Appendix C Preliminary Water Quality Management Plan

Appendix

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Preliminary Water Quality Management Plan (P-WQMP)

Project Name:
Irvine Heritage Community Park Redevelopment Project

Prepared for:

City of Irvine
1 Civic Center Plaza
Irvine, CA 92606
(949) 724-6000

Prepared by:

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February 2023

Preliminary Water Quality Management Plan
(P-WQMP)

This Preliminary Water Quality Management Plan (P-WQMP) for Irvine Heritage Community Park Redevelopment Project has been prepared for the **City or Irvine** by **BKF Engineers**. The P-WQMP is intended to comply with the requirements of the local NPDES Stormwater Program requiring the preparation of the plan.

This project is a street, road, highway or freeway of 5,000 square feet or more of paved surface or an above ground linear lined drainage project. Above ground linear lined drainage projects typically consist of lined vertical or trapezoidal channels. These projects may result in the creation of more than 10,000 square feet of impervious surface and have BMP implementation constraints similar to streets, roads, highways and freeways and must implement similar practices.

The **City of Irvine** 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 current Orange County Drainage Area Management Plan (DAMP) and the intent of the non-point source NPDES Permit for Waste Discharge Requirements for the County of Orange, Orange County Flood Control District and the incorporated Cities of Orange County within the Santa Ana Region. An appropriate number of approved and signed copies of this document shall be available on the subject site in perpetuity.

Public Agency Responsible Manager:			
Name/ Title	Steven Carrillo, Manager of Engineering/City Engineer		
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Signature		Date	

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Section I. Discretionary Permit(s) & Water Quality Conditions

Provide discretionary permit and water quality information. Refer to Section 2.1 in the Technical Guidance Document (TGD) available from the Orange County Stormwater Program (ocwatersheds.com).

Project Infomation	
CIP /Project No.	N/A
Additional Information/ Comments:	Proposed improvements to community park related to recreation, athletic, and education functions.
Water Quality Conditions	
Water Quality Conditions (list verbatim)	Water quality conditions do not apply for this Project.
Watershed-Based Plan Conditions	
Provide applicable conditions from watershed - based plans including WIHMPs and TMDLS.	There are no WIHMPs approved for this watershed based on OC Watersheds. The applicable TMDLs within this watershed include metals, nutrients, pathogens, pesticides, siltation, and priority organics.

Section II. Project Description

II.1. Project Description

Provide a detailed project description including:

- Project Areas: The Project site encompasses ±49 acres, and is a community park in the City of Irvine south of the I-5 Freeway near the intersection of Yale Avenue and Walnut Avenue. The Project site includes the following: Community Park, aquatics center, public library, fine arts center, community center, and fire station.
- Land Uses: The Project landuses relate to recreation (walk, picnic, play), athletic (field, aquatic), education (school, library, arts), circulation (pedestrian, parking), and emergency services (fire).
- Land Cover: The project land cover types include concrete/asphalt walks and parking areas, building structures, and landscaped regions.
- Design Elements: The Project proposes the following new features: community center, play areas, workout areas, picnic areas, pickleball courts, swimming pool, water features, updated pond, expanded library, expanded fine arts center, and parking.
- General Description: The Project will enhance, modernize, and restore the Heritage Community Park following guidelines of the City of Irvine's Park Master Plan adopted in 2017.

Include attributes relevant to determining applicable source controls. *Refer to Section 2.2 in the TGD for information that must be included in the project description.*

Description of Proposed Project	
Development Category (Verbatim from WQMP):	All significant redevelopment projects, where significant redevelopment is defined as the addition or replacement of 5,000 or more square feet of impervious surface on an already developed site. Redevelopment does not include routine maintenance activities that are conducted to maintain original line and grade, hydraulic capacity, original purpose of the facility, or emergency redevelopment activity required to protect public health and safety.
Project Area (ft^2): 2,128,400±	SIC Code: 7999: Amusement and Recreation Services, Not Elsewhere Classified 8211: Elementary and Secondary Schools 8231: Libraries 8412: Museums and Art Galleries

Narrative Project Description:	The Project will include proposed improvements to the existing Heritage Community Park in the City of Irvine. These improvements will serve the community's increasing needs for upgraded recreation, athletic, and education provisions. Portions of the Project interface with Irvine High School. Where this occurs, those areas are included in this Water Quality Management Plan (WQMP). However, the High School's main campus is not undergoing redevelopment and thus is <u>not</u> part of the Project and is <u>not</u> included in this WQMP.			
Project Area	Pervious		Impervious	
	Area (acres or sq ft)	Percentage	Area (acres or sq ft)	Percentage
Pre-Dev. Conditions	33.8 ac	69.1%	15.1 ac	30.9%
Post-Dev. Conditions	27.5 ac	56.2%	21.4 ac	43.8%
Drainage Patterns/Connections	The Project generally drains westerly, and flows are routed by a 42-inch storm line at Walnut Avenue and a 30-inch storm line at Escolar. These lines are tributary to a 74-inch storm line, north of the Project, at Culver Drive and ultimately discharges into an OCFCD Facility (Como Channel).			

II.2. Potential Stormwater Pollutants

Determine and list expected stormwater pollutants based on land uses and site activities. *Refer to Section 2.2.2 and Table 2.1 in the TGD for guidance.*

Pollutants of Concern			
Pollutant	Circle One: E=Expected to be of concern N=Not Expected to be of concern		Additional Information and Comments
Suspended-Solid/ Sediment	E	N	Potential sources: disturbed soils, non-vegetated areas.
Nutrients	E	N	Potential sources: improperly managed landscaping, fertilizers, and eroded soils.
Heavy Metals	E	N	The Project's recreation, athletic, and education functions likely to occur within the Park are not predicted to be a source of heavy metals.

Pathogens (Bacteria/Virus)	E	N	Potential sources: animal fecal waste.
Pesticides	E	N	Potential sources: landscaped areas.
Oil and Grease	E	N	The Project's recreation, athletic, and education functions likely to occur within the Park are not predicted to be a source of oil and grease.
Toxic Organic Compounds	E	N	The Project's recreation, athletic, and education functions likely to occur within the Park are not predicted to be a source of toxic organic compounds.
Trash and Debris	E	N	The Project's recreation, athletic, and education functions likely to occur within the Park are not predicted to be a source of trash and debris.

II.3. Hydrologic Conditions of Concern

Determine if streams located downstream from the project area are determined to be potentially susceptible to hydromodification impacts. *Refer to Section 2.2.3.1 in the TGD.*

☐ No – Show map

☒ Yes – Describe applicable hydrologic conditions of concern below. *Refer to Section 2.2.3 in the TGD.*

For the North Orange County permit area, Hydrologic Conditions of Concern (HCOCs) exist if any streams located downstream from the project are determined to be potentially susceptible to hydromodification impacts and either of the following conditions exists:

- Post-development runoff volume for the 2-year, 24-hour storm exceeds the pre-development runoff volume for the 2-year, 24-hour storm by more than 5 percent.

OR

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

The Project area is ±49 acres and will be 30.9% impervious in pre-development condition and 43.8% impervious in post-development condition.

The calculations apply the Army Corps of Engineers HEC-HMS software and follow the *NRCS Technical Release 55 Urban Hydrology for Small Watersheds* and *Orange County Hydrology Manual* publications. The HEC-HMS calculations determine the pre-development and post-development runoff volumes for each Drainage Management Area (DMA).

A summary of time of concentrations and volumes is tabulated below (next page) for each DMA and calculations from HEC-HMS are included in **Appendix B-1**.

Pre-Development Time of Concentrations and Volumes

DMA ID	Total Area (ac)	Impervious (%)	T_c (min)	Q 2-Yr, 24-Hr (cfs)	Vol 2-Yr, 24-Hr (ft^3)
110	7.82	5.3%	11.0	1.33	13,983
130	6.70	7.8%	8.9	1.34	12,981
210	2.52	73.0%	9.2	2.04	14,680
220	2.23	66.5%	7.8	1.79	12,110
230	3.90	60.7%	8.2	2.85	19,907
240	2.85	60.3%	9.0	1.99	14,462
250	7.75	34.5%	10.4	3.34	27,399
260	4.16	7.7%	9.7	0.82	8,059
270	5.48	4.6%	9.4	0.94	9,583
280	5.44	65.4%	10.6	3.82	29,229
Σ	48.9	30.9%	----	----	----

Results from HEC-HMS modeling, refer to **Appendix B-1**.

Post-Development Time of Concentrations and Volumes

DMA ID	Total Area (ac)	Impervious (%)	T_c (min)	Q 2-Yr, 24-Hr (cfs)	Vol 2-Yr, 24-Hr (ft^3)
110	7.82	42.2%	11.0	3.87	31,233
130	6.70	10.7%	8.9	1.51	14,157
215	2.48	44.4%	9.0	1.34	10,193
225	2.95	77.5%	9.0	2.55	17,990
235	4.29	69.2%	8.2	3.50	24,045
245	2.83	60.9%	9.0	1.98	14,418
255	7.40	50.9%	10.4	4.25	33,323
265	4.26	41.6%	9.6	2.12	16,858
275	4.70	3.6%	9.1	0.77	7,928
280	5.44	66.2%	10.6	3.86	29,490
Σ	48.9	43.8%	----	----	----

Results from HEC-HMS modeling, refer to **Appendix B-1**.

To determine if Hydrologic Conditions of Concern (HCOCs) exist, a comparison for each DMA is computed as follows:

- (Volume 2-Year, Post / Volume 2-Year Pre) ≤ 1.05
- (T_c 2-Year, Post / T_c 2-Year Pre) ≤ 1.05

Based on the comparison, Hydrologic Conditions of Concern (HCOCs) are determined to exist for the following six (6) DMAs (see blue highlighted rows in table below):

1. DMA 110
2. DMA 130
3. DMA 225
4. DMA 235
5. DMA 255
6. DMA 265

Post-Dev. vs. Pre-Dev. Time of Concentrations and Volumes

Pre-Dev. DMA ID	Post-Dev. DMA ID	$T_{c\ Post}/T_{c\ Pre}$	Vol_{Post}/Vol_{Pre}
110	**110**	1.00	**2.23**
130	**130**	1.00	**1.09**
210	215	0.98	0.69
220	**225**	**1.16**	**1.49**
230	**235**	1.00	**1.21**
240	245	1.00	1.00
250	**255**	1.00	**1.22**
260	**265**	1.00	**2.09**
270	275	0.96	0.83
280	280	1.00	1.01

Hydrologic Conditions of Concern (HCOCs) are determined to not exist for DMAs 215, 245, 275, and 280.

II.4. Post Development Drainage Characteristics

Describe post development drainage characteristics. *Refer to Section 2.2.4 in the TGD.*

The Project's post-development condition will not significantly change the drainage patterns of the pre-development condition. The Project onsite area drains westerly through surface flow and captured flow via inlets. The onsite flows are conveyed to a 42-inch stormdrain along Walnut Avenue at the Project's southwestern perimeter and a 30-inch stormdrain along Escolar at the Project's northwestern perimeter. The 42-inch and 30-inch join with a 60-inch sending flows northerly along Walnut Avenue, which connects to a 66-/72-/74-inch stormdrain at Culver Drive and outfalls into Como Channel. Como Channel joins Peters Canyon Channel and San Diego Creek Reach 1 which discharges into Newport Bay and ultimately the Pacific Ocean.

Refer to **Appendix C** for OCFCD Base Map of Drainage Facilities near Irvine Heritage Community Park.

Section III. Site Description

III.1. Physical Setting

Fill out table with relevant information. *Refer to Section 2.3.1 in the TGD.*

Planning Area/ Community Name	PA 11 – El Camino Real (see **Appendix C**)
Location/Address	Irvine Heritage Community Park
	14301 Yale Ave, Irvine, CA 92604
Land Use	Recreation, Educational, Public (see **Appendix C**)
Zoning	1.5 – Recreation, 6.1 – Institutional (see **Appendix C**)
Acreage	±49 acres
Predominant Soil Type	Soil Type C based on NRCS Web Soil Survey (see **Appendix C**)

III.2. Site Characteristics

Fill out table with relevant information and include information regarding BMP sizing, suitability, and feasibility, as applicable. *Refer to Section 2.7.1 in the TGD.*

Ownership of Land Adjacent to Right of Ways	City of Irvine, Irvine Unified School District, Irvine Ranch Water District, Orange County Public Libraries, Orange County Fire Authority
Topography/Longitudinal Slope	The Project site slopes gradually, ranging from 1% to 2%.
Grade differential between road surface and storm drain system.	The grade differential between road and storm drain to be determined.
Soil Type, Geology, and Infiltration Properties	The Project site consists of Soil Type C, specifically Sorrento clay loam per NRCS Web Soil Survey. The site has design infiltration rates of 0.01 inches per hour based on the Geotechnical Investigation Report from 2022 (see **Appendix D**).

Site Characteristics (continued)	
Hydrogeologic (Groundwater) Conditions	The Project has groundwater depths between 10 to 20 feet according to the North Orange County Technical Guidance Document, refer to **Appendix A**, **Figure 8**. Based on the Geotechnical Investigation Report from 2022 (see **Appendix D**), groundwater was not encountered at depths of ±20 feet. Thus, the Geotechnical Report states groundwater is not expected to be encountered during Project construction.
Geotechnical Conditions (relevant to infiltration)	The Project is located in the *Selenium Contamination Area* per the *North Orange County Groundwater Protection Areas*, refer to **Appendix A**, **Figure 10**. Infiltration is not feasible for the Project given the underlying *Contamination Area* and soils low infiltration rate (0.01 inches per hour).
Maintenance Access Considerations	No applicable maintenance access considerations.
Utility and Infrastructure Information	The Project has a 42-inch storm line at Walnut Avenue and a 30-inch storm line at Escolar. Refer to **Appendix C** for a conceptual existing utility exhibit (*illustrative reference only*).

III.3. Watershed Description

Fill out table with relevant information and include information regarding BMP sizing, suitability, and feasibility, as applicable. *Refer to Section 2.3.3 in the TGD.*

Receiving Waters	Como Channel, Peters Canyon Channel, San Diego Creek Reach 1, Upper Newport Bay, Lower Newport Bay
303(d) Listed Impairments	Como Channel – not listed Peters Canyon Channel – DDT, Indicator Bacteria, pH and Toxaphene San Diego Creek Reach 1 – Fecal Coliform, Nutrients, Pesticides, Sedimentation/Siltation, Selenium, and Toxaphene Upper Newport Bay – Chlordane, Copper, DDT, Indicator Bacteria, Metals, Nutrients, Polychlorinated Biphenyls (PCBs), Pesticides, Sediment Toxicity, and Sedimentation/Siltation Lower Newport Bay – Chlordane, Copper, DDT, Indicator Bacteria, Metals, Nutrients, Polychlorinated Biphenyls (PCBs), Pesticides, and Sediment Toxicity

Applicable TMDLs	For the Project watershed, applicable TMDLs include metals, nutrients, pathogens, pesticides, siltation, and priority organics.
Pollutants of Concern for the Project	Pollutants of Concern for the Project include suspended-solid / sediment, nutrients, pathogens (bacteria/virus), and pesticides.
Environmentally Sensitive and Special Biological Significant Areas	The Project is not located within 200 feet of an adjacent Environmentally Sensitive Areas (ESA). Also, there are no Areas of Special Biological Significance (ASBS) in the City of Irvine.

Section IV. Best Management Practices (BMPs)

IV.1. Project Performance Criteria

The Project will incorporate United States Environmental Protection Agency (USEPA) guidance, "Managing Wet Weather with Green Infrastructure: Green Streets" as described in the Model WQMP Appendix B, in a manner consistent with the maximum extent practicable (MEP) standard. This approach includes:

- Selecting LID BMPs that integrate with both the opportunities and constraints of the project site and to attempt to address pollutants of concern and HCOCs,
- Developing innovative stormwater management configurations integrating "green" with "grey" infrastructure,
- Sizing BMPs opportunistically to provide stormwater pollution reduction to the MEP, accounting for the many competing considerations in right of ways.

Describe project performance criteria. This includes:

- If applicable, determine applicable hydromodification control performance criteria. *Refer to Section 7.II-2.4.2.2 of the Model WQMP*
- The standard LID hierarchy described in Section 7.II-2.4.3 of the Model WQMP is not applicable to this project and is replaced by considering all feasible LID approaches listed in the Green Streets manual.
- Calculate the target LID design storm capture volume for the project. The target is that Priority Projects infiltrate, harvest and use, evapotranspire, or biotreat/biofilter, the 85th percentile, 24-hour storm event (Design Capture Volume) *to Section 7.II-2.4.3 of the Model WQMP*

Project Performance Criteria (continued)	
If HCOC exists, list applicable hydromodification control performance criteria (Section 7.II-2.4.2.2 in MWQMP)	Following the North Orange County Model WQMP, evaluation of potential impacts is based on: • Increases in runoff volume • Decreases in infiltration • Changes in time of concentration • Potential for increases in post-development downstream erosion • Potential for adverse downstream impacts on physical structure, aquatic, and riparian habitat For the Project, the 2-year, 24-hour post-development volume exceeds the pre-development volume by more than five (5) percent for six (6) DMAs: DMA 110, DMA 130, DMA 225, DMA 235, DMA 255, and DMA 265. Thus, Hydrologic Conditions of Concern (HCOCs) do exist for these six (6) DMAs.

Calculate target LID design storm capture volume for Project (Section 7.II-2.4.3 from MWQMP).	**Design Capture Volume (DCV):** DCV = C × d × A × 43560 ft^2/ac × 1/12 in/ft C = runoff coefficient = (0.75 × impervious + 0.15) d = storm depth (inches) = 0.75 in – refer to **Appendix A** A = tributary area (acres) **Design Flowrate (Q):** Q = C × i × A C = runoff coefficient = (0.75 × impervious + 0.15) i = rainfall intensity (inches/hour) = 0.23 in/hr (T_c ≈ 10 minutes for all DMAs) – refer to **Appendix B-2** A = tributary area (acres) Refer to **Appendix B-2** for BMP Calculations.

DMA ID [1]	A (ac)	Imp (%)	DCV [2] (ft^3)	Q [3] (cfs)
110	7.82	42.2%	9,942	0.84
130	6.70	10.7%	4,195	0.35
215	2.48	44.4%	3,261	0.28
225	2.95	77.5%	5,871	0.50
235	4.29	69.2%	7,814	0.66
245	2.83	60.9%	4,677	0.40
255	7.40	50.9%	10,718	0.91
265	4.26	41.6%	5,358	0.45
275	4.70	3.6%	2,265	0.19
280	5.44	66.2%	9,582	0.81
Σ	48.9	43.8%	----	----

Notes:

[1] Blue Highlighted rows indicate DMAs in which Hydrologic Conditions of Concern (HCOCs) do exist.

[2] Design Capture Volume (DCV) for 85th percentile, 24-hour storm event.

[3] Design Flowrate (Q) for 85th percentile, 24-hour storm event.

2-Year, 24-hour Storm Event:

Refer to **Appendix B-1** for Delta 2-Year Volume calculations.

Delta 2-Year Volume = Post-Dev $Vol_{2\text{-Year}}$ – Pre-Dev. $Vol_{2\text{-Year}}$

DMA ID [1]	DCV_{85th} [1] (ft^3)	$DCV_{\Delta 2\text{-Year}}$ [2] (ft^3)
110	9,942	**17,250**
130	**4,195**	1,176
225	5,871	**5,880**
235	**7,814**	4,138
255	**10,718**	5,924
265	5,358	**8,799**

Notes:

[1] Design Capture Volume (DCV) for 85th percentile, 24-hour storm event.

[2] Design Capture Volume (DCV) for Delta 2-Year Volume.

IV.2. Site Design & Drainage Plan

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 is designed to allow BMPs to be incorporated to the MEP.
- A table of DMA characteristics and list of LID BMPs proposed in each DMA.
- Reference to the WQMP plot plan.
- A listing of GIS coordinates for LID BMPs (unless not required by local jurisdiction).

Refer to Section 2.4.2 in the TGD.

Site Design

The ±49-acre Project site is located in the City of Irvine south of the I-5 Freeway near the intersection of Yale Avenue and Walnut Avenue. The Project site includes a Community Park, aquatics center, public library, fine arts center, community center, and fire station.

The Project will improve the Irvine Heritage Community Park by providing for recreation, athletic, and education services. The proposed site improvements include community center, play areas, workout areas, picnic areas, pickleball courts, swimming pool, water features, updated pond, expanded library, expanded fine arts center, and parking.

The proposed Project improvements will mimic existing drainage patterns. Onsite flows will be routed to proposed BMPs (bioretention basins and Filterra boxes) before discharging to the offsite stormdrain system.

A vicinity map for the Project is included on **Figure 1** in **Appendix A**.

DMAs

The Project's Drainage Management Areas (DMAs) are delineated on **Figure 2** in **Appendix A** and summarized in the table below.

DMA ID	DMA Area	Impervious	Description
110	7.82 ac	42.2%	Irvine High School, existing baseball field, proposed parking lot
130	6.70 ac	10.7%	Irvine High School, existing baseball and soccer fields, proposed pickleball courts
215	2.48 ac	44.4%	Irvine High School, proposed parking
225	2.95 ac	77.5%	Irvine High School, proposed parking
235	4.29 ac	69.2%	Community Park, proposed community center
245	2.83 ac	60.9%	Community Park, proposed surface improvements
255	7.40 ac	50.9%	Community Park, existing pond, existing basketball courts, proposed fine arts center
265	4.26 ac	41.6%	Community Park, proposed swimming pool, proposed picnic area
275	4.70 ac	3.6%	Community Park, proposed surface improvements
280	5.44 ac	66.2%	Community Park, proposed library, existing fire station

BMPs

The Project will implement bioretention basins and Filterra boxes for treating the 85th percentile, 24-hour storm. Additionally, bioretention basins will retain the delta 2-year, 24-hour runoff volume for drainage areas in which Hydrologic Conditions of Concern (HCOCs) exist. The BMPs for the Project are shown graphically on **Figure 3** in **Appendix A** and summarized in the table below (next page).

Refer to **Appendix B-2** for sizing calculations of bioretention basins and Filterra boxes.

Bioretention Basins

Bioretention basins are vegetated shallow reservoirs which filter runoff through roots and engineered soil mix. The Project's proposed bioretention basins will be designed accordingly:

- 12 inches ponding
- 3 inches mulch
- 24 inches minimum soil media
- 12 inches minimum gravel
- 6-inch PVC underdrain
- Geomembrane line (minimum thickness = 30 mils)
- 3:1 side slopes

Refer to **Appendix F** for *Bioretention BMP Fact Sheet* from the North Orange County Technical Guidance Document.

Filterra Boxes

Contech Filterra units are considered "proprietary biotreatment". Proprietary biotreatment are devices manufactured to simulate natural systems and provide treatment at higher flowrates or higher volumes and with smaller footprints than their natural counterparts.

Refer to **Appendix F** for *Proprietary Biotreatment BMP Fact Sheet* from the North Orange County Technical Guidance Document.

Filterra is an engineered small-footprint, high-performance bioretention system for developed urban sites. For additional Contech Filterra details, refer to **Appendix G**.

DMA ID	Area	BMP ID(s)	BMP Type
110	7.82 ac	110.1	One Bioretention Basin $A_{BioBasin}$ = ±10,781 ft^2
130	6.70 ac	130.1	One Bioretention Basin $A_{BioBasin}$ = ±2,622 ft^2
215	2.48 ac	215.1,215.2	Two Filterra Boxes 12' x 6' Box (each)
225	2.95 ac	225.1	One Bioretention Basin $A_{BioBasin}$ = ±3,675 ft^2
235	4.29 ac	235.1	One Bioretention Basin $A_{BioBasin}$ = ±4,884 ft^2
245	2.83 ac	245.1,245.2	Two Filterra Boxes 13' x 7' Box (each)
255	7.40 ac	255.1,255.2,255.3,255.4	Four Bioretention Basins $A_{BioBasin}$ = ±1,675 ft^2 (each)
265	4.26 ac	265.1	One Bioretention Basin $A_{BioBasin}$ = ±5,499 ft^2
275	4.70 ac	275.1	One Bioretention Basin $A_{BioBasin}$ = ±1,416 ft^2
280	5.44 ac	280.1,280.2,280.3,280.4	Four Filterra Boxes 13' x 7' Box (each)

IV.3. LID BMP Selection & Project Conformance Analysis

IV.3.1. Green Street / Linear Project BMPs

The following is a list of potential BMPs that may be applicable. Check the BMPs included. *Refer to 2.7.2 in the TGD.*

Name	Included?
Street trees (canopy interception)	☐
Stormwater Curb Extensions / Stormwater Planters	☐
Bioretention Areas	☒
Permeable Pavement	☐
Permeable Friction Course Overlays	☐
Vegetated Swales (compost amended were possible)	☐
Filter strips (amended road shoulder)	☐
Proprietary Biotreatment (Contech Filterra)	☒
Infiltration Trench	☐
Cartridge Media Filters	☐
WSDOT Media Filter Drains	☐
Other:	☐
Other:	☐
Other:	☐

Describe how the selected BMPs conform to the North Orange County Permit requirement to implement Green Streets in a manner consistent with the MEP standard. Show calculations below to demonstrate how much of the LID Design Capture Volume can be met with the selected BMPs. Where the BMPs cannot be designed to capture the entire DCV, provide a narrative explanation(s) of constraining factors that prevented full capture from being achieved.

The Irvine Heritage Community Park Project's BMPs will conform to the North Orange County Permit through the following:

- Apply BMPs to manage the Project's pollutants of concern and Hydrologic Conditions of Concern (HCOCs)
- Create stormwater systems to synchronize "green" and "grey" infrastructure
- Develop BMPs to remove pollutants to the maximum extent practicable (MEP)

The Project's BMPs will aim to achieve 80 percent average annual capture efficiency.

The Project's bioretention basins will be sized to handle the Design Capture Volume (DCV). The Project's Filterra boxes will be sized to handle the Design Flowrate (Q) of the 85^{th} percentile, 24-hour storm.

For DMAs in which Hydrologic Conditions of Concern (HCOCs) exist, bioretention basins are sized accordingly.

- For delta 2-year volume > 85^{th} percentile volume, sizing criteria based on DCV = Delta 2-Year
- For 85^{th} percentile volume > delta 2-year volume, sizing criteria based on DCV = 85^{th} Percentile

IV.3.2. Hydromodification Control BMPs

Describe hydromodification control BMPs. *See Section 5 TGD*. Include sections for selection, suitability, sizing, and infeasibility, as applicable. Detail compliance with Prior Conditions of Approval.

Hydrologic Conditions of Concern (HCOCs) are determined to exist for six (6) DMAs, which includes DMA 110, DMA 130, DMA 225, DMA 235, DMA 255, and DMA 265. These DMAs drain to bioretention facilities which will provide retention of the delta 2-year, 24-hour runoff volume.

To address Hydrologic Conditions of Concern (HCOCs), the Project's bioretention basins will provide adequate runoff retention volume to meet the following hydromodification control: post-development 2-year, 24-hour runoff volume does not exceed pre-development by more than 5%.

Hydromodification Control BMPs	
BMP Name	**BMP Description**
110.1	Drains DMA 110; bioretention basin facility with approximate treatment area of 10,781 square feet.
130.1	Drains DMA 130; bioretention basin facility with approximate treatment area of 2,622 square feet
225.1	Drains DMA 225; bioretention basin facility with approximate treatment area of 3,675 square feet
235.1	Drains DMA 235; bioretention basin facility with approximate treatment area of 4,884 square feet
255.1	Drains portion of DMA 255; bioretention basin facility with approximate treatment area of 1,675 square feet
255.2	Drains portion of DMA 255; bioretention basin facility with approximate treatment area of 1,675 square feet
255.3	Drains portion of DMA 255; bioretention basin facility with approximate treatment area of 1,675 square feet
255.4	Drains portion of DMA 255; bioretention basin facility with approximate treatment area of 1,675 square feet
265.1	Drains DMA 265; bioretention basin facility with approximate treatment area of 5,499 square feet

IV.3.3. Non-structural Source Control BMPs

Fill out non-structural source control check box forms or provide a brief narrative explaining if non-structural source controls were not used.

Non-Structural Source Control BMPs				
Identifier	**Name**	**Check One**		**If not applicable, state brief reason**
		Included	**Not Applicable**	
N3	Right-of-Way Landscape Management	☒	☐	
N4	BMP Maintenance	☒	☐	
N11	Right-of-Way Litter Control	☒	☐	
N12	Employee Training	☒	☐	
N14	Right-of-Way Catch Basin Inspection	☒	☐	
N15	Street Sweeping	☒	☐	

N3 Right-of-Way Landscape Management
Identify and develop routine landscape maintenance requirements that are consistent with those in the County Water Conservation Resolution (or City equivalent) that include fertilizers and/or pesticide usage consistent with Management Guidelines for Use of Fertilizers.

N4 BMP Maintenance
The Project WQMP will identify responsibility for implementation of all non-structural BMPs and scheduled cleaning and/or maintenance of all structural BMPs.

N11 Right-of-Way Litter Control
The owner/POA will contract with their landscape maintenance firms to provide regular scheduled maintenance which includes trash patrolling, trash receptacle emptying, and trash disposal violation reporting.

N12 Employee Training
Education programs applicable to future employees. Developer prepares manual(s) providing information on practices that contribute to the protection of stormwater quality.

N14 Right-of-Way Catch Basin Inspection
Storm drain facilities will be inspected, cleaned, and maintained on an annual basis. Facility cleaning will occur in late summer or early fall, prior to the start of the rainy season and annual maintenance records will be documented.

N15 Street Sweeping
Perform sweeping of streets and parking lots in late summer or early fall, prior to the start of the rainy season or equivalent as required by the governing jurisdiction.

IV.3.4. Structural Source Control BMPs

Fill out structural source control check box forms or provide a brief narrative explaining if structural source controls were not used.

Structural Source Control BMPs				
Identifier	**Name**	**Check One**		**If not applicable, state brief reason**
		Included	**Not Applicable**	
S1	Provide storm drain system stenciling and signage	☒	☐	
S4	Use efficient irrigation systems & landscape design, water conservation, smart controllers, and source control	☒	☐	
S5	Protect slopes and channels and provide energy dissipation	☐	☒	Does not apply to Project site.
S12	Hillside landscaping	☐	☒	Does not apply to Project site.

S-1 Provide Storm Drain Stenciling and Signage
Storm drain stencils are highly visible source control messages placed directly adjacent storm drain inlets. The stencils include a statement which prohibits the dumping of illegal materials into the municipal storm drain system. Graphical icons, either illustrating anti-dumping symbols or images of receiving water fauna, are effective supplements to the anti-dumping message. Stencils and signs inform the public the destination of pollutants discharged into stormwater. The following requirements should be included in the project design and shown on the project plans:

1. Provide stenciling or labeling of all storm drain inlets and catch basins, constructed or modified, within the project area with prohibitive language (such as: *NO DUMPING - DRAINS TO OCEAN*) and/or graphical icons to prevent illegal dumping.
2. Post signs and prohibitive language and/or graphical icons, which prohibit illegal dumping at public access points along channels and creeks within the project area.
3. Maintain legibility of stencils and signs.

S-4 Use Efficient Irrigation Systems and Landscape Design
The Project will design timing and application methods of irrigation water to reduce the runoff of excess irrigation water into the municipal storm system. The following methods to reduce excessive irrigation runoff will be considered, and integrated on areas of development where determined applicable and feasible:

1. Employing rain shutoff devices to prevent irrigation after storm events.

2. Designing irrigation systems for each landscape area's specific water requirements.
3. Utilizing flow reducers or shutoff valves triggered by a pressure drop to manage water loss in the event of damaged sprinkler heads or lines.
4. Applying a landscape plan consistent with County Water Conservation Resolution or City equivalent, which may include provision of water sensors, programmed irrigation times (for short cycles), etc.
5. The timing and application methods of irrigation water shall be designed to reduce the runoff of excess irrigation water into the municipal storm system.
6. Applying other comparable, equally effective, methods to reduce irrigation water runoff.
7. Consolidate plants with similar water requirements to reduce excess irrigation runoff and increase surface infiltration. Select plants with low irrigation requirements (i.e. native or drought tolerant species). Consider other design features, including:
    - Apply mulches (such as wood chips or shredded wood products) in planter areas without ground cover to minimize sediment in runoff.
    - Install appropriate plant materials for the location, in accordance with amount of sunlight and climate, and use native plant material where possible and/or as suggested by the landscape architect.
    - Create a vegetative barrier along the property boundary and interior watercourses to serve as a pollutant filter, where applicable and feasible.
    - Select plants that minimize or eliminate the use of fertilizer or pesticides to sustain growth.

S5 Protect Slopes and Channels
Projects will protect slopes and channels as described in *Section 3.4* of the North Orange County Technical Guidance Document.

S12 Site Design and Landscape Planning (Hillside Landscaping)
Hillside areas that are disturbed by project development will be landscaped with deep-rooted, drought tolerant plant species selected for erosion control, satisfactory to the local permitting authority.

Section V. Inspection/Maintenance Responsibility for BMPs

Fill out information in table below. Prepare and attach an Operation and Maintenance Plan. Identify the mechanism through which BMPs will be maintained. Inspection and maintenance records must be kept for a minimum of five years for inspection by the regulatory agencies. *Refer to Section 7.II 4.0 in the Model WQMP.*

BMP Inspection/Maintenance			
BMP	**Reponsible Department / Party(s)**	**Inspection/ Maintenance Activities Required**	**Minimum Frequency of Activities**
Bioretention Basin BMPs	City of Irvine	Prune and remove any dead plant material. Replace dead plants and plants with high mortality rates. Perform weeding.	Semi-Annually
		Remove sediment and debris near inlets and outlets to prevent clogging.	Semi-Annually
		Replace 1 to 2 inches of mulch. Replace more frequently in areas of heavy metal deposition.	Annually
		Analyse soil for fertility and pollutant processing capability, especially in areas of high nutrient and pesticides usage.	Annually
		Inspect flow entrances and overflow risers. Repair structural damage. Clean out underdrain.	Annually

Filterra BMPs	City of Irvine	Inspect individual unit and surrounding area to observe standing water, damage to box, or damage to grate. Repair damaged structures.	Semi-Annually
		Remove grates to remove silt, debris, and trash. Add Filterra media as needed. Check distance from top of media to top of slab. Replace grates.	Semi-Annually
		Examine planting health and condition. Prune plantings to achieve ideal growth.	Semi-Annually

The Irvine Heritage Community Park Redevelopment Project's Operation and Maintenance Plan for BMPs (bioretention basins and Filterra boxes) will be included with the Project's Final Water Quality Management Plan (WQMP).

BMP Inspection/Maintenance			
BMP	**Reponsible Department/ Party(s)**	**Inspection/ Maintenance Activities Required**	**Minimum Frequency of Activities**
N3 Right-of-Way Landscape Management	City of Irvine	Perform appropriate maintenance activities including mowing, weeding, and pruning. Remove non-native vegetation and dispose of plant cuttings. Compost collected vegetation and reduce use of high nitrogen fertilizers.	Semi-Annually
N4 BMP Maintenance	City of Irvine	Perform proper inspection of BMPs. Maintain efficient operation of BMPs through trash/sediment/debris removal and vegetation upkeep.	Annually
N11 Right-of-Way Litter Control	City of Irvine	Perform trash patrol duties with appropriate handling and dumping. Report trash disposal violations to the City. Promote safe housekeeping practises for potentially harmful materials (fertilizers, cleaning solutions, swimming pool chemicals, etc.).	Monthly, Per Existing City Maintenance Guidelines
N12 Employee Training	City of Irvine	Offer environmental awareness educational resources to employees.	Annually
N14 Right-of-Way Catch Basin Inspection	City of Irvine	Inspect inlet facilities for structural integrity and clean/sweep area prior to wet season.	Annually and After Major Storms

N15 Street Sweeping	City of Irvine	Conduct regular scheduled sweeping to remove trash/sediment/debris. Avoid wet weather sweeping if feasible. Inspect catch basin inlets and repair any structural deterioration.	Monthly, Per Existing City Maintenance Guidelines
S-1 Provide Storm Drain Stenciling and Signage	City of Irvine	Inspect stencilling and signage to ensure message is visible and not damaged. No specific maintenance applies.	Annually
S4 Use Efficient Irrigation Systems and Landscape Design	City of Irvine	Include maintenance tasks to support water conservation. Apply effective planting practices and confirm proper irrigation equipment operations. Inspect irrigation systems to prevent water loss due to broken sprinkler heads or lines.	Annually and After Major Storms

Section VI. Site Plan & Drainage Plan

VI.1. Site & 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 BMP locations
- Drainage delineations and flow information
- Drainage connections
- BMP details

The following figures are included in **Appendix A**:

The Project location is shown on **Figure 1**
The Project site boundary and drainage delineations is shown on **Figure 2**.
The Project's layout of BMPs (bioretention basins and Filterra boxes) is shown on **Figure 3**.

Appendix A.

Figures

Plot Feb 01, 2023 at 6:07pm

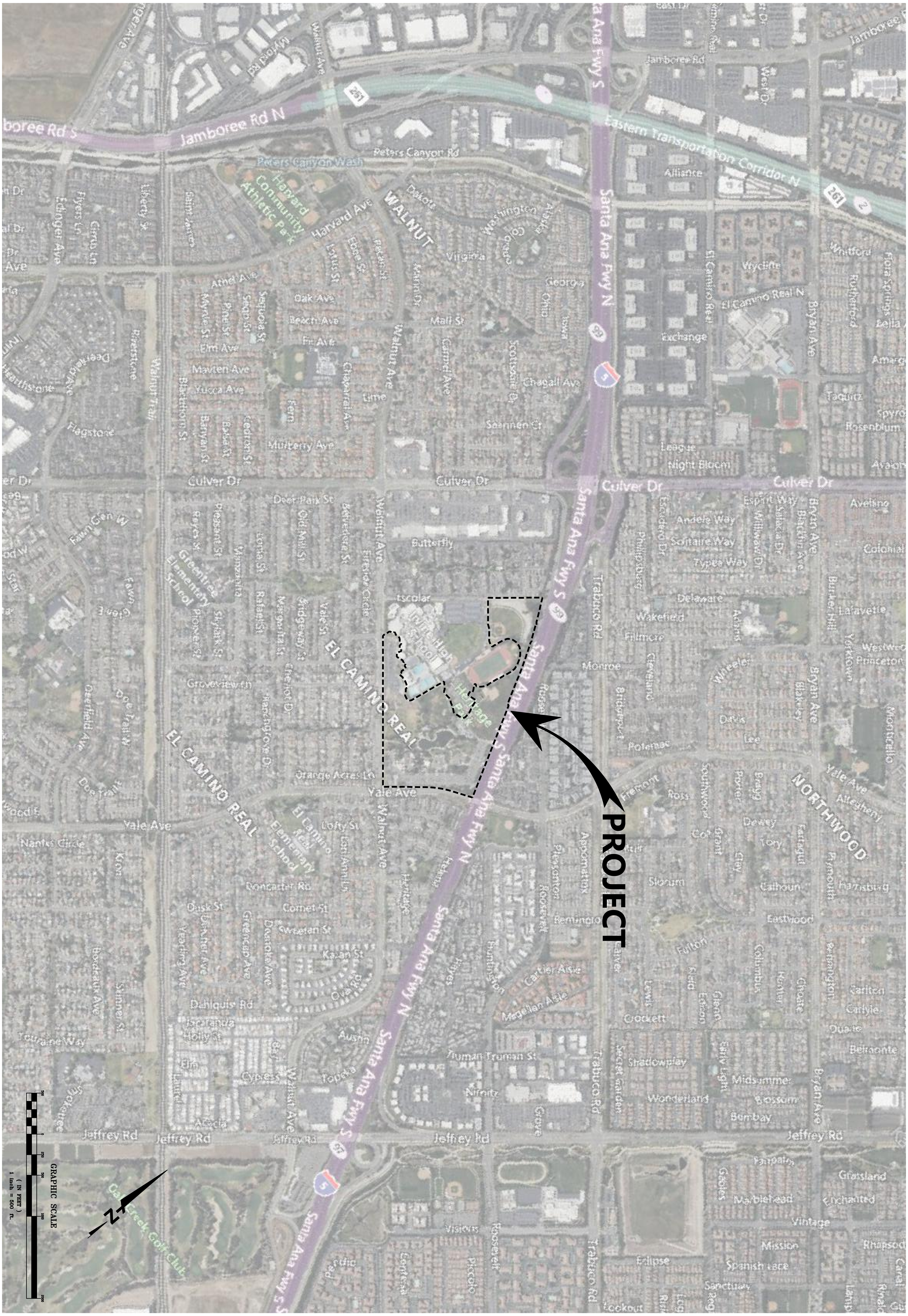


FIGURE 1	
Date: 2/1/2023	
Scale: AS SHOWN	
Design:	
Drawn:	
Approved:	
Job No: 20180780	

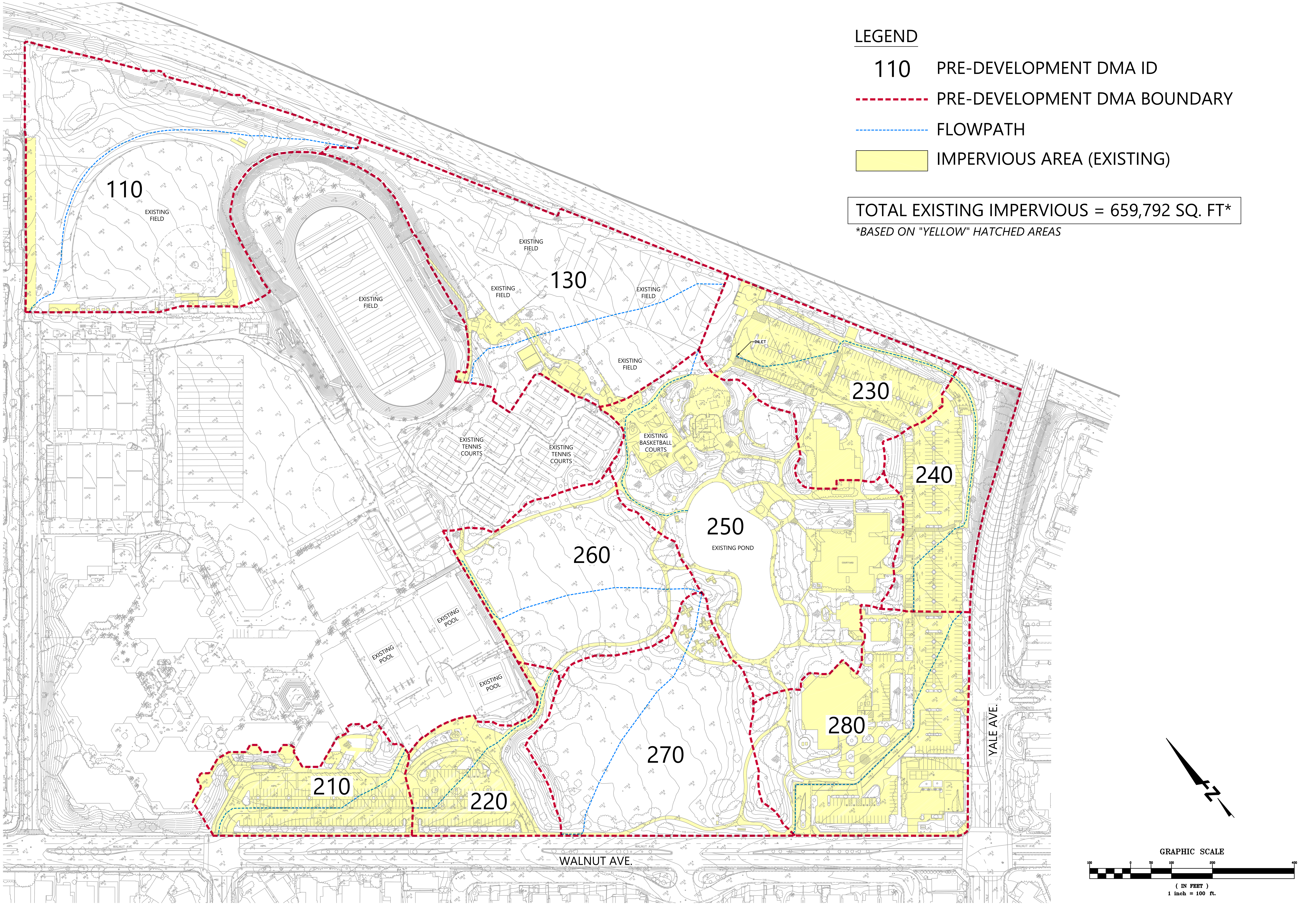
No.	Revisions

HERITAGE COMMUNITY PARK
APN 988-471-02
14301 YALE AVE., IRVINE, CA 92604

PROJECT VICINITY MAP

PRELIMINARY WATER QUALITY MANAGEMENT PLAN (P-WQMP)

BKF
BKF ENGINEERS
4675 MACARTHUR CT.
SUITE 400
NEWPORT BEACH, CA 92660
(949) 526-8460
www.bkf.com



BKF ENGINEERS
4675 MACARTHUR CT.
SUITE 400
NEWPORT BEACH, CA 92660
(949) 526-8460
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PRELIMINARY WATER QUALITY MANAGEMENT PLAN (P-WQMP)

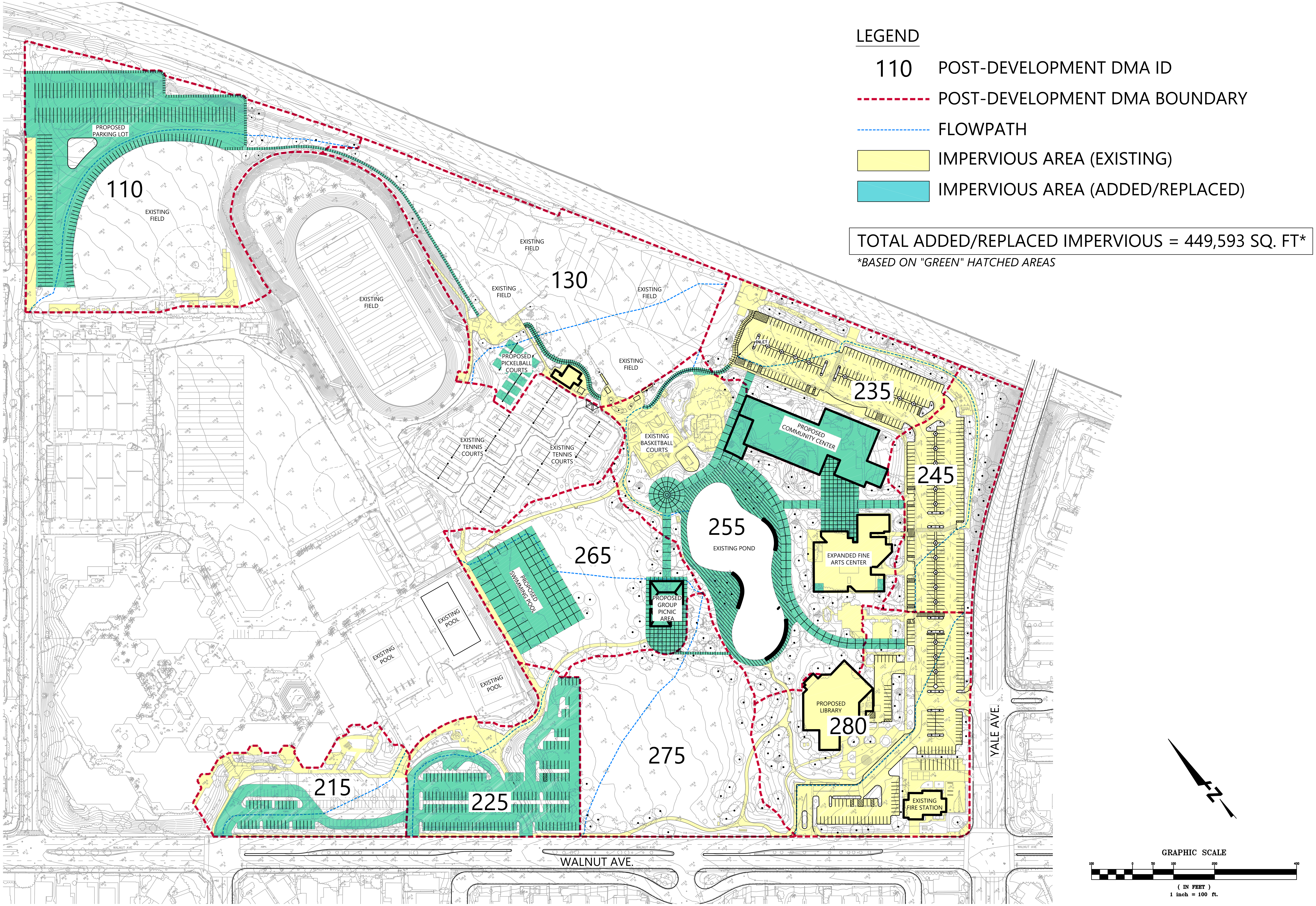
HERITAGE COMMUNITY PARK
APN 988-471-02
14301 YALE AVE., IRVINE, CA 92604

PROJECT SITE & DRAINAGE MAP: PRE-DEVELOPMENT

Revisions
No.

Date: 2/1/2023
Scale: AS SHOWN
Design:
Drawn:
Approved:
Job No: 20180780

FIGURE
2-1



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NEWPORT BEACH, CA 92660
(949) 526-8460
www.bkf.com

PRELIMINARY WATER QUALITY MANAGEMENT PLAN (P-WQMP)

HERITAGE COMMUNITY PARK
APN 988-471-02
14301 YALE AVE., IRVINE, CA 92604

PROJECT SITE & DRAINAGE MAP: POST-DEVELOPMENT

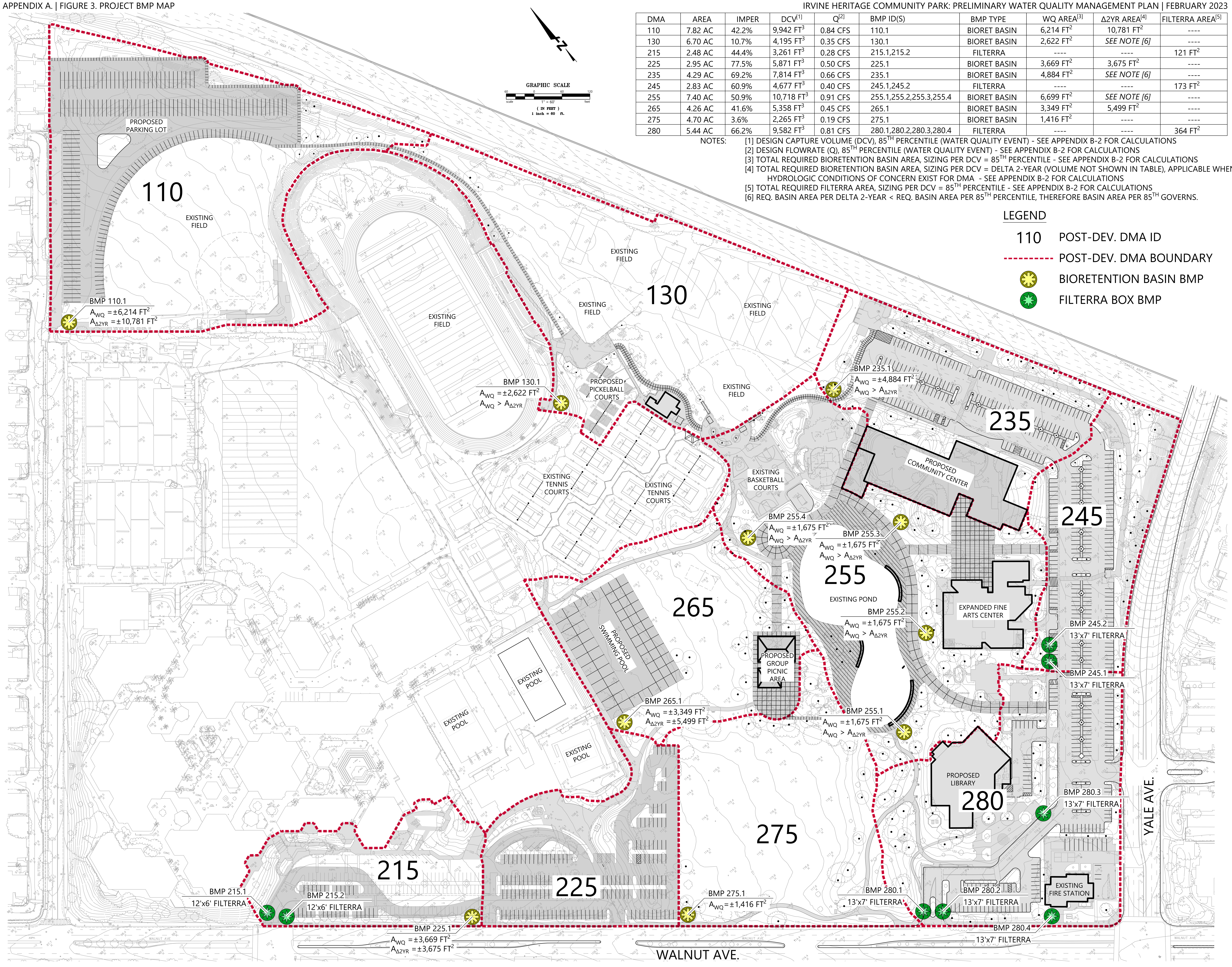
Revisions

Date: 2/1/2023
Scale: AS SHOWN
Design:
Drawn:
Approved:
Job No: 20180780

FIGURE 2-2

DMA	AREA	IMPER	DCV[1]	Q[2]	BMP ID(S)	BMP TYPE	WQ AREA[3]	Δ2YR AREA[4]	FILTERRA AREA[5]
110	7.82 AC	42.2%	9,942 FT^3	0.84 CFS	110.1	BIORET BASIN	6,214 FT^2	10,781 FT^2	----
130	6.70 AC	10.7%	4,195 FT^3	0.35 CFS	130.1	BIORET BASIN	2,622 FT^2	*SEE NOTE [6]*	----
215	2.48 AC	44.4%	3,261 FT^3	0.28 CFS	215.1,215.2	FILTERRA	----	----	121 FT^2
225	2.95 AC	77.5%	5,871 FT^3	0.50 CFS	225.1	BIORET BASIN	3,669 FT^2	3,675 FT^2	----
235	4.29 AC	69.2%	7,814 FT^3	0.66 CFS	235.1	BIORET BASIN	4,884 FT^2	*SEE NOTE [6]*	----
245	2.83 AC	60.9%	4,677 FT^3	0.40 CFS	245.1,245.2	FILTERRA	----	----	173 FT^2
255	7.40 AC	50.9%	10,718 FT^3	0.91 CFS	255.1,255.2,255.3,255.4	BIORET BASIN	6,699 FT^2	*SEE NOTE [6]*	----
265	4.26 AC	41.6%	5,358 FT^3	0.45 CFS	265.1	BIORET BASIN	3,349 FT^2	5,499 FT^2	----
275	4.70 AC	3.6%	2,265 FT^3	0.19 CFS	275.1	BIORET BASIN	1,416 FT^2	----	----
280	5.44 AC	66.2%	9,582 FT^3	0.81 CFS	280.1,280.2,280.3,280.4	FILTERRA	----	----	364 FT^2

NOTES:
[1] DESIGN CAPTURE VOLUME (DCV), 85^{TH} PERCENTILE (WATER QUALITY EVENT) - SEE APPENDIX B-2 FOR CALCULATIONS
[2] DESIGN FLOWRATE (Q), 85^{TH} PERCENTILE (WATER QUALITY EVENT) - SEE APPENDIX B-2 FOR CALCULATIONS
[3] TOTAL REQUIRED BIORETENTION BASIN AREA, SIZING PER DCV = 85^{TH} PERCENTILE - SEE APPENDIX B-2 FOR CALCULATIONS
[4] TOTAL REQUIRED BIORETENTION BASIN AREA, SIZING PER DCV = DELTA 2-YEAR (VOLUME NOT SHOWN IN TABLE), APPLICABLE WHEN HYDROLOGIC CONDITIONS OF CONCERN EXIST FOR DMA - SEE APPENDIX B-2 FOR CALCULATIONS
[5] TOTAL REQUIRED FILTERRA AREA, SIZING PER DCV = 85^{TH} PERCENTILE - SEE APPENDIX B-2 FOR CALCULATIONS
[6] REQ. BASIN AREA PER DELTA 2-YEAR < REQ. BASIN AREA PER 85^{TH} PERCENTILE, THEREFORE BASIN AREA PER 85^{TH} GOVERNS.



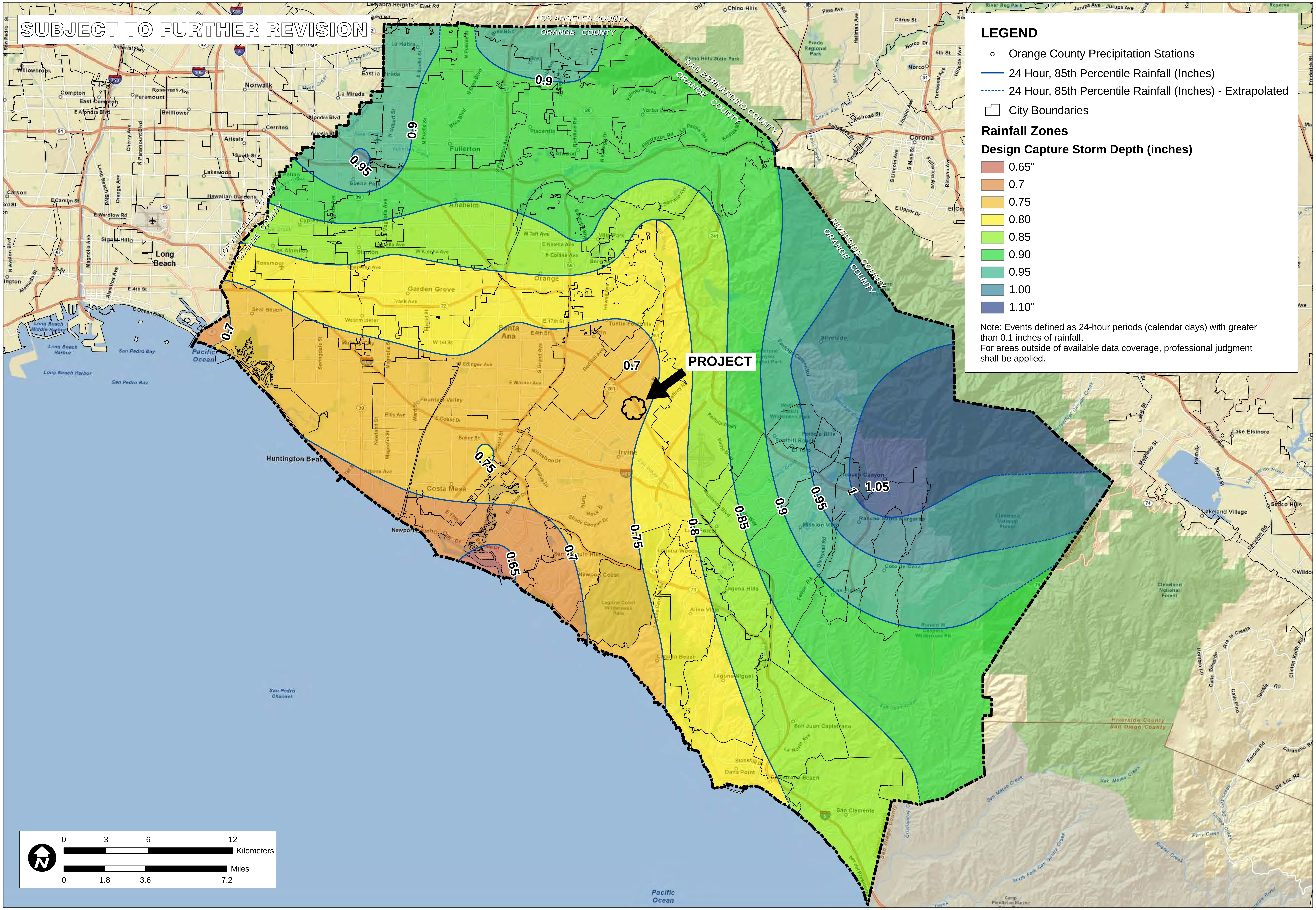
BKF ENGINEERS

PRELIMINARY WATER QUALITY MANAGEMENT PLAN (P-WQMP)

HERITAGE COMMUNITY PARK
APN 988-471-02
14301 YALE AVE, IRVINE, CA 92604

PROJECT BMP MAP

FIGURE 3



TITLE

RAINFALL ZONES

JOB

ORANGE COUNTY TECHNICAL GUIDANCE DOCUMENT

ORANGE CO. CA

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

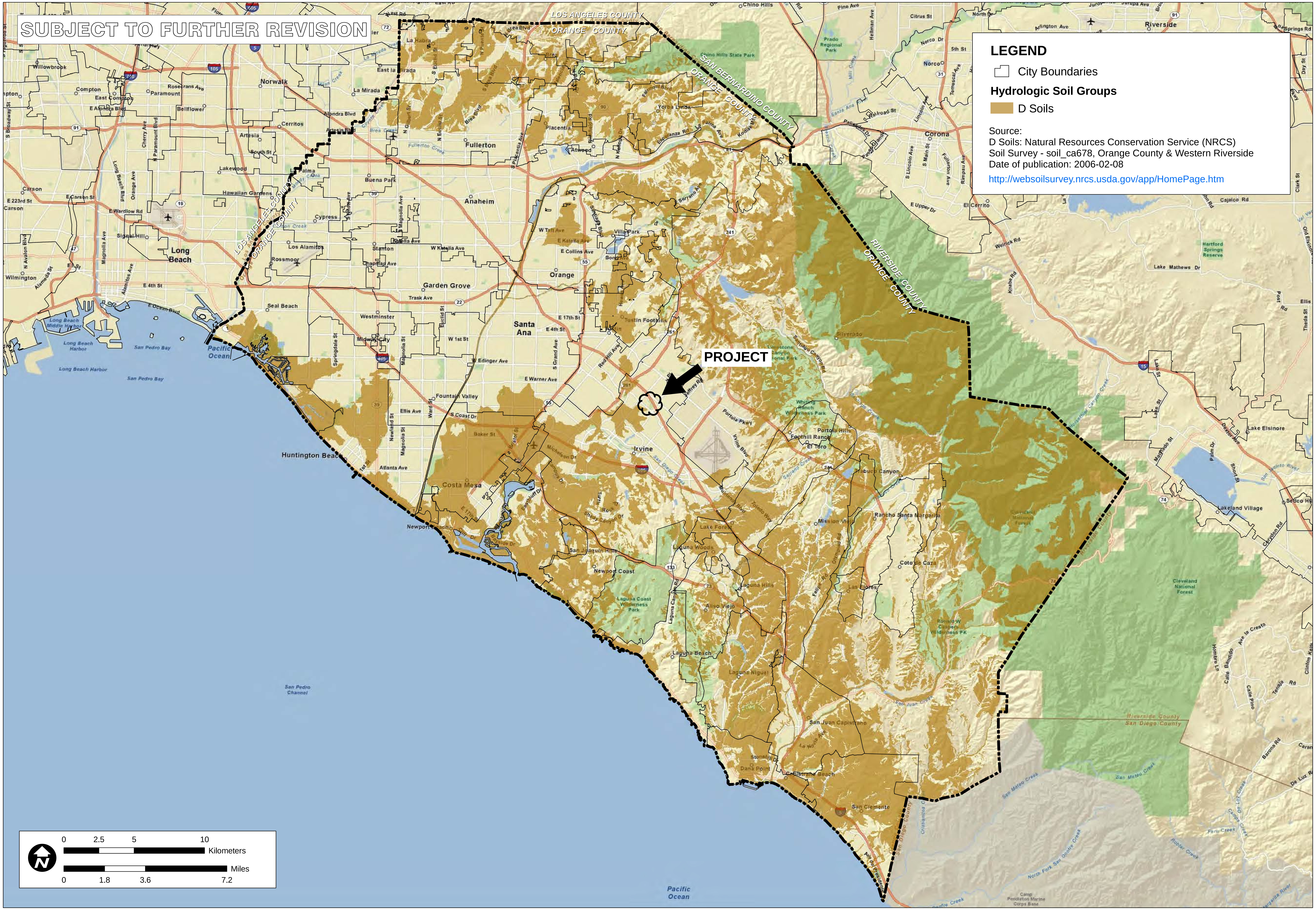
PACE Advanced Water Engineering

FIGURE

XVI-1

P:\9526E\6-GIS\Mxds\Reports\InfiltrationFeasability_20110215\9526E_FigureXVI-1_RainfallZones_20110215.mxd

P:\9526E\6-GIS\Mxds\Reports\InfiltrationFeasability_20110215\9526E_FigureXVI-2a_HydroSoils_20110215.mxd



TITLE
HYDROLOGIC SOIL GROUP
TYPE D NRCS SOIL SURVEY

JOB
ORANGE COUNTY
INFILTRATION STUDY
ORANGE CO. CA

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

PACE
Advanced Water Engineering

FIGURE
XVI-2b

P:\9526E\6-GIS\Mxds\Reports\InfiltrationFeasability_20110215\9526E_FigureXVI-2b_D-Soils_20110215.mxd

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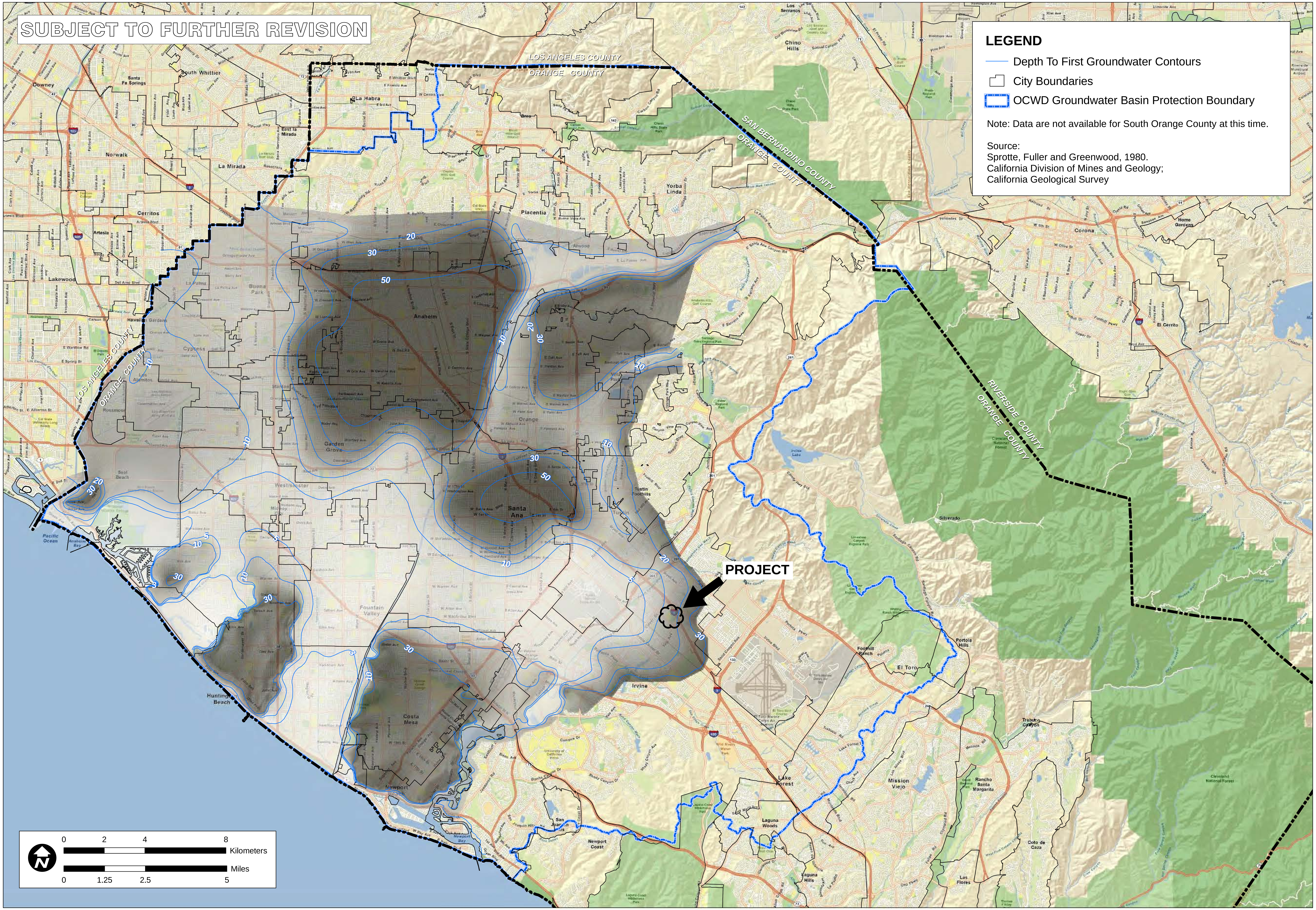

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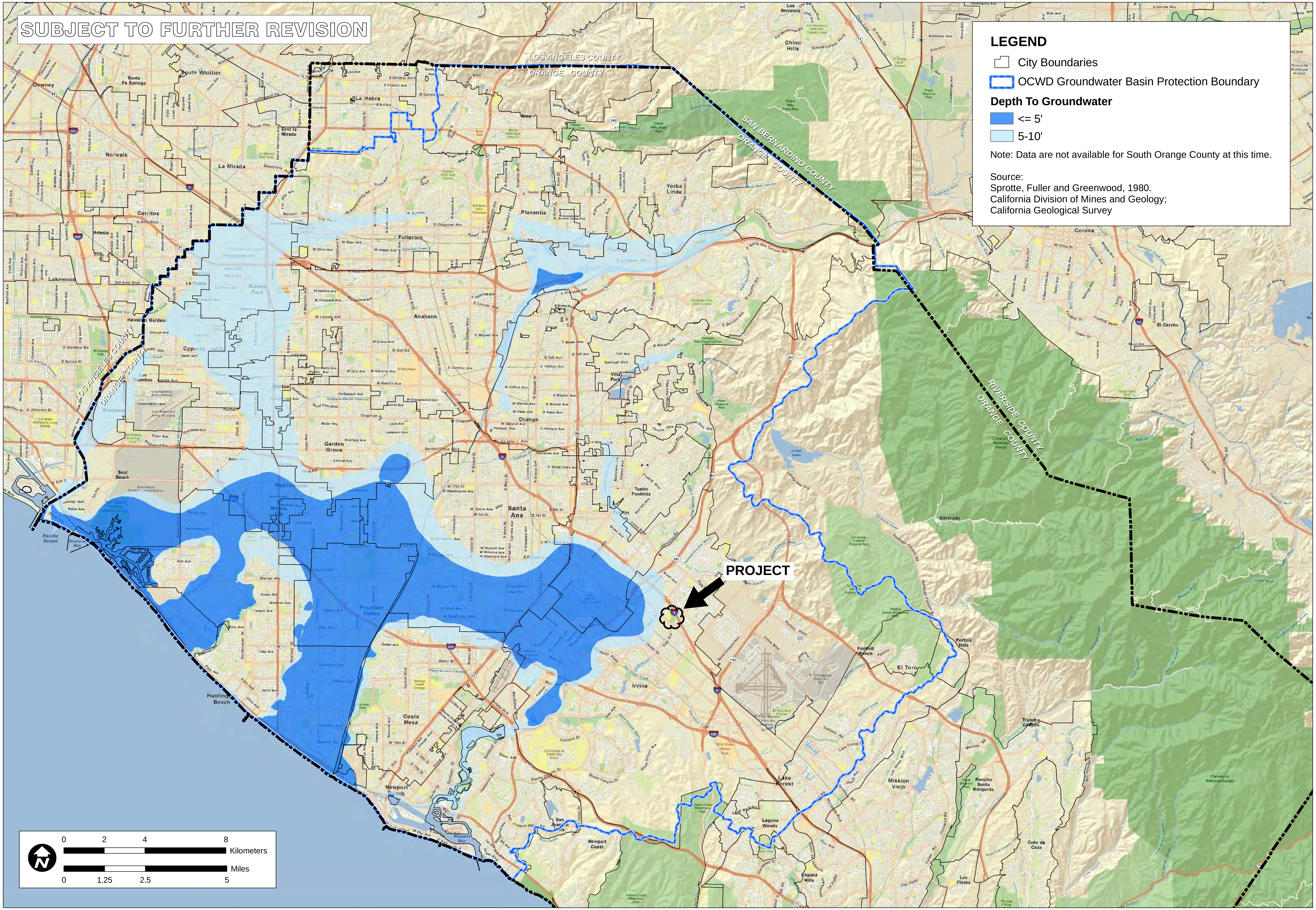
TITLE	NORTH ORANGE COUNTY MAPPED DEPTH TO FIRST GROUNDWATER
JOB	ORANGE COUNTY INFILTRATION STUDY — ORANGE CO. CA
SCALE	1" = 1.25 miles
DESIGNED	TH
DRAWING	TH
CHECKED	BMP
DATE	02/09/11
JOB NO.	9526-E

PACE Advanced Water Engineering

FIGURE XVI-2d



P:\9526E\6-GIS\Mxds\Reports\InfiltrationFeasability_20110215\9526E_FigureXVI-2e_DepthToGroundwater15ft_20110215.mxd

NORTH ORANGE COUNTY MAPPED SHALLOW GROUNDWATER

TITLE

ORANGE COUNTY INFILTRATION STUDY

CA

ORANGE CO.

JOB

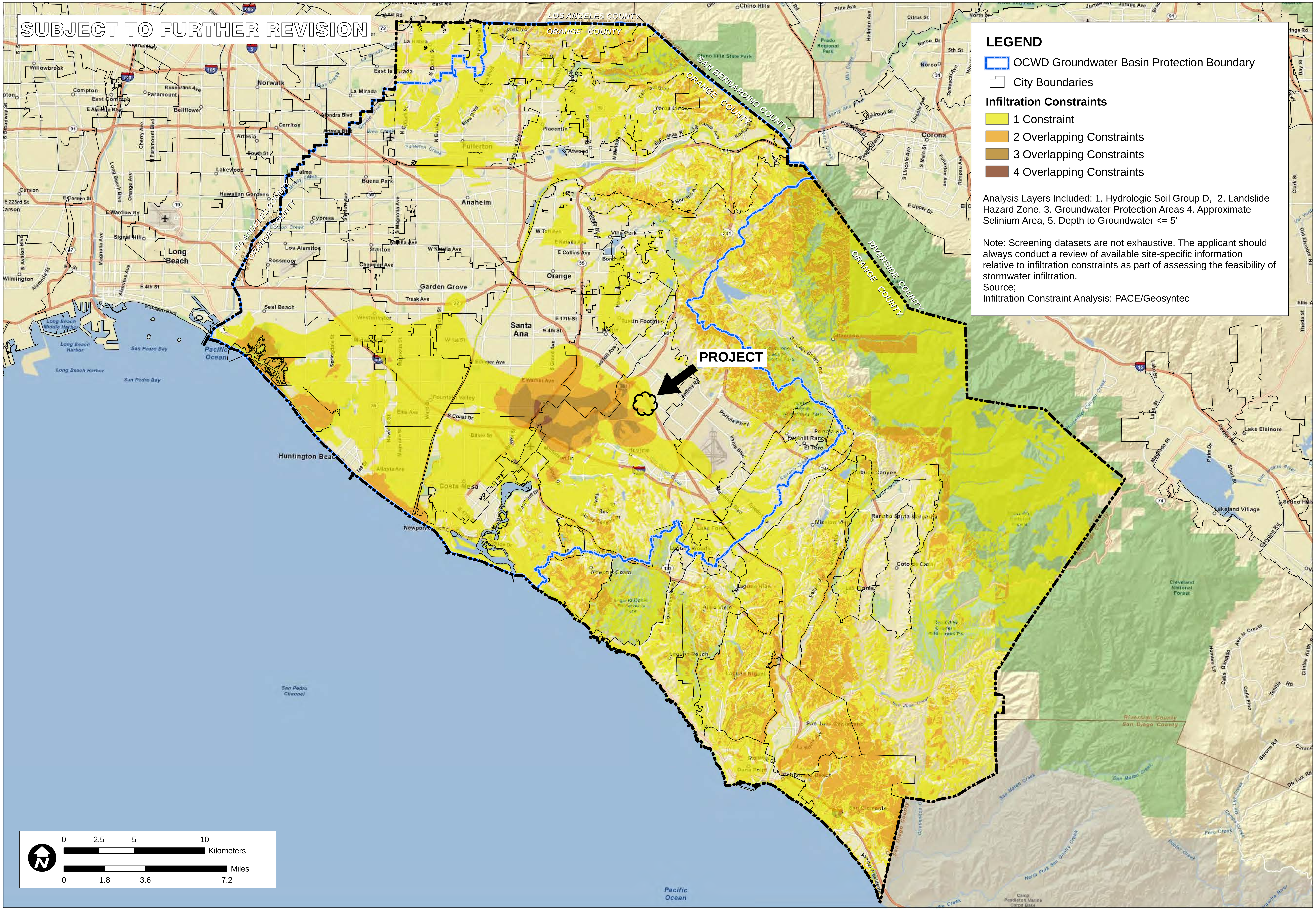
SCALE	1" = 1.25 miles
DESIGNED	TH
DRAWING	TH
CHECKED	BMP
DATE	02/09/11
JOB NO.	9526-E

PACE Advanced Water Engineering

FIGURE

XVI-2e


SUBJECT TO FURTHER REVISION
LEGEND
City Boundaries
OCWD Groundwater Basin Protection Boundary
Plume Protection Boundaries
North Basin Groundwater Protection Project
South Basin Groundwater Protection Project
El Toro Marine Base
Tustin Marine Air Base
Approximate Selenium Contamination Area
Note: Individual contamination sites are not plotted.
See State Water Resources Control Board Geotracker database (http://geotracker.waterboards.ca.gov),
Department of Toxic Substance Control Envirostor database (http://www.envirostor.dtsc.ca.gov) and other applicable sources for current listing of active contaminated sites.
Groundwater basin and plume protection boundaries for South Orange County are not shown on this exhibit at this time
PROJECT
LOS ANGELES COUNTY
ORANGE COUNTY
SAN BERNARDINO COUNTY
ORANGE COUNTY
RIVERSIDE COUNTY
ORANGE COUNTY
0 2 4 8 Kilometers
0 1.25 2.5 5 Miles
TITLE
NORTH ORANGE COUNTY GROUNDWATER PROTECTION AREAS
JOB
ORANGE COUNTY INFILTRATION STUDY
ORANGE CO.
CA
SCALE 1" = 1.25 miles
DESIGNED TH
DRAWING TH
CHECKED BMP
DATE 04/22/10
JOB NO. 9526-E
PACE
Advanced Water Engineering
FIGURE
XVI-2f
P:\9526E\6-GIS\Mxds\Reports\InfiltrationFeasability_20110215\9526E_FigureXVI-2f_NorthOCGroundwaterProtectionAreasStreetMap_20110215.mxd



TITLE
INFILTRATION ANALYSIS OVERLAPPING CONSTRAINT LOCATIONS

JOB
ORANGE COUNTY INFILTRATION STUDY
ORANGE CO. CA

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

PACE Advanced Water Engineering

FIGURE
XVI-2g

P:\9526E\6-GIS\Mxds\Reports\InfiltrationFeasability_20110215\9526E_FigureXVI-2g_InfiltrationFinal_20110215.mxd


Susceptibility
Potential Areas of Erosion, Habitat, & Physical Structure Susceptibility
Channel Type
Earth (Unstable)
Earth (Stabilized)
Stabilized
Tidel Influence
<= Mean High Water Line (4.28')
Water Body
Basin
Dam
Lake
Reservoir
Other Lands
Airport/Military
AnaheimBay-HuntingtonHarbor Watershed
Santa Ana River Watershed
Santa Ana River Watershed
South Orange County
PROJECT
El Modena-Irvine Retarding Basin
Lower Peters Canyon Retarding Basin
Eastfoot Retarding Basin
Orchard Estates Retention Basin
Hicks Canyon Retarding Basin
Rattlesnake Reservoir
East Hicks Canyon Retarding Basin
Siphon Reservoir
Bee Canyon Retarding Basin
Round Canyon Retarding Basin
Trabuco Retarding Basin
Marshburn Retarding Basin
Agua Chinon Retarding Basin
North Lake
South Lake
Basin Number 2
Basin Number 1
Sand Canyon Reservoir
Laguna Reservoir
Bonita Canyon Reservoir
San Joaquin Reservoir
Big Canyon Reservoir
Harbor View Dam
Village Pond Park
John Wayne Airport
Feet
0
9,000
18,000
TITLE
SUSCEPTIBILITY ANALYIS NEWPORT BAY-NEWPORT COASTAL STREAMS
JOB
ORANGE COUNTY WATERSHED MASTER PLANNING
ORANGE CO. CA
SCALE 1" = 12000'
DESIGNED TH
DRAWING TH
CHECKED BMP
DATE 04/30/10
JOB NO. 9526-E
PACE Advanced Water Engineering
FIGURE
4
P:\9526E\6-GIS\Mxds\SusceptabilityMaps_20100505\9526E_NewportBaySusceptibility_20100430.mxd

Appendix B.

Calculations

B-1: Hydrologic Calculations

Pre-Development Time of Concentrations and Volumes

DMA ID	Area, A (ac)	Impervious (%)	Time of Concen, T_c (min) [1]	Q 2-Year (cfs) [2]	Vol 2-Year (ft^3) [2]
110	7.82	5.3%	11.0	1.33	13,983
130	6.70	7.8%	8.9	1.34	12,981
210	2.52	73.0%	9.2	2.04	14,680
220	2.23	66.5%	7.8	1.79	12,110
230	3.90	60.7%	8.2	2.85	19,907
240	2.85	60.3%	9.0	1.99	14,462
250	7.75	34.5%	10.4	3.34	27,399
260	4.16	7.7%	9.7	0.82	8,059
270	5.48	4.6%	9.4	0.94	9,583
280	5.44	65.4%	10.6	3.82	29,229
∑	48.9	30.9%	----	----	----

Post-Development Time of Concentrations and Volumes

DMA ID	Area, A (ac)	Impervious (%)	Time of Concen, T_c (min) [1]	Q 2-Year (cfs) [2]	Vol 2-Year (ft^3) [2]
110	7.82	42.2%	11.0	3.87	31,233
130	6.70	10.7%	8.9	1.51	14,157
215	2.48	44.4%	9.0	1.34	10,193
225	2.95	77.5%	9.0	2.55	17,990
235	4.29	69.2%	8.2	3.50	24,045
245	2.83	60.9%	9.0	1.98	14,418
255	7.40	50.9%	10.4	4.25	33,323
265	4.26	41.6%	9.6	2.12	16,858
275	4.70	3.6%	9.1	0.77	7,928
280	5.44	66.2%	10.6	3.86	29,490
∑	48.9	43.8%	----	----	----

Post-Dev. vs. Pre-Dev. Time of Concentrations and Volumes

ΔArea (ac) [Post] − [Pre]	ΔImpervious (%) [Post] − [Pre]	ΔVol 2-Year (ac) [Post] − [Pre]	$T_{c\ Post}$ / $T_{c\ Pre}$	Vol_{Post} / Vol_{Pre}
0.0	37%	17,250	1.00	**2.23**
0.0	3%	1,176	1.00	**1.09**
0.0	-29%	-4,487	0.98	0.69
0.7	11%	5,880	**1.16**	**1.49**
0.4	8%	4,138	1.00	**1.21**
0.0	1%	-44	1.00	1.00
-0.4	16%	5,924	1.00	**1.22**
0.1	34%	8,799	1.00	**2.09**
-0.8	-1%	-1,655	0.96	0.83
0.0	1%	261	1.00	1.01

Notes

[1] Time of Concentrations (T_c) based on Advanced Engineering Software (AES) analysis, which performs rational method computations following the OC Hydrology Manual - AES calculations included in **Appendix B-3**.

[2] The 2-year flowrates and runoff volumes are based on HEC-HMS modeling.

[3] Blue highlighted rows show DMAs in which Hydrologic Conditions of Concern (HCOCs) are determined to exist .

TABLE B.1.
MAXIMUM PRECIPITATION FOR INDICATED DURATION D-DAYS (INCHES)

BELOW 2000' ELEVATION

Return Period In Yrs.	1D	2D	3D	4D	5D	6D	8D	10D	15D	20D	30D	60D	365D
2	2.05	2.76	3.08	3.21	3.36	3.61	3.94	4.24	4.73	5.21	6.20	8.44	13.60
5	3.05	4.24	4.79	5.01	5.23	5.59	6.05	6.47	7.20	7.83	9.18	12.69	19.13
10	3.68	5.23	5.92	6.22	6.50	6.94	7.44	7.94	8.79	9.49	11.07	15.48	22.56
20	4.31	6.17	6.99	7.38	7.71	8.22	8.74	9.31	10.26	11.02	12.80	18.08	25.69
25	4.49	6.46	7.33	7.75	8.09	8.63	9.15	9.74	10.72	11.49	13.34	18.90	26.66
40	4.89	7.06	8.03	8.50	8.88	9.47	9.98	10.62	10.95	12.46	14.44	20.58	28.63
50	5.07	7.35	8.35	8.86	9.25	9.86	10.38	11.03	12.11	12.91	14.95	21.37	29.55
100	5.63	8.22	9.35	9.95	10.38	11.07	11.57	12.29	13.45	14.28	16.51	23.77	32.32

ABOVE 2000' ELEVATION

Return Period In Yrs.	1D	2D	3D	4D	5D	6D	8D	10D	15D	20D	30D	60D	365D
2	3.81	5.33	5.89	6.22	6.66	7.17	7.88	8.38	8.97	9.62	11.29	15.91	26.05
5	5.71	8.25	9.23	9.75	10.40	11.12	12.17	12.81	13.72	14.51	16.73	23.74	36.88
10	7.05	10.26	11.58	12.23	12.98	13.80	15.02	15.71	16.83	17.66	20.17	28.69	43.86
20	8.36	12.20	13.85	14.63	15.45	16.35	17.72	18.42	19.74	20.59	23.33	33.25	50.33
25	8.76	12.81	14.58	15.40	16.24	17.16	18.57	19.27	20.65	21.50	24.31	34.66	52.35
40	9.62	14.08	16.08	16.99	17.87	18.82	20.32	21.02	22.53	21.95	26.32	37.56	53.33
50	10.02	14.68	16.79	17.74	18.63	19.61	21.14	21.84	23.41	24.25	27.25	38.91	58.43
100	11.27	16.52	18.98	20.05	20.99	22.01	23.65	24.33	26.09	26.91	30.09	42.99	64.30

Curve Numbers of Hydrologic Soil-Cover Complexes For Pervious Areas-AMC II					
Cover Type (3)	Quality of Cover (2)	Soil Group			
		A	B	C	D
NATURAL COVERS -					
Barren (Rockland, eroded and graded land)		78	86	91	93
Chaparral, Broadleaf (Manzonita, ceanothus and scrub oak)	Poor	53	70	80	85
	Fair	40	63	75	81
	Good	31	57	71	78
Chaparral, Narrowleaf (Chamise and redshank)	Poor	71	82	88	91
	Fair	55	72	81	86
Grass, Annual or Perennial	Poor	67	78	86	89
	Fair	50	69	79	84
	Good	38	61	74	80
Meadows or Cienegas (Areas with seasonally high water table, principal vegetation is sod forming grass)	Poor	63	77	85	88
	Fair	51	70	80	84
	Good	30	58	71	78
Open Brush (Soft wood shrubs - buckwheat, sage, etc.)	Poor	62	76	84	88
	Fair	46	66	77	83
	Good	41	63	75	81
Woodland (Coniferous or broadleaf trees predominate. Canopy density is at least 50 percent.)	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	25	55	70	77
Woodland, Grass (Coniferous or broadleaf trees with canopy density from 20 to 50 percent)	Poor	57	73	82	86
	Fair	44	65	77	82
	Good	33	58	72	79
URBAN COVERS -					
Residential or Commercial Landscaping (Lawn, shrubs, etc.)	Good	32	56	69	75
Turf (Irrigated and mowed grass)	Poor	58	74	83	87
	Fair	44	65	77	82
	Good	33	58	72	79
AGRICULTURAL COVERS -					
Fallow (Land plowed but not tilled or seeded)		77	86	91	94

ORANGE COUNTY
HYDROLOGY MANUAL

CURVE NUMBERS FOR PERVIOUS AREAS

Figure C-3 (1 of 2)

Project: IHP_HMS_Jan2023
Simulation Run: Run 2-Yr 24-Hr
Simulation Start: 31 December 2022, 24:00
Simulation End: 2 January 2023, 04:00

HMS Version: 4.10
Executed: 09 January 2023, 04:02

Global Parameter Summary - Subbasin

Area (MI2)

Element Name		Area (MI2)
Pre - 110	**7.82 ac**	0.01
Pre - 120	**5.36 ac**	0.01
Pre - 130	**6.70 ac**	0.01
Pre - 140	**4.58 ac**	0.01
Pre - 150	**6.58 ac**	0.01
Pre - 160	**2.65 ac**	0
Pre - 170	**4.74 ac**	0.01
Pre - 180	**2.87 ac**	0
Pre - 190	**4.82 ac**	0.01
Pre - 200	**3.46 ac**	0.01
Pre - 210	**2.52 ac**	0
Pre - 220	**2.23 ac**	0
Pre - 230	**3.90 ac**	0.01
Pre - 240	**2.85 ac**	0
Pre - 250	**7.75 ac**	0.01
Pre - 260	**4.16 ac**	0.01
Pre - 270	**5.48 ac**	0.01
Pre - 280	**5.44 ac**	0.01
Post - 110	**7.82 ac**	0.01
Post - 120	**5.36 ac**	0.01
Post - 130	**6.70 ac**	0.01
Post - 140	**4.58 ac**	0.01
Post - 150	**6.58 ac**	0.01
Post - 160	**2.65 ac**	0
Post - 170	**4.74 ac**	0.01

Post - 180	**2.87 ac**	0
Post - 190	**4.82 ac**	0.01
Post - 200	**3.46 ac**	0.01
Post - 215	**2.48 ac**	0
Post - 225	**2.95 ac**	0
Post - 235	**4.29 ac**	0.01
Post - 245	**2.83 ac**	0
Post - 255	**7.40 ac**	0.01
Post - 265	**4.26 ac**	0.01
Post - 275	**4.70 ac**	0.01
Post - 280	**5.44 ac**	0.01

Loss Rate: Scs

Element Name		Percent Impervious Area	Curve Number
Pre - 110	7.82 ac	5.3	75
Pre - 120	5.36 ac	37.7	75
Pre - 130	6.70 ac	7.8	75
Pre - 140	4.58 ac	82.5	75
Pre - 150	6.58 ac	18.7	75
Pre - 160	2.65 ac	83.1	75
Pre - 170	4.74 ac	80.8	75
Pre - 180	2.87 ac	94.1	75
Pre - 190	4.82 ac	74.3	75
Pre - 200	3.46 ac	87.3	75
Pre - 210	2.52 ac	73	75
Pre - 220	2.23 ac	66.5	75
Pre - 230	3.90 ac	60.7	75
Pre - 240	2.85 ac	60.3	75
Pre - 250	7.75 ac	34.5	75
Pre - 260	4.16 ac	7.7	75
Pre - 270	5.48 ac	4.6	75
Pre - 280	5.44 ac	65.4	75
Post - 110	7.82 ac	42.2	75
Post - 120	5.36 ac	37.7	75
Post - 130	6.70 ac	10.7	75
Post - 140	4.58 ac	82.5	75
Post - 150	6.58 ac	18.7	75
Post - 160	2.65 ac	83.1	75
Post - 170	4.74 ac	80.8	75
Post - 180	2.87 ac	94.1	75
Post - 190	4.82 ac	74.3	75
Post - 200	3.46 ac	87.2	75
Post - 215	2.48 ac	44.4	75
Post - 225	2.95 ac	77.5	75
Post - 235	4.29 ac	69.2	75
Post - 245	2.83 ac	60.9	75
Post - 255	7.40 ac	50.9	75
Post - 265	4.26 ac	41.6	75
Post - 275	4.70 ac	3.6	75
Post - 280	5.44 ac	66.2	75

Transform: Scs

Element Name		Lag	Unitgraph Type
Pre - 110	7.82 ac	11	Standard
Pre - 120	5.36 ac	9.1	Standard
Pre - 130	6.70 ac	8.9	Standard
Pre - 140	4.58 ac	9.7	Standard
Pre - 150	6.58 ac	11	Standard
Pre - 160	2.65 ac	9	Standard
Pre - 170	4.74 ac	12	Standard
Pre - 180	2.87 ac	10.6	Standard
Pre - 190	4.82 ac	11.4	Standard
Pre - 200	3.46 ac	10	Standard
Pre - 210	2.52 ac	9.2	Standard
Pre - 220	2.23 ac	7.8	Standard
Pre - 230	3.90 ac	8.2	Standard
Pre - 240	2.85 ac	9	Standard
Pre - 250	7.75 ac	10.4	Standard
Pre - 260	4.16 ac	9.7	Standard
Pre - 270	5.48 ac	9.4	Standard
Pre - 280	5.44 ac	10.6	Standard
Post - 110	7.82 ac	11	Standard
Post - 120	5.36 ac	9.1	Standard
Post - 130	6.70 ac	8.9	Standard
Post - 140	4.58 ac	9.7	Standard
Post - 150	6.58 ac	11	Standard
Post - 160	2.65 ac	9	Standard
Post - 170	4.74 ac	12	Standard
Post - 180	2.87 ac	10.6	Standard
Post - 190	4.82 ac	11.4	Standard
Post - 200	3.46 ac	10	Standard
Post - 215	2.48 ac	9	Standard
Post - 225	2.95 ac	9	Standard
Post - 235	4.29 ac	8.2	Standard
Post - 245	2.83 ac	9	Standard
Post - 255	7.40 ac	10.4	Standard
Post - 265	4.26 ac	9.6	Standard
Post - 275	4.70 ac	9.1	Standard
Post - 280	5.44 ac	10.6	Standard

Global Results Summary

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Pre - 110 7.82 ac	0.01	1.33	01Jan2023, 10:06	0.49
Pre - 120 5.36 ac	0.01	2.55	01Jan2023, 10:00	1.03
Pre - 130 6.70 ac	0.01	1.34	01Jan2023, 10:06	0.53
Pre - 140 4.58 ac	0.01	4.03	01Jan2023, 10:00	1.76
Pre - 150 6.58 ac	0.01	1.89	01Jan2023, 10:06	0.71
Pre - 160 2.65 ac	0	2.44	01Jan2023, 10:00	1.77
Pre - 170 4.74 ac	0.01	3.89	01Jan2023, 10:06	1.73
Pre - 180 2.87 ac	0	2.74	01Jan2023, 10:06	1.95
Pre - 190 4.82 ac	0.01	3.73	01Jan2023, 10:06	1.63
Pre - 200 3.46 ac	0.01	3.16	01Jan2023, 10:00	1.84
Pre - 210 2.52 ac	0	2.04	01Jan2023, 10:00	1.61
Pre - 220 2.23 ac	0	1.79	01Jan2023, 10:00	1.5
Pre - 230 3.90 ac	0.01	2.85	01Jan2023, 10:00	1.4
Pre - 240 2.85 ac	0	1.99	01Jan2023, 10:00	1.4
Pre - 250 7.75 ac	0.01	3.34	01Jan2023, 10:06	0.97
Pre - 260 4.16 ac	0.01	0.82	01Jan2023, 10:06	0.53
Pre - 270 5.48 ac	0.01	0.94	01Jan2023, 10:06	0.48
Pre - 280 5.44 ac	0.01	3.82	01Jan2023, 10:06	1.48
Post - 110 7.82 ac	0.01	3.87	01Jan2023, 10:06	1.1
Post - 120 5.36 ac	0.01	2.55	01Jan2023, 10:00	1.03
Post - 130 6.70 ac	0.01	1.51	01Jan2023, 10:06	0.58
Post - 140 4.58 ac	0.01	4.03	01Jan2023, 10:00	1.76
Post - 150 6.58 ac	0.01	1.89	01Jan2023, 10:06	0.71
Post - 160 2.65 ac	0	2.44	01Jan2023, 10:00	1.77
Post - 170 4.74 ac	0.01	3.89	01Jan2023, 10:06	1.73
Post - 180 2.87 ac	0	2.74	01Jan2023, 10:06	1.95
Post - 190 4.82 ac	0.01	3.73	01Jan2023, 10:06	1.63
Post - 200 3.46 ac	0.01	3.16	01Jan2023, 10:00	1.84
Post - 215 2.48 ac	0	1.34	01Jan2023, 10:00	1.14
Post - 225 2.95 ac	0	2.55	01Jan2023, 10:00	1.68
Post - 235 4.29 ac	0.01	3.5	01Jan2023, 10:00	1.54
Post - 245 2.83 ac	0	1.98	01Jan2023, 10:00	1.41
Post - 255 7.40 ac	0.01	4.25	01Jan2023, 10:06	1.24
Post - 265 4.26 ac	0.01	2.12	01Jan2023, 10:00	1.09
Post - 275 4.70 ac	0.01	0.77	01Jan2023, 10:06	0.46
Post - 280 5.44 ac	0.01	3.86	01Jan2023, 10:06	1.49

Pre-Project (2-Year, 24-Hour)

Subbasin: Pre-110

Area (MI2) : 0.01

Loss Rate: Scs

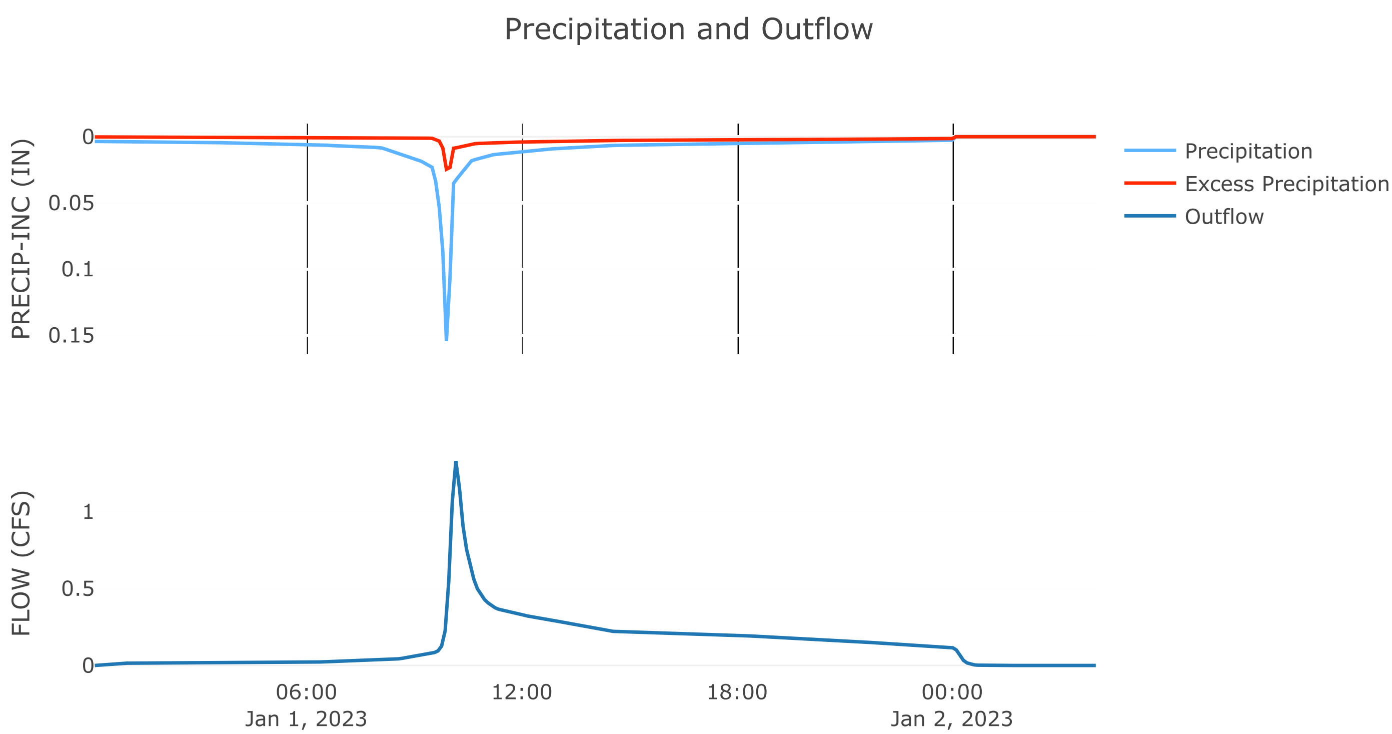
Percent Impervious Area	5.3
Curve Number	75

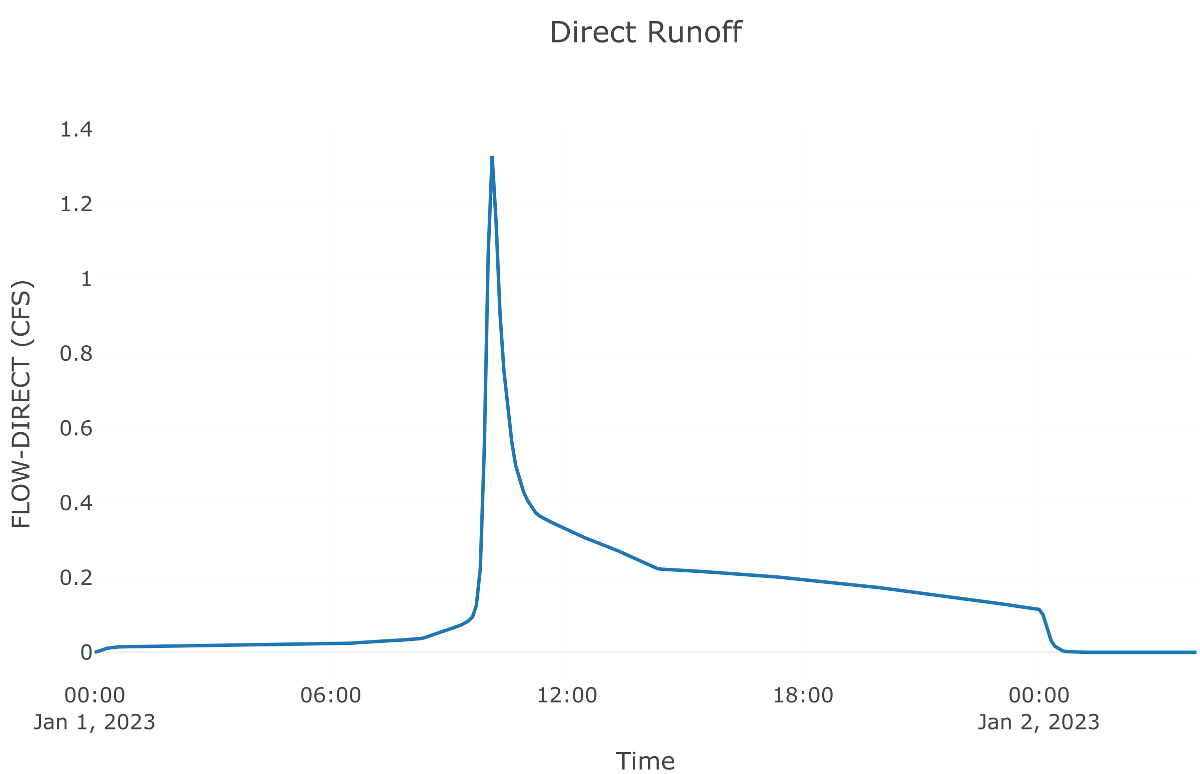
Transform: Scs

Lag	11
Unitgraph Type	Standard

Results: Pre-110

Peak Discharge (CFS)	1.33
Time of Peak Discharge	01Jan2023, 10:06
Volume (IN)	0.49
Precipitation Volume (AC - FT)	1.34
Loss Volume (AC - FT)	1.01
Excess Volume (AC - FT)	0.32
Direct Runoff Volume (AC - FT)	0.32
Baseflow Volume (AC - FT)	0


Precipitation and Outflow
PRECIP-INC (IN)
0
0.05
0.1
0.15
Precipitation
Excess Precipitation
Outflow
FLOW (CFS)
1
0.5
0
06:00
Jan 1, 2023
12:00
18:00
00:00
Jan 2, 2023


Direct Runoff
FLOW-DIRECT (CFS)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
00:00
Jan 1, 2023
06:00
12:00
18:00
00:00
Jan 2, 2023
Time

Subbasin: Pre-120

Area (MI2) : 0.01

Loss Rate: Scs

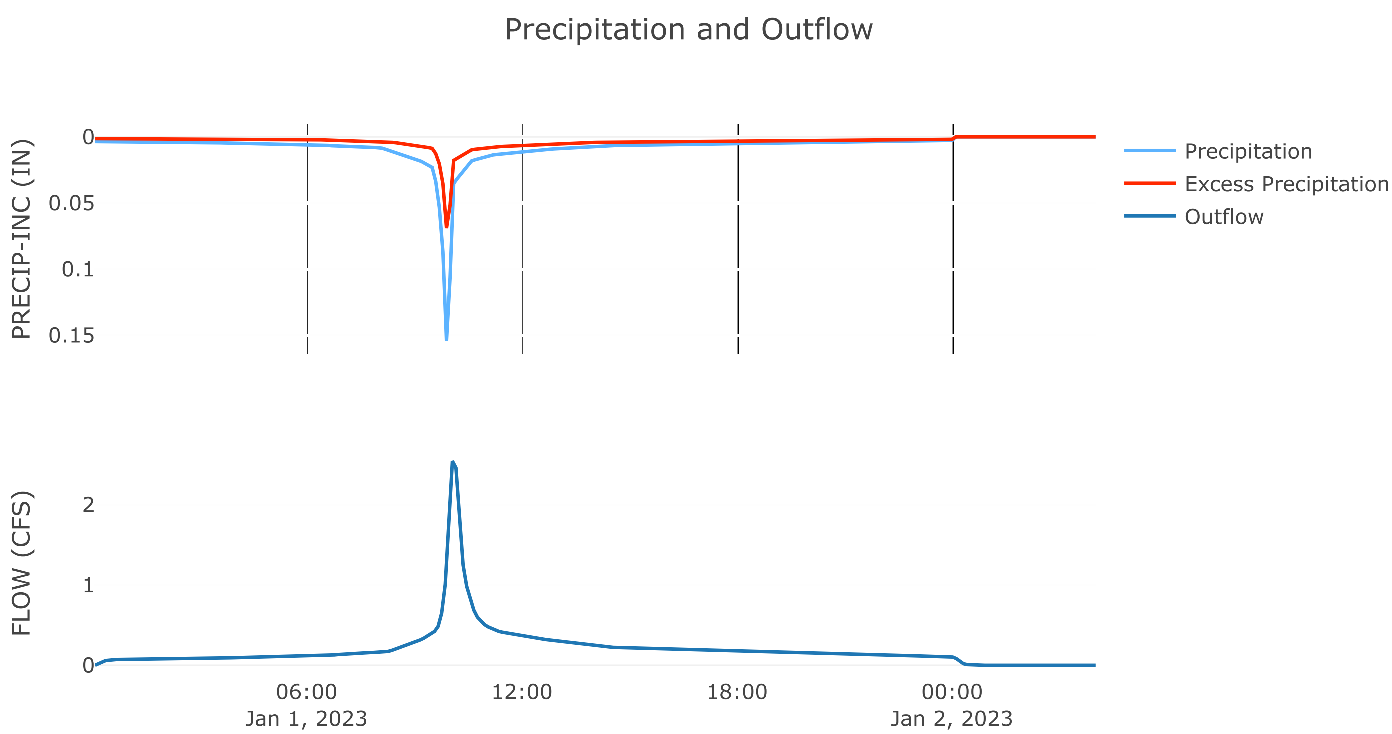
Percent Impervious Area	37.7
Curve Number	75

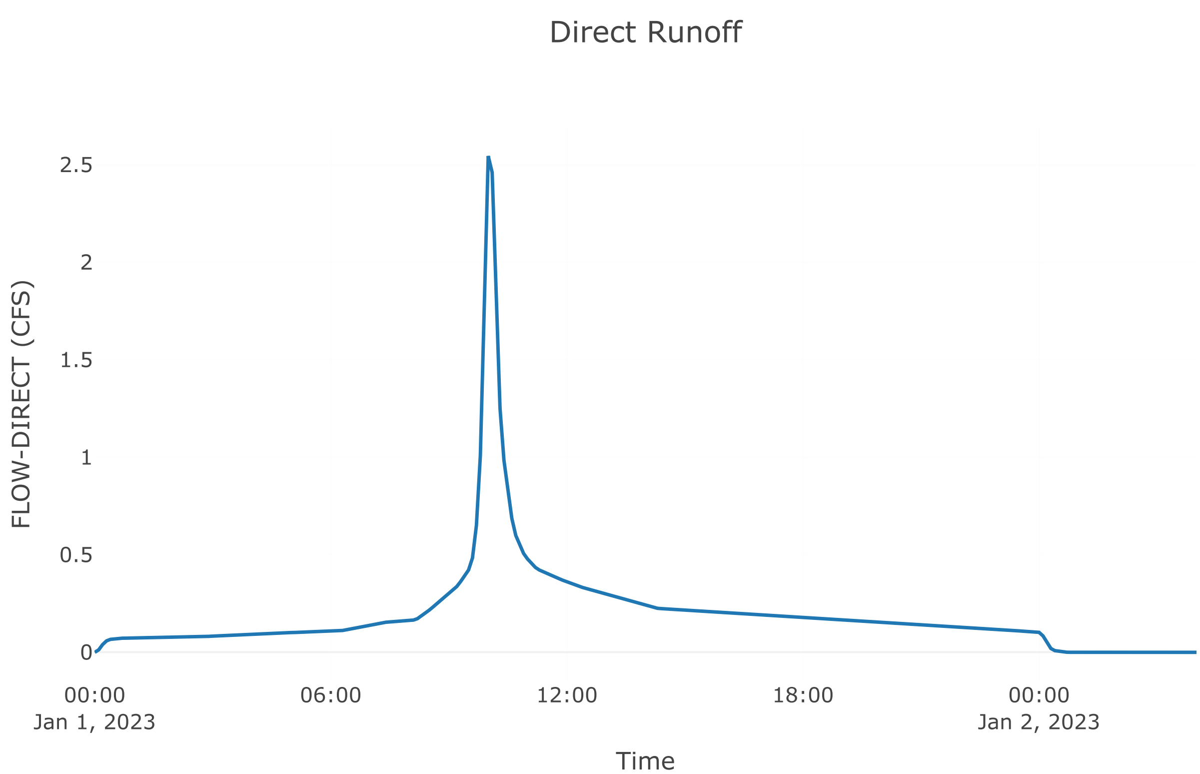
Transform: Scs

Lag	9.1
Unitgraph Type	Standard

Results: Pre-120

Peak Discharge (CFS)	2.55
Time of Peak Discharge	01Jan2023, 10:00
Volume (IN)	1.03
Precipitation Volume (AC - FT)	0.92
Loss Volume (AC - FT)	0.46
Excess Volume (AC - FT)	0.46
Direct Runoff Volume (AC - FT)	0.46
Baseflow Volume (AC - FT)	0


Precipitation and Outflow
PRECIP-INC (IN)
0
0.05
0.1
0.15
Precipitation
Excess Precipitation
Outflow
FLOW (CFS)
2
1
0
06:00
Jan 1, 2023
12:00
18:00
00:00
Jan 2, 2023


Direct Runoff
FLOW-DIRECT (CFS)
2.5
2
1.5
1
0.5
0
00:00
Jan 1, 2023
06:00
12:00
18:00
00:00
Jan 2, 2023
Time

Subbasin: Pre-130

Area (MI2) : 0.01

Loss Rate: Scs

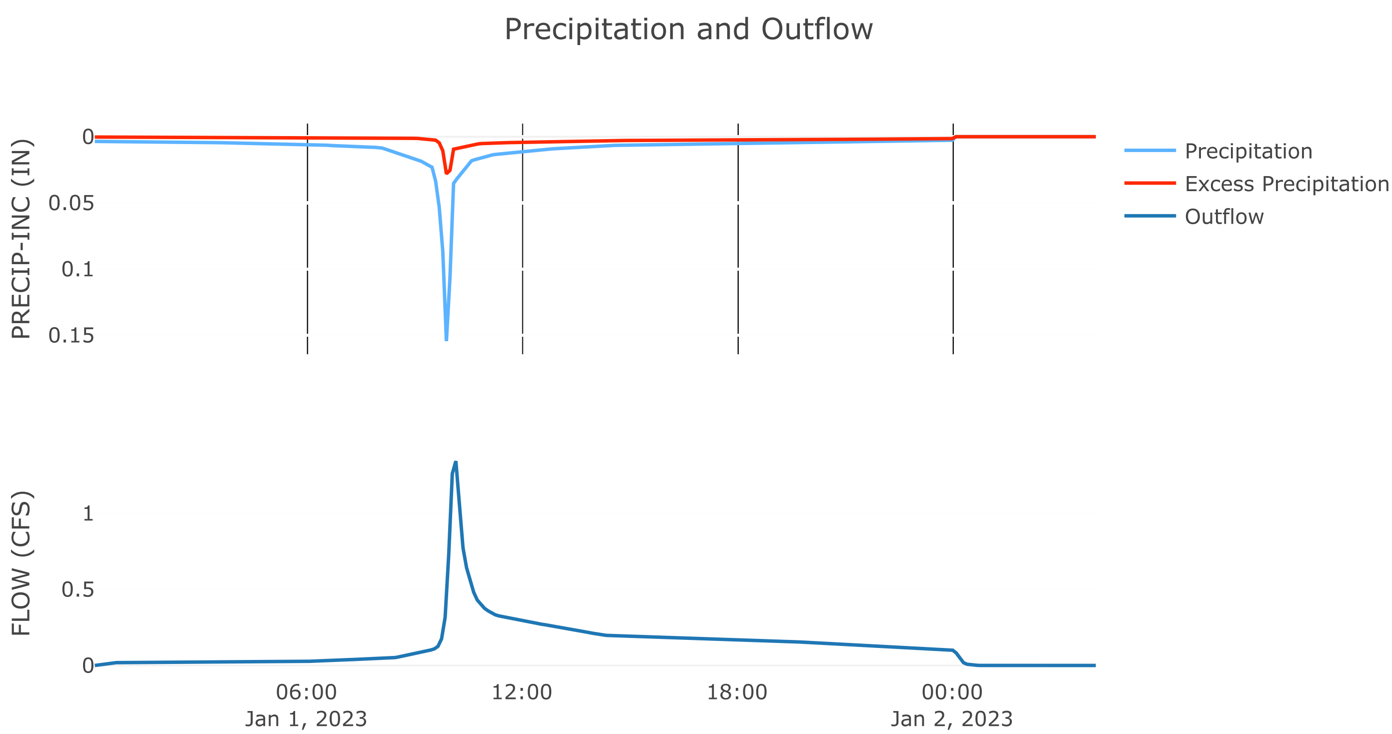
Percent Impervious Area	7.8
Curve Number	75

Transform: Scs

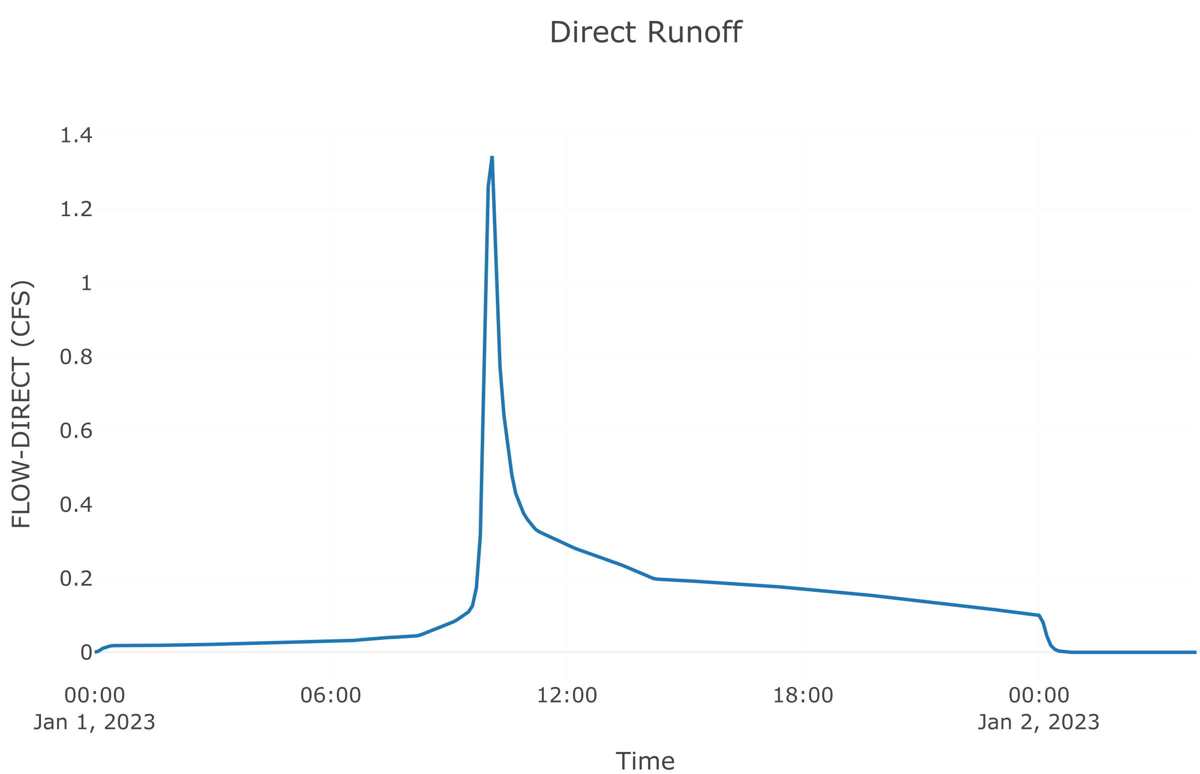
Lag	8.9
Unitgraph Type	Standard

Results: Pre-130

Peak Discharge (CFS)	1.34
Time of Peak Discharge	01Jan2023, 10:06
Volume (IN)	0.53
Precipitation Volume (AC - FT)	1.14
Loss Volume (AC - FT)	0.85
Excess Volume (AC - FT)	0.3
Direct Runoff Volume (AC - FT)	0.3
Baseflow Volume (AC - FT)	0



Precipitation and Outflow
PRECIP-INC (IN)
0
0.05
0.1
0.15
FLOW (CFS)
1
0.5
0
06:00
Jan 1, 2023
12:00
18:00
00:00
Jan 2, 2023
Precipitation
Excess Precipitation
Outflow



Direct Runoff
FLOW-DIRECT (CFS)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
00:00
Jan 1, 2023
06:00
12:00
18:00
00:00
Jan 2, 2023
Time

Subbasin: Pre-140

Area (MI2) : 0.01

Loss Rate: Scs

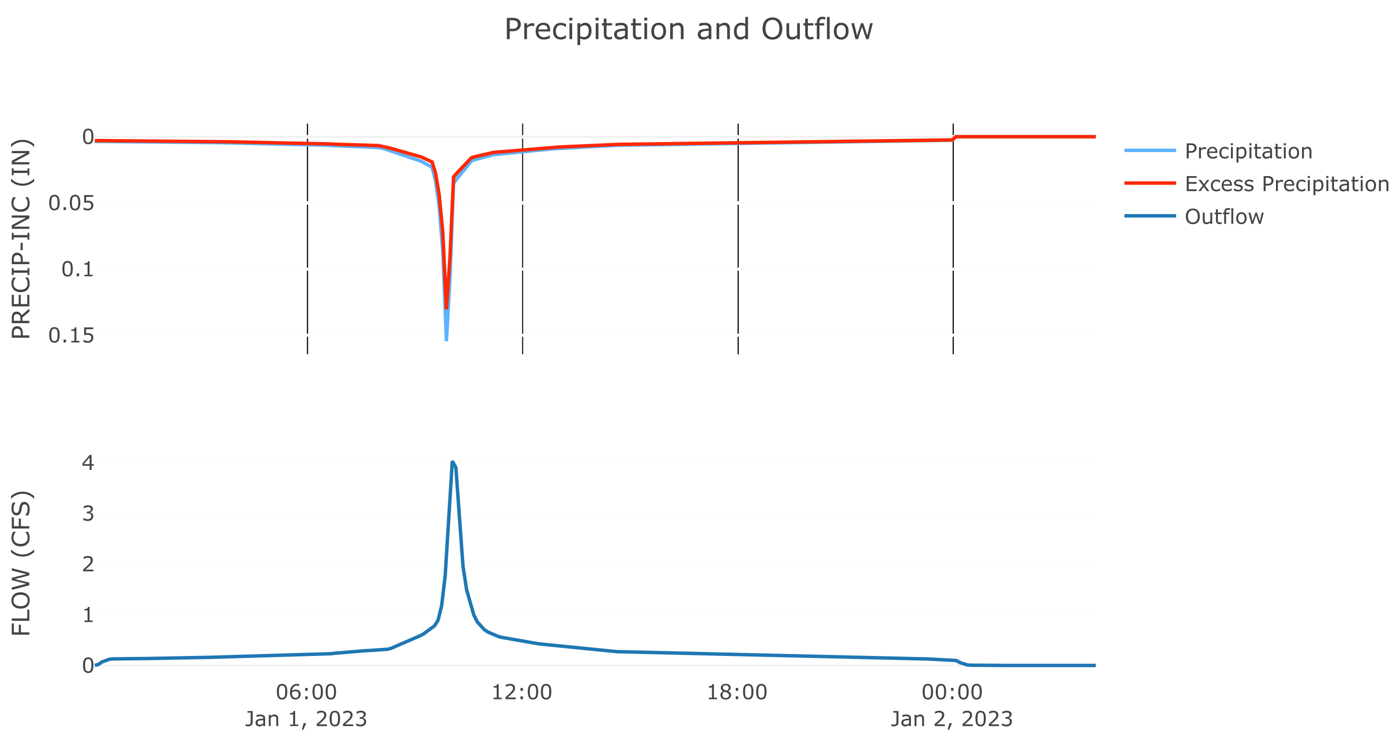
Percent Impervious Area	82.5
Curve Number	75

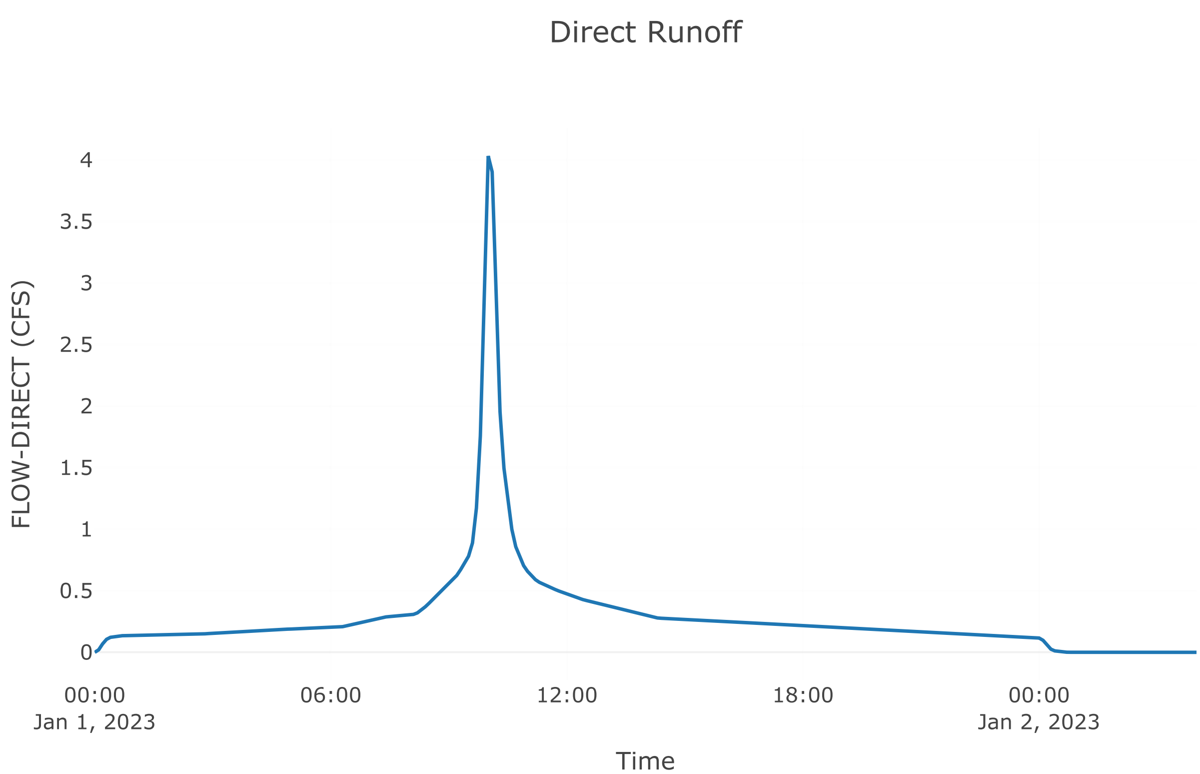
Transform: Scs

Lag	9.7
Unitgraph Type	Standard

Results: Pre-140

Peak Discharge (CFS)	4.03
Time of Peak Discharge	01Jan2023, 10:00
Volume (IN)	1.76
Precipitation Volume (AC - FT)	0.78
Loss Volume (AC - FT)	0.11
Excess Volume (AC - FT)	0.67
Direct Runoff Volume (AC - FT)	0.67
Baseflow Volume (AC - FT)	0


Precipitation and Outflow
PRECIP-INC (IN)
0
0.05
0.1
0.15
Precipitation
Excess Precipitation
Outflow
FLOW (CFS)
4
3
2
1
0
06:00
Jan 1, 2023
12:00
18:00
00:00
Jan 2, 2023


Direct Runoff
FLOW-DIRECT (CFS)
4
3.5
3
2.5
2
1.5
1
0.5
0
00:00
Jan 1, 2023
06:00
12:00
18:00
00:00
Jan 2, 2023
Time

Subbasin: Pre-150

Area (MI2) : 0.01

Loss Rate: Scs

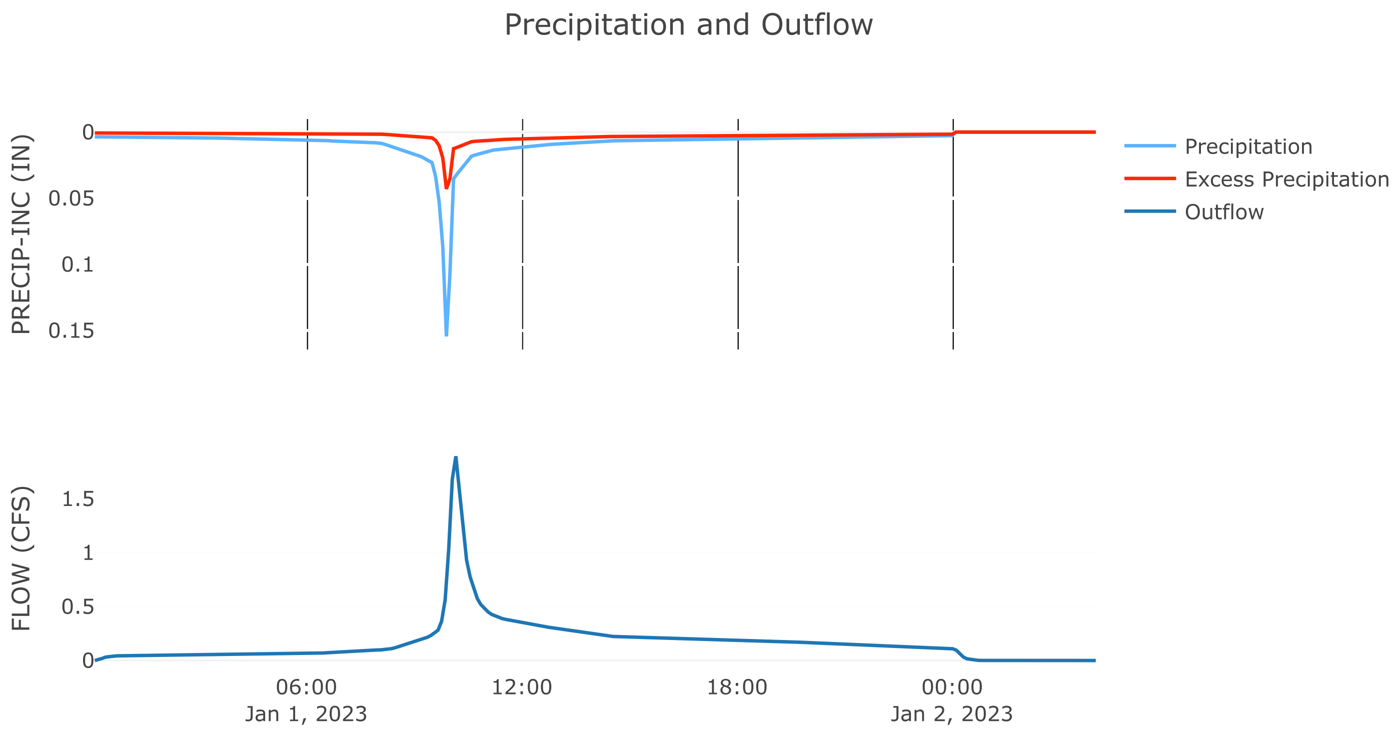
Percent Impervious Area	18.7
Curve Number	75

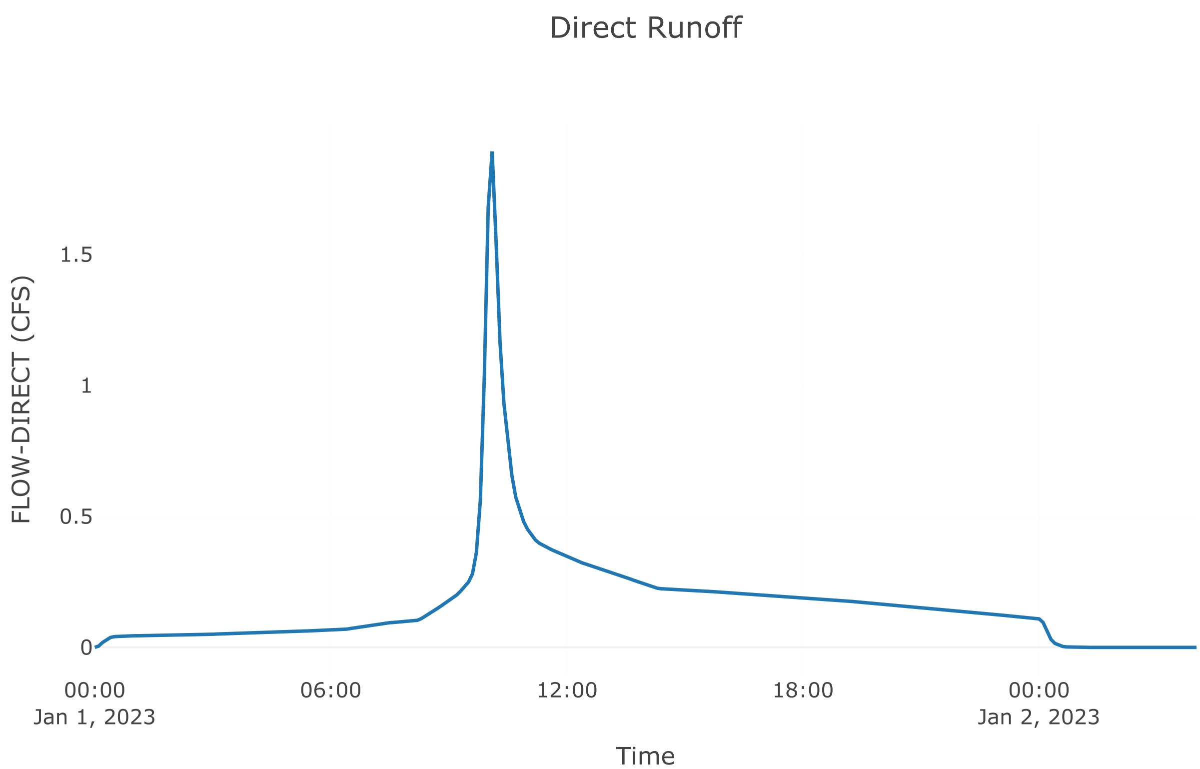
Transform: Scs

Lag	11
Unitgraph Type	Standard

Results: Pre-150

Peak Discharge (CFS)	1.89
Time of Peak Discharge	01Jan2023, 10:06
Volume (IN)	0.71
Precipitation Volume (AC - FT)	1.12
Loss Volume (AC - FT)	0.73
Excess Volume (AC - FT)	0.39
Direct Runoff Volume (AC - FT)	0.39
Baseflow Volume (AC - FT)	0


Precipitation and Outflow
PRECIP-INC (IN)
0
0.05
0.1
0.15
Precipitation
Excess Precipitation
Outflow
FLOW (CFS)
1.5
1
0.5
0
06:00
Jan 1, 2023
12:00
18:00
00:00
Jan 2, 2023


Direct Runoff
FLOW-DIRECT (CFS)
1.5
1
0.5
0
00:00
Jan 1, 2023
06:00
12:00
18:00
00:00
Jan 2, 2023
Time

Subbasin: Pre-160

Area (MI2) : 0

Loss Rate: Scs

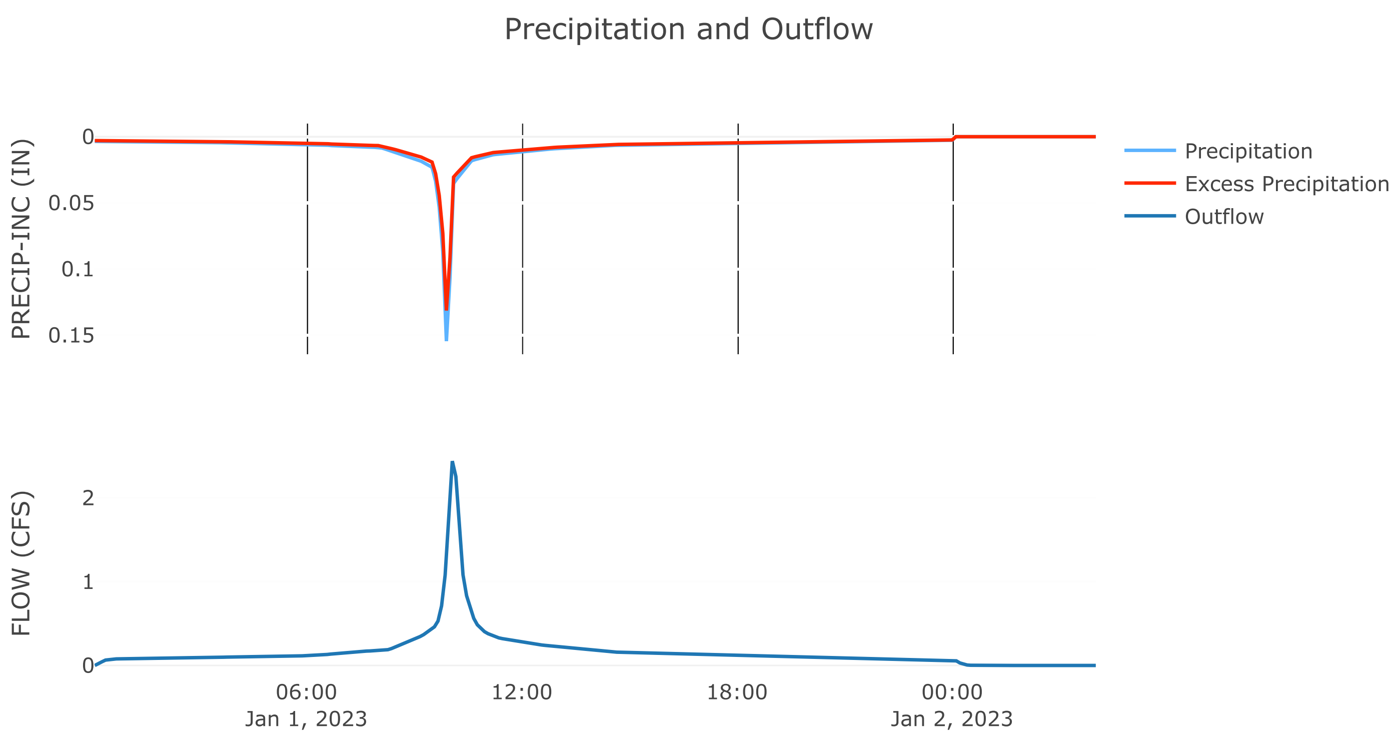
Percent Impervious Area	83.1
Curve Number	75

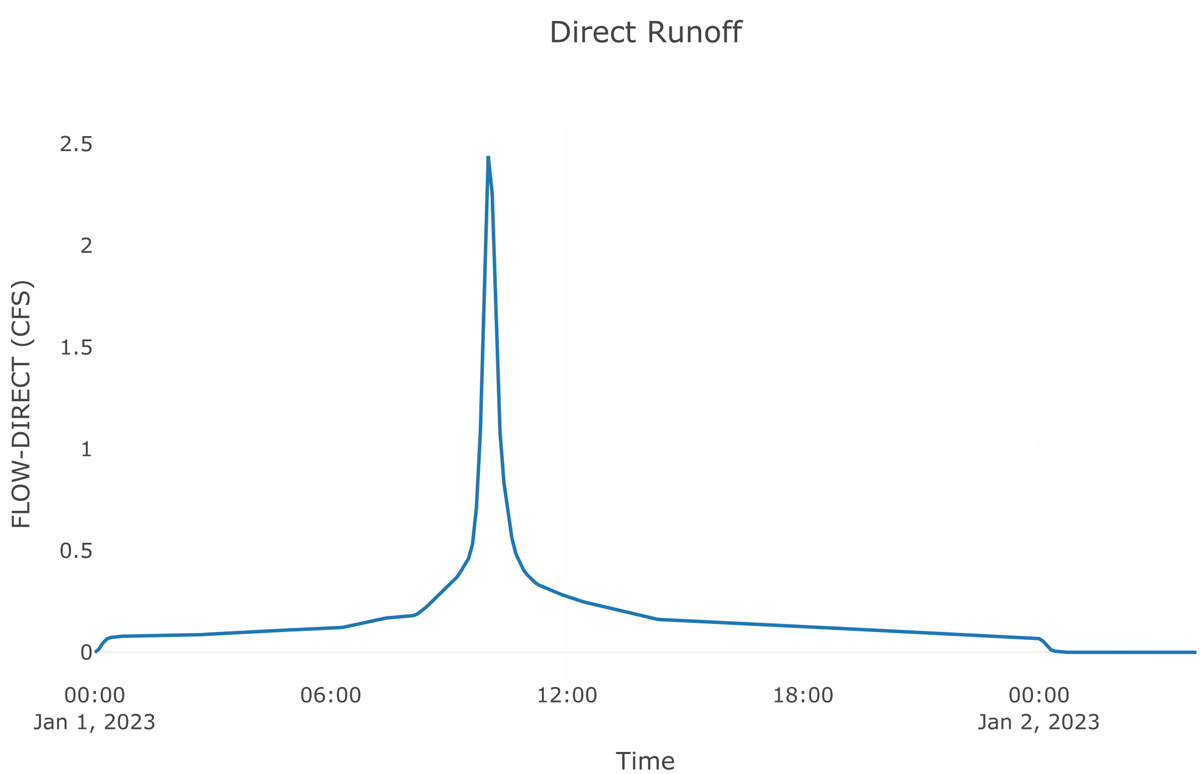
Transform: Scs

Lag	9
Unitgraph Type	Standard

Results: Pre-160

Peak Discharge (CFS)	2.44
Time of Peak Discharge	01Jan2023, 10:00
Volume (IN)	1.77
Precipitation Volume (AC - FT)	0.45
Loss Volume (AC - FT)	0.06
Excess Volume (AC - FT)	0.39
Direct Runoff Volume (AC - FT)	0.39
Baseflow Volume (AC - FT)	0


Precipitation and Outflow
PRECIP-INC (IN)
0
0.05
0.1
0.15
Precipitation
Excess Precipitation
Outflow
FLOW (CFS)
2
1
0
06:00
Jan 1, 2023
12:00
18:00
00:00
Jan 2, 2023


Direct Runoff
FLOW-DIRECT (CFS)
2.5
2
1.5
1
0.5
0
00:00
Jan 1, 2023
06:00
12:00
18:00
00:00
Jan 2, 2023
Time

Subbasin: Pre-170

Area (MI2) : 0.01

Loss Rate: Scs

Percent Impervious Area	80.8
Curve Number	75

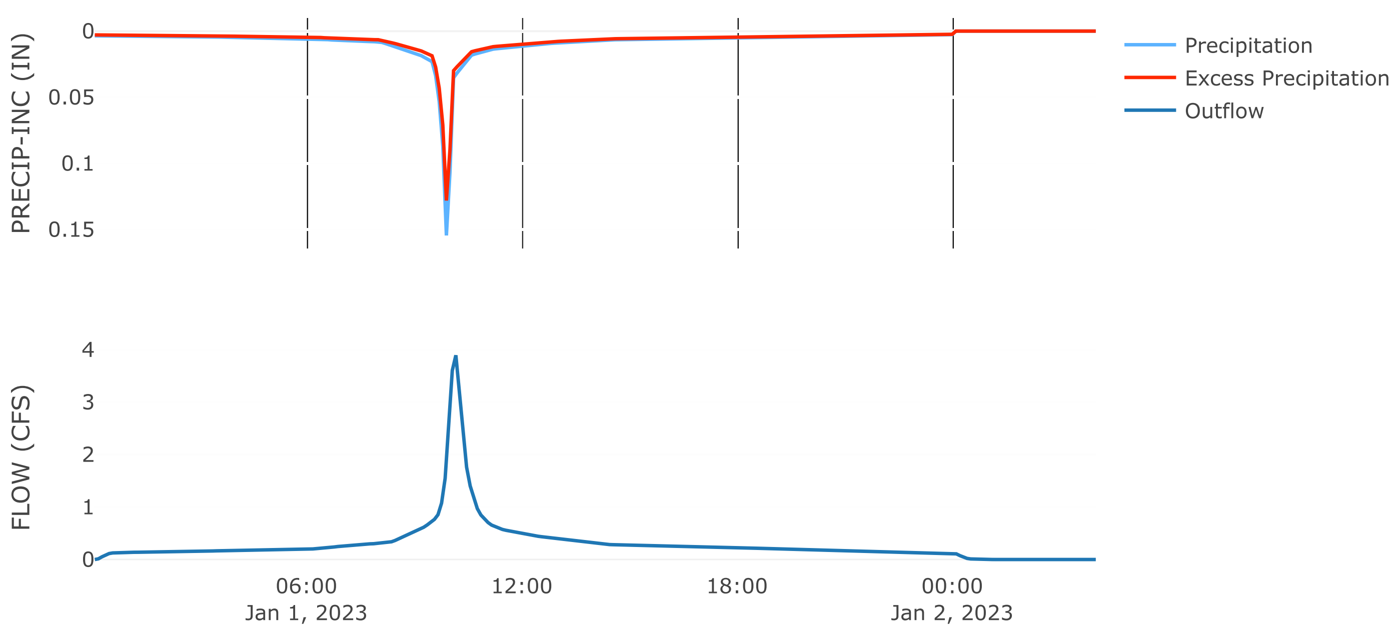
Transform: Scs

Lag	12
Unitgraph Type	Standard

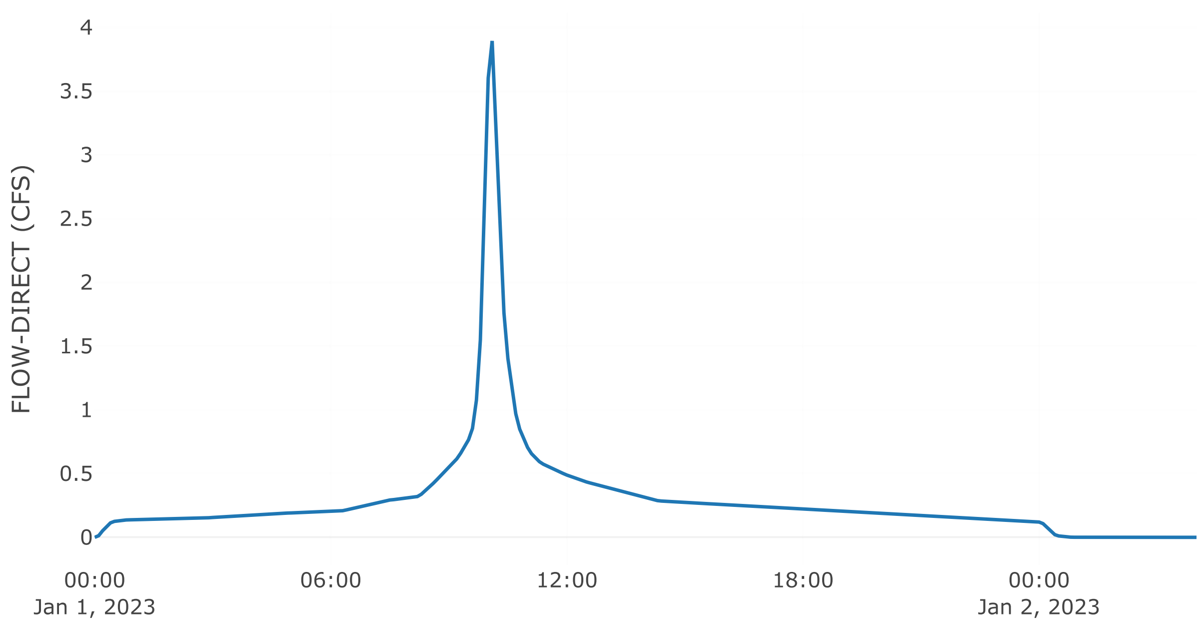
Results: Pre-170

Peak Discharge (CFS)	3.89
Time of Peak Discharge	01Jan2023, 10:06
Volume (IN)	1.73
Precipitation Volume (AC - FT)	0.81
Loss Volume (AC - FT)	0.12
Excess Volume (AC - FT)	0.68
Direct Runoff Volume (AC - FT)	0.68
Baseflow Volume (AC - FT)	0

Precipitation and Outflow



Direct Runoff



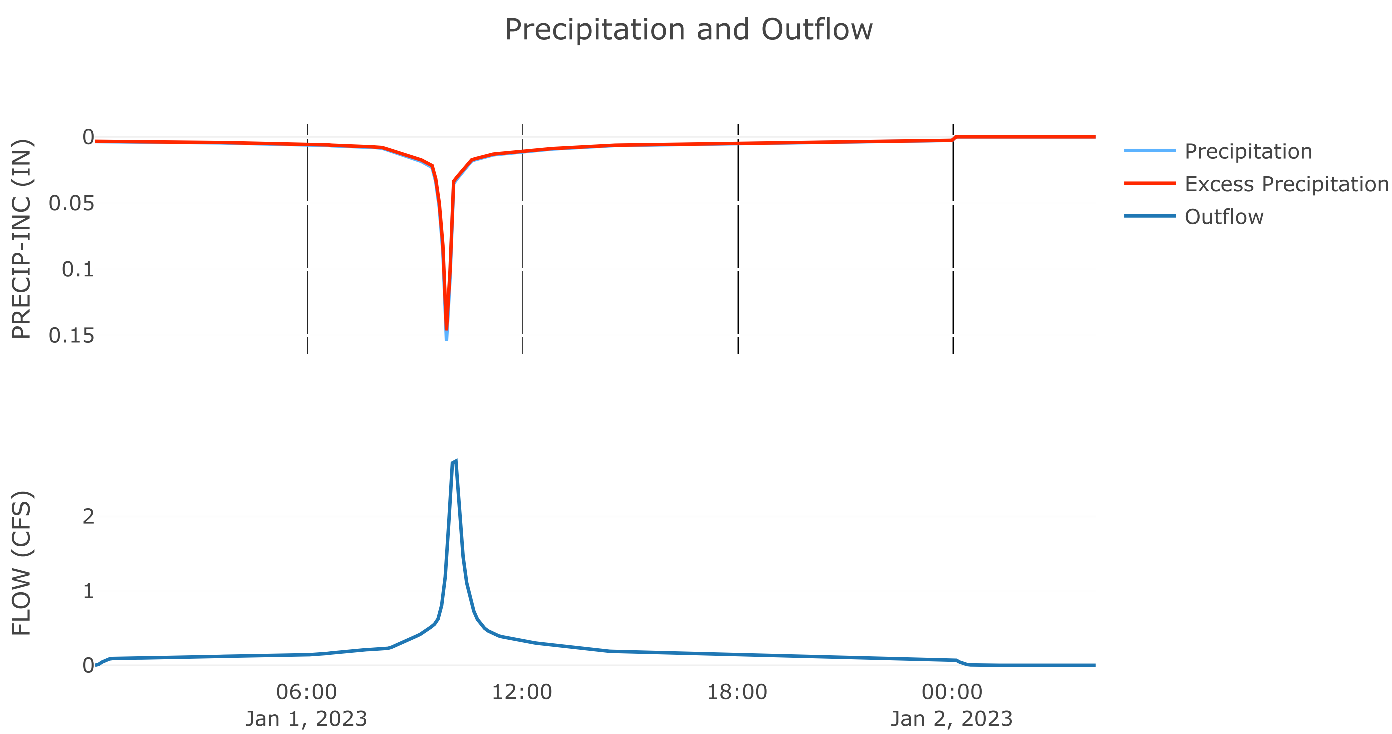
Subbasin: Pre-180

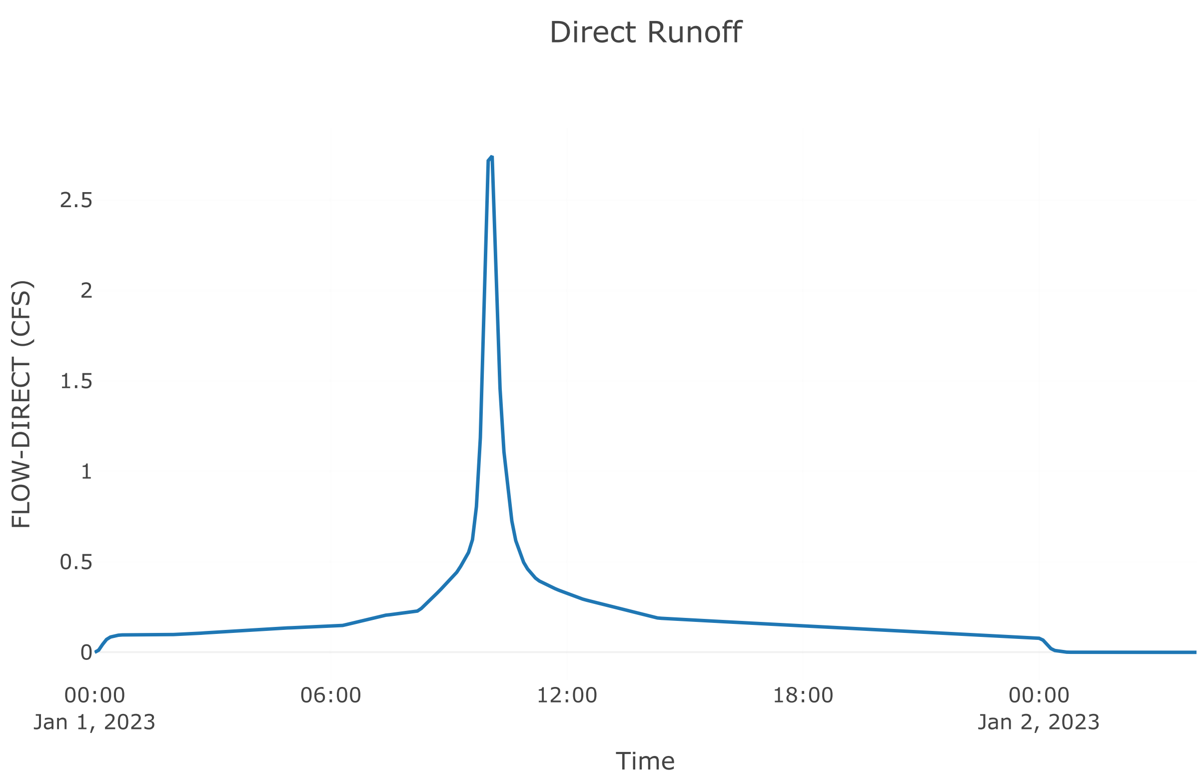
Area (MI2) : 0

Loss Rate: Scs	
Percent Impervious Area	94.1
Curve Number	75

Transform: Scs	
Lag	10.6
Unitgraph Type	Standard

Results: Pre-180	
Peak Discharge (CFS)	2.74
Time of Peak Discharge	01Jan2023, 10:06
Volume (IN)	1.95
Precipitation Volume (AC - FT)	0.49
Loss Volume (AC - FT)	0.02
Excess Volume (AC - FT)	0.47
Direct Runoff Volume (AC - FT)	0.47
Baseflow Volume (AC - FT)	0


Precipitation and Outflow
PRECIP-INC (IN)
0
0.05
0.1
0.15
Precipitation
Excess Precipitation
Outflow
FLOW (CFS)
2
1
0
06:00
Jan 1, 2023
12:00
18:00
00:00
Jan 2, 2023


Direct Runoff
FLOW-DIRECT (CFS)
2.5
2
1.5
1
0.5
0
00:00
Jan 1, 2023
06:00
12:00
18:00
00:00
Jan 2, 2023
Time

Subbasin: Pre-190

Area (MI2) : 0.01

Loss Rate: Scs

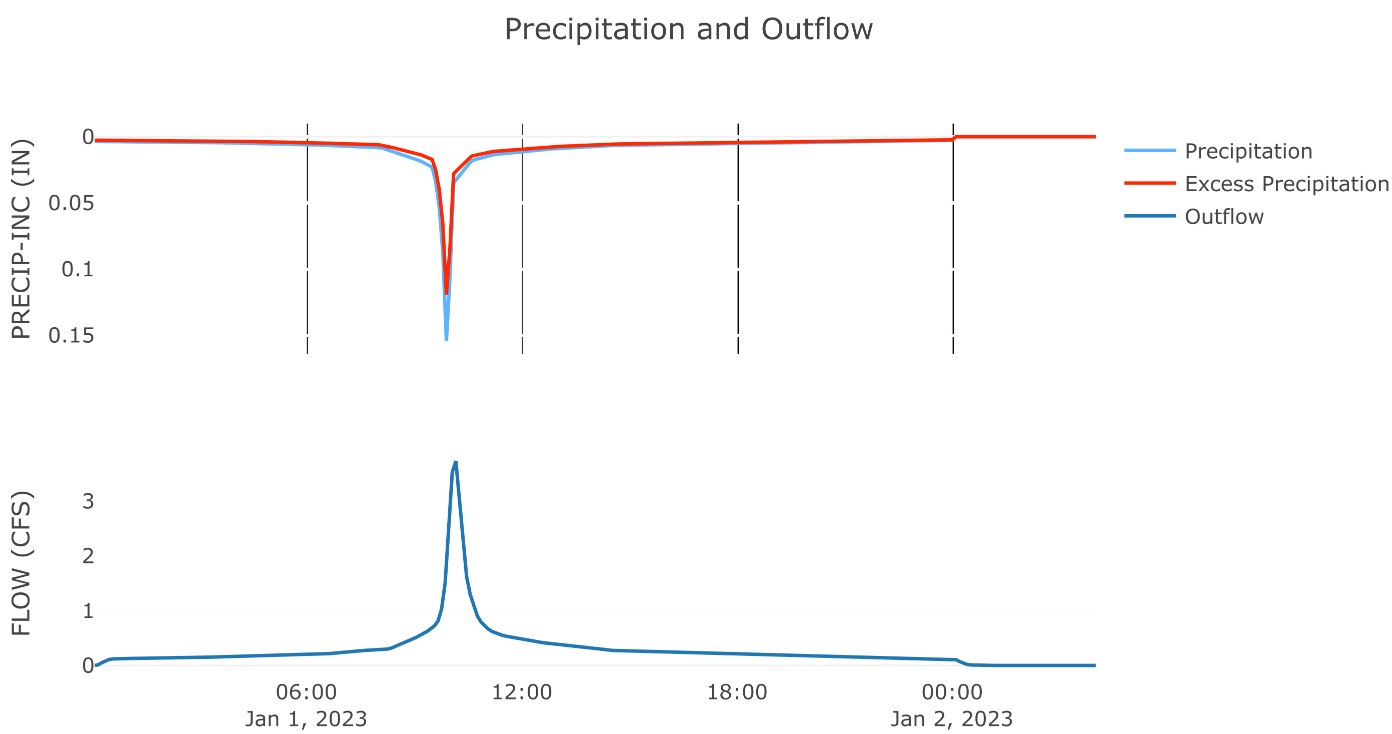
Percent Impervious Area	74.3
Curve Number	75

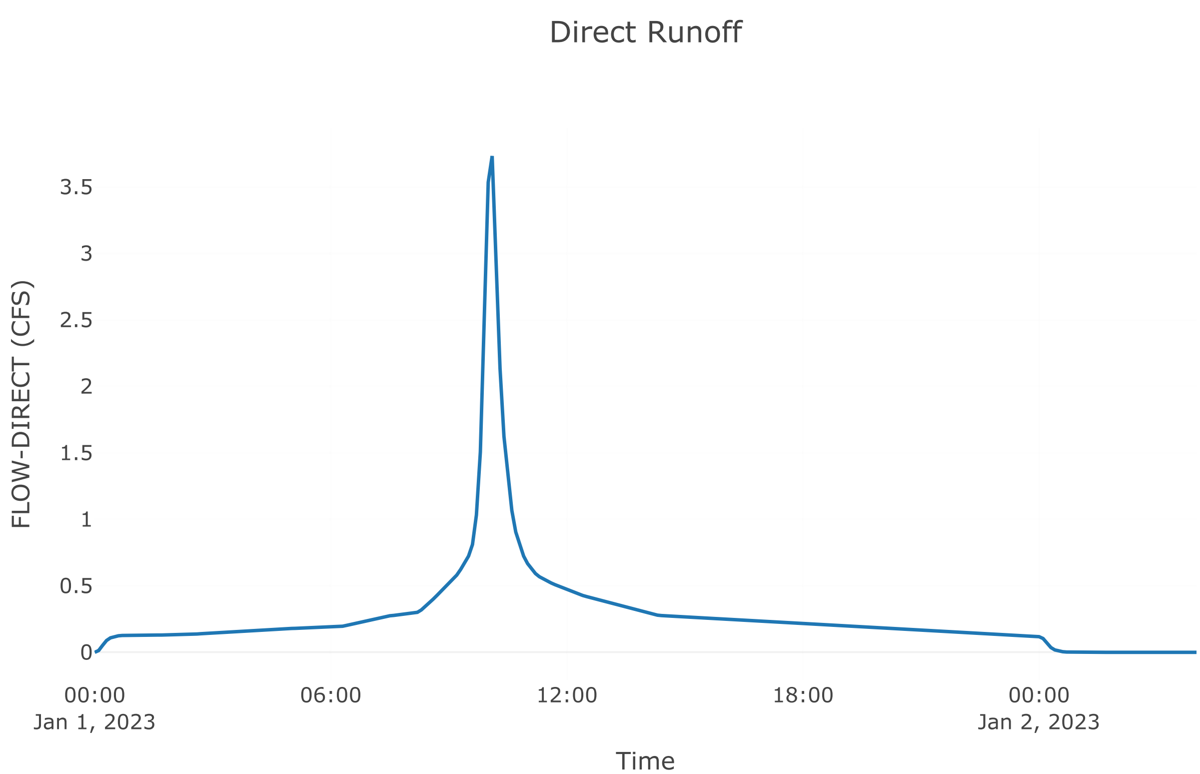
Transform: Scs

Lag	11.4
Unitgraph Type	Standard

Results: Pre-190

Peak Discharge (CFS)	3.73
Time of Peak Discharge	01Jan2023, 10:06
Volume (IN)	1.63
Precipitation Volume (AC - FT)	0.82
Loss Volume (AC - FT)	0.17
Excess Volume (AC - FT)	0.65
Direct Runoff Volume (AC - FT)	0.65
Baseflow Volume (AC - FT)	0


Precipitation and Outflow
PRECIP-INC (IN)
0
0.05
0.1
0.15
Precipitation
Excess Precipitation
Outflow
FLOW (CFS)
3
2
1
0
06:00
Jan 1, 2023
12:00
18:00
00:00
Jan 2, 2023


Direct Runoff
FLOW-DIRECT (CFS)
3.5
3
2.5
2
1.5
1
0.5
0
00:00
Jan 1, 2023
06:00
12:00
18:00
00:00
Jan 2, 2023
Time

Subbasin: Pre-200

Area (MI2) : 0.01

Loss Rate: Scs

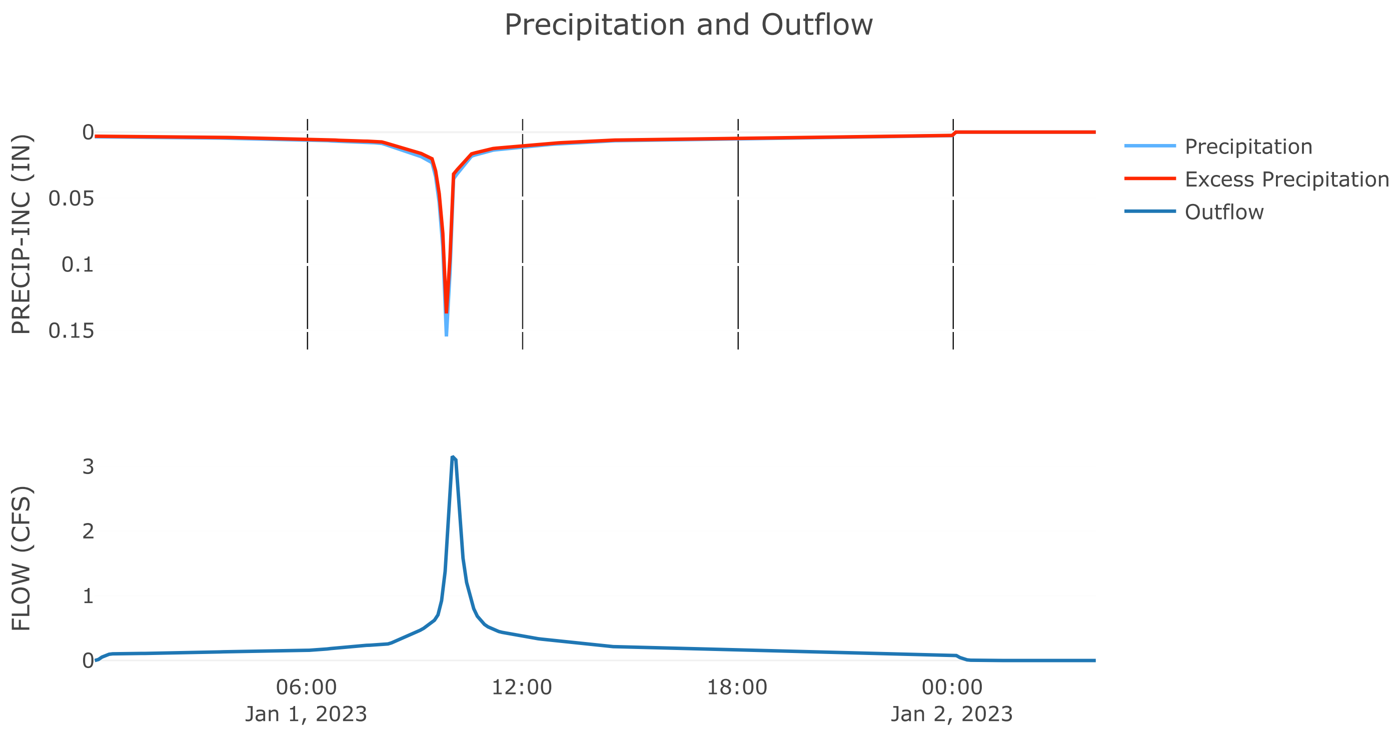
Percent Impervious Area	87.3
Curve Number	75

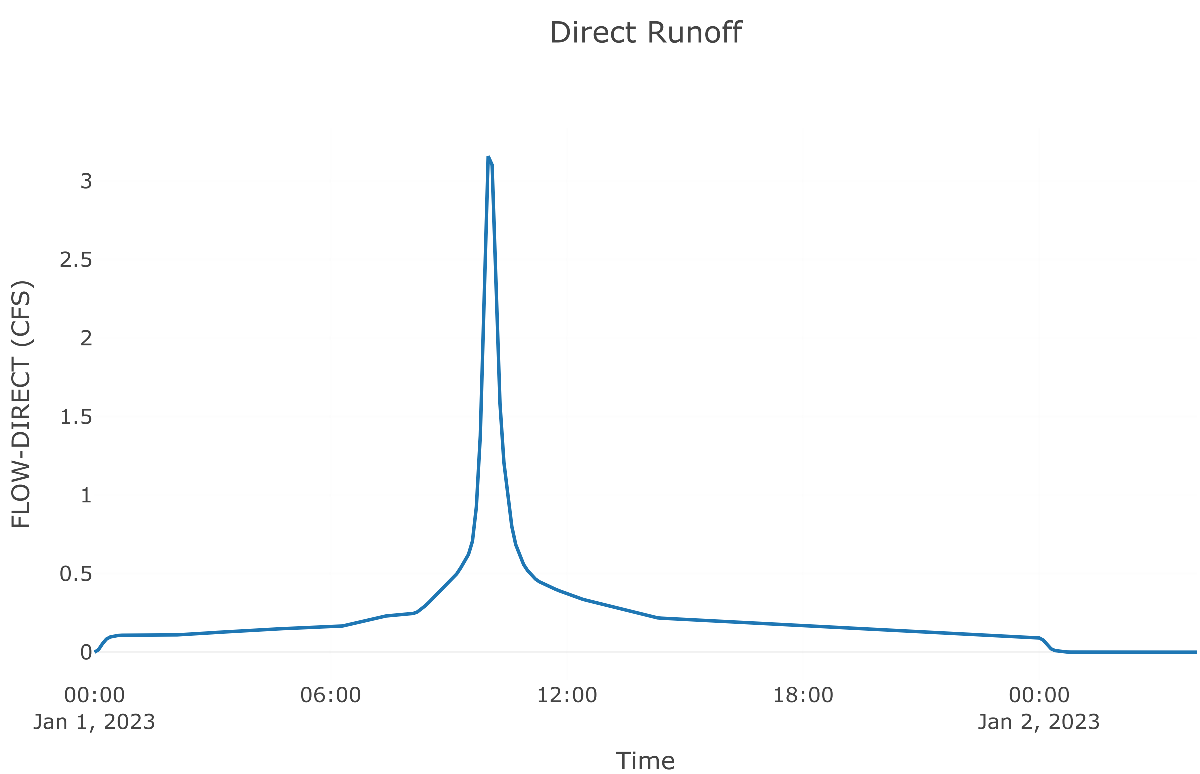
Transform: Scs

Lag	10
Unitgraph Type	Standard

Results: Pre-200

Peak Discharge (CFS)	3.16
Time of Peak Discharge	01Jan2023, 10:00
Volume (IN)	1.84
Precipitation Volume (AC - FT)	0.59
Loss Volume (AC - FT)	0.06
Excess Volume (AC - FT)	0.53
Direct Runoff Volume (AC - FT)	0.53
Baseflow Volume (AC - FT)	0


Precipitation and Outflow
PRECIP-INC (IN)
0
0.05
0.1
0.15
Precipitation
Excess Precipitation
Outflow
FLOW (CFS)
3
2
1
0
06:00
Jan 1, 2023
12:00
18:00
00:00
Jan 2, 2023


Direct Runoff
FLOW-DIRECT (CFS)
3
2.5
2
1.5
1
0.5
0
00:00
Jan 1, 2023
06:00
12:00
18:00
00:00
Jan 2, 2023
Time

Subbasin: Pre-210

Area (MI2) : 0

Loss Rate: Scs

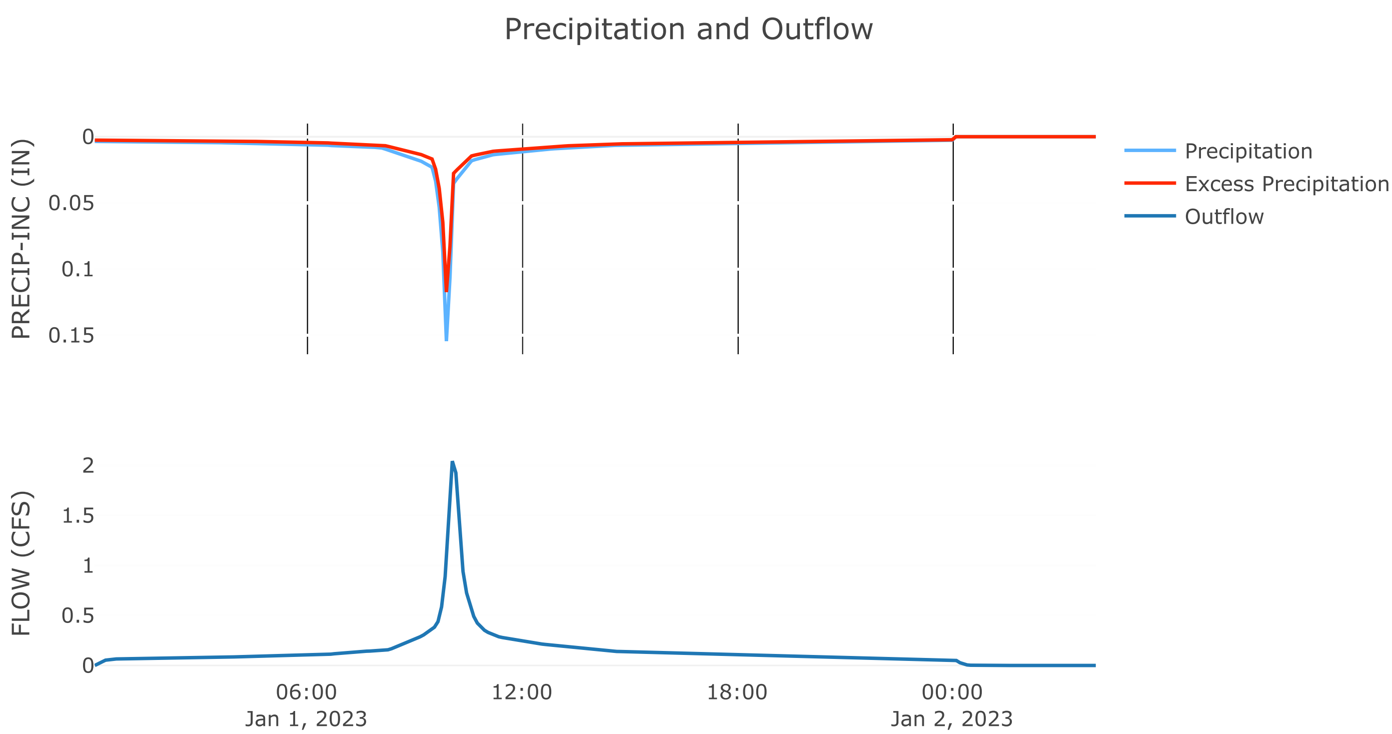
Percent Impervious Area	73
Curve Number	75

Transform: Scs

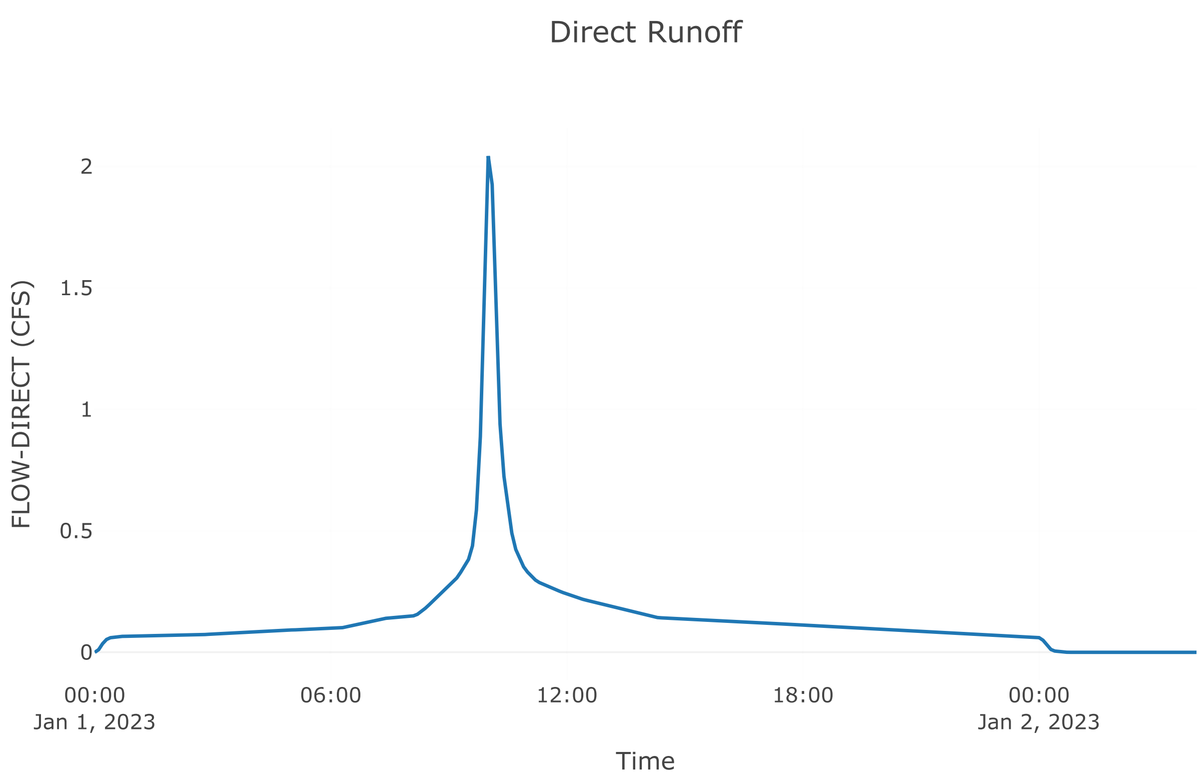
Lag	9.2
Unitgraph Type	Standard

Results: Pre-210

Peak Discharge (CFS)	2.04
Time of Peak Discharge	01Jan2023, 10:00
Volume (IN)	1.61
Precipitation Volume (AC - FT)	0.43
Loss Volume (AC - FT)	0.09
Excess Volume (AC - FT)	0.34
Direct Runoff Volume (AC - FT)	0.34
Baseflow Volume (AC - FT)	0



Precipitation and Outflow
PRECIP-INC (IN)
0
0.05
0.1
0.15
Precipitation
Excess Precipitation
Outflow
FLOW (CFS)
2
1.5
1
0.5
0
06:00
Jan 1, 2023
12:00
18:00
00:00
Jan 2, 2023



Direct Runoff
FLOW-DIRECT (CFS)
2
1.5
1
0.5
0
00:00
Jan 1, 2023
06:00
12:00
18:00
00:00
Jan 2, 2023
Time

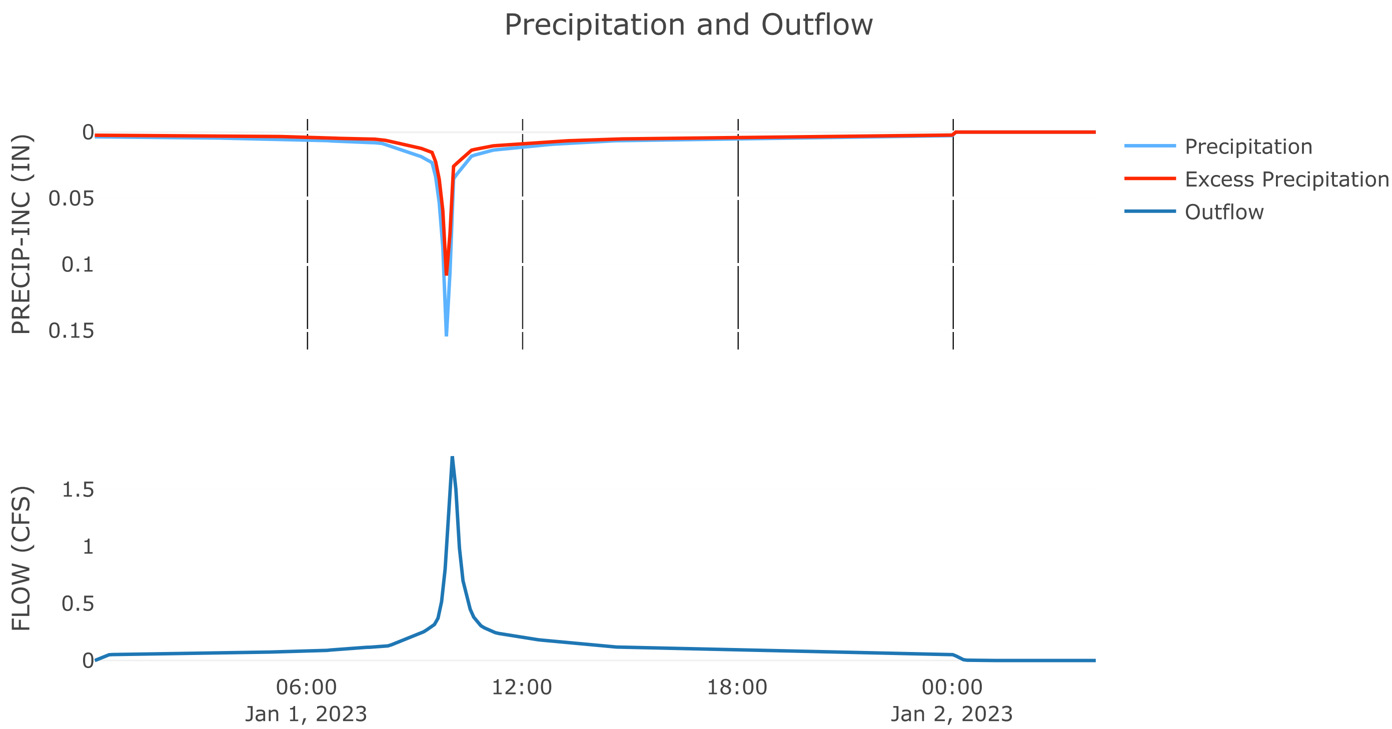
Subbasin: Pre-220

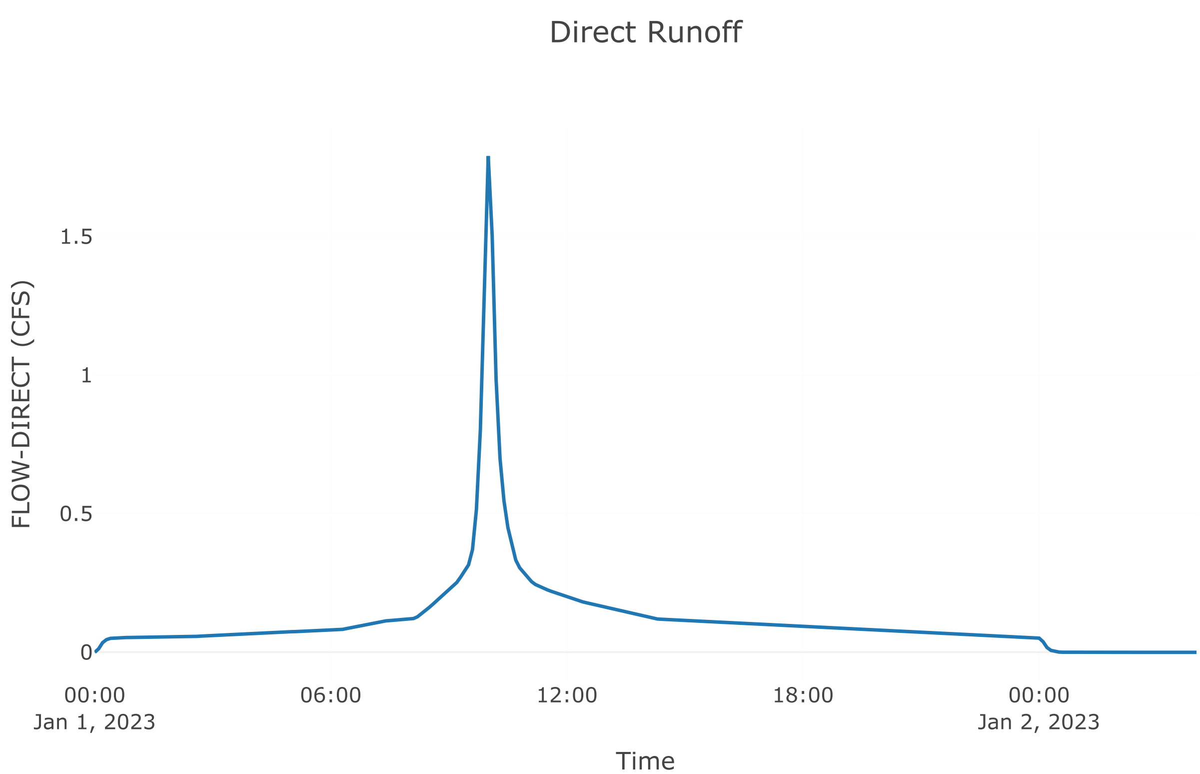
Area (MI2) : 0

Loss Rate: Scs	
Percent Impervious Area	66.5
Curve Number	75

Transform: Scs	
Lag	7.8
Unitgraph Type	Standard

Results: Pre-220	
Peak Discharge (CFS)	1.79
Time of Peak Discharge	01Jan2023, 10:00
Volume (IN)	1.5
Precipitation Volume (AC - FT)	0.38
Loss Volume (AC - FT)	0.1
Excess Volume (AC - FT)	0.28
Direct Runoff Volume (AC - FT)	0.28
Baseflow Volume (AC - FT)	0


Precipitation and Outflow
PRECIP-INC (IN)
0
0.05
0.1
0.15
Precipitation
Excess Precipitation
Outflow
FLOW (CFS)
1.5
1
0.5
0
06:00
Jan 1, 2023
12:00
18:00
00:00
Jan 2, 2023


Direct Runoff
FLOW-DIRECT (CFS)
1.5
1
0.5
0
00:00
Jan 1, 2023
06:00
12:00
18:00
00:00
Jan 2, 2023
Time

Subbasin: Pre-230

Area (MI2) : 0.01

Loss Rate: Scs

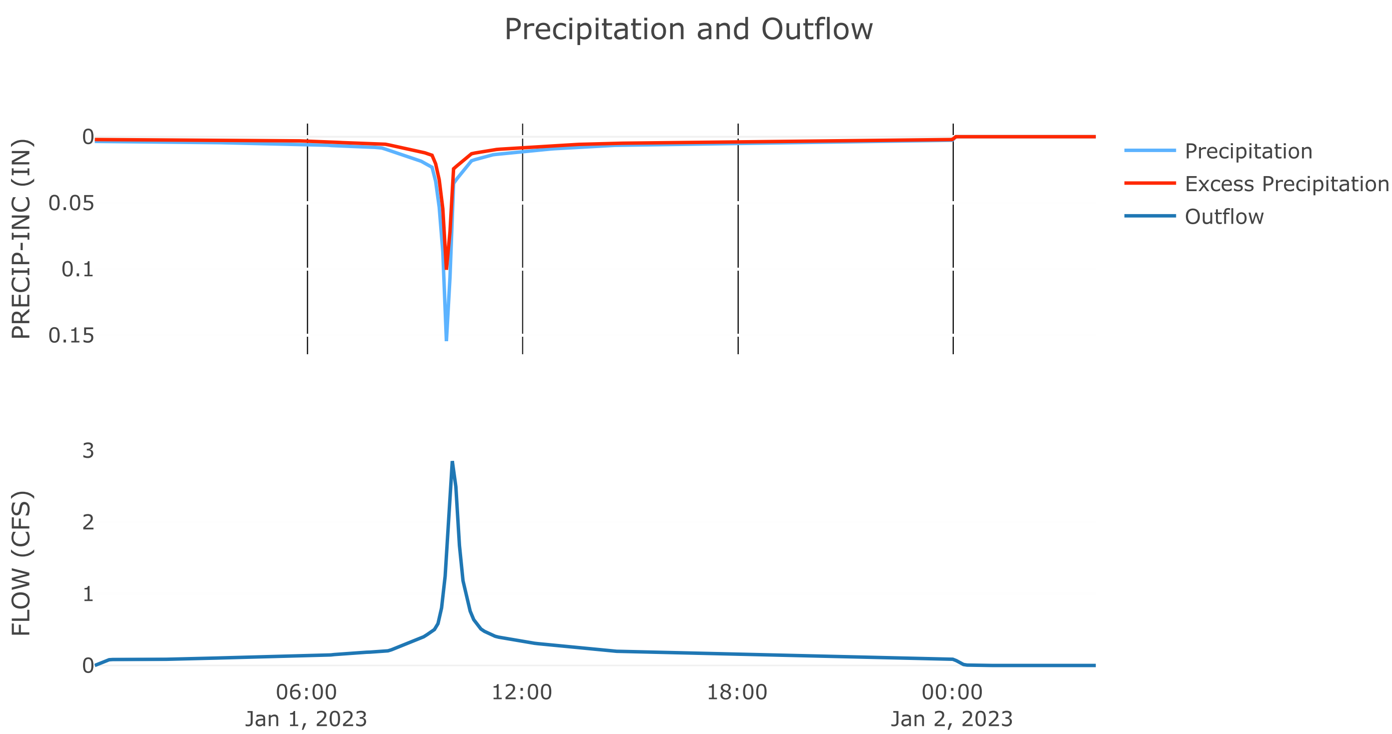
Percent Impervious Area	60.7
Curve Number	75

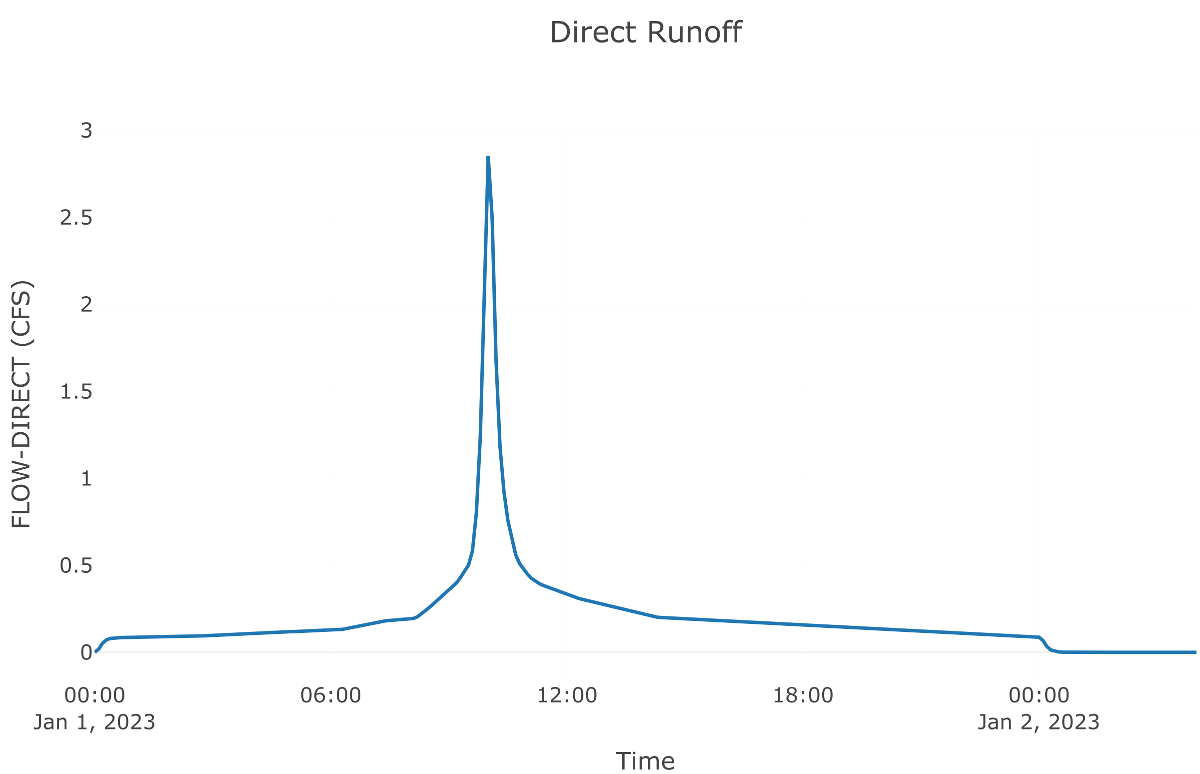
Transform: Scs

Lag	8.2
Unitgraph Type	Standard

Results: Pre-230

Peak Discharge (CFS)	2.85
Time of Peak Discharge	01Jan2023, 10:00
Volume (IN)	1.4
Precipitation Volume (AC - FT)	0.67
Loss Volume (AC - FT)	0.21
Excess Volume (AC - FT)	0.46
Direct Runoff Volume (AC - FT)	0.46
Baseflow Volume (AC - FT)	0


Precipitation and Outflow
PRECIP-INC (IN)
0
0.05
0.1
0.15
Precipitation
Excess Precipitation
Outflow
FLOW (CFS)
3
2
1
0
06:00
Jan 1, 2023
12:00
18:00
00:00
Jan 2, 2023


Direct Runoff
FLOW-DIRECT (CFS)
3
2.5
2
1.5
1
0.5
0
00:00
Jan 1, 2023
06:00
12:00
18:00
00:00
Jan 2, 2023
Time

Subbasin: Pre-240

Area (MI2) : 0

Loss Rate: Scs

Percent Impervious Area	60.3
Curve Number	75

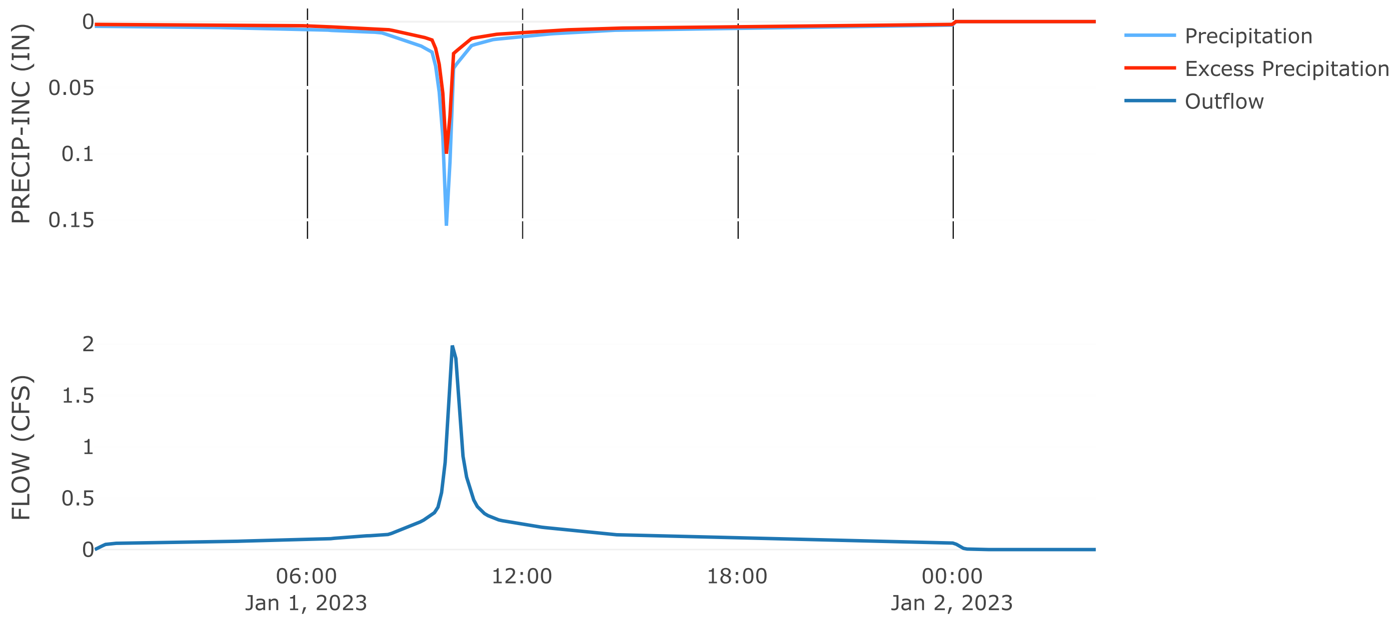
Transform: Scs

Lag	9
Unitgraph Type	Standard

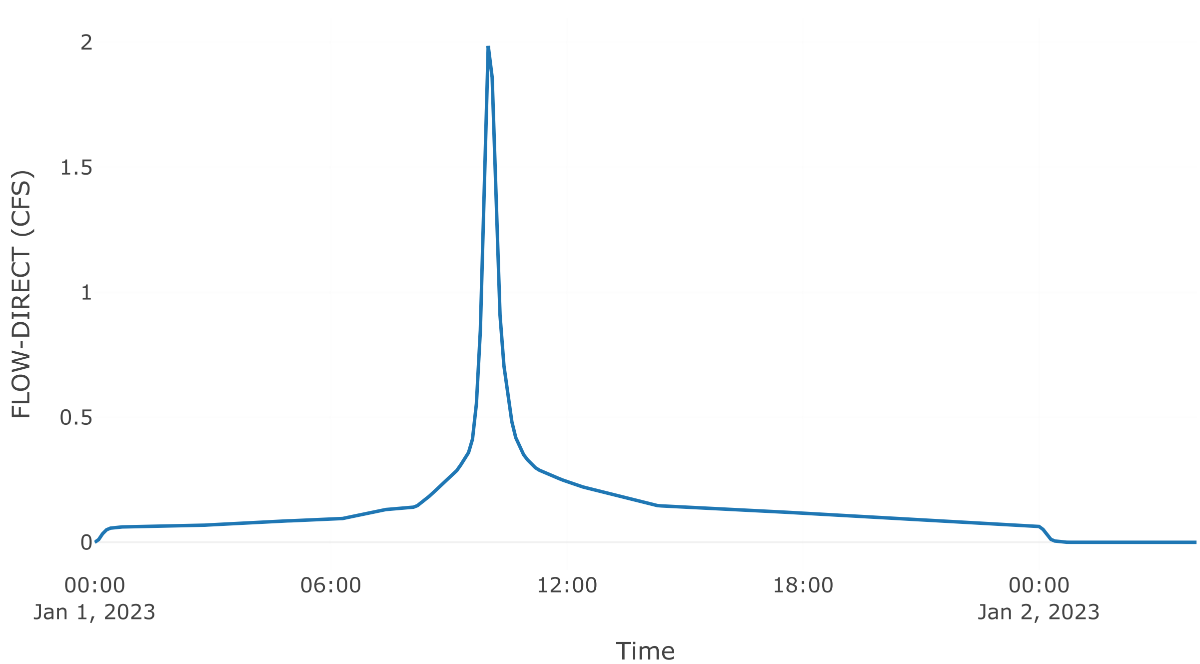
Results: Pre-240

Peak Discharge (CFS)	1.99
Time of Peak Discharge	01Jan2023, 10:00
Volume (IN)	1.4
Precipitation Volume (AC - FT)	0.49
Loss Volume (AC - FT)	0.15
Excess Volume (AC - FT)	0.33
Direct Runoff Volume (AC - FT)	0.33
Baseflow Volume (AC - FT)	0

Precipitation and Outflow



Direct Runoff



Subbasin: Pre-250

Area (MI2) : 0.01

Loss Rate: Scs

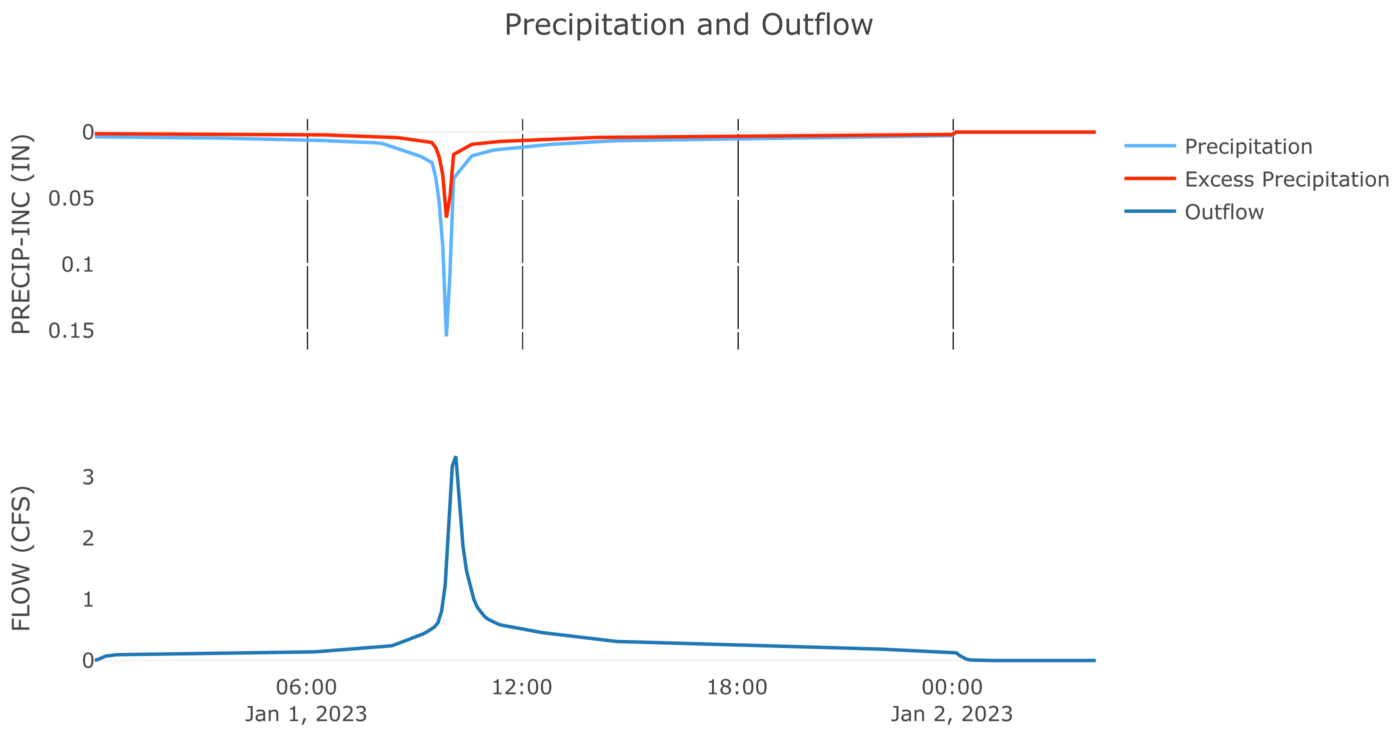
Percent Impervious Area	34.5
Curve Number	75

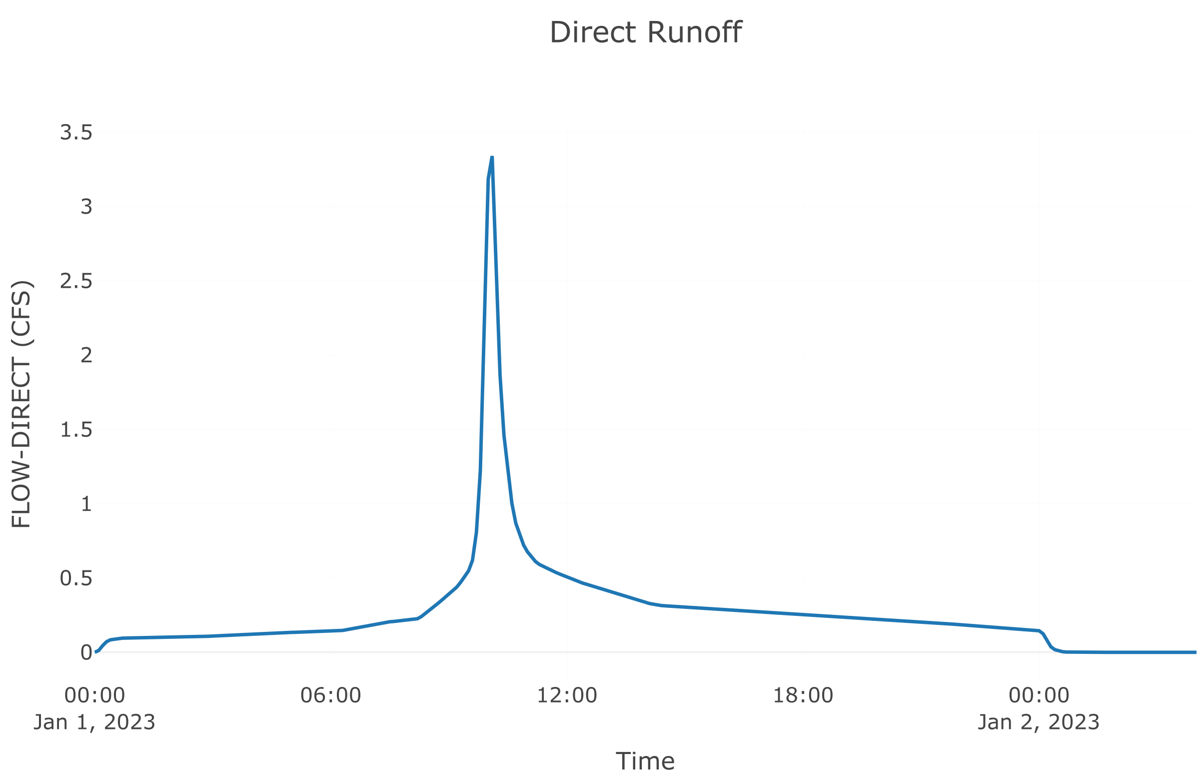
Transform: Scs

Lag	10.4
Unitgraph Type	Standard

Results: Pre-250

Peak Discharge (CFS)	3.34
Time of Peak Discharge	01Jan2023, 10:06
Volume (IN)	0.97
Precipitation Volume (AC - FT)	1.33
Loss Volume (AC - FT)	0.7
Excess Volume (AC - FT)	0.63
Direct Runoff Volume (AC - FT)	0.63
Baseflow Volume (AC - FT)	0


Precipitation and Outflow
PRECIP-INC (IN)
0
0.05
0.1
0.15
Precipitation
Excess Precipitation
Outflow
FLOW (CFS)
3
2
1
0
06:00
Jan 1, 2023
12:00
18:00
00:00
Jan 2, 2023


Direct Runoff
FLOW-DIRECT (CFS)
3.5
3
2.5
2
1.5
1
0.5
0
00:00
Jan 1, 2023
06:00
12:00
18:00
00:00
Jan 2, 2023
Time

Subbasin: Pre-260

Area (MI2) : 0.01

Loss Rate: Scs

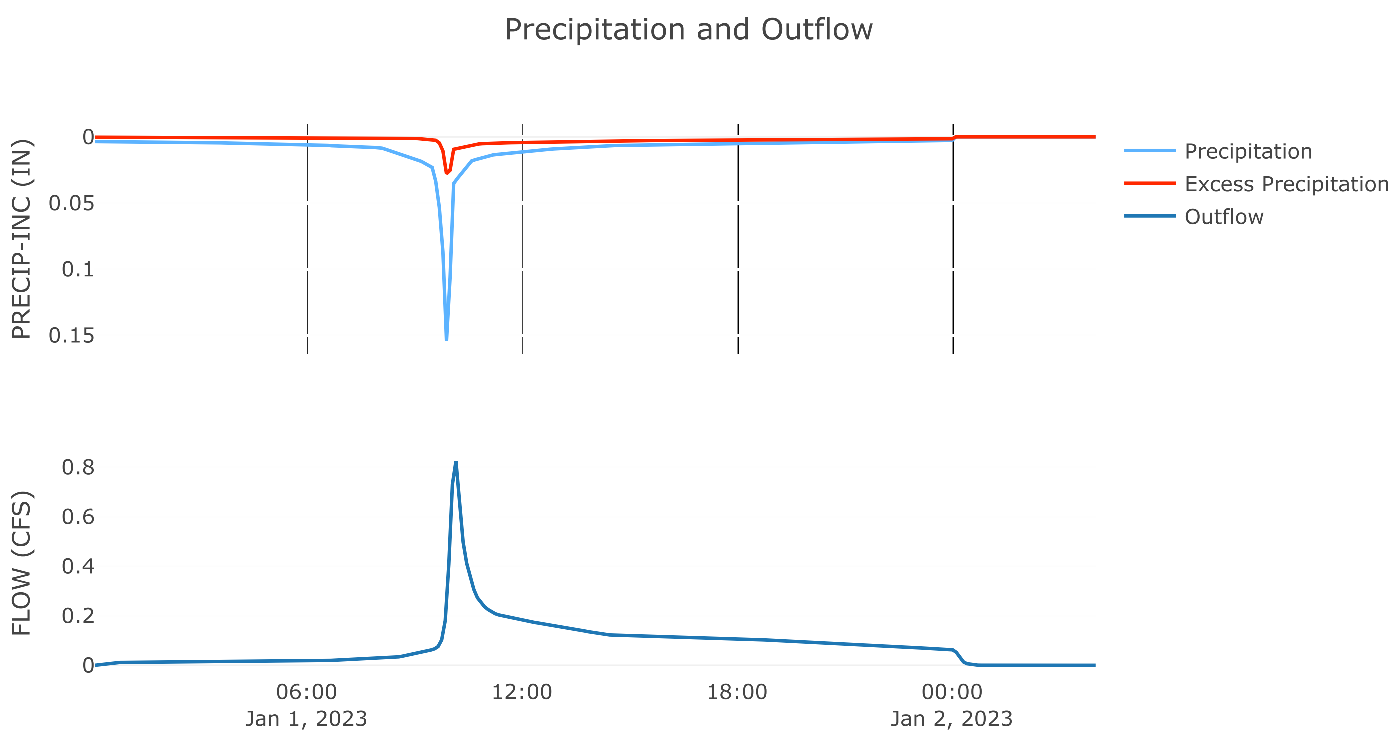
Percent Impervious Area	7.7
Curve Number	75

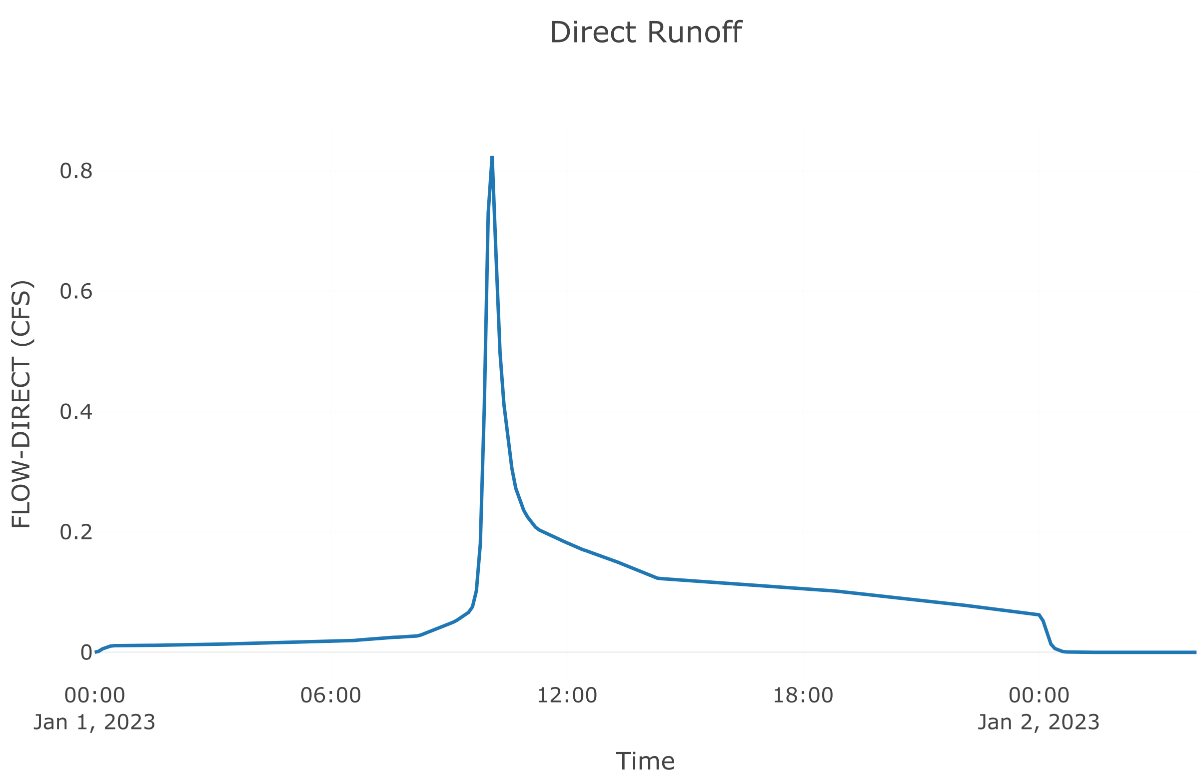
Transform: Scs

Lag	9.7
Unitgraph Type	Standard

Results: Pre-260

Peak Discharge (CFS)	0.82
Time of Peak Discharge	01Jan2023, 10:06
Volume (IN)	0.53
Precipitation Volume (AC - FT)	0.71
Loss Volume (AC - FT)	0.53
Excess Volume (AC - FT)	0.18
Direct Runoff Volume (AC - FT)	0.18
Baseflow Volume (AC - FT)	0


Precipitation and Outflow
PRECIP-INC (IN)
0
0.05
0.1
0.15
Precipitation
Excess Precipitation
Outflow
FLOW (CFS)
0.8
0.6
0.4
0.2
0
06:00
Jan 1, 2023
12:00
18:00
00:00
Jan 2, 2023


Direct Runoff
FLOW-DIRECT (CFS)
0.8
0.6
0.4
0.2
0
00:00
Jan 1, 2023
06:00
12:00
18:00
00:00
Jan 2, 2023
Time

Subbasin: Pre-270

Area (MI2) : 0.01

Loss Rate: Scs

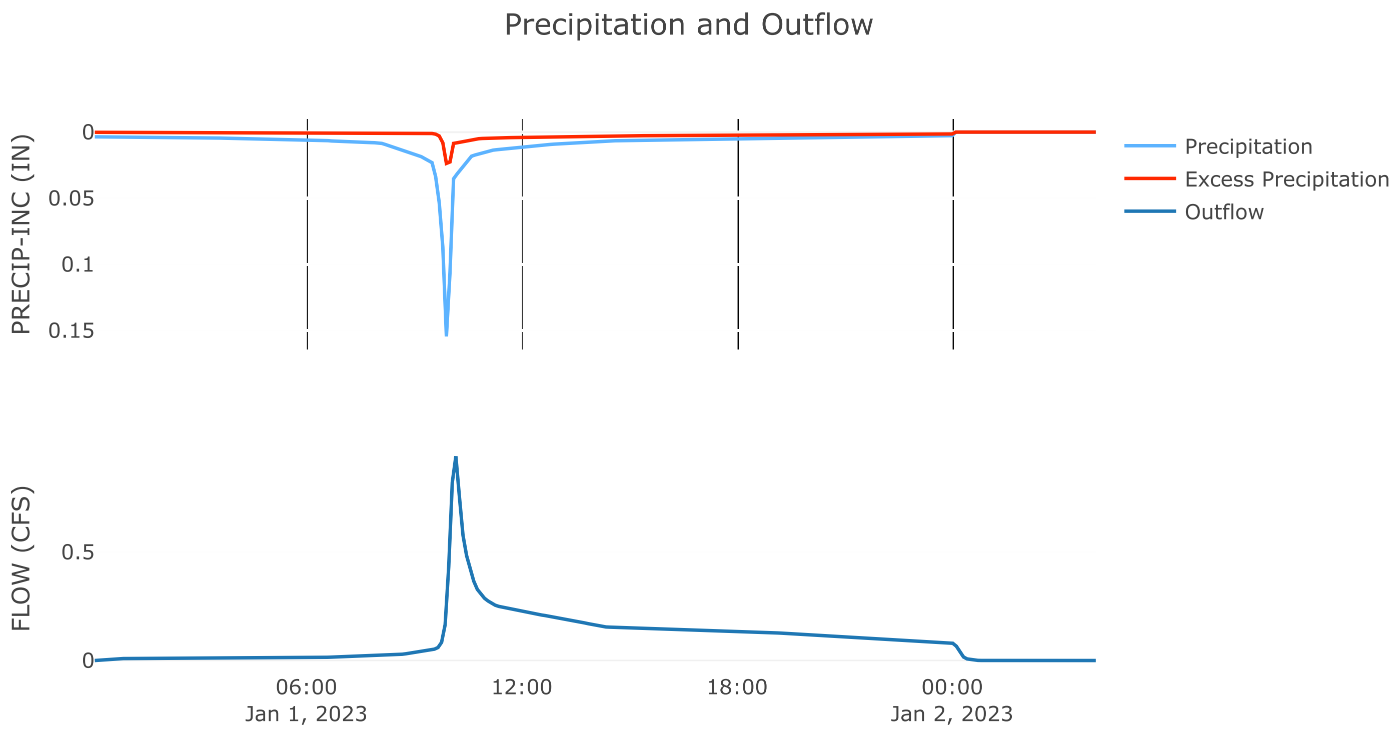
Percent Impervious Area	4.6
Curve Number	75

Transform: Scs

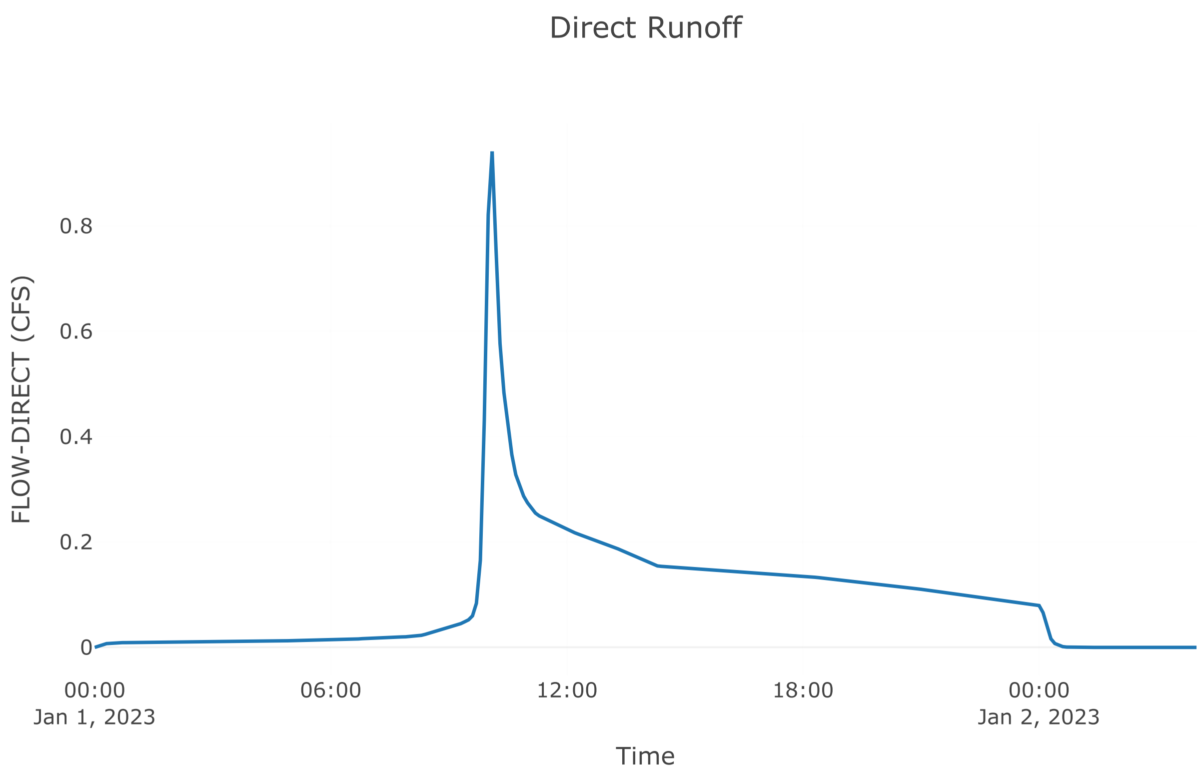
Lag	9.4
Unitgraph Type	Standard

Results: Pre-270

Peak Discharge (CFS)	0.94
Time of Peak Discharge	01Jan2023, 10:06
Volume (IN)	0.48
Precipitation Volume (AC - FT)	0.94
Loss Volume (AC - FT)	0.72
Excess Volume (AC - FT)	0.22
Direct Runoff Volume (AC - FT)	0.22
Baseflow Volume (AC - FT)	0



Precipitation and Outflow
PRECIP-INC (IN)
0
0.05
0.1
0.15
Precipitation
Excess Precipitation
Outflow
FLOW (CFS)
0.5
0
06:00
Jan 1, 2023
12:00
18:00
00:00
Jan 2, 2023



Direct Runoff
FLOW-DIRECT (CFS)
0.8
0.6
0.4
0.2
0
00:00
Jan 1, 2023
06:00
12:00
18:00
00:00
Jan 2, 2023
Time

Subbasin: Pre-280

Area (MI2) : 0.01

Loss Rate: Scs

Percent Impervious Area	65.4
Curve Number	75

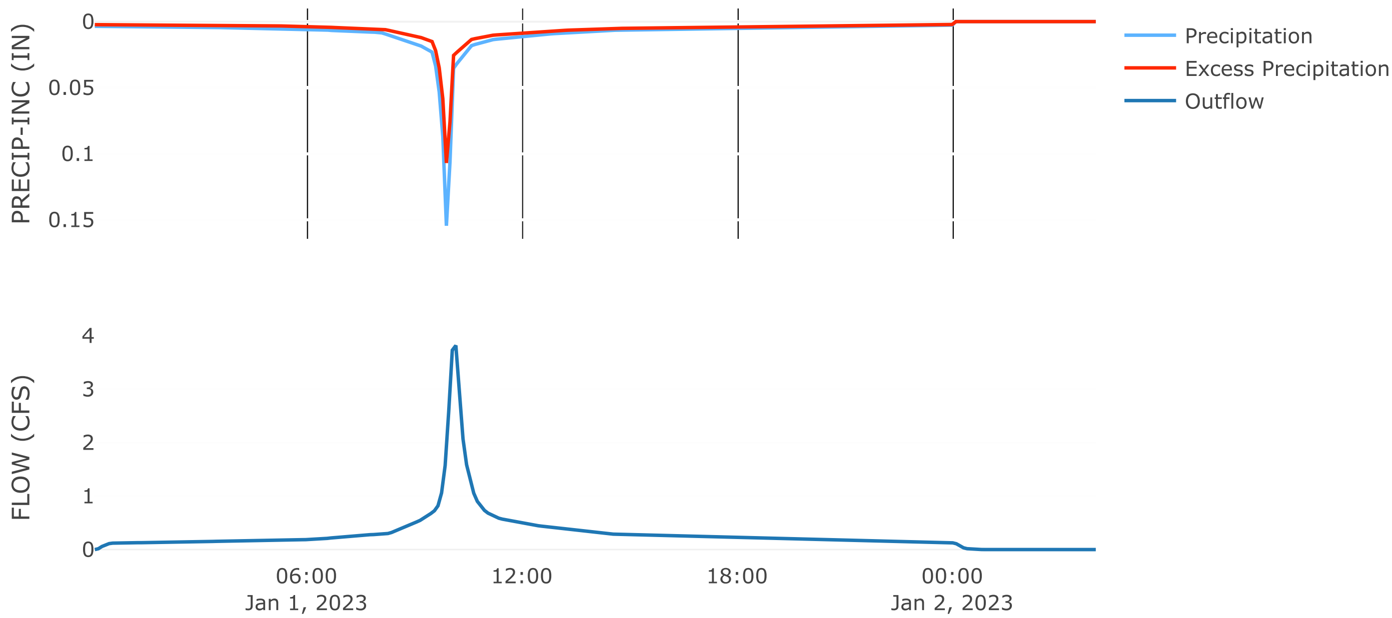
Transform: Scs

Lag	10.6
Unitgraph Type	Standard

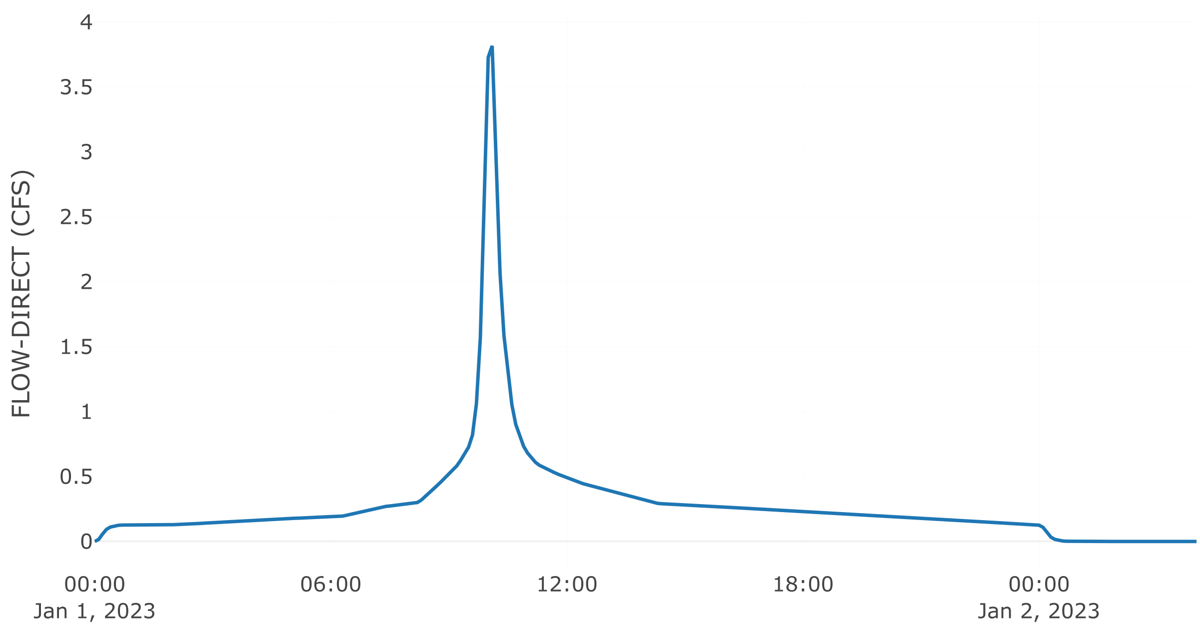
Results: Pre-280

Peak Discharge (CFS)	3.82
Time of Peak Discharge	01Jan2023, 10:06
Volume (IN)	1.48
Precipitation Volume (AC - FT)	0.93
Loss Volume (AC - FT)	0.26
Excess Volume (AC - FT)	0.67
Direct Runoff Volume (AC - FT)	0.67
Baseflow Volume (AC - FT)	0

Precipitation and Outflow



Direct Runoff



Post-Project (2-Year, 24-Hour)

Subbasin: Post-110

Area (MI2) : 0.01

Loss Rate: Scs

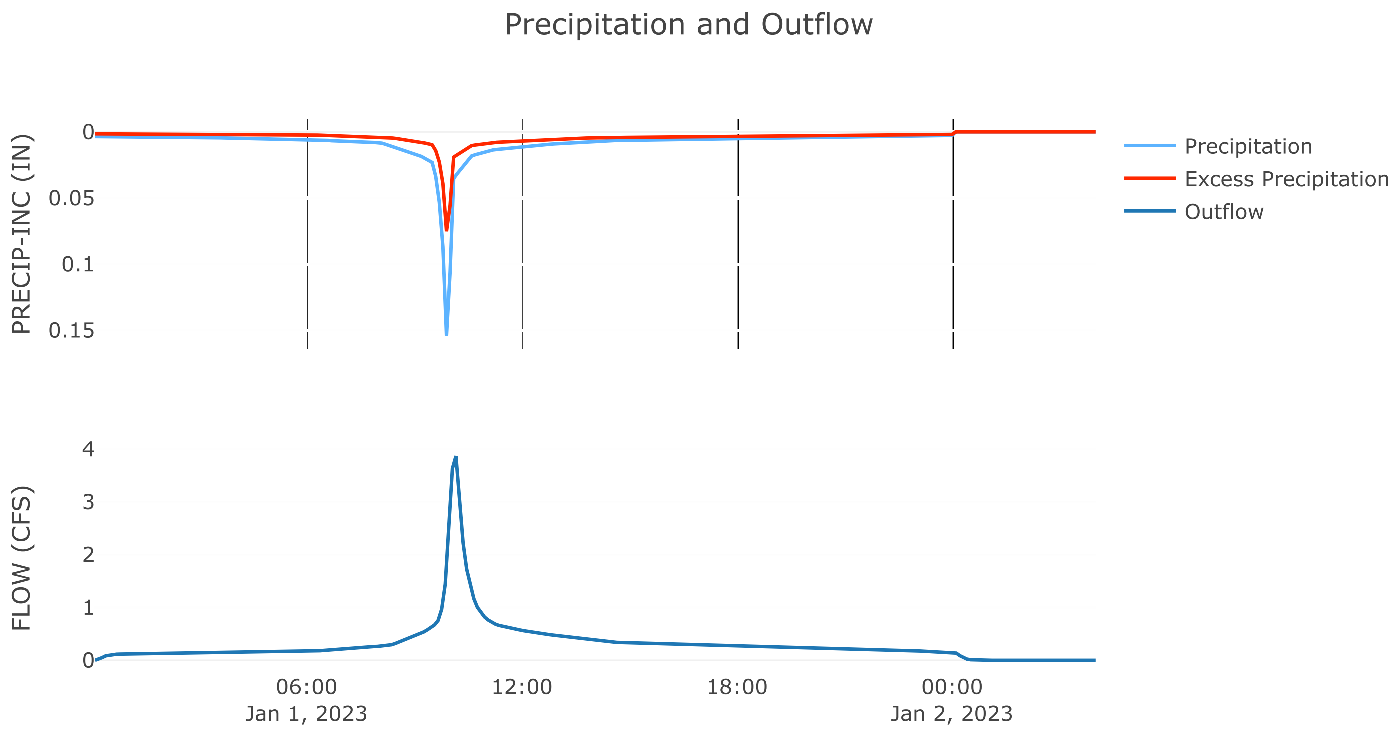
Percent Impervious Area	42.2
Curve Number	75

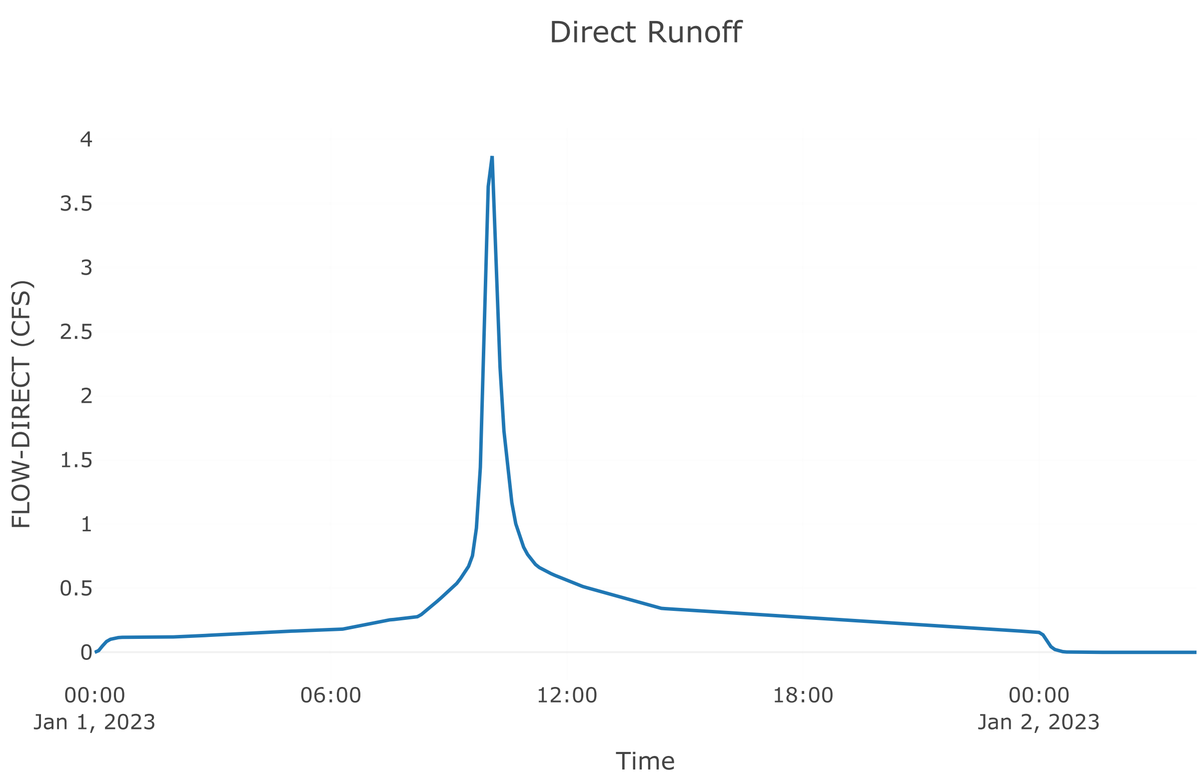
Transform: Scs

Lag	11
Unitgraph Type	Standard

Results: Post-110

Peak Discharge (CFS)	3.87
Time of Peak Discharge	01Jan2023, 10:06
Volume (IN)	1.1
Precipitation Volume (AC - FT)	1.34
Loss Volume (AC - FT)	0.62
Excess Volume (AC - FT)	0.72
Direct Runoff Volume (AC - FT)	0.72
Baseflow Volume (AC - FT)	0


Precipitation and Outflow
PRECIP-INC (IN)
0
0.05
0.1
0.15
Precipitation
Excess Precipitation
Outflow
FLOW (CFS)
4
3
2
1
0
06:00
Jan 1, 2023
12:00
18:00
00:00
Jan 2, 2023


Direct Runoff
FLOW-DIRECT (CFS)
4
3.5
3
2.5
2
1.5
1
0.5
0
00:00
Jan 1, 2023
06:00
12:00
18:00
00:00
Jan 2, 2023
Time

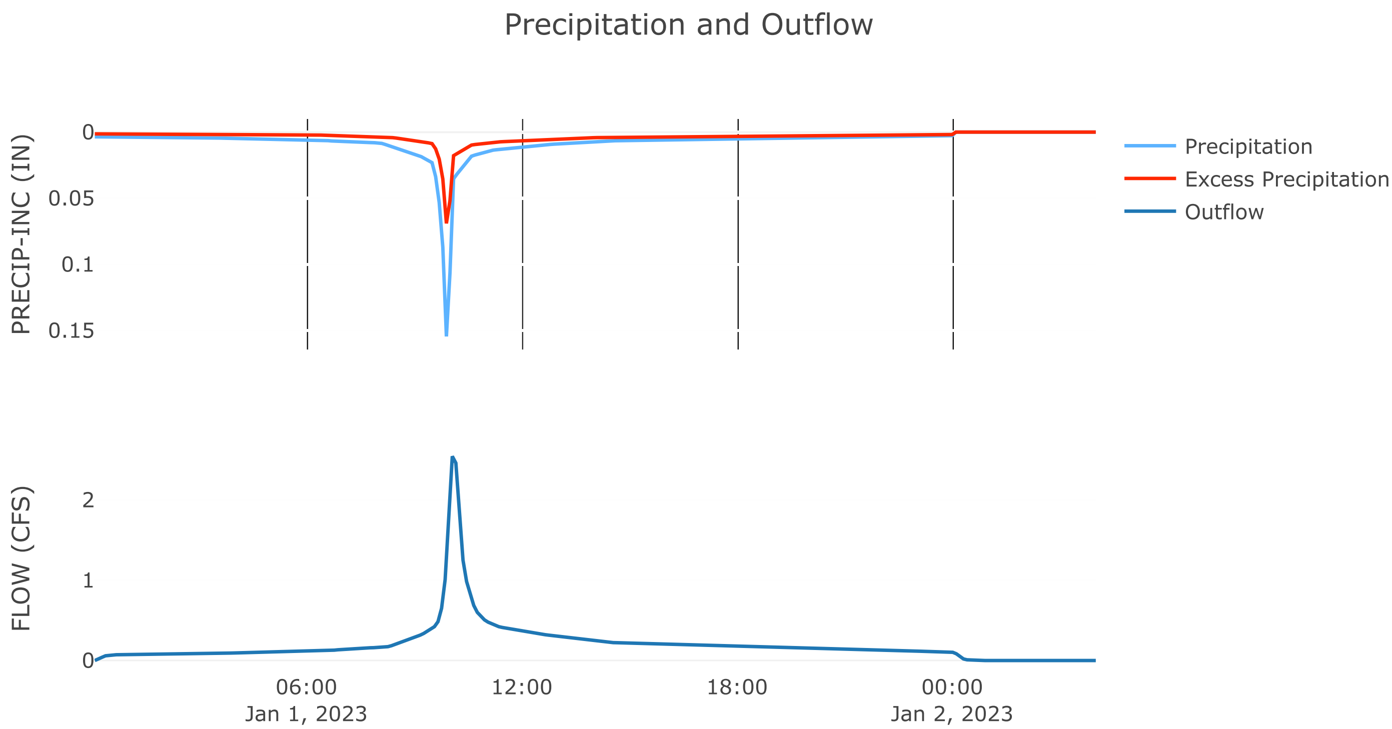
Subbasin: Post-120

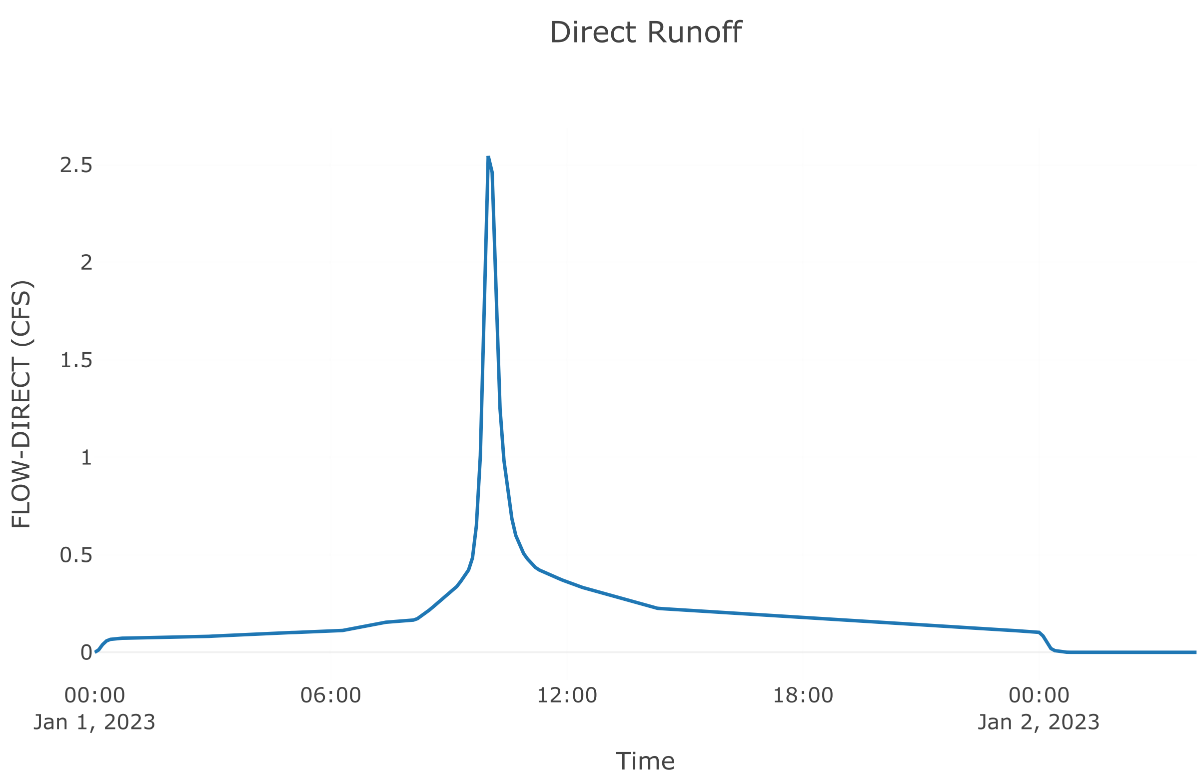
Area (MI2) : 0.01

Loss Rate: Scs	
Percent Impervious Area	37.7
Curve Number	75

Transform: Scs	
Lag	9.1
Unitgraph Type	Standard

Results: Post-120	
Peak Discharge (CFS)	2.55
Time of Peak Discharge	01Jan2023, 10:00
Volume (IN)	1.03
Precipitation Volume (AC - FT)	0.92
Loss Volume (AC - FT)	0.46
Excess Volume (AC - FT)	0.46
Direct Runoff Volume (AC - FT)	0.46
Baseflow Volume (AC - FT)	0


Precipitation and Outflow
PRECIP-INC (IN)
0
0.05
0.1
0.15
Precipitation
Excess Precipitation
Outflow
FLOW (CFS)
2
1
0
06:00
Jan 1, 2023
12:00
18:00
00:00
Jan 2, 2023


Direct Runoff
FLOW-DIRECT (CFS)
2.5
2
1.5
1
0.5
0
00:00
Jan 1, 2023
06:00
12:00
18:00
00:00
Jan 2, 2023
Time

Subbasin: Post-130

Area (MI2) : 0.01

Loss Rate: Scs

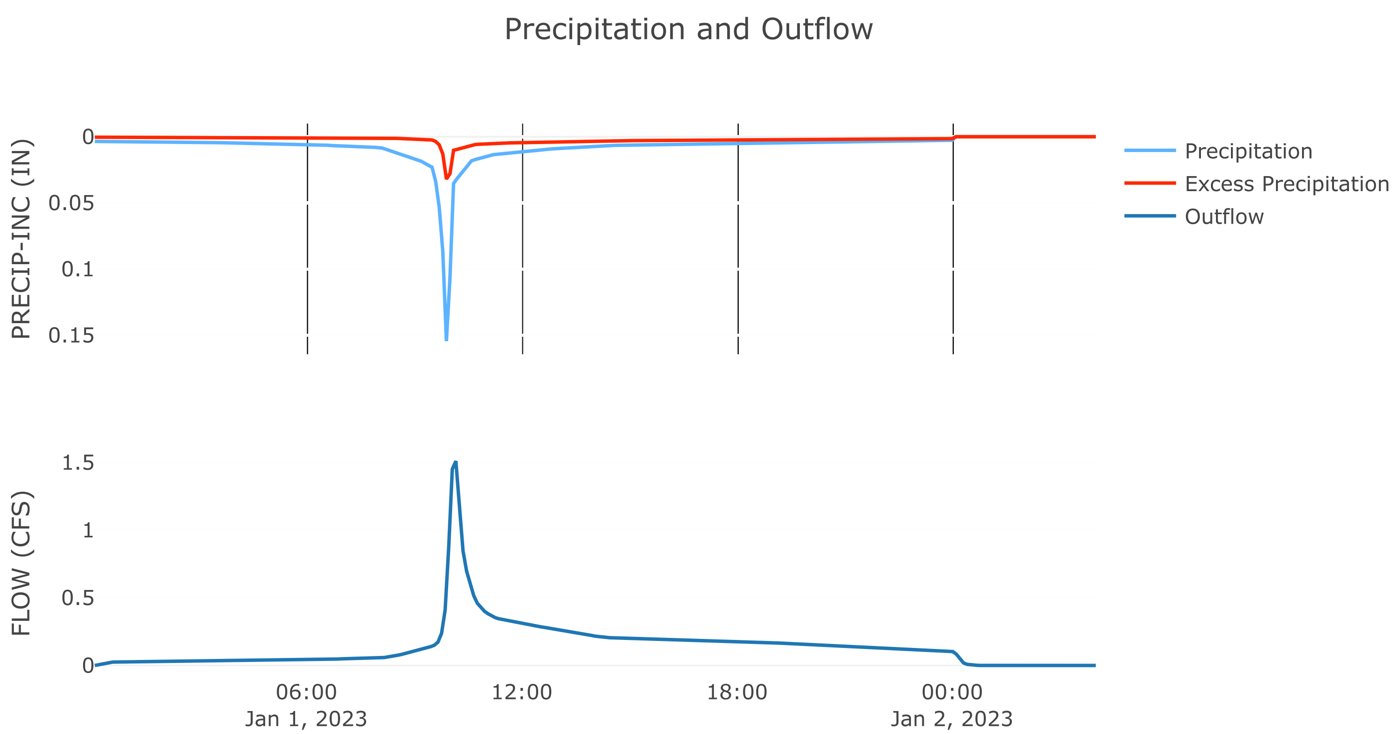
Percent Impervious Area	10.7
Curve Number	75

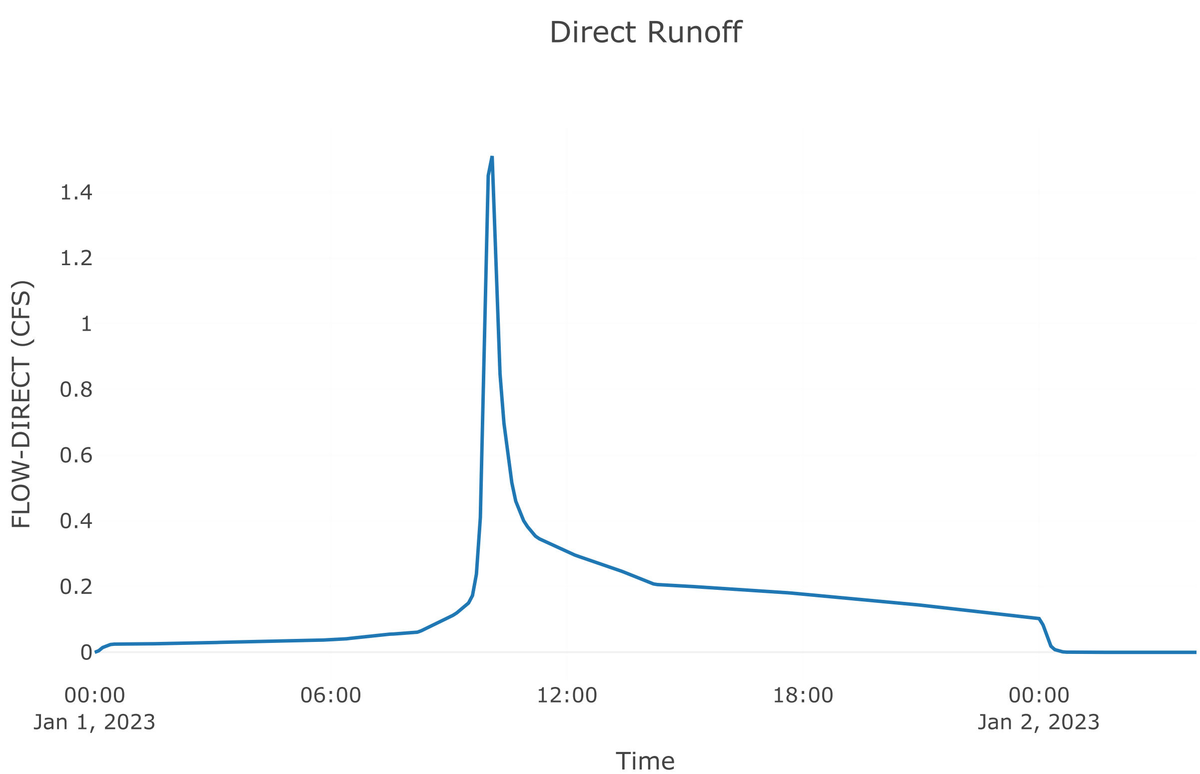
Transform: Scs

Lag	8.9
Unitgraph Type	Standard

Results: Post-130

Peak Discharge (CFS)	1.51
Time of Peak Discharge	01Jan2023, 10:06
Volume (IN)	0.58
Precipitation Volume (AC - FT)	1.14
Loss Volume (AC - FT)	0.82
Excess Volume (AC - FT)	0.32
Direct Runoff Volume (AC - FT)	0.32
Baseflow Volume (AC - FT)	0


Precipitation and Outflow
PRECIP-INC (IN)
0
0.05
0.1
0.15
Precipitation
Excess Precipitation
Outflow
FLOW (CFS)
1.5
1
0.5
0
06:00
Jan 1, 2023
12:00
18:00
00:00
Jan 2, 2023


Direct Runoff
FLOW-DIRECT (CFS)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
00:00
Jan 1, 2023
06:00
12:00
18:00
00:00
Jan 2, 2023
Time

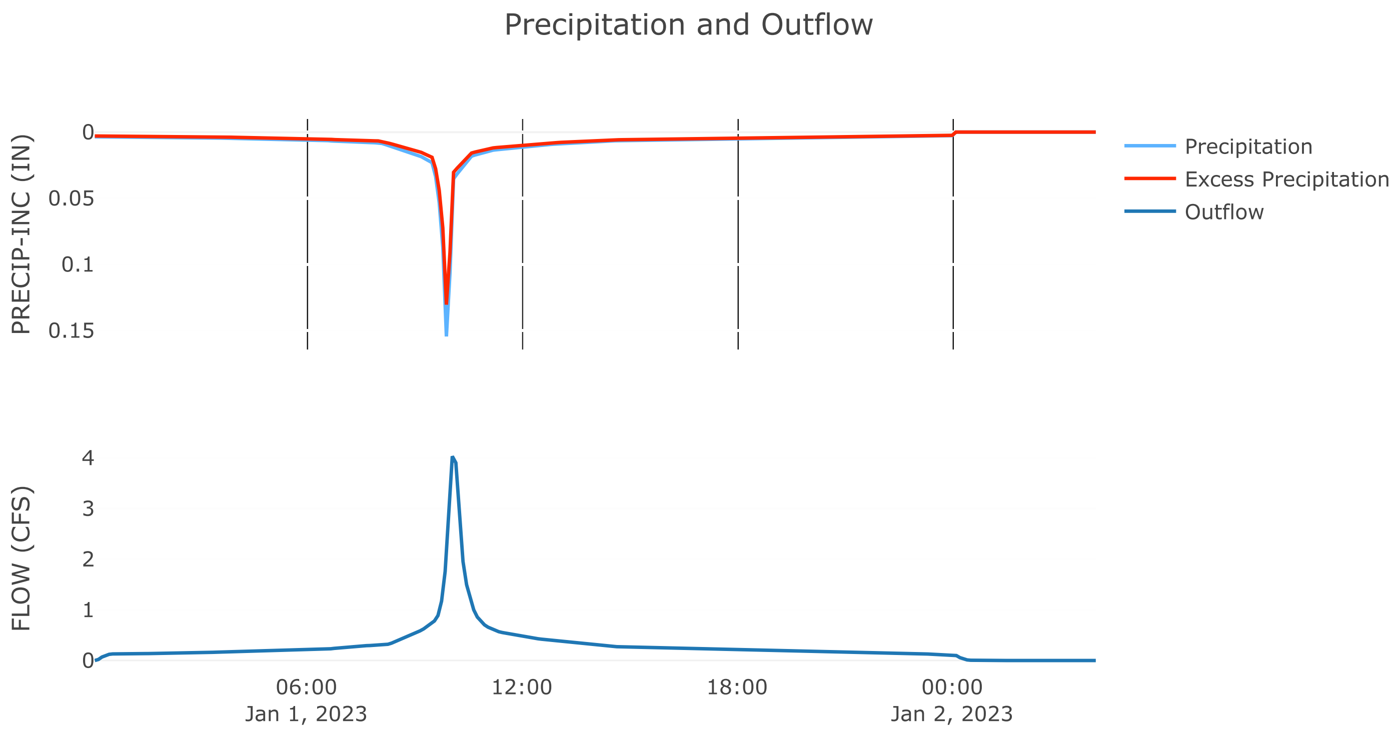
Subbasin: Post-140

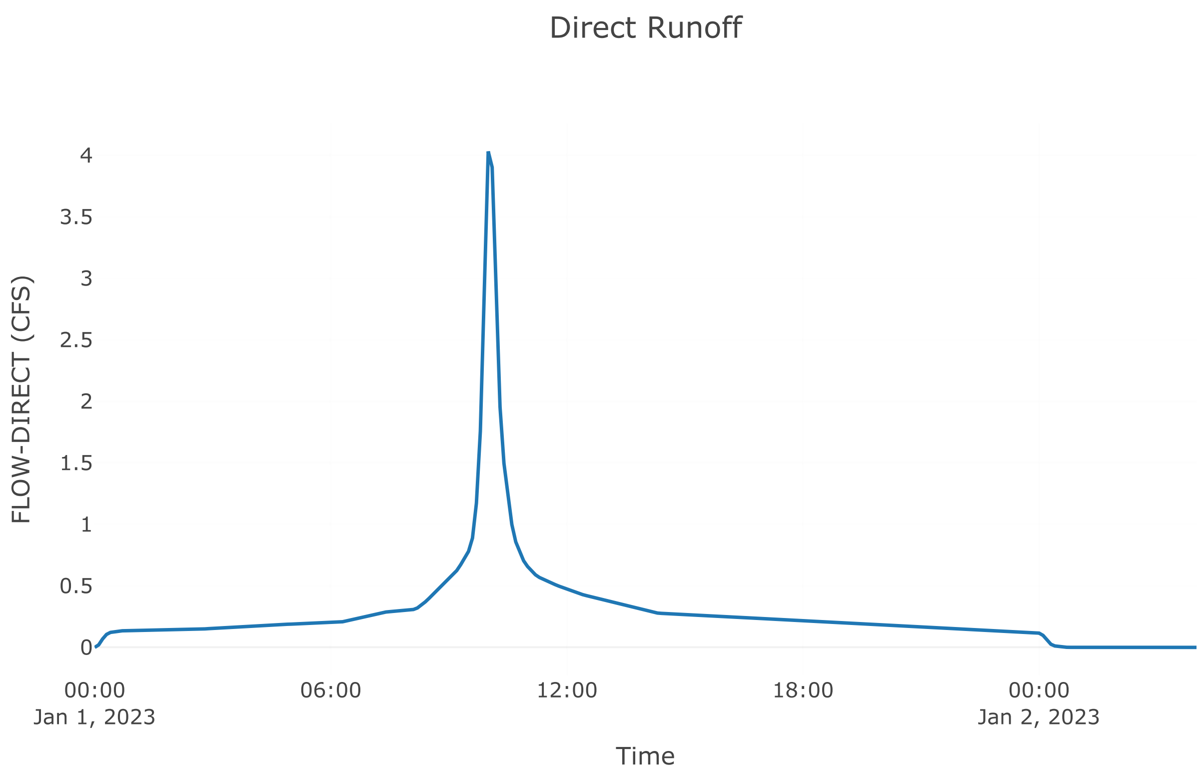
Area (MI2) : 0.01

Loss Rate: Scs	
Percent Impervious Area	82.5
Curve Number	75

Transform: Scs	
Lag	9.7
Unitgraph Type	Standard

Results: Post-140	
Peak Discharge (CFS)	4.03
Time of Peak Discharge	01Jan2023, 10:00
Volume (IN)	1.76
Precipitation Volume (AC - FT)	0.78
Loss Volume (AC - FT)	0.11
Excess Volume (AC - FT)	0.67
Direct Runoff Volume (AC - FT)	0.67
Baseflow Volume (AC - FT)	0


Precipitation and Outflow
PRECIP-INC (IN)
0
0.05
0.1
0.15
Precipitation
Excess Precipitation
Outflow
FLOW (CFS)
4
3
2
1
0
06:00
Jan 1, 2023
12:00
18:00
00:00
Jan 2, 2023


Direct Runoff
FLOW-DIRECT (CFS)
4
3.5
3
2.5
2
1.5
1
0.5
0
00:00
Jan 1, 2023
06:00
12:00
18:00
00:00
Jan 2, 2023
Time

Subbasin: Post-150

Area (MI2) : 0.01

Loss Rate: Scs

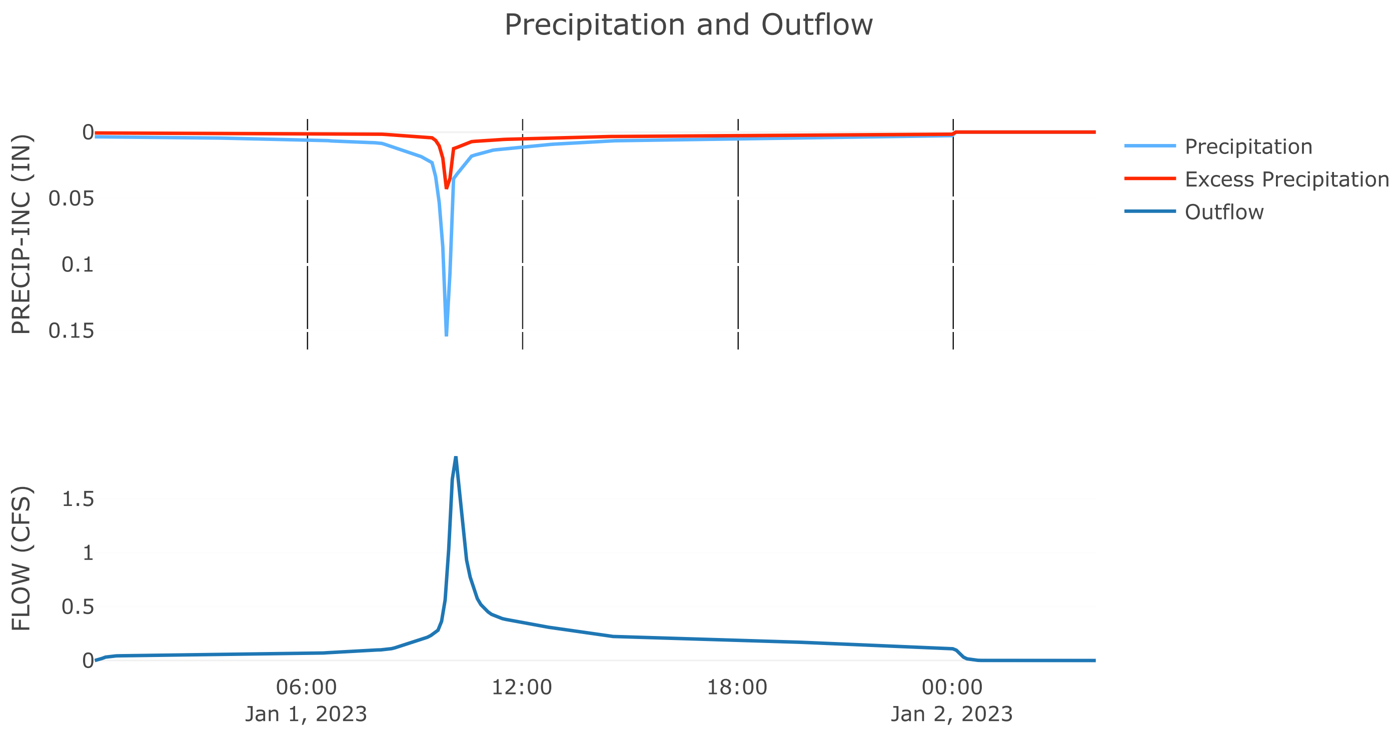
Percent Impervious Area	18.7
Curve Number	75

Transform: Scs

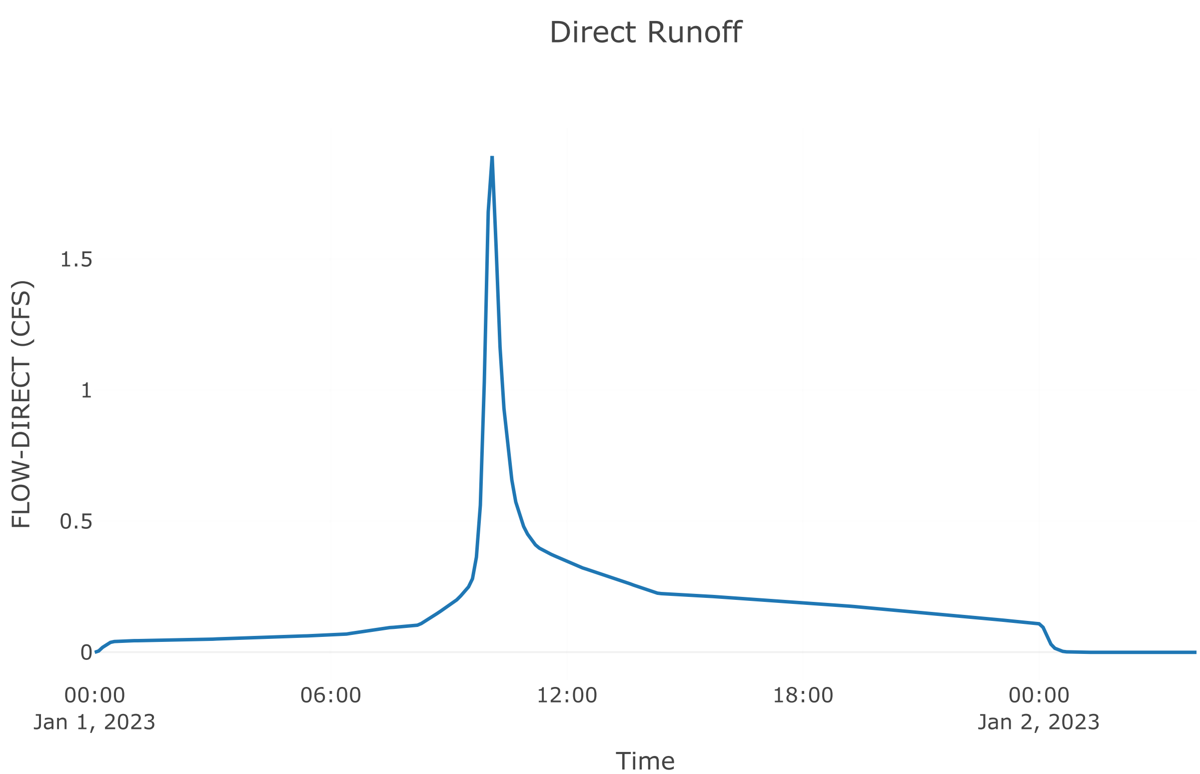
Lag	11
Unitgraph Type	Standard

Results: Post-150

Peak Discharge (CFS)	1.89
Time of Peak Discharge	01Jan2023, 10:06
Volume (IN)	0.71
Precipitation Volume (AC - FT)	1.12
Loss Volume (AC - FT)	0.73
Excess Volume (AC - FT)	0.39
Direct Runoff Volume (AC - FT)	0.39
Baseflow Volume (AC - FT)	0



Precipitation and Outflow
PRECIP-INC (IN)
0
0.05
0.1
0.15
Precipitation
Excess Precipitation
Outflow
FLOW (CFS)
1.5
1
0.5
0
06:00
Jan 1, 2023
12:00
18:00
00:00
Jan 2, 2023



Direct Runoff
FLOW-DIRECT (CFS)
1.5
1
0.5
0
00:00
Jan 1, 2023
06:00
12:00
18:00
00:00
Jan 2, 2023
Time

Subbasin: Post-160

Area (MI2) : 0

Loss Rate: Scs

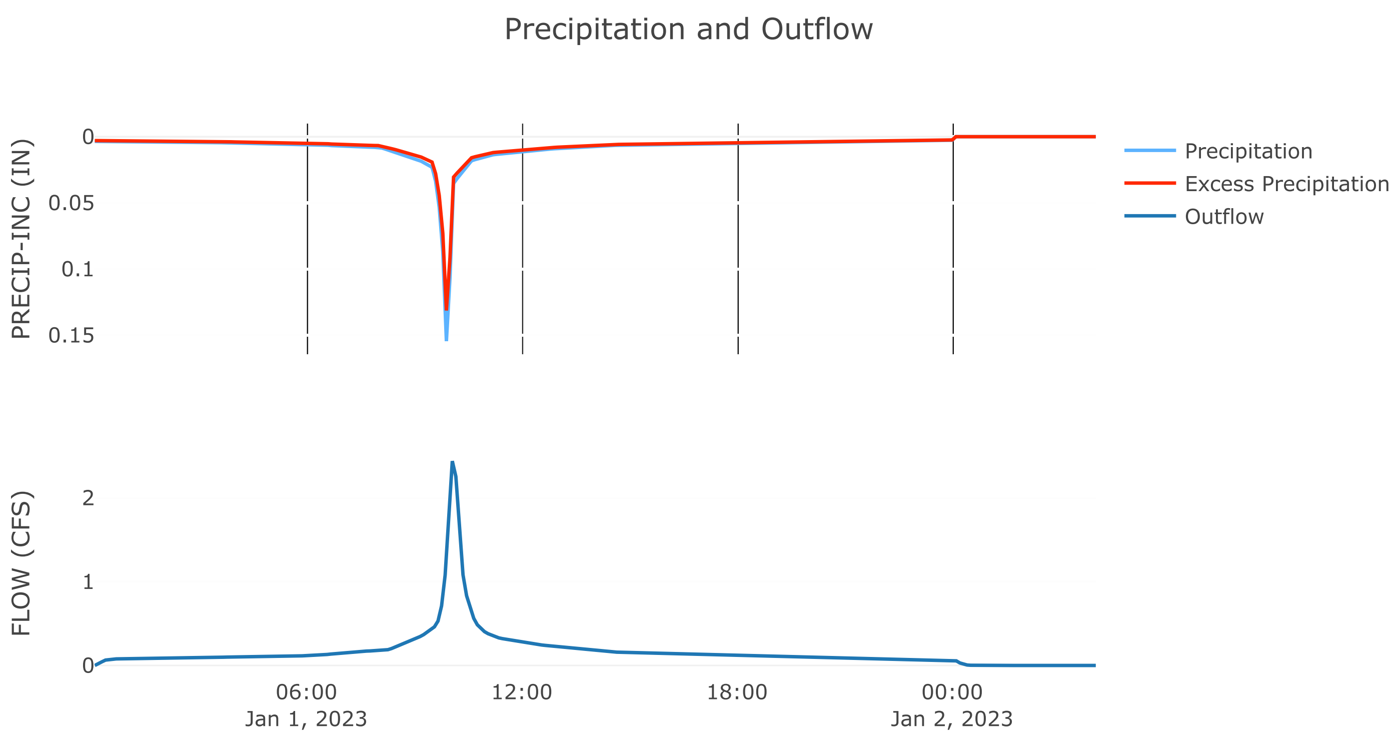
Percent Impervious Area	83.1
Curve Number	75

Transform: Scs

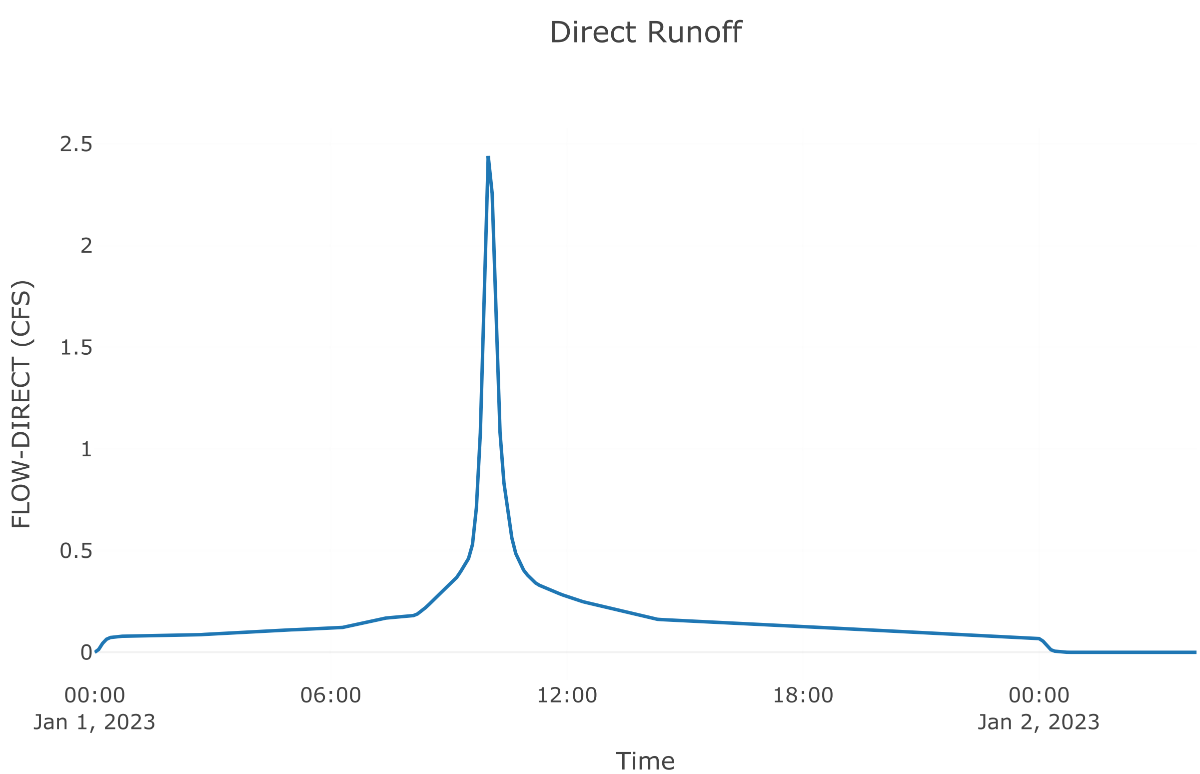
Lag	9
Unitgraph Type	Standard

Results: Post-160

Peak Discharge (CFS)	2.44
Time of Peak Discharge	01Jan2023, 10:00
Volume (IN)	1.77
Precipitation Volume (AC - FT)	0.45
Loss Volume (AC - FT)	0.06
Excess Volume (AC - FT)	0.39
Direct Runoff Volume (AC - FT)	0.39
Baseflow Volume (AC - FT)	0



Precipitation and Outflow
PRECIP-INC (IN)
0
0.05
0.1
0.15
Precipitation
Excess Precipitation
Outflow
FLOW (CFS)
2
1
0
06:00
Jan 1, 2023
12:00
18:00
00:00
Jan 2, 2023



Direct Runoff
FLOW-DIRECT (CFS)
2.5
2
1.5
1
0.5
0
00:00
Jan 1, 2023
06:00
12:00
18:00
00:00
Jan 2, 2023
Time

Subbasin: Post-170

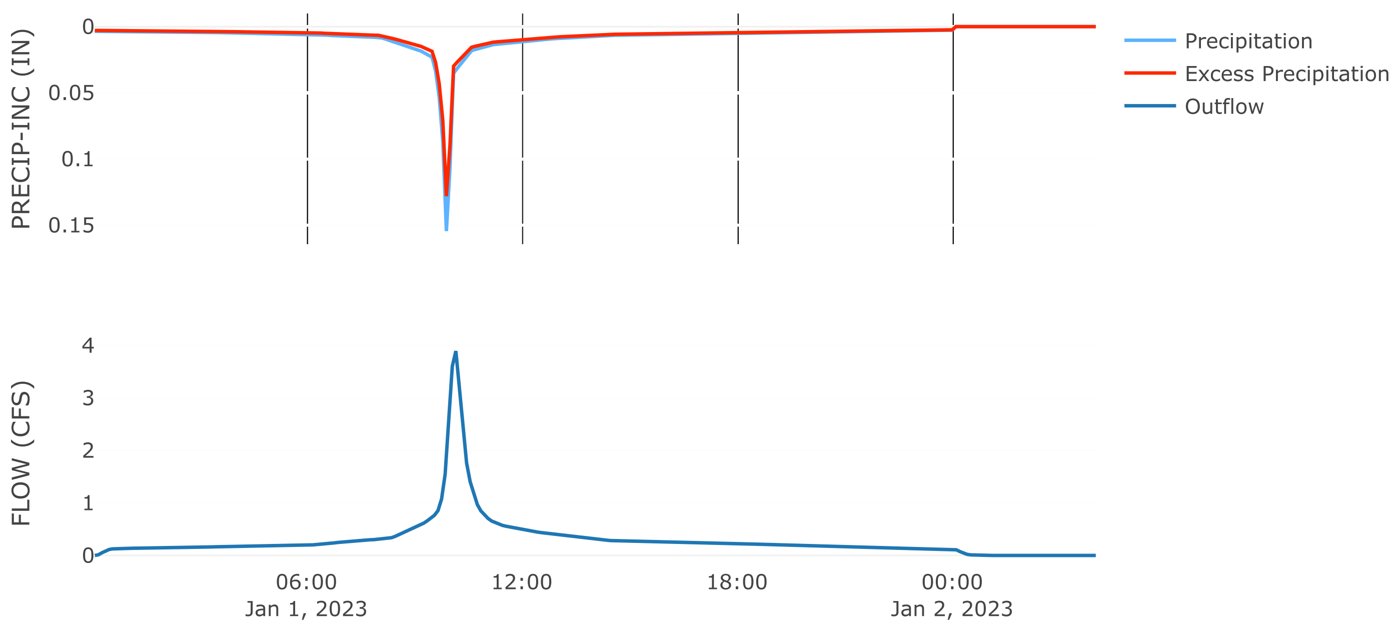
Area (MI2) : 0.01

Loss Rate: Scs	
Percent Impervious Area	80.8
Curve Number	75

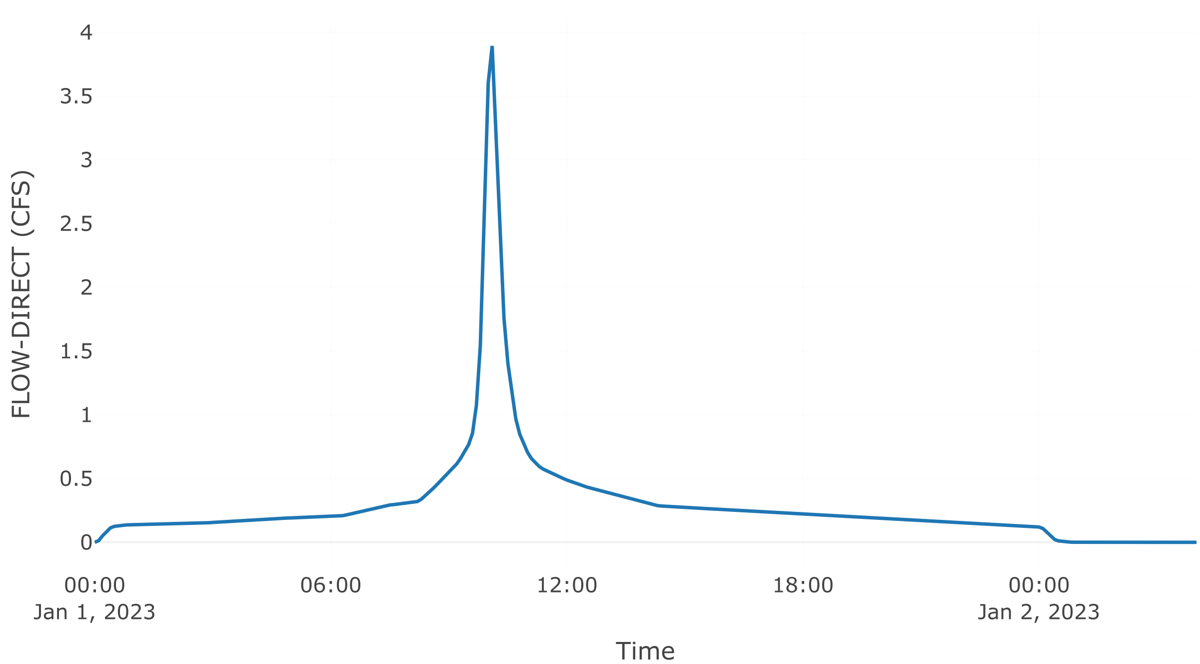
Transform: Scs	
Lag	12
Unitgraph Type	Standard

Results: Post-170	
Peak Discharge (CFS)	3.89
Time of Peak Discharge	01Jan2023, 10:06
Volume (IN)	1.73
Precipitation Volume (AC - FT)	0.81
Loss Volume (AC - FT)	0.12
Excess Volume (AC - FT)	0.68
Direct Runoff Volume (AC - FT)	0.68
Baseflow Volume (AC - FT)	0

Precipitation and Outflow



Direct Runoff



Subbasin: Post-180

Area (MI2) : 0

Loss Rate: Scs

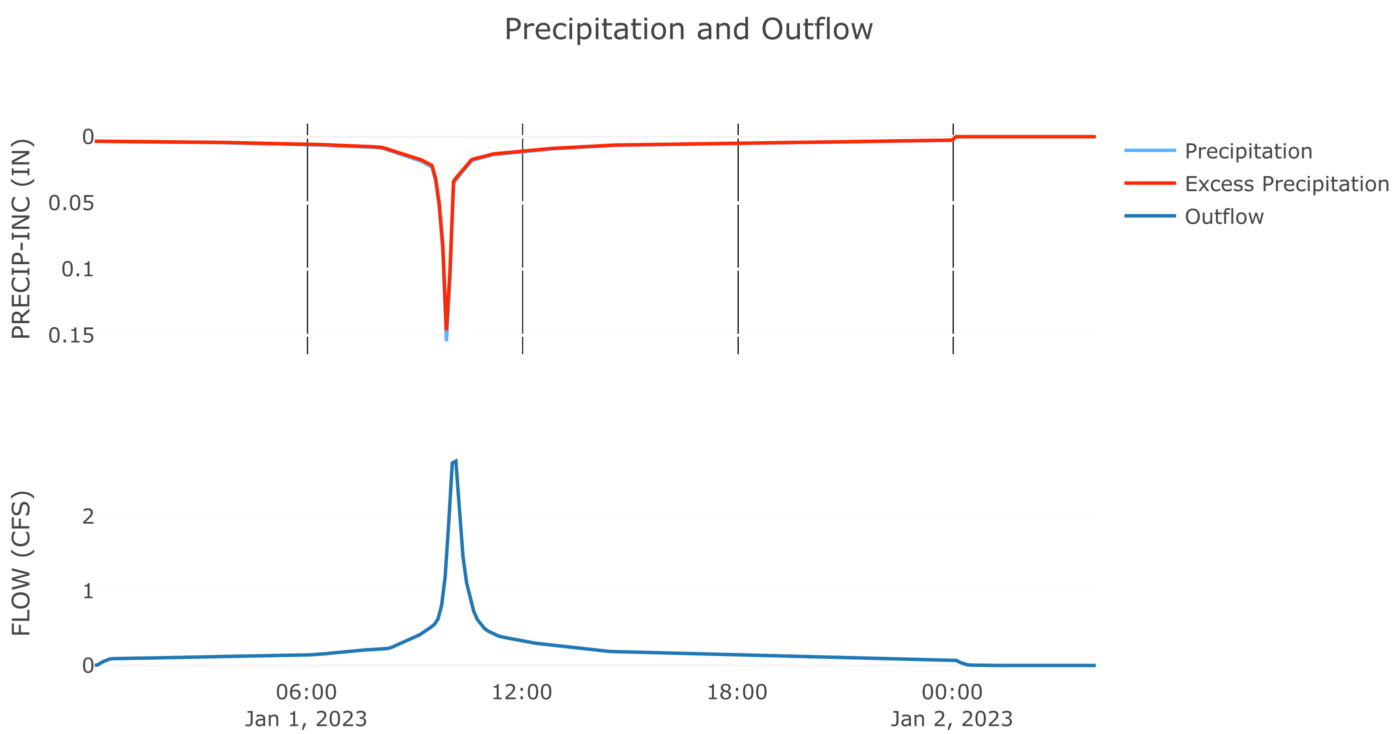
Percent Impervious Area	94.1
Curve Number	75

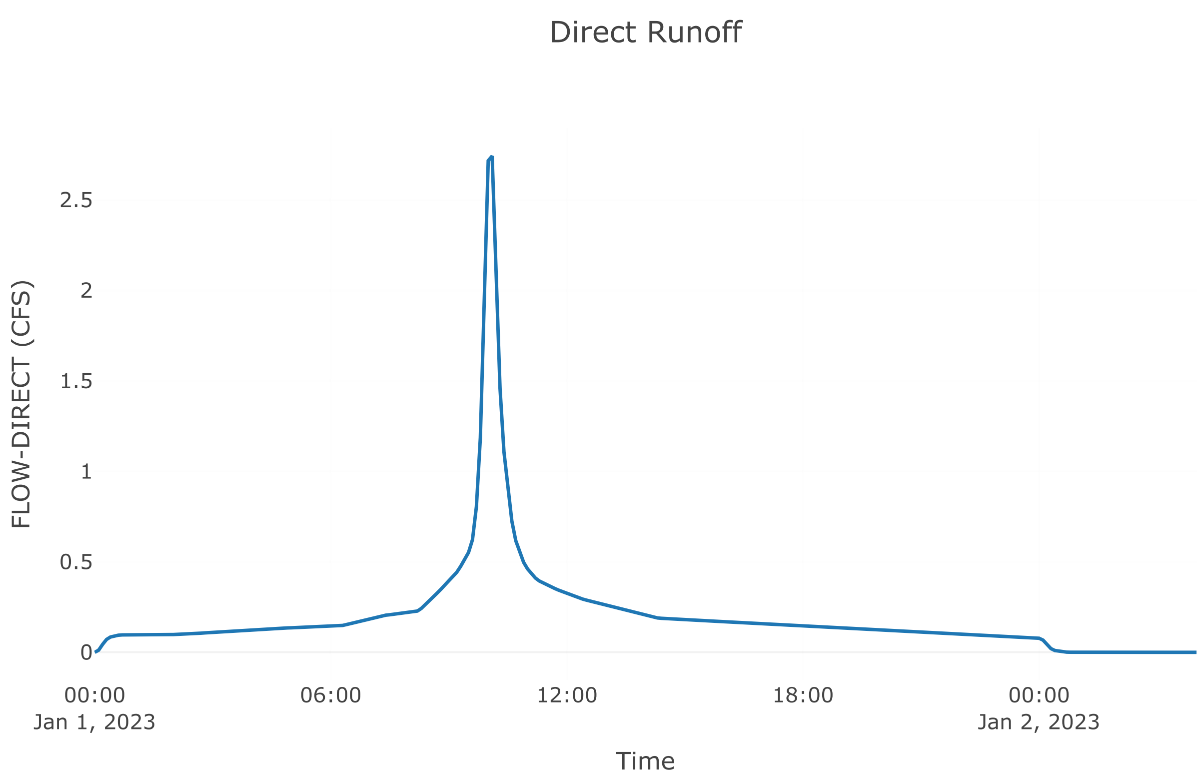
Transform: Scs

Lag	10.6
Unitgraph Type	Standard

Results: Post-180

Peak Discharge (CFS)	2.74
Time of Peak Discharge	01Jan2023, 10:06
Volume (IN)	1.95
Precipitation Volume (AC - FT)	0.49
Loss Volume (AC - FT)	0.02
Excess Volume (AC - FT)	0.47
Direct Runoff Volume (AC - FT)	0.47
Baseflow Volume (AC - FT)	0


Precipitation and Outflow
PRECIP-INC (IN)
0
0.05
0.1
0.15
Precipitation
Excess Precipitation
Outflow
FLOW (CFS)
2
1
0
06:00
Jan 1, 2023
12:00
18:00
00:00
Jan 2, 2023


Direct Runoff
FLOW-DIRECT (CFS)
2.5
2
1.5
1
0.5
0
00:00
Jan 1, 2023
06:00
12:00
18:00
00:00
Jan 2, 2023
Time

Subbasin: Post-190

Area (MI2) : 0.01

Loss Rate: Scs

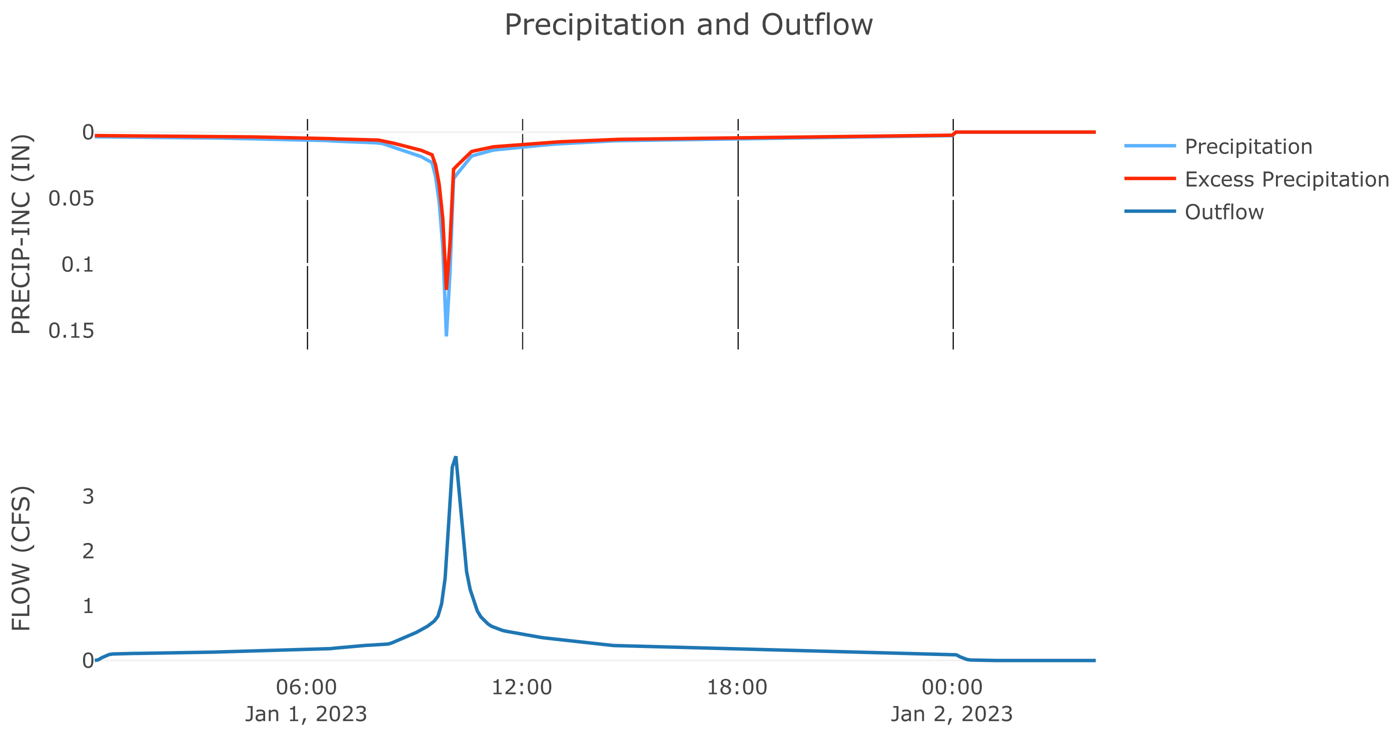
Percent Impervious Area	74.3
Curve Number	75

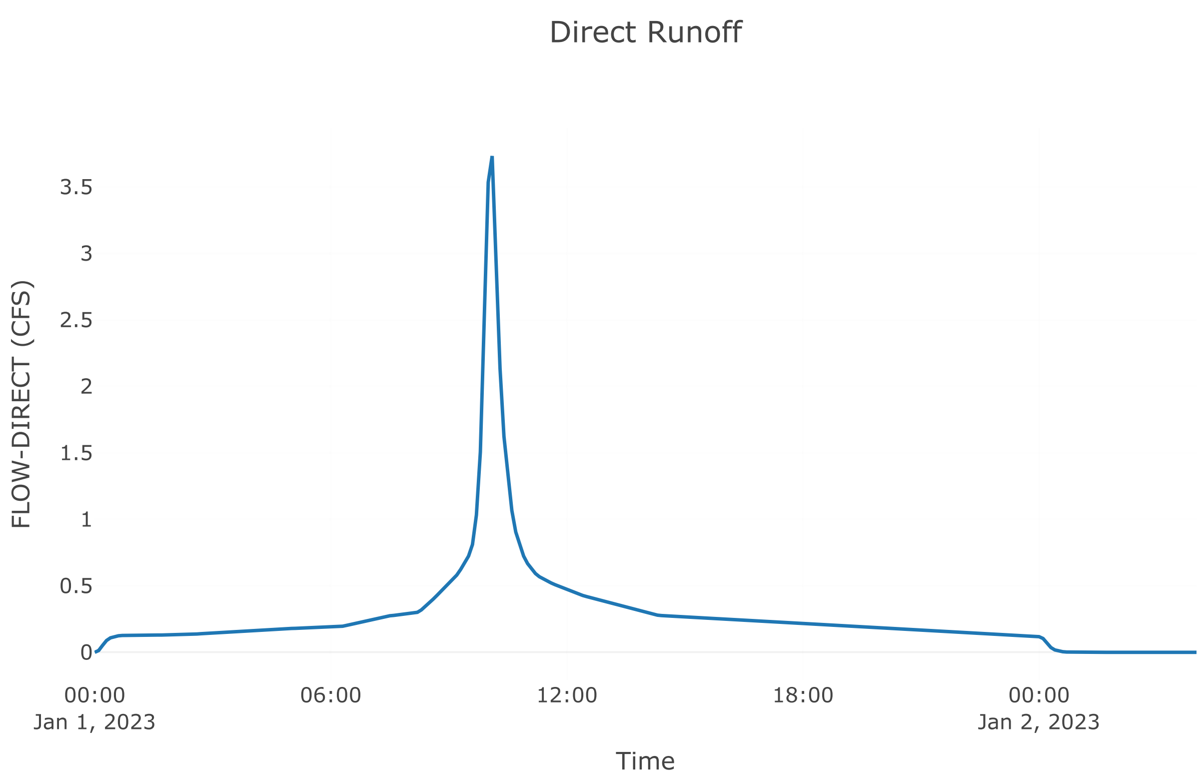
Transform: Scs

Lag	11.4
Unitgraph Type	Standard

Results: Post-190

Peak Discharge (CFS)	3.73
Time of Peak Discharge	01Jan2023, 10:06
Volume (IN)	1.63
Precipitation Volume (AC - FT)	0.82
Loss Volume (AC - FT)	0.17
Excess Volume (AC - FT)	0.65
Direct Runoff Volume (AC - FT)	0.65
Baseflow Volume (AC - FT)	0


Precipitation and Outflow
PRECIP-INC (IN)
0
0.05
0.1
0.15
Precipitation
Excess Precipitation
Outflow
FLOW (CFS)
3
2
1
0
06:00
Jan 1, 2023
12:00
18:00
00:00
Jan 2, 2023


Direct Runoff
FLOW-DIRECT (CFS)
3.5
3
2.5
2
1.5
1
0.5
0
00:00
Jan 1, 2023
06:00
12:00
18:00
00:00
Jan 2, 2023
Time

Subbasin: Post-200

Area (MI2) : 0.01

Loss Rate: Scs

Percent Impervious Area	87.2
Curve Number	75

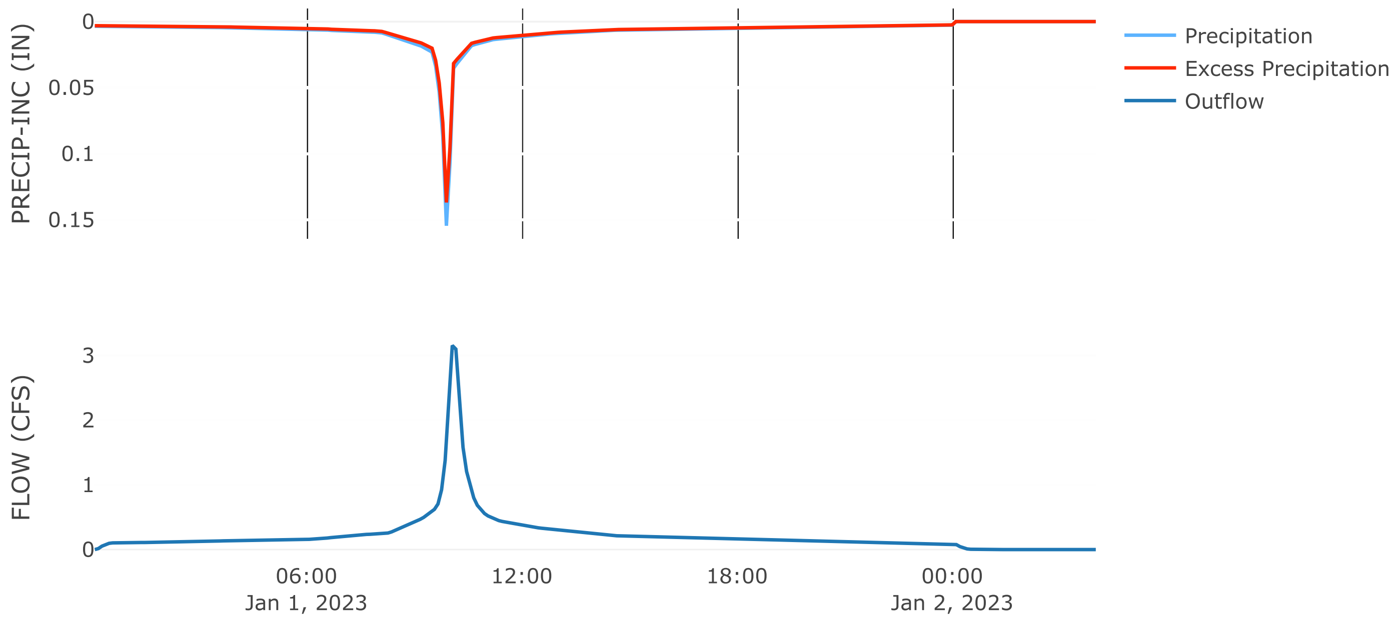
Transform: Scs

Lag	10
Unitgraph Type	Standard

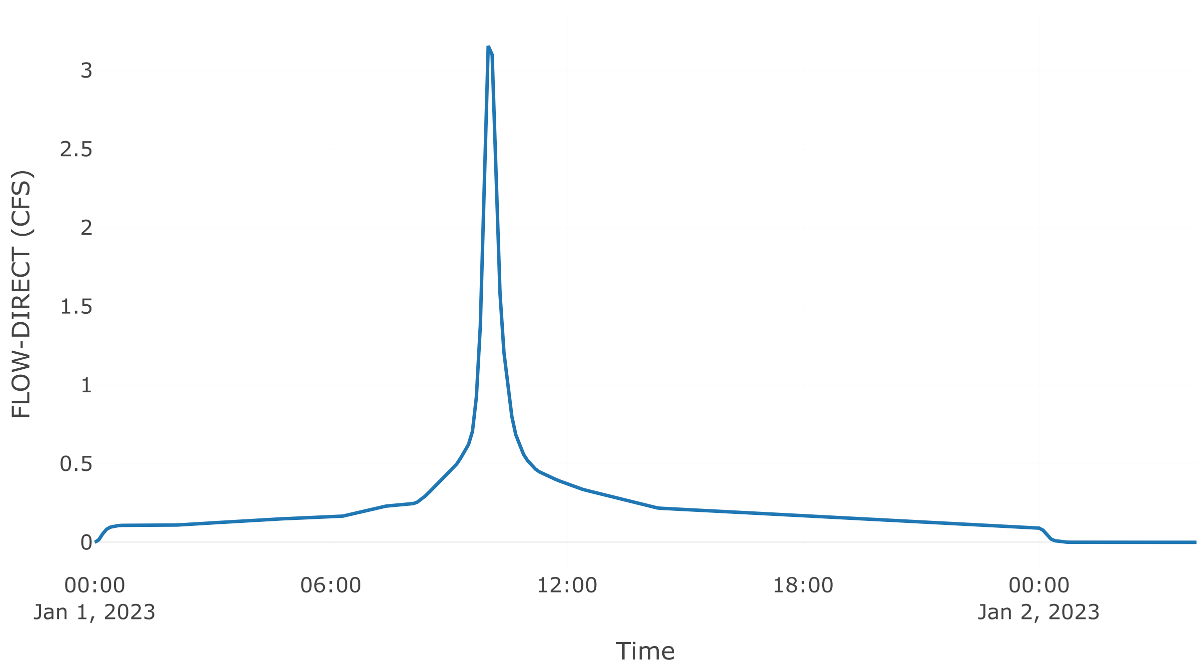
Results: Post-200

Peak Discharge (CFS)	3.16
Time of Peak Discharge	01Jan2023, 10:00
Volume (IN)	1.84
Precipitation Volume (AC - FT)	0.59
Loss Volume (AC - FT)	0.06
Excess Volume (AC - FT)	0.53
Direct Runoff Volume (AC - FT)	0.53
Baseflow Volume (AC - FT)	0

Precipitation and Outflow



Direct Runoff



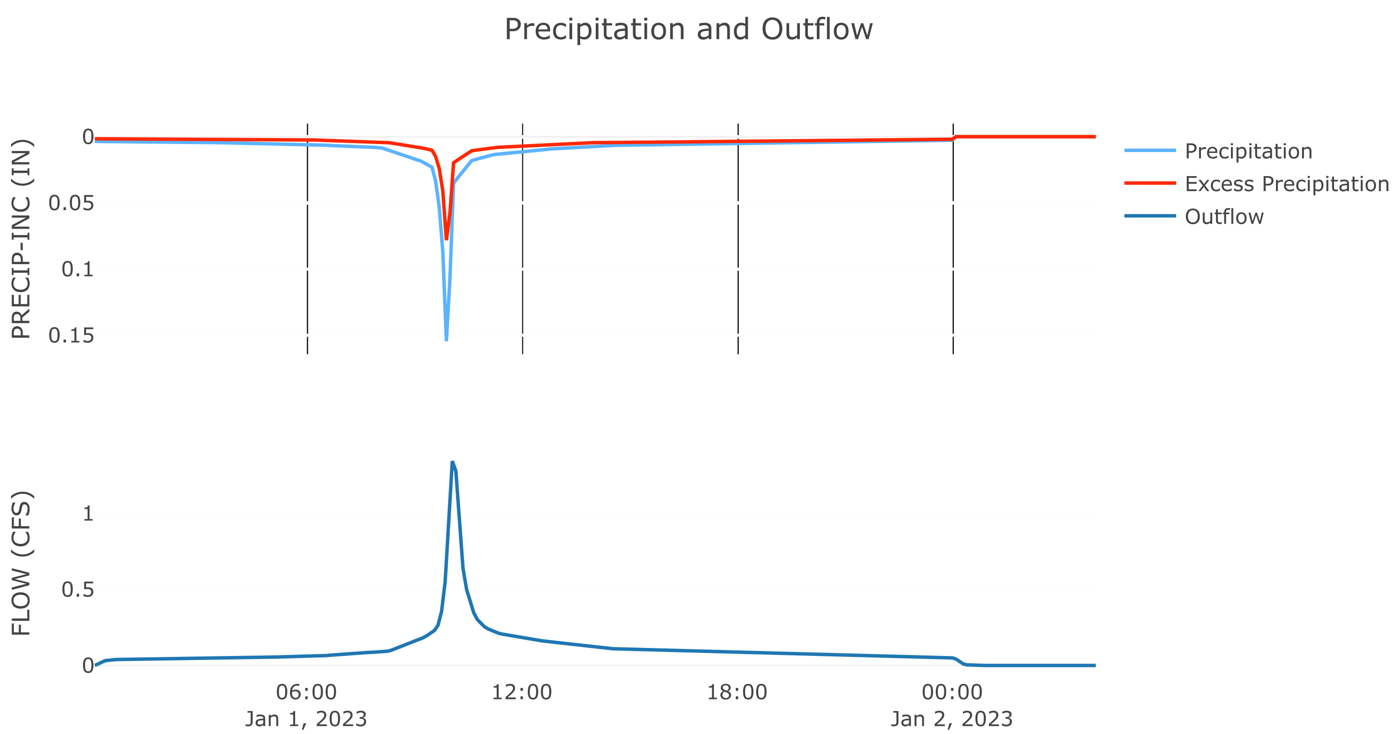
Subbasin: Post-215

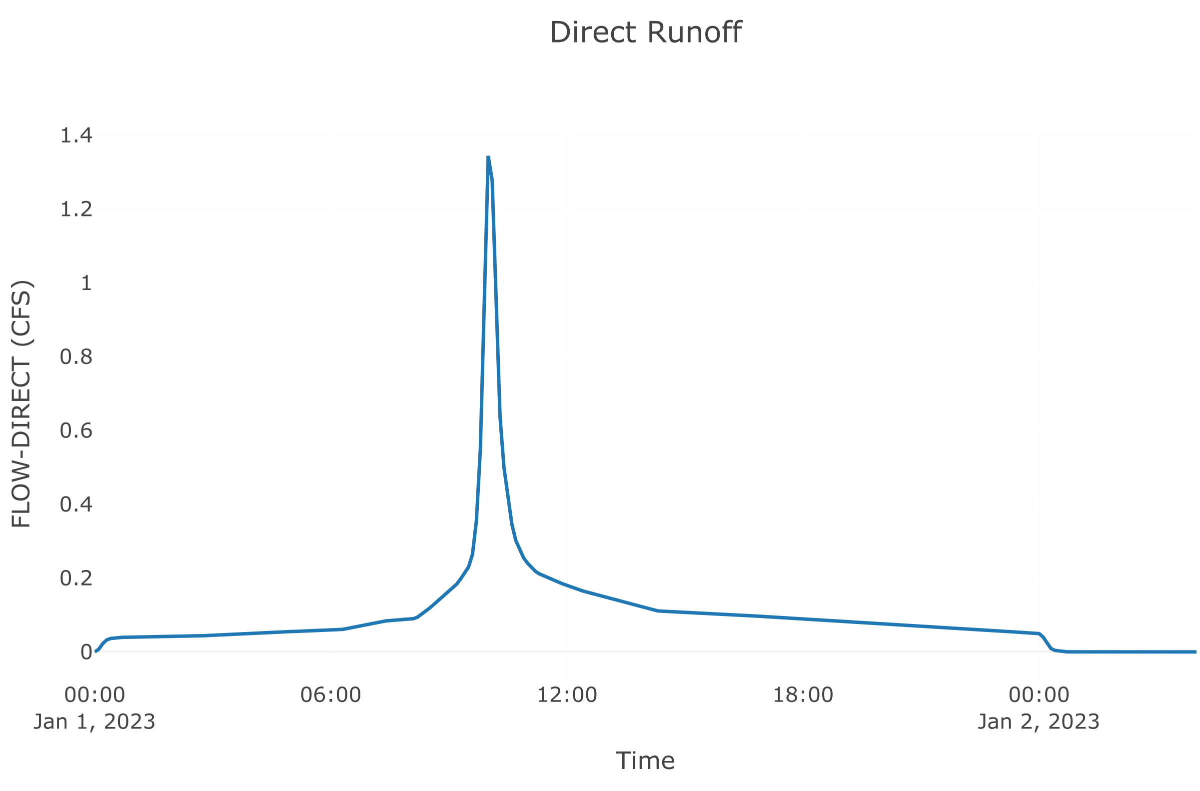
Area (MI2) : 0

Loss Rate: Scs	
Percent Impervious Area	44.4
Curve Number	75

Transform: Scs	
Lag	9
Unitgraph Type	Standard

Results: Post-215	
Peak Discharge (CFS)	1.34
Time of Peak Discharge	01Jan2023, 10:00
Volume (IN)	1.14
Precipitation Volume (AC - FT)	0.42
Loss Volume (AC - FT)	0.19
Excess Volume (AC - FT)	0.23
Direct Runoff Volume (AC - FT)	0.23
Baseflow Volume (AC - FT)	0


Precipitation and Outflow
PRECIP-INC (IN)
0
0.05
0.1
0.15
Precipitation
Excess Precipitation
Outflow
FLOW (CFS)
1
0.5
0
06:00
Jan 1, 2023
12:00
18:00
00:00
Jan 2, 2023


Direct Runoff
FLOW-DIRECT (CFS)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
00:00
Jan 1, 2023
06:00
12:00
18:00
00:00
Jan 2, 2023
Time

Subbasin: Post-225

Area (MI2) : 0

Loss Rate: Scs

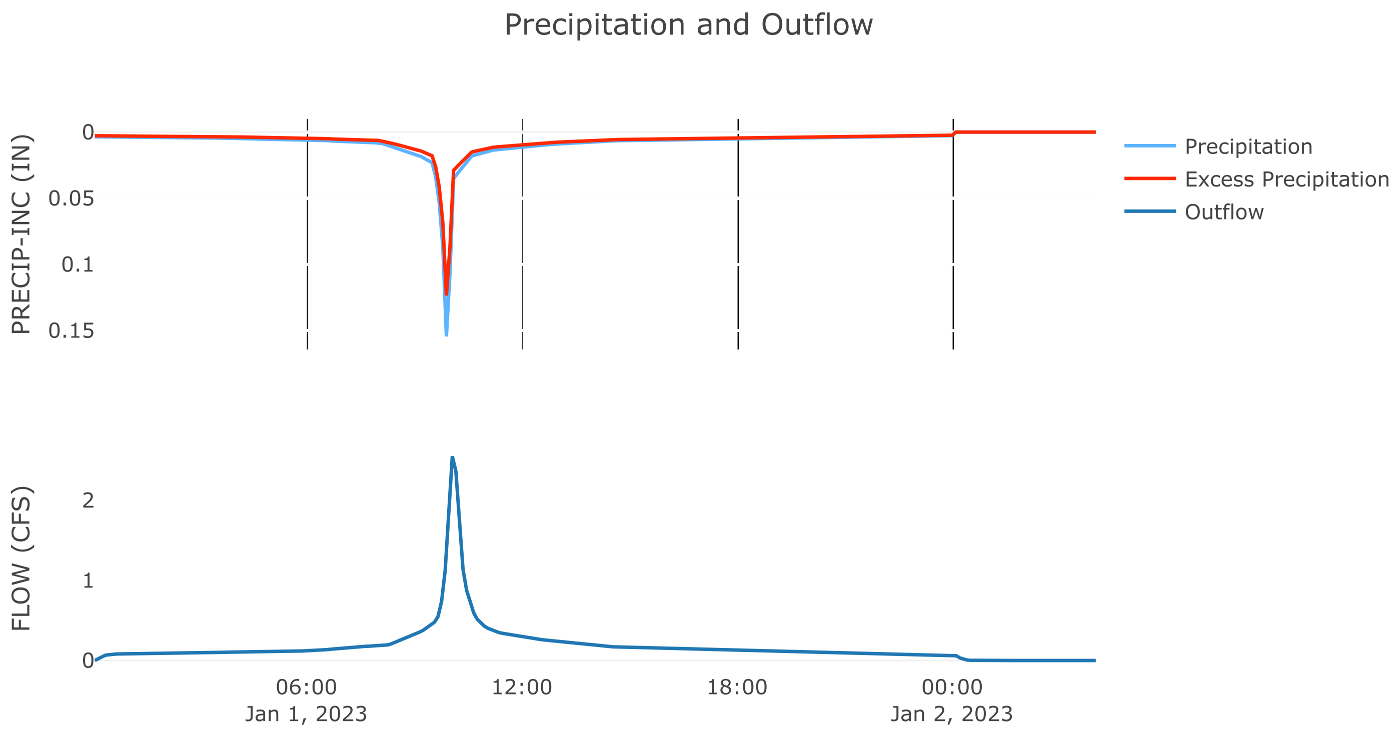
Percent Impervious Area	77.5
Curve Number	75

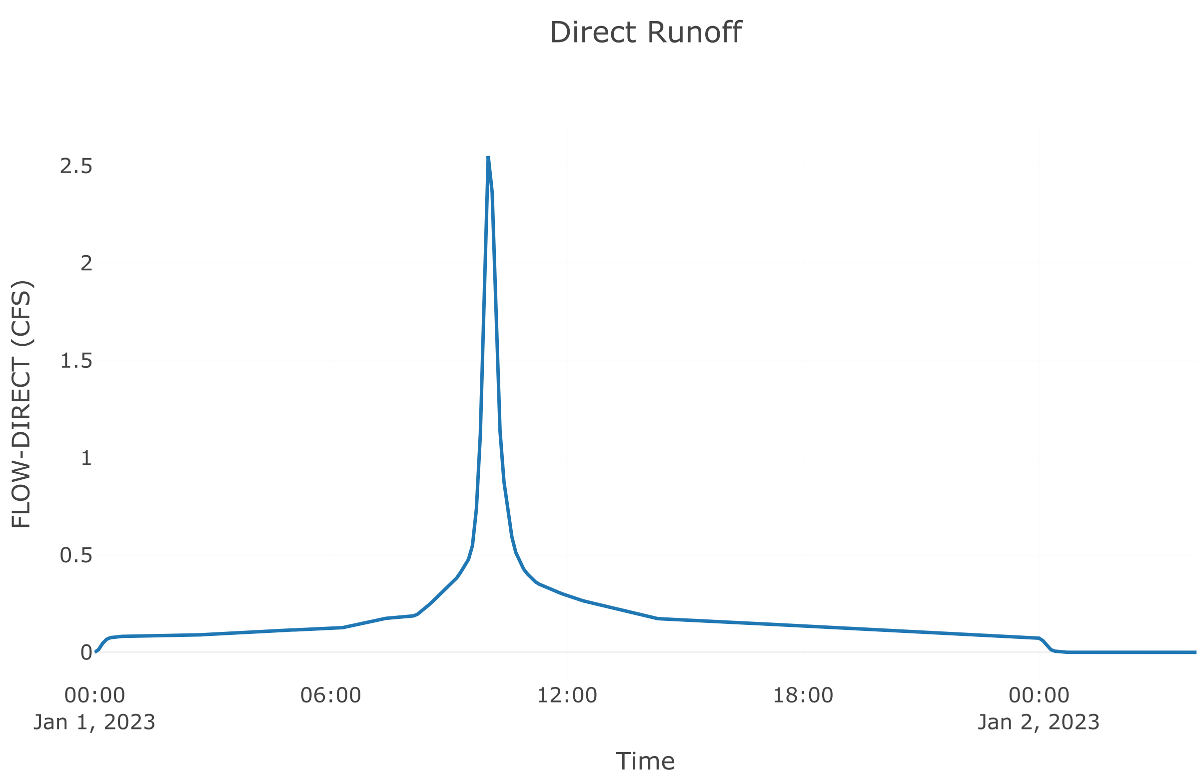
Transform: Scs

Lag	9
Unitgraph Type	Standard

Results: Post-225

Peak Discharge (CFS)	2.55
Time of Peak Discharge	01Jan2023, 10:00
Volume (IN)	1.68
Precipitation Volume (AC - FT)	0.5
Loss Volume (AC - FT)	0.09
Excess Volume (AC - FT)	0.41
Direct Runoff Volume (AC - FT)	0.41
Baseflow Volume (AC - FT)	0


Precipitation and Outflow
PRECIP-INC (IN)
0
0.05
0.1
0.15
Precipitation
Excess Precipitation
Outflow
FLOW (CFS)
2
1
0
06:00
Jan 1, 2023
12:00
18:00
00:00
Jan 2, 2023


Direct Runoff
FLOW-DIRECT (CFS)
2.5
2
1.5
1
0.5
0
00:00
Jan 1, 2023
06:00
12:00
18:00
00:00
Jan 2, 2023
Time

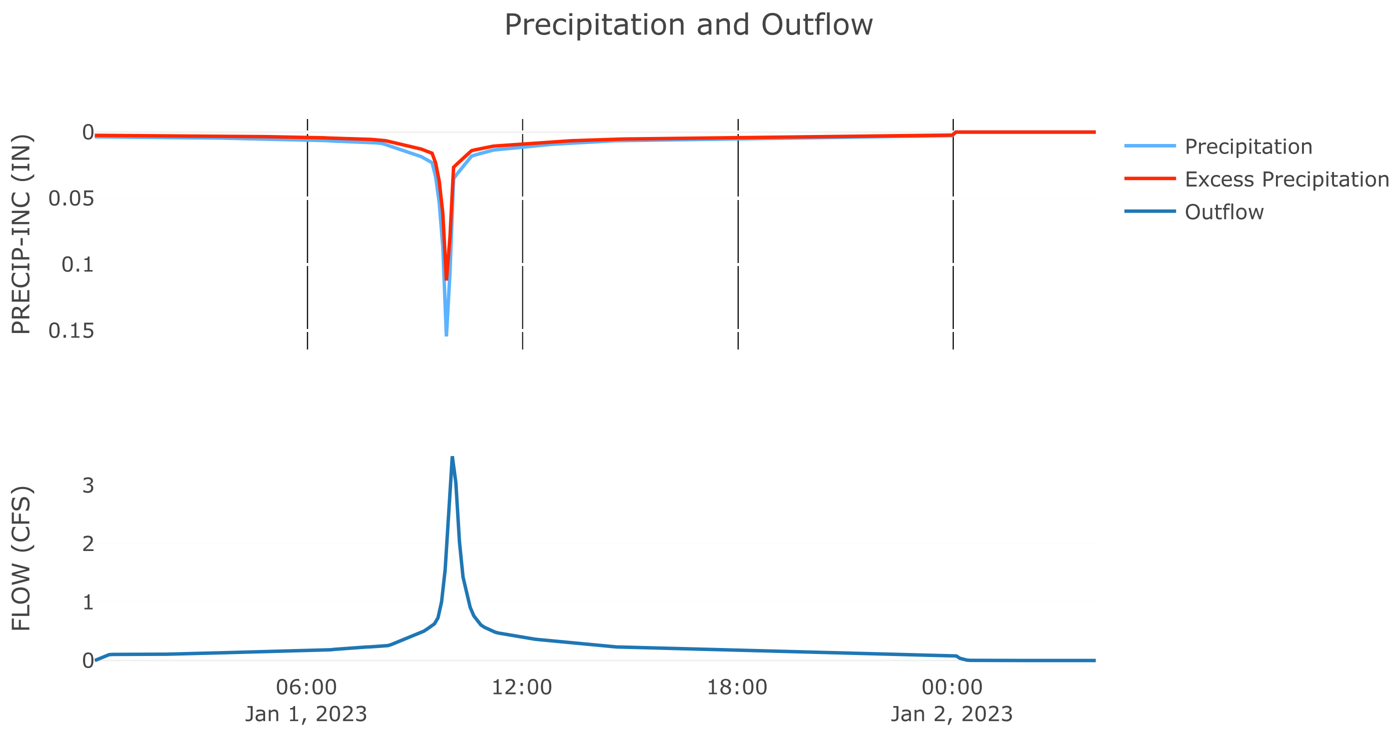
Subbasin: Post-235

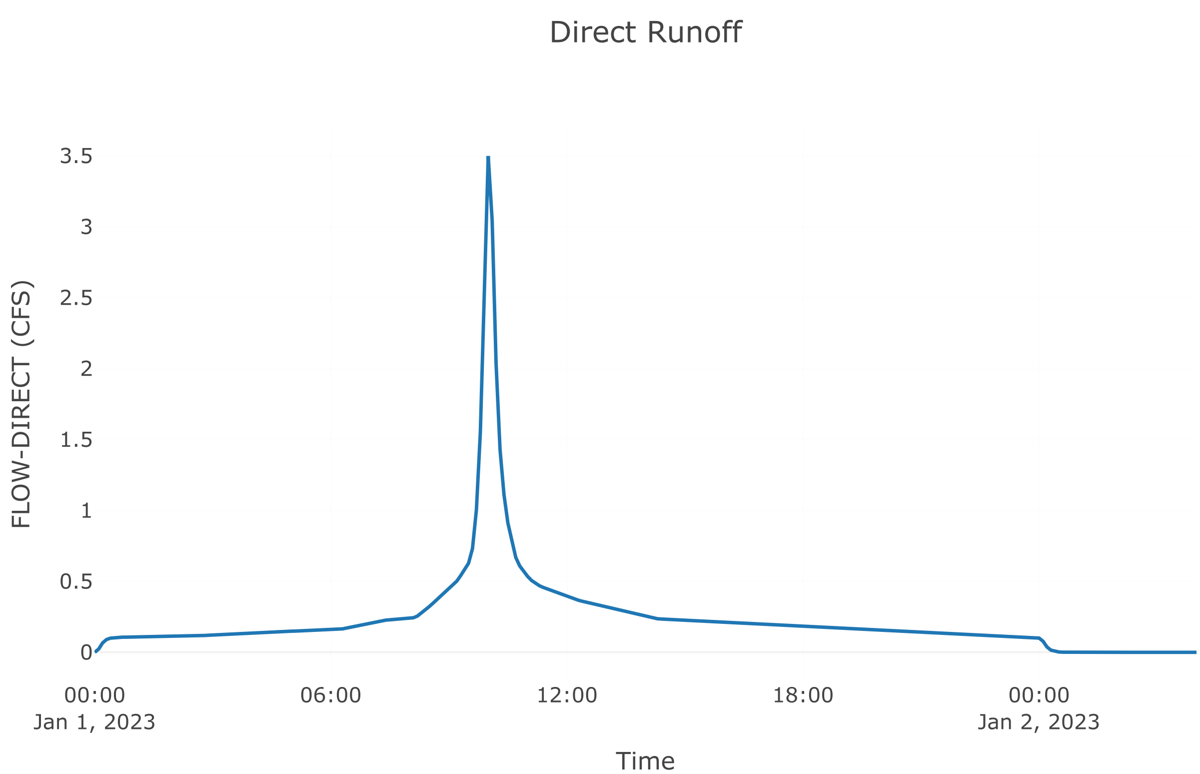
Area (MI2) : 0.01

Loss Rate: Scs	
Percent Impervious Area	69.2
Curve Number	75

Transform: Scs	
Lag	8.2
Unitgraph Type	Standard

Results: Post-235	
Peak Discharge (CFS)	3.5
Time of Peak Discharge	01Jan2023, 10:00
Volume (IN)	1.54
Precipitation Volume (AC - FT)	0.73
Loss Volume (AC - FT)	0.18
Excess Volume (AC - FT)	0.55
Direct Runoff Volume (AC - FT)	0.55
Baseflow Volume (AC - FT)	0


Precipitation and Outflow
PRECIP-INC (IN)
0
0.05
0.1
0.15
Precipitation
Excess Precipitation
Outflow
FLOW (CFS)
3
2
1
0
06:00
Jan 1, 2023
12:00
18:00
00:00
Jan 2, 2023


Direct Runoff
FLOW-DIRECT (CFS)
3.5
3
2.5
2
1.5
1
0.5
0
00:00
Jan 1, 2023
06:00
12:00
18:00
00:00
Jan 2, 2023
Time

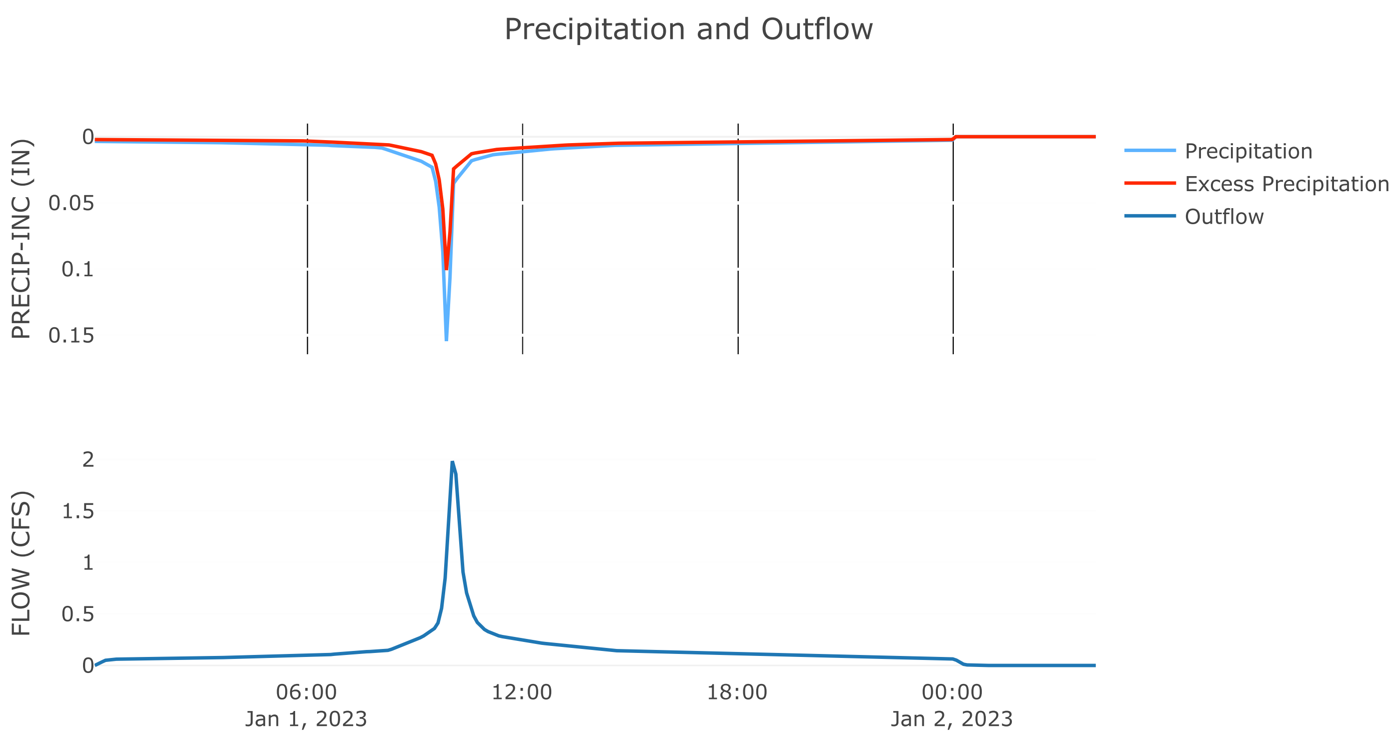
Subbasin: Post-245

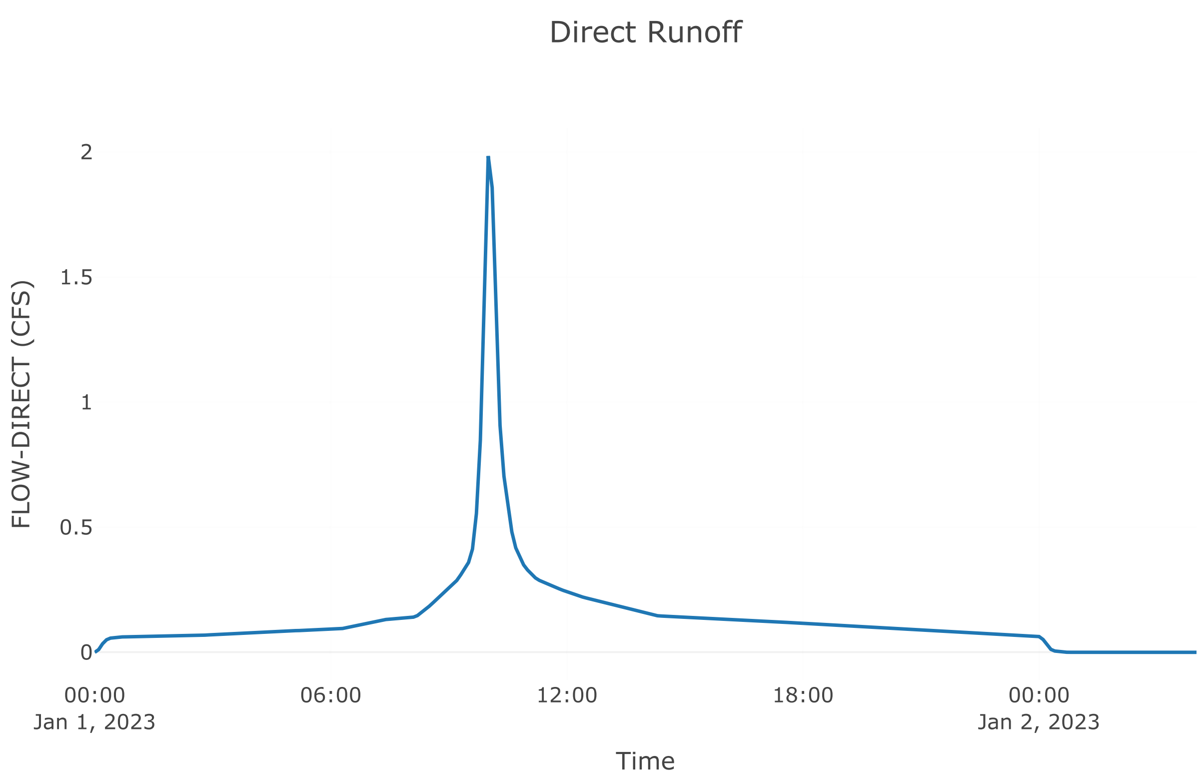
Area (MI2) : 0

Loss Rate: Scs	
Percent Impervious Area	60.9
Curve Number	75

Transform: Scs	
Lag	9
Unitgraph Type	Standard

Results: Post-245	
Peak Discharge (CFS)	1.98
Time of Peak Discharge	01Jan2023, 10:00
Volume (IN)	1.41
Precipitation Volume (AC - FT)	0.48
Loss Volume (AC - FT)	0.15
Excess Volume (AC - FT)	0.33
Direct Runoff Volume (AC - FT)	0.33
Baseflow Volume (AC - FT)	0


Precipitation and Outflow
PRECIP-INC (IN)
0
0.05
0.1
0.15
Precipitation
Excess Precipitation
Outflow
FLOW (CFS)
2
1.5
1
0.5
0
06:00
Jan 1, 2023
12:00
18:00
00:00
Jan 2, 2023


Direct Runoff
FLOW-DIRECT (CFS)
2
1.5
1
0.5
0
00:00
Jan 1, 2023
06:00
12:00
18:00
00:00
Jan 2, 2023
Time

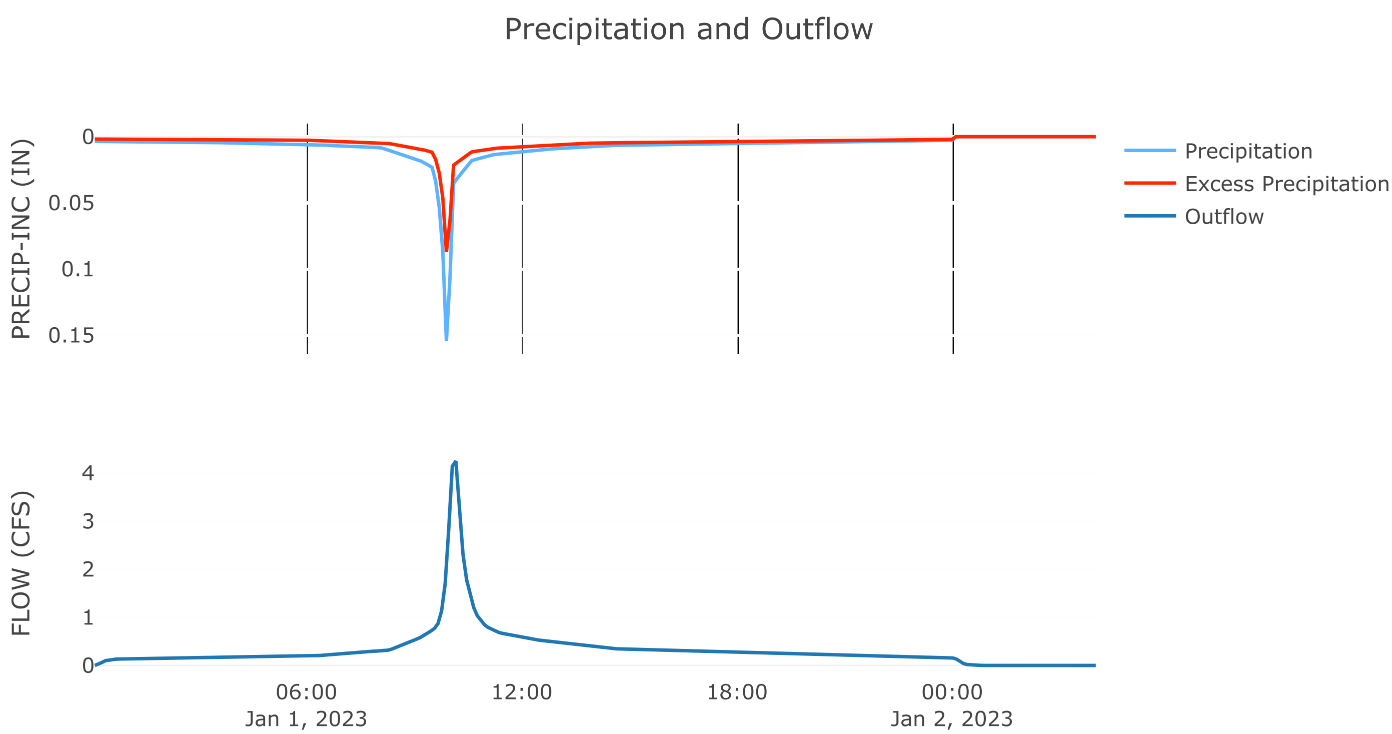
Subbasin: Post-255

Area (MI2) : 0.01

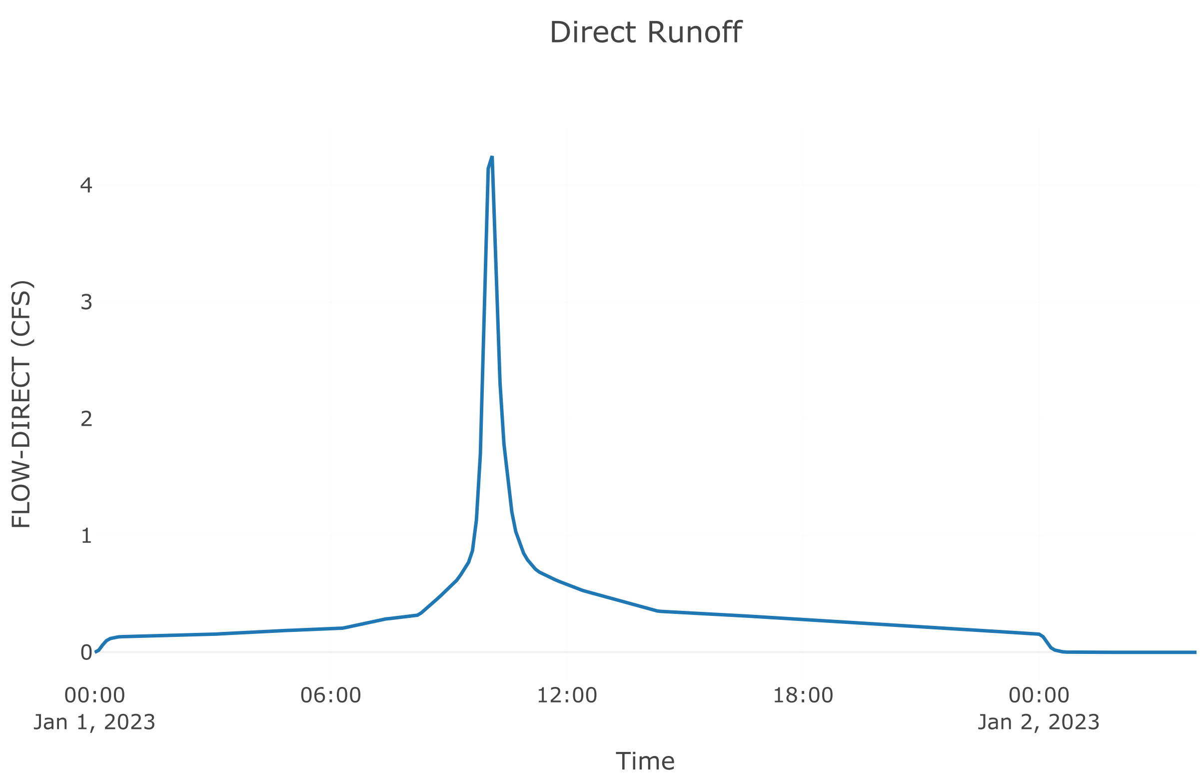
Loss Rate: Scs	
Percent Impervious Area	50.9
Curve Number	75

Transform: Scs	
Lag	10.4
Unitgraph Type	Standard

Results: Post-255	
Peak Discharge (CFS)	4.25
Time of Peak Discharge	01Jan2023, 10:06
Volume (IN)	1.24
Precipitation Volume (AC - FT)	1.26
Loss Volume (AC - FT)	0.5
Excess Volume (AC - FT)	0.77
Direct Runoff Volume (AC - FT)	0.77
Baseflow Volume (AC - FT)	0



Precipitation and Outflow
PRECIP-INC (IN)
0
0.05
0.1
0.15
Precipitation
Excess Precipitation
Outflow
FLOW (CFS)
4
3
2
1
0
06:00
Jan 1, 2023
12:00
18:00
00:00
Jan 2, 2023



Direct Runoff
FLOW-DIRECT (CFS)
4
3
2
1
0
00:00
Jan 1, 2023
06:00
12:00
18:00
00:00
Jan 2, 2023
Time

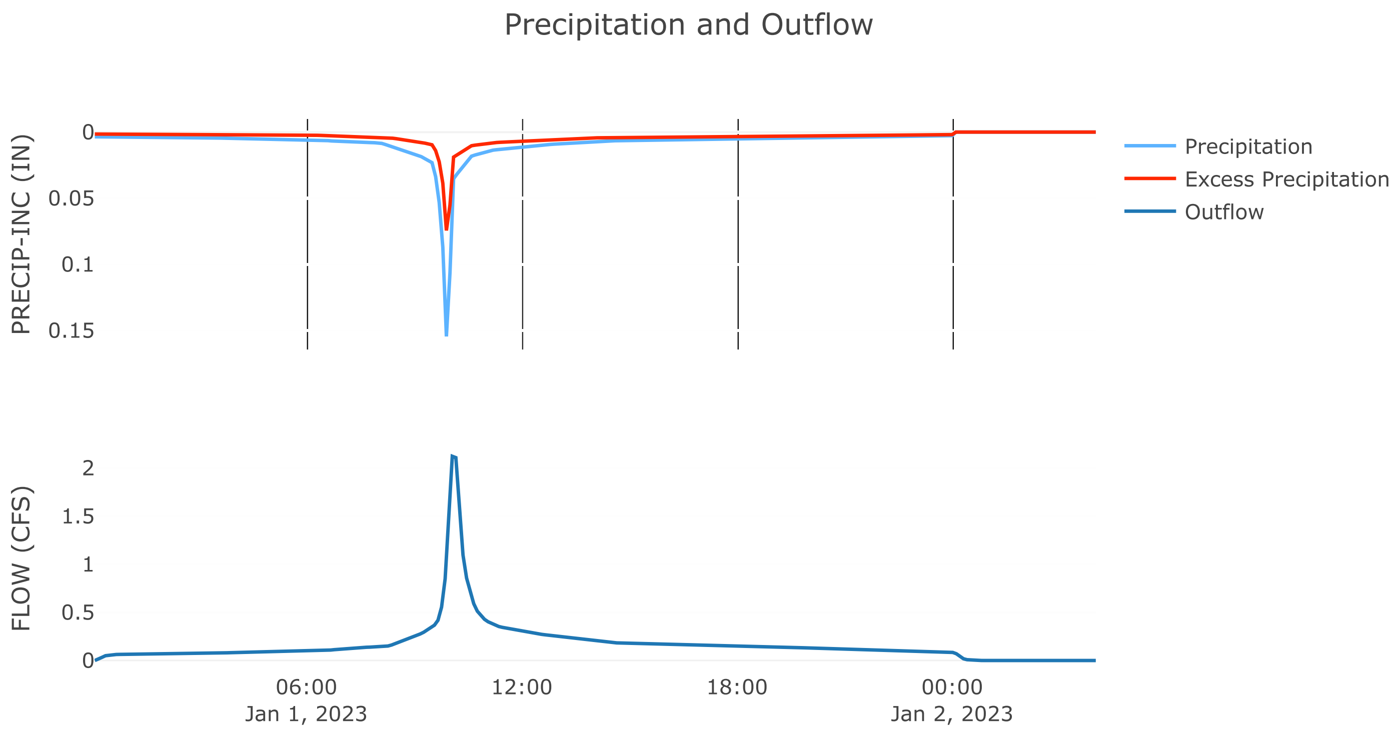
Subbasin: Post-265

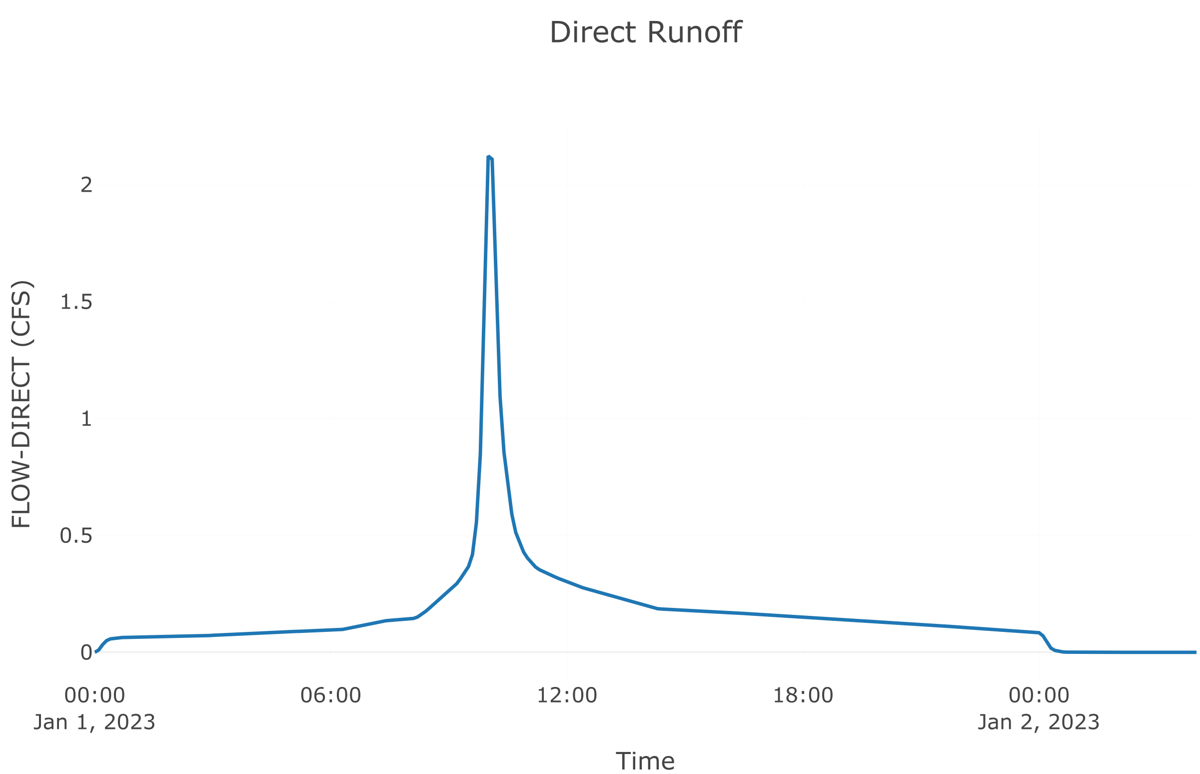
Area (MI2) : 0.01

Loss Rate: Scs	
Percent Impervious Area	41.6
Curve Number	75

Transform: Scs	
Lag	9.6
Unitgraph Type	Standard

Results: Post-265	
Peak Discharge (CFS)	2.12
Time of Peak Discharge	01Jan2023, 10:00
Volume (IN)	1.09
Precipitation Volume (AC - FT)	0.73
Loss Volume (AC - FT)	0.34
Excess Volume (AC - FT)	0.39
Direct Runoff Volume (AC - FT)	0.39
Baseflow Volume (AC - FT)	0


Precipitation and Outflow
PRECIP-INC (IN)
0
0.05
0.1
0.15
Precipitation
Excess Precipitation
Outflow
FLOW (CFS)
2
1.5
1
0.5
0
06:00
Jan 1, 2023
12:00
18:00
00:00
Jan 2, 2023


Direct Runoff
FLOW-DIRECT (CFS)
2
1.5
1
0.5
0
00:00
Jan 1, 2023
06:00
12:00
18:00
00:00
Jan 2, 2023
Time

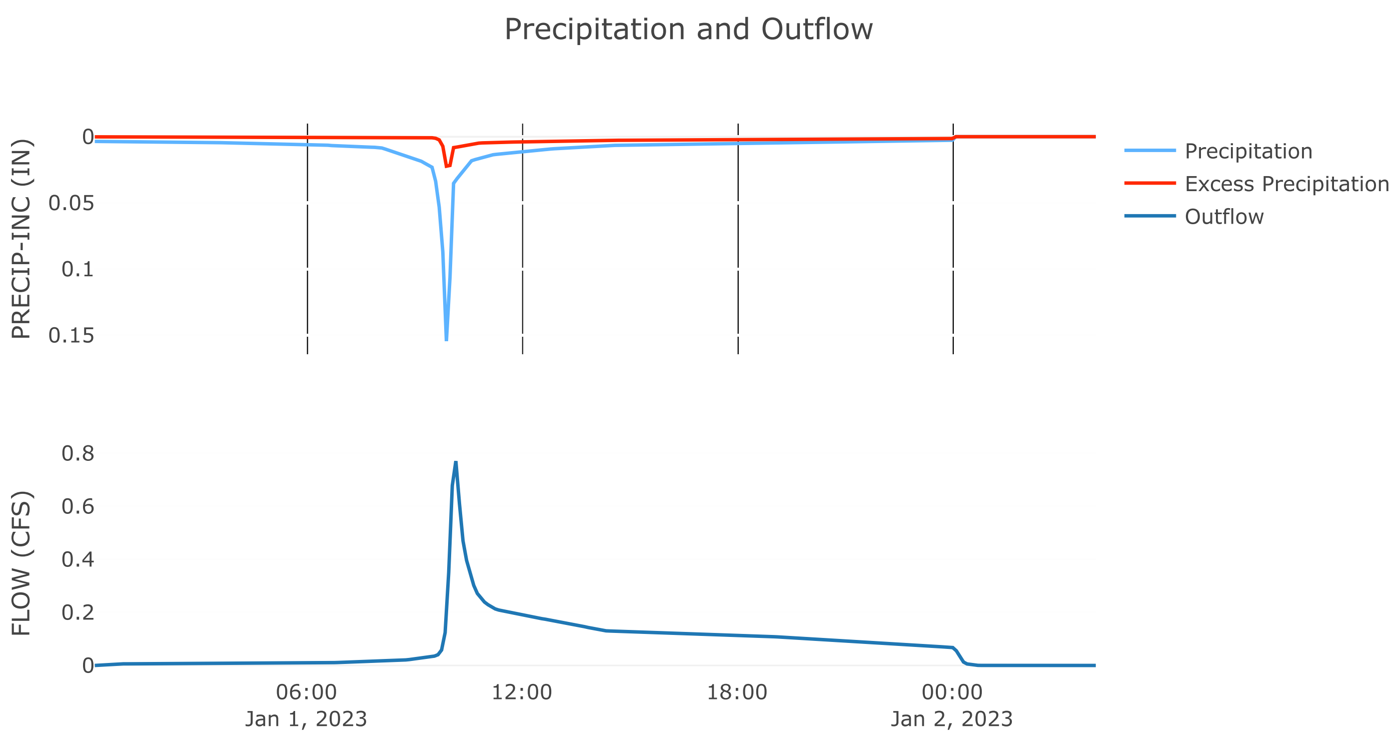
Subbasin: Post-275

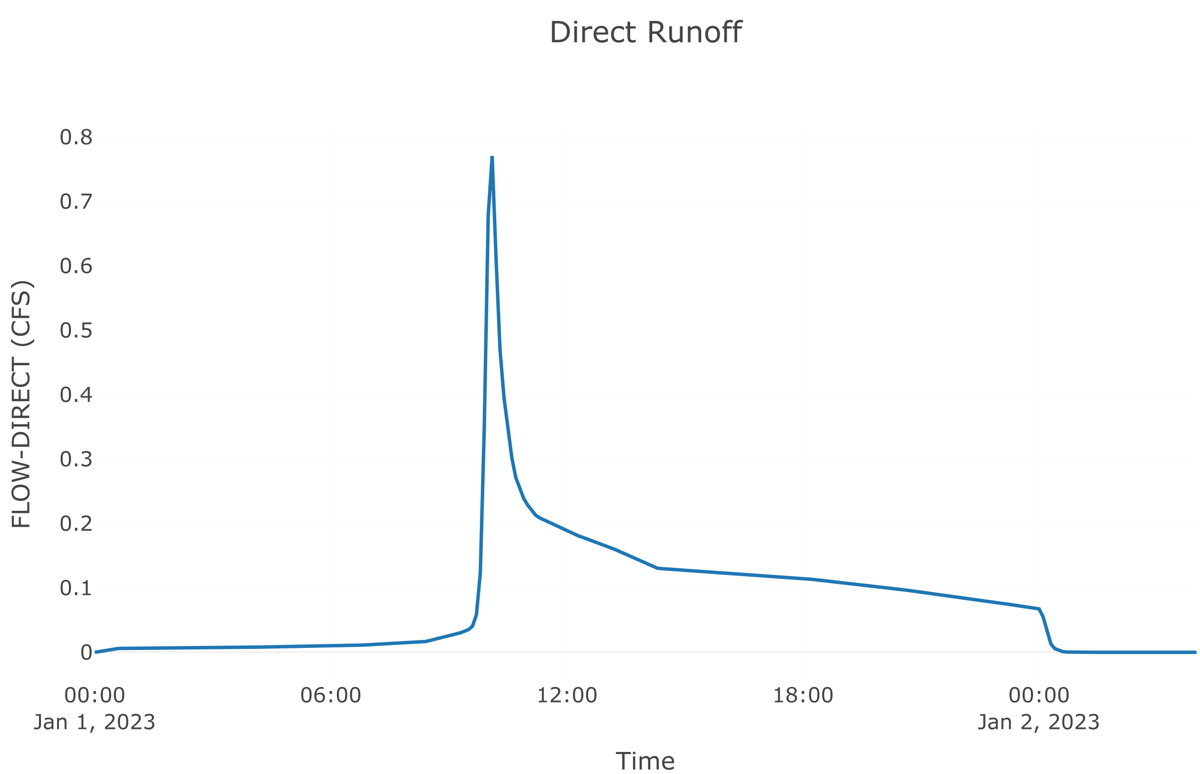
Area (MI2) : 0.01

Loss Rate: Scs	
Percent Impervious Area	3.6
Curve Number	75

Transform: Scs	
Lag	9.1
Unitgraph Type	Standard

Results: Post-275	
Peak Discharge (CFS)	0.77
Time of Peak Discharge	01Jan2023, 10:06
Volume (IN)	0.46
Precipitation Volume (AC - FT)	0.8
Loss Volume (AC - FT)	0.62
Excess Volume (AC - FT)	0.18
Direct Runoff Volume (AC - FT)	0.18
Baseflow Volume (AC - FT)	0


Precipitation and Outflow
PRECIP-INC (IN)
0
0.05
0.1
0.15
Precipitation
Excess Precipitation
Outflow
FLOW (CFS)
0.8
0.6
0.4
0.2
0
06:00
Jan 1, 2023
12:00
18:00
00:00
Jan 2, 2023


Direct Runoff
FLOW-DIRECT (CFS)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
00:00
Jan 1, 2023
06:00
12:00
18:00
00:00
Jan 2, 2023
Time

Subbasin: Post-280

Area (MI2) : 0.01

Loss Rate: Scs

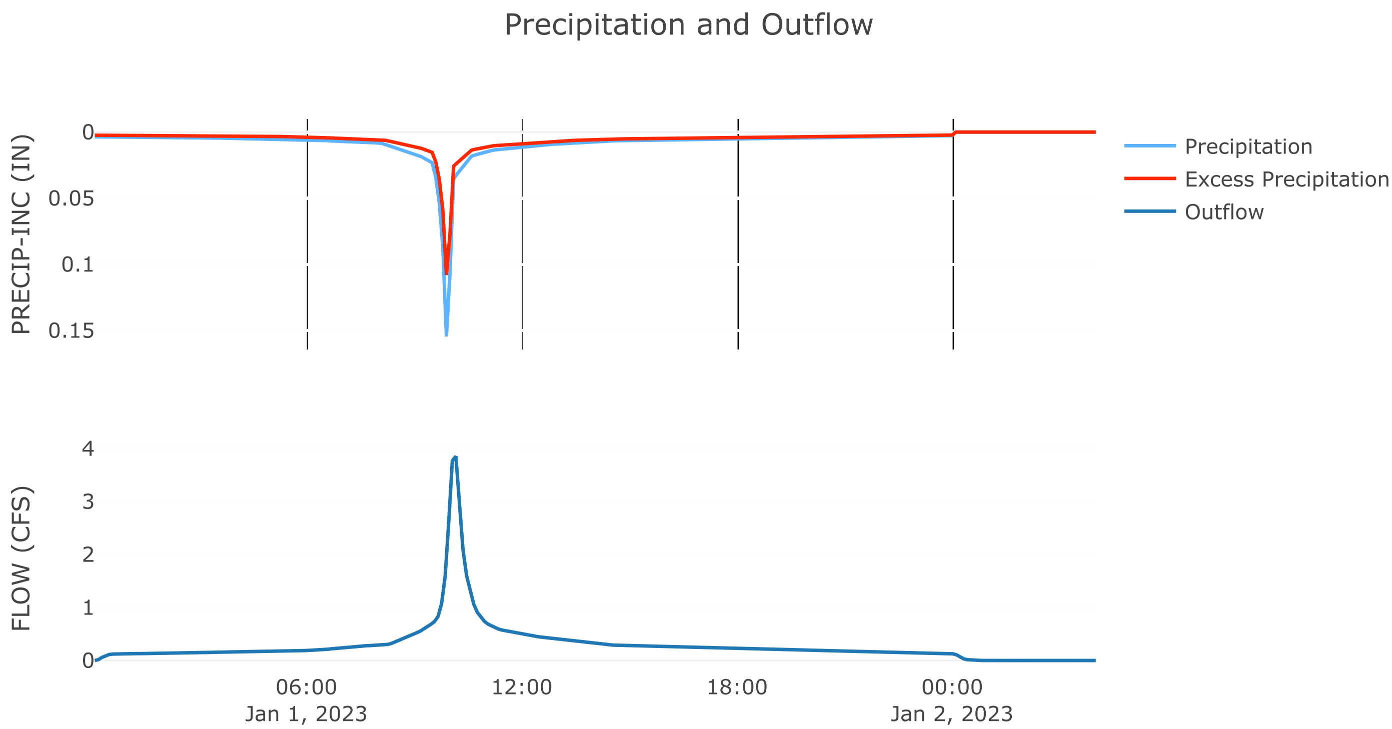
Percent Impervious Area	66.2
Curve Number	75

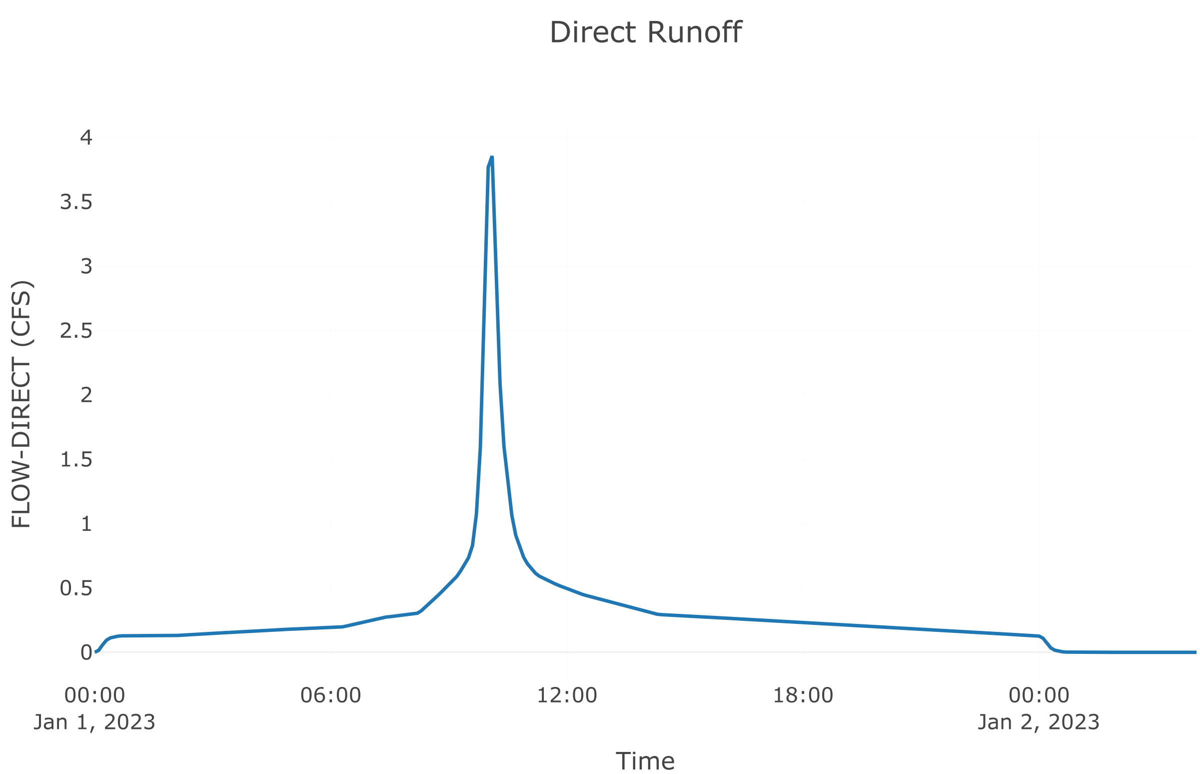
Transform: Scs

Lag	10.6
Unitgraph Type	Standard

Results: Post-280

Peak Discharge (CFS)	3.86
Time of Peak Discharge	01Jan2023, 10:06
Volume (IN)	1.49
Precipitation Volume (AC - FT)	0.93
Loss Volume (AC - FT)	0.25
Excess Volume (AC - FT)	0.68
Direct Runoff Volume (AC - FT)	0.68
Baseflow Volume (AC - FT)	0


Precipitation and Outflow
PRECIP-INC (IN)
0
0.05
0.1
0.15
Precipitation
Excess Precipitation
Outflow
FLOW (CFS)
4
3
2
1
0
06:00
Jan 1, 2023
12:00
18:00
00:00
Jan 2, 2023


Direct Runoff
FLOW-DIRECT (CFS)
4
3.5
3
2.5
2
1.5
1
0.5
0
00:00
Jan 1, 2023
06:00
12:00
18:00
00:00
Jan 2, 2023
Time

B-2: BMP Calculations

Design Capture Volume (DCV), 85th Percentile, 24-hour
&
Design Flowrate (Q), 85th Percentile, 24-hour

Calculations

APPENDIX III. HYDROLOGIC CALCULATIONS AND SIZING METHODS FOR LID BMPS

III.1. Hydrologic Methods for Design Capture Storm

This section describes the hydrologic methods that shall be used to compute the design runoff volume or flowrate resulting from a given precipitation depth or intensity and a given imperviousness fraction. These methods are applicable to the Design Capture Storm (85th percentile, 24-hour) as well as the water quality design storm and water quality design intensity. These methods are applicable for hydrologic analysis of the 2-year design storm for small projects, as allowed per limitations in Appendix VI.

III.1.1. Simple Method Runoff Coefficient for Volume-Based BMP Sizing

This hydrologic method shall be used to calculate the runoff volume associated with LID and water quality design storms. The runoff volume shall be calculated as:

$$V = C \times d \times A \times 43560\ sf/ac \times 1/12\ in/ft \qquad \text{Equation III.1}$$

Where:

V = runoff volume during the design storm event, cu-ft

C = runoff coefficient = $(0.75 \times imp + 0.15)$

imp = impervious fraction of drainage area (ranges from 0 to 1)

d = storm depth (inches)

A = tributary area (acres)

Note: the tributary area includes the portions of the drainage area within the project and any run-on from off-site areas that comingles with project runoff.

An example of this calculation is provided in **Example III.1**.

Example III.2: Back-computing Storm Depth from Runoff Volume

Given:
• A drainage area consists of a 1 acre building roof surrounded by 0.25 acres of landscaping (80 percent composite imperviousness)
• An LID BMP with 1,200 cu-ft of storage is provided.
Required:
• What is the equivalent design storm corresponding to this BMP volume?
Result:
1) From Equation 2.2: d = V × 12 in/ft/[C × A × 43560 sf/ac]
2) V = 1,200 cu-ft (given)
3) C = (0.8×0.75 + 0.15) = 0.75
4) A = 1.25 ac
5) d = 1,200 cu-ft × 12 in/ft / [0.75 × 1.25 ac × 43560 sf/ac] = **0.35 inches**

III.1.2. Simple Method Runoff Coefficient for Flow-based BMP Sizing

This hydrologic method shall be used to calculate the runoff flowrate associated with a water quality design storm intensity. Design flow calculations for flow-based BMPs should be calculated as:

$$Q = C \times i \times A \qquad \text{Equation III.3}$$

Where:

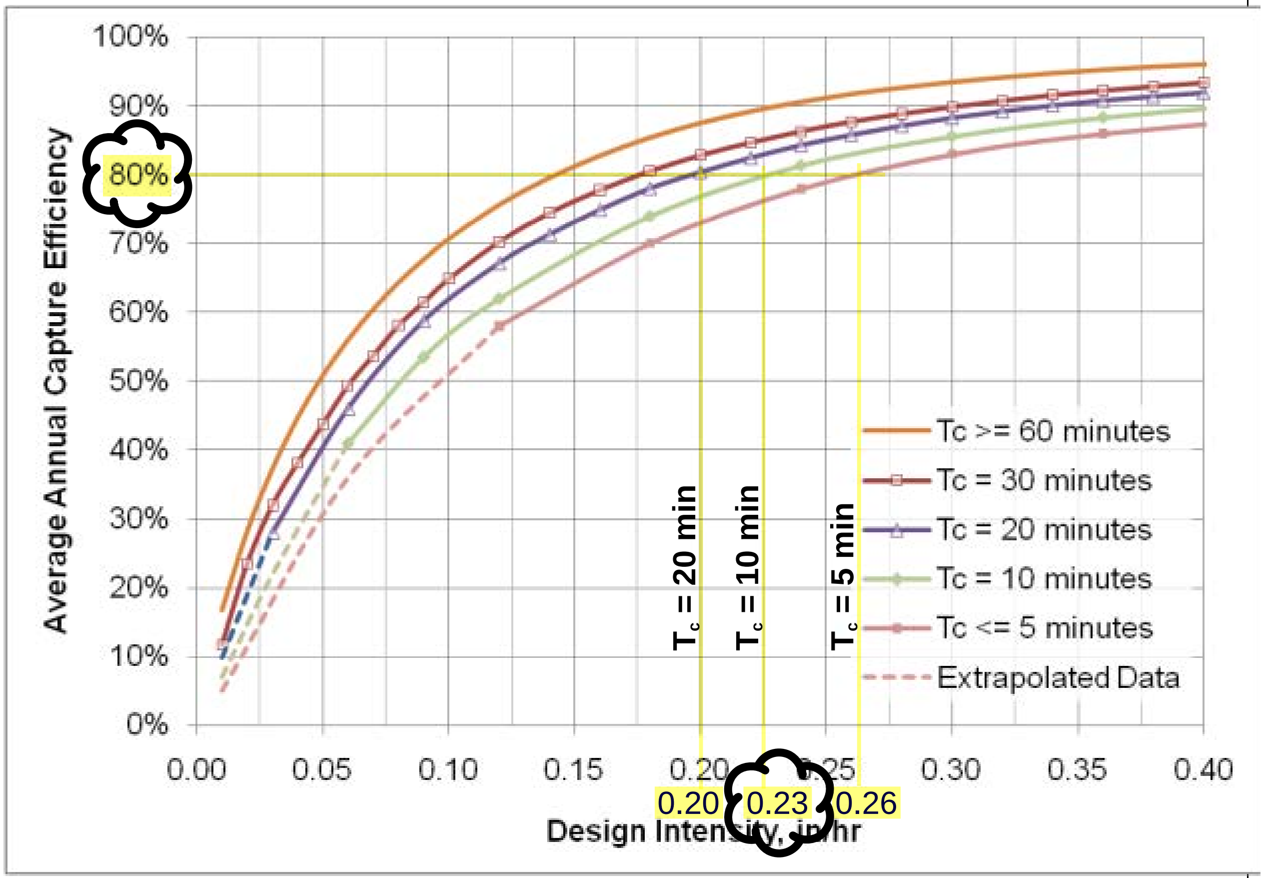
Q = design flowrate, cfs
C = runoff coefficient = $(0.75 \times imp + 0.15)$
imp = impervious fraction of drainage area (ranges from 0 to 1)
i = design intensity (inches)
A = tributary area (acres)

Note: the tributary area includes the portions of the drainage area within the project and any run-on from off-site areas that comingles with project runoff.

III.1.3. Sizing and Accounting for Hydrologic Source Controls (HSCs)

The effects of HSCs are accounted for in hydrologic calculations as an adjustment to the storm depth used in the calculations described above. Adjustments to design storm depth are based on the type and magnitude of HSCs employed for the drainage area. This section provides guidance for both elements of this calculation.

Worksheet D: Capture Efficiency Method for Flow-Based BMPs

Graphical Operations

Provide supporting graphical operations. See Example III.7.

DMA ID	Area, A (ac)	Impervious (%)	Time of Concen, T_c (min)	Runoff Coeffic, C [1]	Depth, d (in) [2]	Intensity, i (in/hr) [3]	DCV (ft^3) [4]	Q (cfs) [5]
110	7.82	42.2%	11.0	0.467	0.75	0.23	9,942	0.84
130	6.70	10.7%	8.9	0.230	0.75	0.23	4,195	0.35
215	2.48	44.4%	9.0	0.483	0.75	0.23	3,261	0.28
225	2.95	77.5%	9.0	0.731	0.75	0.23	5,871	0.50
235	4.29	69.2%	8.2	0.669	0.75	0.23	7,814	0.66
245	2.83	60.9%	9.0	0.607	0.75	0.23	4,677	0.40
255	7.40	50.9%	10.4	0.532	0.75	0.23	10,718	0.91
265	4.26	41.6%	9.6	0.462	0.75	0.23	5,358	0.45
275	4.70	3.6%	9.1	0.177	0.75	0.23	2,265	0.19
280	5.44	66.2%	10.6	0.647	0.75	0.23	9,582	0.81
Σ	**48.9**	**43.8%**	**----**	**----**	**----**	**----**	**63,683**	**5.4**

Notes

[1] C = runoff coefficient = (0.75 × impervious + 0.15)

[2] d = 0.75 in, 24-hour, 85th percentile rainfall depth for all drainage areas

[3] i = 0.23 in/hr, 85th percentile rainfall intensity, $T_c \approx$ 10 minutes for all drainage areas. Time of Concentrations (T_c) based on Advanced Engineering Software (AES) analysis, which performs rational method computations following the OC Hydrology Manual - AES calculations included in **Appendix B-3**.

[4] DCV = C × d × A × 43560 ft^2/ac × 1/12 in/ft

[5] Q = C × i × A

Bioretention Basins
&
Filterra Boxes

Sizing Calculations

DMA ID 110

Bioretention Basin (w/ Underdrain) Sizing

Design Capture Volume (DCV):

DCV = C × d × A × 43560 ft^2/ac × 1/12 in/ft

C = runoff coefficient = (0.75 × impervious + 0.15)

d = storm depth (inches) = 0.75 in – refer to **Appendix A**, Figure 4

A = tributary area (acres)

Design Flowrate (Q):

Q = C × i × A

C = runoff coefficient = (0.75 × impervious + 0.15)

i = rainfall intensity (inches/hour) = 0.23 in/hr (T_c ≈ 10 minutes for all DMAs) – refer to **Appendix B-2**

A = tributary area (acres)

DMA ID	A (ac)	impervious	DCV (ft^3)	Q (cfs)
110	7.82	42.2%	9,942	0.84

Calculations follow Appendix XIV. of the North Orange County Technical Guidance Document

Refer to **Appendix F** of P-WQMP for Bioretention Fact Sheets with calculation steps.

Step 1. Determine DCV

DCV = **9,942** ft^3

Step 2. Verify Ponding Depth will Draw Down within 48 hours

DD_p = (d_p / K_{MEDIA}) x 12 in/ft

DD_p = time to drain ponded water, hrs

d_p = depth of ponding, ft = **1.0 ft**

K_{MEDIA} = media design infiltration rate, in/hr = **2.5 in/hr**

DD_p = **4.8** hrs

Step 3. Determine Depth of Water Filtered During Design Capture Storm

$d_{FILTERED}$ = Minimum of K_{MEDIA} x $T_{ROUTING}$/12 or d_p

$d_{FILTERED}$ = depth of water filtered during design storm event, ft

$T_{ROUTING}$ = storm duration assumed for routing calculations (max 3 hours) = **3.0 hrs**

K_{MEDIA} x $T_{ROUTING}$/12 = **0.6** ft

d_p = **1.0** ft

$d_{FILTERED}$ = **0.6** ft

Step 4. Determine Facility Surface Area

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

A = required area of bioretention facility, ft^2

d_p + $d_{FILTERED}$ = **1.6** ft

A = **6,214** ft^2 **(Based on 85th Percentile Volume)**

Do Hydrologic Conditions of Concern (HCOCs) Exist for DMA? **Yes.**

→ Check Delta 2-Year Volume.

DMA ID 110

Bioretention Basin (w/ Underdrain) Sizing

Post-Dev. 2-Year Volume =	**31,233**	ft^3
Pre-Dev. 2-Year Volume =	**13,983**	ft^3
Delta 2-Year Volume =	**17,250**	ft^3
85th Percentile Volume =	**9,942**	ft^3

Is Delta 2-Year Volume greater than 85th Percentile Volume? **Yes.**

→ Determine Bioretention Facility Surface Area w/ DCV = Delta 2-Year

DMA ID	A (ac)	impervious
110	7.82	42.2%

Calculations follow Appendix XIV. of the North Orange County Technical Guidance Document

Refer to **Appendix F** of P-WQMP for Bioretention Fact Sheets with calculation steps.

Step 1. Determine DCV

DCV = **17,250** ft^3

Step 2. Verify Ponding Depth will Draw Down within 48 hours

$DD_p = (d_p / K_{MEDIA}) \times 12$ in/ft

DD_p = time to drain ponded water, hrs

d_p = depth of ponding, ft = **1.0 ft**

K_{MEDIA} = media design infiltration rate, in/hr = **2.5 in/hr**

DD_p = **4.8** hrs

Step 3. Determine Depth of Water Filtered During Design Capture Storm

$d_{FILTERED}$ = Minimum of $K_{MEDIA} \times T_{ROUTING}/12$ or d_p

$d_{FILTERED}$ = depth of water filtered during design storm event, ft

$T_{ROUTING}$ = storm duration assumed for routing calculations (max 3 hours) = **3.0 hrs**

$K_{MEDIA} \times T_{ROUTING}/12$ = **0.6** ft

d_p = **1.0** ft

$d_{FILTERED}$ = **0.6** ft

Step 4. Determine Facility Surface Area

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

A = required area of bioretention facility, ft^2

$d_p + d_{FILTERED}$ = **1.6** ft

A = **10,781** ft^2 **(Based on Delta 2-Year Volume)**

DMA ID 130

Bioretention Basin (w/ Underdrain) Sizing

Design Capture Volume (DCV):

DCV = C × d × A × 43560 ft^2/ac × 1/12 in/ft

C = runoff coefficient = (0.75 × impervious + 0.15)

d = storm depth (inches) = 0.75 in – refer to **Appendix A**, Figure 4

A = tributary area (acres)

Design Flowrate (Q):

Q = C × i × A

C = runoff coefficient = (0.75 × impervious + 0.15)

i = rainfall intensity (inches/hour) = 0.23 in/hr (T_c ≈ 10 minutes for all DMAs) – refer to **Appendix B-2**

A = tributary area (acres)

DMA ID	A (ac)	impervious	DCV (ft^3)	Q (cfs)
130	6.70	10.7%	4,195	0.35

Calculations follow Appendix XIV. of the North Orange County Technical Guidance Document

Refer to **Appendix F** of P-WQMP for Bioretention Fact Sheets with calculation steps.

Step 1. Determine DCV

DCV = **4,195** ft^3

Step 2. Verify Ponding Depth will Draw Down within 48 hours

DD_p = (d_p / K_{MEDIA}) x 12 in/ft

DD_p = time to drain ponded water, hrs

d_p = depth of ponding, ft = **1.0 ft**

K_{MEDIA} = media design infiltration rate, in/hr = **2.5 in/hr**

DD_p = **4.8** hrs

Step 3. Determine Depth of Water Filtered During Design Capture Storm

$d_{FILTERED}$ = Minimum of K_{MEDIA} x $T_{ROUTING}$/12 or d_p

$d_{FILTERED}$ = depth of water filtered during design storm event, ft

$T_{ROUTING}$ = storm duration assumed for routing calculations (max 3 hours) = **3.0 hrs**

K_{MEDIA} x $T_{ROUTING}$/12 = **0.6** ft

d_p = **1.0** ft

$d_{FILTERED}$ = **0.6** ft

Step 4. Determine Facility Surface Area

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

A = required area of bioretention facility, ft^2

d_p + $d_{FILTERED}$ = **1.6** ft

A = **2,622** ft^2 **(Based on 85th Percentile Volume)**

Do Hydrologic Conditions of Concern (HCOCs) Exist for DMA? **Yes.**

→ **Check Delta 2-Year Volume.**

DMA ID 130

Bioretention Basin (w/ Underdrain) Sizing

Post-Dev. 2-Year Volume =	**14,157**	ft^3
Pre-Dev. 2-Year Volume =	**12,981**	ft^3
Delta 2-Year Volume =	**1,176**	ft^3
85th Percentile Volume =	**4,195**	ft^3

Is Delta 2-Year Volume greater than 85th Percentile Volume? **<u>No.</u>**

→ No Additional Calculations.

DMA ID 215

Filterra Bioretention System Sizing

Design Capture Volume (DCV):

DCV = C × d × A × 43560 ft^2/ac × 1/12 in/ft

C = runoff coefficient = (0.75 × impervious + 0.15)

d = storm depth (inches) = 0.75 in – refer to **Appendix A**, Figure 4

A = tributary area (acres)

Design Flowrate (Q):

Q = C × i × A

C = runoff coefficient = (0.75 × impervious + 0.15)

i = rainfall intensity (inches/hour) = 0.23 in/hr (T_c ≈ 10 minutes for all DMAs) – refer to **Appendix B-2**

A = tributary area (acres)

DMA ID	A (ac)	impervious	DCV (ft^3)	Q (cfs)
215	2.48	44.4%	3,261	0.28

For Filterra Bioretention System Sizing, manufacturer recommends between 100 in/hr and 175 in/hr

Bio Media Flowrate =	100 in/hr	0.0023 ft/s
Max Bio Media Flowrate =	175 in/hr	0.0041 ft/s

Required Filterra Area = (Q) / (Bio Media Flowrate)

Required Filterra Area = 121 sf (based on 100 in/hr)

Refer to **Appendix G** of P-WQMP for Contech Filterra Configuration Details.

Proposed Filterra Box Configuration(s)

Media Bay Size: **12 x 6**

Long Side Inlet Designation: **FTBSV1206**

Short Side Inlet Designation: **FTBSV0612**

Media Bay Area: **72 sf**

Number of Filterra Boxes: **2**

Cumulative Media Bay Area: **144 sf**

Do Hydrologic Conditions of Concern (HCOCs) Exist for DMA? **No.**

→ **No Additional Calculations.**

DMA ID 225

Bioretention Basin (w/ Underdrain) Sizing

Design Capture Volume (DCV):

DCV = C × d × A × 43560 ft^2/ac × 1/12 in/ft

C = runoff coefficient = (0.75 × impervious + 0.15)

d = storm depth (inches) = 0.75 in – refer to **Appendix A**, Figure 4

A = tributary area (acres)

Design Flowrate (Q):

Q = C × i × A

C = runoff coefficient = (0.75 × impervious + 0.15)

i = rainfall intensity (inches/hour) = 0.23 in/hr (T_c ≈ 10 minutes for all DMAs) – refer to **Appendix B-2**

A = tributary area (acres)

DMA ID	A (ac)	impervious	DCV (ft^3)	Q (cfs)
225	2.95	77.5%	5,871	0.50

Calculations follow Appendix XIV. of the North Orange County Technical Guidance Document

Refer to **Appendix F** of P-WQMP for Bioretention Fact Sheets with calculation steps.

Step 1. Determine DCV

DCV = **5,871** ft^3

Step 2. Verify Ponding Depth will Draw Down within 48 hours

DD_p = (d_p / K_{MEDIA}) x 12 in/ft

DD_p = time to drain ponded water, hrs

d_p = depth of ponding, ft = **1.0 ft**

K_{MEDIA} = media design infiltration rate, in/hr = **2.5 in/hr**

DD_p = **4.8** hrs

Step 3. Determine Depth of Water Filtered During Design Capture Storm

$d_{FILTERED}$ = Minimum of K_{MEDIA} x $T_{ROUTING}$/12 or d_p

$d_{FILTERED}$ = depth of water filtered during design storm event, ft

$T_{ROUTING}$ = storm duration assumed for routing calculations (max 3 hours) = **3.0 hrs**

K_{MEDIA} x $T_{ROUTING}$/12 = **0.6** ft

d_p = **1.0** ft

$d_{FILTERED}$ = **0.6** ft

Step 4. Determine Facility Surface Area

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

A = required area of bioretention facility, ft^2

d_p + $d_{FILTERED}$ = **1.6** ft

A = **3,669** ft^2 **(Based on 85th Percentile Volume)**

Do Hydrologic Conditions of Concern (HCOCs) Exist for DMA? **Yes.**

→ **Check Delta 2-Year Volume.**

DMA ID 225

Bioretention Basin (w/ Underdrain) Sizing

Post-Dev. 2-Year Volume =	**17,990**	ft^3
Pre-Dev. 2-Year Volume =	**12,110**	ft^3
Delta 2-Year Volume =	**5,880**	ft^3
85th Percentile Volume =	**5,871**	ft^3

Is Delta 2-Year Volume greater than 85th Percentile Volume? **Yes.**

→ Determine Bioretention Facility Surface Area w/ DCV = Delta 2-Year

DMA ID	A (ac)	impervious
225	2.95	77.5%

Calculations follow Appendix XIV. of the North Orange County Technical Guidance Document

Refer to **Appendix F** of P-WQMP for Bioretention Fact Sheets with calculation steps.

Step 1. Determine DCV

DCV = **5,880** ft^3

Step 2. Verify Ponding Depth will Draw Down within 48 hours

$DD_p = (d_p / K_{MEDIA}) \times 12$ in/ft

DD_p = time to drain ponded water, hrs

d_p = depth of ponding, ft = **1.0 ft**

K_{MEDIA} = media design infiltration rate, in/hr = **2.5 in/hr**

DD_p = **4.8** hrs

Step 3. Determine Depth of Water Filtered During Design Capture Storm

$d_{FILTERED}$ = Minimum of $K_{MEDIA} \times T_{ROUTING}/12$ or d_p

$d_{FILTERED}$ = depth of water filtered during design storm event, ft

$T_{ROUTING}$ = storm duration assumed for routing calculations (max 3 hours) = **3.0 hrs**

$K_{MEDIA} \times T_{ROUTING}/12$ = **0.6** ft

d_p = **1.0** ft

$d_{FILTERED}$ = **0.6** ft

Step 4. Determine Facility Surface Area

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

A = required area of bioretention facility, ft^2

$d_p + d_{FILTERED}$ = **1.6** ft

A = **3,675** ft^2 **(Based on Delta 2-Year Volume)**

DMA ID 235

Bioretention Basin (w/ Underdrain) Sizing

Design Capture Volume (DCV):

DCV = C × d × A × 43560 ft^2/ac × 1/12 in/ft

C = runoff coefficient = (0.75 × impervious + 0.15)

d = storm depth (inches) = 0.75 in – refer to **Appendix A**, Figure 4

A = tributary area (acres)

Design Flowrate (Q):

Q = C × i × A

C = runoff coefficient = (0.75 × impervious + 0.15)

i = rainfall intensity (inches/hour) = 0.23 in/hr (T_c ≈ 10 minutes for all DMAs) – refer to **Appendix B-2**

A = tributary area (acres)

DMA ID	A (ac)	impervious	DCV (ft^3)	Q (cfs)
235	4.29	69.2%	7,814	0.66

Calculations follow Appendix XIV. of the North Orange County Technical Guidance Document

Refer to **Appendix F** of P-WQMP for Bioretention Fact Sheets with calculation steps.

Step 1. Determine DCV

DCV = **7,814** ft^3

Step 2. Verify Ponding Depth will Draw Down within 48 hours

DD_p = (d_p / K_{MEDIA}) x 12 in/ft

DD_p = time to drain ponded water, hrs

d_p = depth of ponding, ft = **1.0 ft**

K_{MEDIA} = media design infiltration rate, in/hr = **2.5 in/hr**

DD_p = **4.8** hrs

Step 3. Determine Depth of Water Filtered During Design Capture Storm

$d_{FILTERED}$ = Minimum of K_{MEDIA} x $T_{ROUTING}$/12 or d_p

$d_{FILTERED}$ = depth of water filtered during design storm event, ft

$T_{ROUTING}$ = storm duration assumed for routing calculations (max 3 hours) = **3.0 hrs**

K_{MEDIA} x $T_{ROUTING}$/12 = **0.6** ft

d_p = **1.0** ft

$d_{FILTERED}$ = **0.6** ft

Step 4. Determine Facility Surface Area

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

A = required area of bioretention facility, ft^2

d_p + $d_{FILTERED}$ = **1.6** ft

A = **4,884** ft^2 **(Based on 85th Percentile Volume)**

Do Hydrologic Conditions of Concern (HCOCs) Exist for DMA? **Yes.**

→ **Check Delta 2-Year Volume.**

DMA ID 235

Bioretention Basin (w/ Underdrain) Sizing

Post-Dev. 2-Year Volume =	**24,045**	ft^3
Pre-Dev. 2-Year Volume =	**19,907**	ft^3
Delta 2-Year Volume =	**4,138**	ft^3
85th Percentile Volume =	**7,814**	ft^3

Is Delta 2-Year Volume greater than 85th Percentile Volume? **No.**

→ No Additional Calculations.

DMA ID 245

Filterra Bioretention System Sizing

Design Capture Volume (DCV):

DCV = C × d × A × 43560 ft^2/ac × 1/12 in/ft

C = runoff coefficient = (0.75 × impervious + 0.15)

d = storm depth (inches) = 0.75 in – refer to **Appendix A**, Figure 4

A = tributary area (acres)

Design Flowrate (Q):

Q = C × i × A

C = runoff coefficient = (0.75 × impervious + 0.15)

i = rainfall intensity (inches/hour) = 0.23 in/hr (T_c ≈ 10 minutes for all DMAs) – refer to **Appendix B-2**

A = tributary area (acres)

DMA ID	A (ac)	impervious	DCV (ft^3)	Q (cfs)
245	2.83	60.9%	4,677	0.40

For Filterra Bioretention System Sizing, manufacturer recommends between 100 in/hr and 175 in/hr

Bio Media Flowrate =	100 in/hr	0.0023 ft/s
Max Bio Media Flowrate =	175 in/hr	0.0041 ft/s

Required Filterra Area = (Q) / (Bio Media Flowrate)

Required Filterra Area = 173 sf (based on 100 in/hr)

Refer to **Appendix G** of P-WQMP for Contech Filterra Configuration Details.

Proposed Filterra Box Configuration(s)

Media Bay Size: **13 x 7**

Long Side Inlet Designation: **FTBSV1307**

Short Side Inlet Designation: **FTBSV0713**

Media Bay Area: **91 sf**

Number of Filterra Boxes: **2**

Cumulative Media Bay Area: **182 sf**

Do Hydrologic Conditions of Concern (HCOCs) Exist for DMA? **No.**

→ **No Additional Calculations.**

DMA ID 255

Bioretention Basin (w/ Underdrain) Sizing

Design Capture Volume (DCV):

DCV = C × d × A × 43560 ft^2/ac × 1/12 in/ft

C = runoff coefficient = (0.75 × impervious + 0.15)

d = storm depth (inches) = 0.75 in – refer to **Appendix A**, Figure 4

A = tributary area (acres)

Design Flowrate (Q):

Q = C × i × A

C = runoff coefficient = (0.75 × impervious + 0.15)

i = rainfall intensity (inches/hour) = 0.23 in/hr (T_c ≈ 10 minutes for all DMAs) – refer to **Appendix B-2**

A = tributary area (acres)

DMA ID	A (ac)	impervious	DCV (ft^3)	Q (cfs)
255	7.40	50.9%	10,718	0.91

Calculations follow Appendix XIV. of the North Orange County Technical Guidance Document

Refer to **Appendix F** of P-WQMP for Bioretention Fact Sheets with calculation steps.

Step 1. Determine DCV

DCV = **10,718** ft^3

Step 2. Verify Ponding Depth will Draw Down within 48 hours

DD_p = (d_p / K_{MEDIA}) x 12 in/ft

DD_p = time to drain ponded water, hrs

d_p = depth of ponding, ft = **1.0 ft**

K_{MEDIA} = media design infiltration rate, in/hr = **2.5 in/hr**

DD_p = **4.8** hrs

Step 3. Determine Depth of Water Filtered During Design Capture Storm

$d_{FILTERED}$ = Minimum of K_{MEDIA} x $T_{ROUTING}$/12 or d_p

$d_{FILTERED}$ = depth of water filtered during design storm event, ft

$T_{ROUTING}$ = storm duration assumed for routing calculations (max 3 hours) = **3.0 hrs**

K_{MEDIA} x $T_{ROUTING}$/12 = **0.6** ft

d_p = **1.0** ft

$d_{FILTERED}$ = **0.6** ft

Step 4. Determine Facility Surface Area

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

A = required area of bioretention facility, ft^2

d_p + $d_{FILTERED}$ = **1.6** ft

A = **6,699** ft^2 **(Based on 85th Percentile Volume)**

Do Hydrologic Conditions of Concern (HCOCs) Exist for DMA? **Yes.**

→ **Check Delta 2-Year Volume.**

DMA ID 255

Bioretention Basin (w/ Underdrain) Sizing

Post-Dev. 2-Year Volume =	**33,323**	ft^3
Pre-Dev. 2-Year Volume =	**27,399**	ft^3
Delta 2-Year Volume =	**5,924**	ft^3
85th Percentile Volume =	**10,718**	ft^3

Is Delta 2-Year Volume greater than 85th Percentile Volume? **No.**

→ No Additional Calculations.

DMA ID 265

Bioretention Basin (w/ Underdrain) Sizing

Design Capture Volume (DCV):

DCV = C × d × A × 43560 ft^2/ac × 1/12 in/ft

C = runoff coefficient = (0.75 × impervious + 0.15)

d = storm depth (inches) = 0.75 in – refer to **Appendix A**, Figure 4

A = tributary area (acres)

Design Flowrate (Q):

Q = C × i × A

C = runoff coefficient = (0.75 × impervious + 0.15)

i = rainfall intensity (inches/hour) = 0.23 in/hr (T_c ≈ 10 minutes for all DMAs) – refer to **Appendix B-2**

A = tributary area (acres)

DMA ID	A (ac)	impervious	DCV (ft^3)	Q (cfs)
265	4.26	41.6%	5,358	0.45

Calculations follow Appendix XIV. of the North Orange County Technical Guidance Document

Refer to **Appendix F** of P-WQMP for Bioretention Fact Sheets with calculation steps.

Step 1. Determine DCV

DCV = **5,358** ft^3

Step 2. Verify Ponding Depth will Draw Down within 48 hours

DD_p = (d_p / K_{MEDIA}) x 12 in/ft

DD_p = time to drain ponded water, hrs

d_p = depth of ponding, ft = **1.0 ft**

K_{MEDIA} = media design infiltration rate, in/hr = **2.5 in/hr**

DD_p = **4.8** hrs

Step 3. Determine Depth of Water Filtered During Design Capture Storm

$d_{FILTERED}$ = Minimum of K_{MEDIA} x $T_{ROUTING}$/12 or d_p

$d_{FILTERED}$ = depth of water filtered during design storm event, ft

$T_{ROUTING}$ = storm duration assumed for routing calculations (max 3 hours) = **3.0 hrs**

K_{MEDIA} x $T_{ROUTING}$/12 = **0.6** ft

d_p = **1.0** ft

$d_{FILTERED}$ = **0.6** ft

Step 4. Determine Facility Surface Area

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

A = required area of bioretention facility, ft^2

d_p + $d_{FILTERED}$ = **1.6** ft

A = **3,349** ft^2 **(Based on 85th Percentile Volume)**

Do Hydrologic Conditions of Concern (HCOCs) Exist for DMA? **Yes.**

→ **Check Delta 2-Year Volume.**

DMA ID 265

Bioretention Basin (w/ Underdrain) Sizing

Post-Dev. 2-Year Volume =	**16,858**	ft^3
Pre-Dev. 2-Year Volume =	**8,059**	ft^3
Delta 2-Year Volume =	**8,799**	ft^3

85th Percentile Volume =	**5,358**	ft^3

Is Delta 2-Year Volume greater than 85th Percentile Volume? **Yes.**

→ Determine Bioretention Facility Surface Area w/ DCV = Delta 2-Year

DMA ID	A (ac)	impervious
265	4.26	41.6%

Calculations follow Appendix XIV. of the North Orange County Technical Guidance Document

Refer to **Appendix F** of P-WQMP for Bioretention Fact Sheets with calculation steps.

Step 1. Determine DCV

DCV = **8,799** ft^3

Step 2. Verify Ponding Depth will Draw Down within 48 hours

$DD_p = (d_p / K_{MEDIA}) \times 12$ in/ft

DD_p = time to drain ponded water, hrs

d_p = depth of ponding, ft = **1.0 ft**

K_{MEDIA} = media design infiltration rate, in/hr = **2.5 in/hr**

DD_p = **4.8** hrs

Step 3. Determine Depth of Water Filtered During Design Capture Storm

$d_{FILTERED}$ = Minimum of $K_{MEDIA} \times T_{ROUTING}/12$ or d_p

$d_{FILTERED}$ = depth of water filtered during design storm event, ft

$T_{ROUTING}$ = storm duration assumed for routing calculations (max 3 hours) = **3.0 hrs**

$K_{MEDIA} \times T_{ROUTING}/12$ =	**0.6**	ft
d_p =	**1.0**	ft
$d_{FILTERED}$ =	**0.6**	ft

Step 4. Determine Facility Surface Area

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

A = required area of bioretention facility, ft^2

$d_p + d_{FILTERED}$ =	**1.6**	ft	
A =	**5,499**	ft^2	**(Based on Delta 2-Year Volume)**

DMA ID 275

Bioretention Basin (w/ Underdrain) Sizing

Design Capture Volume (DCV):

DCV = C × d × A × 43560 ft^2/ac × 1/12 in/ft

C = runoff coefficient = (0.75 × impervious + 0.15)

d = storm depth (inches) = 0.75 in – refer to **Appendix A**, Figure 4

A = tributary area (acres)

Design Flowrate (Q):

Q = C × i × A

C = runoff coefficient = (0.75 × impervious + 0.15)

i = rainfall intensity (inches/hour) = 0.23 in/hr (T_c ≈ 10 minutes for all DMAs) – refer to **Appendix B-2**

A = tributary area (acres)

DMA ID	A (ac)	impervious	DCV (ft^3)	Q (cfs)
275	4.70	3.6%	2,265	0.19

Calculations follow Appendix XIV. of the North Orange County Technical Guidance Document

Refer to **Appendix F** of P-WQMP for Bioretention Fact Sheets with calculation steps.

Step 1. Determine DCV

DCV = **2,265** ft^3

Step 2. Verify Ponding Depth will Draw Down within 48 hours

DD_p = (d_p / K_{MEDIA}) x 12 in/ft

DD_p = time to drain ponded water, hrs

d_p = depth of ponding, ft = **1.0 ft**

K_{MEDIA} = media design infiltration rate, in/hr = **2.5 in/hr**

DD_p = **4.8** hrs

Step 3. Determine Depth of Water Filtered During Design Capture Storm

$d_{FILTERED}$ = Minimum of K_{MEDIA} x $T_{ROUTING}$/12 or d_p

$d_{FILTERED}$ = depth of water filtered during design storm event, ft

$T_{ROUTING}$ = storm duration assumed for routing calculations (max 3 hours) = **3.0 hrs**

K_{MEDIA} x $T_{ROUTING}$/12 = **0.6** ft

d_p = **1.0** ft

$d_{FILTERED}$ = **0.6** ft

Step 4. Determine Facility Surface Area

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

A = required area of bioretention facility, ft^2

d_p + $d_{FILTERED}$ = **1.6** ft

A = **1,416** ft^2 **(Based on 85th Percentile Volume)**

Do Hydrologic Conditions of Concern (HCOCs) Exist for DMA? **No.**

→ **No Additional Calculations.**

DMA ID 280

Filterra Bioretention System Sizing

Design Capture Volume (DCV):

DCV = C × d × A × 43560 ft^2/ac × 1/12 in/ft

C = runoff coefficient = (0.75 × impervious + 0.15)

d = storm depth (inches) = 0.75 in – refer to **Appendix A**, Figure 4

A = tributary area (acres)

Design Flowrate (Q):

Q = C × i × A

C = runoff coefficient = (0.75 × impervious + 0.15)

i = rainfall intensity (inches/hour) = 0.23 in/hr (T_c ≈ 10 minutes for all DMAs) – refer to **Appendix B-2**

A = tributary area (acres)

DMA ID	A (ac)	impervious	DCV (ft^3)	Q (cfs)
280	5.44	66.2%	9,582	0.81

For Filterra Bioretention System Sizing, manufacturer recommends between 100 in/hr and 175 in/hr

Bio Media Flowrate =	100 in/hr	0.0023 ft/s
Max Bio Media Flowrate =	175 in/hr	0.0041 ft/s

Required Filterra Area = (Q) / (Bio Media Flowrate)

Required Filterra Area = 350 sf (based on 100 in/hr)

Refer to **Appendix G** of P-WQMP for Contech Filterra Configuration Details.

Proposed Filterra Box Configuration(s)

Media Bay Size: **13 x 7**

Long Side Inlet Designation: **FTBSV1307**

Short Side Inlet Designation: **FTBSV0713**

Media Bay Area: **91 sf**

Number of Filterra Boxes: **4**

Cumulative Media Bay Area: **364 sf**

Do Hydrologic Conditions of Concern (HCOCs) Exist for DMA? **No.**

→ **No Additional Calculations.**

B-3: Time of Concentration Calculations

Advanced Engineering Software (AES)
Pre-Development
Time of Concentration Calculations

```
****************************************************************************
             RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
            (Reference: 1986 ORANGE COUNTY HYDROLOGY CRITERION)
         (c) Copyright 1983-2016 Advanced Engineering Software (aes)
             Ver. 23.0  Release Date: 07/01/2016  License ID 1676

                           Analysis prepared by:




----------------------------------------------------------------------------
  FILE NAME: IHPEX25.DAT
  TIME/DATE OF STUDY: 16:43 12/14/2022
============================================================================
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
============================================================================
                    --*TIME-OF-CONCENTRATION MODEL*--

  USER SPECIFIED STORM EVENT(YEAR) =   25.00
  SPECIFIED MINIMUM PIPE SIZE(INCH) =  12.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.50
  *DATA BANK RAINFALL USED*
  *ANTECEDENT MOISTURE CONDITION (AMC) II ASSUMED FOR RATIONAL METHOD*

  *USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL*
     HALF-  CROWN TO   STREET-CROSSFALL:   CURB  GUTTER-GEOMETRIES:  MANNING
     WIDTH  CROSSFALL  IN-  / OUT-/PARK-  HEIGHT  WIDTH  LIP   HIKE  FACTOR
NO.   (FT)     (FT)    SIDE / SIDE/ WAY    (FT)    (FT)  (FT)  (FT)    (n)
===  =====  =========  ================  ======  ===== ====== ===== =======
  1   30.0     20.0    0.018/0.018/0.020   0.67    2.00 0.0312 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    110.20 TO NODE    110.10 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =  1000.00
  ELEVATION DATA: UPSTREAM(FEET) =    122.00  DOWNSTREAM(FEET) =    106.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   11.017
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  3.085
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                 D        0.46      0.20     0.100    75   11.02
  NATURAL GOOD COVER
  "GRASS"                    D        7.37      0.20     1.000    80   33.88
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.947
  SUBAREA RUNOFF(CFS) =     20.40
  TOTAL AREA(ACRES) =      7.83   PEAK FLOW RATE(CFS) =     20.40

****************************************************************************
  FLOW PROCESS FROM NODE    120.20 TO NODE    120.10 IS CODE =  21
```

```
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   684.00
  ELEVATION DATA: UPSTREAM(FEET) =    125.00  DOWNSTREAM(FEET) =    112.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    9.144
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  3.428
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                 D        2.24      0.20     0.100    75    9.14
  NATURAL GOOD COVER
  "GRASS"                    D        3.12      0.20     1.000    80   28.12
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.624
  SUBAREA RUNOFF(CFS) =     15.93
  TOTAL AREA(ACRES) =      5.36   PEAK FLOW RATE(CFS) =     15.93

****************************************************************************
  FLOW PROCESS FROM NODE    130.20 TO NODE    130.10 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   704.00
  ELEVATION DATA: UPSTREAM(FEET) =    128.00  DOWNSTREAM(FEET) =    112.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    8.925
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  3.475
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                 D        0.59      0.20     0.100    75    8.92
  NATURAL GOOD COVER
  "GRASS"                    D        6.11      0.20     1.000    80   27.45
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.921
  SUBAREA RUNOFF(CFS) =     19.84
  TOTAL AREA(ACRES) =      6.70   PEAK FLOW RATE(CFS) =     19.84

****************************************************************************
  FLOW PROCESS FROM NODE    140.20 TO NODE    140.10 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   979.00
  ELEVATION DATA: UPSTREAM(FEET) =    130.00  DOWNSTREAM(FEET) =    102.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    9.725
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  3.310
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                 D        4.19      0.20     0.100    75    9.73
  NATURAL GOOD COVER
  "GRASS"                    D        0.39      0.20     1.000    80   29.91
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.177
  SUBAREA RUNOFF(CFS) =     13.50
  TOTAL AREA(ACRES) =      4.58   PEAK FLOW RATE(CFS) =     13.50

****************************************************************************
```

```
  FLOW PROCESS FROM NODE    150.20 TO NODE    150.10 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   900.00
  ELEVATION DATA: UPSTREAM(FEET) =    118.00  DOWNSTREAM(FEET) =    106.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   10.954
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  3.095
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp        Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                 D        1.37      0.20     0.100    75   10.95
  NATURAL GOOD COVER
  "GRASS"                    D        5.21      0.20     1.000    80   33.69
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.813
  SUBAREA RUNOFF(CFS) =     17.36
  TOTAL AREA(ACRES) =      6.58   PEAK FLOW RATE(CFS) =     17.36

****************************************************************************
  FLOW PROCESS FROM NODE    160.20 TO NODE    160.10 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   563.00
  ELEVATION DATA: UPSTREAM(FEET) =    121.00  DOWNSTREAM(FEET) =    113.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    8.965
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  3.466
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp        Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                 D        2.46      0.20     0.100    75    8.97
  NATURAL GOOD COVER
  "GRASS"                    D        0.20      0.20     1.000    80   27.57
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.168
  SUBAREA RUNOFF(CFS) =      8.22
  TOTAL AREA(ACRES) =      2.66   PEAK FLOW RATE(CFS) =      8.22

****************************************************************************
  FLOW PROCESS FROM NODE    170.20 TO NODE    170.10 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   984.00
  ELEVATION DATA: UPSTREAM(FEET) =    109.00  DOWNSTREAM(FEET) =     99.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   11.986
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  2.941
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp        Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                 D        4.26      0.20     0.100    75   11.99
  NATURAL GOOD COVER
  "GRASS"                    D        0.48      0.20     1.000    80   36.86
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.191
  SUBAREA RUNOFF(CFS) =     12.38
  TOTAL AREA(ACRES) =      4.74   PEAK FLOW RATE(CFS) =     12.38
```

```
****************************************************************************
  FLOW PROCESS FROM NODE    180.20 TO NODE    180.10 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   635.00
  ELEVATION DATA: UPSTREAM(FEET) =    114.00  DOWNSTREAM(FEET) =    109.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   10.586
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  3.155
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                 D        2.87      0.20     0.100    75   10.59
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
  SUBAREA RUNOFF(CFS) =      8.10
  TOTAL AREA(ACRES) =      2.87   PEAK FLOW RATE(CFS) =      8.10

****************************************************************************
  FLOW PROCESS FROM NODE    190.20 TO NODE    190.10 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   994.00
  ELEVATION DATA: UPSTREAM(FEET) =    110.00  DOWNSTREAM(FEET) =     97.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   11.442
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  3.019
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                 D        3.98      0.20     0.100    75   11.44
  NATURAL GOOD COVER
  "GRASS"                    D        0.85      0.20     1.000    80   35.19
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.258
  SUBAREA RUNOFF(CFS) =     12.90
  TOTAL AREA(ACRES) =      4.83   PEAK FLOW RATE(CFS) =     12.90

****************************************************************************
  FLOW PROCESS FROM NODE    200.20 TO NODE    200.10 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   540.00
  ELEVATION DATA: UPSTREAM(FEET) =    114.00  DOWNSTREAM(FEET) =    110.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   10.044
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  3.250
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                 D        3.36      0.20     0.100    75   10.04
  NATURAL GOOD COVER
  "GRASS"                    D        0.11      0.20     1.000    80   30.89
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.129
  SUBAREA RUNOFF(CFS) =     10.07
  TOTAL AREA(ACRES) =      3.47   PEAK FLOW RATE(CFS) =     10.07

****************************************************************************
```

```
  FLOW PROCESS FROM NODE    210.20 TO NODE    210.10 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   565.00
  ELEVATION DATA: UPSTREAM(FEET) =    108.00  DOWNSTREAM(FEET) =    101.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    9.227
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  3.410
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                 D        2.04      0.20     0.100    75    9.23
  NATURAL GOOD COVER
  "GRASS"                    D        0.47      0.20     1.000    80   28.38
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.269
  SUBAREA RUNOFF(CFS) =      7.58
  TOTAL AREA(ACRES) =      2.51   PEAK FLOW RATE(CFS) =      7.58

****************************************************************************
  FLOW PROCESS FROM NODE    220.20 TO NODE    220.10 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   511.00
  ELEVATION DATA: UPSTREAM(FEET) =    116.00  DOWNSTREAM(FEET) =    104.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    7.800
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  3.750
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                 D        1.64      0.20     0.100    75    7.80
  NATURAL GOOD COVER
  "GRASS"                    D        0.58      0.20     1.000    80   23.99
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.335
  SUBAREA RUNOFF(CFS) =      7.36
  TOTAL AREA(ACRES) =      2.22   PEAK FLOW RATE(CFS) =      7.36

****************************************************************************
  FLOW PROCESS FROM NODE    230.20 TO NODE    230.10 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   570.00
  ELEVATION DATA: UPSTREAM(FEET) =    135.00  DOWNSTREAM(FEET) =    122.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    8.196
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  3.647
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                 D        2.63      0.20     0.100    75    8.20
  NATURAL GOOD COVER
  "GRASS"                    D        1.27      0.20     1.000    80   25.21
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.393
  SUBAREA RUNOFF(CFS) =     12.52
  TOTAL AREA(ACRES) =      3.90   PEAK FLOW RATE(CFS) =     12.52
```

```
****************************************************************************
  FLOW PROCESS FROM NODE    240.20 TO NODE    240.10 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   653.00
  ELEVATION DATA: UPSTREAM(FEET) =    135.00  DOWNSTREAM(FEET) =    123.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    9.036
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  3.451
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                 D        1.91      0.20     0.100    75    9.04
  NATURAL GOOD COVER
  "GRASS"                    D        0.94      0.20     1.000    80   27.79
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.397
  SUBAREA RUNOFF(CFS) =      8.65
  TOTAL AREA(ACRES) =      2.85   PEAK FLOW RATE(CFS) =      8.65

****************************************************************************
  FLOW PROCESS FROM NODE    250.20 TO NODE    250.10 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   618.00
  ELEVATION DATA: UPSTREAM(FEET) =    125.00  DOWNSTREAM(FEET) =    120.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   10.415
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  3.184
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                 D        2.97      0.20     0.100    75   10.42
  NATURAL GOOD COVER
  "GRASS"                    D        4.79      0.20     1.000    80   32.03
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.656
  SUBAREA RUNOFF(CFS) =     21.32
  TOTAL AREA(ACRES) =      7.76   PEAK FLOW RATE(CFS) =     21.32

****************************************************************************
  FLOW PROCESS FROM NODE    260.20 TO NODE    260.10 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   688.00
  ELEVATION DATA: UPSTREAM(FEET) =    124.00  DOWNSTREAM(FEET) =    114.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    9.670
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  3.321
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                 D        0.36      0.20     0.100    75    9.67
  NATURAL GOOD COVER
  "GRASS"                    D        3.81      0.20     1.000    80   29.74
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.922
  SUBAREA RUNOFF(CFS) =     11.77
  TOTAL AREA(ACRES) =      4.17   PEAK FLOW RATE(CFS) =     11.77
```

```
****************************************************************************
  FLOW PROCESS FROM NODE    270.20 TO NODE    270.10 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   721.00
  ELEVATION DATA: UPSTREAM(FEET) =    124.00  DOWNSTREAM(FEET) =    111.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    9.437
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  3.367
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                 D       0.28      0.20     0.100    75    9.44
  NATURAL GOOD COVER
  "GRASS"                    D       5.20      0.20     1.000    80   29.03
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.954
  SUBAREA RUNOFF(CFS) =     15.66
  TOTAL AREA(ACRES) =      5.48   PEAK FLOW RATE(CFS) =     15.66

****************************************************************************
  FLOW PROCESS FROM NODE    280.20 TO NODE    280.10 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   778.00
  ELEVATION DATA: UPSTREAM(FEET) =    125.00  DOWNSTREAM(FEET) =    116.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   10.632
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  3.147
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                 D       3.96      0.20     0.100    75   10.63
  NATURAL GOOD COVER
  "GRASS"                    D       1.49      0.20     1.000    80   32.70
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.346
  SUBAREA RUNOFF(CFS) =     15.10
  TOTAL AREA(ACRES) =      5.45   PEAK FLOW RATE(CFS) =     15.10
============================================================================
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)     =        5.4  TC(MIN.) =     10.63
  EFFECTIVE AREA(ACRES) =      5.45  AREA-AVERAGED Fm(INCH/HR)=  0.07
  AREA-AVERAGED Fp(INCH/HR) =  0.20  AREA-AVERAGED Ap = 0.346
  PEAK FLOW RATE(CFS)   =      15.10
============================================================================
============================================================================
  END OF RATIONAL METHOD ANALYSIS
```

Advanced Engineering Software (AES)
Post-Development
Time of Concentration Calculations

```
****************************************************************************
             RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
            (Reference: 1986 ORANGE COUNTY HYDROLOGY CRITERION)
         (c) Copyright 1983-2016 Advanced Engineering Software (aes)
             Ver. 23.0  Release Date: 07/01/2016  License ID 1676

                           Analysis prepared by:

----------------------------------------------------------------------------
  FILE NAME: IHPPR25.DAT
  TIME/DATE OF STUDY: 16:44 12/14/2022
============================================================================
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
============================================================================
                    --*TIME-OF-CONCENTRATION MODEL*--

  USER SPECIFIED STORM EVENT(YEAR) =   25.00
  SPECIFIED MINIMUM PIPE SIZE(INCH) =  12.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.50
  *DATA BANK RAINFALL USED*
  *ANTECEDENT MOISTURE CONDITION (AMC) II ASSUMED FOR RATIONAL METHOD*

  *USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL*
     HALF-  CROWN TO   STREET-CROSSFALL:   CURB  GUTTER-GEOMETRIES:  MANNING
     WIDTH  CROSSFALL  IN-  / OUT-/PARK-  HEIGHT  WIDTH  LIP   HIKE  FACTOR
NO.   (FT)     (FT)    SIDE / SIDE/ WAY    (FT)    (FT)  (FT)  (FT)    (n)
===  =====  =========  ================  ======  ===== ====== ===== =======
  1   30.0     20.0    0.018/0.018/0.020   0.67    2.00 0.0312 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    110.20 TO NODE    110.10 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =  1000.00
  ELEVATION DATA: UPSTREAM(FEET) =    122.00  DOWNSTREAM(FEET) =    106.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   11.017
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  3.085
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                 D        3.67      0.20     0.100    75   11.02
  NATURAL GOOD COVER
  "GRASS"                    D        4.16      0.20     1.000    80   33.88
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.578
  SUBAREA RUNOFF(CFS) =     20.92
  TOTAL AREA(ACRES) =      7.83   PEAK FLOW RATE(CFS) =     20.92

****************************************************************************
  FLOW PROCESS FROM NODE    120.20 TO NODE    120.10 IS CODE =  21
```

```
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   684.00
  ELEVATION DATA: UPSTREAM(FEET) =    125.00  DOWNSTREAM(FEET) =    112.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    9.144
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  3.428
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp        Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                 D        2.24      0.20     0.100    75    9.14
  NATURAL GOOD COVER
  "GRASS"                    D        3.12      0.20     1.000    80   28.12
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.624
  SUBAREA RUNOFF(CFS) =     15.93
  TOTAL AREA(ACRES) =      5.36   PEAK FLOW RATE(CFS) =     15.93

****************************************************************************
  FLOW PROCESS FROM NODE    130.20 TO NODE    130.10 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   704.00
  ELEVATION DATA: UPSTREAM(FEET) =    128.00  DOWNSTREAM(FEET) =    112.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    8.925
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  3.475
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp        Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                 D        0.80      0.20     0.100    75    8.92
  NATURAL GOOD COVER
  "GRASS"                    D        5.90      0.20     1.000    80   27.45
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.893
  SUBAREA RUNOFF(CFS) =     19.88
  TOTAL AREA(ACRES) =      6.70   PEAK FLOW RATE(CFS) =     19.88

****************************************************************************
  FLOW PROCESS FROM NODE    140.20 TO NODE    140.10 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   979.00
  ELEVATION DATA: UPSTREAM(FEET) =    130.00  DOWNSTREAM(FEET) =    102.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    9.725
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  3.310
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp        Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                 D        4.19      0.20     0.100    75    9.73
  NATURAL GOOD COVER
  "GRASS"                    D        0.39      0.20     1.000    80   29.91
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.177
  SUBAREA RUNOFF(CFS) =     13.50
  TOTAL AREA(ACRES) =      4.58   PEAK FLOW RATE(CFS) =     13.50

****************************************************************************
```

```
  FLOW PROCESS FROM NODE    150.20 TO NODE    150.10 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   900.00
  ELEVATION DATA: UPSTREAM(FEET) =    118.00  DOWNSTREAM(FEET) =    106.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   10.954
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  3.095
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp        Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                 D        1.37      0.20     0.100    75   10.95
  NATURAL GOOD COVER
  "GRASS"                    D        5.21      0.20     1.000    80   33.69
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.813
  SUBAREA RUNOFF(CFS) =     17.36
  TOTAL AREA(ACRES) =      6.58   PEAK FLOW RATE(CFS) =     17.36

****************************************************************************
  FLOW PROCESS FROM NODE    160.20 TO NODE    160.10 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   563.00
  ELEVATION DATA: UPSTREAM(FEET) =    121.00  DOWNSTREAM(FEET) =    113.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    8.965
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  3.466
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp        Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                 D        2.46      0.20     0.100    75    8.97
  NATURAL GOOD COVER
  "GRASS"                    D        0.20      0.20     1.000    80   27.57
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.168
  SUBAREA RUNOFF(CFS) =      8.22
  TOTAL AREA(ACRES) =      2.66   PEAK FLOW RATE(CFS) =      8.22

****************************************************************************
  FLOW PROCESS FROM NODE    170.20 TO NODE    170.10 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   984.00
  ELEVATION DATA: UPSTREAM(FEET) =    109.00  DOWNSTREAM(FEET) =     99.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   11.986
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  2.941
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp        Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                 D        4.26      0.20     0.100    75   11.99
  NATURAL GOOD COVER
  "GRASS"                    D        0.48      0.20     1.000    80   36.86
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.191
  SUBAREA RUNOFF(CFS) =     12.38
  TOTAL AREA(ACRES) =      4.74   PEAK FLOW RATE(CFS) =     12.38
```

```
****************************************************************************
  FLOW PROCESS FROM NODE    180.20 TO NODE    180.10 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   635.00
  ELEVATION DATA: UPSTREAM(FEET) =    114.00  DOWNSTREAM(FEET) =    109.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   10.586
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  3.155
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                 D        2.87      0.20     0.100    75   10.59
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
  SUBAREA RUNOFF(CFS) =      8.10
  TOTAL AREA(ACRES) =      2.87   PEAK FLOW RATE(CFS) =      8.10

****************************************************************************
  FLOW PROCESS FROM NODE    190.20 TO NODE    190.10 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   994.00
  ELEVATION DATA: UPSTREAM(FEET) =    110.00  DOWNSTREAM(FEET) =     97.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   11.442
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  3.019
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                 D        3.98      0.20     0.100    75   11.44
  NATURAL GOOD COVER
  "GRASS"                    D        0.85      0.20     1.000    80   35.19
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.258
  SUBAREA RUNOFF(CFS) =     12.90
  TOTAL AREA(ACRES) =      4.83   PEAK FLOW RATE(CFS) =     12.90

****************************************************************************
  FLOW PROCESS FROM NODE    200.20 TO NODE    200.10 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   540.00
  ELEVATION DATA: UPSTREAM(FEET) =    114.00  DOWNSTREAM(FEET) =    110.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   10.044
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  3.250
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                 D        3.36      0.20     0.100    75   10.04
  NATURAL GOOD COVER
  "GRASS"                    D        0.11      0.20     1.000    80   30.89
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.129
  SUBAREA RUNOFF(CFS) =     10.07
  TOTAL AREA(ACRES) =      3.47   PEAK FLOW RATE(CFS) =     10.07

****************************************************************************
```

```
  FLOW PROCESS FROM NODE    215.20 TO NODE    215.10 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   545.00
  ELEVATION DATA: UPSTREAM(FEET) =    108.00  DOWNSTREAM(FEET) =    101.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    9.030
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  3.452
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                 D        1.22      0.20     0.100    75    9.03
  NATURAL GOOD COVER
  "GRASS"                    D        1.26      0.20     1.000    80   27.77
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.557
  SUBAREA RUNOFF(CFS) =      7.46
  TOTAL AREA(ACRES) =      2.48   PEAK FLOW RATE(CFS) =      7.46

****************************************************************************
  FLOW PROCESS FROM NODE    225.20 TO NODE    225.10 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   616.00
  ELEVATION DATA: UPSTREAM(FEET) =    116.00  DOWNSTREAM(FEET) =    106.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    9.049
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  3.448
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                 D        2.54      0.20     0.100    75    9.05
  NATURAL GOOD COVER
  "GRASS"                    D        0.41      0.20     1.000    80   27.83
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.225
  SUBAREA RUNOFF(CFS) =      9.03
  TOTAL AREA(ACRES) =      2.95   PEAK FLOW RATE(CFS) =      9.03

****************************************************************************
  FLOW PROCESS FROM NODE    235.20 TO NODE    235.10 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   570.00
  ELEVATION DATA: UPSTREAM(FEET) =    135.00  DOWNSTREAM(FEET) =    122.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    8.196
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  3.647
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                 D        3.29      0.20     0.100    75    8.20
  NATURAL GOOD COVER
  "GRASS"                    D        1.00      0.20     1.000    80   25.21
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.310
  SUBAREA RUNOFF(CFS) =     13.84
  TOTAL AREA(ACRES) =      4.29   PEAK FLOW RATE(CFS) =     13.84
```

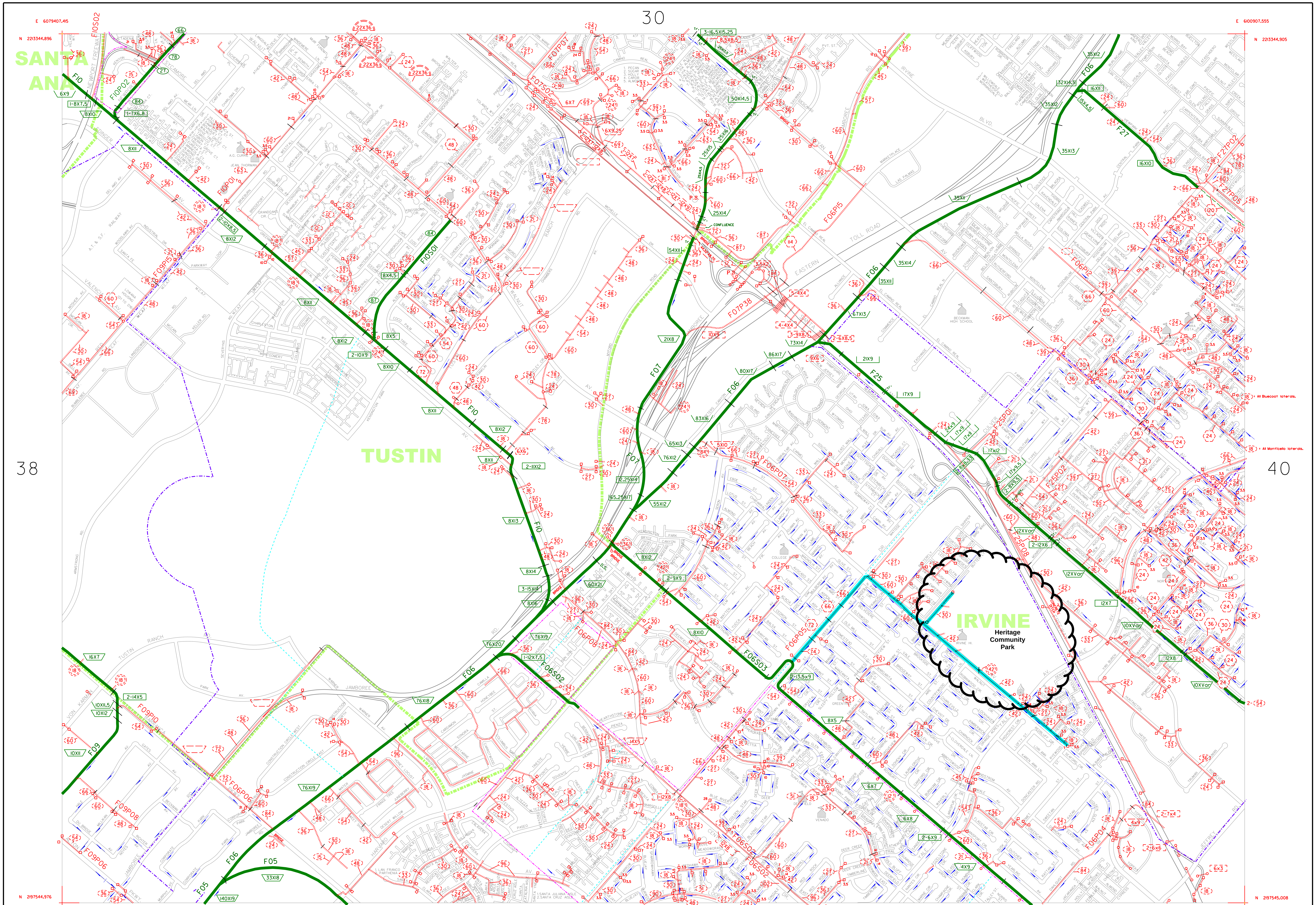
```
****************************************************************************
  FLOW PROCESS FROM NODE    245.20 TO NODE    245.10 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   653.00
  ELEVATION DATA: UPSTREAM(FEET) =    135.00  DOWNSTREAM(FEET) =    123.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    9.036
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  3.451
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                  D        1.91      0.20     0.100    75    9.04
  NATURAL GOOD COVER
  "GRASS"                     D        0.91      0.20     1.000    80   27.79
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.390
  SUBAREA RUNOFF(CFS) =      8.56
  TOTAL AREA(ACRES) =      2.82   PEAK FLOW RATE(CFS) =      8.56

****************************************************************************
  FLOW PROCESS FROM NODE    255.20 TO NODE    255.10 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   619.00
  ELEVATION DATA: UPSTREAM(FEET) =    125.00  DOWNSTREAM(FEET) =    120.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   10.425
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  3.182
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                  D        4.19      0.20     0.100    75   10.43
  NATURAL GOOD COVER
  "GRASS"                     D        3.21      0.20     1.000    80   32.07
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.490
  SUBAREA RUNOFF(CFS) =     20.54
  TOTAL AREA(ACRES) =      7.40   PEAK FLOW RATE(CFS) =     20.54

****************************************************************************
  FLOW PROCESS FROM NODE    265.20 TO NODE    265.10 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   683.00
  ELEVATION DATA: UPSTREAM(FEET) =    124.00  DOWNSTREAM(FEET) =    114.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    9.628
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  3.329
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                  D        1.97      0.20     0.100    75    9.63
  NATURAL GOOD COVER
  "GRASS"                     D        2.29      0.20     1.000    80   29.61
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.584
  SUBAREA RUNOFF(CFS) =     12.32
  TOTAL AREA(ACRES) =      4.26   PEAK FLOW RATE(CFS) =     12.32
```

```
****************************************************************************
  FLOW PROCESS FROM NODE    275.20 TO NODE    275.10 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   677.00
  ELEVATION DATA: UPSTREAM(FEET) =    124.00  DOWNSTREAM(FEET) =    111.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    9.087
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  3.440
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                 D       0.19      0.20     0.100    75    9.09
  NATURAL GOOD COVER
  "GRASS"                    D       4.51      0.20     1.000    80   27.95
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.964
  SUBAREA RUNOFF(CFS) =     13.73
  TOTAL AREA(ACRES) =      4.70   PEAK FLOW RATE(CFS) =     13.73

****************************************************************************
  FLOW PROCESS FROM NODE    280.20 TO NODE    280.10 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   778.00
  ELEVATION DATA: UPSTREAM(FEET) =    125.00  DOWNSTREAM(FEET) =    116.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   10.632
  *  25 YEAR RAINFALL INTENSITY(INCH/HR) =  3.147
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                 D       4.00      0.20     0.100    75   10.63
  NATURAL GOOD COVER
  "GRASS"                    D       1.44      0.20     1.000    80   32.70
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.20
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.338
  SUBAREA RUNOFF(CFS) =     15.08
  TOTAL AREA(ACRES) =      5.44   PEAK FLOW RATE(CFS) =     15.08
============================================================================
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)     =        5.4  TC(MIN.) =     10.63
  EFFECTIVE AREA(ACRES) =      5.44  AREA-AVERAGED Fm(INCH/HR)=  0.07
  AREA-AVERAGED Fp(INCH/HR) =  0.20  AREA-AVERAGED Ap = 0.338
  PEAK FLOW RATE(CFS)   =      15.08
============================================================================
============================================================================
  END OF RATIONAL METHOD ANALYSIS
```

Appendix C.

Additional Documents

C-1: OCFCD Base Map of Drainage Facilities



NOTICE

The drainage information has been prepared for information purposes only. The location, ownership, facility information and limits have been determined from available information provided by public agencies, but may not be exact, accurate, or up–to–date. The user of this information is responsible for verifying exact location, ownership, accuracy, and the regional versus local character of drainage facilities.

Additional information may be obtained from public plans and recorded deeds. Facility designations included with this information are for convenience only and are not controlling or intended to imply ownership by the County or the Orange County Flood Control District (OCFCD). The information is being provided as a courtesy and neither the County of Orange nor OCFCD assume any liabilities for inaccuracy of the information.

To notify the Resources & Development Management Department (RDMD) of additions or corrections, please contact Sal Gutierrez at (714) 834–5396 or by email at sal.gutierrez@rdmd.ocgov.com

ORANGE COUNTY FLOOD CONTROL DISTRICT

BASE MAP OF DRAINAGE FACILITIES IN ORANGE COUNTY

REVISION	DATE	SHEET NO.	DWG. NO.
S. GUTIERREZ	APR. 28, 2008	39	MAPS–113–3

Channel Drainage Area Boundary
Major Sub–Area Drainage Boundary
Minor Sub–Area Drainage Boundary
Existing O.C.F.C.D. Facility
Existing Local Facility
Existing Retarding Basin or Reservoir
Natural Watercourse
City Limits
G G Greenbelt
P.S. P.S. Pump Station
Catch Basin (length in feet)
Drop Inlet or Other Entry
OCFCD Basins or Reservoirs

Ownership (If other than City or County): Private = P State = S Federal = F

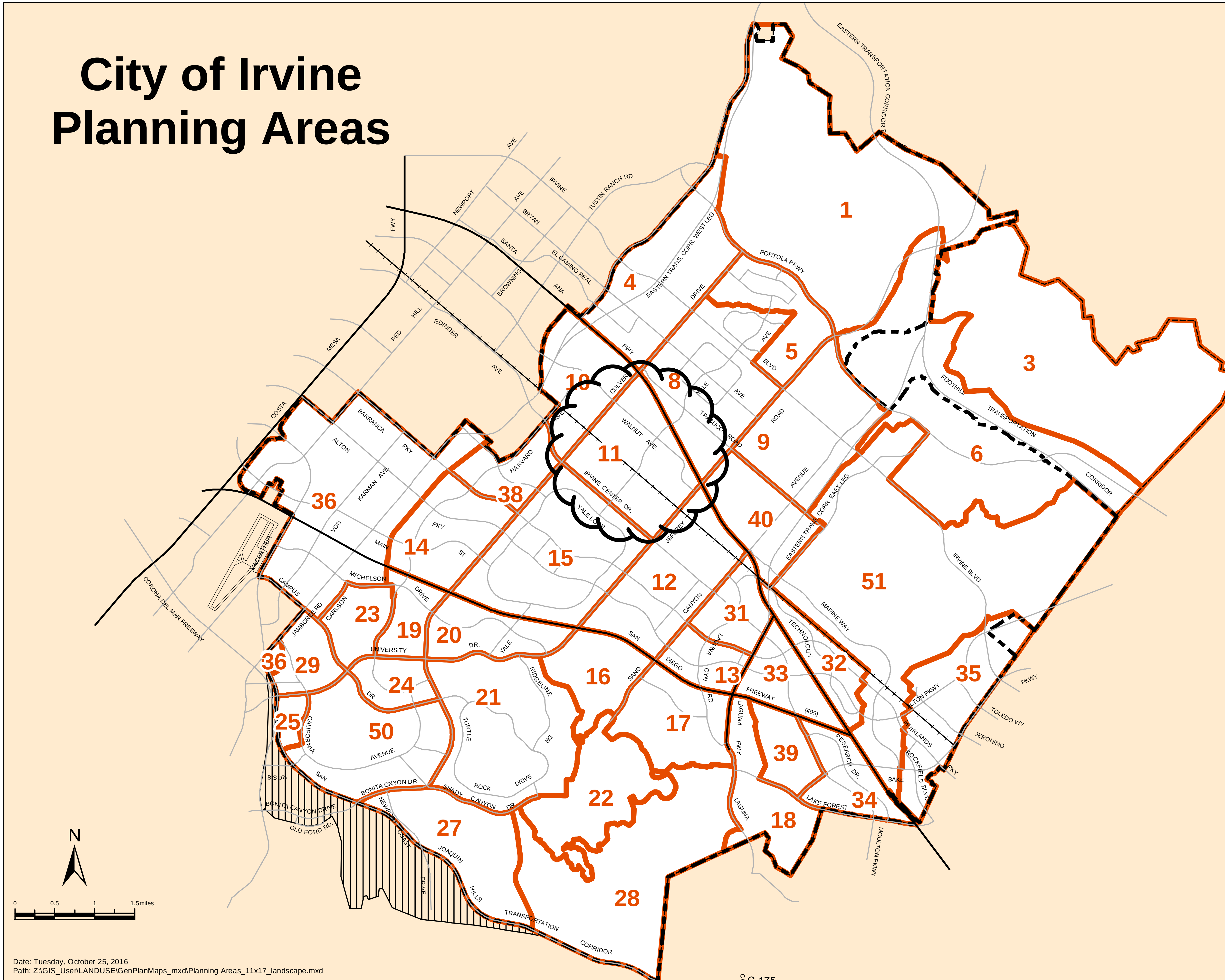
EXISTING FACILITIES

O.C.F.C.D. LOCAL

Earth Trapezoidal Channel (base width by height in feet)
Reinforced Concrete Trapezoidal Channel (base width by height in feet)
Reinforced Concrete Rectangular Channel (base width by height in feet)
Reinforced Concrete Box (RCB) (number of barrels–span by height in feet)
Reinforced Concrete Pipe (RCP) (diameter in inches)
Metal Sheet Channel (MSC) (Base width by pile height in feet/Sheet pile total length)
Corrugated Metal Pipe (CMP) (diameter in inches)
Concrete Pipe (diameter in inches)
Concrete Oval Pipe (width by height in inches)
Steel Pipe (diameter in inches)
Reinforced Concrete Arch (base span by height in inches)
Corrugated Metal Arch (base span by height in inches)

C-2: City of Irvine Planning Areas

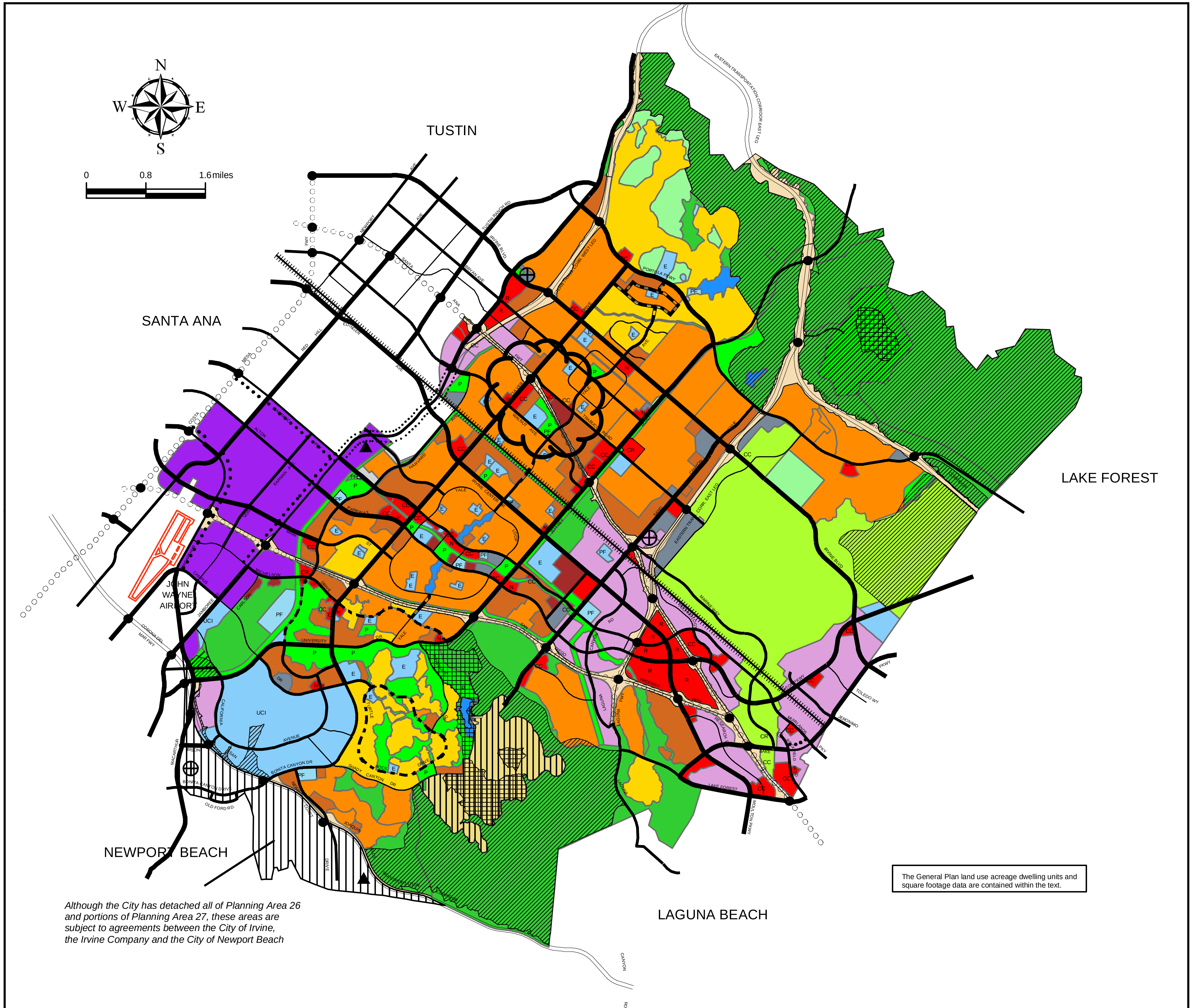
City of Irvine Planning Areas



PA1 Orchard Hills
PA3 Limestone Canyon - Open Space
PA4 Lower Peters Canyon
PA5 Northwood Point
PA6 Portola Springs
PA8 Northwood
PA9
PA9A Woodbury
PA9B & C2 Stonegate
PA9C1 Woodbury East
PA10 Walnut
PA11 El Camino Real
PA12 Oakcreek
PA13 Irvine Spectrum 4
PA14 Westpark
PA15 Woodbridge
PA16 Quail Hill - Open Space
PA17 Quail Hill
PA18
N: Laguna Altura
S: Hidden Canyon
PA19 Rancho San Joaquin
PA20 University Park
PA21 Turtle Rock
PA22 Shady Canyon
PA23 San Joaquin Marsh
PA24 University Town Center
PA25 University Research Center
PA27 Turtle Ridge
PA28 Bommer Canyon - Open Space
PA29 UCI - North Campus
PA31 Irvine Spectrum 6
PA32 Irvine Spectrum 3
PA33 Irvine Spectrum Center
PA34 Irvine Spectrum 5
PA35 Irvine Spectrum 2
PA36 Irvine Business Complex
PA38 Westpark II
PA39 Los Olivos
PA40 Cypress Village
PA50 University of California, Irvine
PA51 Orange County Great Park

Date: Tuesday, October 25, 2016
Path: Z:\GIS_User\LANDUSE\GenPlanMaps_mxd\Planning Areas_11x17_landscape.mxd

C-3: City of Irvine Land Use



City of Irvine General Plan

Figure A-3

LAND USE

LEGEND

CONSERVATION OPEN SPACE
- Recreation
- Preservation
- Water Bodies
- Agriculture
- Golf Course Overlay
- Landfill Overlay
- NCCP Reserve
- NCCP Special Linkage

MILITARY[1][3][4]

MULTI USE[3][4]

Orange County Great Park

COMMERCIAL
- N — Neighborhood Commercial[4]
- CC — Community Commercial[4]
- R — Regional Commercial[4]
- CR — Commercial Recreation[4]

RESIDENTIAL
- Estate[4]
- Low Density[4]
- Medium Density[4]
- Medium High Density[4]
- High Density[4]

BUSINESS/INDUSTRIAL
- Research and Industrial[4]
- Urban and Industrial[3][4]

INSTITUTIONAL
- E — Educational Facilities[1][2][3][4]
- PF — Public Facilities[4]

- Historic Resources
- Waste Facility
- Freeway
- Interchange
- Transportation Corridor
- Expressway
- Major Highway 8-Lanes
- Major Highway 6-Lanes
- Primary Highway
- Secondary Highway
- Commuter
- Railroads

NOTES TO LAND USES

(1) Land Use authority and corresponding regulatory activities are the responsibilities of the government agencies which own this land.

(2) These governmental agencies are subject to the General Plan reqiurements contained within the California Government Code sections 65401 and 65402.

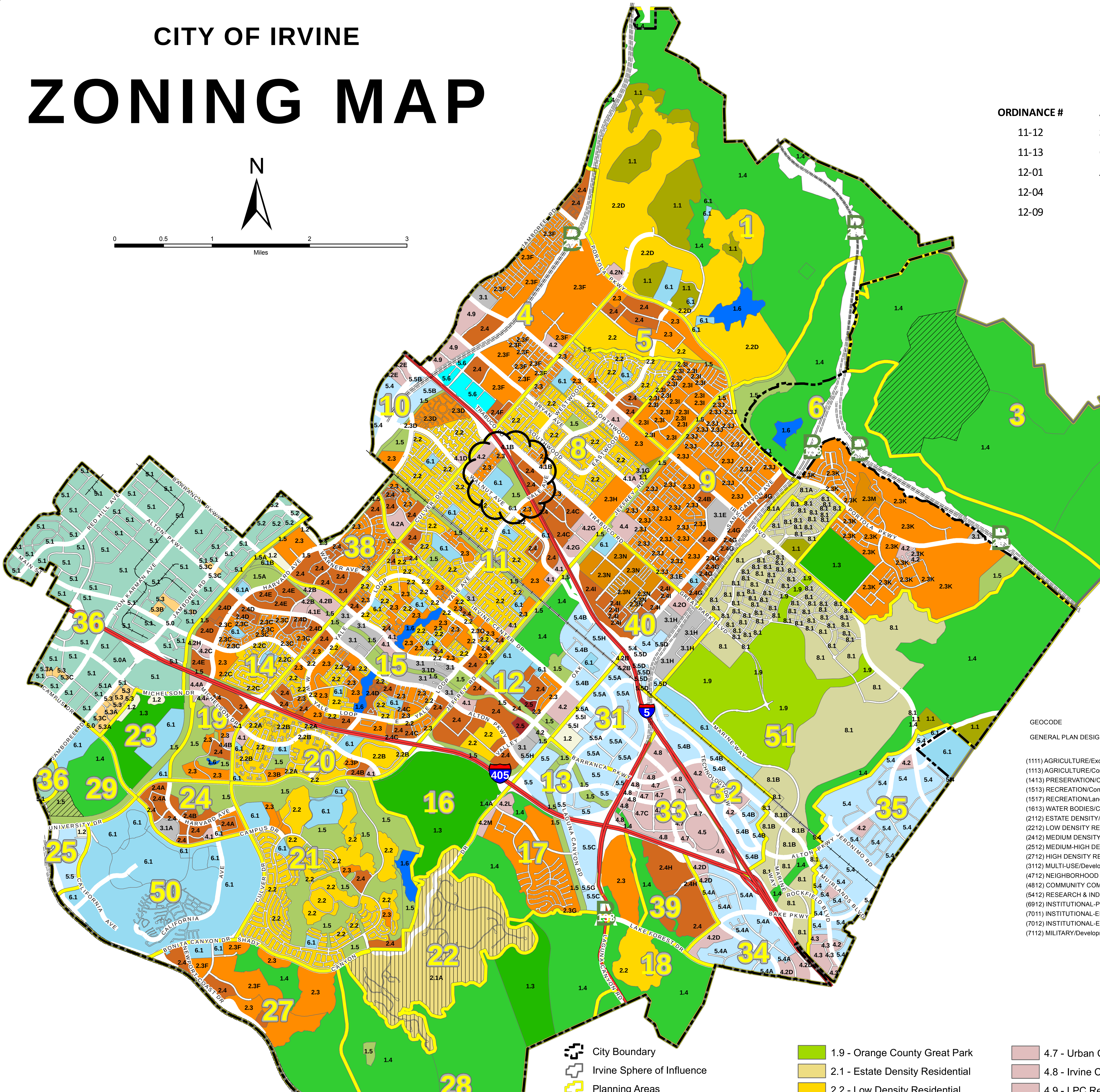
(3) These Land Use categories also allow residential developments noted in the General Plan text.

(4) The Land Use Element Table A-1 establishes and regulates land use building intesity standards. Building intensity standards are allocated by Planning Area.

C-4: City of Irvine Zoning Map

CITY OF IRVINE

ZONING MAP



ORDINANCE #	APPROVAL DATE
11-12	September 13, 2011
11-13	October 11, 2011
12-01	January 24, 2012
12-04	March 13, 2012
12-09	Mary 22, 2012

GEOCODE

GENERAL PLAN DESIGNATION/ZONING DISTRICT

(1111) AGRICULTURE/Exclusive Agriculture
(1113) AGRICULTURE/Conservation & Open Space Reserve
(1413) PRESERVATION/Conservation & Open Space Reserve
(1513) RECREATION/Conservation & Open Space Reserve
(1517) RECREATION/Landfill Overlay
(1613) WATER BODIES/Conservation & Open Space Reserve
(2112) ESTATE DENSITY/Development Reserve
(2212) LOW DENSITY RES/Development Reserve
(2412) MEDIUM DENSITY RES/Development Reserve
(2512) MEDIUM-HIGH DENSITY RES/Development Reserve
(2712) HIGH DENSITY RES/Development Reserve
(3112) MULTI-USE/Development Reserve
(4712) NEIGHBORHOOD COMMERCIAL/Development Reserve
(4812) COMMUNITY COMMERCIAL/Development Reserve
(5412) RESEARCH & INDUSTRIAL/Development Reserve
(6912) INSTITUTIONAL-PUBLIC FACILITIES/Development Reserve
(7011) INSTITUTIONAL-EDUCATIONAL FAC./Exclusive Agriculture
(7012) INSTITUTIONAL-EDUCATIONAL FAC./Development Reserve
(7112) MILITARY/Development Reserve

City Boundary
Irvine Sphere of Influence
Planning Areas
Railroad Line

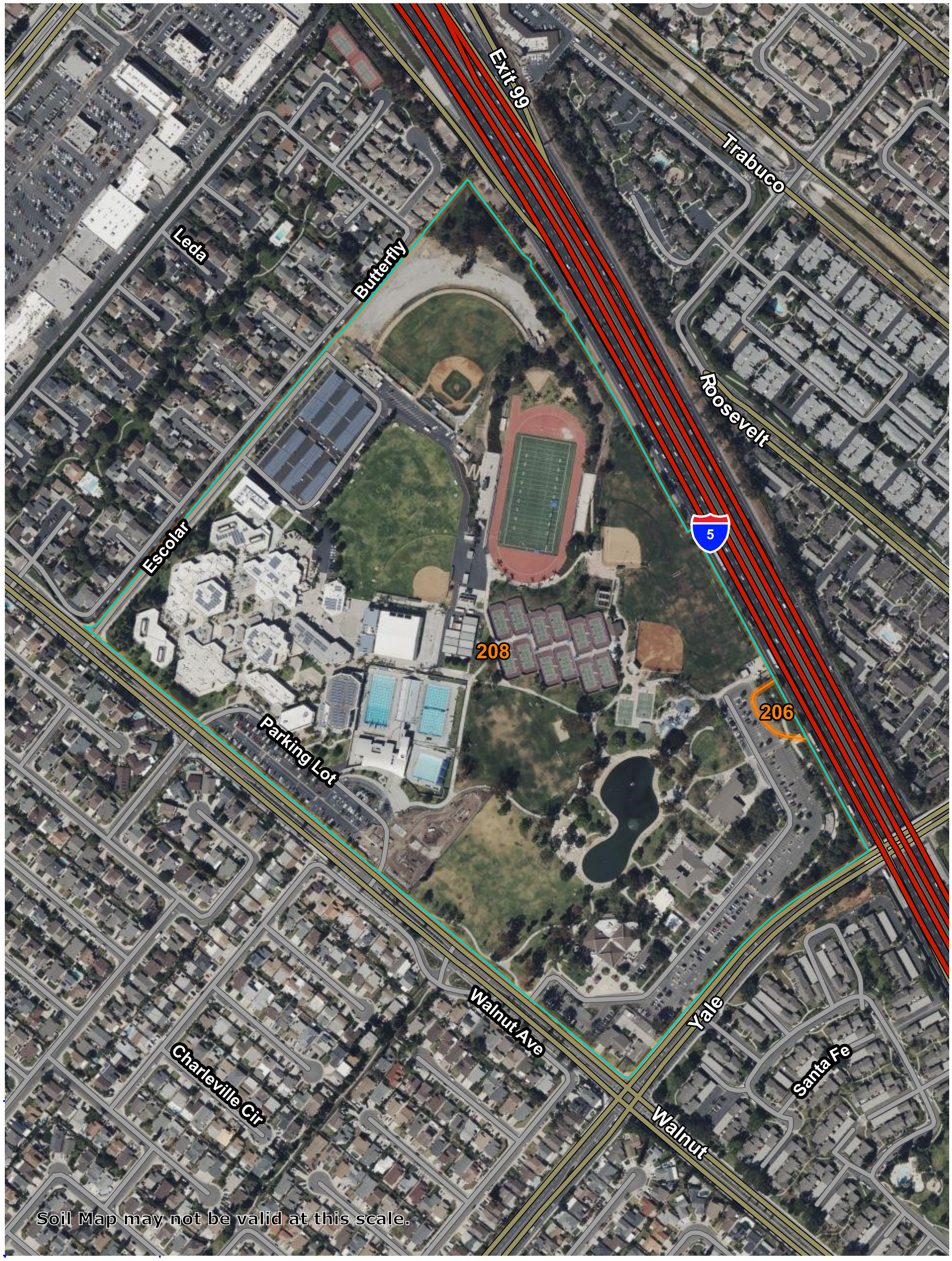
Zoning Codes

1.1 - Exclusive Agriculture
1.2 - Development Reserve
1.3 - Conservation Open Space Reserve
1.4 - Preservation
1.5 - Recreation
1.6 - Water Bodies
1.7 - Landfill Overlay
1.8 - Golf Course Overlay
1.9 - Orange County Great Park
2.1 - Estate Density Residential
2.2 - Low Density Residential
2.3 - Medium Density Residential
2.4 - Medium-High Density Residential
2.5 - High Density Residential
3.1 - Multi-Use
4.1 - Neighborhood Commercial
4.2 - Community Commercial
4.3 - Vehicle-Related Commercial
4.4- Commercial Recreation
4.5 - Regional Commercial
4.6 - Retail Office
4.7 - Urban Commercial
4.8 - Irvine Center Garden Commercial
4.9 - LPC Regional Commercial
5.0 - IBC Mixed-Use
5.1 - IBC Multi-Use
5.2 - IBC Industrial
5.3 - IBC Residential
5.4 - General Industrial
5.5 - Medical and Science
5.6 - Business Park
6.1 - Institutional
8.1 - Trails and Transit Oriented Development

Date Updated: Jan 22, 2018
Date Printed: 1/22/2018
Path: X:\GIS_User\ZONING\WALLMAPS\Zoning-Map_24x24_20180122.mxd

C-5: NRCS Web Soil Survey

117° 47' 6" W
117° 46' 29" W
33° 42' 29" N
33° 42' 29" N



33° 41' 48" N
33° 41' 48" N
117° 47' 6" W
117° 46' 29" W

Map Scale: 1:6,120 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 50, 100, 200, 300

Feet: 0, 250, 500, 1000, 1500

N

Map projection: Web Mercator   Corner coordinates: WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Unit Polygons

Soil Map Unit Lines

Soil Map Unit Points

Special Point Features

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

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: Orange County and Part of Riverside County, California
Survey Area Data: Version 16, Sep 6, 2022

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

Date(s) aerial images were photographed: Mar 14, 2022—Mar 17, 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.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
206	Sorrento loam, 0 to 2 percent slopes, warm MAAT, MLRA 19 Soil Group: C	0.4	0.5%
208	Sorrento clay loam, 0 to 2 percent slopes, warm MAAT, MLRA 19 Soil Group: C	83.5	99.5%
Totals for Area of Interest		**83.9**	**100.0%**

C-6: Conceptual Existing Utility Exhibit

COMPOSITE (WET) UTILITY EXHIBIT

BKF 100+ YEARS
ENGINEERS . SURVEYORS . PLANNERS
4675 MACARTHUR CT., SUITE 400
NEWPORT BEACH, CA 92660
(949) 526-8460
www.bkf.com
JOB NO.: 20180780

HERITAGE PARK AERIAL

IRVINE, CA

DATE: 10/3/2018

C1.0

Appendix D.

Geotechnical Investigation Report

Converse Consultants
Geotechnical Engineering
Environmental & Groundwater Science
Inspection & Testing Services

GEOTECHNICAL INVESTIGATION AND WATER PERCOLATION TEST REPORT

HERITAGE PARK POOL FACILITY AND PARKING LOT
14301 YALE AVENUE
CITY OF IRVINE, ORANGE COUNTY, CALIFORNIA

CONVERSE PROJECT NO. 22-32-125-01

Prepared For:
MIG
109 West Union Avenue
Fullerton, California 92832

Presented By:
CONVERSE CONSULTANTS
3176 Pullman Street, Suite 108
Costa Mesa, CA 92626

December 12, 2022

Converse Consultants
Geotechnical Engineering, Environmental & Groundwater Science, Inspection & Testing Services

December 12, 2022

Mr. Steve Lang
Principal
MIG
109 West Union Avenue
Fullerton, California 92832

Subject: **GEOTECHNICAL INVESTIGATION AND WATER PERCOLATION TEST REPORT**
Heritage Park Pool Facility and Parking Lot
14301 Yale Avenue
City of Irvine, Orange County, California
Converse Project No. 22-32-125-01

Dear Mr. Lang:

Converse Consultants (Converse) is pleased to submit this geotechnical investigation report to assist with the design and construction of the Heritage Park Master Plan Update project, located at 14301 Yale Avenue, City of Irvine, Orange County, California. The report was prepared in accordance with our proposal dated July 19, 2022, and your Acceptance of Agreement and Authorization to Proceed through email dated October 18, 2022.

Based upon our field investigation, laboratory data, and analyses, the project site is considered feasible from a geotechnical standpoint, provided the recommendations presented in this report are incorporated into the design and development of the project.

We appreciate the opportunity to be of service to MIG and City of Irvine. Should you have any questions, please do not hesitate to contact us at 909-474-2847.

CONVERSE CONSULTANTS

Hashmi S. E. Quazi, PhD, PE, GE
Principal Engineer

Dist.: 1-Electronic Pdf /Addressee
SR/SM/HSQ/kvg

PROFESSIONAL CERTIFICATION

This report has been prepared by the following professionals whose seals and signatures appear hereon.

The findings, recommendations, specifications, and professional opinions contained in this report were prepared in accordance with the generally accepted professional engineering and engineering geologic principle and practice in this area of Southern California. We make no other warranty, either expressed or implied.

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Senior Staff Engineer

Stephen McPherson
Staff Geologist

Hashmi S. E. Quazi, PhD, PE, GE
Principal Engineer

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APPENDICES

1.0 INTRODUCTION

This report presents the results of our geotechnical investigation and water percolation test performed for the Heritage Park Pool Facility and Parking Lot project, located at 14301 Yale Avenue, City of Irvine, Orange County, California. The approximate location of the site is shown on Figure No. 1, *Approximate Site Location Map*.

The purposes of this investigation were to determine the nature and engineering properties of the subsurface soils and to provide recommendations for site earthwork, and design and construction of the proposed improvements.

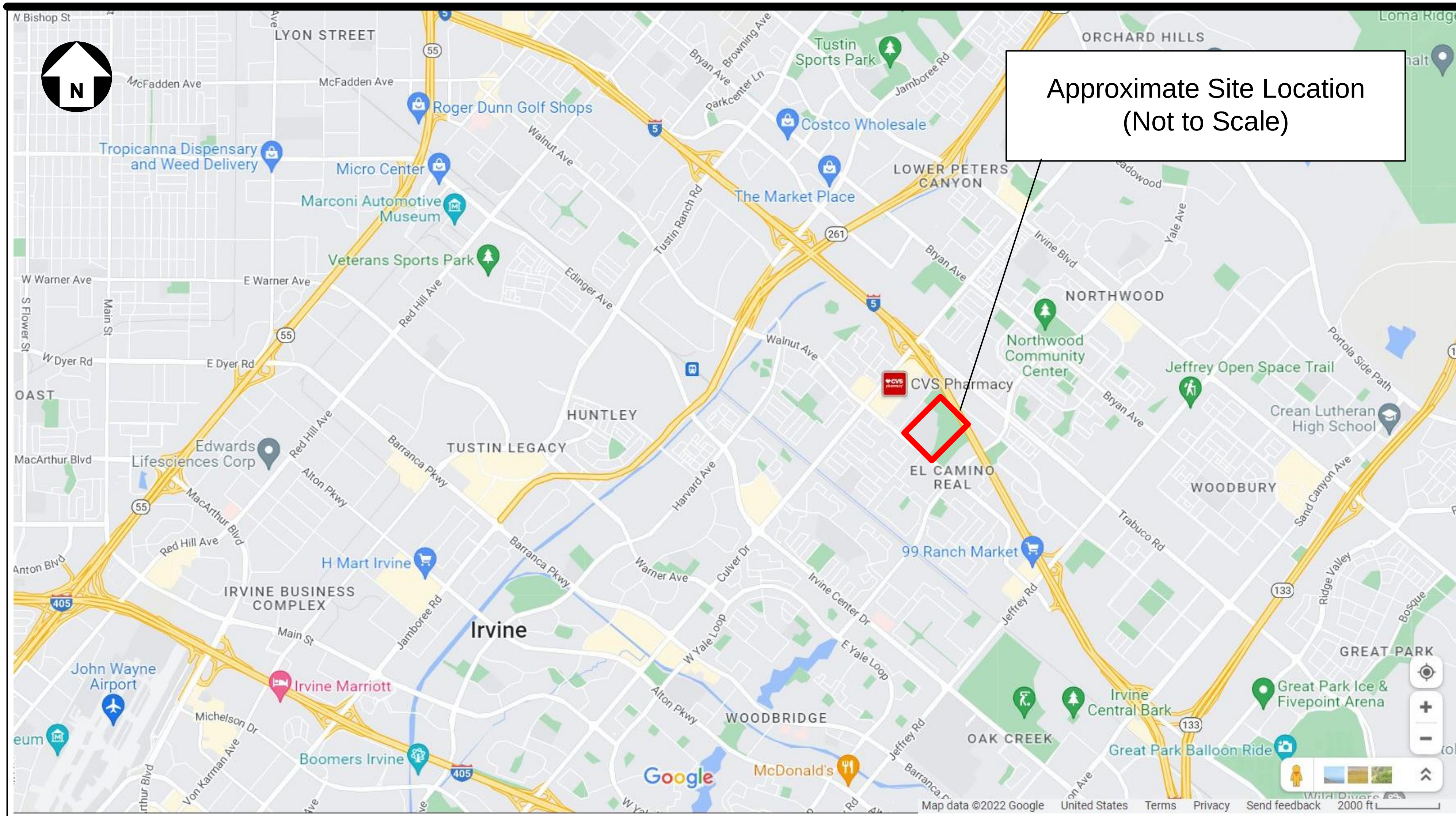
This report is prepared for the project described herein and is intended for use solely by MIG, City of Irvine, and their authorized agents for design purposes. It should not be used as a bidding document but may be made available to the potential contractors for information on factual data only. For bidding purposes, the contractors should be responsible for making their own interpretation of the data contained in this report.

2.0 PROJECT DESCRIPTION

According to the information provided by MIG, the Heritage Park Pool Facility and Parking Lot project will include design and construction of a pool facility and at-grade parking. The pool facility will be a 65m competition pool with concrete apron, bleachers for 2000 people, and about 6,000 square feet of locker rooms/mechanical. At-grade parking would be an asphalt or concrete parking lot with pedestrian circulation paths that connect to existing sidewalks.

3.0 SITE DESCRIPTION

Heritage Community Park is located at 14301 Yale Avenue, City of Irvine, Orange County, California. The park site is bounded by Santa Ana Fwy on the northeast, Yale Avenue on the southeast, Walnut Avenue on the southwest, and Escolar Drive on the northwest. Existing features in the park site include Nature Play, Splash Play, Children's Play, Pickleball Courts, Water Tower Plaza, Connecting Plaza, Drop-Off Area, Water Features, Fine Arts Center, Group Picnic Areas, Tai Chi/Flexible Workout Area, Parking, Promenade, Library, Open Meadow, Pool, Competition Pool, Locker Rooms/Toilets, Mechanical/Storage/Support Space, Lobby/Entrance etc. Present site conditions are depicted in Photograph Nos. 1 through 3.



Project: Heritage Park Pool Facility and Parking Lot

Location: 14301 Yale Avenue
City of Irvine, Orange County, California

For: MIG

Approximate Site Location Map

Project No.
22-32-125-01

Converse Consultants

C-193

Figure No.
1

Photograph No. 1: Present site conditions at BH-01 facing southwest.

Photograph No. 2: Present site conditions at BH-02 facing southeast.

Photograph No. 3: Present site conditions at BH-03 facing northwest.

4.0 SCOPE OF WORK

The scope of this investigation includes the following tasks presented below.

4.1 Project Set-up

As part of the project set-up, our staff performed the following tasks.

- Prepared the boring and percolation test locations map and submitted it for your review and approval.
- Conducted a site reconnaissance and staked/marked the boring and percolation test locations such that drill rig access to all the locations was available.
- Provided necessary documentation to City of Irvine for encroachment permit application.
- Notified Underground Service Alert (USA) at least 48 hours prior to drilling to clear the borings and percolation test locations of any conflict with existing underground utilities.
- Engaged a California-licensed driller to drill exploratory borings.

4.2 Subsurface Exploration

Three exploratory borings (BH-01 through BH-03) were drilled on November 7, 2022, to investigate the subsurface conditions. All borings were drilled to depths between 11.5 and 21.5 feet below ground surface (bgs).

Due to the close proximity of the borings BH-02 and BH-03 to the percolation test locations PT-01 and PT-02, after collection of soil samples, BH-02 and BH-03 were set up for percolation testing and also refereed as PT-01 and PT-02 respectively. The depth of PT-01 and PT-02 were 10.0 feet bgs. Details about the percolation tests are presented in Appendix C, Percolation Testing.

The borings were advanced using a truck-mounted drill rig equipped with 8-inch diameter hollow-stem augers for soils sampling.

The approximate locations of the borings are shown on Figure No. 2, *Approximate Boring and Percolation Test Locations Map.* A detailed discussion of the subsurface exploration is presented in Appendix A, *Field Exploration*.

4.3 Laboratory Testing

Representative samples of the site soils were tested in the laboratory to aid in the soil classification and to evaluate the relevant engineering properties. These tests included the following.

- *In-situ* moisture contents and dry density (ASTM D2216 and ASTM D2937)
- Soil expansion Index (ASTM D4829)
- R-value (California Test 301)
- Collapse potential (ASTM D4546)
- Soil corrosivity (California Tests 422, 417, and 643)
- Grain size distribution (ASTM D6913)
- Maximum dry density and optimum moisture content (ASTM D1557)
- Direct shear (ASTM D3080)

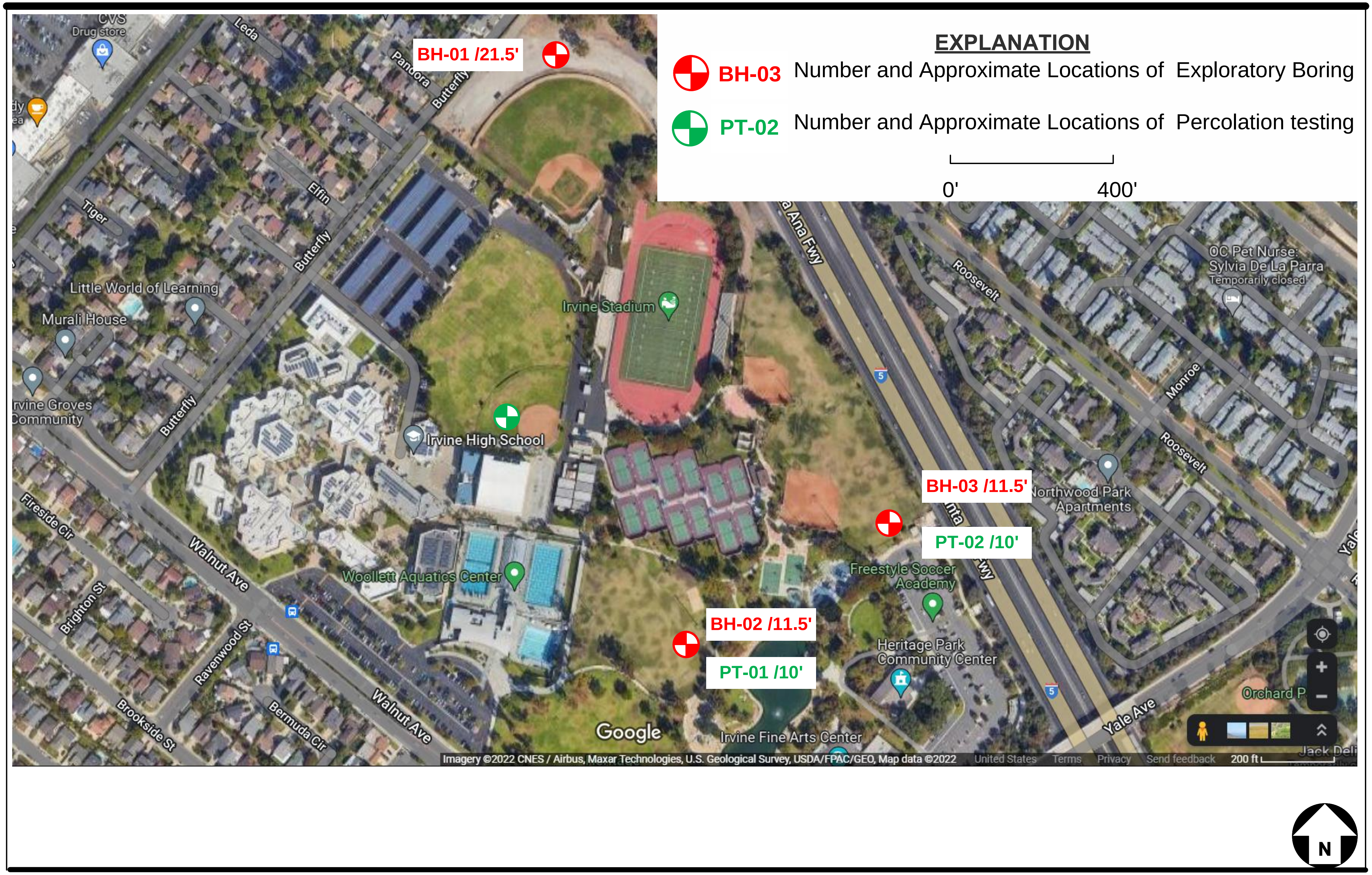
For *in-situ* moisture and dry density data, see the Logs of Borings in Appendix A, *Field Exploration*. For a description of the laboratory test methods and test results, see Appendix B, *Laboratory Testing Program*.

4.4 Report Preparation

Data and information obtained from the document review, field exploration, and laboratory testing program were compiled and evaluated. Geotechnical analyses of the compiled data were performed, and this report was prepared to present our findings, conclusions, and recommendations for the proposed improvements.

5.0 SITE CONDITIONS

The subsurface conditions encountered at the site during our field investigation are described in the following sections.



Project: Heritage Park Pool Facility and Parking Lot

Location: 14301 Yale Avenue
City of Irvine, Orange County, California

For: MIG

Approximate Boring and Percolation Test Locations Map

Project No.
22-32-125-01

Converse Consultants

Figure No.
2

5.1 Subsurface Profile

Based on the exploratory borings and laboratory test results, the subsurface soils at the site consisted primarily of a mixture of sand, silt, clay, and gravel. Scattered to little gravel up to 2-inches in largest dimension was observed in the borings.

Discernible fill soils were not identified in our subsurface exploration; however, the site may have been previously graded for the existing structures and soccer playground and fill soil is likely present. If present, the fill soils were likely derived from on-site sources and are similar to the native alluvial soils in composition and density.

For a detailed description of the subsurface materials encountered in the exploratory borings, see Drawings No. A-2 through A-4 *Logs of Borings,* in Appendix A, *Field Exploration.*

5.2 Groundwater

Groundwater was not encountered during the field investigation up to the explored depth of 21.5 feet bgs.

For comparison, regional groundwater data from the GeoTracker database (SWRCB, 2022) was reviewed to evaluate the current and historical groundwater levels from sites within approximately a 1.0-mile radius of the project site. Data from search are provided below.

- SHELL OIL (Site No. #T0605999018), located approximately 2,400 feet north of the project site reported groundwater at depths ranging from 15.22 to 21.31 feet bgs between 2000 and 2012.
- TREASURE FARMS/IRVINE COMPANY (Site No. # T0605901258), located approximately 3,400 feet northwest of the project site reported groundwater at a depth of 32.35 feet bgs in 2001.
- ARCO (Site No. # T0605900659), located approximately 2,750 feet northwest of the project site reported groundwater at a depth of 4.0 feet bgs in 1993.
- HERITAGE ECONOMY INC (Site No. # T0605902251), located approximately 2,500 feet northwest of the project site reported groundwater at depths ranging from 7.09 to 11.10 feet bgs between 2000 and 2009.

The National Water Information System (USGS, 2022) was reviewed to evaluate current and historical groundwater levels from sites within approximately a 1.0-mile radius of the project site. Data from that search is provided below.

Table No. 1, Summary of USGS Groundwater Depth Data

Alignment No.	Location	Groundwater Depth Range (ft. bgs)	Date Range
334231117464601	I-5, Santa Ana Freeway; approximately 1,900 feet north of project site	95.00	2008
334240117465401	Culver drive at I-5; approximately 1,400 feet north of project site	34.00-44.00	2008-2022
334202117460401	Remington; approximately 3,200 feet southeast of project site	38.87-172.50	1969-1986
334133117461401	Remington; approximately 5,000 feet southeast of project site	45.00	1977

The California Department of Water Resources database (DWR, 2022) was reviewed for historical groundwater data from sites within a 1.0-mile radius of the project site. One site was identified within a 1.0-mile radius of the project site that contained groundwater elevation data. Details of that record are listed below.

- Well No. 05S09W25D001S (Station 337112N1177826W001), located approximately 3,000 feet north of the project site, reported groundwater at a depth ranging from 16.70 to 256.70 feet bgs between 1982 and 2010.
- Well No. 05S09W36C001S (Station 337008N1177759W001), located approximately 750 feet east of the project site, reported groundwater at a depth ranging from 54.00 to 305.00 feet bgs between 2006 and 2010.
- Well No. 05S09W36B001S (Station 337006N1177696W001), located approximately 3,000 feet east of the project site, reported groundwater at a depth ranging from 38.50 to 172.50 feet bgs between 1969 and 1986.
- Well No. 05S09W35J001S (Station 336914N1177833W001), located approximately 4,100 feet southwest of the project site, reported groundwater at a depth ranging from 88.10 to 94.80 feet bgs in 1969.
- Well No. 05S09W35D002S (Station 336983N1177947W001), located approximately 5,000 feet southeast east of the project site, reported groundwater at a depth ranging from -15.25 to 195.90 feet bgs between 1984 and 2010.
- Well No. 05S09W25N001S (Station 337049N1177813W001), located approximately 1,250 feet northeast of the project site, reported groundwater at a depth ranging from 23.00 to 256.60 feet bgs between 2006 and 2010.

Based on available data, the historical high groundwater level reported at wells within approximately one mile of the site was at or above the surface at one location near the Como Channel. However, based on historical high groundwater level reported at wells not located near a water channel, groundwater depth was reported 4.00 feet bgs. Current groundwater is expected to be deeper than about 21.5 feet bgs. Therefore, groundwater is not expected to be encountered during the construction of the project. It should be noted that the groundwater level could vary depending upon the seasonal precipitation and possible groundwater pumping activity in the site vicinity. Shallow perched groundwater may be present locally, particularly following precipitation.

5.3 Excavatability

The subsurface materials at the site are expected to be excavatable by conventional heavy-duty earth moving and trenching equipment. <u>However, excavation will be difficult if concentration of gravel is encountered.</u>

The phrase "conventional heavy-duty excavation equipment" is intended to include commonly used equipment such as excavators, scrapers, and trenching machines. It does not include hydraulic hammers ("breakers"), jackhammers, blasting, or other specialized equipment and techniques used to excavate hard earth materials. Selection of an appropriate excavation equipment models should be done by an experienced earthwork contractor.

5.4 Subsurface Variations

Based on results of the subsurface exploration and our experience, some variations in the continuity and nature of subsurface conditions within the site should be anticipated. Because of the uncertainties involved in the nature and depositional characteristics of the earth material, care should be exercised in interpolating or extrapolating subsurface conditions between or beyond the boring locations.

6.0 LABORATORY TEST RESULTS

Results of the various laboratory tests are presented in Appendix B, *Laboratory Testing Program,* except for the results of *in-situ* moisture and dry density tests which are presented on the Logs of Borings in Appendix A, *Field Exploration.* The results are also discussed below.

6.1 Physical Testing

The results of laboratory tests on samples obtained from the site are presented below.

- <u>*In-situ* Moisture and Dry Density</u> – *In-situ* dry density and moisture content of the site soils were determined in accordance with ASTM Standard D2216 and D2937*.* The dry densities of upper 0 to 10 feet soils of the site ranged from 107 to 117 pcf with moisture contents ranging from 12 to 20 percent. Results are presented in the log of borings in Appendix A, *Field Exploration.*
- <u>Expansion Index (EI)</u> – One representative soil sample was tested to evaluate the expansion potential in accordance with ASTM Standard D4829. The test result showed an EI of 27, corresponding to low expansion potential.
- <u>R-Value</u> – One representative bulk sample was tested in accordance with Caltrans Test Method 301. The result of the R-value test was 15.

- Collapse Potential – The collapse potential of two relatively undisturbed samples were tested under a vertical stress of up to 2.0 kips per square foot (ksf) in accordance with the ASTM Standard D4546 test method. The test results showed a collapse potential of 0.01 and 0.05, indicating no collapse potential.
- Grain Size Analysis – Two representative soil samples were tested to determine the relative grain size distribution in accordance with the ASTM Standard D6913. The test result is graphically presented in Drawing No. B-1, *Grain Size Distribution Results.*
- Maximum Dry Density and Optimum Moisture Content – The moisture-density relationship of a representative soil sample was tested in according to ASTM Standard D1557 and the results are presented in Drawing No. B-2, *Moisture-Density Relationship Results*, in Appendix B, *Laboratory Testing Program.* The laboratory maximum dry density was 115.5 pounds per cubic feet (pcf) with optimum moisture content of 12.2 percent.
- Direct Shear – One direct shear test was performed in accordance with ASTM Standard D3080 on relatively undisturbed ring samples. The results of the direct shear tests are presented in Drawing No. B-3, *Direct Shear Test Results* in Appendix B, *Laboratory Testing Program*.

6.2 Chemical Testing - Corrosivity Evaluation

One representative soil sample was tested to determine minimum electrical resistivity, pH, and chemical content, including soluble sulfate and chloride concentrations. The purpose of these tests was to determine the corrosion potential of site soils when placed in contact with common construction materials. These tests were performed by AP Engineering and Testing, Inc. (Pomona, CA) in accordance with California Tests 643, 422, and 417. The test results are presented in Appendix B, *Laboratory Testing Program* and summarized below.

- The pH measurement of the sample was 8.0.
- The soluble sulfate content of the sample was 302 ppm (0.0302 percent by weight).
- The chloride concentration of the sample was 126 ppm.
- The minimum electrical resistivity (wet condition) of the sample when saturated was 1,017 ohm-cm.

7.0 PERCOLATION TESTING

Two percolation tests (PT-01 and PT-02) were performed on November 9, 2022, to evaluate water infiltration rate. The measured percolation test data and calculations are represented in Appendix C, *Percolation Testing*. The estimated infiltration rates at each test hole are presented in the following table.

Table No. 2, Estimated Infiltration Rates

Percolation Test	Depth of Boring* (feet)	Predominant Soil Types (USCS)	Average Percolation Rate (inches/hour)	Design Percolation Rate (inches/hour)
PT-01	10	Sandy Clay (CL), Clay with Sand (CL), Clay (CL)	0.01	0.01
PT-02	10	Sandy Clay (CL), Clay with Sand (CL)	0.01	0.01

(* Approximate depth)

Based on the calculated infiltration rate during the final respective intervals in each test, a design infiltration rate of 0.01 (inches/hour) can be used for depth of 10 feet for specified soil types and selected percolation testing locations. Please note that infiltration rates may change if the soil type and location of the proposed system changes. If that is the case, then additional percolation testing should be performed in the required location.

8.0 FAULTING AND SEISMICITY

The approximate distance and seismic characteristics of nearby faults as well as seismic design coefficients are presented in the following subsections.

8.1 Faulting

The proposed site is situated in a seismically active region. As is the case for most areas of Southern California, ground-shaking resulting from earthquakes associated with nearby and more distant faults may occur at the project site. During the life of the project, seismic activity associated with active faults can be expected to generate moderate to strong ground shaking at the site. Review of recent seismological and geophysical publications indicates that the seismic hazard for the project is high.

The project site is not located within a currently mapped State of California Earthquake Fault Zone for surface fault rupture. Table No. 3, *Summary of Regional Faults,* summarizes selected data of known faults capable of seismic activity within 100 kilometers of the site. The data presented below was calculated using the National Seismic Hazard Maps Database (USGS, 2008) and other published geologic data.

Table No. 3, Summary of Regional Faults

Fault Name and Section	Closest Distance (km)	Slip Sense	Length (km)	Slip Rate (mm/year)	Maximum Magnitude
San Joaquin Hills	3.33	thrust	27	0.5	7.10
Newport Inglewood Connected alt 2	17.22	strike slip	208	1.3	7.50
Newport Inglewood Connected alt 1	17.46	strike slip	208	1.3	7.50

Fault Name and Section	Closest Distance (km)	Slip Sense	Length (km)	Slip Rate (mm/year)	Maximum Magnitude
Newport-Inglewood, alt 1	17.48	strike slip	65	1.0	7.20
Newport-Inglewood	17.52	strike slip	66	1.5	7.00
Elsinore	19.87	strike slip	241	n/a	7.79
Puente Hills (Coyote Hills)	22.93	thrust	17	0.7	6.90
Chino, alt 1	23.67	strike slip	24	1.0	6.70
Chino, alt 2	23.82	strike slip	29	1.0	6.80
Puente Hills (Santa Fe Springs)	33.76	thrust	11	0.7	6.70
Palos Verdes	36.07	strike slip	99	3.0	7.30
Palos Verdes Connected	36.07	strike slip	285	3.0	7.70
San Jose	38.6	strike slip	20	0.5	6.70
Puente Hills (LA)	43.76	thrust	22	0.7	7.00
Sierra Madre	46.67	reverse	57	2.0	7.20
Sierra Madre Connected	46.67	reverse	76	2.0	7.30
Cucamonga	47.22	thrust	28	5.0	6.70
Coronado Bank	48.51	strike slip	186	3.0	7.40
Elysian Park (Upper)	50.41	reverse	20	1.3	6.70
Raymond	54.8	strike slip	22	1.5	6.80
Clamshell-Sawpit	56.62	reverse	16	0.5	6.70
Verdugo	58.96	reverse	29	0.5	6.90
San Jacinto	60.75	strike slip	241	n/a	7.88
Hollywood	62.4	strike slip	17	1.0	6.70
Santa Monica Connected alt 2	65.06	strike slip	93	2.4	7.40
S. San Andreas	69.07	strike slip	548	n/a	8.18
Santa Monica Connected alt 1	71.38	strike slip	79	2.6	7.30
Santa Monica, alt 1	71.38	strike slip	14	1.0	6.60
Rose Canyon	72.19	strike slip	70	1.5	6.90
Cleghorn	73.59	strike slip	25	3.0	6.80
Malibu Coast, alt 2	78.04	strike slip	38	0.3	7.00
Malibu Coast, alt 1	78.04	strike slip	38	0.3	6.70
Sierra Madre (San Fernando)	79.83	thrust	18	2.0	6.70
Anacapa-Dume, alt 2	79.85	thrust	65	3.0	7.20
San Gabriel	82.59	strike slip	71	1.0	7.30
North Frontal (West)	82.92	reverse	50	1.0	7.20
Northridge	87.29	thrust	33	1.5	6.90
Anacapa-Dume, alt 1	90.42	thrust	51	3.0	7.20
Santa Susana, alt 1	95.71	reverse	27	5.0	6.90

(Source: https://earthquake.usgs.gov/cfusion/hazfaults_2008_search/)

8.2 CBC Seismic Design Parameters

Seismic parameters based on the 2022 California Building Code (CBSC, 2022) and ASCE 7-16 are provided in the following table. These parameters were determined using the generalized coordinates for the location and the Seismic Design Maps ATC online tool.

Table No. 4, CBC Seismic Design Parameters

Parameter	Value
Site Coordinates	33.701564 N, 117.779201 W
Risk Category	II
Site Class	D
Mapped Short period (0.2-sec) Spectral Response Acceleration, S_S	1.258g
Mapped 1-second Spectral Response Acceleration, S_1	0.450g
Site Coefficient (from Table 1613.5.3(1)), F_a	1.0
Site Coefficient (from Table 1613.5.3(2)), F_v	1.850
MCE 0.2-sec period Spectral Response Acceleration, S_{MS}	1.258g
MCE 1-second period Spectral Response Acceleration, S_{M1}	0.833g
Design Spectral Response Acceleration for short period S_{DS}	0.839g
Design Spectral Response Acceleration for 1-second period, S_{D1}	0.555g
Peak Ground Acceleration, PGA_M	0.577g

8.3 Secondary Effects of Seismic Activity

In general, secondary effects of seismic activity include surface fault rupture, soil liquefaction, landslides, lateral spreading, and settlement due to seismic shaking, tsunamis, seiches, and earthquake-induced flooding. The site-specific potential for each of these seismic hazards is discussed in the following sections.

Surface Fault Rupture: The project site is not located within a currently designated State of California or Department of Conservation, Geologic Hazards Map (CGS, 2007; DOC, 2022). There are no known active faults projecting toward or extending across the project site. The potential for surface rupture resulting from the movement of nearby major faults is not known with certainty but is considered low.

Liquefaction: Liquefaction is defined as the phenomenon in which a cohesionless soil mass within the upper 50 feet of the ground surface suffers a substantial reduction in its shear strength, due to the development of excess pore pressures. During earthquakes, excess pore pressures in saturated soil deposits may develop as a result of induced cyclic shear stresses, resulting in liquefaction.

Soil liquefaction generally occurs in submerged granular soils and non-plastic silts during or after strong ground shaking. There are several general requirements for liquefaction to occur and they are as follows.

- Soil must be submerged.
- Soils must be loose to medium-dense.
- Ground motion must be intense.
- Duration of shaking must be sufficient for the soil to lose shear resistance.

Based on a review of state and county hazard maps, the project site is located within an area at risk for liquefaction by the State of California (CGS, 2007). Due to the limitation of field investigation depth, site specific liquefaction analysis was not performed. However, due to the presence of clayey soil and groundwater not being encountered up to a depth of 21.5 feet bgs, the potential for liquefaction can be considered low.

Seismic Settlement: Dynamic dry settlement may occur in loose, granular, unsaturated soils during a large seismic event. Classification of the samples and sampling blow counts indicate that the site is loose, medium dense, to dense. The potential for dry seismic settlement is not known with certainty, however, the potential is considered low.

Landslides: Seismically induced landslides and slope failures are common occurrences during or soon after large earthquakes. Due to the flat nature of the site and the distance away from any foothills, the potential for seismically induced landslides affecting the proposed site is considered to be very low.

Lateral Spreading: Seismically induced lateral spreading involves primarily lateral movement of earth materials over underlying materials which are liquefied due to ground shaking. It differs from slope failure in that complete ground failure involving large movement does not occur due to the relatively smaller gradient of the initial ground surface. Lateral spreading is demonstrated by near-vertical cracks with predominantly horizontal movement of the soil mass involved. The topography at the project site and in the immediate vicinity is very flat. Under these circumstances, the potential for lateral spreading at the subject site is considered low to moderate.

Tsunamis: Tsunamis are large waves generated in open bodies of water by fault displacement or major ground movement. Due to the inland location of the site, tsunamis are not considered to be a risk.

Seiches: Seiches are large waves generated in enclosed bodies of water in response to ground shaking. Due to the site being a far distance from bodies of water, seiches are not considered to be a risk.

Earthquake-Induced Flooding: Dams or other water-retaining structures may fail as a result of large earthquakes. The project site is located within a designated dam inundation area (DSOD, 2022). The Syphon Canyon, No. 1029-4, has a potential to inundate the project area.

9.0 EARTHWORK RECOMMENDATIONS

Earthwork recommendations for the project are presented below.

9.1 General

This section contains our general recommendations regarding earthwork and grading for the proposed improvements. These recommendations are based on the results of our field exploration, laboratory tests, our experience with similar projects, and data evaluation as presented in the preceding sections. These recommendations may require modification by the geotechnical consultant based on findings during the final investigation or observation of the actual field conditions during grading.

All existing underground utilities and appurtenances should be located at the site. Such utilities should either be protected in-place or removed and replaced during construction as required by the project specifications. All excavations should be conducted in such a manner as not to cause loss of bearing and/or lateral support of existing structures or utilities.

All debris, deleterious material, demolished material, and artificial fill (if any) and surficial soils containing roots and perishable materials should be stripped and removed from the site. Deleterious material, including organics, concrete, and debris generated during excavation, should not be placed as fill.

The final bottom surfaces of all excavations should be observed and approved by the project geotechnical consultant prior to placing any fill. Based on these observations, localized areas may require remedial grading deeper than indicated herein. Therefore, some variations in the depth and lateral extent of excavation recommended in this report should be anticipated.

9.2 Overexcavation/Removal

Structural footings, slabs, and pavements should be uniformly supported by compacted fill. In order to provide uniform support, structural areas should be overexcavated, scarified, and recompacted as follows.

Table No. 5, Overexcavation Depths

Structure/Pavement	Minimum Excavation Depth
Swimming Pool	18 inches below footing bottoms
Bleachers	15 inches below footing bottoms, or 2 feet below ground surface, whichever is deeper
Locker Rooms	18 inches below footing bottoms, or 3 feet below ground surface, whichever is deeper
Slabs, Pavement	12 inches below finish grade

The depth of over excavation below the footings, slab, and pavements should be uniform. The over excavation should extend to at least 2 feet beyond the footprint of the footings and slabs and 1-foot beyond the edge of the pavement. The over excavation bottom should be scarified and compacted as described in Section 9.4, *Compacted Fill Placement*.

If isolated pockets of very soft, loose, eroded, or pumping soil are encountered, the unstable soil should be excavated as needed to expose undisturbed, firm, and unyielding soils.

The contractor should determine the best manner to conduct the excavations, such that there are no losses of bearing and/or lateral support to the existing structures or utilities. Consideration should be given to using slot cuts or other excavation methods which preserve lateral support during excavation operations near the existing structures.

9.3 Engineered/Structural Fill

No fill or aggregate base should be placed until excavations and/or natural ground preparation have been observed by the geotechnical consultant. The native soils encountered within the site are generally considered suitable for re-use as compacted fill. Excavated soils should be processed, including cleaning roots and debris, removal of oversized particles, mixing, and moisture conditioning, before placing as compacted fill. On-site soils used as fill should meet the following criteria.

- No particles larger than 3 inches in largest dimension.
- Rocks larger than 1 inch should not be placed within the upper 12 inches of subgrade soils.
- Free of all organic matter, debris, or other deleterious material.
- Expansion index of 30 or less.
- Sand Equivalent greater than 15 (greater than 30 for pipe bedding).
- Contain less than 30 percent by weight retained in 3/4-inch sieve.
- Contain less than 40 percent fines (passing #200 sieve).

Based on field investigation and laboratory testing results, on-site soils may be suitable as structural/engineered fill materials provided corrosion recommendations presented in

Section 10.10, *Soil Corrosivity* are implemented. Also, since the in-situ moisture within upper 5 feet of soil is higher than the optimum moisture content, moisture conditioning will be required during grading.

Any imported fills should be tested and approved by the geotechnical representative prior to delivery to the site. Imported materials, if required, should meet the above criteria prior to being used as compacted fill.

9.4 Compacted Fill Placement

All surfaces to receive structural fills should be scarified to a depth of 6 inches. The soil should be moisture conditioned to within ±3 percent of optimum moisture content for coarse soils and 0 to 2 percent above optimum moisture content for fine soils. The scarified soils should be recompacted to at least 90 percent of the laboratory maximum dry density.

Fill soils should be thoroughly mixed, and moisture conditioned to within ±3 percent of optimum moisture content for coarse soils and 0 to 2 percent above optimum moisture content for fine soils. Fill soils should be evenly spread in horizontal lifts not exceeding 8 inches in uncompacted thickness.

All fill placed at the site should be compacted to at least 90 percent of the laboratory maximum dry densities as determined by ASTM Standard D1557 test method unless a higher compaction is specified herein. At least the upper 1 feet of subgrade soils underneath pavements intended to support vehicle loads should be scarified, moisture conditioned, and compacted to at least 95 percent of the laboratory maximum dry density.

Fill materials should not be placed, spread, or compacted during unfavorable weather conditions. When site grading is interrupted by heavy rain, filling operations should not resume until the geotechnical consultant approves the moisture and density conditions of the previously placed fill.

9.5 Compaction Behind Wall

The backfill for the retaining wall of the swimming pool should be compacted to 90 percent of laboratory the maximum dry density. Compaction of backfill adjacent to wall can produce excessive lateral pressures. Improper types and locations of compaction equipment and/or compaction techniques may damage the wall. The use of heavy compaction equipment should not be permitted within a horizontal distance of 5 feet from the wall. Backfill behind any wall within the recommended 5-foot zone should be compacted using lightweight construction equipment such as handheld compactors to avoid overstressing the wall.

9.6 Shrinkage and Subsidence

The volume of excavated and recompacted soils may be expected to decrease as a result of grading. The shrinkage would depend on, among other factors, the depth of cut and/or fill, and the grading method and equipment utilized. For preliminary estimation, shrinkage factors for various units of earth material at the site may be taken as presented below.

- An average shrinkage factor (defined as a percentage of soil volume reduction when moisture conditioned and compacted to the average of 92 percent relative compaction) of 5 percent can be used for the upper 5 feet of soils for preliminary earthwork planning.
- Subsidence (defined as the settlement of native materials from the equipment load applied during grading) would depend on the construction methods including type of equipment utilized. For estimation purposes, ground subsidence may be taken as 0.1 to 0.15 feet.

Although these values are only approximate, they represent our best estimates of the factors to be used to calculate lost volume that may occur during grading. If more accurate shrinkage and subsidence factors are needed, it is recommended that field-testing using the actual equipment and grading techniques be conducted.

9.7 Site Drainage

Adequate positive drainage should be provided away from the structures and excavation areas to prevent ponding and to reduce percolation of water into the foundation soils. The building pad should have a gradient of at least 2 percent towards drainage facilities. The drainage gradient should be 1 percent for paved areas and 2 percent in landscaped areas. Surface drainage should be directed to suitable non-erosive devices.

10.0 DESIGN RECOMMENDATIONS

Design recommendations are presented in the following sections.

10.1 General Evaluation

The various design recommendations provided in this section are based on the assumptions that in preparing the site, the above earthwork recommendations will be implemented.

10.2 Shallow Foundation Design Parameters

The proposed swimming pool may be supported on continuous and/or isolated stiffened spread footings. The design of the shallow foundations should be based on the recommended parameters presented in the table below.

Table No. 6, Recommended Foundation Parameters

Parameter	Value
Minimum continuous spread footing width	15 inches
Minimum isolated footing width	15 inches
Minimum continuous or isolated footing depth of embedment below lowest adjacent grade	15 inches
Allowable net bearing capacity	2,500 psf

The allowable bearing capacity can be increased by 500 psf with each foot of additional embedment and 100 psf with each foot of additional width up to a maximum of 3,500 psf.

The net allowable bearing values indicated above are for the dead loads and frequently applied live loads and are obtained by applying a factor of safety of 3.0 to the net ultimate bearing capacity. If normal code requirements are applied for design, the above vertical bearing value may be increased by 33 percent for short duration loadings, which will include loadings induced by wind or seismic forces.

10.3 Mat Foundation Design Parameters

The swimming pool may be supported by mat foundation. The modulus of subgrade reaction (k) for design of flexible mat foundation can be estimated from the available soil compressibility data and published charts. For design of flexible mat foundation, the following equation may be used.

$k= k_1[(B+1)/2B]^2$

Where:
k= vertical modulus of subgrade reaction for mat foundation, kips per cubic feet
k_1= 200 kcf, normalized modulus of subgrade reaction for 1-square-foot footing
B= foundation width, feet

Other necessary parameters (modulus of elasticity and Poisson's ratio) for mat foundation design are as follows.

$E= 33\ W_c^{1.5}\ f_c^{\ 0.5}$ psi
Where, E = Modulus of Elasticity of Concrete (psi)
W_c = weight of concrete (pcf)
f_c = compressive strength of concrete at 28 days (psi)
ν = 0.35, Poisson's Ratio

An allowable net bearing capacity of 2,500 psf may be used for mat foundations founded on compacted native soil. The mat should be reinforced with top and bottom steel, as appropriate, to provide structural continuity and to permit spanning of local irregularities. The mat foundation dimensions, and reinforcement should be based on structural design. For design purposes, the self-weight of the mat foundation can be negligible.

10.4 Lateral Earth Pressures and Resistance to Lateral Loads

In the following subsections, the lateral earth pressures and resistance to lateral loads are estimated by using on-site native soils strength parameters obtained from laboratory testing.

10.4.1 Active Earth Pressures

The active earth pressure behind any buried wall or foundation depends primarily on the allowable wall movement, type of backfill materials, backfill slopes, wall or foundation inclination, surcharges, and any hydrostatic pressures. The recommended lateral earth pressures without surcharge for the site are presented in the following table.

Table No. 7, Active and At-Rest Earth Pressures

Loading Conditions	Lateral Earth Pressure (psf/ft depth)
Active earth conditions (wall is free to deflect at least 0.001 radian)	45
At-rest (wall is restrained)	66
Horizontal Seismic Coefficient	0.22H*

*H = height of buried wall

These pressures assume a level ground surface around the structure for a distance greater than the structure height, no surcharge, and no hydrostatic pressure. If water pressure is allowed to build up behind the structure, the active pressures should be reduced by 50 percent and added to a full hydrostatic pressure to compute the design pressures against the structure.

10.4.2 Passive Earth Pressure

Resistance to lateral loads can be assumed to be provided by a combination of friction acting at the base of foundations and by passive earth pressure. A coefficient of friction of 0.35 between concrete and soil may be used with the dead load forces. An allowable passive earth pressure of 210 psf per foot of depth may be used for the sides of footings poured against recompacted soils. A factor of safety of 1.5 was applied in calculating passive earth pressure. The maximum value of the passive earth pressure should be limited to 2,500 psf for compacted fill.

Vertical and lateral bearing values indicated above are for the total dead loads and frequently applied live loads. If normal code requirements are applied for design, the above vertical bearing and lateral resistance values may be increased by 33 percent for short duration loading, which will include the effect of wind or seismic forces.

Due to the low overburden stress of the soil at shallow depth, the upper 1 foot of passive resistance should be neglected unless the soil is confined by pavement or slab.

10.5 Drilled Pier Foundations

The Bleachers can also be supported on drilled pier foundations deriving their support primarily through skin friction. The piers may be designed for compression using an allowable skin friction value of 250 psf for a minimum of 12 feet deep below the finished grade. This value may be increased by 33 percent for transient wind and seismic forces. For pier design in tension, 50 percent of the recommended allowable skin friction values in compression may be used. The drilled pier should have a minimum diameter of 24 inches. For design purposes, the upper 2 feet of the soil should be neglected in determining the skin friction and point of fixity can be considered in the toe of pier.

The equivalent lateral earth pressure equal to 210 pounds per square foot per foot of depth may be used for the design.

10.6 Drilled Pier Foundation Installation Recommendations

It is the responsibility of the contractor to select proper construction equipment and method to correctly install the piers based on his own interpretation of the information presented in this report.

Groundwater was not encountered in the exploratory boreholes up to depth of 21.5 feet below existing ground surface and due to the presence of clayey soil, there is less possibility of caving. However, casing, or other methods approved by the project geotechnical consultant, may be used to support the sides of the excavation. Casing should be used at the discretion of the contractor. The casing should be advanced as drilling proceeds by drilling with a flight or bucket auger smaller in diameter than the inside of the casing. Occasional hammering may be required to advance the casing within the excavation. The casing, when used, should not be left in place as the pier designs are based on skin friction only. The casing should be pulled as the concrete is being poured, while always maintaining a head of concrete inside the casing. The contractor should have equipment on-site with sufficient pulling capacity to pull the casing at the proper time. The casing should have an outside diameter not less than the specified diameter of the pier.

The bottoms of the excavations should be cleaned of any loose cuttings before placing concrete. All applicable state and federal OSHA safety regulations must be satisfied during construction.

Drilled pier installation shall be performed under continuous observation by the project geotechnical consultant to confirm that the subsurface soils are similar to the soils encountered during our field investigation, which have formed the basis of our pier design recommendations. The contractor shall provide access and necessary facilities, including droplights, at his expense, to accommodate pier observations.

Drilled pier installation shall be performed such that compliance with all safety rules and requirements is achieved.

10.7 Slabs-on-Grade

Slabs-on-grade should be supported on properly compacted fill. Compacted fill used to support slabs-on-grade should be placed and compacted in accordance with Section 9.4 *Compacted Fill Placement*.

Structural design elements of slabs-on-grade, including but not limited to thickness, reinforcement, joint spacing of more heavily loaded slabs will be dependent upon the anticipated loading conditions and the modulus of subgrade reaction of the supporting materials and should be designed by a structural engineer. Slab should be monolithically constructed with the footings and grade beams.

Slabs should be designed and constructed as promulgated by the American Concrete Institute (ACI) and the Portland Cement Association (PCA). Care should be taken during concrete placement to avoid slab curling. Prior to the slab pour, all utility trenches should be properly backfilled and compacted.

Subgrade for slabs-on-grade should be firm and uniform. All loose or disturbed soils including under-slab utility trench backfill should be recompacted.

If moisture-sensitive flooring or environments are planned, slabs-on-grade should be protected by 10-mil-thick polyethylene vapor barriers. The sub-grade surface should be free of all exposed rocks or other sharp objects prior to placement of the barrier. The barrier should be overlain by 2 inches pf sand, to minimize punctures and to aid in the concrete curing. At discretion of the structure engineer, the sand layer may be eliminated. Converse does not practice in the field of moisture vapor transmission evaluation/mitigation since this does not fall under the geotechnical disciplines. Therefore, we recommend that a qualified person, such as the flooring contractor, structural engineer, and/or architect be consulted to evaluate the general and specific moisture vapor transmission paths and any impact on the proposed construction.

In hot weather, the contractor should take appropriate curing precautions after placement of concrete to minimize cracking or curling of the slabs. The potential for slab cracking may be lessened by the addition of fiber mesh to the concrete and/or control of the water/cement ratio.

Concrete should be cured by protecting it against loss of moisture and rapid temperature change for at least 7 days after placement. Moist curing, waterproof paper, white polyethylene sheeting, white liquid membrane compound, or a combination thereof may be used after finishing operations have been completed. The edges of concrete slabs exposed after removal of forms should be immediately protected to provide continuous curing.

10.8 Retaining Wall Drainage

The recommended lateral earth pressure values do not include lateral pressures due to hydrostatic forces. Therefore, wall backfill should be free draining and provisions should be made to collect and dispose excess water that may accumulate behind earth retaining structures. Wall drainage may be provided by free-draining gravel surrounded by synthetic filter fabric or by prefabricated, synthetic drain panels or weep holes. In either case, drainage should be collected by perforated pipes and directed to a sump, storm drain, or other suitable location for disposal. We recommend drain rock should consist of durable stone having 100 percent passing the 1-inch sieve and less than 5 percent passing the No. 4 sieve. Synthetic filter fabric should have an equivalent opening size (EOS), U.S. Standard Sieve, of between 40 and 70, a minimum flow rate of 110 gallons per minute per square foot of fabric, and a minimum puncture strength of 110 pounds.

10.9 Settlement

The total settlement of shallow footings from static structural loads and short-term settlement of properly compacted fill is anticipated to be 1 inch or less. The differential settlement resulting from static loads is anticipated to be 0.5 inches or less over a horizontal distance of 40 feet.

10.10 Soil Corrosivity

The results of chemical testing of one representative soil sample were evaluated for corrosivity with respect to common construction materials such as concrete and steel. The test results are presented in Appendix B, *Laboratory Testing Program,* and general discussion pertaining to soil corrosivity is presented below.

The sulfate contents of the sampled soil correspond to American Concrete Institute (ACI) exposure category S0 for these sulfate concentrations (ACI 318-14, Table 19.3.1.1). Concrete type restrictions are specified for exposure category S0 (ACI 318-14, Table 19.3.2.1). A minimum compressive strength of 2,500 psi is recommended.

We anticipate that concrete structures such as footings, slabs, and flatwork will be exposed to moisture from precipitation and irrigation. Based on the site locations and the results of chloride testing of the site soils, we do not anticipate that concrete structures will be exposed to external sources of chlorides, such as deicing chemicals, salt, brackish water, or seawater. ACI specifies exposure category C1 where concrete is exposed to moisture, but not to external sources of chlorides (ACI 318-14, Table 19.3.1.1). ACI provides concrete design recommendations in ACI 318-14, Table 19.3.2.1, including a compressive strength of at least 2,500 psi and a maximum chloride content of 0.3 percent.

According to Romanoff, 1957, the following table provides general guideline of soil corrosion based on electrical resistivity.

Table No. 8, Correlation Between Resistivity and Corrosion

Soil Resistivity (ohm-cm) per Caltrans CT 643	Corrosivity Category
Over 10,000	Mildly corrosive
2,000 – 10,000	Moderately corrosive
1,000 – 2,000	corrosive
Less than 1,000	Severe corrosive

The measured value of the minimum electrical resistivity of the sample when saturated was 1,017 Ohm-cm. This indicates that the soil tested of the site is corrosive to ferrous metals in contact with the soils (Romanoff, 1957). <u>Converse does not practice in the area of corrosion consulting. A qualified corrosion consultant should provide appropriate corrosion mitigation measures for any ferrous metals in contact with the site and site soils.</u>

10.11 Flexible Pavement Recommendations

Based on the laboratory test result, the R-value of the subgrade soil was 15. For pavement design, we have utilized an R-value of 15 and design Traffic Indices (TIs) ranging from 5 to 8.

Based on the above information, asphalt concrete and aggregate base thickness results are presented using the Caltrans Highway Design Manual (Caltrans, 2021), Chapter 630 with a safety factor of 0.2 for asphalt concrete/aggregate base section and 0.1 for full depth asphalt concrete section. Preliminary asphalt concrete pavement sections are presented in the following table below.

Table No. 9, Recommended Preliminary Pavement Sections

R-value	Traffic Index (TI)	Pavement Section		
		Option 1		Option 2
		Asphalt Concrete (inches)	Aggregate Base (inches)	Full AC Section (inches)
15	5	4.0	6.0	4.0
	6	4.5	8.5	5.0
	7	5.0	11.0	6.5
	8	5.5	14.0	7.5

At or near the completion of grading, subsurface samples should be tested to evaluate the actual subgrade R-value for final pavement design.

Prior to placement of aggregate base, appropriate earthworks should be performed according to specifications provided in Section 9.0 *Earthwork Recommendations.*

Base materials should conform with Section 200-2.2,"*Crushed Aggregate Base*," of the current Standard Specifications for Public Works Construction (SSPWC; Public Works Standards, 2021) and should be placed in accordance with Section 301.2 of the SSPWC.

Asphaltic concrete materials should conform to Section 203 of the SSPWC and should be placed in accordance with Section 302.5 of the SSPWC.

10.12 Rigid Pavement Recommendations

Rigid pavement design recommendations were provided in accordance with the Portland Cement Association's (PCA) Southwest Region Publication P-14, Portland Cement Concrete Pavement (PCCP) for Light, Medium and Heavy Traffic Rigid Pavement. For pavement design, we have utilized a design subgrade R-value of 15 and design Traffic Indices (TIs) ranging from 5 to 9 for both Bradford and Fairhaven Well sites. We recommend that the project structural engineer consider the loading conditions at various locations and select the appropriate pavement sections from the following table.

Table No. 9, Rigid Pavement Structural Sections for Fairhaven and Bradford Well Sites

Design R-Value	Design Traffic Index (TI)	PCCP Pavement Section (inches)
15	5.0	7.5
	6.0	7.5
	7.0	8.0
	8.0	8.5

The above pavement section is based on a minimum 28-day Modulus of Rupture (M-R) of 550 psi and a compressive strength of 3,750 psi. The third point method of testing beams should be used to evaluate modulus of rupture. The concrete mix design should contain a minimum cement content of 5.5 sacks per cubic yard. Recommended maximum and minimum values of slump for pavement concrete are 3.0 inches to 1.0 inch, respectively.

Transverse contraction joints should not be spaced more than 10 feet and should be cut to a depth of 1/4 the thickness of the slab. Longitudinal joints should not be spaced more than 12 feet apart. A longitudinal joint is not necessary in the pavement adjacent to the curb and gutter section.

Prior to placement of concrete, at least the upper 12.0 inches of subgrade soils below rigid pavement sections should be compacted to at least ninety-five percent (95%) relative compaction as defined by the ASTM D 1557 standard test method.

Positive drainage should be provided away from all pavement areas to prevent seepage of surface and/or subsurface water into pavement base and/or subgrade.

10.13 Concrete Flatwork

Except as modified herein, concrete walks, driveways, access ramps, curb and gutters should be constructed in accordance with Section 303-5, *Concrete Curbs, Walks, Gutters, Cross-Gutters, Alley Intersections, Access Ramps, and Driveways*, of the Standard Specifications for Public Works Construction (Public Works Standards, 2021).

The subgrade soils under the above structures should consist of compacted fill placed as described in this report. Prior to placement of concrete, the upper 2 feet of subgrade soils should be moisture conditioned to between within 3 percent of optimum moisture content for coarse-grained soils and 0 and 2 percent above optimum for fine-grained soils.

The cement concrete thickness of driveways for passenger vehicles should be at least 4 inches, or as required by the civil or structural engineer. Transverse control joints for driveways should be spaced not more than 10 feet apart. Driveways wider than 12 feet should be provided with a longitudinal control joint.

Concrete walks subjected to pedestrian and bicycle loading should be at least 4 inches thick, or as required by the civil or structural engineer. Transverse joints should be spaced 15 feet or less and should be cut to a depth of one-fourth the slab thickness.

Positive drainage should be provided away from all driveways and sidewalks to prevent seepage of surface and/or subsurface water into the concrete base and/or subgrade.

11.0 CONSTRUCTION RECOMMENDATIONS

Temporary sloped excavation recommendations are presented in the following sections.

11.1 General

Prior to the start of construction, all existing underground utilities should be located at the project site. Such utilities should either be protected in-place or removed and replaced during construction as required by the project specifications.

Sloped excavations may not be feasible in locations adjacent to existing utilities or pavement. Recommendations pertaining to temporary excavations are presented in this section.

Excavations near existing utilities or pavement may require vertical side wall excavation. Where the side of the excavation is a vertical cut, it should be adequately supported by temporary shoring to protect workers and any adjacent structures.

All applicable requirements of the California Construction and General Industry Safety Orders, the Occupational Safety and Health Act, and the Construction Safety Act should be met. The soils exposed in cuts should be observed during excavation by the geotechnical consultant and the competent person designated by the contractor. If potentially unstable soil conditions are encountered, modifications of slope ratios for temporary cuts may be required.

11.2 Temporary Sloped Excavations

Temporary open-cut trenches may be constructed with side slopes as recommended in the following table. Temporary cuts encountering soft and wet fine-grained soils; dry loose, cohesionless soils or loose fill from trench backfill may have to be constructed at a flatter gradient than presented below.

Table No. 10, Slope Ratios for Temporary Excavations

Soil Type	OSHA Soil Type	Depth of Cut (feet)	Recommended Maximum Slope (Horizontal: Vertical) [1]
Clay (CL), Sandy Clay (CL), Clay with Sand (CL) Clayey Sand (SC), Silty Sand (SM), Sand with Silt (SP-SM), Silty Clay (CL-ML),	C	0-10	1.5:1

[1] Slope ratio is assumed to be constant from top to toe of slope, with level adjacent ground.

Shallow excavations up to 4 feet bgs can be vertical. For steeper temporary construction slopes or deeper excavations, or unstable soil encountered during the excavation, shoring or trenches should be provided by the contractor to protect the workers in the excavation. Design recommendations for temporary shoring can be provided if necessary.

Surfaces exposed in slope excavations should be kept moist but not saturated to retard raveling and sloughing during construction. Adequate provisions should be made to protect the slopes from erosion during periods of rainfall. Surcharge loads, including construction materials, should not be placed within 5 feet of the unsupported slope edge. Stockpiled soils with a height higher than 6 feet will require greater distance from trench edges.

12.0 GEOTECHNICAL SERVICES DURING CONSTRUCTION

The project geotechnical consultant should review plans and specifications as the project design progresses. Such review is necessary to identify design elements, assumptions, or new conditions which require revisions or additions to our geotechnical recommendations.

The project geotechnical consultant should be present to observe conditions during construction. Testing should be performed to determine density and moisture of the compacted soils. Geotechnical observation and testing should be performed as needed to verify compliance with project specifications. Additional geotechnical recommendations may be required based on subsurface conditions encountered during construction.

13.0 CLOSURE

This report is prepared for the project described herein and is intended for use solely by MIG, City of Irvine, and their authorized agents, to assist in the design and construction of the proposed project. Our findings and recommendations were obtained in accordance with generally accepted professional principles practiced in geotechnical engineering. We make no other warranty, either expressed or implied.

Converse Consultants is not responsible or liable for any claims or damages associated with interpretation of available information provided to others. Site exploration identifies actual soil conditions only at those points where samples are taken, when they are taken. Data derived through sampling and laboratory testing is extrapolated by Converse employees who render an opinion about the overall soil conditions. Actual conditions in areas not sampled may differ. In the event that changes to the project occur, or additional, relevant information about the project is brought to our attention, the recommendations contained in this report may not be valid unless these changes and additional relevant information is reviewed, and the recommendations of this report are modified or verified in writing. In addition, the recommendations can only be finalized by observing actual subsurface conditions revealed during construction. Converse cannot be held responsible for misinterpretation or changes to our recommendations made by others during construction.

As the project evolves, continued consultation and construction monitoring by a qualified geotechnical consultant should be considered an extension of geotechnical investigation services performed to date. The geotechnical consultant should review plans and specifications to verify that the recommendations presented herein have been appropriately interpreted, and that the design assumptions used in this report are valid. Where significant design changes occur, Converse may be required to augment or modify the recommendations presented herein. Subsurface conditions may differ in some locations from those encountered in the explorations, and may require additional analyses and, possibly, modified recommendations.

Design recommendations given in this report are based on the assumption that the recommendations contained in this report are implemented. Additional consultation may be prudent to interpret Converse's findings for contractors, or to possibly refine these recommendations based upon the review of the actual site conditions encountered during construction. If the scope of the project changes, if project completion is to be delayed, or if the report is to be used for another purpose, this office should be consulted.

14.0 REFERENCES

AMERICAN CONCRETE INSTITUTE (ACI), 2014, Building Code Requirements for Structural Concrete (ACI 318-14) and Commentary, October 2014.

Appendix VII. Infiltration Rate Evaluation Protocol and Factor of Safety Recommendations (City of Santa Ana, 2013)

CALIFORNIA BUILDING STANDARDS COMMISSION (CBSC), 2022, California Building Code (CBC).

CALIFORNIA STATE WATER RESOURCES CONTROL BOARD (SWRCB), 2022, GeoTracker database (http://geotracker.waterboards.ca.gov/), accessed in 2022.

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U.S. GEOLOGICAL SURVEY (USGS), 2022, U.S. Seismic Design Maps Application (http://geohazards.usgs.gov/designmaps/us/application.php), accessed on October 1, 2022.

U.S. GEOLOGICAL SURVEY (USGS), 2022, National Water Information System: Web Interface (https://maps.waterdata.usgs.gov/mapper/index.html), accessed on October 1, 2022.

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Appendix A

Field Exploration

APPENDIX A

FIELD EXPLORATION

Our field investigation included a site reconnaissance and a subsurface exploration program consisting of drilling soil borings and water percolation test. During the site reconnaissance, the surface conditions were noted, and the borings were marked at locations approved by Ms. Kathleen Haton with City of Irvine. The approximate boring locations were established in the field using approximate distances from local streets as well as existing structures as a guide and should be considered accurate only to the degree implied by the method used to locate them.

Three exploratory borings (BH-01 through BH-03) were drilled on November 7, 2022, to investigate the subsurface conditions. All borings were drilled to depths between 11.5 and 21.5 feet below ground surface (bgs).

Due to the close proximity of the borings BH-02 and BH-03 to the percolation test locations PT-01 and PT-02, after collection of soil samples, BH-02 and BH-03 were set up for percolation testing and also refereed as PT-01 and PT-02, respectively. The depth of PT-01 and PT-02 were 10.0 feet bgs. Details about the percolation tests are presented in Appendix C, *Percolation Testing*.

The borings were advanced using a truck-mounted drill rig equipped with 8-inch diameter hollow-stem augers for soils sampling. Encountered materials were continuously logged by a Converse Engineer and classified in the field by visual classification in accordance with the Unified Soil Classification System. Where appropriate, the field descriptions and classifications have been modified to reflect laboratory test results.

Relatively undisturbed samples were obtained using California Modified Samplers (2.4 inches inside diameter and 3.0 inches outside diameter) lined with thin sample rings. The steel ring sampler was driven into the bottom of the borehole with successive drops of a 140-pound driving weight falling 30 inches. Blow counts at each sample interval are presented on the boring logs. Samples were retained in brass rings (2.4 inches inside diameter and 1.0 inch in height) and carefully sealed in waterproof plastic containers for shipment to the Converse laboratory. Bulk samples of typical soil types were also obtained in plastic bags.

The exact depths at which material changes occur cannot always be established accurately. Unless a more precise depth can be established by other means, changes in material conditions that occur between drive samples are indicated on the logs at the top of the next drive sample.

Following the completion of logging and sampling, the boring BH-01 was backfilled with soil cuttings mixed with cement and compacted by pushing down with an auger using the drill rig weight. After completion of percolation testing, the pipes were removed from PT-01 (BH-02) and PT-02 (BH-03), and boreholes were backfilled with soil cuttings and tamped. If construction is delayed, the surface at the borings may settle over time. We recommend the owner monitor the boring locations and backfill any depressions that might occur or provide protection around the boring locations to prevent trip and fall injuries from occurring near the area of any potential settlement.

For a key to soil symbols and terminology used in the boring logs, refer to Drawing Nos. A-1a and A-1b, *Unified Soil Classification and Key to Boring Log Symbols*. For logs of borings, see Drawing Nos. A-2 through A-4, *Logs of Borings*. All elevations are based on Google Earth.

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	SAND AND SANDY SOILS	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

FIELD AND LABORATORY TESTS

- **C** Consolidation (ASTM D 2435)
- **CL** Collapse Potential (ASTM D 4546)
- **CP** Compaction Curve (ASTM D 1557)
- **CR** Corrosion, Sulfates, Chlorides (CTM 643-99; 417; 422)
- **CU** Consolidated Undrained Triaxial (ASTM D 4767)
- **DS** Direct Shear (ASTM D 3080)
- **EI** Expansion Index (ASTM D 4829)
- **M** Moisture Content (ASTM D 2216)
- **OC** Organic Content (ASTM D 2974)
- **P** Permeablility (ASTM D 2434)
- **PA** Particle Size Analysis (ASTM D 6913 [2002])
- **PI** Liquid Limit, Plastic Limit, Plasticity Index (ASTM D 4318)
- **PL** Point Load Index (ASTM D 5731)
- **PM** Pressure Meter
- **PP** Pocket Penetrometer
- **R** R-Value (CTM 301)
- **SE** Sand Equivalent (ASTM D 2419)
- **SG** Specific Gravity (ASTM D 854)
- **SW** Swell Potential (ASTM D 4546)
- **TV** Pocket Torvane
- **UC** Unconfined Compression - Soil (ASTM D 2166)
  Unconfined Compression - Rock (ASTM D 7012)
- **UU** Unconsolidated Undrained Triaxial (ASTM D 2850)
- **UW** Unit Weight (ASTM D 2937)
- **WA** Passing No. 200 Sieve

BORING LOG SYMBOLS

SAMPLE TYPE

- STANDARD PENETRATION TEST Split barrel sampler in accordance with ASTM D-1586-84 Standard Test Method
- DRIVE SAMPLE 2.42" I.D. sampler (CMS).
- DRIVE SAMPLE No recovery
- BULK SAMPLE
- GROUNDWATER WHILE DRILLING
- GROUNDWATER AFTER DRILLING

DRILLING METHOD SYMBOLS

- Auger Drilling
- Mud Rotary Drilling
- Dynamic Cone or Hand Driven
- Diamond Core

UNIFIED SOIL CLASSIFICATION AND KEY TO BORING LOG SYMBOLS

Converse Consultants

Heritage Park Pool Facility and Parking Lot
14301 Yale Avenue
City of Irvine, Orange County, California For:
MIG

Project No.	Drawing No.
22-32-125-01	A-1a

Project ID: 22-32-125-01.GPJ;Template: KEY

CONSISTENCY OF COHESIVE SOILS

Descriptor	Unconfined Compressive Strength (tsf)	SPT Blow Counts	Pocket Penetrometer (tsf)	CA Sampler	Torvane (tsf)	Field Approximation
Very Soft	<0.25	< 2	<0.25	<3	<0.12	Easily penetrated several inches by fist
Soft	0.25 - 0.50	2 - 4	0.25 - 0.50	3 - 6	0.12 - 0.25	Easily penetrated several inches by thumb
Medium Stiff	0.50 - 1.0	5 - 8	0.50 - 1.0	7 - 12	0.25 - 0.50	Can be penetrated several inches by thumb with moderate effort
Stiff	1.0 - 2.0	9 - 15	1.0 - 2.0	13 - 25	0.50 - 1.0	Readily indented by thumb but penetrated only with great effort
Very Stiff	2.0 - 4.0	16 - 30	2.0 - 4.0	26 - 50	1.0 - 2.0	Readily indented by thumbnail
Hard	>4.0	>30	>4.0	>50	>2.0	Indented by thumbnail with difficulty

APPARENT DENSITY OF COHESIONLESS SOILS

Descriptor	SPT N_{60}- Value (blows / foot)	CA Sampler
Very Loose	<4	<5
Loose	4- 10	5 - 12
Medium Dense	11 - 30	13 - 35
Dense	31 - 50	36 - 60
Very Dense	>50	>60

MOISTURE

Descriptor	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

PERCENT OF PROPORTION OF SOILS

Descriptor	Criteria
Trace (fine)/ Scattered (coarse)	Particles are present but estimated to be less than 5%
Few	5 to 10%
Little	15 to 25%
Some	30 to 45%
Mostly	50 to 100%

SOIL PARTICLE SIZE

Descriptor		Size
Boulder		> 12 inches
Cobble		3 to 12 inches
Gravel	Coarse	3/4 inch to 3 inches
	Fine	No. 4 Sieve to 3/4 inch
Sand	Coarse	No. 10 Sieve to No. 4 Sieve
	Medium	No. 40 Sieve to No. 10 Sieve
	Fine	No. 200 Sieve to No. No. 40 Sieve
Silt and Clay		Passing No. 200 Sieve

PLASTICITY OF FINE-GRAINED SOILS

Descriptor	Criteria
Nonplastic	A 1/8-inch thread cannot be rolled at any water content.
Low	The thread can barely be rolled, and the lump cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll, and not much time is required to reach the plastic limit; it cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.

CEMENTATION/ Induration

Descriptor	Criteria
Weak	Crumbles or breaks with handling or little finger pressure.
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Will not crumble or break with finger pressure.

NOTE: This legend sheet provides descriptions and associated criteria for required soil description components only. Refer to Caltrans Soil and Rock Logging, Classification, and Presentation Manual (2010), Section 2, for tables of additional soil description components and discussion of soil description and identification.

UNIFIED SOIL CLASSIFICATION AND KEY TO BORING LOG SYMBOLS

Converse Consultants

Heritage Park Pool Facility and Parking Lot
14301 Yale Avenue
City of Irvine, Orange County, California For:
MIG

Project No. **22-32-125-01**

Drawing No. **A-1b**

Log of Boring No. BH-01

Date Drilled: 11/7/2022 Logged by: Aleksey Zhukov Checked By: Hashmi Quazi

Equipment: 8" HOLLOW STEM AUGER Driving Weight and Drop: 140 lbs / 30 in

Ground Surface Elevation (ft): 112 Depth to Water (ft, bgs): NOT ENCOUNTERED

SUMMARY OF SUBSURFACE CONDITIONS

This log is part of the report prepared by Converse for this project and should be read together with the report. This summary applies only at the location of the Boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.

Depth (ft)	Summary of Subsurface Conditions	Samples: Drive	Samples: Bulk	Blows	Moisture (%)	Dry Unit Wt. (pcf)	Other
0	**ALLUVIUM:** **CLAYEY SAND/SANDY CLAY WITH GRAVEL (SC/CL):** fine to coarse-grained, little gravel up to 2 inches in maximum dimension, sub-angular to sub-rounded, medium dense, moist, dark brown. - roots and rootlets, dark brown to black		X				PA
2.5		X	X	10/13/12	10	117	
5	**SANDY CLAY (CL):** fine to coarse-grained sand, few gravel up to 1" in maximum dimension, medium stiff to stiff, moist, brown to dark brown.	X	X	3/5/6	15	114	
7.5		X	X	7/8/15	18	112	PA
10	**CLAY WITH SAND (CL):** fine to medium-grained sand, tan oxidation streaking, medium plasticity, very stiff, moist, dark brown.	X		6/12/18	15	114	
15	**SAND WITH SILT (SP-SM):** fine to medium-grained, scattered gravel up to 0.3" in maximum dimension - sub-rounded, medium dense, moist, orangish brown.	X		5/6/7	5	106	
20	**SILTY CLAY (CL-ML):** trace fine-grained sand, medium plasticity, stiff, moist, brown to dark brown.	X		3/8/12	27	96	

End of Boring at 21.5 feet bgs.
No groundwater was encountered.
Borehole was backfilled with soil cuttings and compacted by pushing down with an augers using the drill rig weight on 11/7/2022.

Log of Boring No. BH-02 / PT-01

Date Drilled: 11/7/2022 Logged by: Aleksey Zhukov Checked By: Hashmi Quazi

Equipment: 8" HOLLOW STEM AUGER Driving Weight and Drop: 140 lbs / 30 in

Ground Surface Elevation (ft): 119 Depth to Water (ft, bgs): NOT ENCOUNTERED

Depth (ft)	Graphic Log	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read together with the report. This summary applies only at the location of the Boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.	SAMPLES DRIVE	SAMPLES BULK	BLOWS	MOISTURE (%)	DRY UNIT WT. (pcf)	OTHER
		ALLUVIUM: **SANDY CLAY (CL):** fine to medium-grained sand, scattered gravel up to 0.5 inches in maximum dimension, rootlets, medium plasticity, moist, dark brown.		X				CP, CR, EI
5		**CLAY WITH SAND (CL):** fine to medium-grained sand, trace silt, tan oxidation streaking, stiff, moist, dark brown.	X		4/10/15	20	107	
			X		4/8/10	16	107	CL, DS
10		**CLAY (CL):** trace fine to medium-grained sand, trace silt, tan oxidation streaking, very stiff, moist, dark brown to black.	X		7/16/22	22	105	

End of Boring at 11.5 feet bgs.
No groundwater was encountered.
Borehole was used for percolation testing. After completion of the percolation testing, pipe was removed, and borehole was backfilled with soil cuttings and tamped on 11/9/2022.

Log of Boring No. BH-03 / PT-02

Date Drilled: 11/7/2022 Logged by: Aleksey Zhukov Checked By: Hashmi Quazi

Equipment: 8" HOLLOW STEM AUGER Driving Weight and Drop: 140 lbs / 30 in

Ground Surface Elevation (ft): 126 Depth to Water (ft, bgs): NOT ENCOUNTERED

Depth (ft)	Graphic Log	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read together with the report. This summary applies only at the location of the Boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.	SAMPLES DRIVE	SAMPLES BULK	BLOWS	MOISTURE (%)	DRY UNIT WT. (pcf)	OTHER
0		**ALLUVIUM:** **CLAYEY SAND/SANDY CLAY (SC/CL):** fine to coarse-grained, roots and rootlets, moist, dark brown.		X				R
5		**SANDY CLAY (CL):** fine to medium-grained sand, scattered gravel up to 2" in maximum dimension - sub-angular to sub-rounded, trace silt, tan oxidation streaking, very stiff, moist, dark brown.	X		2/7/13	12	109	
		CLAY WITH SAND (CL): fine to medium-grained sand, trace silt, tan oxidation streaking, very stiff, moist, dark brown.	X		8/15/17	17	114	
10			X		9/12/21	19	108	

End of Boring at 11.5 feet bgs.
No groundwater was encountered.
Borehole was used for percolation testing. After completion of the percolation testing, pipe was removed, and borehole was backfilled with soil cuttings and tamped on 11/9/2022.

Converse Consultants

Heritage Park Pool Facility and Parking Lot
14301 Yale Avenue
City of Irvine, Orange County, California
For: MIG

Project No. 22-32-125-01

Drawing No. A-4

Appendix B

Laboratory Testing Program

APPENDIX B

LABORATORY TESTING PROGRAM

Tests were conducted in our laboratory on representative soil samples for the purpose of classification and evaluation of their physical properties and engineering characteristics. The amount and selection of tests were based on the geotechnical parameters required for this project. Test results are presented herein and on the Logs of Borings, in Appendix A, *Field Exploration*. The following is a summary of the various laboratory tests conducted for this project.

In-Situ **Moisture Content and Dry Density**

In-situ dry density and moisture content tests were performed on relatively undisturbed ring samples, in accordance with ASTM Standard D2216 and ASTM D2937 to aid soils classification and to provide qualitative information on strength and compressibility characteristics of the site soils. For test results, see the Logs of Borings in Appendix A, *Field Exploration.*

Expansion Index

One sample was tested to evaluate the expansion potential in accordance with ASTM Standard D4829. The test result is presented in the following table.

Table No. B-1, Expansion Index Test Result

Boring No.	Depth (feet)	Soil Description	Expansion Index	Expansion Potential
BH-02	0-5	Sandy Clay (CL)	27	Low

R-value

One representative bulk soil sample was tested in accordance with California Test Method CT301 for resistance value (R-value). The test provides a relative measure of soil strength for use in pavement design. The test result is presented in the following table.

Table No. B-2, R-Value Test Result

Boring No.	Depth (feet)	Soil Classification	Measured R-value
BH-03	0-5	Sandy Clay (CL)/Clayey Sand (SC)	15

Collapse

To evaluate the moisture sensitivity (collapse/swell potential) of the encountered soils, two collapse tests were performed in accordance with the ASTM Standard D4546 laboratory procedure. The samples were loaded to approximately 2 kips per square foot (ksf), allowed to stabilize under load, and then submerged. The test results are presented in the following table.

Table No. B-3, Collapse Test Results

Boring No.	Depth (feet)	Soil Classification	Percent Swell (+) Percent Collapse (-)	Collapse Potential
BH-02	7.5-9.0	Clay with Sand (CL)	+0.01	None
BH-03	5.0-6.5	Sandy Clay (CL)	-0.05	None

Soil Corrosivity Test

One representative soil sample was tested to determine minimum electrical resistivity (wet condition), pH, and chemical content, including soluble sulfate and chloride concentrations. The purpose of these tests was to determine the corrosion potential of site soils when placed in contact with common construction materials. The tests were performed by AP Engineering and Testing, Inc. (Pomona, CA) in accordance with Caltrans Tests 643, 422 and 417. Test results are presented in the following table.

Table No. B-4, Summary of Soil Corrosivity Test Results

Boring No.	Depth (feet)	pH	Soluble Sulfates (CA 417) (ppm)	Soluble Chlorides (CA 422) (ppm)	Min. Resistivity (CA 643) (Ohm-cm)
BH-02	0-5	8.0	302	126	1,017

Grain-Size Analyses

To assist in classification of soils, mechanical grain-size analyses were performed on two select samples in accordance with the ASTM Standard ASTM D6913 test method. Grain-size curve is shown in Drawing No. B-1, *Grain Size Distribution Result*.

Table No. B-5, Grain Size Distribution Test Results

Boring No.	Depth (ft)	Soil Classification	% Gravel	% Sand	%Silt	%Clay
BH-01	0-5	Clayey Sand/Sandy Clay with Gravel (SC/CL)	23.0	39.7	37.3	
BH-01	5-10	Sandy Clay (CL)	6.0	44.1	49.9	

Maximum Density and Optimum Moisture Content

Laboratory maximum dry density-optimum moisture content relationship test was performed on one representative bulk soil sample. The test was conducted in accordance with the ASTM Standard D1557 test method. The test results are presented in Drawing No. B-2, *Moisture-Density Relationship Results,* and are summarized in the following table.

Table No B-6, Summary of Moisture-Density Relationship Results

Boring No.	Depth (feet)	Soil Description	Optimum Moisture (%)	Maximum Density (lb/cft)
BH-02	0-5	Sandy Clay (CL), Dark Brown	12.2	115.5

Direct Shear

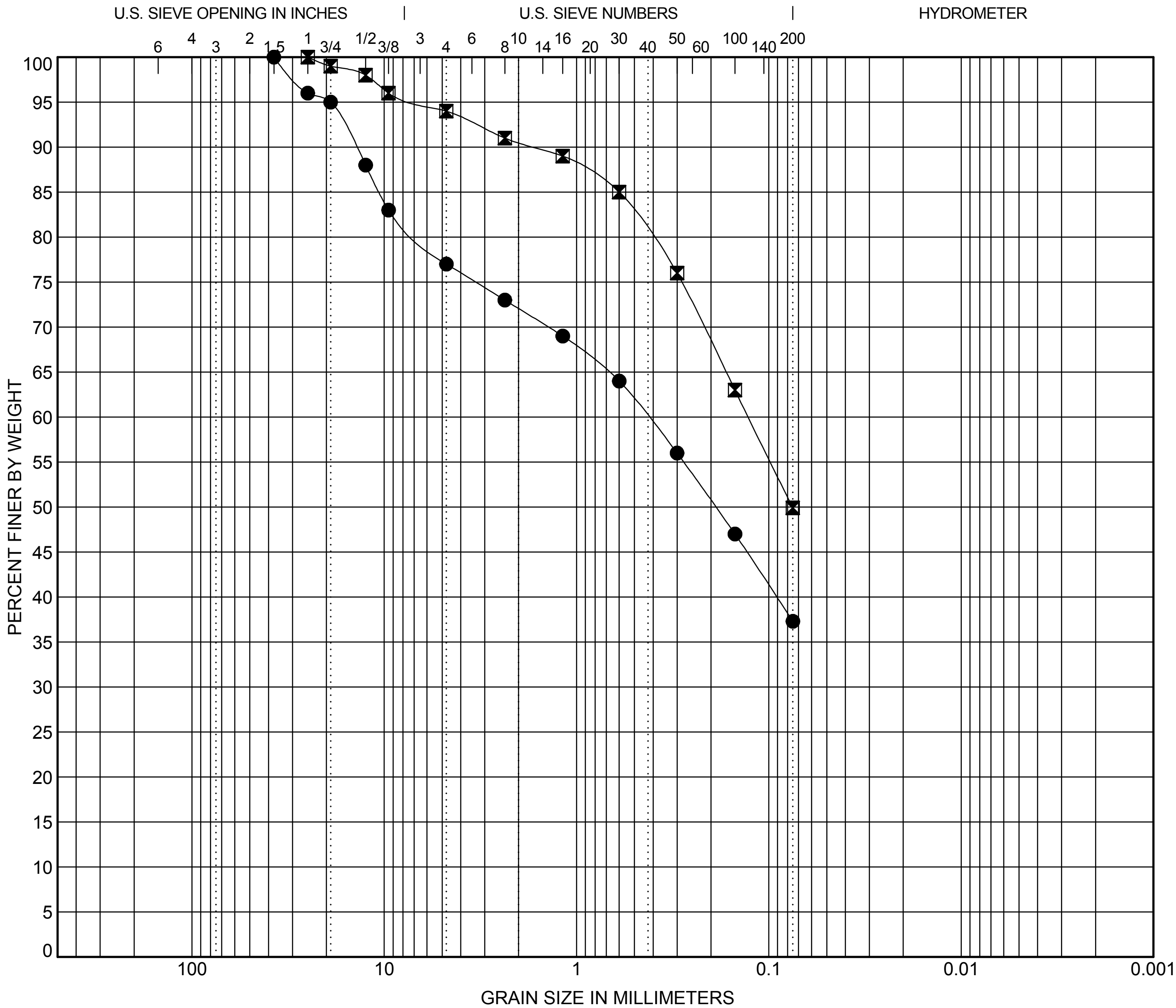
One direct shear test was performed on relatively undisturbed samples under soaked moisture condition in accordance with ASTM D3080. For this test, three samples contained in brass sampler rings were placed, one at a time, directly into the test apparatus and subjected to a range of normal loads appropriate for the anticipated conditions. The samples were then sheared at a constant strain rate of 0.004 inch/minute. Shear deformation was recorded until a maximum of about 0.25-inch shear displacement was achieved. Ultimate strength was selected from the shear-stress deformation data and plotted to determine the shear strength parameters. For test data, including sample density and moisture content, see Drawing No. B-3*, Direct Shear Test Result,* and the following table.

Table No. B-7, Summary of Direct Shear Test Results

Boring No.	Depth (feet)	Soil Description	Peak Strength Parameters	
			Friction Angle (degrees)	Cohesion (psf)
BH-02	7.5-9.0	Clay with Sand (CL)	27	220

Sample Storage

Soil samples presently stored in our laboratory will be discarded 30 days after the date of this report, unless this office receives a specific request to retain the samples for a longer period.



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.	Depth (ft)	Description	LL	PL	PI	Cc	Cu
●	**BH-01**	**0-5.0**	**CLAYEY SAND/SANDY CLAY WITH GRAVEL(SC/CL)**					
⊠	**BH-01**	**5.0-10.0**	**SANDY CLAY (CL)**					

	Boring No.	Depth (ft)	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**BH-01**	**0-5.0**	**37.5**	**0.424**			**23.0**	**39.7**	**37.3**	
⊠	**BH-01**	**5.0-10.0**	**25**	**0.128**			**6.0**	**44.1**	**49.9**	

GRAIN SIZE DISTRIBUTION RESULTS

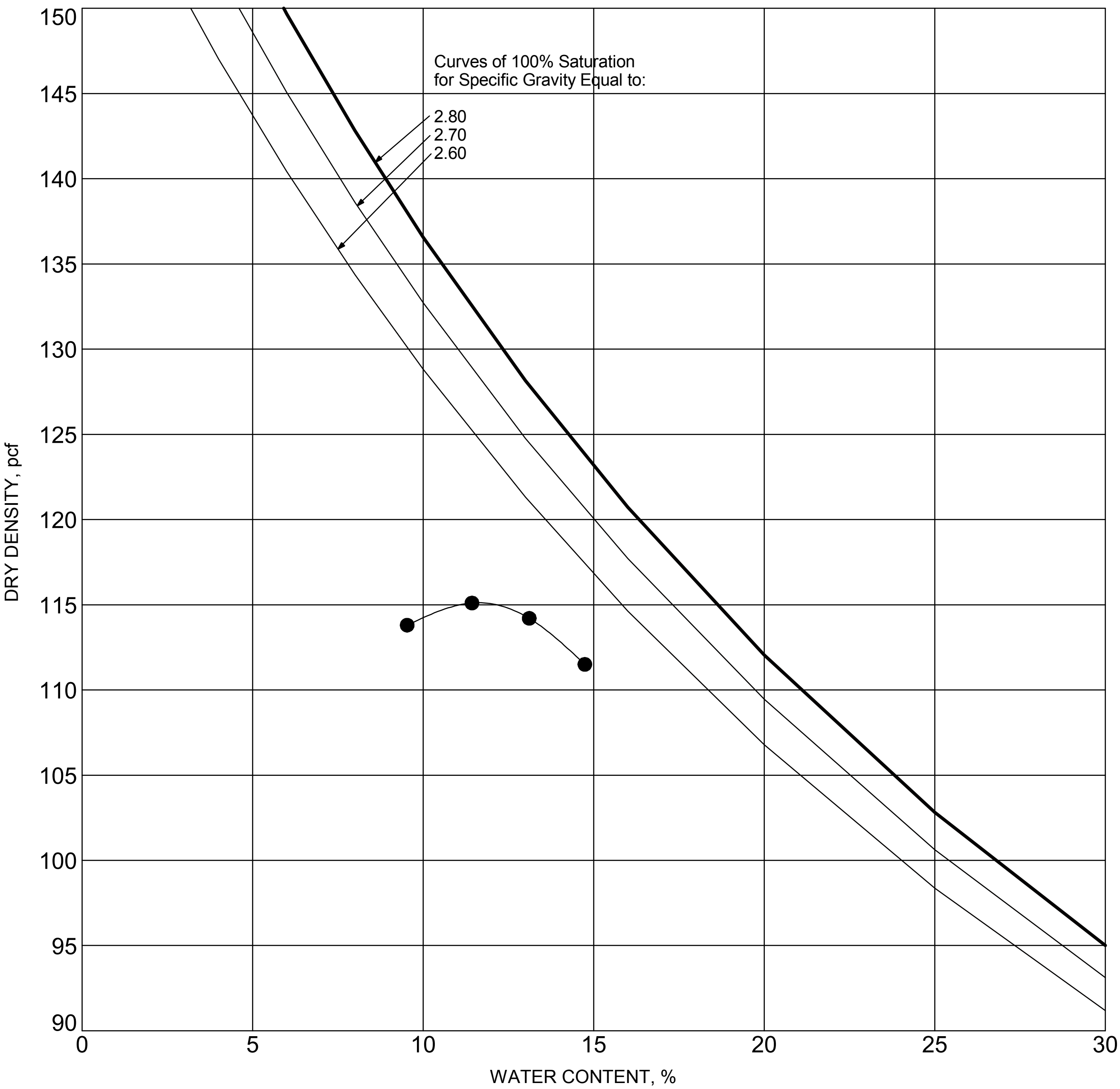
Converse Consultants

Heritage Park Pool Facility and Parking Lot
14301 Yale Avenue
City of Irvine, Orange County, California
For: MIG

Project No. **22-32-125-01**

Drawing No. **B-1**

Project ID: 22-32-125-01.GPJ; Template: GRAIN SIZE



SYMBOL	BORING NO.	DEPTH (ft)	DESCRIPTION	ASTM TEST METHOD	OPTIMUM WATER, %	MAXIMUM DRY DENSITY, pcf
●	**BH-02 / PT-01**	**0-5.0**	**SANDY CLAY (CL), DARK BROWN**	**D1557 Method B**	**12.2**	**115.5**

MOISTURE-DENSITY RELATIONSHIP RESULTS

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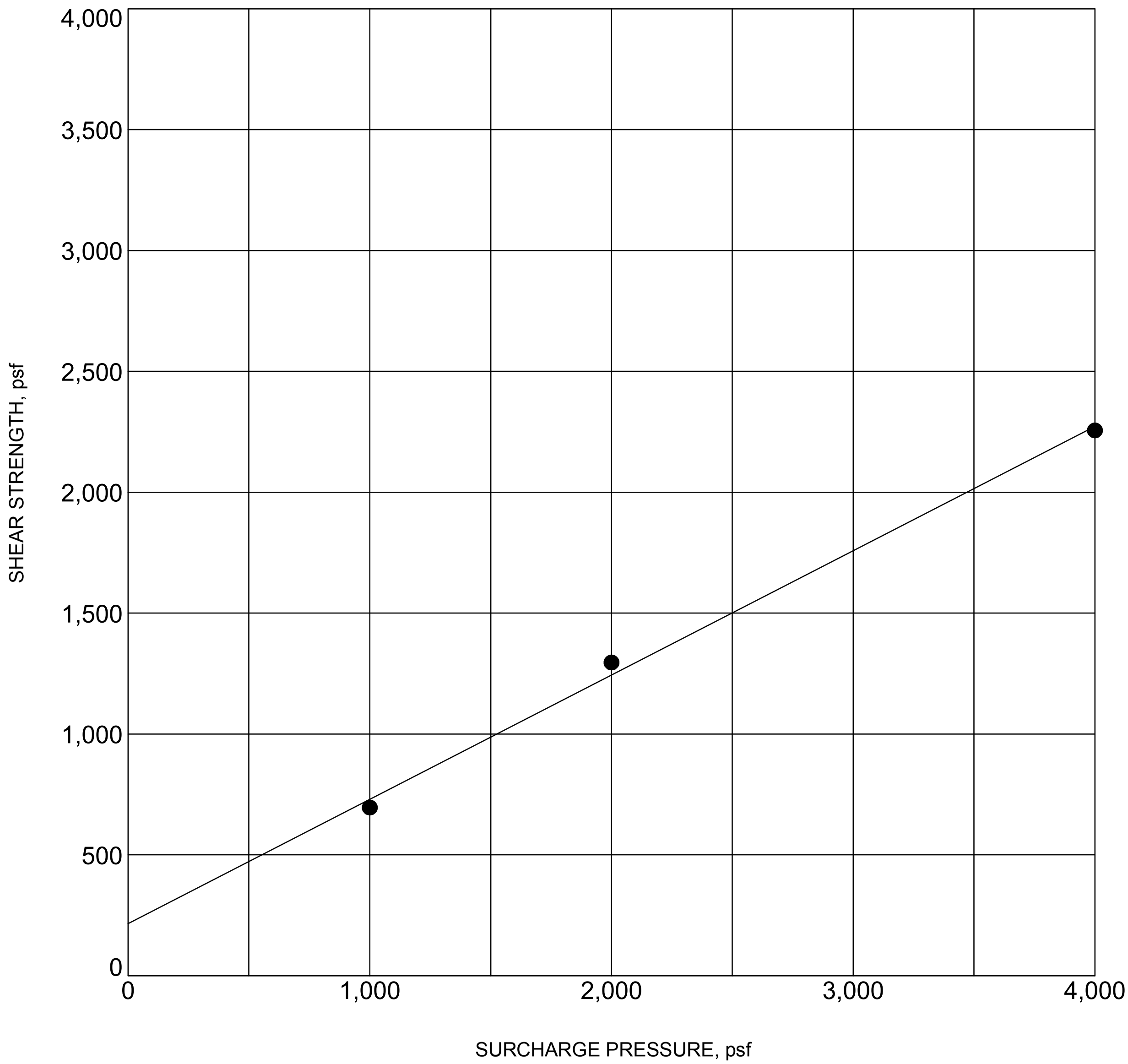
City of Irvine, Orange County, California
For: MIG

Project No.
22-32-125-01

Drawing No.
B-2

Project ID: 22-32-125-01.GPJ; Template: COMPACTION



BORING NO.	:	**BH-02 / PT-01**	DEPTH (ft)	:	**7.5-9.0**
DESCRIPTION	:	**CLAY WITH SAND (CL)**			
COHESION (psf)	:	**220**	FRICTION ANGLE (degrees):		**27**
MOISTURE CONTENT (%)	:	**16.0**	DRY DENSITY (pcf)	:	**107.0**

NOTE: Ultimate Strength.

DIRECT SHEAR TEST RESULTS

Converse Consultants

Heritage Park Pool Facility and Parking Lot
14301 Yale Avenue
City of Irvine, Orange County, California
For: MIG

Project No. **22-32-125-01**

Drawing No. **B-3**

Project ID: 22-32-125-01.GPJ; Template: DIRECT SHEAR

Appendix C

Percolation Testing

APPENDIX C

PERCOLATION TESTING

Percolation testing was performed at two locations (PT-01 and PT-02) on November 9, 2022, in general accordance with the Technical Guidance Document (TGD) for the Preparation of Conceptual/Preliminary and/or Project Water Quality Management Plans (WQMP), Appendix VII, Infiltration Rate Evaluation Protocol and Factor of Safety Recommendations (Orange County, 2013) for using a percolation testing method to estimate infiltration rates.

Upon completion of drilling the test holes, an approximately 2-inch-thick gravel layer was placed at the bottom of each hole and a 3.0-inch diameter perforated pipe was installed above the gravel to the ground surface. The boring annulus around the pipe was filled with gravel. The purpose of the pipe and gravel was to reduce the potential for erosion and caving due to the addition of water to the hole.

Each test hole was presoaked by filling with water to at least 5 times the radius of the test hole. After pre-soaking, water was added until the water levels were as near the required testing depth as could be achieved. The water levels were measured to the nearest 1/10-foot and recorded every 30 minutes. Following the completion of percolation testing, the pipe was removed from PT-01 and PT-02, and borehole backfilled with soil cuttings and tamped.

Percolation rates describe the movement of water horizontally and downward into the soil from a boring. Infiltration rates describe the downward movement of water through a horizontal surface, such as the floor of a retention basin. Percolation rates are related to infiltration rates but are generally higher and require conversion before use in design. The percolation test data was used to estimate infiltration rates using the Porchet Inverse Borehole Method, in accordance with the Orange County technical guidelines. A factor of safety of 2 was applied to the measured infiltration rates to account for subsurface variations, uncertainty in the test method, and future siltation. The infiltration structure designer should determine whether additional design-related safety factors are appropriate.

The measured percolation test data, calculations and estimated infiltration rates are shown on Plates No. 1 and 2. The estimated infiltration rates at the test holes are presented in the following table.

Table C-1, Estimated Infiltration Rates

Percolation Test	Depth (feet)	Soil Type	Infiltration Rate (inches/hour) (FOS 2)
PT-01	10	Sandy Clay (CL), Clay with Sand (CL), Clay (CL)	0.01
PT-02	10	Sandy Clay (CL), Clay with Sand (CL)	0.01

Based on the calculated infiltration rates during the final respective intervals in each test, a design infiltration rate of 0.01(inches/hour) can be used for depth of 10 feet for specified soil types for selected percolation testing locations. Please note that infiltration rates may change if the soil type and location of the proposed system changes. If that is the case, then additional percolation testing is required to be performed in the required location.

Estimated Infiltration Rate from Percolation Test Data, PT-01

Project Name	Heritage Park Master Plan Update
Project Number	22-32-125-01
Test Number	PT-01
Test Location	33.701087, -117.778963
Personnel	Aleksey Zhukov
Presoak Date	11/7/2022
Test Date	11/9/2022

Shaded cells contain calculated values.

Test Hole Radius, r (inches)			4
Total Depth of Test hole, D_T (inches)			120
Inside Diameter of Pipe, I (inches)			3.00
Outside Diameter of Pipe, O (inches)			3.13
Factor of Safety (FOS), F			2

Interval No.	Time Interval, Δt (min)	Initial Depth to Water, D_0 (inches)	Final Depth to Water, D_f (inches)	Elapsed Time (min)	Initial Height of Water, H_0 (inches)	Final Height of Water, H_f (inches)	Change in Height of Water, ΔH (inches)	Average Head Height, H_{avg} (inches)	Infiltration Rate, I_t (inches/hr)		Infiltration Rate with FOS, I_f (inches/hr)
				0							0
1	25.00	19.36	19.60	25.00	100.64	100.40	0.24	100.52	0.01		0.01
2	30.00	8.00	8.50	55.00	112.00	111.50	0.50	111.75	0.02		0.01
3	30.00	8.00	8.63	85.00	112.00	111.37	0.63	111.69	0.02		0.01
4	30.00	8.00	8.63	115.00	112.00	111.37	0.63	111.69	0.02		0.01
5	30.00	8.00	8.63	145.00	112.00	111.37	0.63	111.69	0.02		0.01
6	30.00	8.00	8.63	175.00	112.00	111.37	0.63	111.69	0.02		0.01
7	30.00	8.00	8.63	205.00	112.00	111.37	0.63	111.69	0.02		0.01
8	32.00	8.00	8.63	237.00	112.00	111.37	0.63	111.69	0.02		0.01
9	30.00	8.00	8.63	267.00	112.00	111.37	0.63	111.69	0.02		0.01
10	30.00	8.00	8.63	297.00	112.00	111.37	0.63	111.69	0.02		0.01

Recommended Design Infiltration Rate (inches/hr)	**0.01**

San Bernardino County Technical Guidance Document for Water Quality Management Plans, Appendix VII, Infiltration Rate Evaluation Protocol and Factor of Safety Recommendations (San Bernardino County, 2013)

$H_0 = D_T - D_0$

$H_f = D_T - D_f$

$\Delta H = H_0 - H_f$

$H_{avg} = (H_0 + H_f) / 2$

$I_t = (\Delta H * (60 * r)) / (\Delta t * (r + (2 * H_{avg}))$

Plate No. 1

Infiltration Rate versus Time, PT-01

Project Name	Heritage Park Master Plan Update
Project Number	22-32-125-01
Test Number	PT-01
Test Location	33.701087, -117.778963
Personnel	Aleksey Zhukov
Presoak Date	11/7/2022
Test Date	11/9/2022

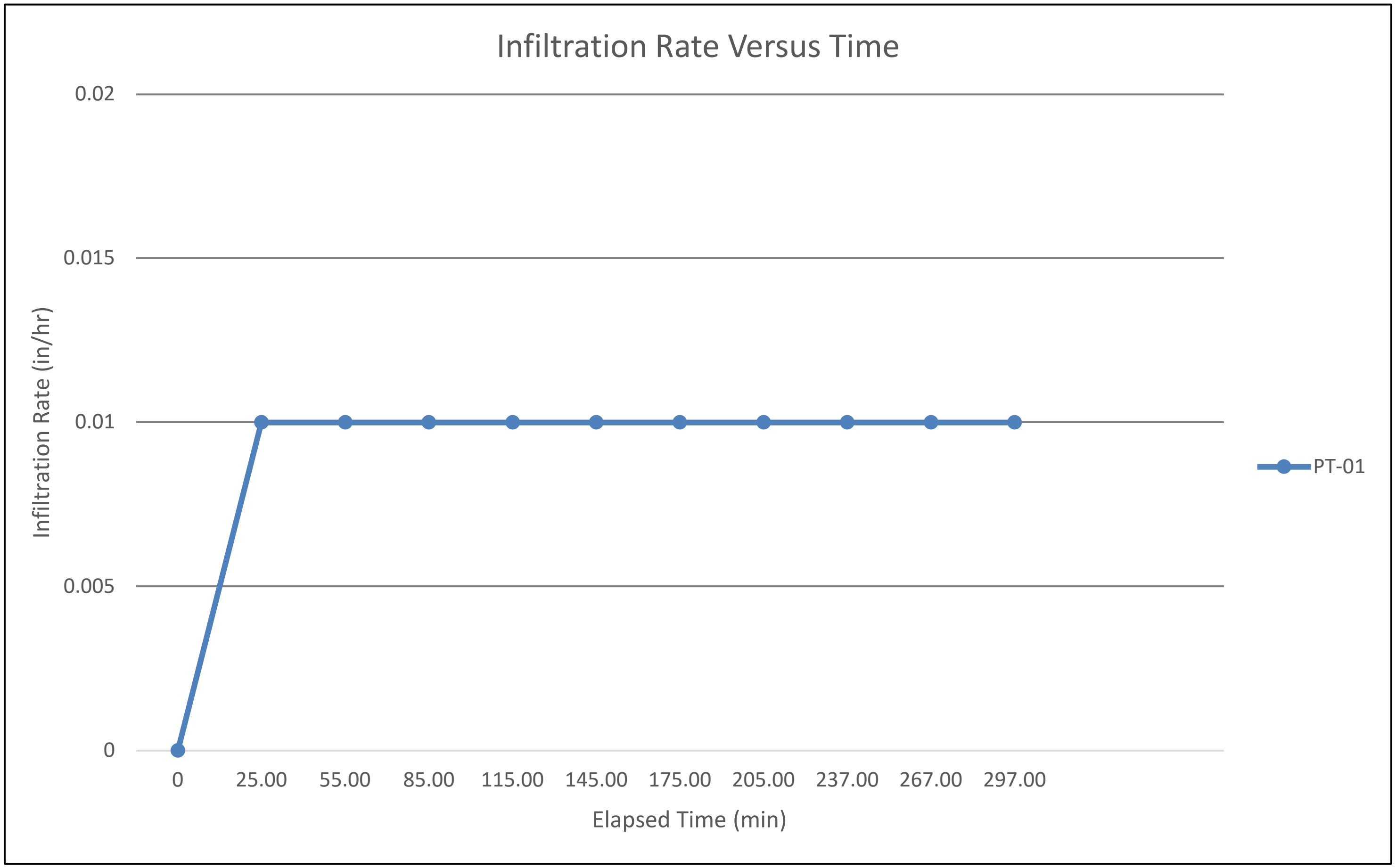


Plate No. 2

Estimated Infiltration Rate from Percolation Test Data, PT-02

Project Name	Heritage Park Master Plan Update
Project Number	22-32-125-01
Test Number	PT-02
Test Location	33.702110, -117.777103
Personnel	Aleksey Zhukov
Presoak Date	11/7/2022
Test Date	11/9/2022

Shaded cells contain calculated values.

Test Hole Radius, r (inches)	4
Total Depth of Test hole, D_T (inches)	120
Inside Diameter of Pipe, I (inches)	3.00
Outside Diameter of Pipe, O (inches)	3.13
Factor of Safety (FOS), F	2

Interval No.	Time Interval, Δt (min)	Initial Depth to Water, D_0 (inches)	Final Depth to Water, D_f (inches)	Elapsed Time (min)	Initial Height of Water, H_0 (inches)	Final Height of Water, H_f (inches)	Change in Height of Water, ΔH (inches)	Average Head Height, H_{avg} (inches)	Infiltration Rate, I_t (inches/hr)		Infiltration Rate with FOS, I_f (inches/hr)
				0							0
1	25.00	14.10	14.34	25.00	105.90	105.66	0.24	105.78	0.01		0.01
2	25.00	14.34	14.58	50.00	105.66	105.42	0.24	105.54	0.01		0.01
3	30.00	7.50	8.00	80.00	112.50	112.00	0.50	112.25	0.02		0.01
4	30.00	7.50	8.00	110.00	112.50	112.00	0.50	112.25	0.02		0.01
5	30.00	7.50	8.00	140.00	112.50	112.00	0.50	112.25	0.02		0.01
6	30.00	7.00	7.50	170.00	113.00	112.50	0.50	112.75	0.02		0.01
7	30.00	7.50	7.88	200.00	112.50	112.12	0.38	112.31	0.01		0.01
8	30.00	7.50	7.88	230.00	112.50	112.12	0.38	112.31	0.01		0.01
9	30.00	7.50	7.88	260.00	112.50	112.12	0.38	112.31	0.01		0.01

Recommended Design Infiltration Rate (inches/hr)	**0.01**

San Bernardino County Technical Guidance Document for Water Quality Management Plans, Appendix VII, Infiltration Rate Evaluation Protocol and Factor of Safety Recommendations (San Bernardino County, 2013)

$H_0 = D_T - D_0$

$H_f = D_T - D_f$

$\Delta H = H_0 - H_f$

$H_{avg} = (H_0 + H_f) / 2$

$I_t = (\Delta H * (60 * r)) / (\Delta t * (r + (2 * H_{avg}))$

Plate No. 3

Infiltration Rate versus Time, PT-02

Project Name	Heritage Park Master Plan Update
Project Number	22-32-125-01
Test Number	PT-02
Test Location	33.702110, -117.777103
Personnel	Aleksey Zhukov
Presoak Date	11/7/2022
Test Date	11/9/2022

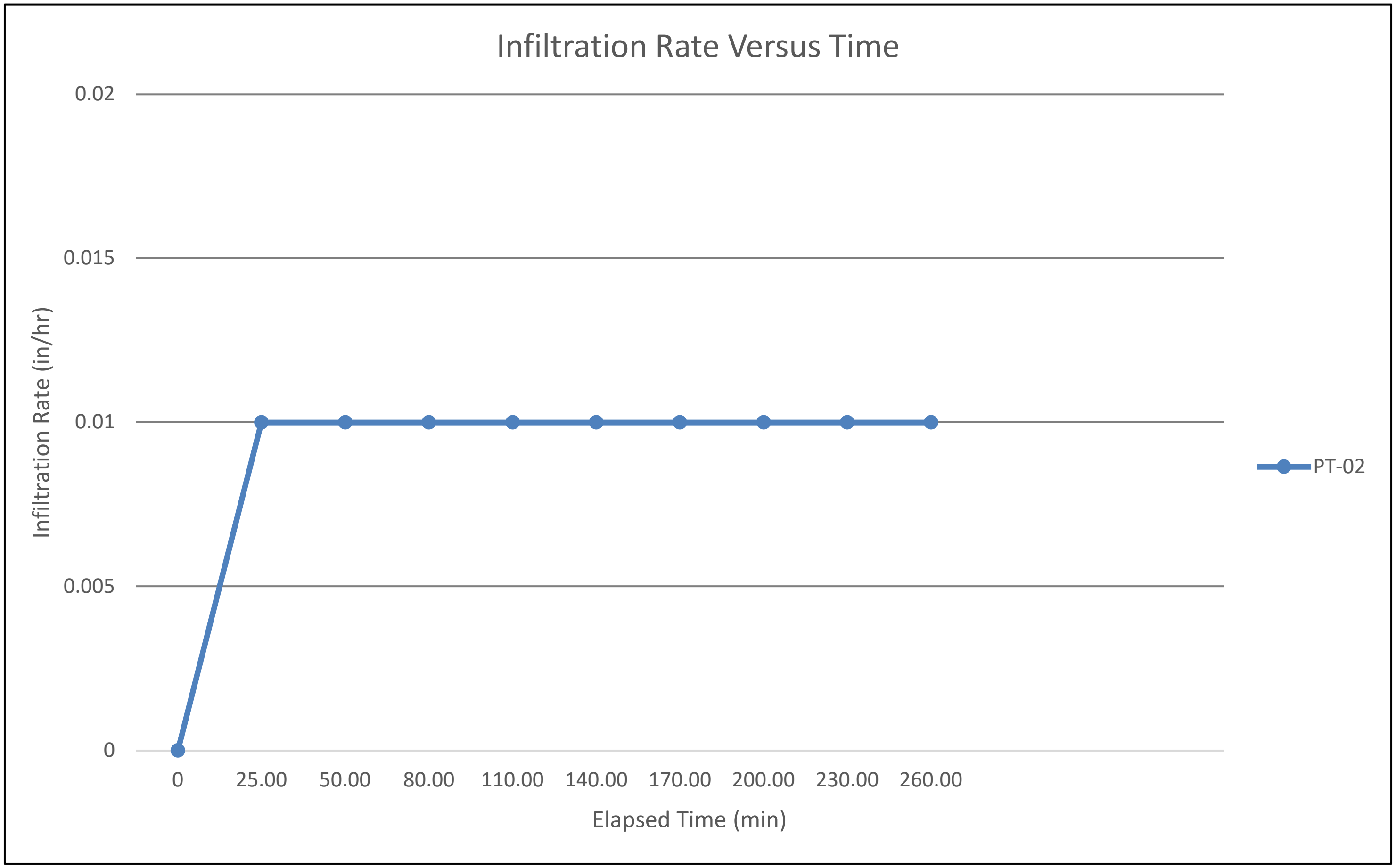


Plate No. 4

Appendix E.

CASQA Reference Documents

Building & Grounds Maintenance SC-41

Description

Stormwater runoff from building and grounds maintenance activities can be contaminated with toxic hydrocarbons in solvents, fertilizers and pesticides, suspended solids, heavy metals, abnormal pH, and oils and greases. Utilizing the protocols in this fact sheet will prevent or reduce the discharge of pollutants to stormwater from building and grounds maintenance activities by washing and cleaning up with as little water as possible, following good landscape management practices, preventing and cleaning up spills immediately, keeping debris from entering the storm drains, and maintaining the stormwater collection system.

Approach

Reduce potential for pollutant discharge through source control pollution prevention and BMP implementation. Successful implementation depends on effective training of employees on applicable BMPs and general pollution prevention strategies and objectives.

General Pollution Prevention Protocols

- ☐ Switch to non-toxic chemicals for maintenance to the maximum extent possible.
- ☐ Choose cleaning agents that can be recycled.
- ☐ Encourage proper lawn management and landscaping, including use of native vegetation.
- ☐ Encourage use of Integrated Pest Management techniques for pest control.
- ☐ Encourage proper onsite recycling of yard trimmings.
- ☐ Recycle residual paints, solvents, lumber, and other material as much as possible.

Objectives

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

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

Minimum BMPs Covered	
Good Housekeeping	✓
Preventative Maintenance	
Spill and Leak Prevention and Response	✓
Material Handling & Waste Management	✓
Erosion and Sediment Controls	
Employee Training Program	✓
Quality Assurance Record Keeping	✓

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- Clean work areas at the end of each work shift using dry cleaning methods such as sweeping and vacuuming.

Good Housekeeping

Pressure Washing of Buildings, Rooftops, and Other Large Objects

- In situations where soaps or detergents are used and the surrounding area is paved, pressure washers must use a water collection device that enables collection of wash water and associated solids. A sump pump, wet vacuum or similarly effective device must be used to collect the runoff and loose materials. The collected runoff and solids must be disposed of properly.

- If soaps or detergents are not used, and the surrounding area is paved, wash runoff does not have to be collected but must be screened. Pressure washers must use filter fabric or some other type of screen on the ground and/or in the catch basin to trap the particles in wash water runoff.

- If you are pressure washing on a grassed area (with or without soap), runoff must be dispersed as sheet flow as much as possible, rather than as a concentrated stream. The wash runoff must remain on the grass and not drain to pavement.

Landscaping Activities

- Dispose of grass clippings, leaves, sticks, or other collected vegetation as garbage, or by composting. Do not dispose of collected vegetation into waterways or storm drainage systems.

- Use mulch or other erosion control measures on exposed soils. See also SC-40, Contaminated and Erodible Areas, for more information.

Building Repair, Remodeling, and Construction

- Do not dump any toxic substance or liquid waste on the pavement, the ground, or toward a storm drain.

- Use ground or drop cloths underneath outdoor painting, scraping, and sandblasting work, and properly dispose of collected material daily.

- Use a ground cloth or oversized tub for activities such as paint mixing and tool cleaning.

- Clean paintbrushes and tools covered with water-based paints in sinks connected to sanitary sewers or in portable containers that can be dumped into a sanitary sewer drain. Brushes and tools covered with non-water-based paints, finishes, or other materials must be cleaned in a manner that enables collection of used solvents (e.g., paint thinner, turpentine, etc.) for recycling or proper disposal.

- Use a storm drain cover, filter fabric, or similarly effective runoff control mechanism if dust, grit, wash water, or other pollutants may escape the work area and enter a catch basin. This is particularly necessary on rainy days. The containment device(s) must be in place at the beginning of the work day, and accumulated dirty runoff and solids must be collected and disposed of before removing the containment device(s) at the end of the work day.

- If you need to de-water an excavation site, you may need to filter the water before discharging to a catch basin or off-site. If directed off-site, you should direct the water through hay bales and filter fabric or use other sediment filters or traps.

- Store toxic material under cover during precipitation events and when not in use. A cover would include tarps or other temporary cover material.

Mowing, Trimming, and Planting

- Dispose of leaves, sticks, or other collected vegetation as garbage, by composting or at a permitted landfill. Do not dispose of collected vegetation into waterways or storm drainage systems.

- Use mulch or other erosion control measures when soils are exposed.

- Place temporarily stockpiled material away from watercourses and drain inlets, and berm or cover stockpiles to prevent material releases to the storm drain system.

- Consider an alternative approach when bailing out muddy water: do not put it in the storm drain; pour over landscaped areas.

- Use hand weeding where practical.

Fertilizer and Pesticide Management

- Do not use pesticides if rain is expected.

- Do not mix or prepare pesticides for application near storm drains.

- Use the minimum amount needed for the job.

- Calibrate fertilizer distributors to avoid excessive application.

- Employ techniques to minimize off-target application (e.g., spray drift) of pesticides, including consideration of alternative application techniques.

- Apply pesticides only when wind speeds are low.

- Fertilizers should be worked into the soil rather than dumped or broadcast onto the surface.

- Irrigate slowly to prevent runoff and then only as much as is needed.

- Clean pavement and sidewalk if fertilizer is spilled on these surfaces before applying irrigation water.

Inspection

- Inspect irrigation system periodically to ensure that the right amount of water is being applied and that excessive runoff is not occurring. Minimize excess watering and repair leaks in the irrigation system as soon as they are observed.

Spill Response and Prevention Procedures

- Keep your Spill Prevention Control and Countermeasure (SPCC) Plan up-to-date.
- Place a stockpile of spill cleanup materials, such as brooms, dustpans, and vacuum sweepers (if desired) near the storage area where it will be readily accessible.
- Have employees trained in spill containment and cleanup present during the loading/unloading of dangerous wastes, liquid chemicals, or other materials.
- Familiarize employees with the Spill Prevention Control and Countermeasure Plan.
- Clean up spills immediately.

Material Handling and Waste Management

- Follow all federal, state, and local laws and regulations governing the use, storage, and disposal of fertilizers and pesticides and training of applicators and pest control advisors.
- Use less toxic pesticides that will do the job when applicable. Avoid use of copper-based pesticides if possible.
- Dispose of empty pesticide containers according to the instructions on the container label.
- Use up the pesticides. Rinse containers, and use rinse water as product. Dispose of unused pesticide as hazardous waste.
- Implement storage requirements for pesticide products with guidance from the local fire department and County Agricultural Commissioner. Provide secondary containment for pesticides.

Employee Training Program

- Educate and train employees on pesticide use and in pesticide application techniques to prevent pollution.
- Train employees and contractors in proper techniques for spill containment and cleanup.
- Be sure the frequency of training takes into account the complexity of the operations and the needs of individual staff.

Quality Assurance and Record Keeping

- Keep accurate logs that document maintenance activities performed and minimum BMP measures implemented.
- Keep accurate logs of spill response actions that document what was spilled, how it was cleaned up, and how the waste was disposed.
- Establish procedures to complete logs and file them in the central office.

Potential Capital Facility Costs and Operation & Maintenance Requirements

Facilities

- Additional capital costs are not anticipated for building and grounds maintenance. Implementation of the minimum BMPs described above should be conducted as part of regular site operations.

Maintenance

- Maintenance activities for the BMPs described above will be minimal, and no additional cost is anticipated.

Supplemental Information

Fire Sprinkler Line Flushing

Site fire sprinkler line flushing may be a source of non-stormwater runoff pollution. The water entering the system is usually potable water, though in some areas it may be non-potable reclaimed wastewater. There are subsequent factors that may drastically reduce the quality of the water in such systems. Black iron pipe is usually used since it is cheaper than potable piping, but it is subject to rusting and results in lower quality water. Initially, the black iron pipe has an oil coating to protect it from rusting between manufacture and installation; this will contaminate the water from the first flush but not from subsequent flushes. Nitrates, poly-phosphates and other corrosion inhibitors, as well as fire suppressants and antifreeze may be added to the sprinkler water system. Water generally remains in the sprinkler system a long time (typically a year) and between flushes may accumulate iron, manganese, lead, copper, nickel, and zinc. The water generally becomes anoxic and contains living and dead bacteria and breakdown products from chlorination. This may result in a significant BOD problem and the water often smells. Consequently dispose fire sprinkler line flush water into the sanitary sewer. Do not allow discharge to storm drain or infiltration due to potential high levels of pollutants in fire sprinkler line water.

References and Resources

City of Seattle, Seattle Public Utilities Department of Planning and Development, 2009. *Stormwater Manual Vol. 1 Source Control Technical Requirements Manual.*

Kennedy/Jenks Consultants, 2007. *The Truckee Meadows Industrial and Commercial Storm Water Best Management Practices Handbook.* Available online at: http://www.cityofsparks.us/sites/default/files/assets/documents/env-control/construction/TM-I-C_BMP_Handbook_2-07-final.pdf.

Orange County Stormwater Program, Best Management Practices for Industrial/Commercial Business Activities. Available online at: http://ocwatersheds.com/documents/bmp/industrialcommercialbusinessesactivities.

Sacramento Stormwater Management Program. *Best Management Practices for Industrial Storm Water Pollution Control.* Available online at:

http://www.msa.saccounty.net/sactostormwater/documents/guides/industrial-BMP-manual.pdf.

US EPA, 1997. *Best Management Practices Handbook for Hazardous Waste Containers*. Available online at: http://www.epa.gov/region6/6en/h/handbk4.pdf.

Ventura Countywide Stormwater Management Program Clean Business Fact Sheets. Available online at: http://www.vcstormwater.org/documents/programs_business/building.pdf.

Parking Area Maintenance SC-43

Description

Parking lots can contribute a number of substances, such as trash, suspended solids, hydrocarbons, oil and grease, and heavy metals that can enter receiving waters through stormwater runoff or non-stormwater discharges. The protocols in this fact sheet are intended to prevent or reduce the discharge of pollutants from parking areas and include using good housekeeping practices, following appropriate cleaning BMPs, and training employees.

BMPs for other outdoor areas on site (loading/unloading, material storage, and equipment operations) are described in SC-30 through SC-33.

Approach

The goal of this program is to ensure stormwater pollution prevention practices are considered when conducting activities on or around parking areas to reduce potential for pollutant discharge to receiving waters. Successful implementation depends on effective training of employees on applicable BMPs and general pollution prevention strategies and objectives.

General Pollution Prevention Protocols

- ☐ Encourage advanced designs and maintenance strategies for impervious parking lots. Refer to the treatment control BMP fact sheets in this manual for additional information.

- ☐ Keep accurate maintenance logs to evaluate BMP implementation.

Good Housekeeping

- ☐ Keep all parking areas clean and orderly. Remove debris, litter, and sediments in a timely fashion.

- ☐ Post "No Littering" signs and enforce anti-litter laws.

Objectives

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

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

Minimum BMPs Covered	
Good Housekeeping	✓
Preventative Maintenance	✓
Spill and Leak Prevention and Response	✓
Material Handling & Waste Management	
Erosion and Sediment Controls	
Employee Training Program	✓
Quality Assurance Record Keeping	✓

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- ☐ Provide an adequate number of litter receptacles.
- ☐ Clean out and cover litter receptacles frequently to prevent spillage.

Preventative Maintenance

Inspection

Have designated personnel conduct inspections of parking facilities and stormwater conveyance systems associated with parking facilities on a regular basis.

- ☐ Inspect cleaning equipment/sweepers for leaks on a regular basis.

Surface Cleaning

- ☐ Use dry cleaning methods (e.g., sweeping, vacuuming) to prevent the discharge of pollutants into the stormwater conveyance system if possible.
- ☐ Establish frequency of public parking lot sweeping based on usage and field observations of waste accumulation.
- ☐ Sweep all parking lots at least once before the onset of the wet season.
- ☐ Dispose of parking lot sweeping debris and dirt at a landfill.
- ☐ Follow the procedures below if water is used to clean surfaces:
  - ✓ Block the storm drain or contain runoff.
  - ✓ Collect and pump wash water to the sanitary sewer or discharge to a pervious surface. Do not allow wash water to enter storm drains.
- ☐ Follow the procedures below when cleaning heavy oily deposits:
  - ✓ Clean oily spots with absorbent materials.
  - ✓ Use a screen or filter fabric over inlet, then wash surfaces.
  - ✓ Do not allow discharges to the storm drain.
  - ✓ Vacuum/pump discharges to a tank or discharge to sanitary sewer.
  - ✓ Dispose of spilled materials and absorbents appropriately.

Surface Repair

- ☐ Check local ordinance for SUSMP/LID ordinance.
- ☐ Preheat, transfer or load hot bituminous material away from storm drain inlets.
- ☐ Apply concrete, asphalt, and seal coat during dry weather to prevent contamination from contacting stormwater runoff.
- ☐ Cover and seal nearby storm drain inlets where applicable (with waterproof material or mesh) and manholes before applying seal coat, slurry seal, etc. Leave covers in

place until job is complete and all water from emulsified oil sealants has drained or evaporated. Clean any debris from these covered manholes and drains for proper disposal.

- Use only as much water as necessary for dust control during sweeping to avoid runoff.
- Catch drips from paving equipment that is not in use with pans or absorbent material placed under the machines. Dispose of collected material and absorbents properly.

Spill Response and Prevention Procedures

- Keep your Spill Prevention Control and Countermeasure (SPCC) Plan up-to-date.
- Place a stockpile of spill cleanup materials where it will be readily accessible or at a central location.
- Clean up fluid spills immediately with absorbent rags or material.
- Dispose of spilled material and absorbents properly.

Employee Training Program

- Provide regular training to field employees and/or contractors regarding cleaning of paved areas and proper operation of equipment.
- Train employees and contractors in proper techniques for spill containment and cleanup.
- Use a training log or similar method to document training.

Quality Assurance and Record Keeping

- Keep accurate maintenance logs that document minimum BMP activities performed for parking area maintenance, types and quantities of waste disposed of, and any improvement actions.
- Keep accurate logs of spill response actions that document what was spilled, how it was cleaned up, and how the waste was disposed.
- Establish procedures to complete logs and file them in the central office.

Potential Capital Facility Costs and Operation & Maintenance Requirements

Facilities

- Capital investments may be required at some sites to purchase sweeping equipment, train sweeper operators, install oil/water/sand separators, or implement advanced BMPs. These costs can vary significantly depending upon site conditions and the amount of BMPs required.

Maintenance

- Sweep and clean parking lots regularly to minimize pollutant transport into storm drains from stormwater runoff.
- Clean out oil/water/sand separators regularly, especially after heavy storms.
- Maintain advanced BMPs such as vegetated swales, infiltration trenches, or detention basins as appropriate. Refer to the treatment control fact sheets for more information.

Supplemental Information

Advanced BMPs

Some parking areas may require advanced BMPs to further reduce pollutants in stormwater runoff, and a few examples are listed below. Refer to the Treatment Control Fact Sheets and the New Development and Redevelopment Manual for more information.

- When possible, direct sheet runoff to flow into biofilters (vegetated strip and swale) and/or infiltration devices.
- Utilize sand filters or oleophilic collectors for oily waste in low quantities.
- Arrange rooftop drains to prevent drainage directly onto paved surfaces.
- Design lot to include semi-permeable hardscape.

References and Resources

City of Seattle, Seattle Public Utilities Department of Planning and Development, 2009. *Stormwater Manual Vol. 1 Source Control Technical Requirements Manual.*

California Stormwater Quality Association, 2003. *New Development and Redevelopment Stormwater Best Management Practice Handbook.* Available online at: https://www.casqa.org/resources/bmp-handbooks/new-development-redevelopment-bmp-handbook.

Kennedy/Jenks Consultants, 2007. *The Truckee Meadows Industrial and Commercial Storm Water Best Management Practices Handbook.* Available online at: http://www.cityofsparks.us/sites/default/files/assets/documents/env-control/construction/TM-I-C_BMP_Handbook_2-07-final.pdf.

Orange County Stormwater Program, Best Management Practices for Industrial/Commercial Business Activities. Available online at: http://ocwatersheds.com/documents/bmp/industrialcommercialbusinessesactivities.

Pollution from Surface Cleaning Folder, 1996, 2003. Bay Area Stormwater Management Agencies Association. Available online at: http://basmaa.org/Portals/0/documents/pdf/Pollution%20from%20Surface%20Cleaning.pdf.

Sacramento Stormwater Management Program. *Best Management Practices for Industrial Storm Water Pollution Control.* Available online at: http://www.msa.saccounty.net/sactostormwater/documents/guides/industrial-BMP-manual.pdf.

The Storm Water Managers Resource Center, http://www.stormwatercenter.net.

US EPA. *Post-Construction Stormwater Management in New Development and Redevelopment.* BMP Fact Sheets. Available online at: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=min_measure&min_measure_id=5.

Objectives

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

Targeted Constituents

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

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.

- 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) plant 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 STOPPP - (http://stoppp.tripod.com/bmp.html)

Objectives

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

Targeted Constituents

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

Description

Streets, roads, and highways are significant sources of pollutants in stormwater discharges, and operation and maintenance (O&M) practices, if not conducted properly, can contribute to the problem. Stormwater pollution from roadway and bridge maintenance should be addressed on a site-specific basis. Use of the procedures outlined below, that address street sweeping and repair, bridge and structure maintenance, and unpaved roads will reduce pollutants in stormwater.

Approach

Pollution Prevention

- Use the least toxic materials available (e.g. water based paints, gels or sprays for graffiti removal)
- Recycle paint and other materials whenever possible.
- Enlist the help of citizens to keep yard waste, used oil, and other wastes out of the gutter.

Suggested Protocols

Street Sweeping and Cleaning

- Maintain a consistent sweeping schedule. Provide minimum monthly sweeping of curbed streets.
- Perform street cleaning during dry weather if possible.

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- Avoid wet cleaning or flushing of street, and utilize dry methods where possible.
- Consider increasing sweeping frequency based on factors such as traffic volume, land use, field observations of sediment and trash accumulation, proximity to water courses, etc. For example:
  - Increase the sweeping frequency for streets with high pollutant loadings, especially in high traffic and industrial areas.
  - Increase the sweeping frequency just before the wet season to remove sediments accumulated during the summer.
  - Increase the sweeping frequency for streets in special problem areas such as special events, high litter or erosion zones.
- Maintain cleaning equipment in good working condition and purchase replacement equipment as needed. Old sweepers should be replaced with new technologically advanced sweepers (preferably regenerative air sweepers) that maximize pollutant removal.
- Operate sweepers at manufacturer requested optimal speed levels to increase effectiveness.
- To increase sweeping effectiveness consider the following:
  - Institute a parking policy to restrict parking in problematic areas during periods of street sweeping.
  - Post permanent street sweeping signs in problematic areas; use temporary signs if installation of permanent signs is not possible.
  - Develop and distribute flyers notifying residents of street sweeping schedules.
- Regularly inspect vehicles and equipment for leaks, and repair immediately.
- If available use vacuum or regenerative air sweepers in the high sediment and trash areas (typically industrial/commercial).
- Keep accurate logs of the number of curb-miles swept and the amount of waste collected.
- Dispose of street sweeping debris and dirt at a landfill.
- Do not store swept material along the side of the street or near a storm drain inlet.
- Keep debris storage to a minimum during the wet season or make sure debris piles are contained (e.g. by berming the area) or covered (e.g. with tarps or permanent covers).

Street Repair and Maintenance

Pavement marking

- Schedule pavement marking activities for dry weather.

- Develop paint handling procedures for proper use, storage, and disposal of paints.
- Transfer and load paint and hot thermoplastic away from storm drain inlets.
- Provide drop cloths and drip pans in paint mixing areas.
- Properly maintain application equipment.
- Street sweep thermoplastic grindings. Yellow thermoplastic grindings may require special handling as they may contain lead.
- Paints containing lead or tributyltin are considered a hazardous waste and must be disposed of properly.
- Use water based paints whenever possible. If using water based paints, clean the application equipment in a sink that is connected to the sanitary sewer.
- Properly store leftover paints if they are to be kept for the next job, or dispose of properly.

Concrete installation and repair

- Schedule asphalt and concrete activities for dry weather.
- Take measures to protect any nearby storm drain inlets and adjacent watercourses, prior to breaking up asphalt or concrete (e.g. place san bags around inlets or work areas).
- Limit the amount of fresh concrete or cement mortar mixed, mix only what is needed for the job.
- Store concrete materials under cover, away from drainage areas. Secure bags of cement after they are open. Be sure to keep wind-blown cement powder away from streets, gutters, storm drains, rainfall, and runoff.
- Return leftover materials to the transit mixer. Dispose of small amounts of hardened excess concrete, grout, and mortar in the trash.
- Do not wash sweepings from exposed aggregate concrete into the street or storm drain. Collect and return sweepings to aggregate base stockpile, or dispose in the trash.
- When making saw cuts in pavement, use as little water as possible and perform during dry weather. Cover each storm drain inlet completely with filter fabric or plastic during the sawing operation and contain the slurry by placing straw bales, sandbags, or gravel dams around the inlets. After the liquid drains or evaporates, shovel or vacuum the slurry residue from the pavement or gutter and remove from site. Alternatively, a small onsite vacuum may be used to pick up the slurry as this will prohibit slurry from reaching storm drain inlets.
- Wash concrete trucks off site or in designated areas on site designed to preclude discharge of wash water to drainage system.

Patching, resurfacing, and surface sealing

- Schedule patching, resurfacing and surface sealing for dry weather.
- Stockpile materials away from streets, gutter areas, storm drain inlets or watercourses. During wet weather, cover stockpiles with plastic tarps or berm around them if necessary to prevent transport of materials in runoff.
- Pre-heat, transfer or load hot bituminous material away from drainage systems or watercourses.
- Where applicable, cover and seal nearby storm drain inlets (with waterproof material or mesh) and maintenance holes before applying seal coat, slurry seal, etc. Leave covers in place until job is complete and until all water from emulsified oil sealants has drained or evaporated. Clean any debris from covered maintenance holes and storm drain inlets when the job is complete.
- Prevent excess material from exposed aggregate concrete or similar treatments from entering streets or storm drain inlets. Designate an area for clean up and proper disposal of excess materials.
- Use only as much water as necessary for dust control, to avoid runoff.
- Sweep, never hose down streets to clean up tracked dirt. Use a street sweeper or vacuum truck. Do not dump vacuumed liquid in storm drains.
- Catch drips from paving equipment that is not in use with pans or absorbent material placed under the machines. Dispose of collected material and absorbents properly.

Equipment cleaning maintenance and storage

- Inspect equipment daily and repair any leaks. Place drip pans or absorbent materials under heavy equipment when not in use.
- Perform major equipment repairs at the corporation yard, when practical.
- If refueling or repairing vehicles and equipment must be done onsite, use a location away from storm drain inlets and watercourses.
- Clean equipment including sprayers, sprayer paint supply lines, patch and paving equipment, and mud jacking equipment at the end of each day. Clean in a sink or other area (e.g. vehicle wash area) that is connected to the sanitary sewer.

Bridge and Structure Maintenance

Paint and Paint Removal

- Transport paint and materials to and from job sites in containers with secure lids and tied down to the transport vehicle.
- Do not transfer or load paint near storm drain inlets or watercourses.

- Test and inspect spray equipment prior to starting to paint. Tighten all hoses and connections and do not overfill paint container.
- Plug nearby storm drain inlets prior to starting painting where there is significant risk of a spill reaching storm drains. Remove plugs when job is completed.
- If sand blasting is used to remove paint, cover nearby storm drain inlets prior to starting work.
- Perform work on a maintenance traveler or platform, or use suspended netting or tarps to capture paint, rust, paint removing agents, or other materials, to prevent discharge of materials to surface waters if the bridge crosses a watercourse. If sanding, use a sander with a vacuum filter bag.
- Capture all clean-up water, and dispose of properly.
- Recycle paint when possible (e.g. paint may be used for graffiti removal activities). Dispose of unused paint at an appropriate household hazardous waste facility.

Graffiti Removal

- Schedule graffiti removal activities for dry weather.
- Protect nearby storm drain inlets prior to removing graffiti from walls, signs, sidewalks, or other structures needing graffiti abatement. Clean up afterwards by sweeping or vacuuming thoroughly, and/or by using absorbent and properly disposing of the absorbent.
- When graffiti is removed by painting over, implement the procedures under Painting and Paint Removal above.
- Direct runoff from sand blasting and high pressure washing (with no cleaning agents) into a landscaped or dirt area. If such an area is not available, filter runoff through an appropriate filtering device (e.g. filter fabric) to keep sand, particles, and debris out of storm drains.
- If a graffiti abatement method generates wash water containing a cleaning compound (such as high pressure washing with a cleaning compound), plug nearby storm drains and vacuum/pump wash water to the sanitary sewer.
- Consider using a waterless and non-toxic chemical cleaning method for graffiti removal (e.g. gels or spray compounds).

Repair Work

- Prevent concrete, steel, wood, metal parts, tools, or other work materials from entering storm drains or watercourses.
- Thoroughly clean up the job site when the repair work is completed.
- When cleaning guardrails or fences follow the appropriate surface cleaning methods (depending on the type of surface) outlined in SC-71 Plaza & Sidewalk Cleaning fact sheet.

- If painting is conducted, follow the painting and paint removal procedures above.
- If graffiti removal is conducted, follow the graffiti removal procedures above.
- If construction takes place, see the Construction Activity BMP Handbook.
- Recycle materials whenever possible.

Unpaved Roads and Trails

- Stabilize exposed soil areas to prevent soil from eroding during rain events. This is particularly important on steep slopes.
- For roadside areas with exposed soils, the most cost-effective choice is to vegetate the area, preferably with a mulch or binder that will hold the soils in place while the vegetation is establishing. Native vegetation should be used if possible.
- If vegetation cannot be established immediately, apply temporary erosion control mats/blankets; a comma straw, or gravel as appropriate.
- If sediment is already eroded and mobilized in roadside areas, temporary controls should be installed. These may include: sediment control fences, fabric-covered triangular dikes, gravel-filled burlap bags, biobags, or hay bales staked in place.

Non-Stormwater Discharges

Field crews should be aware of non-stormwater discharges as part of their ongoing street maintenance efforts.

- Refer to SC-10 Non-Stormwater Discharges
- Identify location, time and estimated quantity of discharges.
- Notify appropriate personnel.

Training

- Train employees regarding proper street sweeping operation and street repair and maintenance.
- Instruct employees and subcontractors to ensure that measures to reduce the stormwater impacts of roadway/bridge maintenance are being followed.
- Require engineering staff and/or consulting A/E firms to address stormwater quality in new bridge designs or existing bridge retrofits.
- Use a training log or similar method to document training.
- Train employees on proper spill containment and clean up, and in identifying non-stormwater discharges.

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

- Densely populated areas or heavily used streets may require parking regulations to clear streets for cleaning.
- No currently available conventional sweeper is effective at removing oil and grease. Mechanical sweepers are not effective at removing finer sediments.
- Limitations may arise in the location of new bridges. The availability and cost of land and other economic and political factors may dictate where the placement of a new bridge will occur. Better design of the bridge to control runoff is required if it is being placed near sensitive waters.

Requirements

Costs

- The maintenance of local roads and bridges is already a consideration of most community public works or transportation departments. Therefore, the cost of pollutant reducing management practices will involve the training and equipment required to implement these new practices.
- The largest expenditures for street sweeping programs are in staffing and equipment. The capital cost for a conventional street sweeper is between $60,000 and $120,000. Newer technologies might have prices approaching $180,000. The average useful life of a conventional sweeper is about four years, and programs must budget for equipment replacement. Sweeping frequencies will determine equipment life, so programs that sweep more often should expect to have a higher cost of replacement.
- A street sweeping program may require the following.
  - Sweeper operators, maintenance, supervisory, and administrative personnel are required.
  - Traffic control officers may be required to enforce parking restrictions.
  - Skillful design of cleaning routes is required for program to be productive.
  - Arrangements must be made for disposal of collected wastes.

- If investing in newer technologies, training for operators must be included in operation and maintenance budgets. Costs for public education are small, and mostly deal with the need to obey parking restrictions and litter control. Parking tickets are an effective reminder to obey parking rules, as well as being a source of revenue.

Maintenance
- Not applicable

Supplemental Information
Further Detail of the BMP
Street sweeping

There are advantages and disadvantages to the two common types of sweepers. The best choice depends on your specific conditions. Many communities find it useful to have a compliment of both types in their fleet.

Mechanical Broom Sweepers - More effective at picking up large debris and cleaning wet streets. Less costly to purchase and operate. Create more airborne dust.

Vacuum Sweepers - More effective at removing fine particles and associated heavy metals. Ineffective at cleaning wet streets. Noisier than mechanical broom sweepers which may restrict areas or times of operation. May require an advance vehicle to remove large debris.

Street Flushers - Not affected by biggest interference to cleaning, parked cars. May remove finer sediments, moving them toward the gutter and stormwater inlets. For this reason, flushing fell out of favor and is now used primarily after sweeping. Flushing may be effective for combined sewer systems. Presently street flushing is not allowed under most NPDES permits.

Cross-Media Transfer of Pollutants

The California Air Resources Board (ARB) has established state ambient air quality standards including a standard for respirable particulate matter (less than or equal to 10 microns in diameter, symbolized as PM10). In the effort to sweep up finer sediments to remove attached heavy metals, municipalities should be aware that fine dust, that cannot be captured by the sweeping equipment and becomes airborne, could lead to issues of worker and public safety.

Bridges

Bridges that carry vehicular traffic generate some of the more direct discharges of runoff to surface waters. Bridge scupper drains cause a direct discharge of stormwater into receiving waters and have been shown to carry relatively high concentrations of pollutants. Bridge maintenance also generates wastes that may be either directly deposited to the water below or carried to the receiving water by stormwater. The following steps will help reduce the stormwater impacts of bridge maintenance:

- Site new bridges so that significant adverse impacts to wetlands, sensitive areas, critical habitat, and riparian vegetation are minimized.

- Design new bridges to avoid the use of scupper drains and route runoff to land for treatment control. Existing scupper drains should be cleaned on a regular basis to avoid sediment/debris accumulation.

- Reduce the discharge of pollutants to surface waters during maintenance by using suspended traps, vacuums, or booms in the water to capture paint, rust, and paint removing agents. Many of these wastes may be hazardous. Properly dispose of this waste by referring to CA21 (Hazardous Waste Management) in the Construction Handbook.

- Train employees and subcontractors to reduce the discharge of wastes during bridge maintenance.

De-icing

- Do not over-apply deicing salt and sand, and routinely calibrate spreaders.

- Near reservoirs, restrict the application of deicing salt and redirect any runoff away from reservoirs.

- Consider using alternative deicing agents (less toxic, biodegradable, etc.).

References and Resources

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.

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United States Environmental Protection Agency (USEPA). 2002. Pollution Prevention/Good Housekeeping for Municipal Operations Roadway and Bridge Maintenance. On-line http://www.epa.gov/npdes/menuofbmps/poll_13.htm

Objectives

- Contain
- Educate
- Reduce/Minimize
- Product Substitution

Targeted Constituents

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

Description

Landscape maintenance activities include vegetation removal; herbicide and insecticide application; fertilizer application; watering; and other gardening and lawn care practices. Vegetation control typically involves a combination of chemical (herbicide) application and mechanical methods. All of these maintenance practices have the potential to contribute pollutants to the storm drain system. The major objectives of this BMP are to minimize the discharge of pesticides, herbicides and fertilizers to the storm drain system and receiving waters; prevent the disposal of landscape waste into the storm drain system by collecting and properly disposing of clippings and cuttings, and educating employees and the public.

Approach

Pollution Prevention

- Implement an integrated pest management (IPM) program. IPM is a sustainable approach to managing pests by combining biological, cultural, physical, and chemical tools.
- Choose low water using flowers, trees, shrubs, and groundcover.
- Consider alternative landscaping techniques such as naturescaping and xeriscaping.
- Conduct appropriate maintenance (i.e. properly timed fertilizing, weeding, pest control, and pruning) to help preserve the landscapes water efficiency.

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- Consider grass cycling (grass cycling is the natural recycling of grass by leaving the clippings on the lawn when mowing. Grass clippings decompose quickly and release valuable nutrients back into the lawn).

Suggested Protocols

Mowing, Trimming, and Weeding

- Whenever possible use mechanical methods of vegetation removal (e.g mowing with tractor-type or push mowers, hand cutting with gas or electric powered weed trimmers) rather than applying herbicides. Use hand weeding where practical.

- Avoid loosening the soil when conducting mechanical or manual weed control, this could lead to erosion. Use mulch or other erosion control measures when soils are exposed.

- Performing mowing at optimal times. Mowing should not be performed if significant rain events are predicted.

- Mulching mowers may be recommended for certain flat areas. Other techniques may be employed to minimize mowing such as selective vegetative planting using low maintenance grasses and shrubs.

- Collect lawn and garden clippings, pruning waste, tree trimmings, and weeds. Chip if necessary, and compost or dispose of at a landfill (see waste management section of this fact sheet).

- Place temporarily stockpiled material away from watercourses, and berm or cover stockpiles to prevent material releases to storm drains.

Planting

- Determine existing native vegetation features (location, species, size, function, importance) and consider the feasibility of protecting them. Consider elements such as their effect on drainage and erosion, hardiness, maintenance requirements, and possible conflicts between preserving vegetation and the resulting maintenance needs.

- Retain and/or plant selected native vegetation whose features are determined to be beneficial, where feasible. Native vegetation usually requires less maintenance (e.g., irrigation, fertilizer) than planting new vegetation.

- Consider using low water use groundcovers when planting or replanting.

Waste Management

- Compost leaves, sticks, or other collected vegetation or dispose of at a permitted landfill. Do not dispose of collected vegetation into waterways or storm drainage systems.

- Place temporarily stockpiled material away from watercourses and storm drain inlets, and berm or cover stockpiles to prevent material releases to the storm drain system.

- Reduce the use of high nitrogen fertilizers that produce excess growth requiring more frequent mowing or trimming.

- Avoid landscape wastes in and around storm drain inlets by either using bagging equipment or by manually picking up the material.

Irrigation

- Where practical, use automatic timers to minimize runoff.

- Use popup sprinkler heads in areas with a lot of activity or where there is a chance the pipes may be broken. Consider the use of mechanisms that reduce water flow to sprinkler heads if broken.

- Ensure that there is no runoff from the landscaped area(s) if re-claimed water is used for irrigation.

- If bailing of muddy water is required (e.g. when repairing a water line leak), do not put it in the storm drain; pour over landscaped areas.

- Irrigate slowly or pulse irrigate to prevent runoff and then only irrigate as much as is needed.

- Apply water at rates that do not exceed the infiltration rate of the soil.

Fertilizer and Pesticide Management

- Utilize a comprehensive management system that incorporates integrated pest management (IPM) techniques. There are many methods and types of IPM, including the following:

  - Mulching can be used to prevent weeds where turf is absent, fencing installed to keep rodents out, and netting used to keep birds and insects away from leaves and fruit.

  - Visible insects can be removed by hand (with gloves or tweezers) and placed in soapy water or vegetable oil. Alternatively, insects can be sprayed off the plant with water or in some cases vacuumed off of larger plants.

  - Store-bought traps, such as species-specific, pheromone-based traps or colored sticky cards, can be used.

  - Slugs can be trapped in small cups filled with beer that are set in the ground so the slugs can get in easily.

  - In cases where microscopic parasites, such as bacteria and fungi, are causing damage to plants, the affected plant material can be removed and disposed of (pruning equipment should be disinfected with bleach to prevent spreading the disease organism).

  - Small mammals and birds can be excluded using fences, netting, tree trunk guards.

  - Beneficial organisms, such as bats, birds, green lacewings, ladybugs, praying mantis, ground beetles, parasitic nematodes, trichogramma wasps, seed head weevils, and spiders that prey on detrimental pest species can be promoted.

- Follow all federal, state, and local laws and regulations governing the use, storage, and disposal of fertilizers and pesticides and training of applicators and pest control advisors.

- Use pesticides only if there is an actual pest problem (not on a regular preventative schedule).
- Do not use pesticides if rain is expected. Apply pesticides only when wind speeds are low (less than 5 mph).
- Do not mix or prepare pesticides for application near storm drains.
- Prepare the minimum amount of pesticide needed for the job and use the lowest rate that will effectively control the pest.
- Employ techniques to minimize off-target application (e.g. spray drift) of pesticides, including consideration of alternative application techniques.
- Fertilizers should be worked into the soil rather than dumped or broadcast onto the surface.
- Calibrate fertilizer and pesticide application equipment to avoid excessive application.
- Periodically test soils for determining proper fertilizer use.
- Sweep pavement and sidewalk if fertilizer is spilled on these surfaces before applying irrigation water.
- Purchase only the amount of pesticide that you can reasonably use in a given time period (month or year depending on the product).
- Triple rinse containers, and use rinse water as product. Dispose of unused pesticide as hazardous waste.
- Dispose of empty pesticide containers according to the instructions on the container label.

Inspection

- Inspect irrigation system periodically to ensure that the right amount of water is being applied and that excessive runoff is not occurring. Minimize excess watering, and repair leaks in the irrigation system as soon as they are observed.
- Inspect pesticide/fertilizer equipment and transportation vehicles daily.

Training

- Educate and train employees on use of pesticides and in pesticide application techniques to prevent pollution. Pesticide application must be under the supervision of a California qualified pesticide applicator.
- Train/encourage municipal maintenance crews to use IPM techniques for managing public green areas.
- Annually train employees within departments responsible for pesticide application on the appropriate portions of the agency's IPM Policy, SOPs, and BMPs, and the latest IPM techniques.

- Employees who are not authorized and trained to apply pesticides should be periodically (at least annually) informed that they cannot use over-the-counter pesticides in or around the workplace.

- Use a training log or similar method to document training.

Spill Response and Prevention

- Refer to SC-11, Spill Prevention, Control & Cleanup

- Have spill cleanup materials readily available and in a know in location

- Cleanup spills immediately and use dry methods if possible.

- Properly dispose of spill cleanup material.

Other Considerations

- The Federal Pesticide, Fungicide, and Rodenticide Act and California Title 3, Division 6, Pesticides and Pest Control Operations place strict controls over pesticide application and handling and specify training, annual refresher, and testing requirements. The regulations generally cover: a list of approved pesticides and selected uses, updated regularly; general application information; equipment use and maintenance procedures; and record keeping. The California Department of Pesticide Regulations and the County Agricultural Commission coordinate and maintain the licensing and certification programs. All public agency employees who apply pesticides and herbicides in "agricultural use" areas such as parks, golf courses, rights-of-way and recreation areas should be properly certified in accordance with state regulations. Contracts for landscape maintenance should include similar requirements.

- All employees who handle pesticides should be familiar with the most recent material safety data sheet (MSDS) files.

- Municipalities do not have the authority to regulate the use of pesticides by school districts, however the California Healthy Schools Act of 2000 (AB 2260) has imposed requirements on California school districts regarding pesticide use in schools. Posting of notification prior to the application of pesticides is now required, and IPM is stated as the preferred approach to pest management in schools.

Requirements

Costs

Additional training of municipal employees will be required to address IPM techniques and BMPs. IPM methods will likely increase labor cost for pest control which may be offset by lower chemical costs.

Maintenance

Not applicable

Supplemental Information

Further Detail of the BMP

Waste Management

Composting is one of the better disposal alternatives if locally available. Most municipalities either have or are planning yard waste composting facilities as a means of reducing the amount of waste going to the landfill. Lawn clippings from municipal maintenance programs as well as private sources would probably be compatible with most composting facilities

Contractors and Other Pesticide Users

Municipal agencies should develop and implement a process to ensure that any contractor employed to conduct pest control and pesticide application on municipal property engages in pest control methods consistent with the IPM Policy adopted by the agency. Specifically, municipalities should require contractors to follow the agency's IPM policy, SOPs, and BMPs; provide evidence to the agency of having received training on current IPM techniques when feasible; provide documentation of pesticide use on agency property to the agency in a timely manner.

References and Resources

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Los Angeles County Stormwater Quality Model Programs. Public Agency Activities http://ladpw.org/wmd/npdes/model_links.cfm

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United States Environmental Protection Agency (USEPA). 2002. Pollution Prevention/Good Housekeeping for Municipal Operations Landscaping and Lawn Care. Office of Water. Office of Wastewater Management. On-line: http://www.epa.gov/npdes/menuofbmps/poll_8.htm

Drainage System Maintenance SC-74

Photo Credit: Geoff Brosseau

Objectives

- Contain
- Educate
- Reduce/Minimize

Targeted Constituents

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

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.

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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 steam 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.

- 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 vactor 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 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 we 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 steam 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.

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 he 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 aid watershed instability arid 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.

References and Resources

Ferguson, B.K. 1991. Urban Stream Reclamation, p. 324-322, Journal of Soil and Water Conservation.

Los Angeles County Stormwater Quality. Public Agency Activities Model Program. On-line: http://ladpw.org/wmd/npdes/public_TC.cfm

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.

Orange County Stormwater Program http://www.ocwatersheds.com/StormWater/swp_introduction.asp

Santa Clara Valley Urban Runoff Pollution Prevention Program. 1997 Urban Runoff Management Plan. September 1997, updated October 2000.

San Diego Stormwater Co-permittees Jurisdictional Urban Runoff Management Program (URMP) Municipal Activities Model Program Guidance. 2001. Project Clean Water. November.

United States Environmental Protection Agency (USEPA). 1999. Stormwater Management Fact Sheet Non-stormwater Discharges to Storm Sewers. EPA 832-F-99-022. Office of Water, Washington, D.C. September.

United States Environmental Protection Agency (USEPA). 1999. Stormwater O&M Fact Sheet Catch Basin Cleaning. EPA 832-F-99-011. Office of Water, Washington, D.C. September.

United States Environmental Protection Agency (USEPA). 2002. Pollution Prevention/Good Housekeeping for Municipal Operations Illegal Dumping Control. On line: http://www.epa.gov/npdes/menuofbmps/poll_7.htm

United States Environmental Protection Agency (USEPA). 2002. Pollution Prevention/Good Housekeeping for Municipal Operations Storm Drain System Cleaning. On line: http://www.epa.gov/npdes/menuofbmps/poll_16.htm

Design Objectives

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

Description

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

Approach

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

Suitable Applications

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

Design Considerations

Designing New Installations

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

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

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

Redeveloping Existing Installations

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

Other Resources

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

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

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

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

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.

Appendix F.

Biotreatment BMP Fact Sheets

XIV.5. Biotreatment BMP Fact Sheets (BIO)

Conceptual criteria for biotreatment BMP selection, design, and maintenance are contained in **Appendix XII**. These criteria are generally applicable to the design of biotreatment BMPs in Orange County and BMP-specific guidance is provided in the following fact sheets. [24]

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

BIO-1: Bioretention with Underdrains

Also known as:

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

Bioretention
Source: Geosyntec Consultants

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

Feasibility Screening Considerations

- If there are no hazards associated with infiltration (such as groundwater concerns, contaminant plumes or geotechnical concerns), **bioinfiltration facilities**, which achieve partial infiltration, should be used to maximize infiltration.

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[24] Not all BMPs presented in this section are considered "biofiltration BMPs" under the South Orange County Permit Area. Biofiltration BMPs are vegetated treat-and-release BMPs that filter stormwater through amended soil media that is biologically active, support plant growth, and also promote infiltration and/or evapotranspiration. For projects in South Orange County, the total volume of storage in surface ponding and pores spaces is required to be at least 75% of the remaining DCV that the biofiltration BMP is designed to address. This prevents significant down-sizing of BMPs which otherwise may be possible via routing calculations. Biotreatment BMPs that do not meet this definition are not considered to be LID BMPs, but may be used as treatment control or pre-treatment BMPs. See Section III.7 and Worksheet SOC-1 for guidance.

- Bioretention with underdrain facilities should be lined if contaminant plumes or geotechnical concerns exist. If high groundwater is the reason for infiltration infeasibility, bioretention facilities with underdrains do not need to be lined.

Opportunity Criteria

- Land use may include commercial, residential, mixed use, institutional, and subdivisions. Bioretention may also be applied in parking lot islands, cul-de-sacs, traffic circles, road shoulders, road medians, and next to buildings in planter boxes.
- Drainage area is ≤ 5 acres.
- Area is available for infiltration.
- Site must have adequate relief between land surface and the stormwater conveyance system to permit vertical percolation through the soil media and collection and conveyance in underdrain to stormwater conveyance system.

OC-Specific Design Criteria and Considerations

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

Simple Sizing Method for Bioretention with Underdrain

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

Step 1: Determine DCV

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

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

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

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

Where:

DD_P = time to drain ponded water, hours

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

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

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

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

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

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

Where:

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

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

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

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

Step 4: Determine the Facility Surface Area

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

Where:

A = required area of bioretention facility, sq-ft

DCV = design capture volume, cu-ft

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

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

In South Orange County, the provided ponding plus pore volume must be checked to demonstrate that it is greater than 0.75 of the remaining DCV that this BMP is designed to address. See Section III.7 and Worksheet SOC-1.

Capture Efficiency Method for Bioretention with Underdrains

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

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

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

Where:

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

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

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

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

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

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

Step 3: Determine the Basin Infiltrating Area Needed

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

A = Design Volume / d_p

Where:

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

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

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

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

In South Orange County, the provided ponding plus pore volume must be checked to demonstrate that it is greater than 0.75 of the remaining DCV that this BMP is designed to address. See Section III.7 and Worksheet SOC-1.

Configuration for Use in a Treatment Train

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

Additional References for Design Guidance

- CASQA BMP Handbook for New and Redevelopment: http://www.cabmphandbooks.com/Documents/Development/TC-32.pdf

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

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

BIO-7: Proprietary Biotreatment

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

Also known as:

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

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

Feasibility Screening Considerations

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

Opportunity Criteria

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

OC-Specific Design Criteria and Considerations

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

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

Computing Sizing Criteria for Proprietary Biotreatment Device

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

In South Orange County, the provided ponding plus pore volume must be checked to demonstrate that it is greater than 0.75 of the remaining DCV that this BMP is designed to address. Many propretary biotreatment BMPs will not be able to meet the definition of "biofiltration" that applies in South Orange County. See Section III.7 and Worksheet SOC-1.

Additional References for Design Guidance

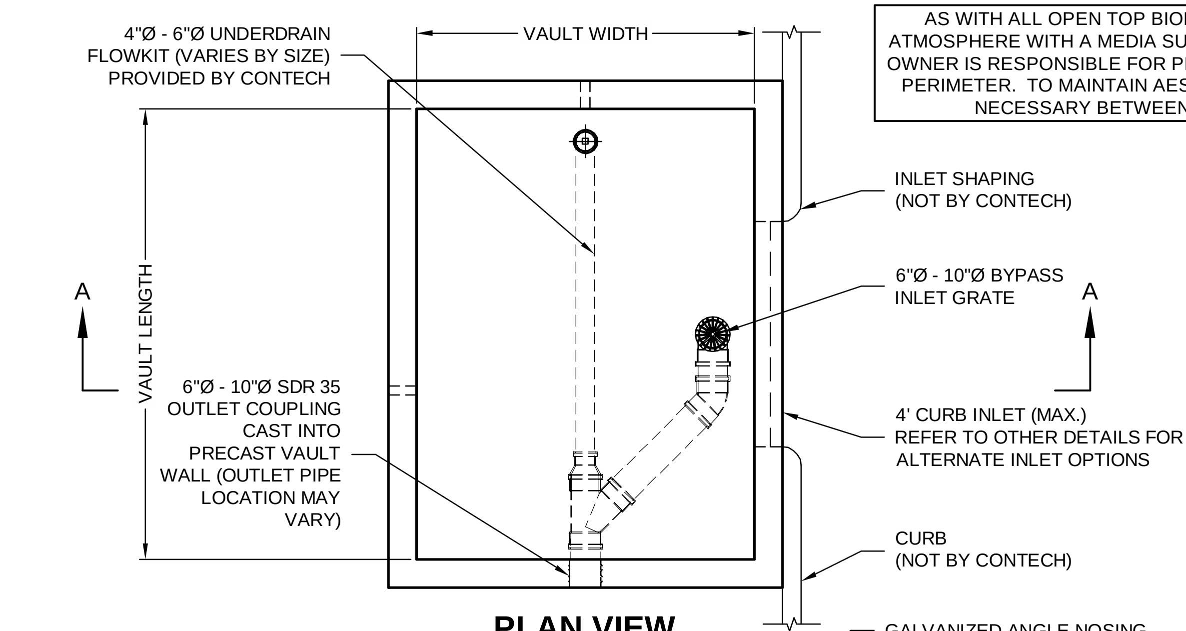
- Los Angeles Unified School District (LAUSD) Stormwater Technical Manual, Chapter 4: **http://www.laschools.org/employee/design/fs-studies-and-reports/download/white_paper_report_material/Storm_Water_Technical_Manual_2009-opt-red.pdf?version_id=76975850**
- Los Angeles County Stormwater BMP Design and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

Appendix G.

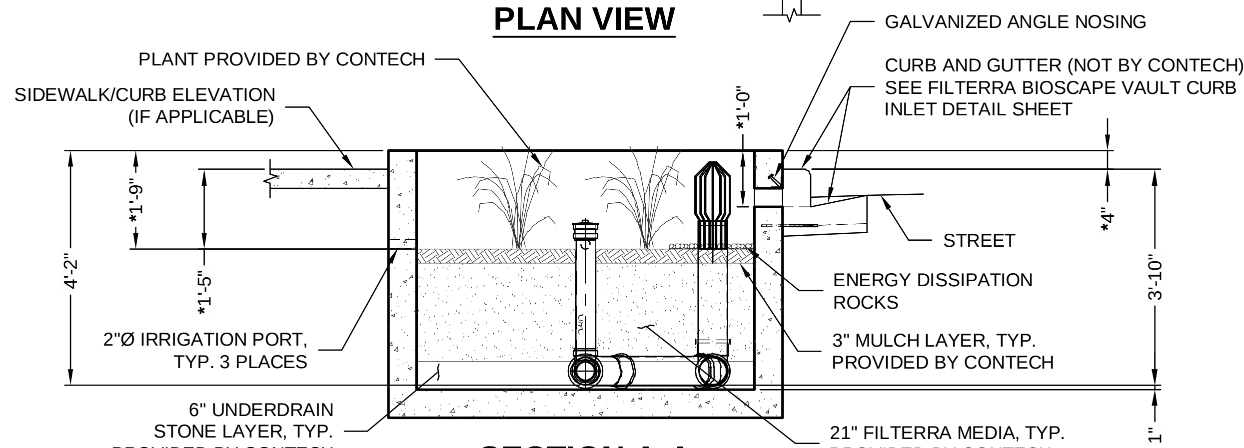
Contech Filterra Details

DIMENSIONS PRECEDED BY " * " ARE CRITICAL AND MAY NOT BE MODIFIED WITHOUT CONSULTING CONTECH

AS WITH ALL OPEN TOP BIORETENTION SYSTEMS, FILTERRA BIOSCAPE IS OPEN TO THE ATMOSPHERE WITH A MEDIA SURFACE RECESSED BELOW FINISHED GRADE. CONTRACTOR OR OWNER IS RESPONSIBLE FOR PROVIDING ANY REQUIRED SAFETY MEASURES AROUND SYSTEM PERIMETER. TO MAINTAIN AESTHETICS, REMOVAL OF HEAVY STORMWATER DEBRIS MAY BE NECESSARY BETWEEN REGULAR FILTERRA SYSTEM MAINTENANCE EVENTS.

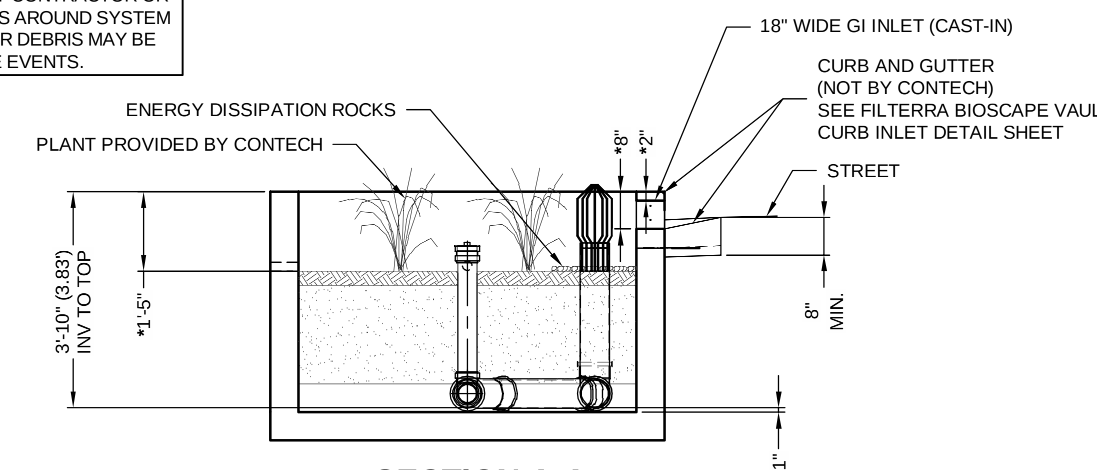


PLAN VIEW



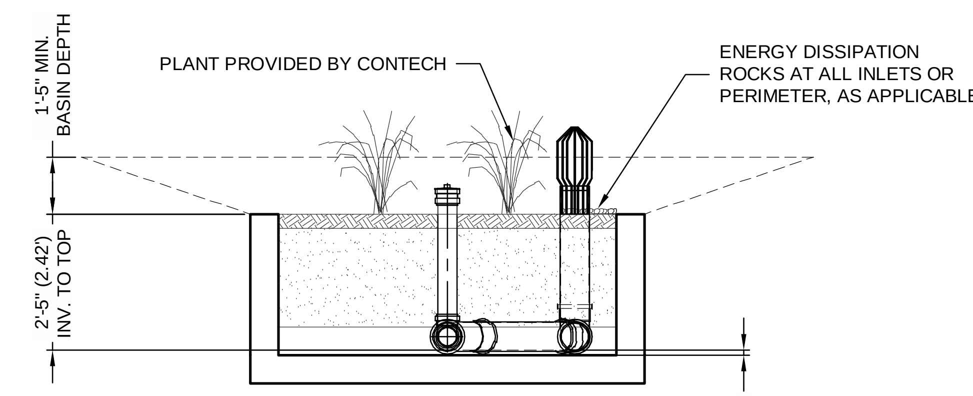
SECTION A-A

(SLOTTED THROAT INLET - TOP EXTENDS 4" ABOVE CURB FOR ADJACENT SIDEWALKS)



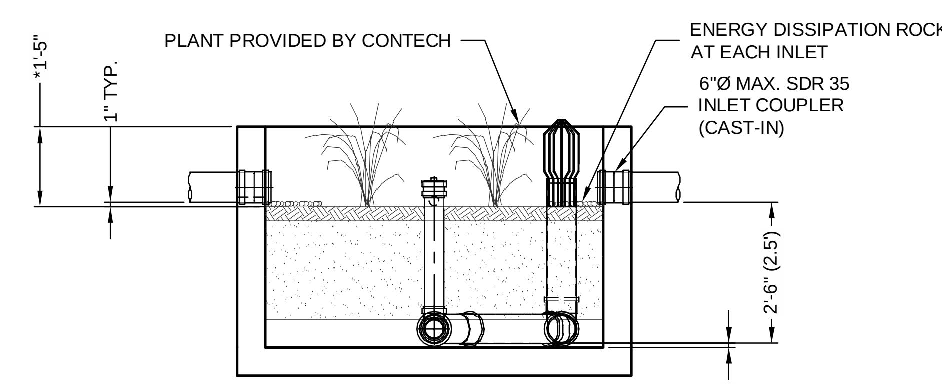
SECTION A-A

GREEN INFRASTRUCTURE INLET - TOP FLUSH WITH TOP OF CURB, NOT INTENDED FOR SIDEWALK APPLICATIONS



SECTION A-A

BASIN - CURB INLET OR PIPE INLETS OPTIONAL



SECTION A-A

PIPE INLET

INTERNAL PIPE CONFIGURATION MAY VARY DEPENDING ON VAULT SIZE.

FTBSVIB CONFIGURATION

(OPTIONS: BASIN "-B", GREEN INFRASTRUCTURE INLET "-I", PIPE INLET "-P", SLOTTED THROAT INLET "-T")

MEDIA BAY SIZE	VAULT SIZE (L x W)	LONG SIDE INLET DESIGNATION	SHORT SIDE INLET DESIGNATION	AVAILABILITY	MAX. OUTLET / BYPASS PIPE DIA.	MAX. BYPASS FLOW (CFS)	UNDERDRAIN PIPE DIA. (PERF)	MIN. NO. OF INLET PIPES (-P ONLY)
4 x 4	4 x 4	FTBSVIB0404	FTBSVIB0404	ALL	6" SDR 35	1.42	4" SDR 35	1
6 x 4	6 x 4	FTBSVIB0604	FTBSVIB0406	ALL	8" SDR 35	1.89	4" SDR 35	1
7.83 x 4.5	7.83 x 4.5	FTBSVIB078045	FTBSVIB045078	DE,MD,NJ,PA,VA,WV ONLY	8" SDR 35	1.89	4" SDR 35	1
8 x 4	8 x 4	FTBSVIB0804	FTBSVIB0408	N/A DE,MD,NJ,PA,VA,WV	8" SDR 35	1.89	4" SDR 35	1
6 x 6	6 x 6	FTBSVIB0606	FTBSVIB0606	ALL	8" SDR 35	1.89	4" SDR 35	1
8 x 6	8 x 6	FTBSVIB0806	FTBSVIB0608	ALL	10" SDR 35	2.37	4" SDR 35	1
10 x 6	10 x 6	FTBSVIB1006	FTBSVIB0610	ALL	10" SDR 35	2.37	6" SDR 35	2
12 x 6	12 x 6	FTBSVIB1206	FTBSVIB0612	ALL	10" SDR 35	2.37	6" SDR 35	2
13 x 7	13 x 7	FTBSVIB1307	FTBSVIB0713	ALL	10" SDR 35	2.37	6" SDR 35	2
14 x 8	14 x 8	FTBSVIB1408†	N/A	ALL	10" SDR 35	2.37	6" SDR 35	3
16 x 8	16 x 8	FTBSVIB1608†	N/A	N/A OR, WA	10" SDR 35	2.37	6" SDR 35	3
15 x 9	15 x 9	FTBSVIB1509†	N/A	OR, WA ONLY	10" SDR 35	2.37	6" SDR 35	3
18 x 8	18 x 8	FTBSVIB1808†	N/A	CALL CONTECH	10" SDR 35	2.37	6" SDR 35	3
20 x 8	20 x 8	FTBSVIB2008†	N/A	CALL CONTECH	10" SDR 35	2.37	6" SDR 35	4
22 x 8	22 x 8	FTBSVIB2208†	N/A	CALL CONTECH	10" SDR 35	2.37	6" SDR 35	4

†UTILIZES (2) CURB OPENINGS WITH MIN 1' SPACING

N/A = NOT AVAILABLE

filterra

THIS PRODUCT MAY BE PROTECTED BY ONE OR MORE OF THE FOLLOWING U.S. PATENTS: 6,277,274; 6,569,321; 7,625,485; 7,425,261; 7,833,412; RELATED FOREIGN PATENTS.

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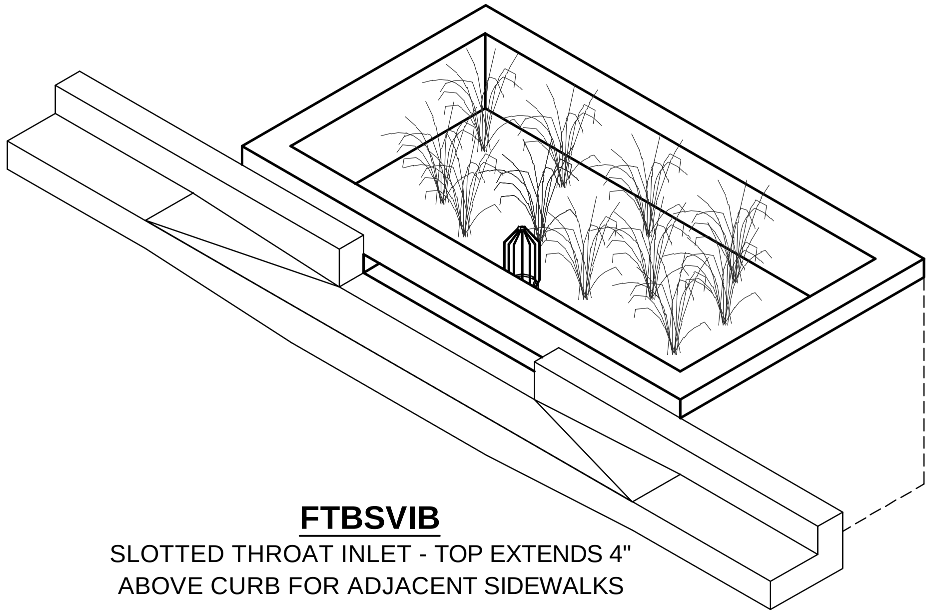
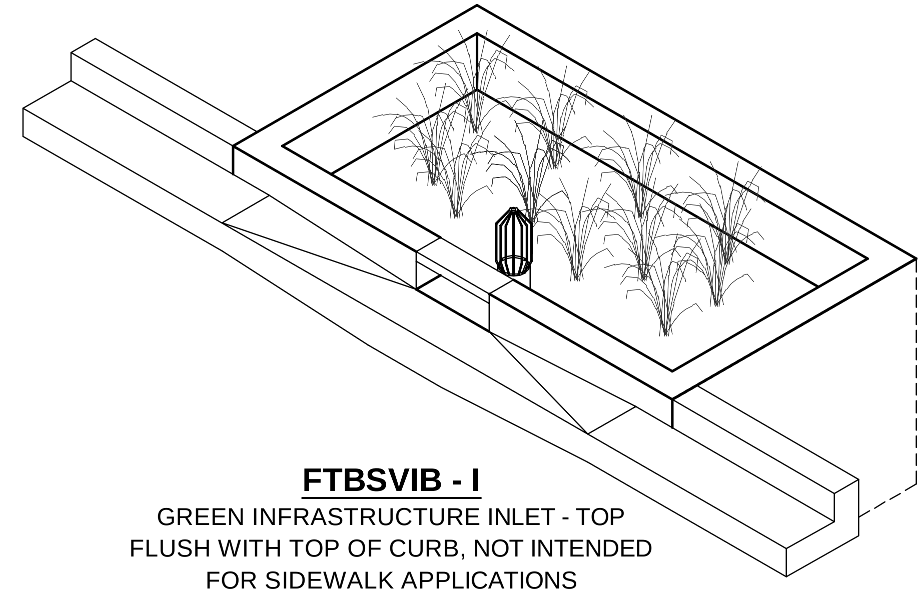
FILTERRA BIOSCAPE VAULT INTERNAL BYPASS (FTBSVIB)
CONFIGURATION DETAIL

I:\STORMWATER\COMMOPS\54 FILTERRA\40 STANDARD DRAWINGS\FTBSVIB - FILTERRA BIOSCAPE VAULT INTERNAL BYPASS\LAYOUT DETAILS\DWG\FTBSVIB - FILTERRA BIOSCAPE VAULT INTERNAL BYPASS CONFIG DTL 1.DWG 9/8/2022 10:47 AM



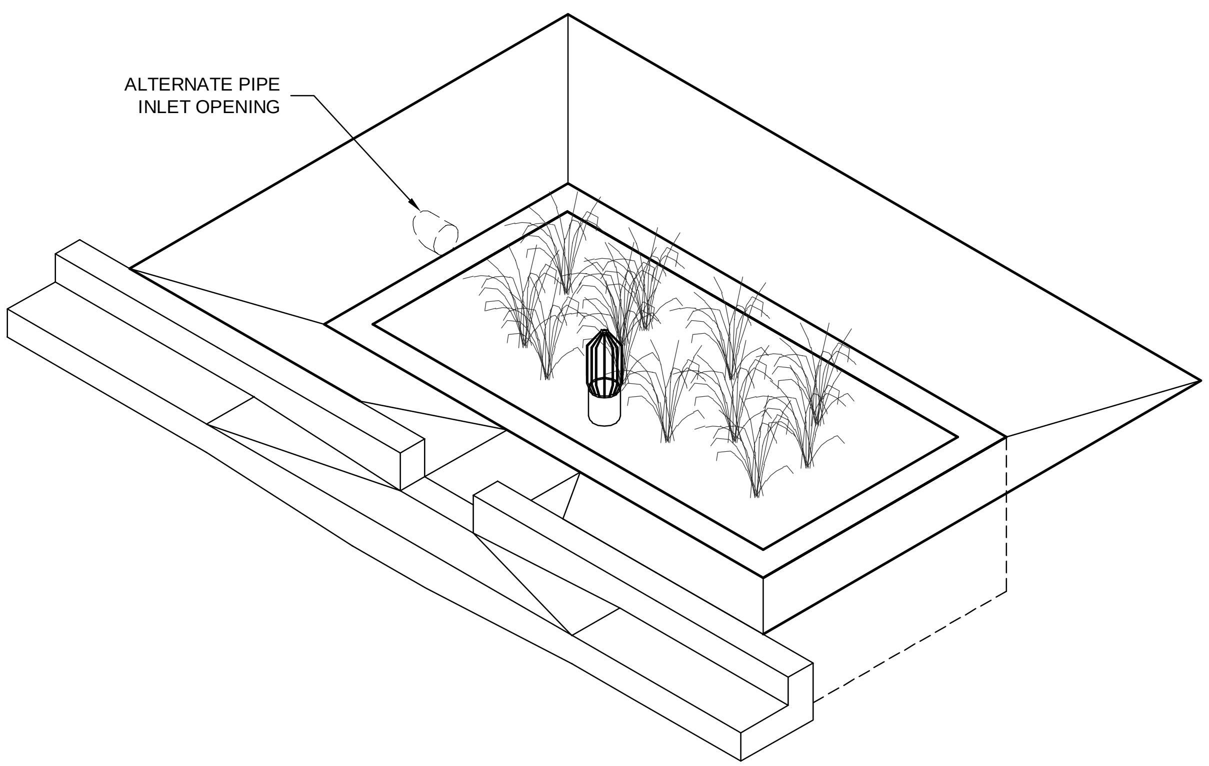
FTBSVIB

SLOTTED THROAT INLET - TOP EXTENDS 4" ABOVE CURB FOR ADJACENT SIDEWALKS



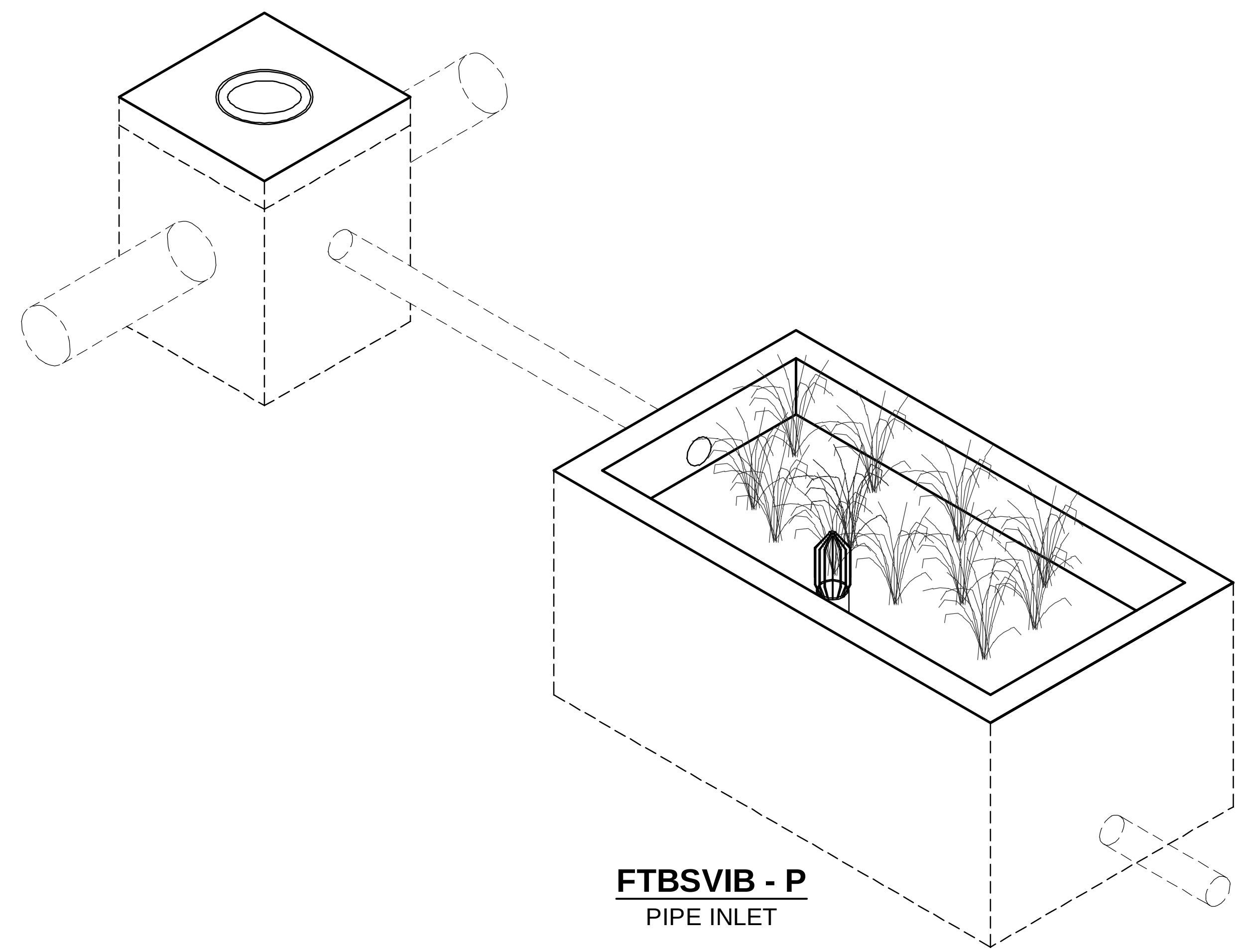
FTBSVIB - I

GREEN INFRASTRUCTURE INLET - TOP FLUSH WITH TOP OF CURB, NOT INTENDED FOR SIDEWALK APPLICATIONS



FTBSVIB - B

BASIN - CURB INLET OR PIPE INLET OPTIONAL



FTBSVIB - P

PIPE INLET

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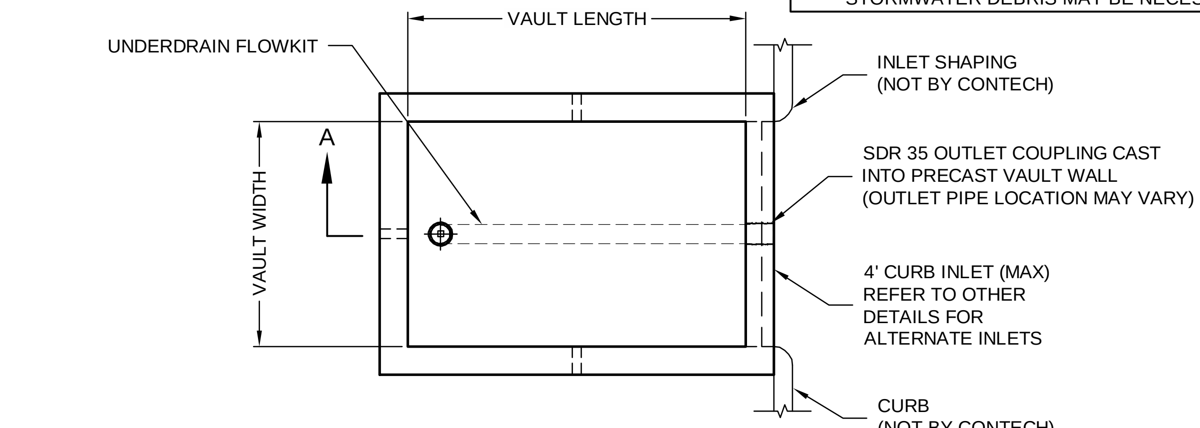
FILTERRA BIOSCAPE VAULT INTERNAL BYPASS (FTBSVIB) SITE LAYOUTS

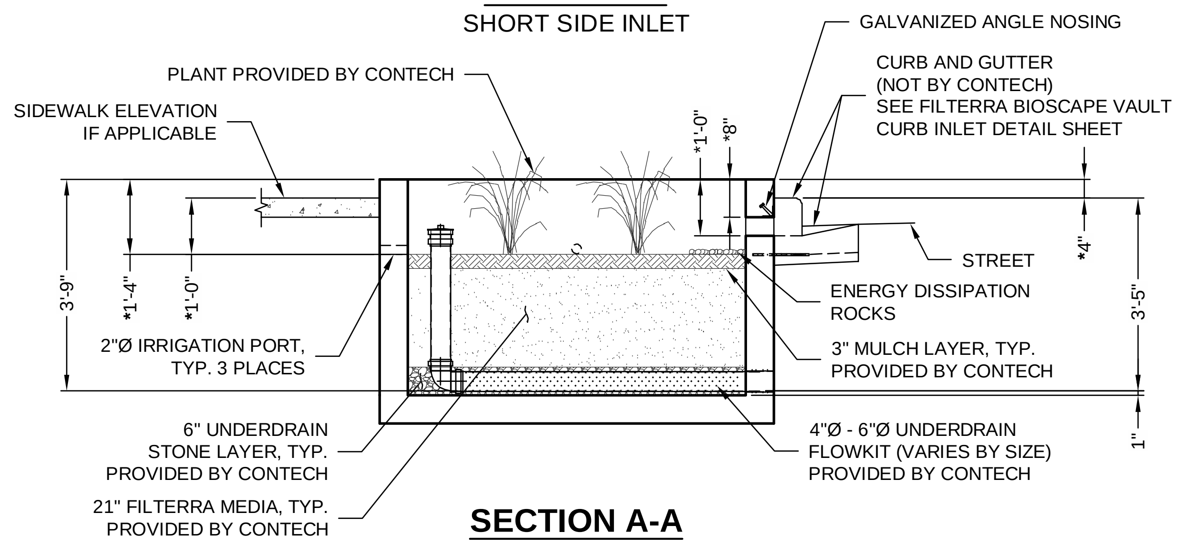
I:\STORMWATER\COMMOPS\54 FILTERRA\40 STANDARD DRAWINGS\FTBSV - FILTERRA BIOSCAPE VAULT OFFLINE\LAYOUT DETAILS\DWG\FTBSV - FILTERRA BIOSCAPE VAULT OFFLINE CONFIG DTL 1.DWG 9/8/2022 10:43 AM

DIMENSIONS PRECEDED BY " * " ARE CRITICAL AND MAY NOT BE MODIFIED WITHOUT CONSULTING CONTECH

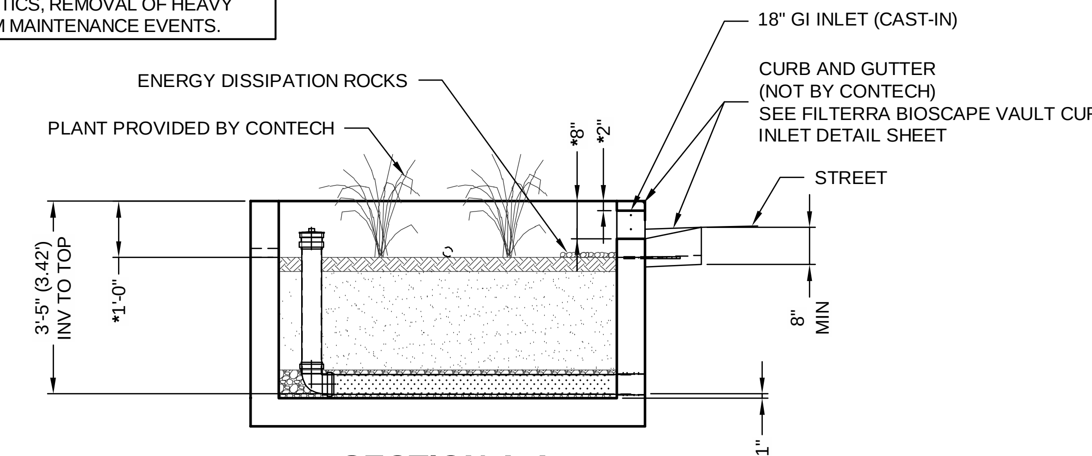
AS WITH ALL OPEN TOP BIORETENTION SYSTEMS, FILTERRA BIOSCAPE IS OPEN TO THE ATMOSPHERE WITH A MEDIA SURFACE RECESSED BELOW FINISHED GRADE. CONTRACTOR OR OWNER IS RESPONSIBLE FOR PROVIDING ANY REQUIRED SAFETY MEASURES AROUND SYSTEM PERIMETER. TO MAINTAIN AESTHETICS, REMOVAL OF HEAVY STORMWATER DEBRIS MAY BE NECESSARY BETWEEN REGULAR FILTERRA SYSTEM MAINTENANCE EVENTS.



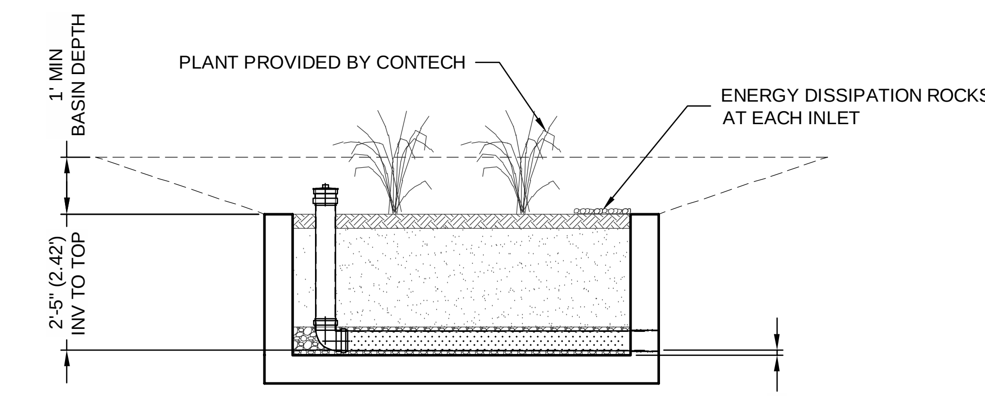
PLAN VIEW
SHORT SIDE INLET



SECTION A-A
SLOTTED THROAT INLET



SECTION A-A
GREEN INFRASTRUCTURE INLET - TOP FLUSH WITH TOP OF CURB, NOT INTENDED FOR SIDEWALK APPLICATIONS



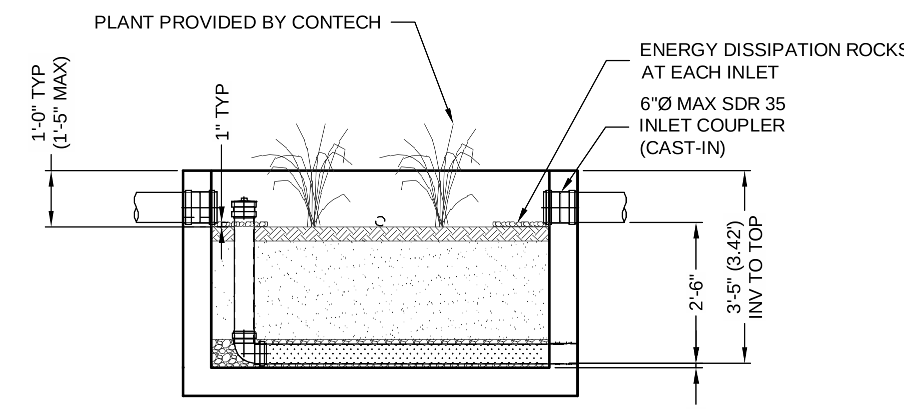
SECTION A-A
BASIN - CURB INLET OR PIPE INLETS OPTIONAL

FTBSV CONFIGURATION

(OPTIONS: BASIN "-B", GREEN INFR. INLET "-I", PIPE INLET "-P", SLOTTED THROAT INLET "-T")

MEDIA BAY SIZE	VAULT SIZE (L x W)	LONG SIDE INLET DESIGNATION	SHORT SIDE INLET DESIGNATION	AVAILABILITY	OUTLET PIPE DIA	MIN. NO. OF INLET PIPES (-P ONLY)
4 x 4	4 x 4	FTBSV0404	FTBSV0404	ALL	4" SDR 35	1
6 x 4	6 x 4	FTBSV0604	FTBSV0406	ALL	4" SDR 35	1
7.83 x 4.5	7.83 x 4.5	FTBSV078045	FTBSV045078	DE,MD,NJ,PA,VA.WV ONLY	4" SDR 35	1
8 x 4	8 x 4	FTBSV0804	FTBSV0408	N/A DE,MD,NJ,PA,VA,WV	4" SDR 35	1
6 x 6	6 x 6	FTBSV0606	FTBSV0606	ALL	4" SDR 35	1
8 x 6	8 x 6	FTBSV0806	FTBSV0608	ALL	4" SDR 35	1
10 x 6	10 x 6	FTBSV1006	FTBSV0610	ALL	6" SDR 35	2
12 x 6	12 x 6	FTBSV1206	FTBSV0612	ALL	6" SDR 35	2
13 x 7	13 x 7	FTBSV1307	FTBSV0713	ALL	6" SDR 35	2
14 x 8	14 x 8	FTBSV1408†	N/A	ALL	6" SDR 35	3
16 x 8	16 x 8	FTBSV1608†	N/A	N/A OR,WA	6" SDR 35	3
15 x 9	15 x 9	FTBSV1509†	N/A	OR,WA ONLY	6" SDR 35	3
18 x 8	18 x 8	FTBSV1808†	N/A	CALL CONTECH	6" SDR 35	3
20 x 8	20 x 8	FTBSV2008†	N/A	CALL CONTECH	6" SDR 35	4
22 x 8	22 x 8	FTBSV2208†	N/A	CALL CONTECH	6" SDR 35	4

†UTILIZES (2) CURB OPENINGS WITH MIN 1' SPACING   N/A = NOT AVAILABLE



SECTION A-A
PIPE INLET

INTERNAL PIPE CONFIGURATION MAY VARY DEPENDING ON VAULT SIZE.

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THIS PRODUCT MAY BE PROTECTED BY ONE OR MORE OF THE FOLLOWING U.S. PATENTS: 6,277,274; 6,569,321; 7,625,485; 7,425,261; 7,833,412; RELATED FOREIGN PATENTS.

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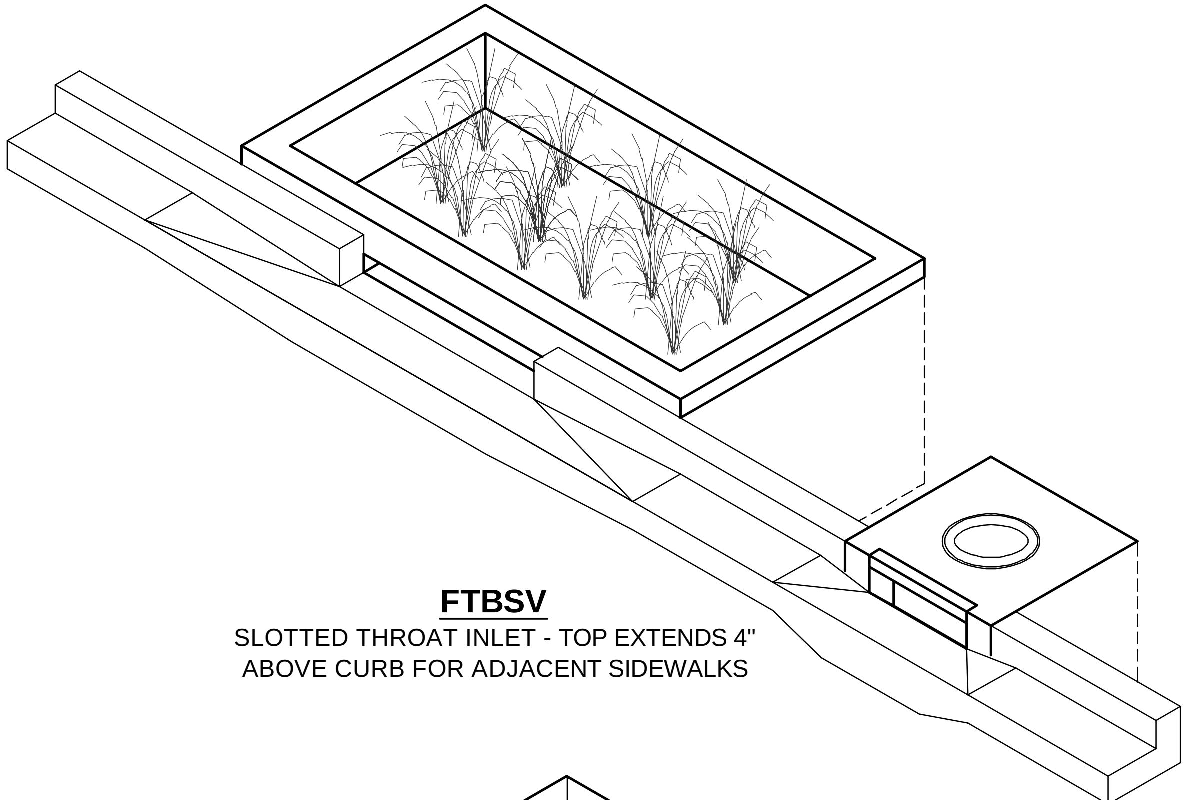
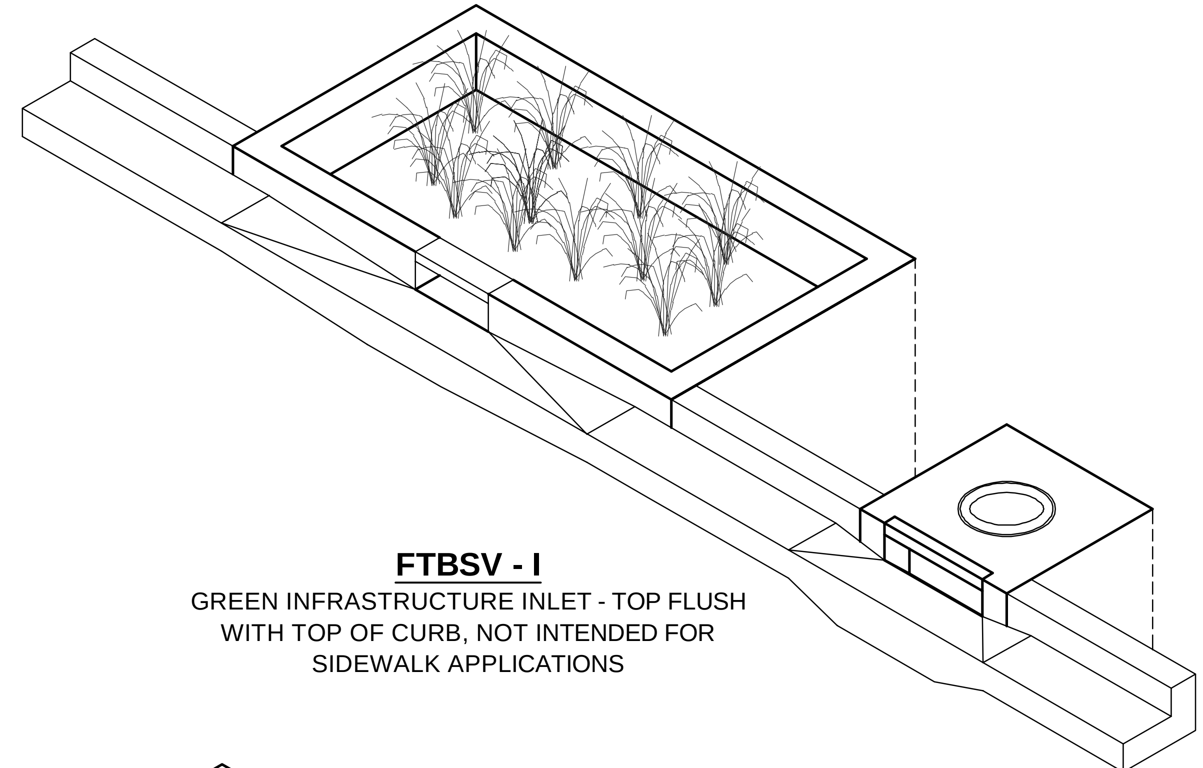
FILTERRA BIOSCAPE VAULT STANDARD OFFLINE (FTBSV)
CONFIGURATION DETAIL



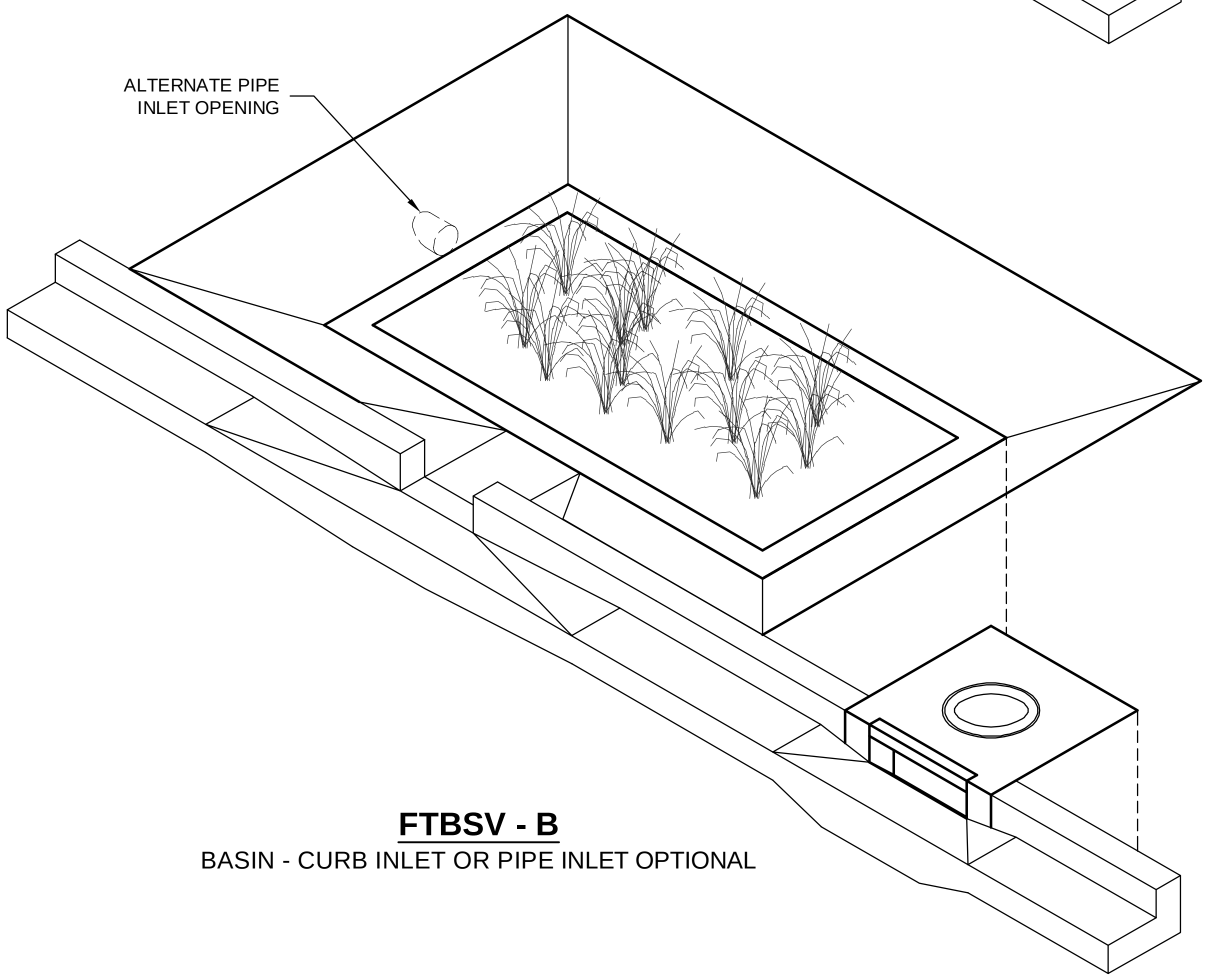
FTBSV

SLOTTED THROAT INLET - TOP EXTENDS 4" ABOVE CURB FOR ADJACENT SIDEWALKS



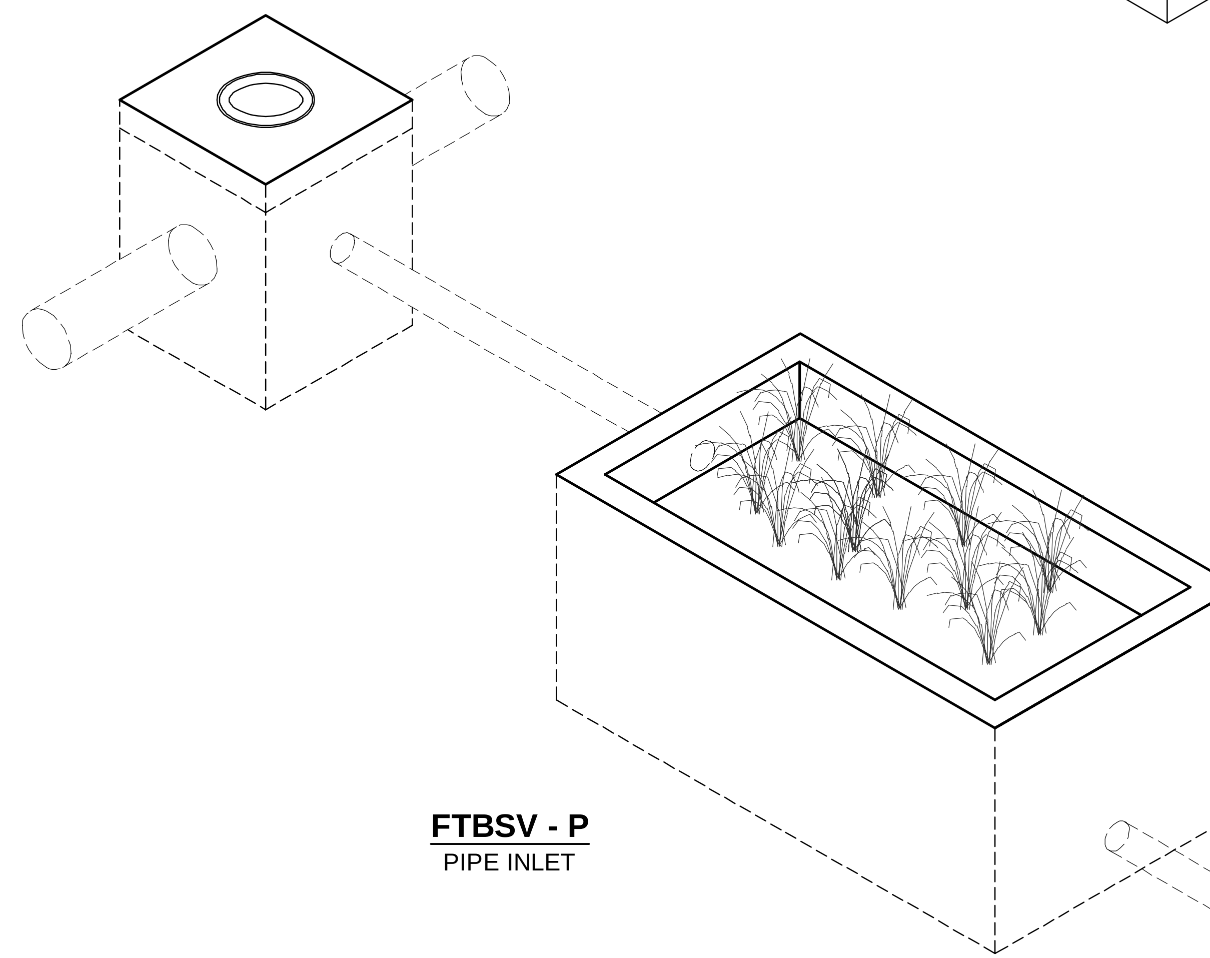
FTBSV - I

GREEN INFRASTRUCTURE INLET - TOP FLUSH WITH TOP OF CURB, NOT INTENDED FOR SIDEWALK APPLICATIONS



FTBSV - B

BASIN - CURB INLET OR PIPE INLET OPTIONAL



FTBSV - P

PIPE INLET

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FILTERRA BIOSCAPE VAULT STANDARD OFFLINE (FTBSV) SITE LAYOUT DETAIL

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