), the Rational Method and these forms should not be used. For such projects, the Unit Hydrograph Method (San Bernardino County Hydrology Manual Section E) shall be applied for hydrologic calculations for hydromodification performance criteria.

Refer to Section 4 in the TGD for WQMP for detailed guidance and instructions.

Form 4.2-1 LID BMP Performance Criteria for Design Capture Volume (DA 1)

1 Project area DA 1 (ft ²): 122,742	2 Imperviousness after applying preventative site design practices (Imp%): 89.5	3 Runoff Coefficient (Rc): 0.72 $R_c = 0.858(\text{Imp}\%)^{0.3} - 0.78(\text{Imp}\%)^{0.2} + 0.774(\text{Imp}\%) + 0.04$
4 Determine 1-hour rainfall depth for a 2-year return period $P_{2\text{yr}-1\text{hr}}$ (in): http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html		
5 Compute P_6 , Mean 6-hr Precipitation (inches): 0.48 $P_6 = \text{Item 4} * C_1$, where C_1 is a function of site climatic region specified in Form 3-1 Item 1 (Desert = 1.2371)		
6 Drawdown Rate Use 48 hours as the default condition. Selection and use of the 24 hour drawdown time condition is subject to approval by the local jurisdiction. The necessary BMP footprint is a function of drawdown time. While shorter drawdown times reduce the performance criteria for LID BMP design capture volume, the depth of water that can be stored is also reduced.		24-hrs ☐ 48-hrs ☒
7 Compute design capture volume, DCV (ft ³): 6931 $DCV = 1/12 * [\text{Item 1} * \text{Item 3} * \text{Item 5} * C_2]$, where C_2 is a function of drawdown rate (24-hr = 1.582; 48-hr = 1.963) Compute separate DCV for each outlet from the project site per schematic drawn in Form 3-1 Item 2		

Form 4.2-2 Summary of Hydromodification Assessment (DA 1)

Is the change in post- and pre- condition flows captured on-site? : Yes ☒ No ☐
If "Yes", then complete Hydromodification assessment of site hydrology for 10yr storm event using Forms 4.2-3 through 4.2-5 and insert results below (Forms 4.2-3 through 4.2-5 may be replaced by computer software analysis based on the San Bernardino County Hydrology Manual- Addendum 1)
If "No," then proceed to Section 4.3 BMP Selection and Sizing

Condition	Runoff Volume (ft ³)	Time of Concentration (min)	Peak Runoff (cfs)
Pre-developed	1 31,399 <i>Form 4.2-3 Item 12</i>	2 16.43 <i>Form 4.2-4 Item 13</i>	3 6.41, <i>Form 4.2-5 Item 10</i>
Post-developed	4 42,350 <i>Form 4.2-3 Item 13</i>	5 7.06 <i>Form 4.2-4 Item 14</i>	6 11.72 <i>Form 4.2-5 Item 14</i>
Difference	7 10,951 <i>Item 4 – Item 1</i>	8 9.37 <i>Item 2 – Item 5</i>	9 5.31 <i>Item 6 – Item 3</i>
Difference (as % of pre-developed)	10 34.8% <i>Item 7 / Item 1</i>	11 57.0% <i>Item 8 / Item 2</i>	12 82.8% <i>Item 9 / Item 3</i>

Form 4.2-3 Hydromodification Assessment for Runoff Volume (DA 1)

Weighted Curve Number Determination for: Pre-developed DA	DMA A	DMA B	DMA C	DMA D	DMA E	DMA F	DMA G	DMA H								
1a Land Cover type																
2a Hydrologic Soil Group (HSG)																
3a DMA Area, ft ² <i>sum of areas of DMA should equal area of DA</i>																
4a Curve Number (CN) <i>use Items 1 and 2 to select the appropriate CN from Appendix C-2 of the TGD for WQMP</i>																
Weighted Curve Number Determination for: Post-developed DA	DMA A	DMA B	DMA C	DMA D	DMA E	DMA F	DMA G	DMA H								
1b Land Cover type																
2b Hydrologic Soil Group (HSG)																
3b DMA Area, ft ² <i>sum of areas of DMA should equal area of DA</i>																
4b Curve Number (CN) <i>use Items 5 and 6 to select the appropriate CN from Appendix C-2 of the TGD for WQMP</i>																
5 Pre-Developed area-weighted CN:	7 Pre-developed soil storage capacity, S (in): $S = (1000 / \text{Item 5}) - 10$					9 Initial abstraction, I _a (in): $I_a = 0.2 * \text{Item 7}$										
6 Post-Developed area-weighted CN:	8 Post-developed soil storage capacity, S (in): $S = (1000 / \text{Item 6}) - 10$					10 Initial abstraction, I _a (in): $I_a = 0.2 * \text{Item 8}$										
11 Precipitation for 10 yr, 24 hr storm (in): Go to: http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html																
12 Pre-developed Volume (ft ³): $V_{pre} = (1 / 12) * (\text{Item sum of Item 3}) * [(\text{Item 11} - \text{Item 9})^2 / ((\text{Item 11} - \text{Item 9} + \text{Item 7}))]$																
13 Post-developed Volume (ft ³): $V_{pre} = (1 / 12) * (\text{Item sum of Item 3}) * [(\text{Item 11} - \text{Item 10})^2 / ((\text{Item 11} - \text{Item 10} + \text{Item 8}))]$																
14 Volume Reduction needed to meet hydromodification requirement, (ft ³): $V_{hydro} = (\text{Item 13} * 0.95) - \text{Item 12}$																

Form 4.2-4 Hydromodification Assessment for Time of Concentration (DA 1)

Compute time of concentration for pre and post developed conditions for each DA (For projects using the Hydrology Manual complete the form below)

Variables	Pre-developed DA1 <i>Use additional forms if there are more than 4 DMA</i>				Post-developed DA1 <i>Use additional forms if there are more than 4 DMA</i>			
	DMA A	DMA B	DMA C	DMA D	DMA A	DMA B	DMA C	DMA D
1 Length of flowpath (ft) <i>Use Form 3-2 Item 5 for pre-developed condition</i>								
2 Change in elevation (ft)								
3 Slope (ft/ft), $S_o = \text{Item 2} / \text{Item 1}$								
4 Land cover								
5 Initial DMA Time of Concentration (min) <i>Appendix C-1 of the TGD for WQMP</i>								
6 Length of conveyance from DMA outlet to project site outlet (ft) <i>May be zero if DMA outlet is at project site outlet</i>								
7 Cross-sectional area of channel (ft ²)								
8 Wetted perimeter of channel (ft)								
9 Manning's roughness of channel (n)								
10 Channel flow velocity (ft/sec) $V_{fps} = (1.49 / \text{Item 9}) * (\text{Item 7}/\text{Item 8})^{0.67} * (\text{Item 3})^{0.5}$								
11 Travel time to outlet (min) $T_t = \text{Item 6} / (\text{Item 10} * 60)$								
12 Total time of concentration (min) $T_c = \text{Item 5} + \text{Item 11}$								
13 Pre-developed time of concentration (min):	<i>Minimum of Item 12 pre-developed DMA</i>							
14 Post-developed time of concentration (min):	<i>Minimum of Item 12 post-developed DMA</i>							
15 Additional time of concentration needed to meet hydromodification requirement (min):	$T_{C-Hydro} = (\text{Item 13} * 0.95) - \text{Item 14}$							

Form 4.2-5 Hydromodification Assessment for Peak Runoff (DA 1)

Compute peak runoff for pre- and post-developed conditions

Variables	Pre-developed DA to Project Outlet (Use additional forms if more than 3 DMA)			Post-developed DA to Project Outlet (Use additional forms if more than 3 DMA)								
	DMA A	DMA B	DMA C	DMA A	DMA B	DMA C						
1 Rainfall Intensity for storm duration equal to time of concentration $I_{peak} = 10^{(LOG \text{ Form 4.2-1 Item 4} - 0.7 LOG \text{ Form 4.2-4 Item 5} / 60)}$												
2 Drainage Area of each DMA (Acres) <i>For DMA with outlet at project site outlet, include upstream DMA (Using example schematic in Form 3-1, DMA A will include drainage from DMA C)</i>												
3 Ratio of pervious area to total area <i>For DMA with outlet at project site outlet, include upstream DMA (Using example schematic in Form 3-1, DMA A will include drainage from DMA C)</i>												
4 Pervious area infiltration rate (in/hr) <i>Use pervious area CN and antecedent moisture condition with Appendix C-3 of the TGD for WQMP</i>												
5 Maximum loss rate (in/hr) $F_m = \text{Item 3} * \text{Item 4}$ <i>Use area-weighted F_m from DMA with outlet at project site outlet, include upstream DMA (Using example schematic in Form 3-1, DMA A will include drainage from DMA C)</i>												
6 Peak Flow from DMA (cfs) $Q_p = \text{Item 2} * 0.9 * (\text{Item 1} - \text{Item 5})$												
7 Time of concentration adjustment factor for other DMA to site discharge point <i>Form 4.2-4 Item 12 DMA / Other DMA upstream of site discharge point (If ratio is greater than 1.0, then use maximum value of 1.0)</i>	DMA A	n/a		n/a								
	DMA B		n/a		n/a							
	DMA C		n/a			n/a						
8 Pre-developed Q_p at T_c for DMA A: $Q_p = \text{Item 6}_{DMAA} + [\text{Item 6}_{DMAB} * (\text{Item 1}_{DMAA} - \text{Item 5}_{DMAB}) / (\text{Item 1}_{DMAB} - \text{Item 5}_{DMAB}) * \text{Item 7}_{DMAA/2}] + [\text{Item 6}_{DMAC} * (\text{Item 1}_{DMAA} - \text{Item 5}_{DMAC}) / (\text{Item 1}_{DMAC} - \text{Item 5}_{DMAC}) * \text{Item 7}_{DMAA/3}]$	9 Pre-developed Q_p at T_c for DMA B: $Q_p = \text{Item 6}_{DMAB} + [\text{Item 6}_{DMAA} * (\text{Item 1}_{DMAB} - \text{Item 5}_{DMAA}) / (\text{Item 1}_{DMAA} - \text{Item 5}_{DMAA}) * \text{Item 7}_{DMAB/1}] + [\text{Item 6}_{DMAC} * (\text{Item 1}_{DMAB} - \text{Item 5}_{DMAC}) / (\text{Item 1}_{DMAC} - \text{Item 5}_{DMAC}) * \text{Item 7}_{DMAB/3}]$		10 Pre-developed Q_p at T_c for DMA C: $Q_p = \text{Item 6}_{DMAC} + [\text{Item 6}_{DMAA} * (\text{Item 1}_{DMAC} - \text{Item 5}_{DMAA}) / (\text{Item 1}_{DMAA} - \text{Item 5}_{DMAA}) * \text{Item 7}_{DMAC/1}] + [\text{Item 6}_{DMAB} * (\text{Item 1}_{DMAC} - \text{Item 5}_{DMAB}) / (\text{Item 1}_{DMAB} - \text{Item 5}_{DMAB}) * \text{Item 7}_{DMAC/2}]$									
10 Peak runoff from pre-developed condition confluence analysis (cfs): <i>Maximum of Item 8, 9, and 10 (including additional forms as needed)</i>												
11 Post-developed Q_p at T_c for DMA A: <i>Same as Item 8 for post-developed values</i>	12 Post-developed Q_p at T_c for DMA B: <i>Same as Item 9 for post-developed values</i>		13 Post-developed Q_p at T_c for DMA C: <i>Same as Item 10 for post-developed values</i>									
14 Peak runoff from post-developed condition confluence analysis (cfs): <i>Maximum of Item 11, 12, and 13 (including additional forms as needed)</i>												
15 Peak runoff reduction needed to meet Hydromodification Requirement (cfs): $Q_{p-hydro} = (\text{Item 14} * 0.95) - \text{Item 10}$												

4.3 BMP Selection and Sizing

Complete the following forms for each project site DA to document that the proposed treatment (LID/Bioretenention) BMPs conform to the project DCV developed to meet performance criteria specified in the Phase II Small MS4 Permit (WQMP Template Section 4.2). For the LID DCV, the forms are ordered according to hierarchy of BMP selection as required by the Phase II Small MS4 Permit (see Section 5.3 in the TGD for WQMP). The forms compute the following for on-site LID BMP:

- Site Design Measures (Form 4.3-2)
- Retention and Infiltration BMPs (Form 4.3-3) or
- Biotreatment BMPs (Form 4.3-4).

Please note that the selected BMPs may also be used as dual purpose for on-site, hydromodification mitigation and management.

At the end of each form, additional fields facilitate the determination of the extent of mitigation provided by the specific BMP category, allowing for use of the next category of BMP in the hierarchy, if necessary.

The first step in the analysis, using Section 5.3.2 of the TGD for WQMP, is to complete Forms 4.3-1 and 4.3-3) to determine if retention and infiltration BMPs are infeasible for the project. For each feasibility criterion in Form 4.3-1, if the answer is “Yes,” provide all study findings that includes relevant calculations, maps, data sources, etc. used to make the determination of infeasibility.

Next, complete Form 4.3-2 to determine the feasibility of applicable Site Design BMPs, and, if their implementation is feasible, the extent of mitigation of the DCV.

If no site constraints exist that would limit the type of BMP to be implemented in a DA, evaluate the use of combinations of LID BMPs, including all applicable Site Design BMPs to maximize on-site retention of the DCV. If no combination of BMP can mitigate the entire DCV, implement the single BMP type, or combination of BMP types, that maximizes on-site retention of the DCV within the minimum effective area.

If the combination of site design, retention and/or infiltration BMPs is unable to mitigate the entire DCV, then the remainder of the volume-based performance criteria that cannot be achieved with site design, retention and/or infiltration BMPs must be managed through biotreatment BMPs. If biotreatment BMPs are used, then they must be sized to provide equivalent effectiveness based on Template Section 4.3.4.

4.3.1 Exceptions to Requirements for Bioretention Facilities

Contingent on a demonstration that use of bioretention or a facility of equivalent effectiveness is infeasible, other types of biotreatment or media filters (such as tree-box-type biofilters or in-vault media filters) may be used for the following categories of Regulated Projects:

- 1) Projects creating or replacing an acre or less of impervious area, and located in a designated pedestrian-oriented commercial district (i.e., smart growth projects), and having at least 85% of the entire project site covered by permanent structures;
- 2) Facilities receiving runoff solely from existing (pre-project) impervious areas; and
- 3) Historic sites, structures or landscapes that cannot alter their original configuration in order to maintain their historic integrity.

Form 4.3-1 Infiltration BMP Feasibility (DA 1)

Feasibility Criterion – Complete evaluation for each DA on the Project Site

¹ Would infiltration BMP pose significant risk for groundwater related concerns?

Yes ☐ No ☒

Refer to Section 5.3.2.1 of the TGD for WQMP

If Yes, Provide basis: (attach)

² Would installation of infiltration BMP significantly increase the risk of geotechnical hazards?

Yes ☐ No ☒

(Yes, if the answer to any of the following questions is yes, as established by a geotechnical expert):

- The location is less than 50 feet away from slopes steeper than 15 percent
- The location is less than ten feet from building foundations or an alternative setback.
- A study certified by a geotechnical professional or an available watershed study determines that stormwater infiltration would result in significantly increased risks of geotechnical hazards.

If Yes, Provide basis: (attach)

³ Would infiltration of runoff on a Project site violate downstream water rights?

Yes ☐ No ☒

If Yes, Provide basis: (attach)

⁴ Is proposed infiltration facility located on hydrologic soil group (HSG) D soils or does the site geotechnical investigation indicate presence of soil characteristics, which support categorization as D soils?

Yes ☐ No ☒

If Yes, Provide basis: (attach)

⁵ Is the design infiltration rate, after accounting for safety factor of 2.0, below proposed facility less than 0.3 in/hr (accounting for soil amendments)?

Yes ☐ No ☒

If Yes, Provide basis: (attach)

⁶ Would on-site infiltration or reduction of runoff over pre-developed conditions be partially or fully inconsistent with watershed management strategies as defined in the WAP, or impair beneficial uses?

Yes ☐ No ☒

See Section 3.5 of the TGD for WQMP and WAP

If Yes, Provide basis: (attach)

⁷ Any answer from Item 1 through Item 3 is "Yes":

Yes ☐ No ☒

If yes, infiltration of any volume is not feasible onsite. Proceed to Form 4.3-4, Selection and Evaluation of Biotreatment BMP.

If no, then proceed to Item 8 below.

⁸ Any answer from Item 4 through Item 6 is "Yes":

Yes ☐ No ☒

If yes, infiltration is permissible but is not required to be considered. Proceed to Form 4.3-2, Site Design BMP.

If no, then proceed to Item 9, below.

⁹ All answers to Item 1 through Item 6 are "No":

Infiltration of the full DCV is potentially feasible, LID infiltration BMP must be designed to infiltrate the full DCV to the MEP.

Proceed to Form 4.3-2, Site Design BMPs.

4.3.2 Site Design BMP

Section E.12.e. of the Small Phase II MS4 Permit emphasizes the use of LID preventative measures; and the use of Site Design Measures reduces the portion of the DCV that must be addressed in downstream BMPs. Therefore, all applicable Site Design Measures shall be provided except where they are mutually exclusive

with each other, or with other BMPs. Mutual exclusivity may result from overlapping BMP footprints such that either would be potentially feasible by itself, but both could not be implemented. Please note that while there are no numeric standards regarding the use of Site Design BMPs. If a project cannot feasibly meet BMP sizing requirements or cannot fully address hydromodification, feasibility of all applicable Site Design BMPs must be part of demonstrating that the BMP system has been designed to retain the maximum feasible portion of the DCV. Complete Form 4.3-2 to identify and calculate estimated retention volume from implementing site design BMP. Refer to Section 5.4 in the TGD for more detailed guidance.

Form 4.3-2 Site Design BMPs (DA 1)			
1 Implementation of Impervious Area Dispersion BMP (i.e. routing runoff from impervious to pervious areas), excluding impervious areas planned for routing to on-lot infiltration BMP: Yes ☐ No ☒ If yes, complete Items 2-5; If no, proceed to Item 6	DA 1 DMA 1 BMP Type	DA DMA BMP Type	DA DMA BMP Type (Use additional forms for more BMPs)
2 Total impervious area draining to pervious area (ft ²)	109,910		
3 Ratio of pervious area receiving runoff to impervious area	0.04		
4 Retention volume achieved from impervious area dispersion (ft ³) $V = \text{Item 2} * \text{Item 3} * (0.5/12)$, assuming retention of 0.5 inches of runoff	4,075		
5 Sum of retention volume achieved from impervious area dispersion (ft ³): 183 $V_{\text{retention}} = \text{Sum of Item 4 for all BMPs}$			
6 Implementation of Localized On-lot Infiltration BMPs (e.g. on-lot rain gardens): Yes ☐ No ☒ If yes, complete Items 7-13 for aggregate of all on-lot infiltration BMP in each DA; If no, proceed to Item 14	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type (Use additional forms for more BMPs)
7 Ponding surface area (ft ²)			
8 Ponding depth (ft) (min. 0.5 ft.)			
9 Surface area of amended soil/gravel (ft ²)			
10 Average depth of amended soil/gravel (ft) (min. 1 ft.)			
11 Average porosity of amended soil/gravel			
12 Retention volume achieved from on-lot infiltration (ft ³) $V_{\text{retention}} = (\text{Item 7} * \text{Item 8}) + (\text{Item 9} * \text{Item 10} * \text{Item 11})$			
13 Runoff volume retention from on-lot infiltration (ft ³): $V_{\text{retention}} = \text{Sum of Item 12 for all BMPs}$			

Form 4.3-2 Site Design BMPs (DA 1)

Form 4.3-2 cont. Site Design BMPs (DA 1)

14 Implementation of Street Trees: Yes ☐ No ☒ <i>If yes, complete Items 14-18. If no, proceed to Item 19</i>	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type <i>(Use additional forms for more BMPs)</i>
15 Number of Street Trees			
16 Average canopy cover over impervious area (ft ²)			
17 Runoff volume retention from street trees (ft ³) <i>$V_{retention} = \text{Item 15} * \text{Item 16} * (0.05/12)$ assume runoff retention of 0.05 inches</i>			
18 Runoff volume retention from street tree BMPs (ft ³): 0 <i>$V_{retention} = \text{Sum of Item 17 for all BMPs}$</i>			
19 Total Retention Volume from Site Design BMPs: 183 <i>Sum of Items 5, 13 and 18</i>			

4.3.3 Infiltration BMPs

Use Form 4.3-3 to compute on-site retention of runoff from proposed retention and infiltration BMPs. Volume retention estimates are sensitive to the percolation rate used, which determines the amount of runoff that can be infiltrated within the specified drawdown time. The infiltration safety factor reduces field measured percolation to account for potential inaccuracy associated with field measurements, declining BMP performance over time, and compaction during construction. Appendix C of the TGD for WQMP provides guidance on estimating an appropriate safety factor to use in Form 4.3-3.

If site constraints limit the use of BMPs to a single type and implementation of retention and infiltration BMPs mitigate no more than 40% of the DCV, then they are considered infeasible and the Project Proponent may evaluate the effectiveness of BMPs lower in the LID hierarchy of use (Section 5.5 of the TGD for WQMP)

If implementation of infiltrations BMPs is feasible as determined using Form 4.3-1, then LID infiltration BMPs shall be implemented to the MEP (section 4.1 of the TGD for WQMP).

4.3.3.1 Allowed Variations for Special Site Conditions

The bioretention system design parameters of this Section may be adjusted for the following special site conditions:

- 1) Facilities located within 10 feet of structures or other potential geotechnical hazards established by the geotechnical expert for the project may incorporate an impervious cutoff wall between the bioretention facility and the structure or other geotechnical hazard.
- 2) Facilities with documented high concentrations of pollutants in underlying soil or groundwater, facilities located where infiltration could contribute to a geotechnical hazard, and facilities located on elevated plazas or other structures may incorporate an impervious liner and may locate the underdrain discharge at the bottom of the subsurface drainage/storage layer (this configuration is commonly known as a “flow-through planter”).
- 3) Facilities located in areas of high groundwater, highly infiltrative soils or where connection of underdrain to a surface drain or to a subsurface storm drain are infeasible, may omit the underdrain.
- 4) Facilities serving high-risk areas such as fueling stations, truck stops, auto repairs, and heavy industrial sites may be required to provide adequate pretreatment to address pollutants of concern unless these high-risk areas are isolated from storm water runoff or bioretention areas with no chance of spill migration.

Form 4.3-3 Infiltration LID BMP - including underground BMPs (DA 1)

1 Remaining LID DCV not met by site design BMP (ft ³): 2,856 $V_{unmet} = \text{Form 4.2-1 Item 7} - \text{Form 4.3-2 Item 19}$			
BMP Type Use columns to the right to compute runoff volume retention from proposed infiltration BMP (select BMP from Table 5-4 in TGD for WQMP) - Use additional forms for more BMPs	DA DMA 1 BMP Type Infiltration	DA DMA BMP Type	DA DMA BMP Type (Use additional forms for more BMPs)
2 Infiltration rate of underlying soils (in/hr) See Section 5.4.2 and Appendix C of the TGD for WQMP for minimum requirements for assessment methods	1		
3 Infiltration safety factor See TGD Section 5.4.2 and Appendix D	2.0		
4 Design percolation rate (in/hr) $P_{design} = \text{Item 2} / \text{Item 3}$	0.5		
5 Ponded water drawdown time (hr) Copy Item 6 in Form 4.2-1	48		
6 Maximum ponding depth (ft) BMP specific, see Table 5-4 of the TGD for WQMP for BMP design details	6		
7 Ponding Depth (ft) $d_{BMP} = \text{Minimum of } (1/12 * \text{Item 4} * \text{Item 5}) \text{ or Item 6}$	6		
8 Infiltrating surface area, SA_{BMP} (ft ²) the lesser of the area needed for infiltration of full DCV or minimum space requirements from Table 5.7 of the TGD for WQMP	4,235		
9 Amended soil depth, d_{media} (ft) Only included in certain BMP types, see Table 5-4 in the TGD for WQMP for reference to BMP design details	-		
10 Amended soil porosity	-		
11 Gravel depth, d_{media} (ft) Only included in certain BMP types, see Table 5-4 of the TGD for WQMP for BMP design details	-		
12 Gravel porosity	-		
13 Duration of storm as basin is filling (hrs) Typical ~ 3hrs	3		
14 Above Ground Retention Volume (ft ³) $V_{retention} = \text{Item 8} * [\text{Item 7} + (\text{Item 9} * \text{Item 10}) + (\text{Item 11} * \text{Item 12}) + (\text{Item 13} * (\text{Item 4} / 12))]$	-		
15 Underground Retention Volume (ft ³) Volume determined using manufacturer's specifications and calculations	14,353		
16 Total Retention Volume from LID Infiltration BMPs: 14,353 (Sum of Items 14 and 15 for all infiltration BMP included in plan)			
17 Fraction of DCV achieved with infiltration BMP: 207% $\text{Retention\%} = \text{Item 16} / \text{Form 4.2-1 Item 7}$			
18 Is full LID DCV retained onsite with combination of hydrologic source control and LID retention/infiltration BMPs? Yes ☒ No ☐ If yes, demonstrate conformance using Form 4.3-10; If no, then reduce Item 3, Factor of Safety to 2.0 and increase Item 8, Infiltrating Surface Area, such that the portion of the site area used for retention and infiltration BMPs equals or exceeds the minimum effective area thresholds (Table 5-7 of the TGD for WQMP) for the applicable category of development and repeat all above calculations.			

4.3.4 Biotreatment BMP

Biotreatment BMPs may be considered if the full LID DCV cannot be met by maximizing retention and infiltration. A key consideration when using biotreatment BMP is the effectiveness of the proposed BMP in addressing the pollutants of concern for the project (see Table 5-5 of the TGD for WQMP).

Use Form 4.3-4 to summarize the potential for volume based and/or flow based biotreatment options to biotreat the remaining unmet LID DCV. Biotreatment computations are included as follows:

- Use Form 4.3-5 to compute biotreatment in small volume based biotreatment BMP (e.g. bioretention w/underdrains);
- Use Form 4.3-6 to compute biotreatment in large volume based biotreatment BMP (e.g. constructed wetlands);
- Use Form 4.3-7 to compute sizing criteria for flow-based biotreatment BMP (e.g. bioswales)

Form 4.3-4 Selection and Evaluation of Biotreatment BMP (DA 1)			
1 Remaining LID DCV not met by site design , or infiltration, BMP for potential biotreatment (ft ³): 0 <i>Form 4.2-1 Item 7 - Form 4.3-2 Item 19 – Form 4.3-3 Item 16</i>		List pollutants of concern <i>Copy from Form 2.3-1.</i>	
2 Biotreatment BMP Selected <i>(Select biotreatment BMP(s) necessary to ensure all pollutants of concern are addressed through Unit Operations and Processes, described in Table 5-5 of the TGD for WQMP)</i>	Volume-based biotreatment <i>Use Forms 4.3-5 and 4.3-6 to compute treated volume</i>		Flow-based biotreatment <i>Use Form 4.3-7 to compute treated flow</i>
	☐ Bioretention with underdrain ☐ Planter box with underdrain ☐ Constructed wetlands ☐ Wet extended detention ☐ Dry extended detention		☐ Vegetated swale ☐ Vegetated filter strip ☐ Proprietary biotreatment
3 Volume biotreated in volume based biotreatment BMP (ft ³): <i>Form 4.3-5 Item 15 + Form 4.3-6 Item 13</i>	4 Compute remaining LID DCV with implementation of volume based biotreatment BMP (ft ³): <i>Item 1 – Item 3</i>		5 Remaining fraction of LID DCV for sizing flow based biotreatment BMP: % <i>Item 4 / Item 1</i>
6 Flow-based biotreatment BMP capacity provided (cfs): <i>Use Figure 5-2 of the TGD for WQMP to determine flow capacity required to provide biotreatment of remaining percentage of unmet LID DCV (Item 5), for the project's precipitation zone (Form 3-1 Item 1)</i>			
7 Metrics for MEP determination: • Provided a WQMP with the portion of site area used for suite of LID BMP equal to minimum thresholds in Table 5-7 of the TGD for WQMP for the proposed category of development: ☐ <i>If maximized on-site retention BMPs is feasible for partial capture, then LID BMP implementation must be optimized to retain and infiltrate the maximum portion of the DCV possible within the prescribed minimum effective area. The remaining portion of the DCV shall then be mitigated using biotreatment BMP.</i>			

Form 4.3-5 Volume Based Biotreatment (DA 1) – Bioretention and Planter Boxes with Underdrains			
Biotreatment BMP Type (Bioretention w/underdrain, planter box w/underdrain, other comparable BMP)	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type (Use additional forms for more BMPs)
1 Pollutants addressed with BMP <i>List all pollutant of concern that will be effectively reduced through specific Unit Operations and Processes described in Table 5-5 of the TGD for WQMP</i>			
2 Amended soil infiltration rate <i>Typical ~ 5.0</i>			
3 Amended soil infiltration safety factor <i>Typical ~ 2.0</i>			
4 Amended soil design percolation rate (in/hr) $P_{design} = \text{Item 2} / \text{Item 3}$			
5 Ponded water drawdown time (hr) <i>Copy Item 6 from Form 4.2-1</i>			
6 Maximum ponding depth (ft) <i>see Table 5-6 of the TGD for WQMP for reference to BMP design details</i>			
7 Ponding Depth (ft) $d_{BMP} = \text{Minimum of } (1/12 * \text{Item 4} * \text{Item 5}) \text{ or Item 6}$			
8 Amended soil surface area (ft ²)			
9 Amended soil depth (ft) <i>see Table 5-6 of the TGD for WQMP for reference to BMP design details</i>			
10 Amended soil porosity, n			
11 Gravel depth (ft) <i>see Table 5-6 of the TGD for WQMP for reference to BMP design details</i>			
12 Gravel porosity, n			
13 Duration of storm as basin is filling (hrs) <i>Typical ~ 3hrs</i>			
14 Biotreated Volume (ft ³) $V_{biotreated} = \text{Item 8} * [(\text{Item 7}/2) + (\text{Item 9} * \text{Item 10}) + (\text{Item 11} * \text{Item 12}) + (\text{Item 13} * (\text{Item 4} / 12))]$			
15 Total biotreated volume from bioretention and/or planter box with underdrains BMP: <i>Sum of Item 14 for all volume-based BMPs included in this form</i>			

Form 4.3-6 Volume Based Biotreatment (DA 1) – Constructed Wetlands and Extended Detention

Biotreatment BMP Type <i>Constructed wetlands, extended wet detention, extended dry detention, or other comparable proprietary BMP. If BMP includes multiple modules (E.g. forebay and main basin), provide separate estimates for storage and pollutants treated in each module.</i>	DA DMA BMP Type		DA DMA BMP Type <i>(Use additional forms for more BMPs)</i>	
	Forebay	Basin	Forebay	Basin
1 Pollutants addressed with BMP forebay and basin <i>List all pollutant of concern that will be effectively reduced through specific Unit Operations and Processes described in Table 5-5 of the TGD for WQMP</i>				
2 Bottom width (ft)				
3 Bottom length (ft)				
4 Bottom area (ft ²) $A_{bottom} = \text{Item 2} * \text{Item 3}$				
5 Side slope (ft/ft)				
6 Depth of storage (ft)				
7 Water surface area (ft ²) $A_{surface} = (\text{Item 2} + (2 * \text{Item 5} * \text{Item 6})) * (\text{Item 3} + (2 * \text{Item 5} * \text{Item 6}))$				
8 Storage volume (ft ³) <i>For BMP with a forebay, ensure fraction of total storage is within ranges specified in BMP specific fact sheets, see Table 5-6 of the TGD for WQMP for reference to BMP design details</i> $V = \text{Item 6} / 3 * [\text{Item 4} + \text{Item 7} + (\text{Item 4} * \text{Item 7})^{0.5}]$				
9 Drawdown Time (hrs) <i>Copy Item 6 from Form 2.1</i>				
10 Outflow rate (cfs) $Q_{BMP} = (\text{Item 8}_{forebay} + \text{Item 8}_{basin}) / (\text{Item 9} * 3600)$				
11 Duration of design storm event (hrs)				
12 Biotreated Volume (ft ³) $V_{biotreated} = (\text{Item 8}_{forebay} + \text{Item 8}_{basin}) * (\text{Item 10} * \text{Item 11} * 3600)$				
13 Total biotreated volume from constructed wetlands, extended dry detention, or extended wet detention : <i>(Sum of Item 12 for all BMP included in plan)</i>				

Form 4.3-7 Flow Based Biotreatment (DA 1)

Biotreatment BMP Type <i>Vegetated swale, vegetated filter strip, or other comparable proprietary BMP</i>	DA DMA BMP Type	DA DMA BMP Type	DA DMA BMP Type <i>(Use additional forms for more BMPs)</i>
1 Pollutants addressed with BMP <i>List all pollutant of concern that will be effectively reduced through specific Unit Operations and Processes described in TGD Table 5-5</i>			
2 Flow depth for water quality treatment (ft) <i>BMP specific, see Table 5-6 of the TGD for WQMP for reference to BMP design details</i>			
3 Bed slope (ft/ft) <i>BMP specific, see Table 5-6 of the TGD for WQMP for reference to BMP design details</i>			
4 Manning's roughness coefficient			
5 Bottom width (ft) <i>$b_w = (\text{Form 4.3-5 Item 6} * \text{Item 4}) / (1.49 * \text{Item 2}^{1.67} * \text{Item 3}^{0.5})$</i>			
6 Side Slope (ft/ft) <i>BMP specific, see Table 5-6 of the TGD for WQMP for reference to BMP design details</i>			
7 Cross sectional area (ft²) <i>$A = (\text{Item 5} * \text{Item 2}) + (\text{Item 6} * \text{Item 2}^2)$</i>			
8 Water quality flow velocity (ft/sec) <i>$V = \text{Form 4.3-5 Item 6} / \text{Item 7}$</i>			
9 Hydraulic residence time (min) <i>Pollutant specific, see Table 5-6 of the TGD for WQMP for reference to BMP design details</i>			
10 Length of flow based BMP (ft) <i>$L = \text{Item 8} * \text{Item 9} * 60$</i>			
11 Water surface area at water quality flow depth (ft²) <i>$SA_{top} = (\text{Item 5} + (2 * \text{Item 2} * \text{Item 6})) * \text{Item 10}$</i>			

4.3.5 Conformance Summary

Complete Form 4.3-8 to demonstrate how on-site LID DCV is met with proposed site design, infiltration, and/or biotreatment BMP. The bottom line of the form is used to describe the basis for infeasibility determination for on-site LID BMP to achieve full LID DCV, and provides methods for computing remaining volume to be addressed in an alternative compliance plan. If the project has more than one outlet, then complete additional versions of this form for each outlet.

Form 4.3-8 Conformance Summary and Alternative Compliance Volume Estimate (DA 1)	
1	Total LID DCV for the Project DA-1 (ft ³): 6,931 <i>Copy Item 7 in Form 4.2-1</i>
2	On-site retention with site design BMP (ft ³): 183 <i>Copy Item 18 in Form 4.3-2</i>
3	On-site retention with LID infiltration BMP (ft ³): 14,353 <i>Copy Item 16 in Form 4.3-3</i>
4	On-site biotreatment with volume based biotreatment BMP (ft ³): 0 <i>Copy Item 3 in Form 4.3-4</i>
5	Flow capacity provided by flow based biotreatment BMP (cfs): 0 <i>Copy Item 6 in Form 4.3-4</i>
6	LID BMP performance criteria are achieved if answer to any of the following is "Yes": - Full retention of LID DCV with site design or infiltration BMP: Yes ☒ No ☐ <i>If yes, sum of Items 2, 3, and 4 is greater than Item 1</i> - Combination of on-site retention BMPs for a portion of the LID DCV and volume-based biotreatment BMP that address all pollutants of concern for the remaining LID DCV: Yes ☐ No ☐ <i>If yes, a) sum of Items 2, 3, 4, and 5 is greater than Item 1, and Items 2, 3 and 4 are maximized; or b) Item 6 is greater than Form 4.3-5 Item 6 and Items 2, 3 and 4 are maximized</i> - On-site retention and infiltration is determined to be infeasible; therefore biotreatment BMP provides biotreatment for all pollutants of concern for full LID DCV: Yes ☐ No ☐ <i>If yes, Form 4.3-1 Items 7 and 8 were both checked yes</i>
7	If the LID DCV is not achieved by any of these means, then the project may be allowed to develop an alternative compliance plan. Check box that describes the scenario which caused the need for alternative compliance: - Combination of Site Design, retention and infiltration, , and biotreatment BMPs provide less than full LID DCV capture: ☐ <i>Checked yes if Form 4.3-4 Item 7 is checked yes, Form 4.3-4 Item 6 is zero, and sum of Items 2, 3, 4, and 5 is less than Item 1. If so, apply water quality credits and calculate volume for alternative compliance, $V_{alt} = (Item\ 1 - Item\ 2 - Item\ 3 - Item\ 4 - Item\ 5) * (100 - Form\ 2.4-1\ Item\ 2)\%$</i> - Facilities, or a combination of facilities, of a different design than in Section E.12.e.(ii)(f) may be permitted if all of the following Phase II Small MS4 General Permit 2013-0001-DWQ 55 February 5, 2013 measures of equivalent effectiveness are demonstrated: 1) Equal or greater amount of runoff infiltrated or evapotranspired; ☐ 2) Equal or lower pollutant concentrations in runoff that is discharged after biotreatment; ☐ 3) Equal or greater protection against shock loadings and spills; ☐ 4) Equal or greater accessibility and ease of inspection and maintenance. ☐

4.3.6 Hydromodification Control BMP

Use Form 4.3-9 to compute the remaining runoff volume retention, after Site Design BMPs are implemented, needed to address hydromodification, and the increase in time of concentration and decrease in peak runoff necessary to meet targets for protection of waterbodies with a potential hydromodification. Describe the proposed hydromodification treatment control BMP. Section 5.6 of the TGD for WQMP provides additional details on selection and evaluation of hydromodification control BMP.

Form 4.3-9 Hydromodification Control BMPs (DA 1)	
1 Volume reduction needed for hydromodification performance criteria (ft ³): 6,931 <i>(Form 4.2-2 Item 4 * 0.95) – Form 4.2-2 Item 1</i>	2 On-site retention with site design and infiltration, BMP (ft ³): 14,353 <i>Sum of Form 4.3-8 Items 2, 3, and 4. Evaluate option to increase implementation of on-site retention in Forms 4.3-2, 4.3-3, and 4.3-4 in excess of LID DCV toward achieving hydromodification volume reduction</i>
3 Remaining volume for hydromodification volume capture (ft ³): 0 <i>Item 1 – Item 2</i>	4 Volume capture provided by incorporating additional on-site BMPs (ft ³): 0
5 Is Form 4.2-2 Item 11 less than or equal to 5%: Yes ☐ No ☒ <i>If yes, hydromodification performance criteria is achieved. If no, select one or more mitigation options below:</i> - Demonstrate increase in time of concentration achieved by proposed LID site design, LID BMP, and additional on-site BMP ☒ In Ground Chamber in excess of 200% of DCV - Increase time of concentration by preserving pre-developed flow path and/or increase travel time by reducing slope and increasing cross-sectional area and roughness for proposed on-site conveyance facilities ☐	
6 Form 4.2-2 Item 12 less than or equal to 5%: Yes ☐ No ☒ <i>If yes, hydromodification performance criteria is achieved. If no, select one or more mitigation options below:</i> Demonstrate reduction in peak runoff achieved by proposed LID site design, LID BMPs, and additional on-site retention BMPs ☒ In Ground Chamber in excess of 200% of DCV	

4.4 Alternative Compliance Plan (if applicable)

Describe an alternative compliance plan (if applicable) for projects not fully able to infiltrate, or biotreat the DCV via on-site LID practices. A project proponent must develop an alternative compliance plan to address the remainder of the LID DCV. Depending on project type some projects may qualify for water quality credits that can be applied to reduce the DCV that must be treated prior to development of an alternative compliance plan (see Form 2.4-1, Water Quality Credits). Form 4.3-9 Item 8 includes instructions on how to apply water quality credits when computing the DCV that must be met through alternative compliance.

Alternative Designs — Facilities, or a combination of facilities, of a different design than in Permit Section E.12.e.(ii)(f) may be permitted if all of the following measures of equivalent effectiveness are demonstrated:

- 1) Equal or greater amount of runoff infiltrated or evapotranspired;
- 2) Equal or lower pollutant concentrations in runoff that is discharged after biotreatment;
- 3) Equal or greater protection against shock loadings and spills;
- 4) Equal or greater accessibility and ease of inspection and maintenance.

The Project Proponent will need to obtain written approval for an alternative design from the Lahontan Regional Water Board Executive Officer (see Section 6 of the TGD for WQMP).

Section 5 Inspection and Maintenance Responsibility for Post Construction BMP

All BMPs included as part of the project WQMP are required to be maintained through regular scheduled inspection and maintenance (refer to Section 8, Post Construction BMP Requirements, in the TGD for WQMP). Fully complete Form 5-1 summarizing all BMP included in the WQMP. Attach additional forms as needed. The WQMP shall also include a detailed Operation and Maintenance Plan for all BMP and a Maintenance Agreement. The Maintenance Agreement must also be attached to the WQMP.

Note that at time of Project construction completion, the Maintenance Agreement must be completed, signed, notarized and submitted to the County Stormwater Department

Form 5-1 BMP Inspection and Maintenance (use additional forms as necessary)			
BMP	Reponsible Party(s)	Inspection/ Maintenance Activities Required	Minimum Frequency of Activities
ADS STORM TECH	OWNER	INSPECT, REMOVE TRASH AND DEBRIS. IF 48-HOUR DRAWDOWN IS NOT ACHIEVED, OWNER WILL HIRE A CONTRACTOR TO INSPECT PORT AND MEASURE SEDIMENT STADIA ROD. IF SEDIMENT MEASURE 3 OR MORE INCHES REMOVE USING JETVAC. APPLY MULTIPLE PASSES OF JETVAC UNTIL BACKFLUSH WATER IS CLEAN.	INSPECT PER MANUFACTURER RECOMENDATIONS

MOJAVE RIVER WATERSHED Water Quality Management Plan (WQMP)

Section 6 WQMP Attachments

6.1. Site Plan and Drainage Plan

Include a site plan and drainage plan sheet set containing the following minimum information:

- Project location
- Site boundary
- Land uses and land covers, as applicable
- Suitability/feasibility constraints
- Structural Source Control BMP locations
- Site Design Hydrologic Source Control BMP locations
- LID BMP details
- Drainage delineations and flow information
- Drainage connections

6.2 Electronic Data Submittal

Minimum requirements include submittal of PDF exhibits in addition to hard copies. Format must not require specialized software to open. If the local jurisdiction requires specialized electronic document formats (as described in their Local Implementation Plan), this section will describe the contents (e.g., layering, nomenclature, geo-referencing, etc.) of these documents so that they may be interpreted efficiently and accurately.

6.3 Post Construction

Attach all O&M Plans and Maintenance Agreements for BMP to the WQMP.

6.4 Other Supporting Documentation

- BMP Educational Materials
- Activity Restriction – C,C&R's & Lease Agreements

Attachment A

WQMP Maintenance Agreement Template

RECORDING REQUESTED BY:

City of Hesperia
Development Services Department

AND WHEN RECORDED MAIL TO:

City of Hesperia
Development Services Department
9700 Seventh Avenue
Hesperia, CA 92345

SPACE ABOVE THIS LINE FOR RECORDER'S USE

COVENANT AND AGREEMENT REGARDING WATER QUALITY MANAGEMENT PLAN AND STORMWATER BEST
MANAGEMENT PRACTICES TRANSFER, ACCESS AND MAINTENANCE

THIS PAGE ADDED TO PROVIDE ADEQUATE SPACE FOR RECORDING INFORMATION

Covenant and Agreement Regarding Water Quality Management Plan and Stormwater Best Management Practices Transfer, Access and Maintenance

Covenant and Agreement Regarding Water Quality Management Plan and Stormwater Best Management Practices Transfer, Access and Maintenance

OWNER NAME: I Ave Property Holdings (Hesperia, CA) LLC

PROPERTY ADDRESS: _____

APN: 0410-072-06

THIS AGREEMENT is made and entered into in

_____, California, this _____ day of

_____, by and between

_____, hereinafter

referred to as Owner, and the CITY OF HESPERIA, a political subdivision of the State of California, hereinafter referred to as "the City";

WHEREAS, the Owner owns real property ("Property") in the State of California, County of San Bernardino, located at [STREET ADDRESS] within the City of Hesperia, more commonly referred to as San Bernardino County Tax Assessor Parcel No. [APN Number] specifically described in Exhibit "A" and depicted in Exhibit "B", each of which is attached hereto and incorporated herein by this reference; and

WHEREAS, at the time of initial approval of the development project known as

_____ within the Property described herein, the City required the project to employ Best Management Practices, hereinafter referred to as "BMPs," to minimize pollutants in urban runoff; and

WHEREAS, the Owner has chosen to install and/or implement BMPs as described in the Water Quality Management Plan, dated _____, on file with the City and incorporated herein by this reference, hereinafter referred to as "WQMP", to minimize pollutants in stormwater and urban runoff and to minimize other adverse impacts of stormwater and urban runoff; and

WHEREAS, said WQMP has been certified by the Owner and reviewed and approved by the City; and

WHEREAS, the Owner is aware that periodic and continuous maintenance, including, but not necessarily limited to, filter material replacement and sediment removal, is required to assure peak performance of all BMPs in the WQMP and that, furthermore, such maintenance activity will require compliance with all Local, State, or Federal laws and regulations, including those pertaining to confined space and waste disposal methods, in effect at the time such maintenance occurs.

Covenant and Agreement Regarding Water Quality Management Plan and Stormwater Best Management Practices Transfer, Access and Maintenance

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

1. Owner shall comply with the WQMP.
2. All maintenance or replacement of any BMPs specified within the approved WQMP is the sole responsibility of the Owner in accordance with the terms of this Agreement.
3. Owner hereby provides the City's designee complete access, of any duration, to the BMPs and their immediate vicinity at any time, upon reasonable notice, or in the event of emergency, as determined by the City, no advance notice, for the purpose of inspection, sampling, testing of the BMPs, and in case of emergency, to undertake all necessary repairs or other preventative measures at owner's expense as provided in paragraph 5 below. The City shall make every effort at all times to minimize or avoid interference with Owner's use of the Property. Denial of access to any premises or facility that contains WQMP features is a breach of this Agreement and may also be a violation of the Clean Water Act, the California Water Code, and/or the City's NPDES Permit Implementation regulations. If there is reasonable cause to believe that an illicit discharge or breach of this Agreement is occurring on the premises then the authorized enforcement agency may seek issuance of a search warrant from any court of competent jurisdiction in addition to other enforcement actions. Owner recognizes that the City may perform routine and regular inspections, as well as emergency inspections, of the BMPs. Owner or Owner's successors or assigns shall pay City for all costs incurred by City in the inspection, sampling, testing of the BMPs within thirty (30) calendar days of City invoice.
4. Owner shall use its best efforts diligently to maintain all BMPs in a manner assuring peak performance at all times. All reasonable precautions shall be exercised by Owner and Owner's representative or contractor in the removal and extraction of any material(s) from the BMPs and the ultimate disposal of the material(s) in a manner consistent with all relevant laws and regulations in effect at the time. As may be requested from time to time by the City, the Owner shall provide the City with documentation identifying the material(s) removed, the quantity, and disposal destination, testing construction or reconstruction.
5. In the event Owner, or its successors or assigns, fails to accomplish the necessary maintenance contemplated by this Agreement, within five (5) business days of being given written notice by the City, the City is hereby authorized to cause any maintenance necessary to be done and charge the entire cost and expense against the Property and/or to the Owner or Owner's successors or assigns, including administrative costs, attorney's fees and interest thereon at the maximum rate authorized by the City Code from the date of the notice of expense until paid in full. Owner or Owner's successors or assigns shall pay City within thirty (30) calendar days of City invoice.
6. The City may require the owner to post security in form and for a time period satisfactory to the City to guarantee the performance of the obligations stated herein. Should the Owner fail to perform the obligations under the Agreement, the City may, in the case of a cash bond, act for the Owner using the proceeds from it, or in the case of a surety bond, require the surety (ies) to perform the obligations of this Agreement.

Covenant and Agreement Regarding Water Quality Management Plan and Stormwater Best Management Practices Transfer, Access and Maintenance

7. The City agrees, from time to time, within ten (10) business days after request of Owner, to execute and deliver to Owner, or Owner's designee, an estoppel certificate requested by Owner, stating that this Agreement is in full force and effect, and that Owner is not in default hereunder with regard to any maintenance or payment obligations (or specifying in detail the nature of Owner's default). Owner shall pay all costs and expenses incurred by the City in its investigation of whether to issue an estoppel certificate within thirty (30) calendar days after receipt of a City invoice and prior to the City's issuance of such certificate. Where the City cannot issue an estoppel certificate, Owner shall pay the City within thirty (30) calendar days of receipt of a City invoice.
8. Owner shall not change any BMPs identified in the WQMP without an amendment to this Agreement approved by authorized representatives of both the City and the Owner.
9. City and Owner shall comply with all applicable laws, ordinances, rules, regulations, court orders and government agency orders now or hereinafter in effect in carrying out the terms of this Agreement. If a provision of this Agreement is terminated or held to be invalid, illegal or unenforceable, the validity, legality and enforceability of the remaining provisions shall remain in full effect.
10. In addition to any remedy available to City under this Agreement, if Owner violates any term of this Agreement and does not cure the violation within the time already provided in this Agreement, or, if not provided, within thirty (30) calendar days, or within such time authorized by the City if said cure reasonably requires more than the subject time, the City may bring an action at law or in equity in a court of competent jurisdiction to enforce compliance by the Owner with the terms of this Agreement. In such action, the City may recover any damages to which the City may be entitled for the violation, enjoin the violation by temporary or permanent injunction without the necessity of proving actual damages or the inadequacy of otherwise available legal remedies, or obtain other equitable relief, including, but not limited to, the restoration of the Property and/or the BMPs identified in the WQMP to the condition in which it/they existed prior to any such violation or injury.
11. This Agreement shall be recorded in the Office of the Recorder of San Bernardino County, California, at the expense of the Owner and shall constitute notice to all successors and assigns of the title to said Property of the obligation herein set forth, and also a lien in such amount as will fully reimburse the City, including interest as herein above set forth, subject to foreclosure in event of default in payment.
12. In event of legal action occasioned by any default or action of the Owner, or its successors or assigns, then the Owner and its successors or assigns agree(s) to hold the City harmless and pay all costs incurred by the City in enforcing the terms of this Agreement, including reasonable attorney's fees and costs, and that the same shall become a part of the lien against said Property.
13. It is the intent of the parties hereto that burdens and benefits herein undertaken shall constitute covenants that run with said Property and constitute a lien there against.
14. The obligations herein undertaken shall be binding upon the heirs, successors, executors, administrators and assigns of the parties hereto. The term "Owner" shall include not only the present Owner, but also its heirs, successors, executors, administrators, and assigns. Owner shall notify any successor to title of all or part of the Property about the existence of

Covenant and Agreement Regarding Water Quality Management Plan and Stormwater Best Management Practices Transfer, Access and Maintenance

this Agreement. Owner shall provide such notice prior to such successor obtaining an interest in all or part of the Property. Owner shall provide a copy of such notice to the City at the same time such notice is provided to the successor.

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

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

17. Owner agrees to indemnify, defend (with counsel reasonably approved by the City) and hold harmless the City and its authorized officers, employees, agents and volunteers from any and all claims, actions, losses, damages, and/or liability arising out of this Agreement from any cause whatsoever, including the acts, errors or omissions of any person and for any costs or expenses incurred by the City on account of any claim except where such indemnification is prohibited by law. This indemnification provision shall apply regardless of the existence or degree of fault of indemnitees. The Owner's indemnification obligation applies to the City's "active" as well as "passive" negligence but does not apply to the City's "sole negligence" or "willful misconduct" within the meaning of Civil Code Section 2782, or to any claims, actions, losses, damages, and/or liabilities, to the extent caused by the acts or omissions of any third party contractors undertaking any work (other than field inspections) or other maintenance on the Property on behalf of the City under this Agreement.

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Covenant and Agreement Regarding Water Quality Management Plan and Stormwater Best Management Practices Transfer, Access and Maintenance

IF TO CITY:

City of Hesperia

9700 Seventh Avenue

Hesperia, CA 92345

IF TO OWNER:

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

OWNER:

Signature: _____

Name: _____

Title: _____

Date: _____

FOR: Maintenance Agreement, dated
_____, for the
project known as

(APN) _____,
As described in the WQMP dated
_____.

OWNER:

Signature: _____

Name: _____

Title: _____

Date: _____

NOTARIES ON FOLLOWING PAGE

A notary acknowledgement is required for recordation.

ACCEPTED BY:

Director of Development Services

Date: _____

Attachment: Notary Acknowledgement

Covenant and Agreement Regarding Water Quality Management Plan and Stormwater Best Management Practices Transfer, Access and Maintenance

ATTACHMENT 1

(Notary Acknowledgement)

Covenant and Agreement Regarding Water Quality Management Plan and Stormwater Best Management Practices Transfer, Access and Maintenance

EXHIBIT A

APN: 041007206

A PORTION OF LOT 'D' IN BLOCK '382' OF TOWN OF HESPERIA,
MAP BOOK 12 PAGES 21-27.

Attachment B - WQMP Exhibit

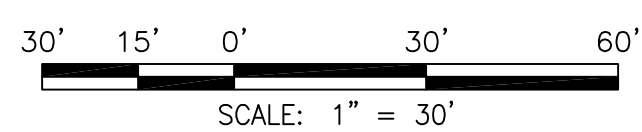
GENERAL PUMP DEVELOPMENT
CITY OF HESPERIA
APN 0410-072-06
COMMERCIAL/INDUSTRIAL



- 1 INFILTRATION BASIN MANAGED PER TC-11
- 2 PARKING LOT TO BE SWEPT MONTHLY
- 3 STORMDRAIN SIGNAGE "DRAINS TO WATERWAY"
- 4 TRASH STORAGE PER SD-32

 PERVIOUS AREA

**Know what's below.
Call before you dig.**



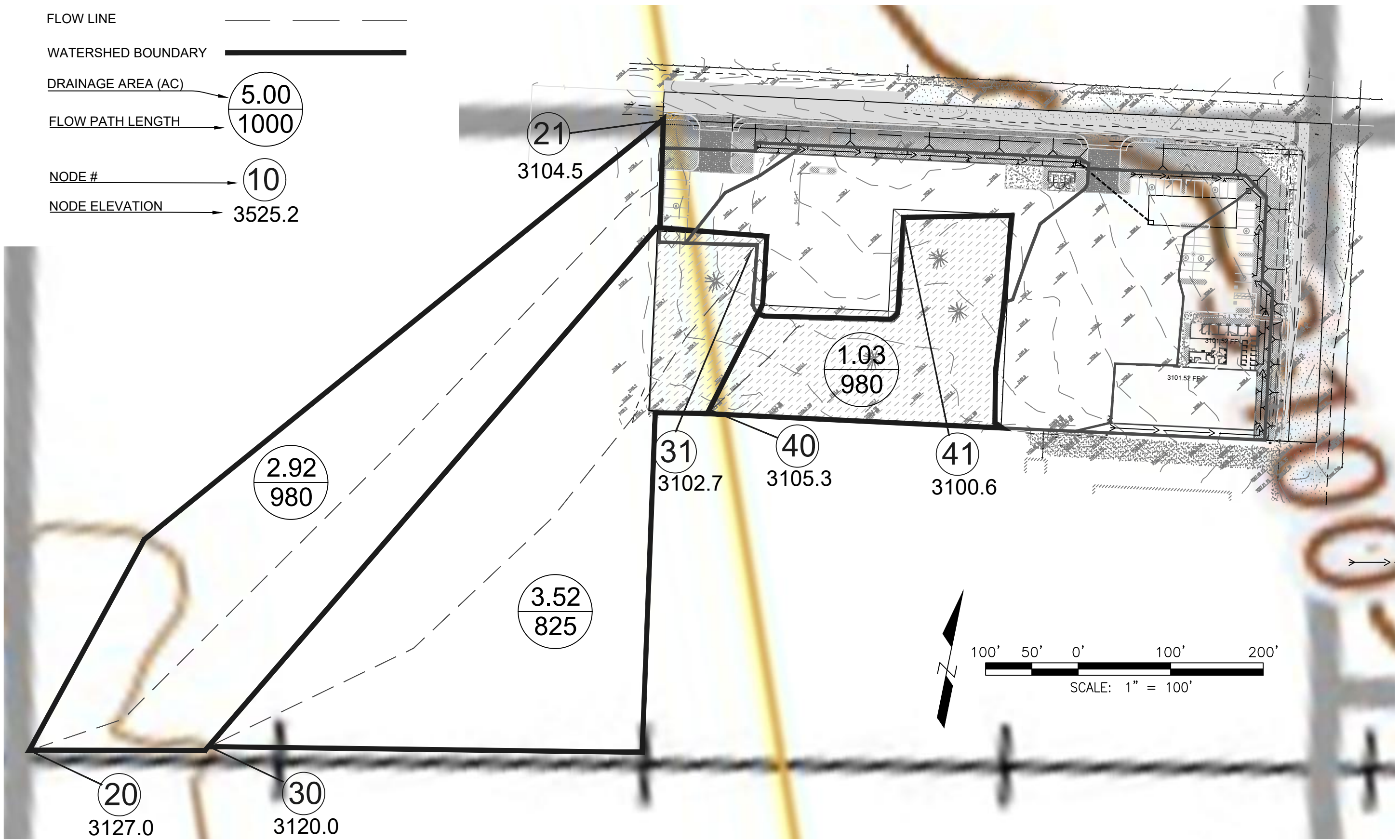
1. INFILTRATION BMP FOOTPRINTS SHALL NOT BE USED FOR STAGING OR STORING OF MATERIALS OR EQUIPMENT DURING CONSTRUCTION.
2. INFILTRATION BMP EXCAVATION SHALL NOT BE USED FOR RECEIVING CONSTRUCTION SITE RUNOFF.
3. INFILTRATION BMP SHALL NOT BE PUT INTO SERVICE OR RECEIVE RUNOFF PRIOR TO STABILIZATION OF THE DRAINAGE FOR EACH BMP.

[illegible]

EXISTING CONDITION HYDROLOGY EXHIBIT

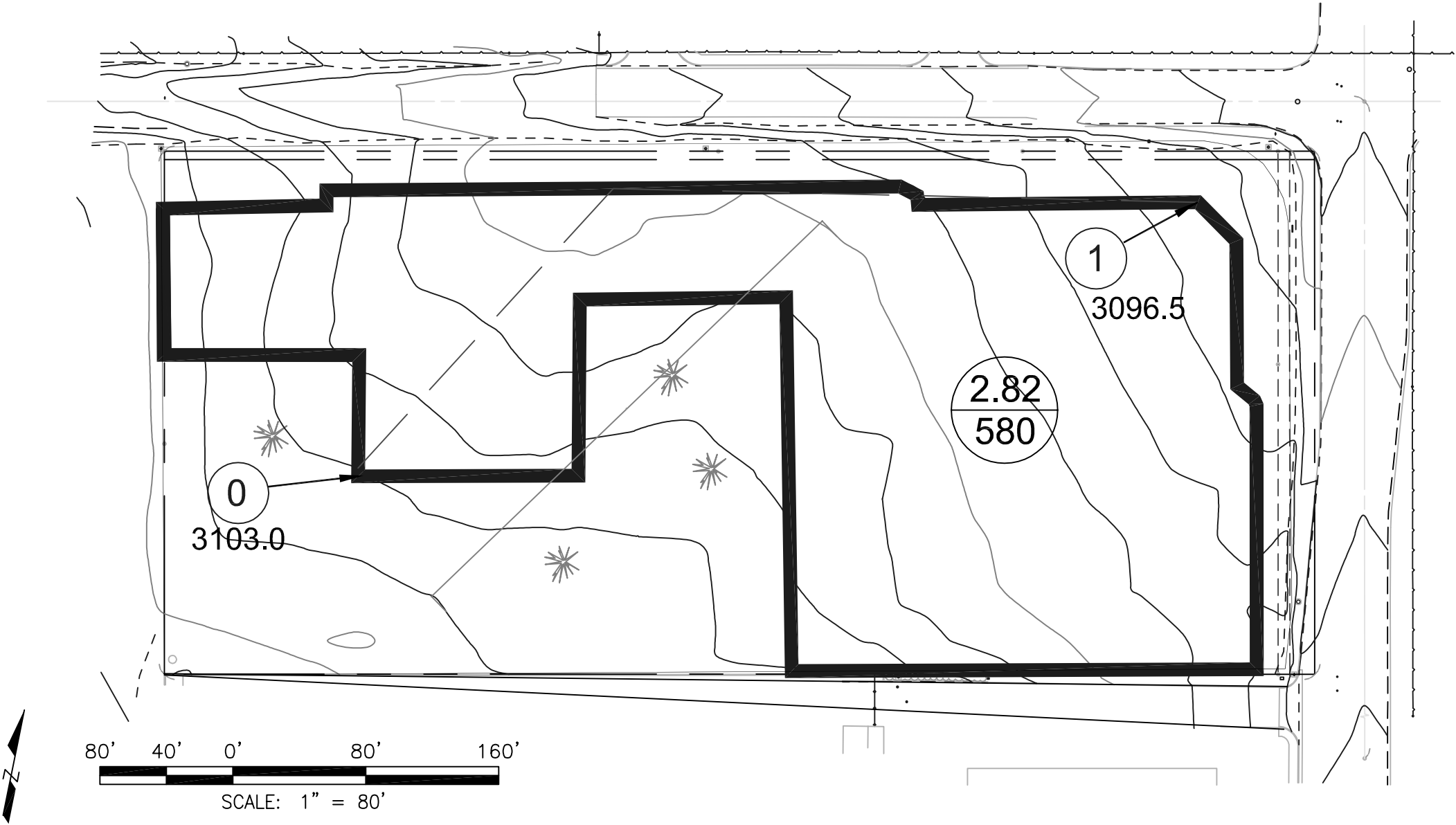
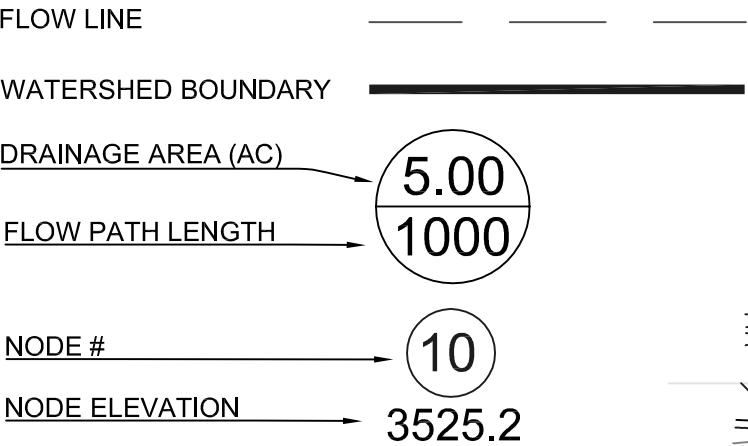
DRAINAGE LEGEND

- FLOW LINE
- WATERSHED BOUNDARY
- DRAINAGE AREA (AC)
- FLOW PATH LENGTH
- NODE #
- NODE ELEVATION



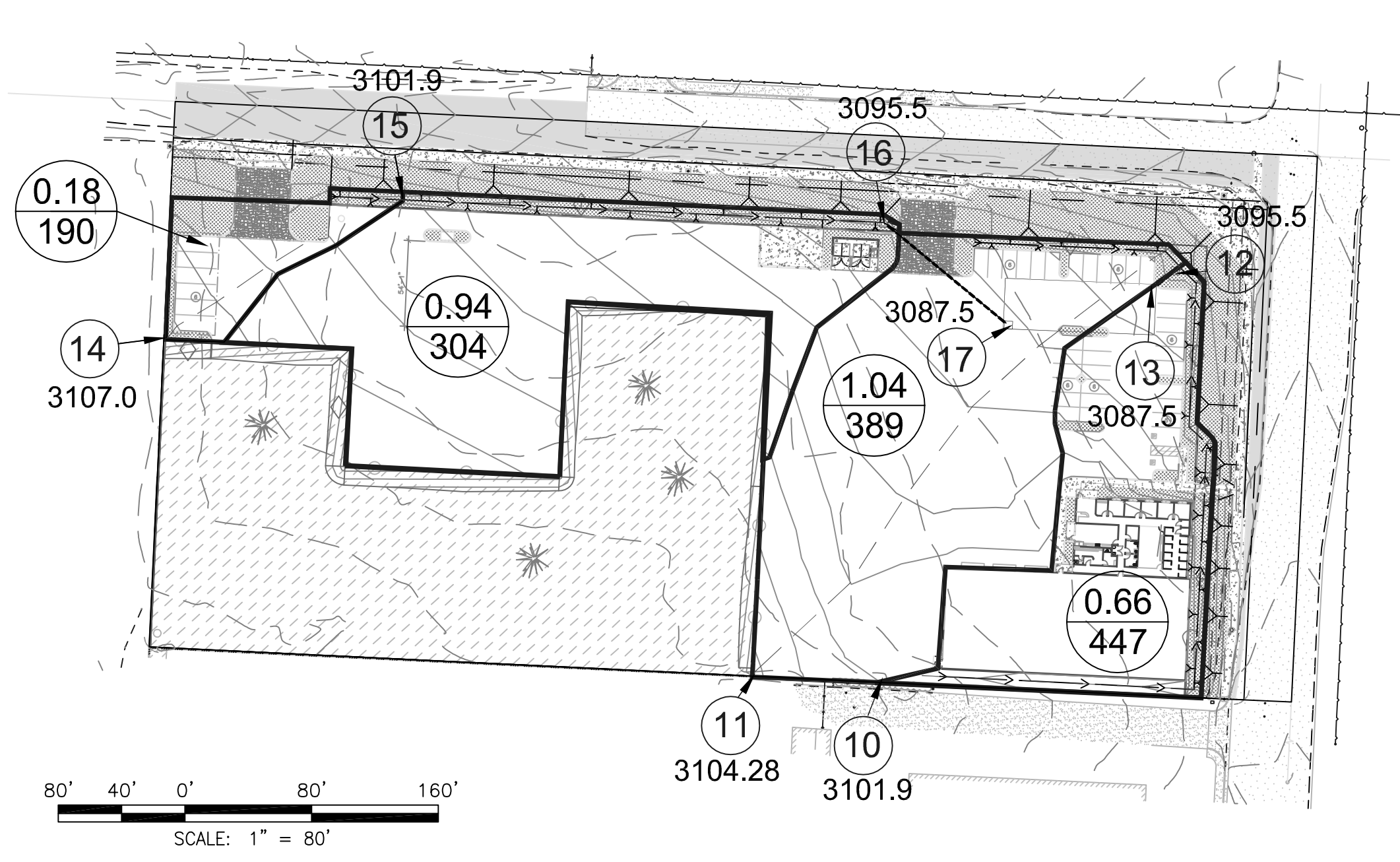
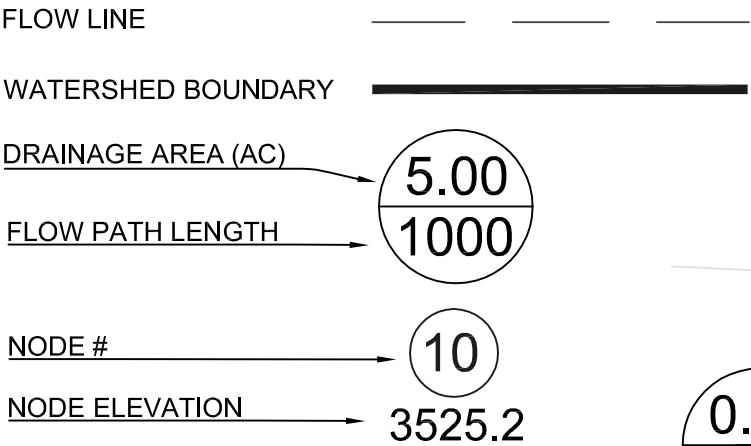
EXISTING CONDITION HYDROLOGY EXHIBIT

DRAINAGE LEGEND



CONCEPTUAL DRAINAGE IMPROVEMENTS EXHIBIT

DRAINAGE LEGEND



Attachment C - Hydrology Reference Material

General Information
Homepage
Progress Reports
FAQ
Glossary

Precipitation
Frequency
Data Server
GIS Grids
Maps
Time Series
Temporals
Documents

Probable Maximum
Precipitation
Documents

Miscellaneous
Publications
Storm Analysis
Record Precipitation

Contact Us
Inquiries



NOAA ATLAS 14 POINT PRECIPITATION FREQUENCY ESTIMATES: CA

Data description

Data type: Precipitation depth Units: English Time series type: Partial duration

Select location

1) Manually:

- a) By location (decimal degrees, use "~" for S and W): Latitude: Longitude: Submit
- b) By station (list of CA stations): Select station
- c) By address Search

2) Use map:

Satellite
Labels

a) Select location
Move crosshair or double click

b) Click on station icon
☐ Show stations on map

Location information:
Name: Hesperia, California, USA*
Latitude: 34.4296°
Longitude: -117.2820°
Elevation: 3104 ft **

* Source: ESRI Maps
** Source: USGS

POINT PRECIPITATION FREQUENCY (PF) ESTIMATES WITH 90% CONFIDENCE INTERVALS AND SUPPLEMENTARY INFORMATION NOAA Atlas 14, Volume 6, Version 2

PF tabular

PF graphical

Supplementary information

Print page

PDS-based precipitation frequency estimates with 90% confidence intervals (in inches) ¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.086 (0.071-0.105)	0.120 (0.099-0.146)	0.166 (0.136-0.203)	0.204 (0.167-0.253)	0.259 (0.205-0.331)	0.303 (0.235-0.396)	0.349 (0.264-0.467)	0.398 (0.293-0.548)	0.467 (0.329-0.670)	0.523 (0.356-0.776)
10-min	0.123 (0.102-0.151)	0.172 (0.142-0.210)	0.237 (0.196-0.291)	0.293 (0.239-0.362)	0.372 (0.294-0.475)	0.435 (0.336-0.567)	0.501 (0.378-0.670)	0.571 (0.419-0.786)	0.670 (0.472-0.961)	0.749 (0.510-1.11)
15-min	0.149 (0.123-0.182)	0.207 (0.171-0.254)	0.287 (0.237-0.352)	0.354 (0.289-0.438)	0.449 (0.355-0.575)	0.526 (0.407-0.696)	0.606 (0.457-0.810)	0.691 (0.507-0.950)	0.810 (0.571-1.15)	0.906 (0.617-1.34)
30-min	0.212 (0.175-0.259)	0.295 (0.244-0.361)	0.409 (0.337-0.501)	0.504 (0.412-0.623)	0.639 (0.505-0.817)	0.748 (0.579-0.976)	0.862 (0.651-1.15)	0.983 (0.722-1.35)	1.15 (0.812-1.65)	1.29 (0.877-1.91)
60-min	0.278 (0.230-0.340)	0.387 (0.319-0.473)	0.536 (0.441-0.657)	0.661 (0.540-0.817)	0.838 (0.662-1.07)	0.980 (0.758-1.28)	1.13 (0.853-1.51)	1.29 (0.946-1.77)	1.51 (1.06-2.17)	1.69 (1.15-2.51)
24-hr	0.395 (0.327-0.483)	0.529 (0.437-0.647)	0.713 (0.587-0.874)	0.868 (0.709-1.07)	1.09 (0.860-1.39)	1.26 (0.979-1.65)	1.45 (1.10-1.94)	1.65 (1.21-2.27)	1.92 (1.36-2.76)	2.15 (1.46-3.19)
34-hr	0.488 (0.403-0.596)	0.644 (0.532-0.788)	0.859 (0.707-1.05)	1.04 (0.850-1.29)	1.30 (1.03-1.66)	1.51 (1.17-1.97)	1.73 (1.30-2.31)	1.96 (1.44-2.69)	2.28 (1.61-3.28)	2.54 (1.73-3.78)
6-hr	0.674 (0.557-0.823)	0.883 (0.729-1.08)	1.17 (0.962-1.43)	1.41 (1.15-1.74)	1.75 (1.38-2.24)	2.03 (1.57-2.65)	2.32 (1.75-3.10)	2.63 (1.93-3.61)	3.06 (2.16-4.39)	3.41 (2.32-5.06)
12-hr	0.868 (0.718-1.06)	1.16 (0.957-1.42)	1.55 (1.29-1.91)	1.89 (1.54-2.33)	2.35 (1.86-3.01)	2.72 (2.11-3.56)	3.11 (2.35-4.16)	3.53 (2.59-4.85)	4.10 (2.89-5.88)	4.56 (3.11-6.77)
24-hr	1.16 (1.03-1.33)	1.59 (1.41-1.83)	2.17 (1.92-2.51)	2.65 (2.32-3.09)	3.33 (2.82-4.01)	3.86 (3.21-4.75)	4.42 (3.58-5.57)	5.01 (3.94-6.48)	5.83 (4.41-7.87)	6.49 (4.74-9.06)
2-day	1.33 (1.18-1.53)	1.85 (1.64-2.13)	2.55 (2.25-2.94)	3.13 (2.74-3.65)	3.95 (3.35-4.76)	4.60 (3.82-5.66)	5.29 (4.28-6.66)	6.01 (4.74-7.78)	7.02 (5.31-9.48)	7.84 (5.73-10.9)
3-day	1.43 (1.27-1.65)	2.00 (1.77-2.30)	2.78 (2.45-3.21)	3.42 (3.00-3.99)	4.34 (3.67-5.22)	5.06 (4.20-6.22)	5.82 (4.72-7.34)	6.64 (5.23-8.59)	7.78 (5.86-10.5)	8.71 (6.36-12.2)
4-day	1.53 (1.36-1.76)	2.14 (1.90-2.47)	2.98 (2.63-3.44)	3.68 (3.22-4.29)	4.66 (3.95-5.62)	5.45 (4.52-6.70)	6.28 (5.08-7.90)	7.15 (5.64-9.27)	8.40 (6.35-11.3)	9.40 (6.87-13.1)
7-day	1.68 (1.49-1.93)	2.34 (2.08-2.70)	3.25 (2.87-3.78)	4.02 (3.52-4.68)	5.10 (4.32-6.14)	5.95 (4.94-7.32)	6.85 (5.55-8.63)	7.81 (6.15-10.1)	9.15 (6.92-12.4)	10.2 (7.48-14.3)
10-day	1.78 (1.58-2.06)	2.49 (2.20-2.87)	3.45 (3.05-3.99)	4.26 (3.73-4.97)	5.41 (4.58-6.52)	6.32 (5.25-7.78)	7.28 (5.90-9.17)	8.30 (6.51-10.7)	9.73 (7.39-13.1)	10.9 (7.95-15.2)
20-day	2.10 (1.86-2.41)	2.93 (2.60-3.38)	4.09 (3.62-4.73)	5.08 (4.45-5.91)	6.48 (5.49-7.80)	7.60 (6.31-9.34)	8.78 (7.11-11.1)	10.0 (7.90-13.0)	11.8 (8.91-15.9)	13.2 (9.94-18.4)
30-day	2.42 (2.14-2.78)	3.38 (3.00-3.90)	4.73 (4.19-5.47)	5.88 (5.15-6.85)	7.53 (6.38-9.07)	8.86 (7.35-10.9)	10.3 (8.31-12.9)	11.7 (9.25-15.2)	13.8 (10.25-19.7)	15.5 (11.3-21.7)
45-day	2.84 (2.52-3.27)	3.97 (3.52-4.58)	5.56 (4.91-6.42)	6.93 (6.07-8.07)	8.91 (7.55-10.7)	10.5 (8.73-12.9)	12.2 (9.89-15.4)	14.0 (11.1-18.2)	16.6 (12.5-22.4)	18.7 (13.6-26.1)
60-day	3.18 (2.82-3.66)	4.41 (3.90-5.08)	6.14 (5.42-7.10)	7.65 (6.70-9.32)	9.84 (8.34-11.9)	11.6 (9.66-14.3)	13.6 (11.0-17.1)	15.6 (12.3-20.2)	18.5 (14.0-25.0)	20.9 (15.3-29.2)

¹ Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS). Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values. Please refer to NOAA Atlas 14 document for more information.

Estimates from the table in CSV format: Precipitation frequency estimates 

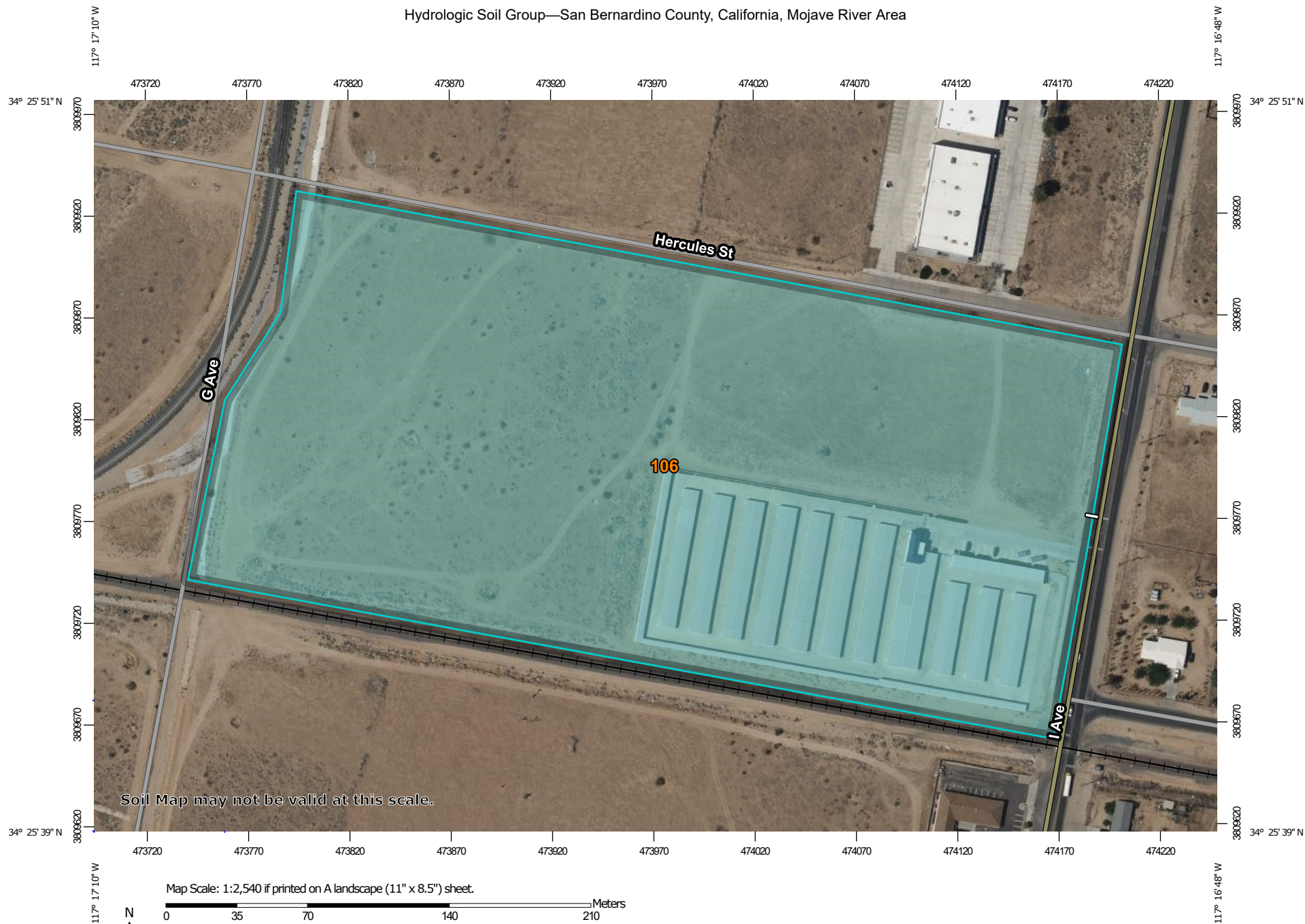
Main Link Categories:
[Home](#) | [OWP](#)

US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
Office of Water Prediction (OWP)
1325 East West Highway
Silver Spring, MD 20910
Page Author: [HIDSC webmaster](#)
Page last modified: April 21, 2017

Map Disclaimer
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Career Opportunities

Hydrologic Soil Group—San Bernardino County, California, Mojave River Area



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 Bernardino County, California, Mojave River Area
Survey Area Data: Version 16, Aug 30, 2024

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

Date(s) aerial images were photographed: Mar 17, 2022—Jun 12, 2022

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
106	BRYMAN LOAMY FINE SAND, 2 TO 5 PERCENT SLOPES	C	20.8	100.0%
Totals for Area of Interest			20.8	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 D – Water Quality Calculations

SAN BERNARDINO COUNTY STORMWATER PROGRAM
MODEL WATER QUALITY MANAGEMENT PLAN GUIDANCE

Estimating Volume- and Flow-based BMP Design Runoff Quantities

BMP Drainage Area designation	Area, A	Impervious area ratio, i	Region	NOAA Atlas 14 Precipitation Depth (2-yr 1-Hr Rainfall)	Factor of Safety ¹	Volume-based BMP drawdown time ²	Composite runoff coefficient, C _{BMP}	Intensity regression coefficient, I	Design rainfall intensity, I _{BMP}	Flow-based BMP treatment flowrate, Q	6-hour rainfall regression coefficient	6-hour mean storm rainfall, P ₆	Drawdown time regression constant, a	Maximized detention volume, P ₀	Target capture volume, V ₀	Target capture volume, V ₀
	acres		(Valley, Mountain, or Desert)	inches/hour		(24 or 48) hours			inches/hour	cfs		inches		inches	acre-feet	ft ³
DA1	2.81	0.895	Desert	0.39	2	48	0.72	0.3250	0.25	0.51	1.2371	0.48	1.963	0.68	0.159	6931

Regression Coefficients for Intensity (I) and 6-hour mean storm rainfall (P ₆)			
Quantity	Valley	Mountain	Desert
	85% upper confidence limits		
I	0.2787	0.3614	0.3250
P ₆	1.4807	1.9090	1.2371

Drawdown Time Regression Constant, a	
Time	a
hours	
24	1.582
48	1.963

Notes:

¹ The SBC MWQMPG recommends a factor of safety of 2.

² The SBC MWQMPG recommends a drawdown time of 48 hours. (A shorter time is not feasible for all soil types. A longer time can negatively affect vector control efforts.)

Attachment E – CASQA BMP Handbook Materials

Description

Promote efficient and safe housekeeping practices (storage, use, and cleanup) when handling potentially harmful materials such as fertilizers, pesticides, cleaning solutions, paint products, automotive products, and swimming pool chemicals. Related information is provided in BMP fact sheets SC-11 Spill Prevention, Control & Cleanup and SC-34 Waste Handling & Disposal.

Approach

Pollution Prevention

- Purchase only the amount of material that will be needed for foreseeable use. In most cases this will result in cost savings in both purchasing and disposal. See SC-61 Safer Alternative Products for additional information.
- Be aware of new products that may do the same job with less environmental risk and for less or the equivalent cost. Total cost must be used here; this includes purchase price, transportation costs, storage costs, use related costs, clean up costs and disposal costs.

Suggested Protocols

General

- Keep work sites clean and orderly. Remove debris in a timely fashion. Sweep the area.
- Dispose of wash water, sweepings, and sediments, properly.
- Recycle or dispose of fluids properly.
- Establish a daily checklist of office, yard and plant areas to confirm cleanliness and adherence to proper storage and security. Specific employees should be assigned specific inspection responsibilities and given the authority to remedy any problems found.
- Post waste disposal charts in appropriate locations detailing for each waste its hazardous nature (poison, corrosive, flammable), prohibitions on its disposal (dumpster, drain, sewer) and the recommended disposal method (recycle, sewer, burn, storage, landfill).
- Summarize the chosen BMPs applicable to your operation and post them in appropriate conspicuous places.

Objectives

- Cover
- Contain
- Educate
- Reduce/Minimize
- Product Substitution

Targeted Constituents

Sediment	☒
Nutrients	☒
Trash	☒
Metals	☒
Bacteria	☒
Oil and Grease	☒
Organics	☒
Oxygen Demanding	☒



- Require a signed checklist from every user of any hazardous material detailing amount taken, amount used, amount returned and disposal of spent material.
- Do a before audit of your site to establish baseline conditions and regular subsequent audits to note any changes and whether conditions are improving or deteriorating.
- Keep records of water, air and solid waste quantities and quality tests and their disposition.
- Maintain a mass balance of incoming, outgoing and on hand materials so you know when there are unknown losses that need to be tracked down and accounted for.
- Use and reward employee suggestions related to BMPs, hazards, pollution reduction, work place safety, cost reduction, alternative materials and procedures, recycling and disposal.
- Have, and review regularly, a contingency plan for spills, leaks, weather extremes etc. Make sure all employees know about it and what their role is so that it comes into force automatically.

Training

- Train all employees, management, office, yard, manufacturing, field and clerical in BMPs and pollution prevention and make them accountable.
- Train municipal employees who handle potentially harmful materials in good housekeeping practices.
- Train personnel who use pesticides in the proper use of the pesticides. The California Department of Pesticide Regulation license pesticide dealers, certify pesticide applicators and conduct onsite inspections.
- Train employees and contractors in proper techniques for spill containment and cleanup. The employee should have the tools and knowledge to immediately begin cleaning up a spill if one should occur.

Spill Response and Prevention

- Refer to SC-11, Spill Prevention, Control & Cleanup.
- Keep your Spill Prevention Control and Countermeasure (SPCC) plan up-to-date, and implement accordingly.
- Have spill cleanup materials readily available and in a known location.
- Cleanup spills immediately and use dry methods if possible.
- Properly dispose of spill cleanup material.

Other Considerations

- There are no major limitations to this best management practice.
- There are no regulatory requirements to this BMP. Existing regulations already require municipalities to properly store, use, and dispose of hazardous materials

Requirements

Costs

- Minimal cost associated with this BMP. Implementation of good housekeeping practices may result in cost savings as these procedures may reduce the need for more costly BMPs.

Maintenance

- Ongoing maintenance required to keep a clean site. Level of effort is a function of site size and type of activities.

Supplemental Information

Further Detail of the BMP

- The California Integrated Waste Management Board's Recycling Hotline, 1-800-553-2962, provides information on household hazardous waste collection programs and facilities.

Examples

There are a number of communities with effective programs. The most pro-active include Santa Clara County and the City of Palo Alto, the City and County of San Francisco, and the Municipality of Metropolitan Seattle (Metro).

References and Resources

British Columbia Lake Stewardship Society. Best Management Practices to Protect Water Quality from Non-Point Source Pollution. March 2000.

<http://www.nalms.org/bclss/bmphome.html#bmp>

King County Stormwater Pollution Control Manual - <http://dnr.metrokc.gov/wlr/dss/spcm.htm>

Model Urban Runoff Program: A How-To Guide for Developing Urban Runoff Programs for Small Municipalities, Prepared by City of Monterey, City of Santa Cruz, California Coastal Commission, Monterey Bay National Marine Sanctuary, Association of Monterey Bay Area Governments, Woodward-Clyde, Central Coast Regional Water Quality Control Board. July, 1998, Revised by California Coastal Commission, February 2002.

Orange County Stormwater Program

http://www.ocwatersheds.com/stormwater/swp_introduction.asp

San Mateo STOPPPP - (<http://stopppp.tripod.com/bmp.html>)



Description

An infiltration basin is a shallow impoundment that is designed to infiltrate stormwater. Infiltration basins use the natural filtering ability of the soil to remove pollutants in stormwater runoff. Infiltration facilities store runoff until it gradually exfiltrates through the soil and eventually into the water table. This practice has high pollutant removal efficiency and can also help recharge groundwater, thus helping to maintain low flows in stream systems. Infiltration basins can be challenging to apply on many sites, however, because of soils requirements. In addition, some studies have shown relatively high failure rates compared with other management practices.

California Experience

Infiltration basins have a long history of use in California, especially in the Central Valley. Basins located in Fresno were among those initially evaluated in the National Urban Runoff Program and were found to be effective at reducing the volume of runoff, while posing little long-term threat to groundwater quality (EPA, 1983; Schroeder, 1995). Proper siting of these devices is crucial as underscored by the experience of Caltrans in siting two basins in Southern California. The basin with marginal separation from groundwater and soil permeability failed immediately and could never be rehabilitated.

Advantages

- Provides 100% reduction in the load discharged to surface waters.
- The principal benefit of infiltration basins is the approximation of pre-development hydrology during which a

Design Considerations

- Soil for Infiltration
- Slope
- Aesthetics

Targeted Constituents

- | | | |
|-------------------------------------|----------------|---|
| ☒ | Sediment | ■ |
| ☒ | Nutrients | ■ |
| ☒ | Trash | ■ |
| ☒ | Metals | ■ |
| ☒ | Bacteria | ■ |
| ☒ | Oil and Grease | ■ |
| ☒ | Organics | ■ |

Legend (Removal Effectiveness)

- | | |
|----------|--------|
| ● Low | ■ High |
| ▲ Medium | |



significant portion of the average annual rainfall runoff is infiltrated and evaporated rather than flushed directly to creeks.

- If the water quality volume is adequately sized, infiltration basins can be useful for providing control of channel forming (erosion) and high frequency (generally less than the 2-year) flood events.

Limitations

- May not be appropriate for industrial sites or locations where spills may occur.
- Infiltration basins require a minimum soil infiltration rate of 0.5 inches/hour, not appropriate at sites with Hydrologic Soil Types C and D.
- If infiltration rates exceed 2.4 inches/hour, then the runoff should be fully treated prior to infiltration to protect groundwater quality.
- Not suitable on fill sites or steep slopes.
- Risk of groundwater contamination in very coarse soils.
- Upstream drainage area must be completely stabilized before construction.
- Difficult to restore functioning of infiltration basins once clogged.

Design and Sizing Guidelines

- Water quality volume determined by local requirements or sized so that 85% of the annual runoff volume is captured.
- Basin sized so that the entire water quality volume is infiltrated within 48 hours.
- Vegetation establishment on the basin floor may help reduce the clogging rate.

Construction/Inspection Considerations

- Before construction begins, stabilize the entire area draining to the facility. If impossible, place a diversion berm around the perimeter of the infiltration site to prevent sediment entrance during construction or remove the top 2 inches of soil after the site is stabilized. Stabilize the entire contributing drainage area, including the side slopes, before allowing any runoff to enter once construction is complete.
- Place excavated material such that it can not be washed back into the basin if a storm occurs during construction of the facility.
- Build the basin without driving heavy equipment over the infiltration surface. Any equipment driven on the surface should have extra-wide ("low pressure") tires. Prior to any construction, rope off the infiltration area to stop entrance by unwanted equipment.
- After final grading, till the infiltration surface deeply.
- Use appropriate erosion control seed mix for the specific project and location.

Performance

As water migrates through porous soil and rock, pollutant attenuation mechanisms include precipitation, sorption, physical filtration, and bacterial degradation. If functioning properly, this approach is presumed to have high removal efficiencies for particulate pollutants and moderate removal of soluble pollutants. Actual pollutant removal in the subsurface would be expected to vary depending upon site-specific soil types. This technology eliminates discharge to surface waters except for the very largest storms; consequently, complete removal of all stormwater constituents can be assumed.

There remain some concerns about the potential for groundwater contamination despite the findings of the NURP and Nightingale (1975; 1987a,b,c; 1989). For instance, a report by Pitt et al. (1994) highlighted the potential for groundwater contamination from intentional and unintentional stormwater infiltration. That report recommends that infiltration facilities not be sited in areas where high concentrations are present or where there is a potential for spills of toxic material. Conversely, Schroeder (1995) reported that there was no evidence of groundwater impacts from an infiltration basin serving a large industrial catchment in Fresno, CA.

Siting Criteria

The key element in siting infiltration basins is identifying sites with appropriate soil and hydrogeologic properties, which is critical for long term performance. In one study conducted in Prince George's County, Maryland (Galli, 1992), all of the infiltration basins investigated clogged within 2 years. It is believed that these failures were for the most part due to allowing infiltration at sites with rates of less than 0.5 in/hr, basing siting on soil type rather than field infiltration tests, and poor construction practices that resulted in soil compaction of the basin invert.

A study of 23 infiltration basins in the Pacific Northwest showed better long-term performance in an area with highly permeable soils (Hilding, 1996). In this study, few of the infiltration basins had failed after 10 years. Consequently, the following guidelines for identifying appropriate soil and subsurface conditions should be rigorously adhered to.

- Determine soil type (consider RCS soil type 'A, B or C' only) from mapping and consult USDA soil survey tables to review other parameters such as the amount of silt and clay, presence of a restrictive layer or seasonal high water table, and estimated permeability. The soil should not have more than 30% clay or more than 40% of clay and silt combined. Eliminate sites that are clearly unsuitable for infiltration.
- Groundwater separation should be at least 3 m from the basin invert to the measured groundwater elevation. There is concern at the state and regional levels of the impact on groundwater quality from infiltrated runoff, especially when the separation between groundwater and the surface is small.
- Location away from buildings, slopes and highway pavement (greater than 6 m) and wells and bridge structures (greater than 30 m). Sites constructed of fill, having a base flow or with a slope greater than 15% should not be considered.
- Ensure that adequate head is available to operate flow splitter structures (to allow the basin to be offline) without ponding in the splitter structure or creating backwater upstream of the splitter.

- Base flow should not be present in the tributary watershed.

Secondary Screening Based on Site Geotechnical Investigation

- At least three in-hole conductivity tests shall be performed using USBR 7300-89 or Bouwer-Rice procedures (the latter if groundwater is encountered within the boring), two tests at different locations within the proposed basin and the third down gradient by no more than approximately 10 m. The tests shall measure permeability in the side slopes and the bed within a depth of 3 m of the invert.
- The minimum acceptable hydraulic conductivity as measured in any of the three required test holes is 13 mm/hr. If any test hole shows less than the minimum value, the site should be disqualified from further consideration.
- Exclude from consideration sites constructed in fill or partially in fill unless no silts or clays are present in the soil boring. Fill tends to be compacted, with clays in a dispersed rather than flocculated state, greatly reducing permeability.
- The geotechnical investigation should be such that a good understanding is gained as to how the stormwater runoff will move in the soil (horizontally or vertically) and if there are any geological conditions that could inhibit the movement of water.

Additional Design Guidelines

- (1) Basin Sizing - The required water quality volume is determined by local regulations or sufficient to capture 85% of the annual runoff.
- (2) Provide pretreatment if sediment loading is a maintenance concern for the basin.
- (3) Include energy dissipation in the inlet design for the basins. Avoid designs that include a permanent pool to reduce opportunity for standing water and associated vector problems.
- (4) Basin invert area should be determined by the equation:

$$A = \frac{WQV}{kt}$$

where A = Basin invert area (m²)

WQV = water quality volume (m³)

k = 0.5 times the lowest field-measured hydraulic conductivity (m/hr)

t = drawdown time (48 hr)

- (5) The use of vertical piping, either for distribution or infiltration enhancement shall not be allowed to avoid device classification as a Class V injection well per 40 CFR146.5(e)(4).

Maintenance

Regular maintenance is critical to the successful operation of infiltration basins. Recommended operation and maintenance guidelines include:

- Inspections and maintenance to ensure that water infiltrates into the subsurface completely (recommended infiltration rate of 72 hours or less) and that vegetation is carefully managed to prevent creating mosquito and other vector habitats.
- Observe drain time for the design storm after completion or modification of the facility to confirm that the desired drain time has been obtained.
- Schedule semiannual inspections for beginning and end of the wet season to identify potential problems such as erosion of the basin side slopes and invert, standing water, trash and debris, and sediment accumulation.
- Remove accumulated trash and debris in the basin at the start and end of the wet season.
- Inspect for standing water at the end of the wet season.
- Trim vegetation at the beginning and end of the wet season to prevent establishment of woody vegetation and for aesthetic and vector reasons.
- Remove accumulated sediment and regrade when the accumulated sediment volume exceeds 10% of the basin.
- If erosion is occurring within the basin, revegetate immediately and stabilize with an erosion control mulch or mat until vegetation cover is established.
- To avoid reversing soil development, scarification or other disturbance should only be performed when there are actual signs of clogging, rather than on a routine basis. Always remove deposited sediments before scarification, and use a hand-guided rotary tiller, if possible, or a disc harrow pulled by a very light tractor.

Cost

Infiltration basins are relatively cost-effective practices because little infrastructure is needed when constructing them. One study estimated the total construction cost at about \$2 per ft (adjusted for inflation) of storage for a 0.25-acre basin (SWRPC, 1991). As with other BMPs, these published cost estimates may deviate greatly from what might be incurred at a specific site. For instance, Caltrans spent about \$18/ft³ for the two infiltration basins constructed in southern California, each of which had a water quality volume of about 0.34 ac.-ft. Much of the higher cost can be attributed to changes in the storm drain system necessary to route the runoff to the basin locations.

Infiltration basins typically consume about 2 to 3% of the site draining to them, which is relatively small. Additional space may be required for buffer, landscaping, access road, and fencing. Maintenance costs are estimated at 5 to 10% of construction costs.

One cost concern associated with infiltration practices is the maintenance burden and longevity. If improperly maintained, infiltration basins have a high failure rate. Thus, it may be necessary to replace the basin with a different technology after a relatively short period of time.

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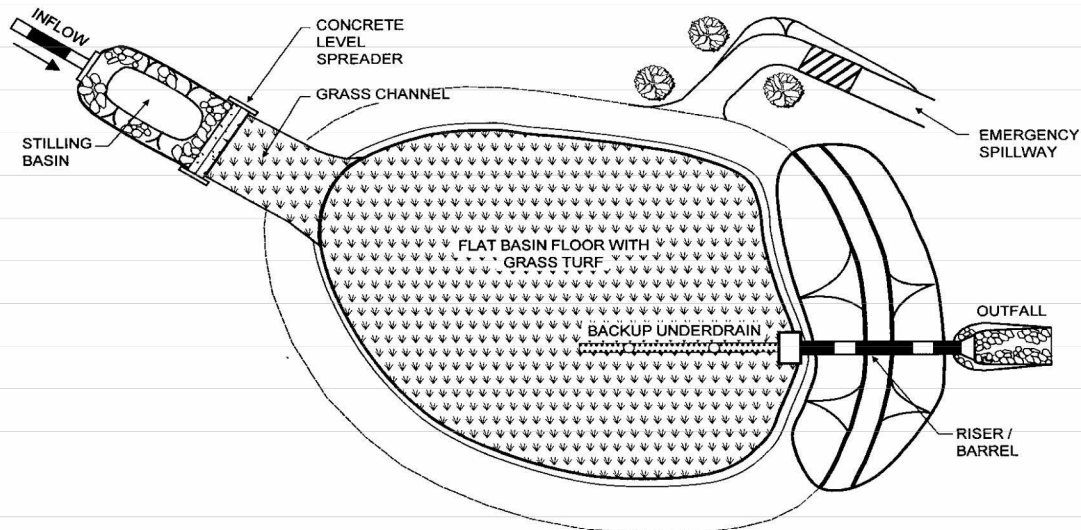
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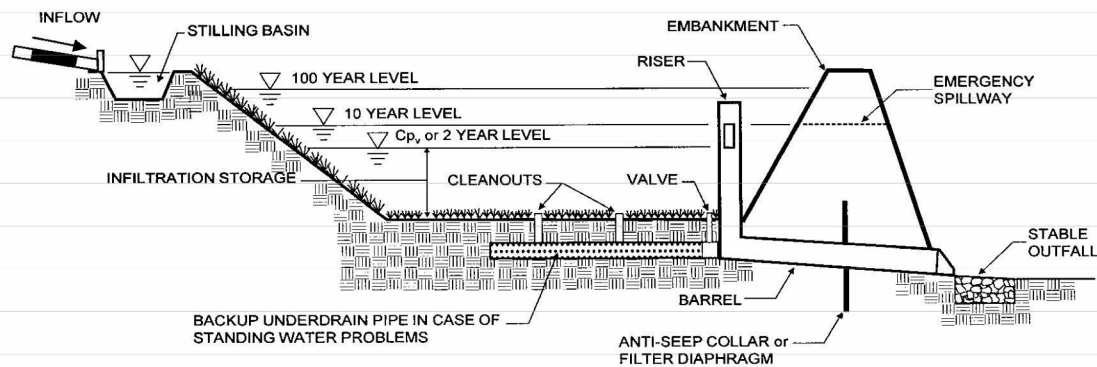
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PLAN VIEW



PROFILE

Site Design & Landscape Planning SD-10



Design Objectives

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

Description

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

Approach

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

Suitable Applications

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

Design Considerations

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



SD-10 Site Design & Landscape Planning

Designing New Installations

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

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

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

Conserve Natural Areas during Landscape Planning

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

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

Maximize Natural Water Storage and Infiltration Opportunities Within the Landscape Unit

- Promote the conservation of forest cover. Building on land that is already deforested affects basin hydrology to a lesser extent than converting forested land. Loss of forest cover reduces interception storage, detention in the organic forest floor layer, and water losses by evapotranspiration, resulting in large peak runoff increases and either their negative effects or the expense of countering them with structural solutions.
- Maintain natural storage reservoirs and drainage corridors, including depressions, areas of permeable soils, swales, and intermittent streams. Develop and implement policies and

Site Design & Landscape Planning SD-10

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

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

Protection of Slopes and Channels during Landscape Design

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

Redeveloping Existing Installations

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

SD-10 Site Design & Landscape Planning

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

Other Resources

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

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

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

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

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



Design Objectives

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

Description

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

Approach

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

Suitable Applications

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

Design Considerations

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

Designing New Installations

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

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



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

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

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

Redeveloping Existing Installations

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

Additional Information

Maintenance Considerations

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

Placement

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

Supplemental Information

Examples

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

Other Resources

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

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

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

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



Photo Credit: Geoff Brosseau

Description

As a consequence of its function, the stormwater conveyance system collects and transports urban runoff that may contain certain pollutants. Maintaining catch basins, stormwater inlets, and other stormwater conveyance structures on a regular basis will remove pollutants, prevent clogging of the downstream conveyance system, restore catch basins' sediment trapping capacity, and ensure the system functions properly hydraulically to avoid flooding.

Approach

Suggested Protocols

Catch Basins/Inlet Structures

- Municipal staff should regularly inspect facilities to ensure the following:
 - Immediate repair of any deterioration threatening structural integrity.
 - Cleaning before the sump is 40% full. Catch basins should be cleaned as frequently as needed to meet this standard.
 - Stenciling of catch basins and inlets (see SC-75 Waste Handling and Disposal).
- Clean catch basins, storm drain inlets, and other conveyance structures in high pollutant load areas just before the wet season to remove sediments and debris accumulated during the summer.

Objectives

- Contain
- Educate
- Reduce/Minimize

Targeted Constituents

Sediment	☒
Nutrients	☒
Trash	☒
Metals	☒
Bacteria	☒
Oil and Grease	☒
Organics	☒
Oxygen Demanding	☒



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- Conduct inspections more frequently during the wet season for problem areas where sediment or trash accumulates more often. Clean and repair as needed.
- Keep accurate logs of the number of catch basins cleaned.
- Record the amount of waste collected.
- Store wastes collected from cleaning activities of the drainage system in appropriate containers or temporary storage sites in a manner that prevents discharge to the storm drain.
- Dewater the wastes with outflow into the sanitary sewer if permitted. Water should be treated with an appropriate filtering device prior to discharge to the sanitary sewer. If discharge to the sanitary sewer is not allowed, water should be pumped or vacuumed to a tank and properly disposed of. Do not dewater near a storm drain or stream.
- Except for small communities with relatively few catch basins that may be cleaned manually, most municipalities will require mechanical cleaners such as eductors, vacuums, or bucket loaders.

Storm Drain Conveyance System

- Locate reaches of storm drain with deposit problems and develop a flushing schedule that keeps the pipe clear of excessive buildup.
- Collect flushed effluent and pump to the sanitary sewer for treatment.

Pump Stations

- Clean all storm drain pump stations prior to the wet season to remove silt and trash.
- Do not allow discharge from cleaning a storm drain pump station or other facility to reach the storm drain system.
- Conduct quarterly routine maintenance at each pump station.
- Inspect, clean, and repair as necessary all outlet structures prior to the wet season.
- Sample collected sediments to determine if landfill disposal is possible, or illegal discharges in the watershed are occurring.

Open Channel

- Consider modification of storm channel characteristics to improve channel hydraulics, to increase pollutant removals, and to enhance channel/creek aesthetic and habitat value.
- Conduct channel modification/improvement in accordance with existing laws. Any person, government agency, or public utility proposing an activity that will change the natural (emphasis added) state of any river, stream, or lake in California, must enter into a stream or Lake Alteration Agreement with the Department of Fish and Game. The developer-applicant should also contact local governments (city, county, special districts), other state agencies

(SWRCB, RWQCB, Department of Forestry, Department of Water Resources), and Federal Corps of Engineers and USFWS

Illicit Connections and Discharges

- During routine maintenance of conveyance system and drainage structures field staff should look for evidence of illegal discharges or illicit connections:
 - Is there evidence of spills such as paints, discoloring, etc.
 - Are there any odors associated with the drainage system
 - Record locations of apparent illegal discharges/illicit connections
 - Track flows back to potential dischargers and conduct aboveground inspections. This can be done through visual inspection of up gradient manholes or alternate techniques including zinc chloride smoke testing, fluorometric dye testing, physical inspection testing, or television camera inspection.
 - Once the origin of flow is established, require illicit discharger to eliminate the discharge.
- Stencil storm drains, where applicable, to prevent illegal disposal of pollutants. Storm drain inlets should have messages such as “Dump No Waste Drains to Stream” stenciled next to them to warn against ignorant or intentional dumping of pollutants into the storm drainage system.
- Refer to fact sheet SC-10 Non-Stormwater Discharges.

Illegal Dumping

- Regularly inspect and clean up hot spots and other storm drainage areas where illegal dumping and disposal occurs.
- Establish a system for tracking incidents. The system should be designed to identify the following:
 - Illegal dumping hot spots
 - Types and quantities (in some cases) of wastes
 - Patterns in time of occurrence (time of day/night, month, or year)
 - Mode of dumping (abandoned containers, “midnight dumping” from moving vehicles, direct dumping of materials, accidents/spills)
 - Responsible parties
- Post “No Dumping” signs in problem areas with a phone number for reporting dumping and disposal. Signs should also indicate fines and penalties for illegal dumping.
- Refer to fact sheet SC-10 Non-Stormwater Discharges.

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- The State Department of Fish and Game has a hotline for reporting violations called Cal TIP (1-800-952-5400). The phone number may be used to report any violation of a Fish and Game code (illegal dumping, poaching, etc.).
- The California Department of Toxic Substances Control's Waste Alert Hotline, 1-800-69TOXIC, can be used to report hazardous waste violations.

Training

- Train crews in proper maintenance activities, including record keeping and disposal.
- Only properly trained individuals are allowed to handle hazardous materials/wastes.
- Train municipal employees from all departments (public works, utilities, street cleaning, parks and recreation, industrial waste inspection, hazardous waste inspection, sewer maintenance) to recognize and report illegal dumping.
- Train municipal employees and educate businesses, contractors, and the general public in proper and consistent methods for disposal.
- Train municipal staff regarding non-stormwater discharges (See SC-10 Non-Stormwater Discharges).

Spill Response and Prevention

- Refer to SC-11, Prevention, Control & Cleanup
- Have spill cleanup materials readily available and in a known location.
- Cleanup spills immediately and use dry methods if possible.
- Properly dispose of spill cleanup material.

Other Considerations

- Cleanup activities may create a slight disturbance for local aquatic species. Access to items and material on private property may be limited. Trade-offs may exist between channel hydraulics and water quality/riparian habitat. If storm channels or basins are recognized as wetlands, many activities, including maintenance, may be subject to regulation and permitting.
- Storm drain flushing is most effective in small diameter pipes (36-inch diameter pipe or less, depending on water supply and sediment collection capacity). Other considerations associated with storm drain flushing may include the availability of a water source, finding a downstream area to collect sediments, liquid/sediment disposal, and disposal of flushed effluent to sanitary sewer may be prohibited in some areas.
- Regulations may include adoption of substantial penalties for illegal dumping and disposal.
- Municipal codes should include sections prohibiting the discharge of soil, debris, refuse, hazardous wastes, and other pollutants into the storm drain system.
- Private property access rights may be needed to track illegal discharges up gradient.

- Requirements of municipal ordinance authority for suspected source verification testing for illicit connections necessary for guaranteed rights of entry.

Requirements

Costs

- An aggressive catch basin cleaning program could require a significant capital and O&M budget. A careful study of cleaning effectiveness should be undertaken before increased cleaning is implemented. Catch basin cleaning costs are less expensive if vacuum street sweepers are available; cleaning catch basins manually can cost approximately twice as much as cleaning the basins with a vacuum attached to a sweeper.
- Methods used for illicit connection detection (smoke testing, dye testing, visual inspection, and flow monitoring) can be costly and time-consuming. Site-specific factors, such as the level of impervious area, the density and ages of buildings, and type of land use will determine the level of investigation necessary. Encouraging reporting of illicit discharges by employees can offset costs by saving expense on inspectors and directing resources more efficiently. Some programs have used funds available from “environmental fees” or special assessment districts to fund their illicit connection elimination programs.

Maintenance

- Two-person teams may be required to clean catch basins with vector trucks.
- Identifying illicit discharges requires teams of at least two people (volunteers can be used), plus administrative personnel, depending on the complexity of the storm sewer system.
- Arrangements must be made for proper disposal of collected wastes.
- Requires technical staff to detect and investigate illegal dumping violations, and to coordinate public education.

Supplemental Information

Further Detail of the BMP

Storm Drain flushing

Sanitary sewer flushing is a common maintenance activity used to improve pipe hydraulics and to remove pollutants in sanitary sewer systems. The same principles that make sanitary sewer flushing effective can be used to flush storm drains. Flushing may be designed to hydraulically convey accumulated material to strategic locations, such as to an open channel, to another point where flushing will be initiated, or over to the sanitary sewer and on to the treatment facilities, thus preventing re-suspension and overflow of a portion of the solids during storm events. Flushing prevents “plug flow” discharges of concentrated pollutant loadings and sediments. The deposits can hinder the designed conveyance capacity of the storm drain system and potentially cause backwater conditions in severe cases of clogging.

Storm drain flushing usually takes place along segments of pipe with grades that are too flat to maintain adequate velocity to keep particles in suspension. An upstream manhole is selected to place an inflatable device that temporarily plugs the pipe. Further upstream, water is pumped into the line to create a flushing wave. When the upstream reach of pipe is sufficiently full to

SC-74 **Drainage System Maintenance**

cause a flushing wave, the inflated device is rapidly deflated with the assistance of a vacuum pump, releasing the backed up water and resulting in the cleaning of the storm drain segment.

To further reduce the impacts of stormwater pollution, a second inflatable device, placed well downstream, may be used to re-collect the water after the force of the flushing wave has dissipated. A pump may then be used to transfer the water and accumulated material to the sanitary sewer for treatment. In some cases, an interceptor structure may be more practical or required to re-collect the flushed waters.

It has been found that cleansing efficiency of periodic flush waves is dependent upon flush volume, flush discharge rate, sewer slope, sewer length, sewer flow rate, sewer diameter, and population density. As a rule of thumb, the length of line to be flushed should not exceed 700 feet. At this maximum recommended length, the percent removal efficiency ranges between 65-75 percent for organics and 55-65 percent for dry weather grit/inorganic material. The percent removal efficiency drops rapidly beyond that. Water is commonly supplied by a water truck, but fire hydrants can also supply water. To make the best use of water, it is recommended that reclaimed water be used or that fire hydrant line flushing coincide with storm drain flushing.

Flow Management

Flow management has been one of the principal motivations for designing urban stream corridors in the past. Such needs may or may not be compatible with the stormwater quality goals in the stream corridor.

Downstream flood peaks can be suppressed by reducing through flow velocity. This can be accomplished by reducing gradient with grade control structures or increasing roughness with boulders, dense vegetation, or complex banks forms. Reducing velocity correspondingly increases flood height, so all such measures have a natural association with floodplain open space. Flood elevations laterally adjacent to the stream can be lowered by increasing through flow velocity.

However, increasing velocity increases flooding downstream and inherently conflicts with channel stability and human safety. Where topography permits, another way to lower flood elevation is to lower the level of the floodway with drop structures into a large but subtly excavated bowl where flood flows were allowed to spread out.

Stream Corridor Planning

Urban streams receive and convey stormwater flows from developed or developing watersheds. Planning of stream corridors thus interacts with urban stormwater management programs. If local programs are intended to control or protect downstream environments by managing flows delivered to the channels, then it is logical that such programs should be supplemented by management of the materials, forms, and uses of the downstream riparian corridor. Any proposal for stream alteration or management should be investigated for its potential flow and stability effects on upstream, downstream, and laterally adjacent areas. The timing and rate of flow from various tributaries can combine in complex ways to alter flood hazards. Each section of channel is unique, influenced by its own distribution of roughness elements, management activities, and stream responses.

Flexibility to adapt to stream features and behaviors as they evolve must be included in stream reclamation planning. The amenity and ecology of streams may be enhanced through the landscape design options of 1) corridor reservation, 2) bank treatment, 3) geomorphic restoration, and 4) grade control.

Corridor reservation - Reserving stream corridors and valleys to accommodate natural stream meandering, aggradation, degradation, and over bank flows allows streams to find their own form and generate less ongoing erosion. In California, open stream corridors in recent urban developments have produced recreational open space, irrigation of streamside plantings, and the aesthetic amenity of flowing water.

Bank treatment - The use of armoring, vegetative cover, and flow deflection may be used to influence a channel's form, stability, and biotic habitat. To prevent bank erosion, armoring can be done with rigid construction materials, such as concrete, masonry, wood planks and logs, riprap, and gabions. Concrete linings have been criticized because of their lack of provision of biotic habitat. In contrast, riprap and gabions make relatively porous and flexible linings. Boulders, placed in the bed reduce velocity and erosive power.

Riparian vegetation can stabilize the banks of streams that are at or near a condition of equilibrium. Binding networks of roots increase bank shear strength. During flood flows, resilient vegetation is forced into erosion-inhibiting mats. The roughness of vegetation leads to lower velocity, further reducing erosive effects. Structural flow deflection can protect banks from erosion or alter fish habitat. By concentrating flow, a deflector causes a pool to be scoured in the bed.

Geomorphic restoration – Restoration refers to alteration of disturbed streams so their form and behavior emulate those of undisturbed streams. Natural meanders are retained, with grading to gentle slopes on the inside of curves to allow point bars and riffle-pool sequences to develop. Trees are retained to provide scenic quality, biotic productivity, and roots for bank stabilization, supplemented by plantings where necessary.

A restorative approach can be successful where the stream is already approaching equilibrium. However, if upstream urbanization continues new flow regimes will be generated that could disrupt the equilibrium of the treated system.

Grade Control - A grade control structure is a level shelf of a permanent material, such as stone, masonry, or concrete, over which stream water flows. A grade control structure is called a sill, weir, or drop structure, depending on the relation of its invert elevation to upstream and downstream channels.

A sill is installed at the preexisting channel bed elevation to prevent upstream migration of nick points. It establishes a firm base level below which the upstream channel can not erode.

A weir or check dam is installed with invert above the preexisting bed elevation. A weir raises the local base level of the stream and causes aggradation upstream. The gradient, velocity, and erosive potential of the stream channel are reduced. A drop structure lowers the downstream invert below its preexisting elevation, reducing downstream gradient and velocity. Weirs and drop structure control erosion by dissipating energy and reducing slope velocity.

SC-74 Drainage System Maintenance

When carefully applied, grade control structures can be highly versatile in establishing human and environmental benefits in stabilized channels. To be successful, application of grade control structures should be guided by analysis of the stream system both upstream and downstream from the area to be reclaimed.

Examples

The California Department of Water Resources began the Urban Stream Restoration Program in 1985. The program provides grant funds to municipalities and community groups to implement stream restoration projects. The projects reduce damages from streambank and watershed instability and floods while restoring streams' aesthetic, recreational, and fish and wildlife values.

In Buena Vista Park, upper floodway slopes are gentle and grassed to achieve continuity of usable park land across the channel of small boulders at the base of the slopes.

The San Diego River is a large, vegetative lined channel, which was planted in a variety of species to support riparian wildlife while stabilizing the steep banks of the floodway.

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Predeveloped Condition 10 Year Storm Event

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

TOTAL 24-HOUR DURATION RAINFALL DEPTH = 2.65 (inches)

SOIL-COVER TYPE	AREA (Acres)	PERCENT OF PERVIOUS AREA	SCS CURVE NUMBER	LOSS RATE Fp(in./hr.)	YIELD
1	2.82	100.00	86.	0.272	0.516

TOTAL AREA (Acres) = 2.82

AREA-AVERAGED LOSS RATE, Fm (in./hr.) = 0.272

AREA-AVERAGED LOW LOSS FRACTION, Y = 0.484

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RATIONAL METHOD CALIBRATION COEFFICIENT = 1.00
TOTAL CATCHMENT AREA(ACRES) = 2.82
SOIL-LOSS RATE, Fm,(INCH/HR) = 0.272
LOW LOSS FRACTION = 0.484
TIME OF CONCENTRATION(MIN.) = 13.10
SMALL AREA PEAK Q COMPUTED USING PEAK FLOW RATE FORMULA
USER SPECIFIED RAINFALL VALUES ARE USED
RETURN FREQUENCY(YEARS) = 10
5-MINUTE POINT RAINFALL VALUE(INCHES) = 0.20
30-MINUTE POINT RAINFALL VALUE(INCHES) = 0.50
1-HOUR POINT RAINFALL VALUE(INCHES) = 0.66
3-HOUR POINT RAINFALL VALUE(INCHES) = 1.04
6-HOUR POINT RAINFALL VALUE(INCHES) = 1.41
24-HOUR POINT RAINFALL VALUE(INCHES) = 2.65

TOTAL CATCHMENT RUNOFF VOLUME(ACRE-FEET) = 0.34
TOTAL CATCHMENT SOIL-LOSS VOLUME(ACRE-FEET) = 0.28

TIME (HOURS)	VOLUME (AF)	Q (CFS)	0.	2.5	5.0	7.5	10.0
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0.06	0.0000	0.00 Q	.	.	.	.
0.28	0.0007	0.07 Q	.	.	.	.
0.50	0.0020	0.07 Q	.	.	.	.
0.72	0.0033	0.07 Q	.	.	.	.
0.93	0.0047	0.08 Q	.	.	.	.
1.15	0.0060	0.08 Q	.	.	.	.
1.37	0.0074	0.08 Q	.	.	.	.
1.59	0.0088	0.08 Q	.	.	.	.
1.81	0.0102	0.08 Q	.	.	.	.
2.03	0.0116	0.08 Q	.	.	.	.
2.24	0.0130	0.08 Q	.	.	.	.
2.46	0.0144	0.08 Q	.	.	.	.
2.68	0.0159	0.08 Q	.	.	.	.
2.90	0.0173	0.08 Q	.	.	.	.
3.12	0.0188	0.08 Q	.	.	.	.
3.34	0.0203	0.08 Q	.	.	.	.
3.55	0.0218	0.08 Q	.	.	.	.
3.77	0.0233	0.08 Q	.	.	.	.
3.99	0.0248	0.08 Q	.	.	.	.
4.21	0.0263	0.09 Q	.	.	.	.
4.43	0.0279	0.09 Q	.	.	.	.
4.65	0.0295	0.09 Q	.	.	.	.
4.86	0.0310	0.09 Q	.	.	.	.
5.08	0.0327	0.09 Q	.	.	.	.
5.30	0.0343	0.09 Q	.	.	.	.
5.52	0.0359	0.09 Q	.	.	.	.
5.74	0.0376	0.09 Q	.	.	.	.
5.96	0.0392	0.09 Q	.	.	.	.
6.17	0.0409	0.09 Q	.	.	.	.
6.39	0.0426	0.10 Q	.	.	.	.
6.61	0.0444	0.10 Q	.	.	.	.
6.83	0.0461	0.10 Q	.	.	.	.
7.05	0.0479	0.10 Q	.	.	.	.
7.27	0.0497	0.10 Q	.	.	.	.
7.48	0.0515	0.10 Q	.	.	.	.
7.70	0.0534	0.10 Q	.	.	.	.
7.92	0.0553	0.11 Q	.	.	.	.
8.14	0.0572	0.11 Q	.	.	.	.
8.36	0.0591	0.11 Q	.	.	.	.
8.58	0.0611	0.11 Q	.	.	.	.
8.80	0.0631	0.11 Q	.	.	.	.
9.01	0.0651	0.11 Q	.	.	.	.
9.23	0.0672	0.12 Q	.	.	.	.
9.45	0.0693	0.12 Q	.	.	.	.
9.67	0.0714	0.12 Q	.	.	.	.

9.89	0.0736	0.12 Q	.	.	.	.
10.10	0.0758	0.12 Q	.	.	.	.
10.32	0.0780	0.13 Q	.	.	.	.
10.54	0.0803	0.13 Q	.	.	.	.
10.76	0.0827	0.13 Q	.	.	.	.
10.98	0.0851	0.14 Q	.	.	.	.
11.20	0.0876	0.14 Q	.	.	.	.
11.41	0.0901	0.14 Q	.	.	.	.
11.63	0.0927	0.14 Q	.	.	.	.
11.85	0.0953	0.15 Q	.	.	.	.
12.07	0.0981	0.15 Q	.	.	.	.
12.29	0.1008	0.15 Q	.	.	.	.
12.51	0.1036	0.16 Q	.	.	.	.
12.73	0.1065	0.16 Q	.	.	.	.
12.94	0.1095	0.17 Q	.	.	.	.
13.16	0.1126	0.18 Q	.	.	.	.
13.38	0.1159	0.18 Q	.	.	.	.
13.60	0.1192	0.19 Q	.	.	.	.
13.82	0.1228	0.20 Q	.	.	.	.
14.03	0.1265	0.21 Q	.	.	.	.
14.25	0.1304	0.21 Q	.	.	.	.
14.47	0.1344	0.23 Q	.	.	.	.
14.69	0.1387	0.24 Q	.	.	.	.
14.91	0.1434	0.28 .Q	.	.	.	.
15.13	0.1486	0.30 .Q	.	.	.	.
15.35	0.1545	0.36 .Q	.	.	.	.
15.56	0.1613	0.39 .Q	.	.	.	.
15.78	0.1703	0.60 .Q	.	.	.	.
16.00	0.1851	1.03 . Q	.	.	.	.
16.22	0.2256	3.46 . . Q	.	.	.	.
16.44	0.2609	0.45 .Q	.	.	.	.
16.66	0.2679	0.32 .Q	.	.	.	.
16.87	0.2732	0.26 .Q	.	.	.	.
17.09	0.2775	0.22 Q	.	.	.	.
17.31	0.2814	0.21 Q	.	.	.	.
17.53	0.2849	0.19 Q	.	.	.	.
17.75	0.2882	0.17 Q	.	.	.	.
17.97	0.2912	0.16 Q	.	.	.	.
18.18	0.2940	0.15 Q	.	.	.	.
18.40	0.2967	0.15 Q	.	.	.	.
18.62	0.2993	0.14 Q	.	.	.	.
18.84	0.3018	0.13 Q	.	.	.	.
19.06	0.3041	0.13 Q	.	.	.	.
19.27	0.3064	0.12 Q	.	.	.	.
19.49	0.3086	0.12 Q	.	.	.	.

3.114

19.71	0.3107	0.11 Q	.	.	.	.
19.93	0.3127	0.11 Q	.	.	.	.
20.15	0.3147	0.11 Q	.	.	.	.
20.37	0.3166	0.10 Q	.	.	.	.
20.58	0.3184	0.10 Q	.	.	.	.
20.80	0.3202	0.10 Q	.	.	.	.
21.02	0.3220	0.10 Q	.	.	.	.
21.24	0.3237	0.09 Q	.	.	.	.
21.46	0.3254	0.09 Q	.	.	.	.
21.68	0.3270	0.09 Q	.	.	.	.
21.89	0.3286	0.09 Q	.	.	.	.
22.11	0.3302	0.09 Q	.	.	.	.
22.33	0.3317	0.08 Q	.	.	.	.
22.55	0.3332	0.08 Q	.	.	.	.
22.77	0.3347	0.08 Q	.	.	.	.
22.99	0.3361	0.08 Q	.	.	.	.
23.20	0.3376	0.08 Q	.	.	.	.
23.42	0.3390	0.08 Q	.	.	.	.
23.64	0.3404	0.08 Q	.	.	.	.
23.86	0.3417	0.07 Q	.	.	.	.
24.08	0.3431	0.07 Q	.	.	.	.
24.30	0.3437	0.00 Q	.	.	.	.
						14971.57

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

Percentile of Estimated Peak Flow Rate	Duration (minutes)
=====	=====
0%	1441.0
10%	78.6
20%	26.2
30%	13.1
40%	13.1
50%	13.1
60%	13.1
70%	13.1
80%	13.1
90%	13.1

RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
(Reference: 1986 SAN BERNARDINO CO. HYDROLOGY CRITERION)
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Ver. 18.0 Release Date: 07/01/2011 License ID 1501

Analysis prepared by:

***** DESCRIPTION OF STUDY *****
* APN 0410-072-06 *
* Predeveloped Condition *
* 10 Year Storm Event *

FILE NAME: PUMPEX.DAT
TIME/DATE OF STUDY: 15:19 10/17/2024

=====

USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:

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--*TIME-OF-CONCENTRATION MODEL*--

USER SPECIFIED STORM EVENT(YEAR) = 10.00
SPECIFIED MINIMUM PIPE SIZE(INCH) = 6.00
SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.90
USER-DEFINED LOGARITHMIC INTERPOLATION USED FOR RAINFALL

SLOPE OF INTENSITY DURATION CURVE(LOG(I;IN/HR) vs. LOG(Tc;MIN)) = 0.7000
USER SPECIFIED 1-HOUR INTENSITY(INCH/HOUR) = 0.6610

ANTECEDENT MOISTURE CONDITION (AMC) II ASSUMED FOR RATIONAL METHOD

USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL

	HALF- WIDTH	CROWN TO CROSSFALL	STREET-CROSSFALL: IN- / OUT- / PARK- SIDE / SIDE / WAY	CURB HEIGHT (FT)	GUTTER-GEOMETRIES: WIDTH (FT)	LIP (FT)	HIKE (FT)	MANNING FACTOR (n)
NO.	(FT)	(FT)						
===	=====	=====	=====	=====	=====	=====	=====	=====
1	30.0	20.0	0.018/0.018/0.020	0.67	2.00	0.0312	0.167	0.0150

GLOBAL STREET FLOW-DEPTH CONSTRAINTS:

1. Relative Flow-Depth = 0.00 FEET
as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
2. (Depth)*(Velocity) Constraint = 6.0 (FT*FT/S)

*SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*

*USER-SPECIFIED MINIMUM TOPOGRAPHIC SLOPE ADJUSTMENT NOT SELECTED

FLOW PROCESS FROM NODE 0.00 TO NODE 1.00 IS CODE = 21

>>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
>>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
=====

INITIAL SUBAREA FLOW-LENGTH(FEET) = 580.00
ELEVATION DATA: UPSTREAM(FEET) = 3103.00 DOWNSTREAM(FEET) = 3096.50

$T_c = K * [(LENGTH ** 3.00) / (ELEVATION\ CHANGE)] ** 0.20$

SUBAREA ANALYSIS USED MINIMUM T_c (MIN.) = 16.430

* 10 YEAR RAINFALL INTENSITY (INCH/HR) = 1.637

SUBAREA T_c AND LOSS RATE DATA (AMC II):

DEVELOPMENT TYPE/ LAND USE	SCS SOIL GROUP	AREA (ACRES)	F_p (INCH/HR)	A_p (DECIMAL)	SCS CN	T_c (MIN.)
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NATURAL POOR COVER

"GRASS"	C	2.82	0.27	1.000	86	16.43
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SUBAREA AVERAGE PERVIOUS LOSS RATE, F_p (INCH/HR) = 0.27

SUBAREA AVERAGE PERVIOUS AREA FRACTION, A_p = 1.000

SUBAREA RUNOFF (CFS) = 3.46

TOTAL AREA (ACRES) = 2.82 PEAK FLOW RATE (CFS) = 3.46

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END OF STUDY SUMMARY:

TOTAL AREA (ACRES) = 2.8 TC (MIN.) = 16.43

EFFECTIVE AREA (ACRES) = 2.82 AREA-AVERAGED F_m (INCH/HR) = 0.27

AREA-AVERAGED F_p (INCH/HR) = 0.27 AREA-AVERAGED A_p = 1.000

PEAK FLOW RATE (CFS) = 3.46

=====

END OF RATIONAL METHOD ANALYSIS

Proposed Condition 10 Year Storm Event

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

TOTAL 24-HOUR DURATION RAINFALL DEPTH = 2.65 (inches)

SOIL-COVER TYPE	AREA (Acres)	PERCENT OF PVIOUS AREA	SCS CURVE NUMBER	LOSS RATE Fp(in./hr.)	YIELD
1	0.30	100.00	91.	0.180	0.659
2	2.52	0.00	98.	0.000	0.913

TOTAL AREA (Acres) = 2.82

AREA-AVERAGED LOSS RATE, Fm (in./hr.) = 0.019

AREA-AVERAGED LOW LOSS FRACTION, Y = 0.114

=====

RATIONAL METHOD CALIBRATION COEFFICIENT = 1.01
TOTAL CATCHMENT AREA(ACRES) = 2.82
SOIL-LOSS RATE, Fm,(INCH/HR) = 0.019
LOW LOSS FRACTION = 0.114
TIME OF CONCENTRATION(MIN.) = 7.06
SMALL AREA PEAK Q COMPUTED USING PEAK FLOW RATE FORMULA
USER SPECIFIED RAINFALL VALUES ARE USED
RETURN FREQUENCY(YEARS) = 10
5-MINUTE POINT RAINFALL VALUE(INCHES) = 0.20
30-MINUTE POINT RAINFALL VALUE(INCHES) = 0.50
1-HOUR POINT RAINFALL VALUE(INCHES) = 0.66
3-HOUR POINT RAINFALL VALUE(INCHES) = 1.04
6-HOUR POINT RAINFALL VALUE(INCHES) = 1.41
24-HOUR POINT RAINFALL VALUE(INCHES) = 2.65

TOTAL CATCHMENT RUNOFF VOLUME(ACRE-FEET) = 0.57
TOTAL CATCHMENT SOIL-LOSS VOLUME(ACRE-FEET) = 0.05

TIME (HOURS)	VOLUME (AF)	Q (CFS)	0.	2.5	5.0	7.5	10.0
--------------	-------------	---------	----	-----	-----	-----	------

0.08	0.0004	0.13 Q	.	.	.	.	.
0.17	0.0013	0.13 Q	.	.	.	.	.
0.25	0.0022	0.13 Q	.	.	.	.	.
0.33	0.0031	0.13 Q	.	.	.	.	.
0.42	0.0040	0.13 Q	.	.	.	.	.
0.50	0.0049	0.13 Q	.	.	.	.	.
0.58	0.0057	0.13 Q	.	.	.	.	.
0.67	0.0066	0.13 Q	.	.	.	.	.
0.75	0.0075	0.13 Q	.	.	.	.	.
0.83	0.0084	0.13 Q	.	.	.	.	.
0.92	0.0093	0.13 Q	.	.	.	.	.
1.00	0.0102	0.13 Q	.	.	.	.	.
1.08	0.0111	0.13 Q	.	.	.	.	.
1.17	0.0121	0.13 Q	.	.	.	.	.
1.25	0.0130	0.13 Q	.	.	.	.	.
1.33	0.0139	0.13 Q	.	.	.	.	.
1.42	0.0148	0.13 Q	.	.	.	.	.
1.50	0.0157	0.13 Q	.	.	.	.	.
1.58	0.0166	0.13 Q	.	.	.	.	.
1.67	0.0176	0.13 Q	.	.	.	.	.
1.75	0.0185	0.14 Q	.	.	.	.	.
1.83	0.0194	0.14 Q	.	.	.	.	.
1.92	0.0204	0.14 Q	.	.	.	.	.
2.00	0.0213	0.14 Q	.	.	.	.	.
2.08	0.0222	0.14 Q	.	.	.	.	.
2.17	0.0232	0.14 Q	.	.	.	.	.
2.25	0.0241	0.14 Q	.	.	.	.	.
2.33	0.0251	0.14 Q	.	.	.	.	.
2.42	0.0260	0.14 Q	.	.	.	.	.
2.50	0.0270	0.14 Q	.	.	.	.	.
2.58	0.0280	0.14 Q	.	.	.	.	.
2.67	0.0289	0.14 Q	.	.	.	.	.
2.75	0.0299	0.14 Q	.	.	.	.	.
2.83	0.0309	0.14 Q	.	.	.	.	.
2.92	0.0318	0.14 Q	.	.	.	.	.
3.00	0.0328	0.14 Q	.	.	.	.	.
3.08	0.0338	0.14 Q	.	.	.	.	.
3.17	0.0348	0.14 Q	.	.	.	.	.
3.25	0.0358	0.14 Q	.	.	.	.	.
3.33	0.0367	0.14 Q	.	.	.	.	.
3.42	0.0377	0.14 Q	.	.	.	.	.
3.50	0.0387	0.14 Q	.	.	.	.	.
3.58	0.0397	0.15 Q	.	.	.	.	.
3.67	0.0407	0.15 Q	.	.	.	.	.

3.75	0.0417	0.15 Q	.	.	.	.
3.83	0.0428	0.15 Q	.	.	.	.
3.92	0.0438	0.15 Q	.	.	.	.
4.00	0.0448	0.15 Q	.	.	.	.
4.08	0.0458	0.15 Q	.	.	.	.
4.17	0.0468	0.15 Q	.	.	.	.
4.25	0.0479	0.15 Q	.	.	.	.
4.33	0.0489	0.15 Q	.	.	.	.
4.42	0.0499	0.15 Q	.	.	.	.
4.50	0.0510	0.15 Q	.	.	.	.
4.58	0.0520	0.15 Q	.	.	.	.
4.67	0.0531	0.15 Q	.	.	.	.
4.75	0.0541	0.15 Q	.	.	.	.
4.83	0.0552	0.15 Q	.	.	.	.
4.92	0.0563	0.15 Q	.	.	.	.
5.00	0.0573	0.16 Q	.	.	.	.
5.08	0.0584	0.16 Q	.	.	.	.
5.17	0.0595	0.16 Q	.	.	.	.
5.25	0.0606	0.16 Q	.	.	.	.
5.33	0.0617	0.16 Q	.	.	.	.
5.42	0.0627	0.16 Q	.	.	.	.
5.50	0.0638	0.16 Q	.	.	.	.
5.58	0.0649	0.16 Q	.	.	.	.
5.67	0.0661	0.16 Q	.	.	.	.
5.75	0.0672	0.16 Q	.	.	.	.
5.83	0.0683	0.16 Q	.	.	.	.
5.92	0.0694	0.16 Q	.	.	.	.
6.00	0.0705	0.16 Q	.	.	.	.
6.08	0.0717	0.16 Q	.	.	.	.
6.17	0.0728	0.17 Q	.	.	.	.
6.25	0.0739	0.17 Q	.	.	.	.
6.33	0.0751	0.17 Q	.	.	.	.
6.42	0.0762	0.17 Q	.	.	.	.
6.50	0.0774	0.17 Q	.	.	.	.
6.58	0.0785	0.17 Q	.	.	.	.
6.67	0.0797	0.17 Q	.	.	.	.
6.75	0.0809	0.17 Q	.	.	.	.
6.83	0.0821	0.17 Q	.	.	.	.
6.92	0.0832	0.17 Q	.	.	.	.
7.00	0.0844	0.17 Q	.	.	.	.
7.08	0.0856	0.17 Q	.	.	.	.
7.17	0.0868	0.17 Q	.	.	.	.
7.25	0.0880	0.18 Q	.	.	.	.
7.33	0.0893	0.18 Q	.	.	.	.
7.42	0.0905	0.18 Q	.	.	.	.

7.50	0.0917	0.18 Q	.	.	.	.
7.58	0.0929	0.18 Q	.	.	.	.
7.67	0.0942	0.18 Q	.	.	.	.
7.75	0.0954	0.18 Q	.	.	.	.
7.83	0.0967	0.18 Q	.	.	.	.
7.92	0.0979	0.18 Q	.	.	.	.
8.00	0.0992	0.18 Q	.	.	.	.
8.08	0.1005	0.19 Q	.	.	.	.
8.17	0.1018	0.19 Q	.	.	.	.
8.25	0.1031	0.19 Q	.	.	.	.
8.33	0.1044	0.19 Q	.	.	.	.
8.42	0.1057	0.19 Q	.	.	.	.
8.50	0.1070	0.19 Q	.	.	.	.
8.58	0.1083	0.19 Q	.	.	.	.
8.67	0.1096	0.19 Q	.	.	.	.
8.75	0.1110	0.19 Q	.	.	.	.
8.83	0.1123	0.20 Q	.	.	.	.
8.92	0.1137	0.20 Q	.	.	.	.
9.00	0.1150	0.20 Q	.	.	.	.
9.08	0.1164	0.20 Q	.	.	.	.
9.17	0.1178	0.20 Q	.	.	.	.
9.25	0.1192	0.20 Q	.	.	.	.
9.33	0.1206	0.20 Q	.	.	.	.
9.42	0.1220	0.21 Q	.	.	.	.
9.50	0.1234	0.21 Q	.	.	.	.
9.58	0.1248	0.21 Q	.	.	.	.
9.67	0.1263	0.21 Q	.	.	.	.
9.75	0.1277	0.21 Q	.	.	.	.
9.83	0.1292	0.21 Q	.	.	.	.
9.92	0.1306	0.21 Q	.	.	.	.
10.00	0.1321	0.22 Q	.	.	.	.
10.08	0.1336	0.22 Q	.	.	.	.
10.17	0.1351	0.22 Q	.	.	.	.
10.25	0.1366	0.22 Q	.	.	.	.
10.33	0.1382	0.22 Q	.	.	.	.
10.42	0.1397	0.22 Q	.	.	.	.
10.50	0.1412	0.23 Q	.	.	.	.
10.58	0.1428	0.23 Q	.	.	.	.
10.67	0.1444	0.23 Q	.	.	.	.
10.75	0.1460	0.23 Q	.	.	.	.
10.83	0.1476	0.23 Q	.	.	.	.
10.92	0.1492	0.24 Q	.	.	.	.
11.00	0.1508	0.24 Q	.	.	.	.
11.08	0.1525	0.24 Q	.	.	.	.
11.17	0.1541	0.24 Q	.	.	.	.

11.25	0.1558	0.24	Q	.	.	.	.
11.33	0.1575	0.25	Q	.	.	.	.
11.42	0.1592	0.25	Q	.	.	.	.
11.50	0.1609	0.25	.Q	.	.	.	.
11.58	0.1627	0.25	.Q	.	.	.	.
11.67	0.1644	0.26	.Q	.	.	.	.
11.75	0.1662	0.26	.Q	.	.	.	.
11.83	0.1680	0.26	.Q	.	.	.	.
11.92	0.1698	0.27	.Q	.	.	.	.
12.00	0.1717	0.27	.Q	.	.	.	.
12.08	0.1735	0.26	.Q	.	.	.	.
12.17	0.1753	0.26	.Q	.	.	.	.
12.25	0.1771	0.27	.Q	.	.	.	.
12.33	0.1790	0.27	.Q	.	.	.	.
12.42	0.1809	0.28	.Q	.	.	.	.
12.50	0.1828	0.28	.Q	.	.	.	.
12.58	0.1847	0.28	.Q	.	.	.	.
12.67	0.1867	0.29	.Q	.	.	.	.
12.75	0.1887	0.29	.Q	.	.	.	.
12.83	0.1907	0.29	.Q	.	.	.	.
12.92	0.1927	0.30	.Q	.	.	.	.
13.00	0.1948	0.30	.Q	.	.	.	.
13.08	0.1969	0.31	.Q	.	.	.	.
13.17	0.1990	0.31	.Q	.	.	.	.
13.25	0.2012	0.32	.Q	.	.	.	.
13.33	0.2034	0.32	.Q	.	.	.	.
13.42	0.2056	0.33	.Q	.	.	.	.
13.50	0.2079	0.33	.Q	.	.	.	.
13.58	0.2102	0.34	.Q	.	.	.	.
13.67	0.2126	0.35	.Q	.	.	.	.
13.75	0.2150	0.36	.Q	.	.	.	.
13.83	0.2175	0.36	.Q	.	.	.	.
13.92	0.2200	0.37	.Q	.	.	.	.
14.00	0.2226	0.38	.Q	.	.	.	.
14.08	0.2252	0.37	.Q	.	.	.	.
14.17	0.2277	0.37	.Q	.	.	.	.
14.25	0.2303	0.39	.Q	.	.	.	.
14.33	0.2330	0.39	.Q	.	.	.	.
14.42	0.2357	0.41	.Q	.	.	.	.
14.50	0.2386	0.42	.Q	.	.	.	.
14.58	0.2415	0.44	.Q	.	.	.	.
14.67	0.2446	0.45	.Q	.	.	.	.
14.75	0.2477	0.47	.Q	.	.	.	.
14.83	0.2510	0.49	.Q	.	.	.	.
14.92	0.2545	0.52	.Q	.	.	.	.

15.00	0.2581	0.53 .Q	.	.	.	.
15.08	0.2619	0.57 .Q	.	.	.	.
15.17	0.2659	0.59 .Q	.	.	.	.
15.25	0.2702	0.64 .Q	.	.	.	.
15.33	0.2747	0.67 .Q	.	.	.	.
15.42	0.2795	0.72 .Q	.	.	.	.
15.50	0.2846	0.76 .Q	.	.	.	.
15.58	0.2903	0.87 .Q	.	.	.	.
15.67	0.2965	0.95 .Q	.	.	.	.
15.75	0.3049	1.47 .Q	.	.	.	.
15.83	0.3156	1.63 .Q	.	.	.	.
15.92	0.3287	2.20 .Q	.	.	.	.
16.00	0.3462	2.86 .Q	.	.	.	.
16.08	0.3794	6.80 .Q	.	.	.	.
16.17	0.4092	1.85 .Q	.	.	.	.
16.25	0.4192	1.04 .Q	.	.	.	.
16.33	0.4256	0.81 .Q	.	.	.	.
16.42	0.4308	0.71 .Q	.	.	.	.
16.50	0.4354	0.62 .Q	.	.	.	.
16.58	0.4394	0.55 .Q	.	.	.	.
16.67	0.4430	0.50 .Q	.	.	.	.
16.75	0.4463	0.46 .Q	.	.	.	.
16.83	0.4494	0.43 .Q	.	.	.	.
16.92	0.4522	0.40 .Q	.	.	.	.
17.00	0.4549	0.38 .Q	.	.	.	.
17.08	0.4575	0.38 .Q	.	.	.	.
17.17	0.4601	0.37 .Q	.	.	.	.
17.25	0.4626	0.35 .Q	.	.	.	.
17.33	0.4649	0.34 .Q	.	.	.	.
17.42	0.4672	0.33 .Q	.	.	.	.
17.50	0.4694	0.32 .Q	.	.	.	.
17.58	0.4716	0.31 .Q	.	.	.	.
17.67	0.4736	0.30 .Q	.	.	.	.
17.75	0.4756	0.29 .Q	.	.	.	.
17.83	0.4776	0.28 .Q	.	.	.	.
17.92	0.4795	0.27 .Q	.	.	.	.
18.00	0.4814	0.27 .Q	.	.	.	.
18.08	0.4832	0.27 .Q	.	.	.	.
18.17	0.4850	0.26 .Q	.	.	.	.
18.25	0.4868	0.26 .Q	.	.	.	.
18.33	0.4886	0.25 .Q	.	.	.	.
18.42	0.4903	0.25 Q	.	.	.	.
18.50	0.4920	0.24 Q	.	.	.	.
18.58	0.4937	0.24 Q	.	.	.	.
18.67	0.4953	0.23 Q	.	.	.	.

18.75	0.4969	0.23 Q	.	.	.	.
18.83	0.4985	0.23 Q	.	.	.	.
18.92	0.5000	0.22 Q	.	.	.	.
19.00	0.5016	0.22 Q	.	.	.	.
19.08	0.5031	0.22 Q	.	.	.	.
19.17	0.5046	0.21 Q	.	.	.	.
19.25	0.5060	0.21 Q	.	.	.	.
19.33	0.5075	0.21 Q	.	.	.	.
19.42	0.5089	0.20 Q	.	.	.	.
19.50	0.5103	0.20 Q	.	.	.	.
19.58	0.5116	0.20 Q	.	.	.	.
19.67	0.5130	0.20 Q	.	.	.	.
19.75	0.5144	0.19 Q	.	.	.	.
19.83	0.5157	0.19 Q	.	.	.	.
19.92	0.5170	0.19 Q	.	.	.	.
20.00	0.5183	0.19 Q	.	.	.	.
20.08	0.5196	0.19 Q	.	.	.	.
20.17	0.5208	0.18 Q	.	.	.	.
20.25	0.5221	0.18 Q	.	.	.	.
20.33	0.5233	0.18 Q	.	.	.	.
20.42	0.5246	0.18 Q	.	.	.	.
20.50	0.5258	0.18 Q	.	.	.	.
20.58	0.5270	0.17 Q	.	.	.	.
20.67	0.5282	0.17 Q	.	.	.	.
20.75	0.5294	0.17 Q	.	.	.	.
20.83	0.5305	0.17 Q	.	.	.	.
20.92	0.5317	0.17 Q	.	.	.	.
21.00	0.5328	0.17 Q	.	.	.	.
21.08	0.5340	0.16 Q	.	.	.	.
21.17	0.5351	0.16 Q	.	.	.	.
21.25	0.5362	0.16 Q	.	.	.	.
21.33	0.5373	0.16 Q	.	.	.	.
21.42	0.5384	0.16 Q	.	.	.	.
21.50	0.5395	0.16 Q	.	.	.	.
21.58	0.5406	0.16 Q	.	.	.	.
21.67	0.5416	0.15 Q	.	.	.	.
21.75	0.5427	0.15 Q	.	.	.	.
21.83	0.5437	0.15 Q	.	.	.	.
21.92	0.5448	0.15 Q	.	.	.	.
22.00	0.5458	0.15 Q	.	.	.	.
22.08	0.5469	0.15 Q	.	.	.	.
22.17	0.5479	0.15 Q	.	.	.	.
22.25	0.5489	0.15 Q	.	.	.	.
22.33	0.5499	0.15 Q	.	.	.	.
22.42	0.5509	0.14 Q	.	.	.	.

22.50	0.5519	0.14 Q	.	.	.	.
22.58	0.5529	0.14 Q	.	.	.	.
22.67	0.5538	0.14 Q	.	.	.	.
22.75	0.5548	0.14 Q	.	.	.	.
22.83	0.5558	0.14 Q	.	.	.	.
22.92	0.5567	0.14 Q	.	.	.	.
23.00	0.5577	0.14 Q	.	.	.	.
23.08	0.5586	0.14 Q	.	.	.	.
23.17	0.5596	0.14 Q	.	.	.	.
23.25	0.5605	0.13 Q	.	.	.	.
23.33	0.5614	0.13 Q	.	.	.	.
23.42	0.5623	0.13 Q	.	.	.	.
23.50	0.5633	0.13 Q	.	.	.	.
23.58	0.5642	0.13 Q	.	.	.	.
23.67	0.5651	0.13 Q	.	.	.	.
23.75	0.5660	0.13 Q	.	.	.	.
23.83	0.5669	0.13 Q	.	.	.	.
23.92	0.5677	0.13 Q	.	.	.	.
24.00	0.5686	0.13 Q	.	.	.	.
24.08	0.5691	0.00 Q	.	.	.	.
						24790

TIME DURATION(minutes) OF PERCENTILES OF ESTIMATED PEAK FLOW RATE:

(Note: 100% of Peak Flow Rate estimate assumed to have
an instantaneous time duration)

Percentile of Estimated Peak Flow Rate	Duration (minutes)
=====	=====
0%	1440.0
10%	65.0
20%	30.0
30%	15.0
40%	10.0
50%	5.0
60%	5.0
70%	5.0
80%	5.0
90%	5.0

RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
(Reference: 1986 SAN BERNARDINO CO. HYDROLOGY CRITERION)
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Ver. 18.0 Release Date: 07/01/2011 License ID 1501

Analysis prepared by:

***** DESCRIPTION OF STUDY *****
* APN 0410-072-06 *
* Developed Condition *
* 10 Year Storm Event *

FILE NAME: PUMP.DAT
TIME/DATE OF STUDY: 13:50 10/24/2024

=====

USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:

=====

--*TIME-OF-CONCENTRATION MODEL*--

USER SPECIFIED STORM EVENT(YEAR) = 10.00
SPECIFIED MINIMUM PIPE SIZE(INCH) = 6.00
SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.90
USER-DEFINED LOGARITHMIC INTERPOLATION USED FOR RAINFALL

SLOPE OF INTENSITY DURATION CURVE($\log(I; \text{IN/HR})$ vs. $\log(T_c; \text{MIN})$) = 0.7000
USER SPECIFIED 1-HOUR INTENSITY(INCH/HOUR) = 0.6610

ANTECEDENT MOISTURE CONDITION (AMC) II ASSUMED FOR RATIONAL METHOD

USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL

NO.	HALF- WIDTH (FT)	CROWN TO CROSSFALL (FT)	STREET-CROSSFALL: IN- / OUT- / PARK- SIDE / SIDE / WAY	CURB HEIGHT (FT)	GUTTER-GEOMETRIES: WIDTH LIP HIKE (FT) (FT) (FT)	MANNING FACTOR (n)
1	30.0	20.0	0.018/0.018/0.020	0.67	2.00 0.0313 0.167	0.0150

GLOBAL STREET FLOW-DEPTH CONSTRAINTS:

1. Relative Flow-Depth = 0.00 FEET
as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
2. (Depth)*(Velocity) Constraint = 6.0 (FT*FT/S)

*SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*

*USER-SPECIFIED MINIMUM TOPOGRAPHIC SLOPE ADJUSTMENT NOT SELECTED

FLOW PROCESS FROM NODE 10.00 TO NODE 12.00 IS CODE = 21

>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<
>>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<

=====

INITIAL SUBAREA FLOW-LENGTH(FEET) = 447.00
ELEVATION DATA: UPSTREAM(FEET) = 3101.90 DOWNSTREAM(FEET) = 3095.50

$T_c = K * [(LENGTH ** 3.00) / (ELEVATION \ CHANGE)] ** 0.20$
 SUBAREA ANALYSIS USED MINIMUM T_c (MIN.) = 8.163
 * 10 YEAR RAINFALL INTENSITY (INCH/HR) = 2.671
 SUBAREA T_c AND LOSS RATE DATA (AMC II):

DEVELOPMENT TYPE/ LAND USE	SCS SOIL GROUP	AREA (ACRES)	F_p (INCH/HR)	A_p (DECIMAL)	SCS CN	T_c (MIN.)
COMMERCIAL	C	0.66	0.57	0.100	69	8.16

 SUBAREA AVERAGE PERVIOUS LOSS RATE, F_p (INCH/HR) = 0.57
 SUBAREA AVERAGE PERVIOUS AREA FRACTION, A_p = 0.100
 SUBAREA RUNOFF (CFS) = 1.55
 TOTAL AREA (ACRES) = 0.66 PEAK FLOW RATE (CFS) = 1.55

 FLOW PROCESS FROM NODE 12.00 TO NODE 12.00 IS CODE = 1

>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<

=====

TOTAL NUMBER OF STREAMS = 2
 CONFLUENCE VALUES USED FOR INDEPENDENT STREAM 1 ARE:
 TIME OF CONCENTRATION (MIN.) = 8.16
 RAINFALL INTENSITY (INCH/HR) = 2.67
 AREA-AVERAGED F_m (INCH/HR) = 0.06
 AREA-AVERAGED F_p (INCH/HR) = 0.57
 AREA-AVERAGED A_p = 0.10
 EFFECTIVE STREAM AREA (ACRES) = 0.66
 TOTAL STREAM AREA (ACRES) = 0.66
 PEAK FLOW RATE (CFS) AT CONFLUENCE = 1.55

 FLOW PROCESS FROM NODE 11.00 TO NODE 12.00 IS CODE = 21

>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
 >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<

=====

INITIAL SUBAREA FLOW-LENGTH (FEET) = 389.00
 ELEVATION DATA: UPSTREAM (FEET) = 3104.28 DOWNSTREAM (FEET) = 3095.50

$T_c = K * [(LENGTH ** 3.00) / (ELEVATION \ CHANGE)] ** 0.20$
 SUBAREA ANALYSIS USED MINIMUM T_c (MIN.) = 7.049
 * 10 YEAR RAINFALL INTENSITY (INCH/HR) = 2.959
 SUBAREA T_c AND LOSS RATE DATA (AMC II):

DEVELOPMENT TYPE/ LAND USE	SCS SOIL GROUP	AREA (ACRES)	F_p (INCH/HR)	A_p (DECIMAL)	SCS CN	T_c (MIN.)
COMMERCIAL	C	1.04	0.57	0.100	69	7.05

 SUBAREA AVERAGE PERVIOUS LOSS RATE, F_p (INCH/HR) = 0.57
 SUBAREA AVERAGE PERVIOUS AREA FRACTION, A_p = 0.100
 SUBAREA RUNOFF (CFS) = 2.72
 TOTAL AREA (ACRES) = 1.04 PEAK FLOW RATE (CFS) = 2.72

 FLOW PROCESS FROM NODE 12.00 TO NODE 12.00 IS CODE = 1

>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
 >>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<

=====

TOTAL NUMBER OF STREAMS = 2
 CONFLUENCE VALUES USED FOR INDEPENDENT STREAM 2 ARE:
 TIME OF CONCENTRATION (MIN.) = 7.05
 RAINFALL INTENSITY (INCH/HR) = 2.96
 AREA-AVERAGED F_m (INCH/HR) = 0.06
 AREA-AVERAGED F_p (INCH/HR) = 0.57

AREA-AVERAGED $A_p = 0.10$
 EFFECTIVE STREAM AREA(ACRES) = 1.04
 TOTAL STREAM AREA(ACRES) = 1.04
 PEAK FLOW RATE(CFS) AT CONFLUENCE = 2.72

**** CONFLUENCE DATA ****

STREAM NUMBER	Q (CFS)	Tc (MIN.)	Intensity (INCH/HR)	Fp(Fm) (INCH/HR)	A_p	Ae (ACRES)	HEADWATER NODE
1	1.55	8.16	2.671	0.57(0.06)	0.10	0.7	10.00
2	2.72	7.05	2.959	0.57(0.06)	0.10	1.0	11.00

RAINFALL INTENSITY AND TIME OF CONCENTRATION RATIO
 CONFLUENCE FORMULA USED FOR 2 STREAMS.

**** PEAK FLOW RATE TABLE ****

STREAM NUMBER	Q (CFS)	Tc (MIN.)	Intensity (INCH/HR)	Fp(Fm) (INCH/HR)	A_p	Ae (ACRES)	HEADWATER NODE
1	4.21	7.05	2.959	0.57(0.06)	0.10	1.6	11.00
2	4.00	8.16	2.671	0.57(0.06)	0.10	1.7	10.00

COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:

PEAK FLOW RATE(CFS) = 4.21 Tc(MIN.) = 7.05
 EFFECTIVE AREA(ACRES) = 1.61 AREA-AVERAGED Fm(INCH/HR) = 0.06
 AREA-AVERAGED Fp(INCH/HR) = 0.57 AREA-AVERAGED $A_p = 0.10$
 TOTAL AREA(ACRES) = 1.7
 LONGEST FLOWPATH FROM NODE 10.00 TO NODE 12.00 = 447.00 FEET.

 FLOW PROCESS FROM NODE 12.00 TO NODE 13.00 IS CODE = 31

>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<

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ELEVATION DATA: UPSTREAM(FEET) = 3093.50 DOWNSTREAM(FEET) = 3087.50
 FLOW LENGTH(FEET) = 12.00 MANNING'S N = 0.013
 DEPTH OF FLOW IN 9.0 INCH PIPE IS 3.8 INCHES
 PIPE-FLOW VELOCITY(FEET/SEC.) = 23.38
 ESTIMATED PIPE DIAMETER(INCH) = 9.00 NUMBER OF PIPES = 1
 PIPE-FLOW(CFS) = 4.21
 PIPE TRAVEL TIME(MIN.) = 0.01 Tc(MIN.) = 7.06
 LONGEST FLOWPATH FROM NODE 10.00 TO NODE 13.00 = 459.00 FEET.

 FLOW PROCESS FROM NODE 13.00 TO NODE 13.00 IS CODE = 1

>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<

=====

TOTAL NUMBER OF STREAMS = 2
 CONFLUENCE VALUES USED FOR INDEPENDENT STREAM 1 ARE:
 TIME OF CONCENTRATION(MIN.) = 7.06
 RAINFALL INTENSITY(INCH/HR) = 2.96
 AREA-AVERAGED Fm(INCH/HR) = 0.06
 AREA-AVERAGED Fp(INCH/HR) = 0.57
 AREA-AVERAGED $A_p = 0.10$
 EFFECTIVE STREAM AREA(ACRES) = 1.61
 TOTAL STREAM AREA(ACRES) = 1.70
 PEAK FLOW RATE(CFS) AT CONFLUENCE = 4.21

 FLOW PROCESS FROM NODE 14.00 TO NODE 15.00 IS CODE = 21

>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<

>>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<

=====

INITIAL SUBAREA FLOW-LENGTH(FEET) = 190.00
ELEVATION DATA: UPSTREAM(FEET) = 3107.00 DOWNSTREAM(FEET) = 3101.90

$T_c = K * [(LENGTH ** 3.00) / (ELEVATION CHANGE)] ** 0.20$

SUBAREA ANALYSIS USED MINIMUM T_c (MIN.) = 5.112

* 10 YEAR RAINFALL INTENSITY (INCH/HR) = 3.706

SUBAREA T_c AND LOSS RATE DATA (AMC II):

DEVELOPMENT TYPE/ LAND USE	SCS SOIL GROUP	AREA (ACRES)	F_p (INCH/HR)	A_p (DECIMAL)	SCS CN	T_c (MIN.)
COMMERCIAL	C	0.18	0.57	0.100	69	5.11

SUBAREA AVERAGE PERVIOUS LOSS RATE, F_p (INCH/HR) = 0.57

SUBAREA AVERAGE PERVIOUS AREA FRACTION, A_p = 0.100

SUBAREA RUNOFF (CFS) = 0.59

TOTAL AREA (ACRES) = 0.18 PEAK FLOW RATE (CFS) = 0.59

FLOW PROCESS FROM NODE 15.00 TO NODE 16.00 IS CODE = 52

>>>>COMPUTE NATURAL VALLEY CHANNEL FLOW<<<<

>>>>TRAVELTIME THRU SUBAREA<<<<

=====

ELEVATION DATA: UPSTREAM(FEET) = 3101.90 DOWNSTREAM(FEET) = 3097.50

CHANNEL LENGTH THRU SUBAREA(FEET) = 304.00 CHANNEL SLOPE = 0.0145

NOTE: CHANNEL FLOW OF 1. CFS WAS ASSUMED IN VELOCITY ESTIMATION

CHANNEL FLOW THRU SUBAREA (CFS) = 0.59

FLOW VELOCITY (FEET/SEC) = 1.80 (PER LACFCD/RCFC&WCD HYDROLOGY MANUAL)

TRAVEL TIME (MIN.) = 2.81 T_c (MIN.) = 7.92

LONGEST FLOWPATH FROM NODE 14.00 TO NODE 16.00 = 494.00 FEET.

FLOW PROCESS FROM NODE 16.00 TO NODE 16.00 IS CODE = 81

>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<

=====

MAINLINE T_c (MIN.) = 7.92

* 10 YEAR RAINFALL INTENSITY (INCH/HR) = 2.728

SUBAREA LOSS RATE DATA (AMC II):

DEVELOPMENT TYPE/ LAND USE	SCS SOIL GROUP	AREA (ACRES)	F_p (INCH/HR)	A_p (DECIMAL)	SCS CN
COMMERCIAL	C	0.94	0.57	0.100	69

SUBAREA AVERAGE PERVIOUS LOSS RATE, F_p (INCH/HR) = 0.57

SUBAREA AVERAGE PERVIOUS AREA FRACTION, A_p = 0.100

SUBAREA AREA (ACRES) = 0.94 SUBAREA RUNOFF (CFS) = 2.26

EFFECTIVE AREA (ACRES) = 1.12 AREA-AVERAGED F_m (INCH/HR) = 0.06

AREA-AVERAGED F_p (INCH/HR) = 0.57 AREA-AVERAGED A_p = 0.10

TOTAL AREA (ACRES) = 1.1 PEAK FLOW RATE (CFS) = 2.69

FLOW PROCESS FROM NODE 16.00 TO NODE 17.00 IS CODE = 31

>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<

>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<

=====

ELEVATION DATA: UPSTREAM(FEET) = 3095.50 DOWNSTREAM(FEET) = 3087.50

FLOW LENGTH (FEET) = 97.00 MANNING'S N = 0.013

DEPTH OF FLOW IN 9.0 INCH PIPE IS 5.0 INCHES

PIPE-FLOW VELOCITY (FEET/SEC.) = 10.65

ESTIMATED PIPE DIAMETER (INCH) = 9.00 NUMBER OF PIPES = 1

PIPE-FLOW(CFS) = 2.69
 PIPE TRAVEL TIME(MIN.) = 0.15 Tc(MIN.) = 8.07
 LONGEST FLOWPATH FROM NODE 14.00 TO NODE 17.00 = 591.00 FEET.

FLOW PROCESS FROM NODE 17.00 TO NODE 13.00 IS CODE = 1

>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
 >>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<

=====

TOTAL NUMBER OF STREAMS = 2
 CONFLUENCE VALUES USED FOR INDEPENDENT STREAM 2 ARE:
 TIME OF CONCENTRATION(MIN.) = 8.07
 RAINFALL INTENSITY(INCH/HR) = 2.69
 AREA-AVERAGED Fm(INCH/HR) = 0.06
 AREA-AVERAGED Fp(INCH/HR) = 0.57
 AREA-AVERAGED Ap = 0.10
 EFFECTIVE STREAM AREA(ACRES) = 1.12
 TOTAL STREAM AREA(ACRES) = 1.12
 PEAK FLOW RATE(CFS) AT CONFLUENCE = 2.69

** CONFLUENCE DATA **

STREAM NUMBER	Q (CFS)	Tc (MIN.)	Intensity (INCH/HR)	Fp(Fm) (INCH/HR)	Ap	Ae (ACRES)	HEADWATER NODE
1	4.21	7.06	2.957	0.57(0.06)	0.10	1.6	11.00
1	4.00	8.17	2.669	0.57(0.06)	0.10	1.7	10.00
2	2.69	8.07	2.692	0.57(0.06)	0.10	1.1	14.00

RAINFALL INTENSITY AND TIME OF CONCENTRATION RATIO
 CONFLUENCE FORMULA USED FOR 2 STREAMS.

** PEAK FLOW RATE TABLE **

STREAM NUMBER	Q (CFS)	Tc (MIN.)	Intensity (INCH/HR)	Fp(Fm) (INCH/HR)	Ap	Ae (ACRES)	HEADWATER NODE
1	6.80	7.06	2.957	0.57(0.06)	0.10	2.6	11.00
2	6.71	8.07	2.692	0.57(0.06)	0.10	2.8	14.00
3	6.67	8.17	2.669	0.57(0.06)	0.10	2.8	10.00

COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
 PEAK FLOW RATE(CFS) = 6.80 Tc(MIN.) = 7.06
 EFFECTIVE AREA(ACRES) = 2.59 AREA-AVERAGED Fm(INCH/HR) = 0.06
 AREA-AVERAGED Fp(INCH/HR) = 0.57 AREA-AVERAGED Ap = 0.10
 TOTAL AREA(ACRES) = 2.8
 LONGEST FLOWPATH FROM NODE 14.00 TO NODE 13.00 = 591.00 FEET.

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END OF STUDY SUMMARY:

TOTAL AREA(ACRES) = 2.8 TC(MIN.) = 7.06
 EFFECTIVE AREA(ACRES) = 2.59 AREA-AVERAGED Fm(INCH/HR) = 0.06
 AREA-AVERAGED Fp(INCH/HR) = 0.57 AREA-AVERAGED Ap = 0.100
 PEAK FLOW RATE(CFS) = 6.80

** PEAK FLOW RATE TABLE **

STREAM NUMBER	Q (CFS)	Tc (MIN.)	Intensity (INCH/HR)	Fp(Fm) (INCH/HR)	Ap	Ae (ACRES)	HEADWATER NODE
1	6.80	7.06	2.957	0.57(0.06)	0.10	2.6	11.00
2	6.71	8.07	2.692	0.57(0.06)	0.10	2.8	14.00
3	6.67	8.17	2.669	0.57(0.06)	0.10	2.8	10.00

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END OF RATIONAL METHOD ANALYSIS