Preliminary Water Quality Management Plan
Supplemental Narrative

For

FORT BRAGG SENIOR APARTMENTS

860 HAZELWOOD STREET
FORT BRAGG, CA
APN: 018-210-29-00

Prepared for:

The Pacific Companies
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Prepared: December 2024

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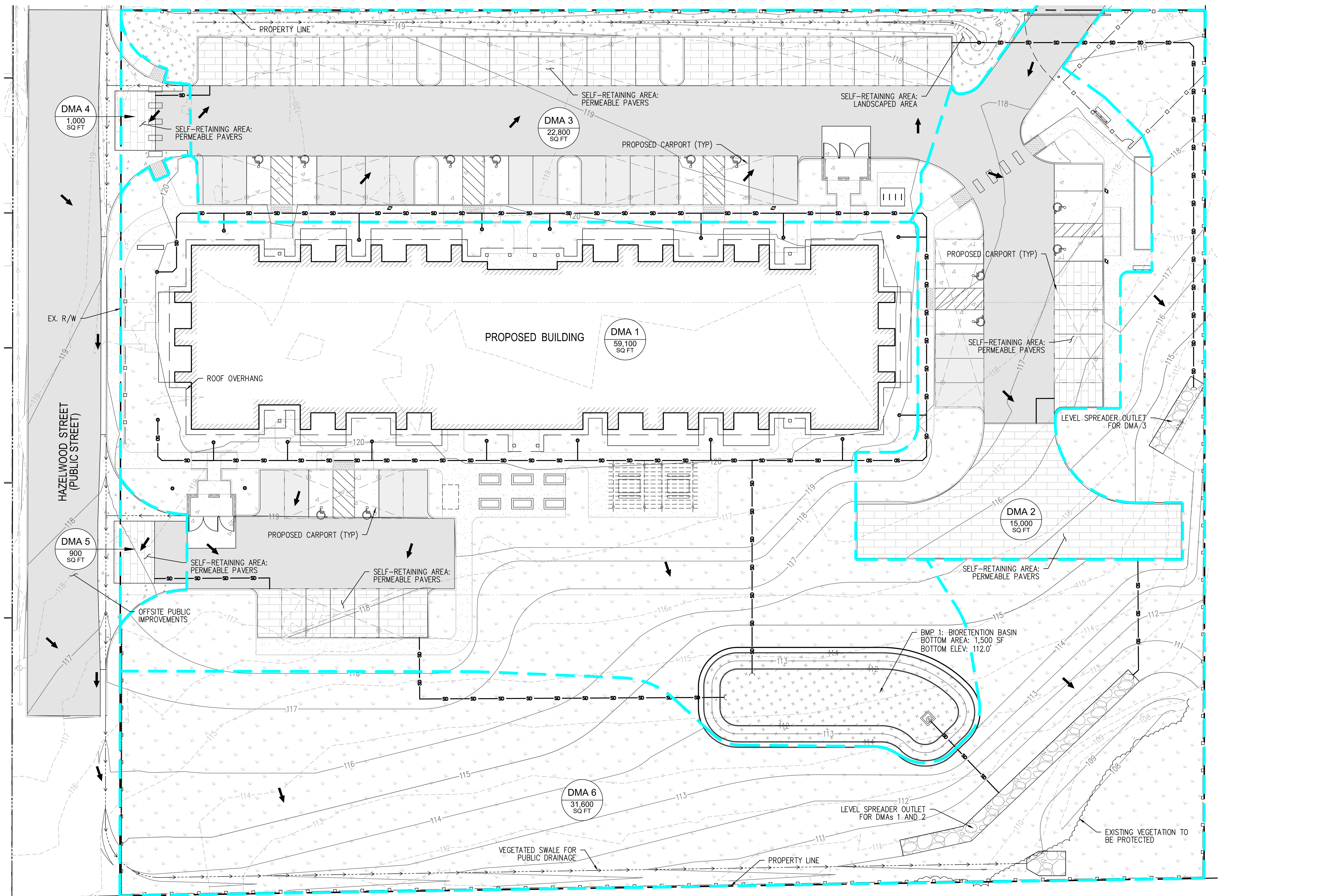


SITE INFORMATION

HYDROLOGIC SOIL GROUP: UNCLASSIFIED

DEPTH TO GROUNDWATER: APPROXIMATELY 10'–13'

FLOOD ZONE DESIGNATION: X – AREAS DETERMINED TO BE OUTSIDE THE 0.2% ANNUAL CHANCE FLOOD PLAIN PER FEMA

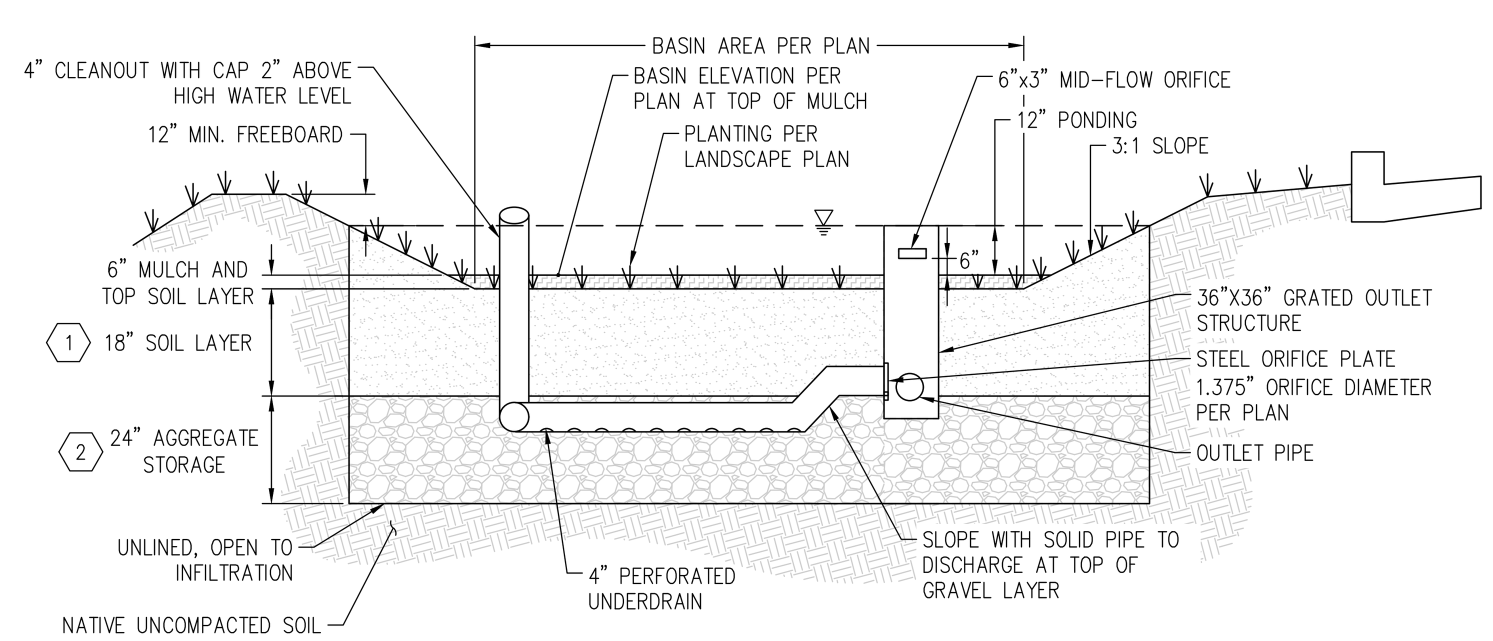
LEGEND

- DMA BOUNDARY
- PROPOSED STORM DRAIN
- PROPOSED CONTOURS
- EXISTING CONTOURS
- BUILDING FOOTPRINT
- LIGHT/HEAVY DUTY AC PAVEMENT
- VEHICULAR CONCRETE PAVEMENT
- PEDESTRIAN CONCRETE
- LANDSCAPE AREA
- PERMEABLE PAVERS
- FLOW DIRECTION
- DMA / X.X SQ FT: DMA ID; TOTAL AREA IN SQ FT

BIORETENTION BASIN NOTES:

BIORETENTION BASIN SHALL COMPLY WITH COUNTY OF MENDOCINO LOW IMPACT DEVELOPMENT STANDARDS MANUAL DATED MAY 2021, APPENDIX 5 SPECIFICATIONS, INCLUDING BUT NOT LIMITED TO:

1. SOIL LAYER SHALL COMPLY WITH THE SPECIFICATIONS OF APPENDIX 5 OF THE COUNTY OF MENDOCINO LOW IMPACT DESIGN STANDARDS MANUAL AND SHALL SUPPORT MINIMUM 5 IN/HR INFILTRATION WHEN INSTALLED.
2. GRAVEL LAYER SHALL CONSIST OF CALTRANS CLASS 2 PERMEABLE MATERIAL.



BMP 1 - BIORETENTION BASIN (PVT.)

NOT TO SCALE

N

GRAPHIC SCALE

20 0 20 40

(IN FEET)
1" = 20'

Civil Engineering • Site Optimization
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ATLAS Civil Design
San Diego • Orange County • Los Angeles • San Luis Obispo • Monterey

DATE	REVISIONS	BY

PROJECT SITE MAP
PROPOSED CONDITION
860 HAZELWOOD STREET, CITY OF FORT BRAGG, COUNTY OF MENDOCINO
STATE OF CALIFORNIA

PROJECT NUMBER: 24-043
PREPARED ON: 12/20/24
REVISED ON:
PREPARED BY: AM
CHECKED BY: LZ

SHEET 2 OF 2

THE CONTRACTOR SHALL VERIFY AND BE RESPONSIBLE FOR ALL DIMENSIONS. DO NOT SCALE THE DRAWING – ANY ERRORS OR OMISSIONS SHALL BE REPORTED TO ATLAS CIVIL DESIGN WITHOUT DELAY. THE COPYRIGHTS TO ALL DESIGNS AND DRAWINGS ARE THE PROPERTY OF ATLAS CIVIL DESIGN. REPRODUCTION OR USE FOR ANY PURPOSE OTHER THAN THAT AUTHORIZED BY ATLAS CIVIL DESIGN IS FORBIDDEN

P:\SHARED\2024\24-043 HAZELWOOD FORT BRAGG\CIVIL\REPORTS\HYDROLOGY\APPENDIX A – PROJECT SITE MAP\24-043 PSM – PROPOSED CONDITION.DWG – PLOT DATE: December 20, 2024

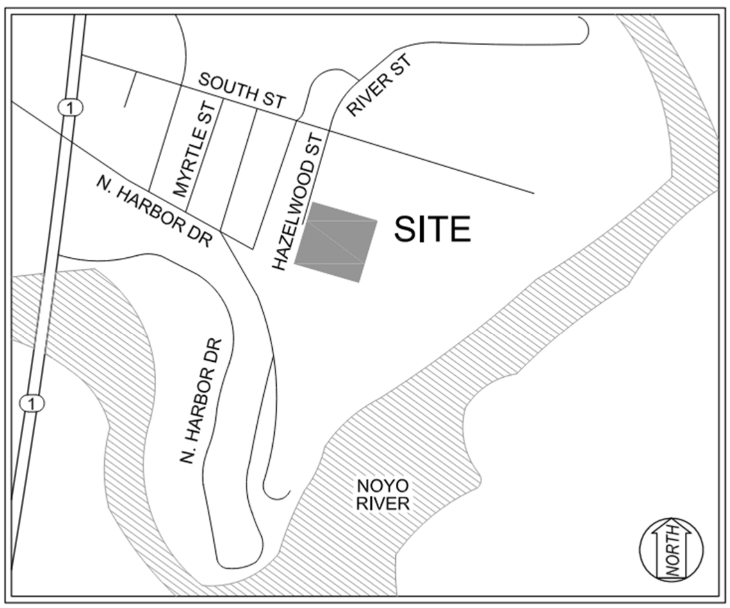
I. PROJECT SUMMARY

Purpose

This narrative accompanies the Stormwater Control Plan for the Fort Bragg Senior Apartments project, prepared on the template per the County of Mendocino Low Impact Development Standards Manual, dated May 2021. The purpose is to provide additional information to demonstrate compliance with applicable stormwater requirements as set forth in the Phase II Small MS4 General Permit, WQ Order No. 2013-0001-DWQ, NPDES No. CAS000004, and its subsequent amendments. The City of Fort Bragg utilizes the County of Mendocino Low Impact Development Standards Manual to ensure compliance with MS4 requirements.

Project Description

The project is located at 860 Hazelwood Street in the City of Fort Bragg within Mendocino County in the State of California. The 2.99-acre site is bounded by an undeveloped public road to the west, a multifamily housing complex to the north, and vacant lots to the east and south. See the Vicinity Map below.



VICINITY MAP
NOT TO SCALE

The project proposes an affordable, senior housing development, consisting of one multifamily housing building with associated parking, hardscape, and landscape improvements.

II. EXISTING CONDITIONS

Existing Condition Overview

The existing project site consists of one single-family structure at the northwest corner with primarily vegetated groundcover on the remainder of the property. The northwest corner of the site, adjacent to the structure, drains toward Hazelwood Street, which is unpaved fronting the site. The northern portion of the site east and south of the structure slopes at approximately 2% southeast. The southern and eastern portions of the site drain at 5% to 10% toward the southern and eastern property lines.

The site receives no significant offsite run-on from the properties to the north, east, and south. Hazelwood Street, a public street to the west of the property, is unpaved and contains no drainage infrastructure. In the existing condition, drainage from the right-of-way flows onto the subject property, draining southeast across the property.

Site soils are considered silty fine sand according to the geotechnical report. Groundwater was encountered approximately 10 to 13 feet below existing grade. See the Project Site Map in Attachment 1 for a depiction of the existing conditions and Attachment 6 for the project-specific geotechnical report.

Opportunities

The area of the site is relatively large compared with the footprint needed to support the proposed development. This allows the proposed design to maintain a large area of pervious landscaping. It also provides the space needed for self-retaining areas and bioretention.

The tested infiltration rates onsite appear to support a moderate level of infiltration, allowing retention of some drainage onsite.

Constraints

No public storm drain infrastructure exists in the near vicinity of the site. Existing drainage runs toward private properties. In order to not exacerbate the cross-lot drainage and because there is no public storm drain to tie into, water must be retained onsite to the extent feasible. Infiltration rates are moderate, but not high, so a large infiltration footprint must be maintained in order to retain drainage within appropriate drawdown times.

Groundwater was encountered 10 to 13 feet below existing grade in the geotechnical investigation borings; however, the borings were not taken in the location of the bioretention basin. Further investigation will be required to determine the groundwater level at the location of the bioretention basin and to ensure adequate separation between the infiltrating surface and water table can be met.

The site receives runon of public drainage from Hazelwood Street, which must continue to pass through the site in the proposed design.

III. Proposed Conditions

Proposed site improvements shall consist of one multifamily housing building, surface parking and associated drive aisles, landscaping, pedestrian hardscape, and outdoor recreation areas.

Project Layout Optimization

The project layout has been optimized per the following low impact design principles.

Minimize Impervious Surfaces

The proposed design utilizes a hammerhead turnaround in lieu of a looped drive aisle around the building in order to reduce impervious surface area. Perimeter parking bays and the turnaround are proposed as permeable pavement. Permeable pavement is also proposed at the driveway entrances. Proposed parking counts have been reduced to the extent feasible in order to minimize paving areas.

Preserve Vegetation

The project borders private lots to the south and east, both of which contain dense areas of trees. The trees within the subject property at the southeast corner of the site will be protected.

Utilize and Conform to Site-Specific Topography

The northern portion of the site is relatively flat with grades at the south and east sloping more steeply toward the southerly and easterly property lines. The proposed site has been laid out consistently with the existing topography. The main development footprint is proposed on the norther portion of the site. The southern portion and eastern edge of the site will consist of pervious slopes drainage toward to southerly and easterly property lines as in the existing condition.

Replicate the Site's Natural Drainage Patterns

The site maintains the existing drainage patterns to the extent feasible. Site grading will match existing drainage direction with relatively flat slopes on the northern portion of the site and perimeter slope grading to the south and east. Detention and infiltration features are provided to mitigate increases in peak flow per the project Runoff Mitigation Plan.

Detain and Retain Runoff Throughout the Site

The overall site limits the ratio of impervious to pervious area to less than 2:1. The project will implement self-retaining landscaped areas and self-retaining permeable pavement throughout the site to maximize infiltration of runoff. Self-retaining planter areas will allow for three inches of ponding below area drains. Permeable pavement will include nine inches of gravel storage below the subdrain. Drainage below the area drains and pavement subdrain will infiltrate.

Impermeable parking stalls, drive aisles and sidewalks will be directed toward the permeable pavement and self-retaining planter areas.

The site will include an unlined bioretention basin, designed to biofilter, detain, and infiltrate runoff. The basin includes 24-inches of gravel storage below the subdrain. Storage below the subdrain will infiltrate.

Roof drains will outlet at grade in landscaped areas where feasible. These areas are not designed as self-retaining areas, as ponding against the building is not advisable. The planter areas will allow for some infiltration of the roof drainage before drainage reaches the area drains.

The public drainage from Hazelwood Street will continue to flow onto the property as it does in the existing condition. It will flow through a gently graded vegetated swale to encourage infiltration of the public drainage.

Site Design Measures

The Phase II MS4 Permit and the Mendocino LID prioritize site design measures with the goal of retaining the 85th percentile, 24-hour storm event to the extent feasible. The manual prioritizes the creation of self-retaining areas, designed to retain a minimum of 3-inches of water with a maximum ratio of tributary impervious area to pervious self-retaining area of 2:1. According to the manual:

> *"In Mendocino County the 85th percentile, 24-hour storm event is equivalent to approximately one inch. When using a 2:1 impervious to pervious ratio for the calculation of the self-retaining area, the area must be able to retain the first 2-inches of stormwater runoff from the impervious areas and the first inch that falls on the self-retaining area itself. This is why the self-retaining area should be depressed in order to achieve this 3-inch retention requirement."*

The manual requires that projects reduce runoff by draining impervious areas to pervious self-retaining areas. If the 2:1 maximum ratio of impervious to pervious area cannot be met, a treatment control BMP must be implemented, with bioretention being the priority.

The proposed project implements site design measures throughout the site. Permeable pavement has been proposed within the perimeter parking bays and the hammerhead turnaround. The permeable pavement is considered to be self-retaining as it will have greater than 3-inches of gravel storage below the subdrain. Self-retaining landscaped areas throughout the site have been proposed.

Where self-retaining areas cannot completely retain the runoff based on the exceedance of the 2:1 impervious to self-retaining area ratio, bioretention has been implemented. The bioretention facility was sized as 4-percent of the tributary area after the application of runoff factors based on surface type.

Self-retaining and bioretention areas are depicted on the Project Site Map in Attachment 1. Calculations are provided in Attachment 3.

Drainage Management Areas

The site has been delineated into six drainage management areas (DMAs) as described below. DMAs were delineated based on the area flowing to each site design feature.

DMA 1 – Area Draining to a Bioretention Facility

DMA 1 encompasses the multifamily building with surrounding landscaped areas, as well as the drive aisle and parking area south of the building. Roof drainage outlets at grade where possible and is captured in landscape swales surrounding the building. Runoff will enter the private storm drain system through area drains. Runoff from the drive aisles, parking stalls, and carport roofs will surface flow onto the permeable pavement in the south parking bay. Runoff below the paver subdrain will infiltrate. When the paver section is full, runoff will enter the subdrain.

As the DMA exceeds the 2:1 ratio of impervious to self-retaining area, bioretention has been provided. Runoff from the paver subdrain and area drains will be piped to a bioretention basin referred to as BMP 1. BMP 1 serves to treat, infiltrate, and detain runoff. Drainage within the bioretention basin will infiltrate below the subdrain. As the water level reaches the subdrain, runoff will exit through an orifice at the subdrain connection to the outlet structure. As the water level rises above the graded bottom of basin, runoff will enter a mid-flow orifice in the outlet structure. In an overflow condition, runoff would enter the grated inlet at the top of the outlet structure. From the outlet structure, drainage is piped to a level spreader outlet at the southeastern corner of the site. The level spreader will dissipate energy, and drainage will spill over evenly toward the property line at the southeastern corner of the site. Drainage leaving the level spreader will travel through existing vegetation to be preserved onsite before leaving the site in the same direction as drainage in the existing condition.

DMA 2 – Area Draining to Self-Retaining Area / Self-Retaining Area

DMA 2 includes the sidewalk, drive aisle, carports and parking east of the building. Drainage surface flows onto the permeable pavement in the parking and hammerhead turnaround. Drainage below the paver subdrain infiltrates. When the paver section is full, runoff will exit through the subdrain. The subdrain will be piped to the level spreader at the southeast corner of the property. DMA 2 has been designed with an impervious to pervious self-retaining area ratio of less than 2:1; therefore, site design requirements have been met.

DMA 3 – Area Draining to Self-Retaining Area / Self-Retaining Area

DMA 3 includes the sidewalk, drive aisle, carports and parking north of the building. Drainage surface flows onto the permeable pavement in the parking as well as into a self-retaining landscaped area designed to allow minimum 3-inches of ponding. Drainage below the subdrain of the pavers and below the raised area drains of the self-retaining area will infiltrate. When the water level reaches the subdrain of the pavers and the area drains in the self-retaining area, drainage will enter the private storm drain, from where it will be piped to a level spreader along the eastern edge of the property. This mimics existing conditions, in which the northeast corner of the site drains toward the eastern property line. DMA 3 has been designed with an impervious to pervious self-retaining area ratio of less than 2:1; therefore, site design requirements have been met.

DMAs 4 and 5 – Area Draining to Self-Retaining Area / Self-Retaining Area

DMAs 4 and 5 consist of the two driveway entrances to the site that will flow offsite into Hazelwood Street. Permeable pavement will be installed within the driveway entrances in order to intercept the drainage to the extent feasible. Drainage below the subdrain will infiltrate. When the water level reaches the subdrain, drainage will be piped toward the eastern property line for DMA 4 and toward BMP 1 for DMA 5. DMAs 4 and 5 have been designed with an impervious to pervious self-retaining area ratio of less than 2:1; therefore, site design requirements have been met.

DMA 6 – Self-Treating Area

DMA 6 includes the pervious graded area surrounding the site that is not tributary to the proposed drainage infrastructure. This area will be planted and does not require treatment or detention as it contains no impervious area and will match the existing conditions. Runoff that is not intercepted in the soil and vegetation will flow toward the south and eastern property lines as in the existing condition.

Offsite

The project proposes the development of a portion of public Hazelwood Street with asphalt pavement, curb, gutter, and sidewalk. The street will be sloped east as in the existing condition. It will be intercepted in the gutter and directed to a proposed vegetated swale. The swale will flow from the public right-of-way onto the subject property and flow along the southerly property line. The swale will allow for the interception of drainage in the soil as infiltration and vegetation as evapotranspiration. Drainage that is not intercepted will flow toward the southeast corner of the site and exit the property as in the existing condition. Treatment of public, offsite drainage has not been tabulated in this analysis.

IV. HYDROMODIFICATION MITIGATION

Overview

According to Section E.12.f of the Phase II MS4 Permit, regulated projects within the California Coastal Ranges shall implement hydromodification management measures, by demonstrating that post-project runoff shall not exceed estimated pre-project runoff for the 2-year, 24-hour storm. The LID Manual notes that if a project has been designed with the 2:1 impervious to self-retaining area ratio for the entire site and that the site supports infiltration of greater than 1 inch per hour, the hydromodification mitigation requirement has been met.

The LID Manual does not provide guidance for how to meet the requirement if the project infiltrates at less than 1 inch per hour or does not meet the required ratio of impervious to self-retaining area for the entire site. The proposed project does not support infiltration of 1 inch per hour with a factor of safety applied to the tested rate and does not comply with the 2:1 ratio for the entire site; therefore, the project has performed hydrology and hydraulic routing calculations for the 2-year, 24-hour storm event to demonstrate compliance.

Hydromodification Mitigation Calculations

In order to demonstrate that the proposed 2-year, 24-hour peak runoff does not exceed that of the existing condition, detention in the permeable pavement and bioretention must be taken into account. Detention analysis requires time distribution of rainfall over a particular storm duration; therefore, the National Resources Conservation Services (NRCS), formerly Soil Conversation Service (SCS), hydrologic procedure was followed.

Calculations described below were performed in Autodesk's Storm Sanitary Analysis program (SSA). SSA input and output can be found in Attachment 4.

NRCS Type IA, 24-hour storm distribution was selected based on the geographic region. Distribution IA is appropriate for the northern California coast per NRCS Technical Release 55, Figure B-2. The storm distribution was applied to the 2-year, 24-hour precipitation depth per NOAA Atlas 14. See reference material in Attachment 5.

Each DMA was modeled as a subbasin in SSA based on area, time of concentration, and curve number. Time of concentration was based on NRCS TR-55 method with calculations occurring directly in SSA. Time of concentration was calculated for the existing condition and for proposed DMA 6, which contains only pervious area. The remaining DMAs were modeled with the minimum time of concentration of five minutes, as they are relatively small with relatively high impervious area.

Composite curve numbers were calculated directly in SSA based on the input impervious and pervious areas for each DMA. Impervious areas were modeled with a curve number of 98, and pervious areas with a curve number of 58. The pervious curve number is from TR-55, Table 2-2c, from the value for meadow with soil type B. This ground cover matches the existing state. Although the NRCS does not list a hydrologic soil group, type B is the most consistent with the soil description and tested infiltration rates.

The existing condition was modeled by running the 2-year, 24-hour storm through the existing subbasin with the above parameters. The model results in a peak flow at the overall discharge point.

For the proposed condition, detention in the permeable pavement and bioretention basin needed to be modeled. The bioretention basin was modeled for DMA 1, and the permeable pavement was modeled for DMAs 2 through 5. The bioretention parameters are per the detail shown on the Project Site Map in Attachment 1. The pavement sections were assumed to have 9-inches of gravel below the subdrain.

The bioretention basin and each paver area were added as a storage node in SSA. A staged storage curve was added representing the depth to volume values for each storage node. Staged storage calculations considered 0.4 porosity for the gravel layers and 0.2 porosity for the basin soil layer.

Infiltration from the basin and paver sections was modeled. The design infiltration rate was calculated by applying a factor of safety of 3 to the tested infiltration rate per the geotechnical report. The design infiltration rate was multiplied by the bottom area of the basin and pavers to obtain an infiltration flow rate for each area. The infiltration flow rate was applied to each storage node based on its bottom area.

Subdrains for the basin and pavers were modeled as orifices in SSA. The paver sections were each modeled with a 4-inch subdrain. The orifice size of the bioretention basin was iterated until the peak 2-year, 24-hour flow rate did not exceed that of the existing condition. The result was an orifice of 1.375-

inches in diameter. A mid-flow orifice was added on the outlet structure above the graded basin bottom for detention of larger storm events per the project Runoff Mitigation Plan. The water level remains below the mid-flow orifice in the 2-year, 24-hour storm event.

The basin and pavers were modeled with overflow structures; however, the sizing resulted in water levels that never reached the overflow for any storage node. For the basin, the grated overflow was modeled as a weir at the grate elevation. For the pavers, the overflow was modeled as a long weir to reflect surface flow leaving the paver area in an overflow condition.

The 2-year, 24-hour storm event was run through the proposed subbasins with runoff then being routed through the storage nodes, orifices, and to the overall outfall. The model results in a peak flow and total at the overall discharge point after considering detention and infiltration in the basin and pavers.

The table below summarizes the results of the hydrologic and hydraulic analysis:

2-Year, 24-Hour Runoff

DMA	Peak Flow (CFS)
Existing	0.09
1	0.06
2	0
3	0
4	0
5	0
6	0.02
Total Proposed	0.08

The analysis shows that the project detention features are sufficient to reduce the proposed peak flow leaving the site in the 2-year, 24-hour storm event to less than that of the existing condition. Therefore, hydromodification mitigation requirements have been met.

V. CONCLUSION

The proposed project has been designed to address site design requirements of the Phase II MS4 Permit as enforced within the Mendocino County LID Manual through the use of self-retaining landscaped areas, permeable pavement, and a bioretention basin. Hydrologic and hydraulic analysis shows that these features are sufficient for compliance with the hydromodification mitigation requirement with the inclusion of a 1.375-inch orifice on the bioretention basin subdrain.

ATTACHMENT 3

Water Quality Calculations

Fort Bragg Senior Apartments - DMA Summary

DMA Area Summary							Site Design Measures								
DMA	**Impervious Area (SF)**	**Impervious Area (AC)**	**Pervious Area (SF)**	**Pervious Area (AC)**	**Total Area (SF)**	**Total Area (AC)**	**Paver Area (SF)**	**Paver Area (AC)**	**SRA Landscape (SF)**	**SRA Landscape (AC)**	**Total SRA (SF)**	**Total SRA (AC)**	**Ratio Impervious to SRA**	**LID Req. met?**	**Bioretention Area (SF)**
1	28200	0.65	30900	0.71	59100	1.36	1100	0.03	0	0.00	1100	0.03	25.6	No	1500
2	8100	0.19	6900	0.16	15000	0.34	4600	0.11	0	0.00	4600	0.11	1.8	Yes	0
3	13100	0.30	9700	0.22	22800	0.52	4700	0.11	4100	0.09	8800	0.20	1.5	Yes	0
4	650	0.01	350	0.01	1000	0.02	350	0.01	0	0.00	350	0.01	1.9	Yes	0
5	550	0.01	350	0.01	900	0.02	350	0.01	0	0.00	350	0.01	1.6	Yes	0
6	0	0.00	31600	0.73	31600	0.73	0	0.00	0	0.00	0	0.00	N/A	Yes	0
Total	50600	1.16	79800	1.83	130400	2.99	11100	0.25	4100	0.09	15200	0.35			
Existing	2300	0.05	0	0.00	130400	2.99									

Table 2. Area Calculations of *Self-retaining Areas* Used to Treat Impervious Areas

1 DMA Name	2 Area (sq. ft.)
1 (Self-retaining)	1,100
2 (Self-retaining)	4,600
3 (Self-retaining)	8,800
4 (Self-retaining)	350
5 (Self-retaining)	350

Table 3. Runoff Factor (surface type)

Roofs and Paving	1.0
Landscaped Area	0.1
Bricks or solid pavers- grouted	1.0
Bricks or solid Pavers-on sand base	0.5
Pervious Concrete Asphalt	0.1
Turfblock or gravel	0.1
Open or Porous pavers	0.1

Tables 4-6 below should be used to quantify the amount of runoff that is reduced by using site design measures. Using the tables in chronological order will calculate the minimum size for your bioretention facility in order to meet the MS4 permit requirements. Several iterations may be need to size facilities according to the site design.

Table 4. Area draining to self-retaining areas

1 DMA Name (must correspond to area on the site map and on Table **1**)	**2** DMA Area (sq. ft.) (Table **1**)	**3** Type of Surface (Runoff Factor Table 3)	**4** Surface with Runoff Factor Column **2** X Column **3**	**5** Area of Self-retaining Area Receiving the Runoff (sq. ft.) (Table 2, Col. 2)	**6** Ratio Col. **4** : Col. **5** Not to exceed 2:1 ratio (if number exceeds 2:1 use table 5 - 6 to reduce tributary area and recalculate or go directly to Table 7)
Example	700	Roof (1.0)	700	100	7:1 (must use site design measures, bioretention or both)
1 (Impervious)	28,200	Roof, paving (1.0)	28,200	1,100	25.6:1
2 (Impervious)	8,100	Paving (1.0)	8,100	4,600	1.8:1
3 (Impervious)	13,100	Paving (1.0)	13,100	8,800	1.5:1
4 (Impervious)	650	Paving (1.0)	650	350	1.9:1
5 (Impervious)	550	Paving (1.0)	550	350	1.6:1

Table 5. Tree Planting and Preservation (if not planting trees, go to Table 6)

1 DMA Name (must correspond to area on the site map)	**2** DMA sq. ft. (from Table 4. Col. 6)	**3** Deciduous (Input 100 for each deciduous tree)	**4** Evergreen (Input 200 for each evergreen tree)	**5** Total Tree Credit (Col. **3** + Col. **4**) (DMA runoff reduction)	**6** New DMA Area Col. **2** – Col. **5** (for use in Table 6 - 8)
Example	700	--------	200	200	500 (new DMA size that must be treated with methods below Table 6-7)

Table 6. Rain Barrels and Cisterns (if not using site design measures, go to Table 8)

1 DMA Name (must correspond to area on the site map)	**2** New DMA sq. ft. (Table 5, Col. 7 or, if no trees used, value from Table 4, Col. 2)	**3** Number of Rain Barrels	**4** Runoff Reduction from using a standard 55 gallon Rain Barrel = 88 sq. ft. Use the following if size is other than the standard (for every gallon of storage, approx. 1.6 sq. ft. of reduction is achieved)	**5** Col. **3 X** Col. **4** (DMA runoff reduction)	**6** New DMA Area Col. **2** - Col. **5**
Example	500	1	88	88	412 (go to Table 7 to recalculate Ratio)

Table 7. New Tabulation of areas draining to self-retaining area after use of site design measures (must achieve a 2:1 ratio; if not achievable, use table 8 to calculate the size of bioretention required)

1 DMA Name (must correspond to area on the site map)	**2** New Square footage of DMA (Col 6, Table 4,5,6)	**3** Area of Self-retaining Area Receiving the Runoff (Table 2, Col. 2)	**4** Ratio Column **2 :** Column **3** Not to exceed 2:1
Example	412 (Table 6)	100	4.12:1(still exceeds 2:1 go back, add more trees, rain barrels, or use bioretention – example uses bioretention, Table 8)
1 (Impervious)	28,200	1,100	25.6:1

Table 8. Tabulation of areas draining to Bioretention Facility

1 DMA Name (must correspond to area on the site map)	**2** DMA sq. ft. (Table 1, Col 2 or new DMA sq. ft. Table 7, Col. 2)	**3** Runoff Factor Table 6 (skip if coming from Table 1)	**5** DMA Area Col. **2** x Col. **3**	**6** Standard Sizing Factor	**Minimum facility size** Col. **5** X Col. **6**	If site does not allow for the minimum size, recalculate DMA using additional Site Design Measures to further reduce the tributary size
Example	300	***1*** (already calculated in steps above,	300	0.04	12 sq. ft.	(proposed facility size on site plans)

		for this example)				
1	28,200 Impervious 30,900 Pervious	1 0.1	28,200 SF 3,090 SF	0.04	1,128 SF → 1,252 SF 124 SF Total	1,500 SF provided. Minimum size achieved.
				0.04		
				0.04		
				0.04		

Table 9. Runoff Factors

Roofs and Paving	1.0
Landscaped Area	0.1
Bricks or solid pavers- grouted	1.0
Bricks or solid Pavers-on sand base	0.5
Pervious Concrete Asphalt	0.1
Turfblock or gravel	0.1
Open or Porous pavers	0.1

G. Operation and Maintenance in Perpetuity

Indicate whether an *Operation and Maintenance Plan* is accompanying this document (Appendix 9).

☐ Yes ☐ No

H. Stormwater Control Plan

A Stormwater Control Plan is required for all Regulated Projects. This worksheet is designed to be the SCP if all requested descriptions and site plans have been attached. This document will be used by the plan checker to confirm that adequate stormwater control measures are being implemented on the project.

Indicate whether all supporting descriptions and worksheets are accompanying this document, Stormwater Control Plan

☐ Yes ☐ No

ATTACHMENT 4

Hydromodification Mitigation Calculations

Fort Bragg Senior Apartments - Hydromodification Mitigation Summary

DMA Area Summary							Detention Features		2-year, 24 hour Results
DMA	Impervious Area (SF)	Impervious Area (AC)	Pervious Area (SF)	Pervious Area (AC)	Total Area (SF)	Total Area (AC)	Paver Area (SF)	Bioretention Area (SF)	Peak Flow (CFS)
1	28200	0.65	30900	0.71	59100	1.36	1100	1500	0.06
2	8100	0.19	6900	0.16	15000	0.34	4600	0	0
3	13100	0.30	9700	0.22	22800	0.52	4700	0	0
4	650	0.01	350	0.01	1000	0.02	350	0	0
5	550	0.01	350	0.01	900	0.02	350	0	0
6	0	0.00	31600	0.73	31600	0.73	0	0	0.02
Total	50600	1.16	79800	1.83	130400	2.99			0.08
Existing	2300	0.05	0	0.00	130400	2.99			0.09

Note: Pavement detention not modeled for DMA 1. Self-retaining landscaped area not modeled for DMA 3.

Fort Bragg Senior Apartments - Design Infiltration Rate

Test[1]	Infiltration Rate (in/hr)
P-1	1.03
P-2	0.94
Average	0.985

[1] Per geotechnical infiltration testing results.

Average Infiltration Rate (in/hr)	0.985	in/hr
FS	3	
Design infiltration rate	0.33	in/hr

Project Description

File Name .... 24-043 Hazelwood Fort Bragg - Existing TR20.SPF

Project Options

Flow Units .... CFS
Elevation Type .... Elevation
Hydrology Method .... SCS TR-20
Time of Concentration (TOC) Method .... SCS TR-55
Link Routing Method .... Kinematic Wave
Enable Overflow Ponding at Nodes .... YES
Skip Steady State Analysis Time Periods ...... YES

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	15	seconds

Number of Elements

	Qty
Rain Gages	4
Subbasins...	1
Nodes...	1
Junctions	0
Outfalls	1
Flow Diversions	0
Inlets	0
Storage Nodes	0
Links...	0
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	0
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
1	Rain Gage-01	Time Series	TS-04	Intensity	inches					User Defined
2	Rain Gage-03	Time Series	TS-02	Cumulative	inches				0.00	
3	Rain Gage-04	Time Series	TS-03	Cumulative	inches				0.00	
4	Rain Gage-05	Time Series	TS-04	Intensity	inches					User Defined

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	E1	2.99	484.00	58.67	3.29	0.40	1.18	0.09	0 00:20:02

Subbasin Hydrology

Subbasin : E1

Input Data

Area (ac) 2.99
Peak Rate Factor 484
Weighted Curve Number 58.67
Rain Gage ID .... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Meadow, non-grazed	2.94	B	58
Paved parking & roofs	0.05	B	98
Composite Area & Weighted CN	2.99		58.67

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.3	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	2	0	0
2 yr, 24 hr Rainfall (in) :	3.4	0	0
Velocity (ft/sec) :	0.1	0	0
Computed Flow Time (min) :	16.55	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	100	130	0
Slope (%) :	1.5	4	0
Surface Type :	Grass pasture	Grass pasture	Unpaved
Velocity (ft/sec) :	0.86	1.4	0
Computed Flow Time (min) :	1.94	1.55	0

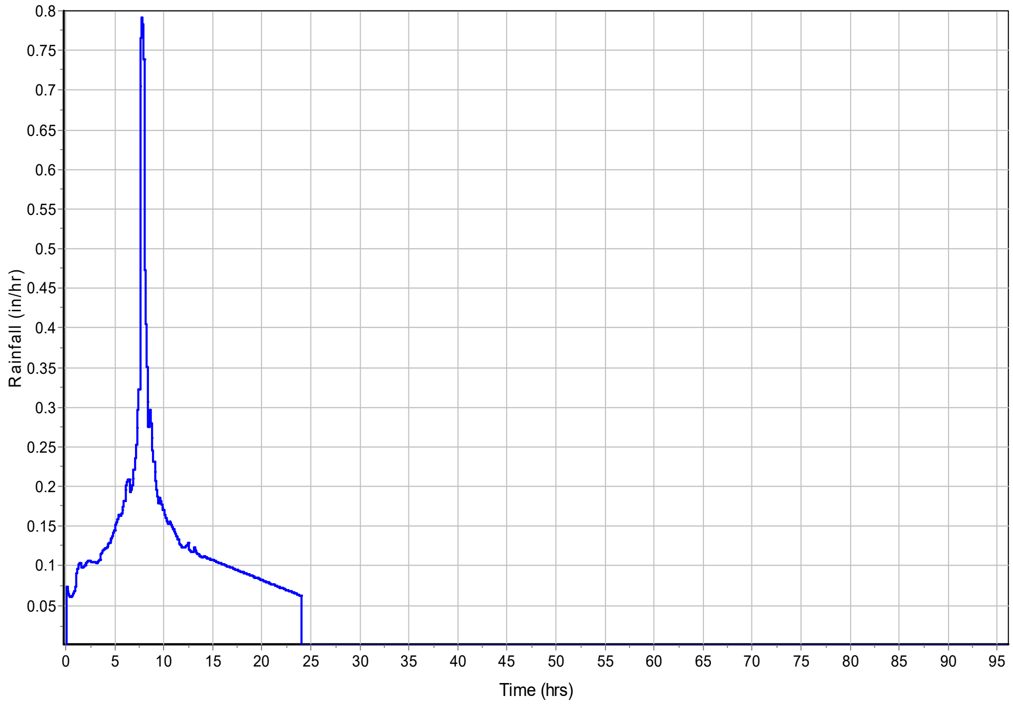
Total TOC (min) 20.04

Subbasin Runoff Results

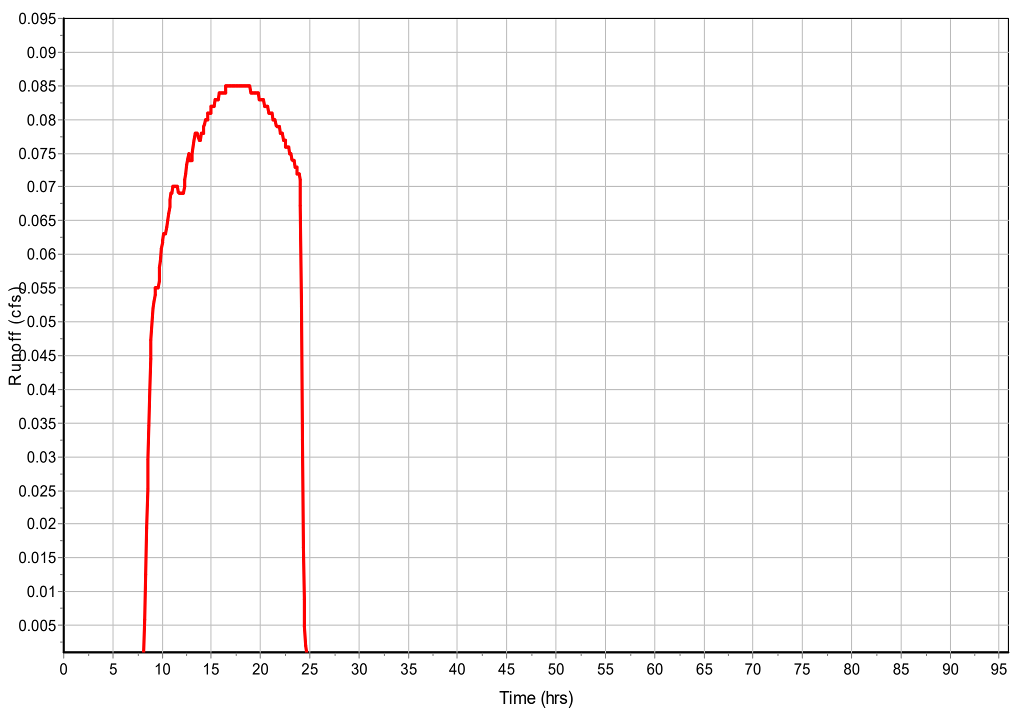
Total Rainfall (in) 3.29
Total Runoff (in) 0.4
Peak Runoff (cfs) 0.09
Weighted Curve Number 58.67
Time of Concentration (days hh:mm:ss) 0 00:20:02

Subbasin : E1

Rainfall Intensity Graph



Runoff Hydrograph



Project Description

File Name .... 24-043 Hazelwood Fort Bragg - Proposed TR-20 Mitigated.SPF

Project Options

Flow Units .... CFS
Elevation Type .... Elevation
Hydrology Method .... SCS TR-20
Time of Concentration (TOC) Method .... SCS TR-55
Link Routing Method .... Kinematic Wave
Enable Overflow Ponding at Nodes .... YES
Skip Steady State Analysis Time Periods ...... YES

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	15	seconds

Number of Elements

	Qty
Rain Gages	2
Subbasins..	6
Nodes..	6
Junctions	0
Outfalls	1
Flow Diversions	0
Inlets	0
Storage Nodes	5
Links..	11
Channels	0
Pipes	0
Pumps	0
Orifices	6
Weirs	5
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
1	Rain Gage-01	Time Series	TS-03	Intensity	inches					User Defined
2	Rain Gage-02	Time Series	TS-02	Cumulative	inches				0.00	

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	P1	1.36	484.00	77.12	3.29	1.28	1.75	0.37	0 00:05:00
2	P2	0.34	484.00	80.35	3.29	1.50	0.51	0.12	0 00:05:00
3	P3	0.52	484.00	81.08	3.29	1.55	0.80	0.19	0 00:05:00
4	P4	0.02	484.00	84.00	3.29	1.71	0.03	0.01	0 00:05:00
5	P5	0.02	484.00	82.00	3.29	1.54	0.03	0.01	0 00:05:00
6	P6	0.73	484.00	58.00	3.29	0.37	0.27	0.02	0 00:12:06

Runoff from subbasins before storage nodes

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-01	Outfall	108.00					0.08	108.00					
2	Stor-01	Storage Node	108.00	114.00	108.00		0.00	0.37	111.57				0.00	0.00
3	Stor-02	Storage Node	116.00	119.00	116.00		0.00	0.12	116.29				0.00	0.00
4	Stor-03	Storage Node	116.00	119.00	116.00		0.00	0.18	116.53				0.00	0.00
5	Stor-04	Storage Node	116.00	119.00	116.00		0.00	0.01	116.26				0.00	0.00
6	Stor-05	Storage Node	116.00	119.00	116.00		0.00	0.01	116.22				0.00	0.00

Peak flow from total site after detention

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Diameter or Height (in)	Manning's Roughness	Peak Flow (cfs)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Reported Condition
1	Orifice-01a	Orifice	Stor-01	Out-01		108.00	108.00		1.375		0.06							
2	Orifice-01b	Orifice	Stor-01	Out-01		108.00	108.00		3.000		0.00							
3	Orifice-02	Orifice	Stor-02	Out-01		116.00	108.00		4.000		0.00							
4	Orifice-03	Orifice	Stor-03	Out-01		116.00	108.00		4.000		0.00							
5	Orifice-04	Orifice	Stor-04	Out-01		116.00	108.00		4.000		0.00							
6	Orifice-05	Orifice	Stor-05	Out-01		116.00	108.00		4.000		0.00							
7	Weir-01	Weir	Stor-01	Out-01		108.00	108.00				0.00							
8	Weir-02	Weir	Stor-02	Out-01		116.00	108.00				0.00							
9	Weir-03	Weir	Stor-03	Out-01		116.00	108.00				0.00							
10	Weir-04	Weir	Stor-04	Out-01		116.00	108.00				0.00							
11	Weir-05	Weir	Stor-05	Out-01		116.00	108.00				0.00							

Peak flow leaving storage nodes from orifices and weirs

Subbasin Hydrology

Subbasin : P1

Input Data

Area (ac) 1.36
Peak Rate Factor 484
Weighted Curve Number 77.12
Rain Gage ID .... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Paved parking & roofs	0.65	B	98
Meadow, non-grazed	0.71	B	58
Composite Area & Weighted CN	1.36		77.12

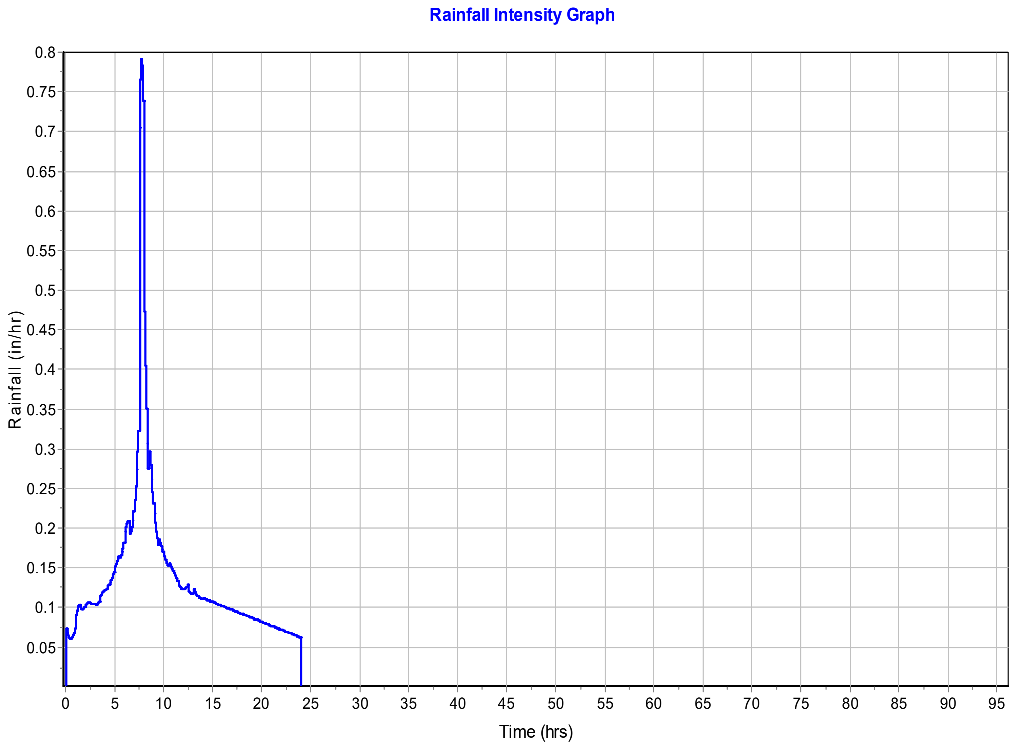
Time of Concentration

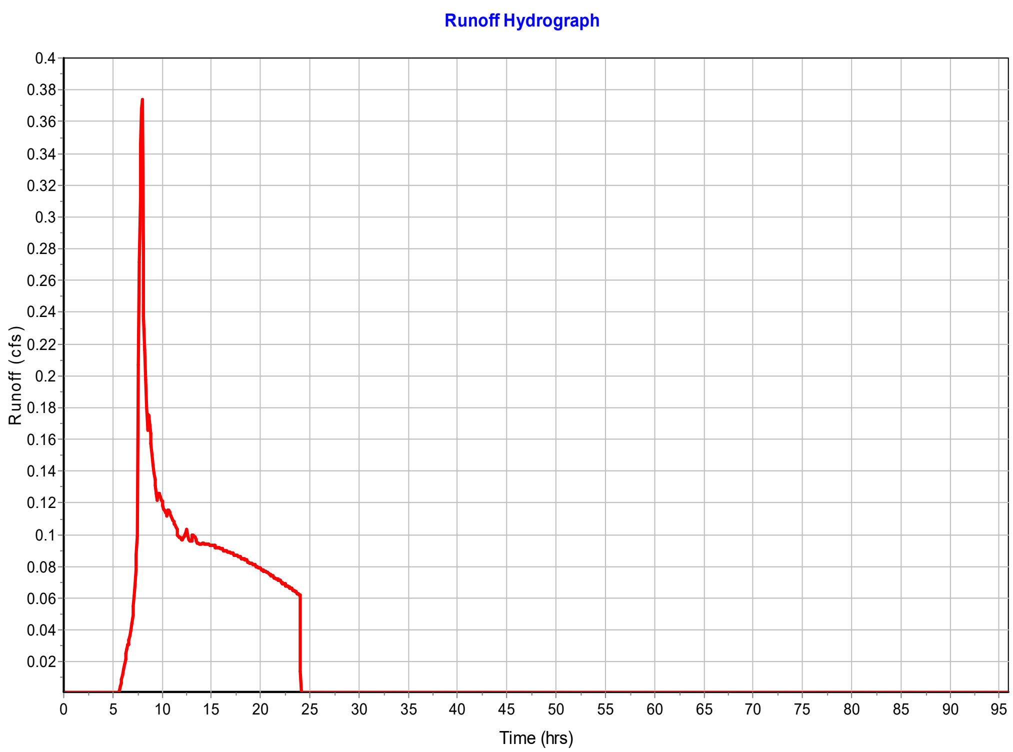
User-Defined TOC override (minutes): 5

Subbasin Runoff Results

Total Rainfall (in) 3.29
Total Runoff (in) 1.28
Peak Runoff (cfs) 0.37
Weighted Curve Number 77.12
Time of Concentration (days hh:mm:ss) 0 00:05:00

Subbasin : P1


Rainfall Intensity Graph
Rainfall (in/hr)
Time (hrs)


Runoff Hydrograph
Runoff (cfs)
Time (hrs)

Subbasin : P2

Input Data

Area (ac) 0.34
Peak Rate Factor 484
Weighted Curve Number 80.35
Rain Gage ID .... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Paved roads with curbs & sewers	0.19	B	98
Meadow, non-grazed	0.15	B	58
Composite Area & Weighted CN	0.34		80.35

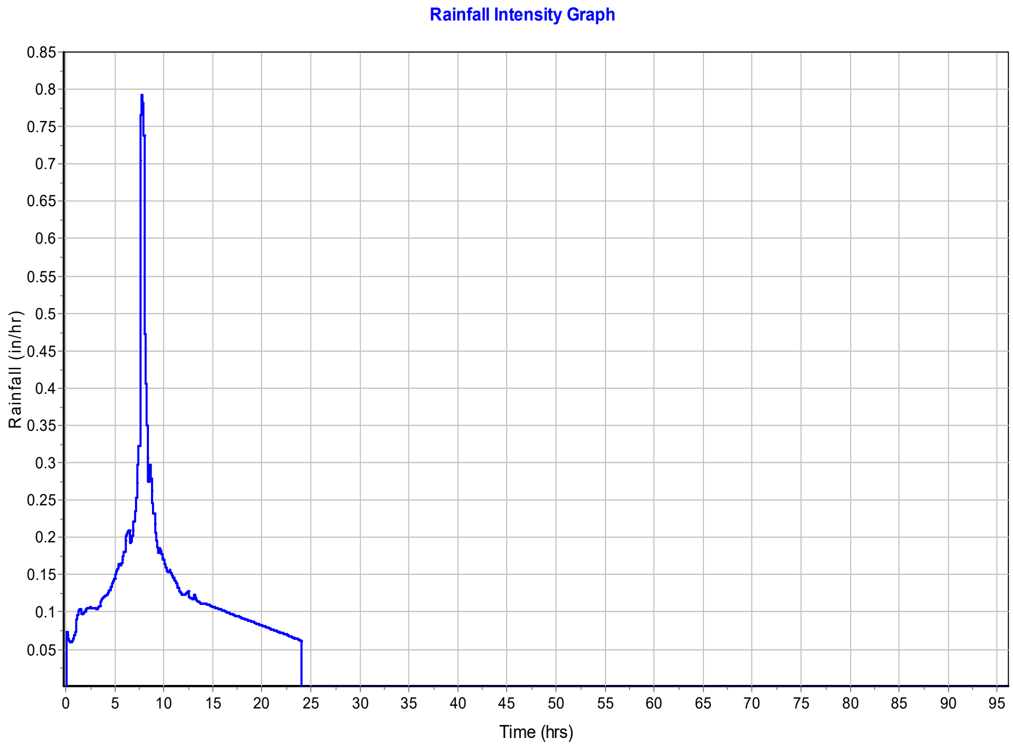
Time of Concentration

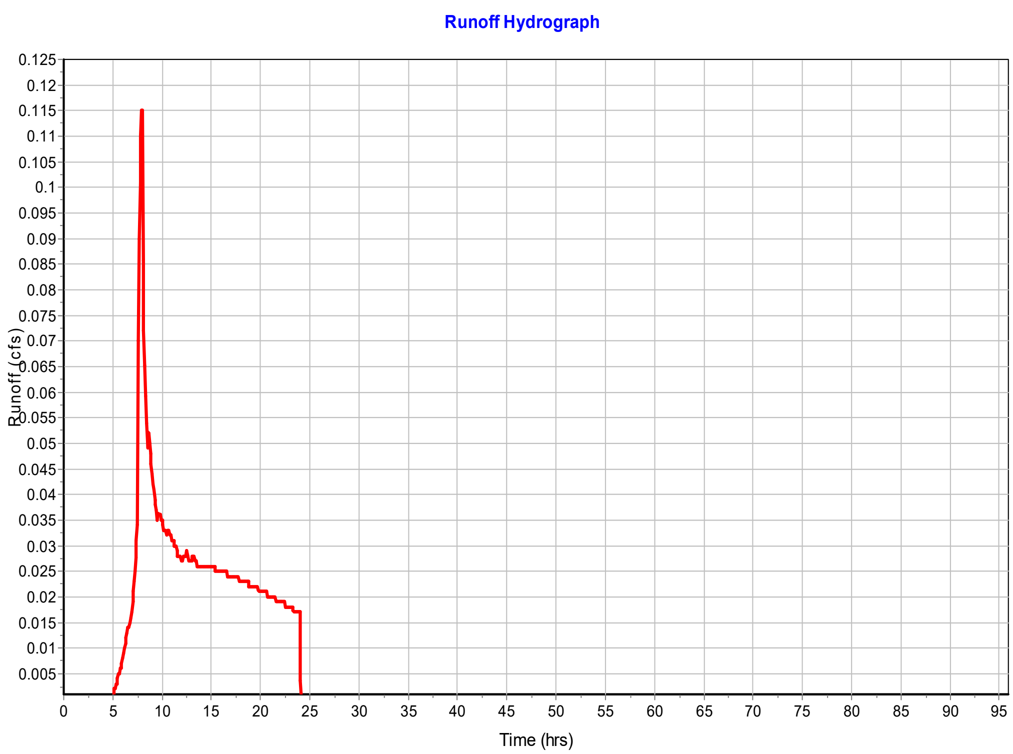
User-Defined TOC override (minutes): 5

Subbasin Runoff Results

Total Rainfall (in) 3.29
Total Runoff (in) 1.5
Peak Runoff (cfs) 0.12
Weighted Curve Number 80.35
Time of Concentration (days hh:mm:ss) 0 00:05:00

Subbasin : P2


Rainfall Intensity Graph
Rainfall (in/hr)
Time (hrs)


Runoff Hydrograph
Runoff (cfs)
Time (hrs)

Subbasin : P3

Input Data

Area (ac) 0.52
Peak Rate Factor 484
Weighted Curve Number 81.08
Rain Gage ID .... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Paved parking & roofs	0.3	B	98
Meadow, non-grazed	0.22	B	58
Composite Area & Weighted CN	0.52		81.08

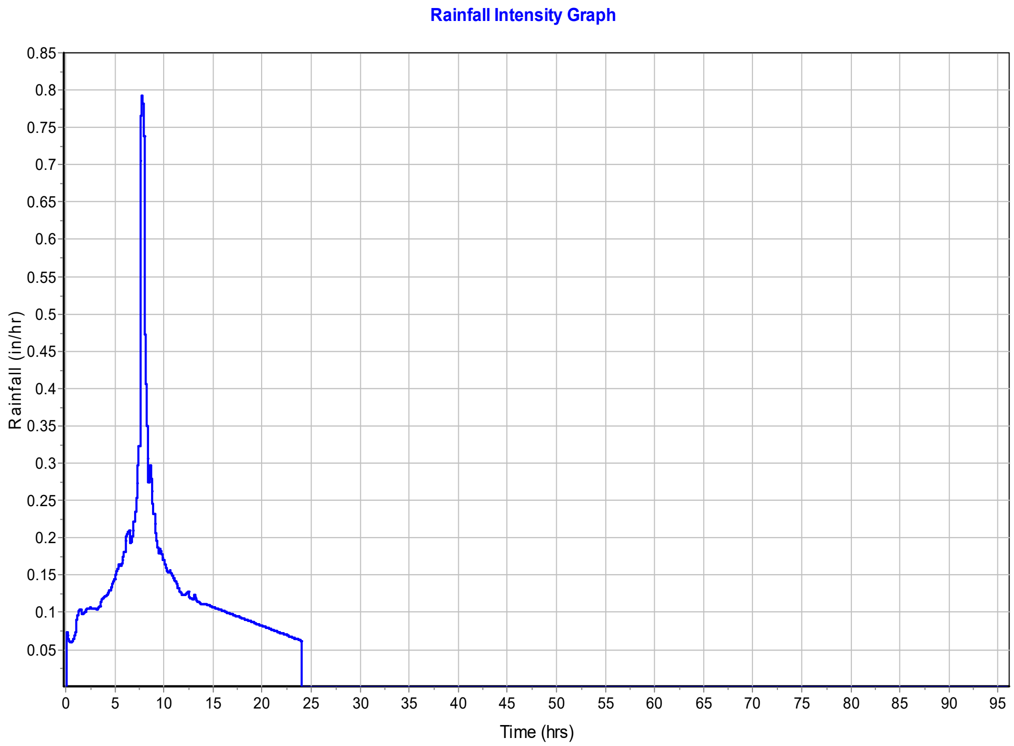
Time of Concentration

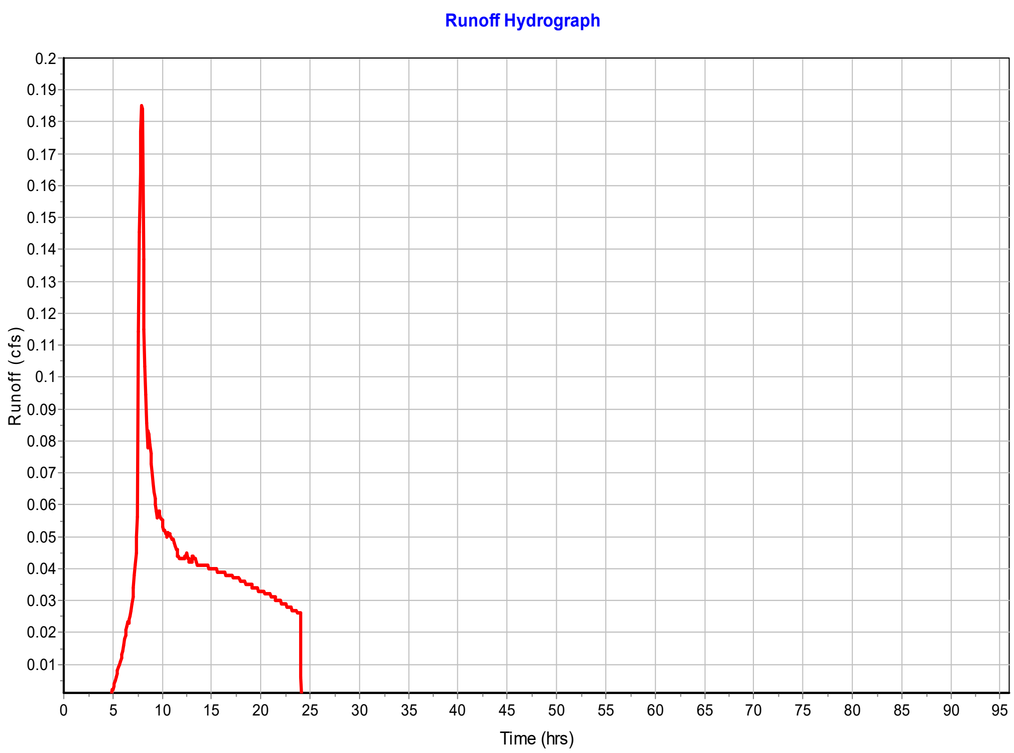
User-Defined TOC override (minutes): 5

Subbasin Runoff Results

Total Rainfall (in) 3.29
Total Runoff (in) 1.55
Peak Runoff (cfs) 0.19
Weighted Curve Number 81.08
Time of Concentration (days hh:mm:ss) 0 00:05:00

Subbasin : P3


Rainfall Intensity Graph
Rainfall (in/hr)
0.85
0.8
0.75
0.7
0.65
0.6
0.55
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95
Time (hrs)


Runoff Hydrograph
Runoff (cfs)
0.2
0.19
0.18
0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95
Time (hrs)

Subbasin : P4

Input Data

Area (ac) 0.02
Peak Rate Factor 484
Weighted Curve Number 84
Rain Gage ID .... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Paved parking & roofs	0.01	B	98
Meadow, non-grazed	0.01	B	58
Composite Area & Weighted CN	0.02		84

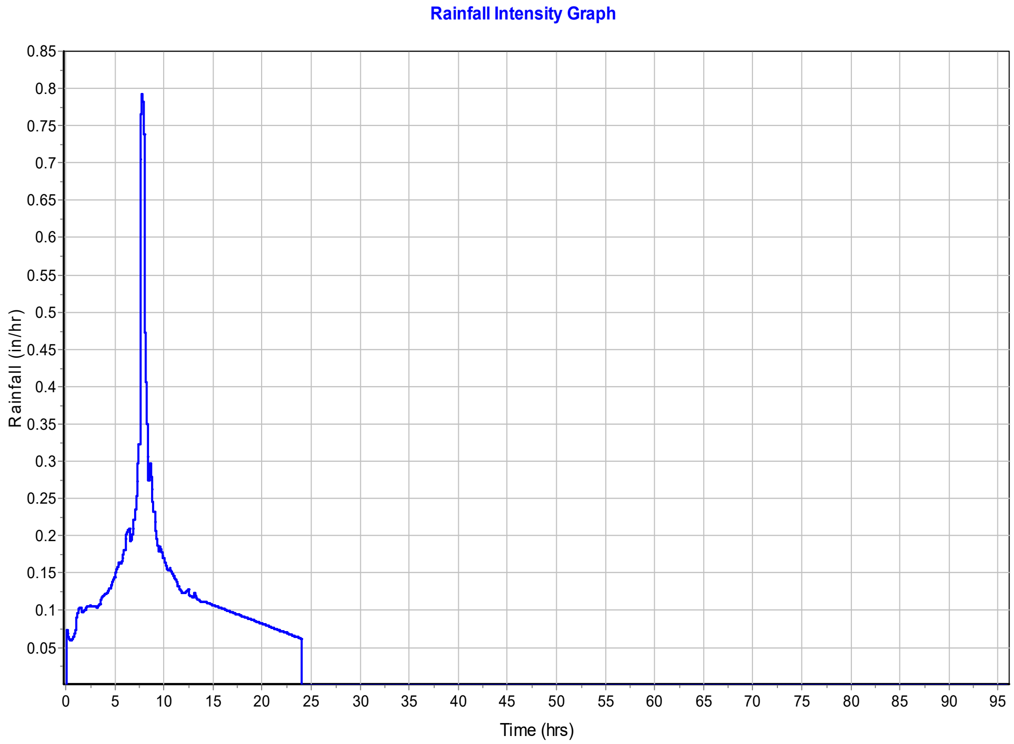
Time of Concentration

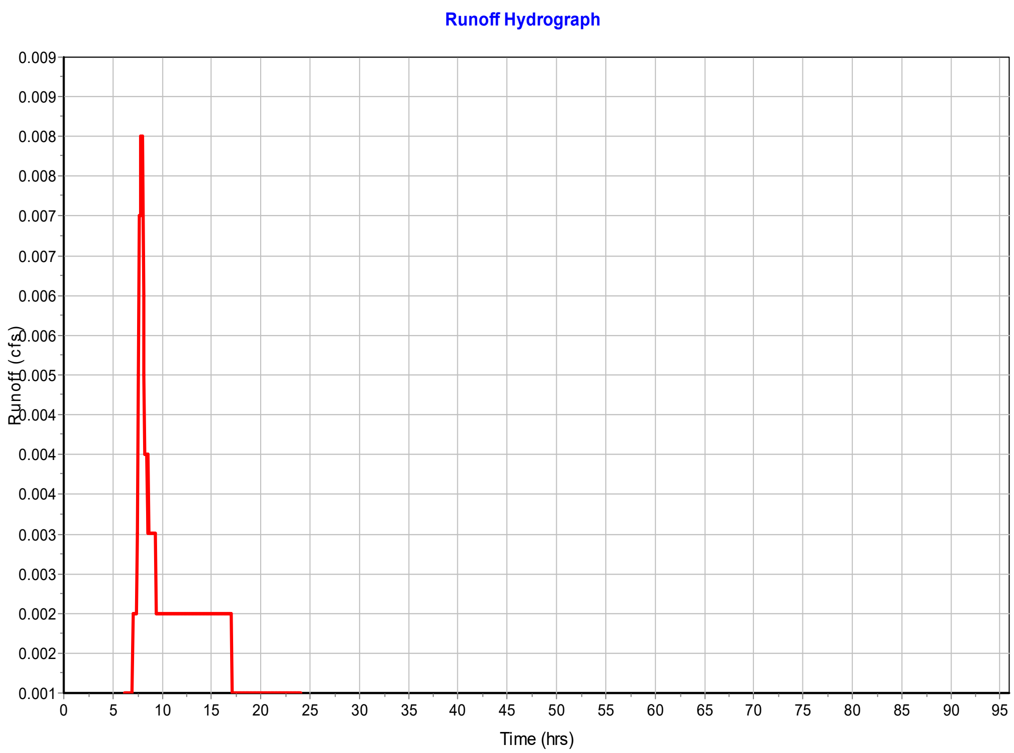
User-Defined TOC override (minutes): 5.00

Subbasin Runoff Results

Total Rainfall (in) 3.29
Total Runoff (in) 1.71
Peak Runoff (cfs) 0.01
Weighted Curve Number 84
Time of Concentration (days hh:mm:ss) 0 00:05:00

Subbasin : P4


Rainfall Intensity Graph
Rainfall (in/hr)
0.85
0.8
0.75
0.7
0.65
0.6
0.55
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95
Time (hrs)


Runoff Hydrograph
Runoff (cfs)
0.009
0.009
0.008
0.008
0.007
0.007
0.006
0.006
0.005
0.004
0.004
0.004
0.003
0.003
0.002
0.002
0.001
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95
Time (hrs)

Subbasin : P5

Input Data

Area (ac) 0.02
Peak Rate Factor 484
Weighted Curve Number 82
Rain Gage ID .... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Paved parking & roofs	0.01	B	98
Meadow, non-grazed	0.01	B	58
Composite Area & Weighted CN	0.02		82

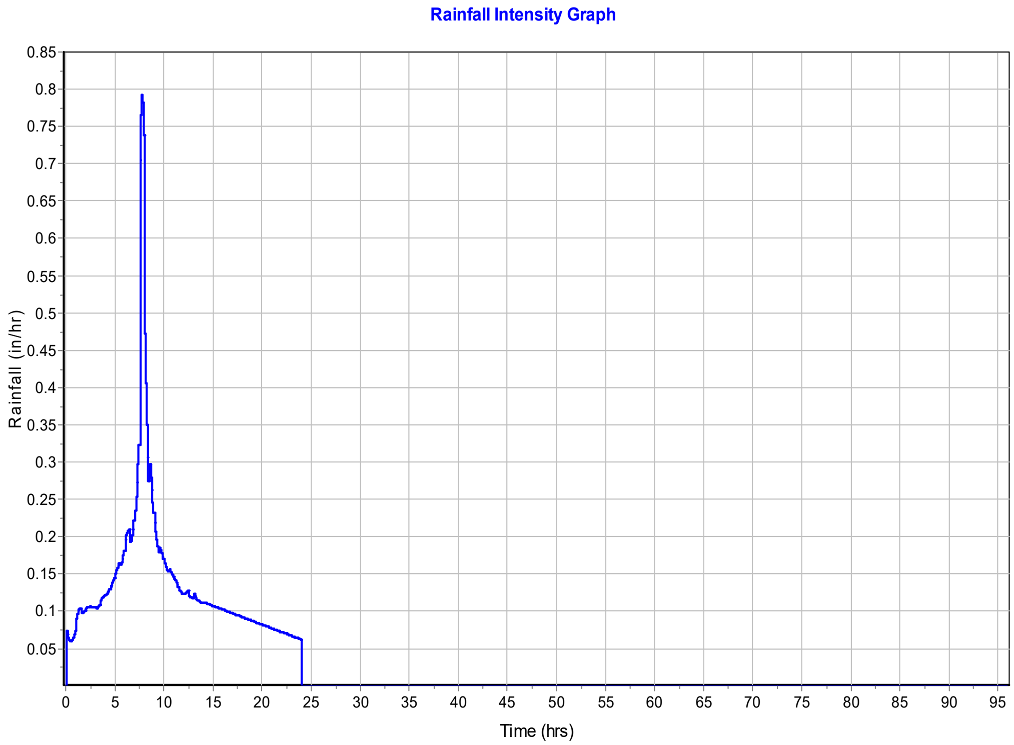
Time of Concentration

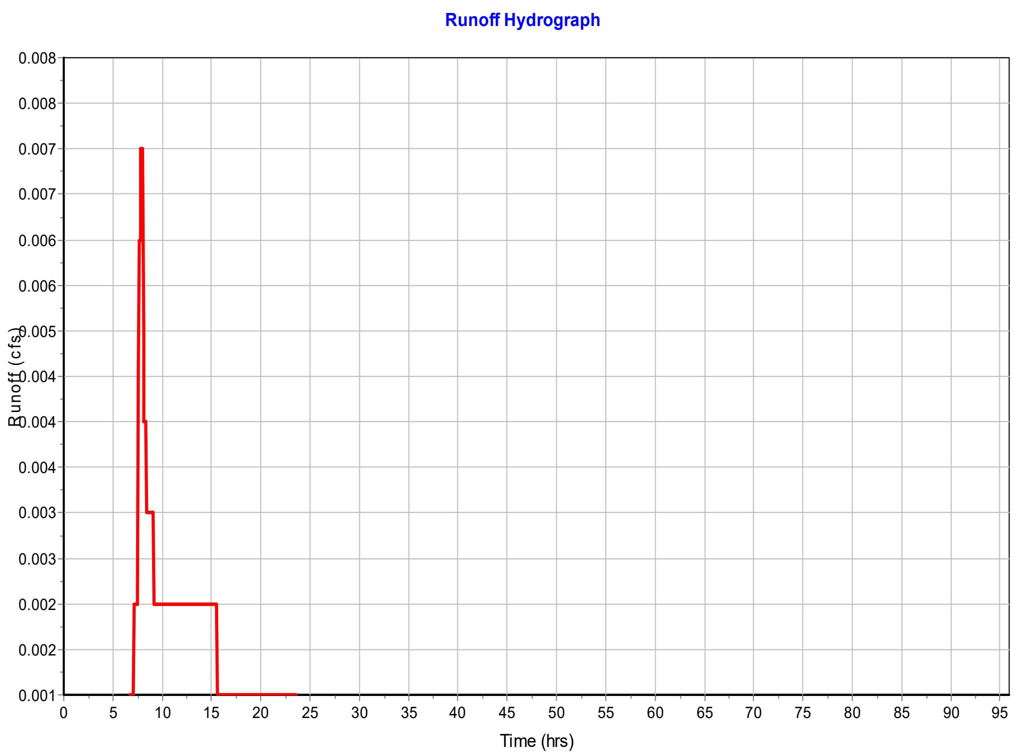
User-Defined TOC override (minutes): 5

Subbasin Runoff Results

Total Rainfall (in) 3.29
Total Runoff (in) 1.54
Peak Runoff (cfs) 0.01
Weighted Curve Number 82
Time of Concentration (days hh:mm:ss) 0 00:05:00

Subbasin : P5


Rainfall Intensity Graph
Rainfall (in/hr)
0.85
0.8
0.75
0.7
0.65
0.6
0.55
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95
Time (hrs)


Runoff Hydrograph
Runoff (cfs)
0.008
0.008
0.007
0.007
0.006
0.006
0.005
0.004
0.004
0.004
0.003
0.003
0.002
0.002
0.001
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95
Time (hrs)

Subbasin : P6

Input Data

Area (ac) 0.73
Peak Rate Factor 484
Weighted Curve Number 58
Rain Gage ID .... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Meadow, non-grazed	0.73	B	58
Composite Area & Weighted CN	0.73		58

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.3	0	0
Flow Length (ft) :	80	0	0
Slope (%) :	3.5	0	0
2 yr, 24 hr Rainfall (in) :	3.4	0	0
Velocity (ft/sec) :	0.12	0	0
Computed Flow Time (min) :	11.07	0	0

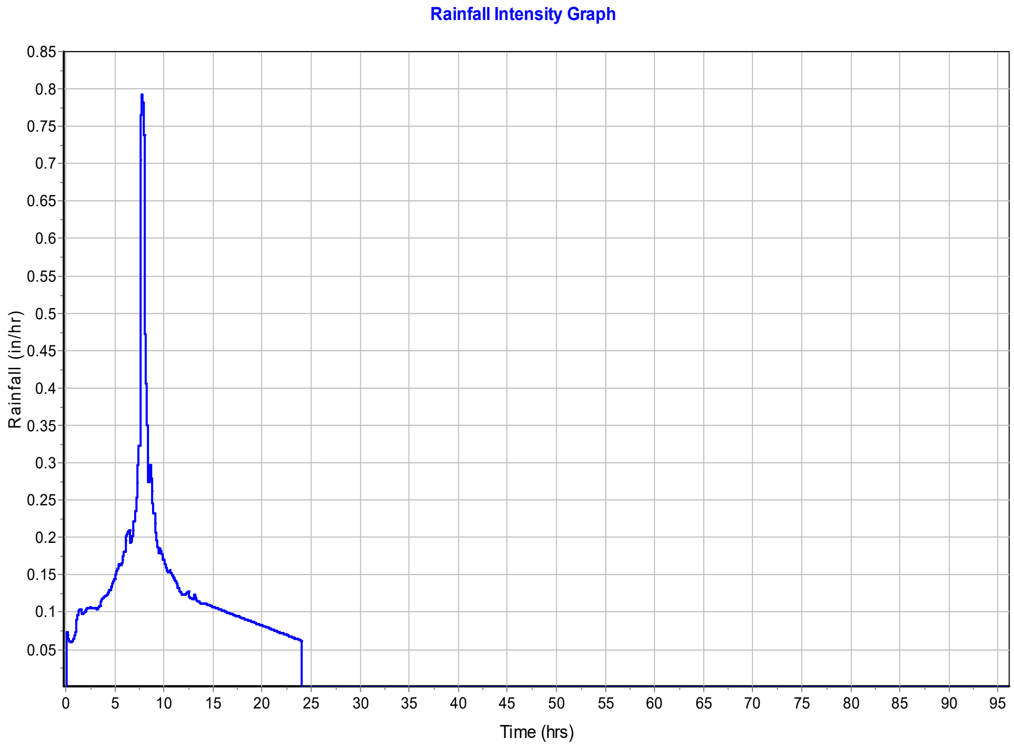
Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	50	0	0
Slope (%) :	1.3	0	0
Surface Type :	Grass pasture	Grass pasture	Unpaved
Velocity (ft/sec) :	0.8	0	0
Computed Flow Time (min) :	1.04	0	0

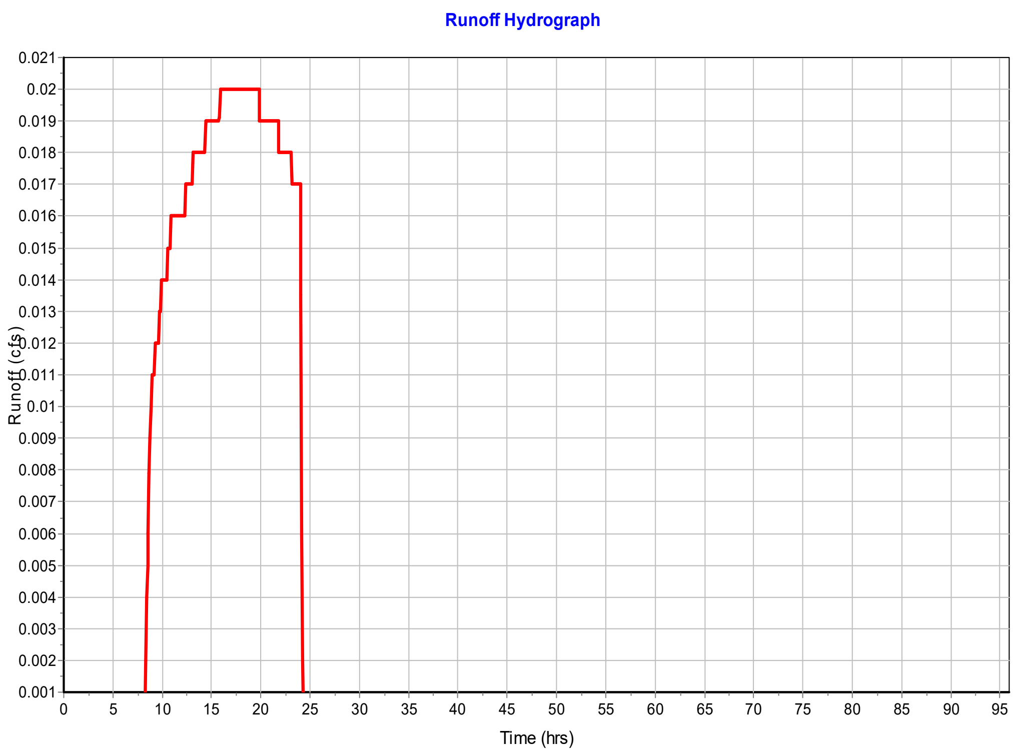
Total TOC (min) 12.11

Subbasin Runoff Results

Total Rainfall (in) 3.29
Total Runoff (in) 0.37
Peak Runoff (cfs) 0.02
Weighted Curve Number 58
Time of Concentration (days hh:mm:ss) 0 00:12:07

Subbasin : P6


Rainfall Intensity Graph
Rainfall (in/hr)
0.85
0.8
0.75
0.7
0.65
0.6
0.55
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95
Time (hrs)


Runoff Hydrograph
Runoff (cfs)
0.021
0.02
0.019
0.018
0.017
0.016
0.015
0.014
0.013
0.012
0.011
0.01
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95
Time (hrs)

Storage Nodes

Storage Node : Stor-01

Input Data

Invert Elevation (ft) 108.00
Max (Rim) Elevation (ft) 114.00
Max (Rim) Offset (ft) 6.00
Initial Water Elevation (ft) 108.00
Initial Water Depth (ft) 0.00
Ponded Area (ft^2) 0.00
Evaporation Loss 0.00

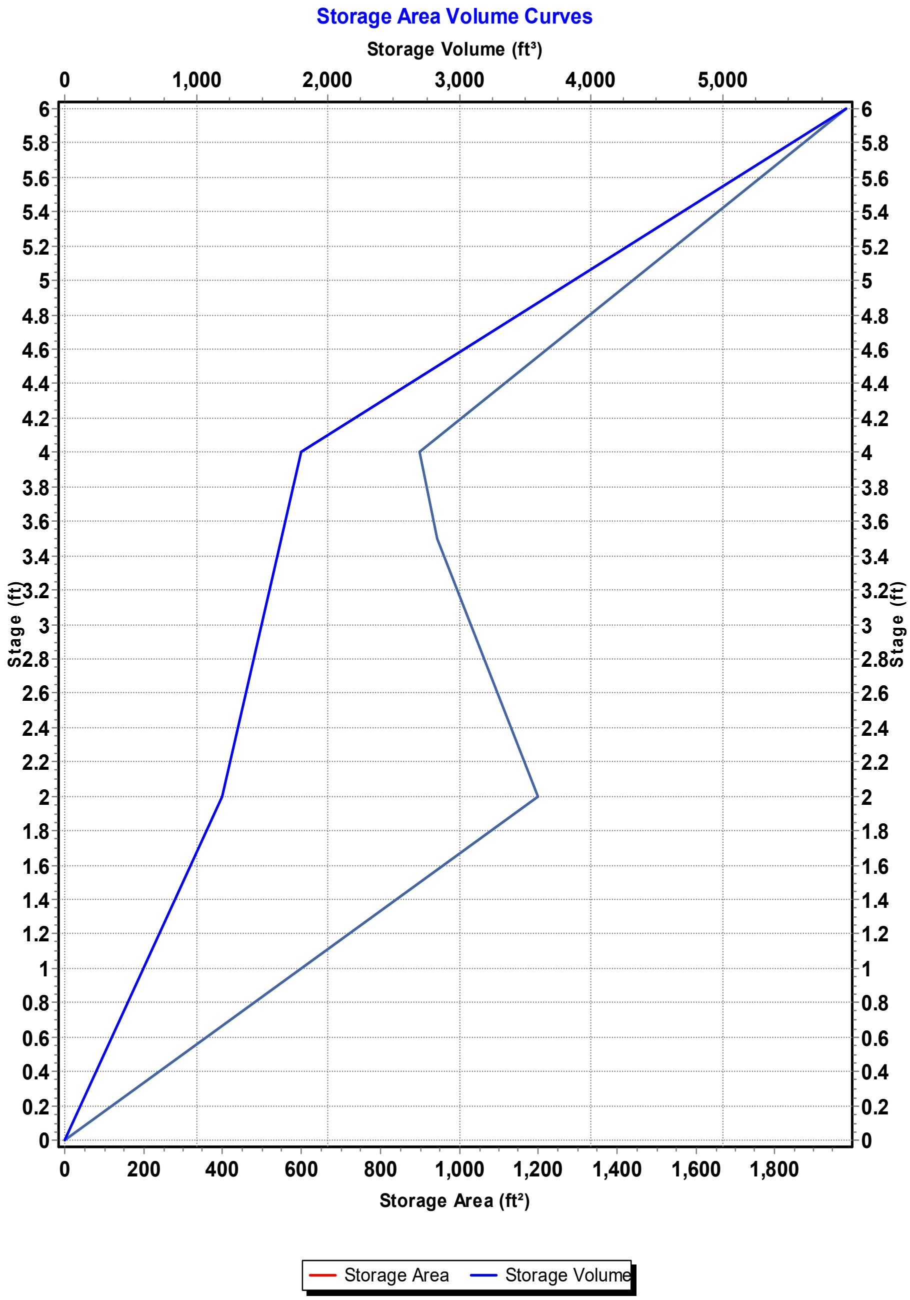
Infiltration/Exfiltration

Constant Flow Rate (cfs) 0.011

Storage Area Volume Curves

Storage Curve : Storage-01

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	0	0
2	1200	1200
3.5	942.86	1650
4	900	1800
6	1980.67	5942


Storage Area Volume Curves
Storage Volume (ft³)
0
1,000
2,000
3,000
4,000
5,000
Stage (ft)
6
5.8
5.6
5.4
5.2
5
4.8
4.6
4.4
4.2
4
3.8
3.6
3.4
3.2
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
200
400
600
800
1,000
1,200
1,400
1,600
1,800
Storage Area (ft²)
Storage Area
Storage Volume

Storage Node : Stor-01 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-01	Trapezoidal	No	113.00	5.00	6.00	1.00	3.33

Outflow Orifices

SN	Element ID	Orifice Type	Orifice Shape	Flap Gate	Circular Orifice Diameter (in)	Rectangular Orifice Height (in)	Rectangular Orifice Width (in)	Orifice Invert Elevation (ft)	Orifice Coefficient
1	Orifice-01a	Side	CIRCULAR	No	1.38			110.00	0.61
2	Orifice-01b	Side	Rectangular	No		3.00	6.00	112.50	0.63

Output Summary Results

Peak Inflow (cfs) 0.37
Peak Lateral Inflow (cfs) 0.37
Peak Outflow (cfs) 0.06
Peak Exfiltration Flow Rate (cfm) 0.66
Max HGL Elevation Attained (ft) 111.57
Max HGL Depth Attained (ft) 3.57
Average HGL Elevation Attained (ft) 109.24
Average HGL Depth Attained (ft) 1.24
Time of Max HGL Occurrence (days hh:mm) 0 21:23
Total Exfiltration Volume (1000-ft^3) 2.359
Total Flooded Volume (ac-in) 0
Total Time Flooded (min) 0
Total Retention Time (sec) 0

Storage Node : Stor-02

Input Data

Invert Elevation (ft) 116.00
Max (Rim) Elevation (ft) 119.00
Max (Rim) Offset (ft) 3.00
Initial Water Elevation (ft) 116.00
Initial Water Depth (ft) 0.00
Ponded Area (ft^2) 0.00
Evaporation Loss 0.00

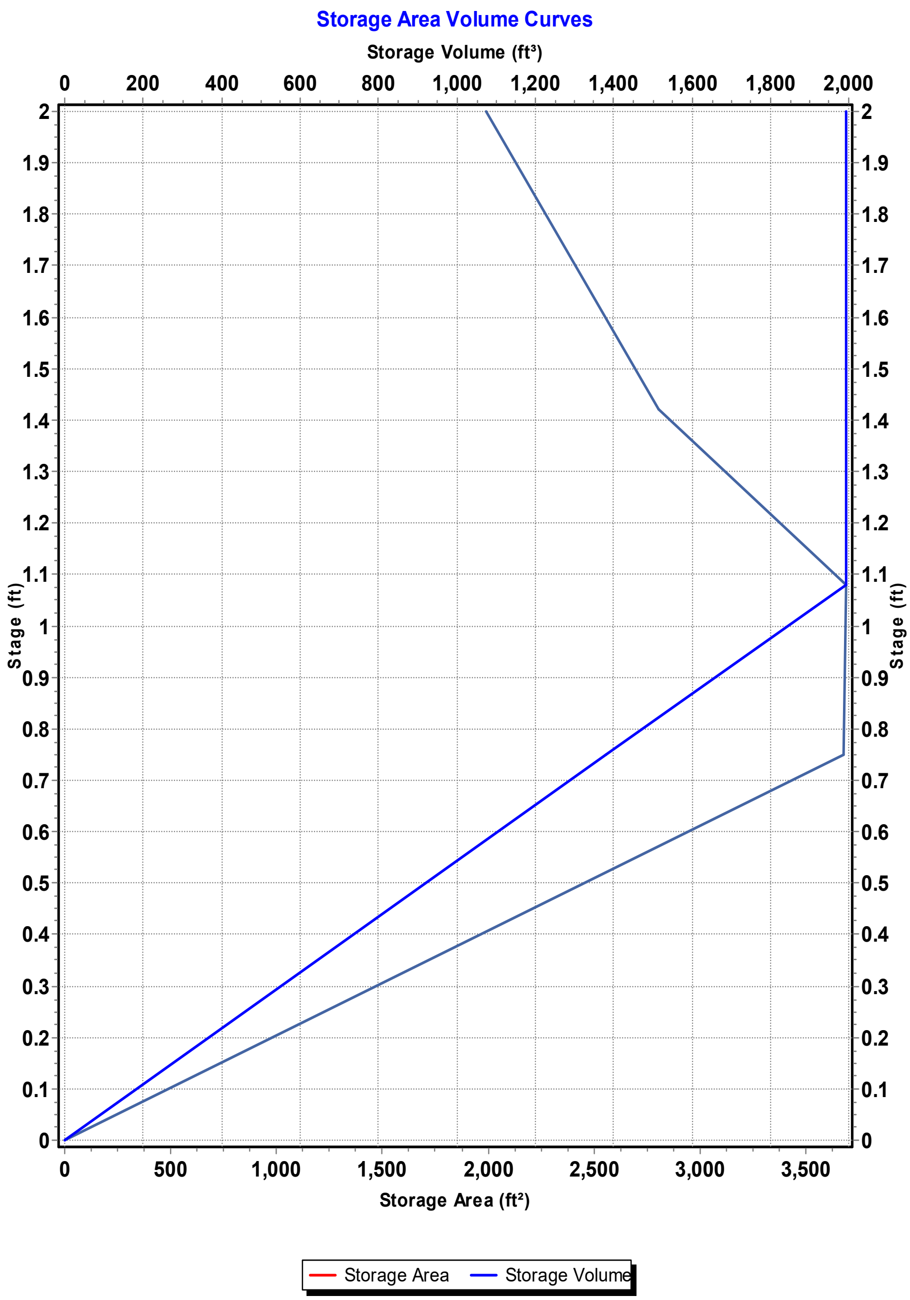
Infiltration/Exfiltration

Constant Flow Rate (cfs) 0.035

Storage Area Volume Curves

Storage Curve : Storage-02-03

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	0	0
0.75	3680	1380
1.08	3690.74	1993
1.42	2807.04	1993
2	1993	1993


Storage Area Volume Curves
Storage Volume (ft³)
0 200 400 600 800 1,000 1,200 1,400 1,600 1,800 2,000
Stage (ft)
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2
Stage (ft)
0 500 1,000 1,500 2,000 2,500 3,000 3,500
Storage Area (ft²)
Storage Area
Storage Volume

Storage Node : Stor-02 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-02	Trapezoidal	No	118.00	2.00	100.00	1.00	3.33

Outflow Orifices

SN	Element ID	Orifice Type	Orifice Shape	Flap Gate	Circular Orifice Diameter (in)	Rectangular Orifice Height (in)	Rectangular Orifice Width (in)	Orifice Invert Elevation (ft)	Orifice Coefficient
1	Orifice-02	Side	CIRCULAR	No	4.00			116.75	0.61

Output Summary Results

Peak Inflow (cfs) 0.12
Peak Lateral Inflow (cfs) 0.12
Peak Outflow (cfs) 0
Peak Exfiltration Flow Rate (cfm) 2.1
Max HGL Elevation Attained (ft) 116.29
Max HGL Depth Attained (ft) 0.29
Average HGL Elevation Attained (ft) 116.02
Average HGL Depth Attained (ft) 0.02
Time of Max HGL Occurrence (days hh:mm) 0 10:05
Total Exfiltration Volume (1000-ft^3) 1.229
Total Flooded Volume (ac-in) 0
Total Time Flooded (min) 0
Total Retention Time (sec) 0

Storage Node : Stor-03

Input Data

Invert Elevation (ft)	116.00
Max (Rim) Elevation (ft)	119.00
Max (Rim) Offset (ft)	3.00
Initial Water Elevation (ft)	116.00
Initial Water Depth (ft)	0.00
Ponded Area (ft^2)	0.00
Evaporation Loss	0.00

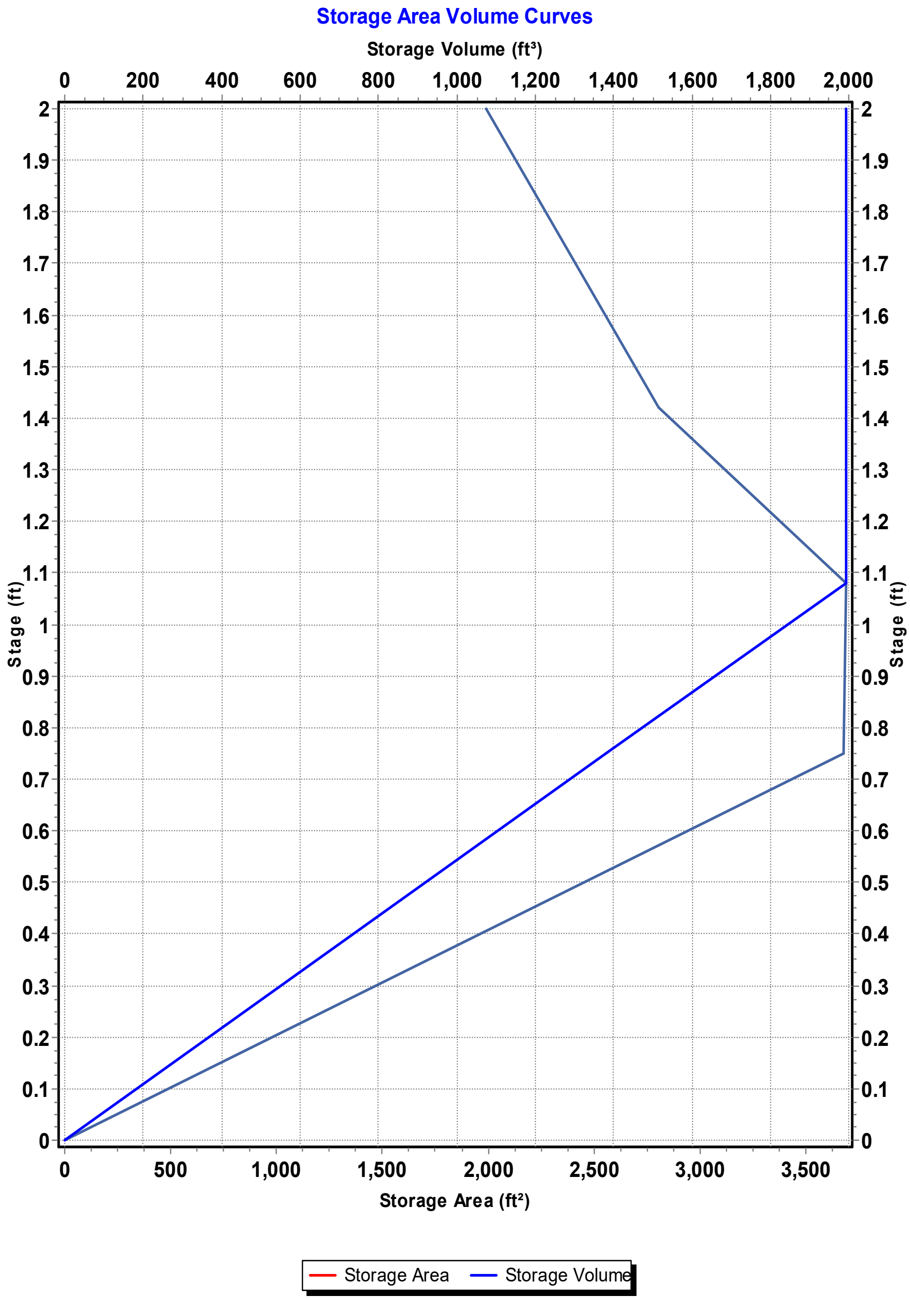
Infiltration/Exfiltration

Constant Flow Rate (cfs)	0.036

Storage Area Volume Curves

Storage Curve : Storage-02-03

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	0	0
0.75	3680	1380
1.08	3690.74	1993
1.42	2807.04	1993
2	1993	1993


Storage Area Volume Curves
Storage Volume (ft³)
0 200 400 600 800 1,000 1,200 1,400 1,600 1,800 2,000
Stage (ft)
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2
0 500 1,000 1,500 2,000 2,500 3,000 3,500
Storage Area (ft²)
Storage Area
Storage Volume

Storage Node : Stor-03 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-03	Trapezoidal	No	118.00	2.00	100.00	1.00	3.33

Outflow Orifices

SN	Element ID	Orifice Type	Orifice Shape	Flap Gate	Circular Orifice Diameter (in)	Rectangular Orifice Height (in)	Rectangular Orifice Width (in)	Orifice Invert Elevation (ft)	Orifice Coefficient
1	Orifice-03	Side	CIRCULAR	No	4.00			116.75	0.61

Output Summary Results

Peak Inflow (cfs) 0.18
Peak Lateral Inflow (cfs) 0.18
Peak Outflow (cfs) 0
Peak Exfiltration Flow Rate (cfm) 2.16
Max HGL Elevation Attained (ft) 116.53
Max HGL Depth Attained (ft) 0.53
Average HGL Elevation Attained (ft) 116.1
Average HGL Depth Attained (ft) 0.1
Time of Max HGL Occurrence (days hh:mm) 0 18:06
Total Exfiltration Volume (1000-ft^3) 2.786
Total Flooded Volume (ac-in) 0
Total Time Flooded (min) 0
Total Retention Time (sec) 0

Storage Node : Stor-04

Input Data

Invert Elevation (ft) 116.00
Max (Rim) Elevation (ft) 119.00
Max (Rim) Offset (ft) 3.00
Initial Water Elevation (ft) 116.00
Initial Water Depth (ft) 0.00
Ponded Area (ft^2) 0.00
Evaporation Loss 0.00

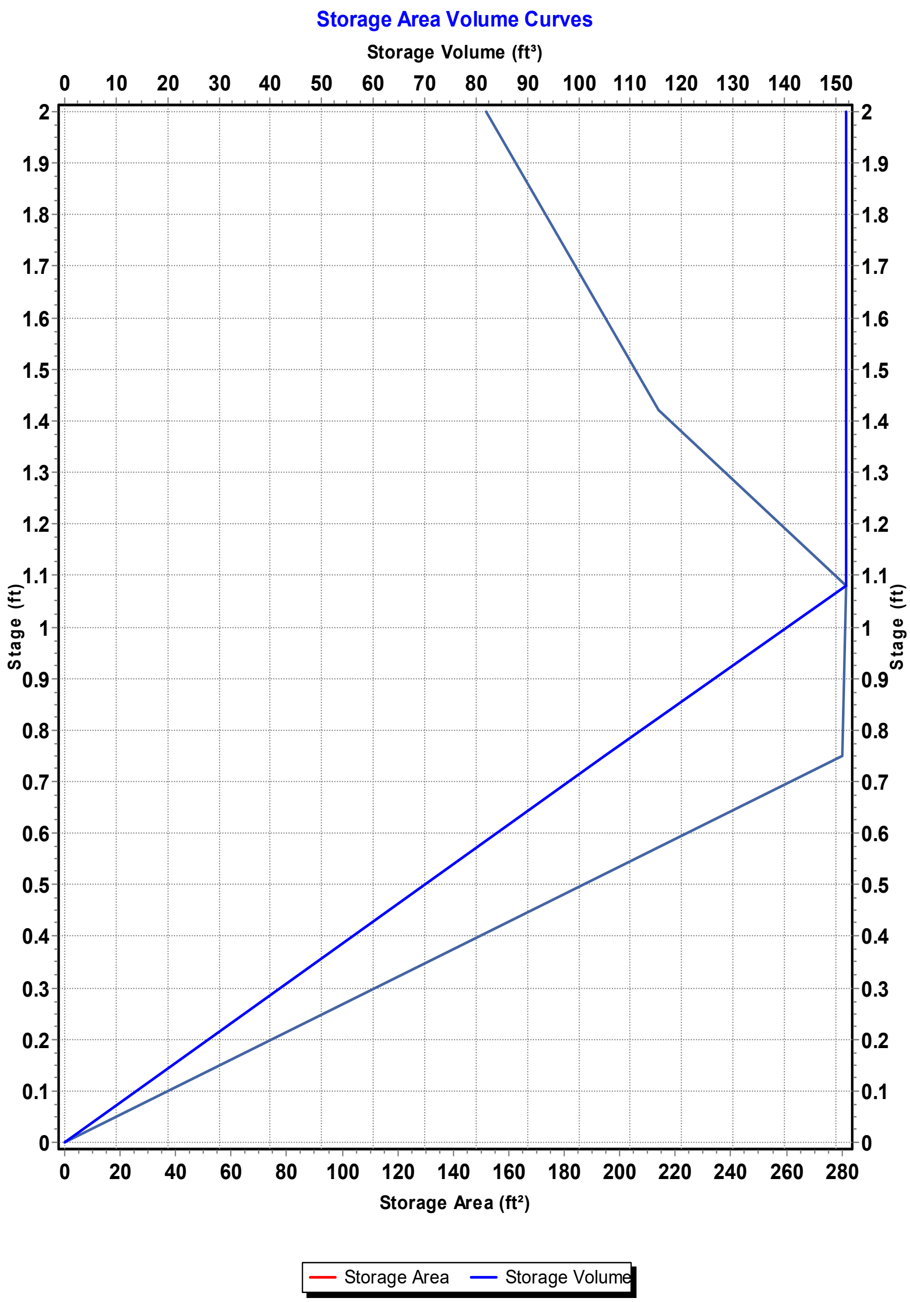
Infiltration/Exfiltration

Constant Flow Rate (cfs) 0.0027

Storage Area Volume Curves

Storage Curve : Storage-04-06

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	0	0
0.75	280	105
1.08	281.48	152
1.42	214.08	152
2	152	152


Storage Area Volume Curves
Storage Volume (ft³)
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150
Stage (ft)
2 1.9 1.8 1.7 1.6 1.5 1.4 1.3 1.2 1.1 1 0.9 0.8 0.7 0.6 0.5 0.4 0.3 0.2 0.1 0
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280
Storage Area (ft²)
Storage Area
Storage Volume

Storage Node : Stor-04 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-04	Trapezoidal	No	118.00	2.00	15.00	1.00	3.33

Outflow Orifices

SN	Element ID	Orifice Type	Orifice Shape	Flap Gate	Circular Orifice Diameter (in)	Rectangular Orifice Height (in)	Rectangular Orifice Width (in)	Orifice Invert Elevation (ft)	Orifice Coefficient
1	Orifice-04	Side	CIRCULAR	No	4.00			116.75	0.61

Output Summary Results

Peak Inflow (cfs) 0.01
Peak Lateral Inflow (cfs) 0.01
Peak Outflow (cfs) 0
Peak Exfiltration Flow Rate (cfm) 0.16
Max HGL Elevation Attained (ft) 116.26
Max HGL Depth Attained (ft) 0.26
Average HGL Elevation Attained (ft) 116.01
Average HGL Depth Attained (ft) 0.01
Time of Max HGL Occurrence (days hh:mm) 0 09:26
Total Exfiltration Volume (1000-ft^3) 0.066
Total Flooded Volume (ac-in) 0
Total Time Flooded (min) 0
Total Retention Time (sec) 0

Storage Node : Stor-05

Input Data

Invert Elevation (ft) 116.00
Max (Rim) Elevation (ft) 119.00
Max (Rim) Offset (ft) 3.00
Initial Water Elevation (ft) 116.00
Initial Water Depth (ft) 0.00
Ponded Area (ft^2) 0.00
Evaporation Loss 0.00

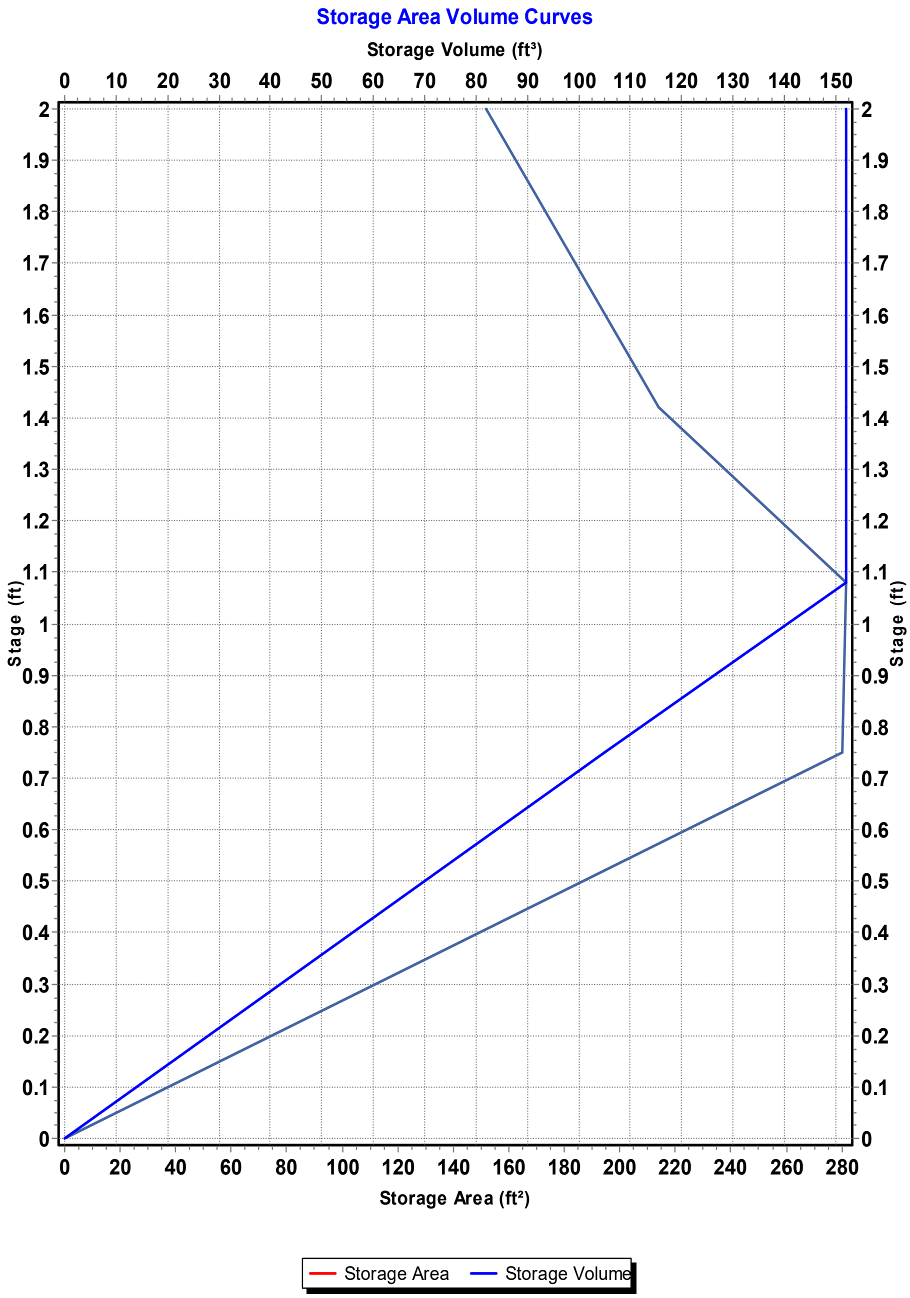
Infiltration/Exfiltration

Constant Flow Rate (cfs) 0.0027

Storage Area Volume Curves

Storage Curve : Storage-04-06

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	0	0
0.75	280	105
1.08	281.48	152
1.42	214.08	152
2	152	152


Storage Area Volume Curves
Storage Volume (ft³)
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150
Stage (ft)
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280
Storage Area (ft²)
Storage Area
Storage Volume

Storage Node : Stor-05 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-05	Trapezoidal	No	118.00	2.00	15.00	1.00	3.33

Outflow Orifices

SN	Element ID	Orifice Type	Orifice Shape	Flap Gate	Circular Orifice Diameter (in)	Rectangular Orifice Height (in)	Rectangular Orifice Width (in)	Orifice Invert Elevation (ft)	Orifice Coefficient
1	Orifice-05	Side	CIRCULAR	No	4.00			116.75	0.61

Output Summary Results

Peak Inflow (cfs) 0.01
Peak Lateral Inflow (cfs) 0.01
Peak Outflow (cfs) 0
Peak Exfiltration Flow Rate (cfm) 0.16
Max HGL Elevation Attained (ft) 116.22
Max HGL Depth Attained (ft) 0.22
Average HGL Elevation Attained (ft) 116.01
Average HGL Depth Attained (ft) 0.01
Time of Max HGL Occurrence (days hh:mm) 0 09:11
Total Exfiltration Volume (1000-ft^3) 0.05
Total Flooded Volume (ac-in) 0
Total Time Flooded (min) 0
Total Retention Time (sec) 0

ATTACHMENT 5

References

ATLAS Civil Design

3) Historic sites, structures or landscapes that cannot alter their original configuration in order to maintain their historic integrity.

By the second year of the effective date of the permit, each Permittee shall adopt or reference appropriate performance criteria for such biotreatment and media filters.

(iii) **Reporting** – The Permittee shall use State Water Board SMARTS to submit a summary of the past year activities and certify compliance with all requirements of this program element. The summary shall also address the relationship between the program element activities and the Permittee's Program Effectiveness Assessment and Improvement Plan that tracks annual and long-term effectiveness of the storm water program. If a Permittee is unable to certify compliance with a requirement in this program element see Section E.16.a.for compliance directions.

E.12.f. Hydromodification Management

(i) **Task Description** – Within the third year of the effective date of the permit, the Permittee shall develop and implement Hydromodification Management procedures. Hydromodification management projects are Regulated Projects that create and/or replace one acre or more of impervious surface. A project that does not increase impervious surface area over the pre-project condition is not a hydromodification management project.

(ii) **Implementation Level** - The Permittee shall implement the following Hydromodification Standard:

(a) Post-project runoff shall not exceed estimated pre-project flow rate for the 2-year, 24-hour storm in the following geomorphic provinces (Figure 1):

- Coast Ranges
- Klamath Mountains
- Cascade Range
- Modoc Plateau
- Basin and Range
- Sierra Nevada
- Great Valley

(b) Post-project runoff shall not exceed estimated pre-project flow rate for the 10-year, 24-hour storm in the following geomorphic provinces (Figure 1):

- Transverse Ranges
- Peninsular Ranges
- Mojave Desert
- Colorado Desert

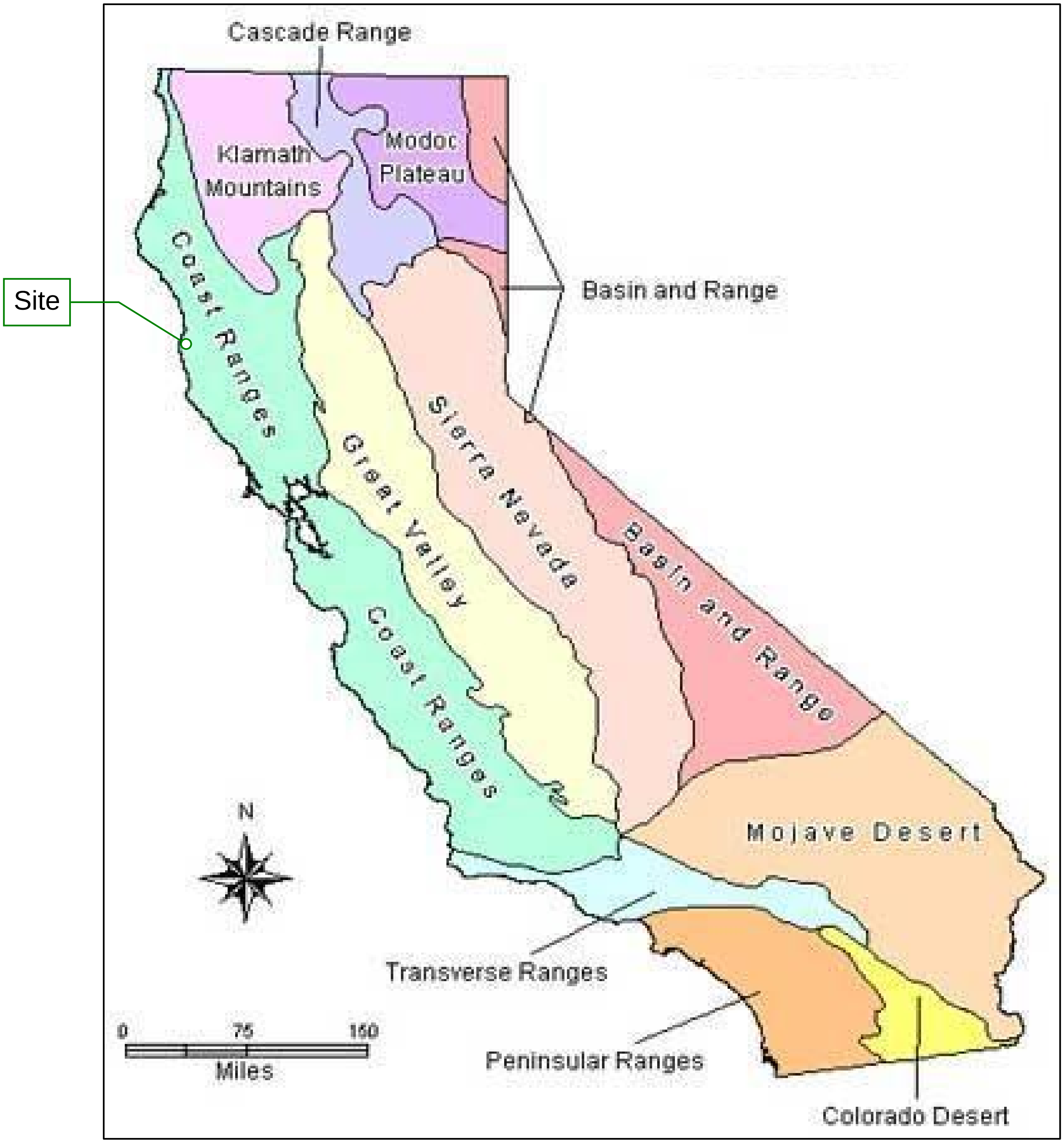


Figure 1 — California Geomorphic Provinces

Alternatively, the Permittee may use a geomorphically based hydromodification standard or set of standards and analysis procedures designed to ensure that Regulated Projects do not cause a decrease in lateral (bank) and vertical (channel bed) stability in receiving stream channels. The alternative hydromodification standard or set of standards and analysis procedures must be reviewed and approved by the Regional Board Executive Officer.

(iii) **Reporting** –The Permittee shall use State Water Board SMARTS to submit a summary of the past year activities and certify compliance with all requirements of this program element. The summary shall also address the relationship between the program element activities and the Permittee's Program Effectiveness Assessment and Improvement Plan that tracks annual and long- term effectiveness of the storm water program. If a Permittee is unable to certify compliance with a requirement in this program element see Section E.16.a.for compliance directions.

E.12.g. Enforceable Mechanisms

(i) **Task Description** - Within the third year of the effective date of the permit, the Permittee shall develop and/or modify enforceable mechanisms that will effectively implement the requirements in Section E.12.b through f (if necessary).

(ii) **Implementation Level** - The Permittee shall develop and/or modify enforceable mechanisms that will effectively implement the requirements in Section E.12.b through E.12.f and may include municipal codes, regulations, standards, and specifications. The Permittee shall:

(a) Conduct an analysis of all applicable codes, regulations, standards, and/or specifications to identify modifications and/or additions necessary to fill gaps and remove impediments to effective implementation of project-scale development requirements.

(b) Approve new and/or modified enforceable mechanisms that effectively resolve regulatory conflicts and implement the requirements in Sections E.12.b through E.12.f (if necessary)

(c) Apply new and/or modified enforceable mechanisms to all applicable new and redevelopment projects. Develop and make available specific guidance for LID BMP design

(d) Complete a Tracking Report indicating the Permittee's accomplishments in education and outreach supporting implementation of LID requirements for new and redevelopment projects.

E.12.h. Operation and Maintenance of Post-Construction Storm Water Management Measures

(i) **Task Description** –Within the second year of the effective date of the permit, the Permittee shall implement an O&M Verification Program for storm water treatment and baseline hydromodification management structural control measures defined in Section E.12.e(ii)(f). Storm Water Treatment Measures and Baseline Hydromodification Management Measures on all Regulated Projects.

(ii) **Implementation Level** – At a minimum, the O&M Verification Program shall include the following elements:

(a) All Regulated Projects shall at a minimum, require at least one of the following from all project proponents and their successors in control of the Project or successors in fee title:

1) The project proponent's signed statement accepting responsibility for the O&M of structural control measure(s) until such responsibility is legally transferred to another entity;

NOAA Atlas 14, Volume 6, Version 2
Location name: Fort Bragg, California, USA*
Latitude: 39.4283°, Longitude: -123.8017°
Elevation: 118 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.131** (0.116-0.150)	**0.193** (0.171-0.220)	**0.269** (0.237-0.309)	**0.328** (0.287-0.380)	**0.405** (0.339-0.488)	**0.460** (0.376-0.569)	**0.515** (0.408-0.655)	**0.568** (0.436-0.748)	**0.637** (0.465-0.881)	**0.688** (0.482-0.991)
10-min	**0.188** (0.167-0.215)	**0.277** (0.245-0.316)	**0.386** (0.340-0.442)	**0.471** (0.411-0.545)	**0.580** (0.486-0.699)	**0.660** (0.539-0.816)	**0.738** (0.585-0.939)	**0.814** (0.625-1.07)	**0.913** (0.667-1.26)	**0.986** (0.691-1.42)
15-min	**0.228** (0.202-0.260)	**0.335** (0.296-0.382)	**0.467** (0.412-0.535)	**0.569** (0.497-0.659)	**0.702** (0.588-0.846)	**0.798** (0.652-0.987)	**0.892** (0.708-1.14)	**0.985** (0.755-1.30)	**1.10** (0.806-1.53)	**1.19** (0.835-1.72)
30-min	**0.312** (0.277-0.356)	**0.459** (0.406-0.524)	**0.640** (0.564-0.733)	**0.781** (0.681-0.904)	**0.962** (0.806-1.16)	**1.09** (0.894-1.35)	**1.22** (0.970-1.56)	**1.35** (1.04-1.78)	**1.51** (1.10-2.10)	**1.63** (1.14-2.36)
60-min	**0.440** (0.390-0.502)	**0.646** (0.571-0.738)	**0.901** (0.795-1.03)	**1.10** (0.959-1.27)	**1.36** (1.14-1.63)	**1.54** (1.26-1.90)	**1.72** (1.37-2.19)	**1.90** (1.46-2.50)	**2.13** (1.56-2.95)	**2.30** (1.61-3.32)
2-hr	**0.668** (0.591-0.761)	**0.893** (0.790-1.02)	**1.18** (1.04-1.36)	**1.42** (1.24-1.64)	**1.72** (1.44-2.08)	**1.96** (1.60-2.42)	**2.19** (1.74-2.79)	**2.43** (1.86-3.20)	**2.74** (2.00-3.79)	**2.98** (2.09-4.29)
3-hr	**0.861** (0.763-0.982)	**1.12** (0.987-1.27)	**1.45** (1.27-1.66)	**1.71** (1.49-1.98)	**2.07** (1.74-2.50)	**2.34** (1.92-2.90)	**2.62** (2.08-3.34)	**2.90** (2.23-3.82)	**3.28** (2.39-4.54)	**3.57** (2.50-5.14)
6-hr	**1.27** (1.12-1.45)	**1.59** (1.41-1.82)	**2.01** (1.78-2.31)	**2.35** (2.05-2.72)	**2.81** (2.36-3.39)	**3.16** (2.58-3.90)	**3.51** (2.78-4.47)	**3.87** (2.97-5.09)	**4.35** (3.17-6.01)	**4.71** (3.30-6.79)
12-hr	**1.80** (1.60-2.06)	**2.32** (2.05-2.65)	**2.96** (2.61-3.39)	**3.45** (3.02-4.00)	**4.10** (3.43-4.94)	**4.57** (3.73-5.64)	**5.02** (3.98-6.40)	**5.47** (4.20-7.21)	**6.05** (4.42-8.38)	**6.48** (4.54-9.34)
24-hr	**2.49** (2.24-2.83)	**3.29** (2.95-3.74)	**4.26** (3.81-4.85)	**4.99** (4.43-5.73)	**5.90** (5.08-7.00)	**6.56** (5.53-7.94)	**7.18** (5.91-8.90)	**7.78** (6.23-9.90)	**8.53** (6.57-11.3)	**9.07** (6.76-12.4)
2-day	**3.28** (2.95-3.73)	**4.21** (3.78-4.78)	**5.34** (4.78-6.09)	**6.22** (5.52-7.14)	**7.33** (6.31-8.70)	**8.13** (6.86-9.84)	**8.91** (7.34-11.0)	**9.66** (7.75-12.3)	**10.6** (8.18-14.1)	**11.3** (8.43-15.5)
3-day	**3.87** (3.48-4.39)	**4.87** (4.37-5.54)	**6.13** (5.48-6.98)	**7.10** (6.31-8.16)	**8.36** (7.19-9.91)	**9.28** (7.82-11.2)	**10.2** (8.37-12.6)	**11.0** (8.86-14.1)	**12.2** (9.38-16.1)	**13.0** (9.69-17.8)
4-day	**4.38** (3.93-4.97)	**5.47** (4.91-6.22)	**6.84** (6.13-7.80)	**7.92** (7.03-9.09)	**9.30** (8.00-11.0)	**10.3** (8.70-12.5)	**11.3** (9.32-14.0)	**12.3** (9.87-15.7)	**13.6** (10.5-18.0)	**14.5** (10.8-19.9)
7-day	**5.54** (4.98-6.29)	**6.90** (6.19-7.84)	**8.60** (7.70-9.81)	**9.94** (8.83-11.4)	**11.7** (10.0-13.8)	**12.9** (10.9-15.6)	**14.2** (11.7-17.5)	**15.4** (12.3-19.6)	**16.9** (13.1-22.5)	**18.1** (13.5-24.8)
10-day	**6.41** (5.76-7.28)	**8.00** (7.18-9.10)	**10.0** (8.95-11.4)	**11.5** (10.3-13.3)	**13.5** (11.7-16.1)	**15.0** (12.6-18.2)	**16.4** (13.5-20.3)	**17.8** (14.3-22.7)	**19.6** (15.1-26.0)	**20.9** (15.6-28.6)
20-day	**8.75** (7.86-9.93)	**11.0** (9.90-12.5)	**13.8** (12.4-15.8)	**16.0** (14.2-18.4)	**18.8** (16.1-22.3)	**20.8** (17.5-25.1)	**22.7** (18.7-28.1)	**24.5** (19.7-31.2)	**26.9** (20.7-35.6)	**28.6** (21.3-39.2)
30-day	**10.8** (9.67-12.2)	**13.7** (12.3-15.5)	**17.2** (15.4-19.6)	**19.9** (17.7-22.8)	**23.3** (20.0-27.6)	**25.7** (21.7-31.1)	**28.0** (23.1-34.7)	**30.3** (24.3-38.5)	**33.1** (25.5-43.8)	**35.1** (26.1-48.1)
45-day	**13.5** (12.1-15.3)	**17.2** (15.4-19.6)	**21.7** (19.4-24.8)	**25.1** (22.3-28.9)	**29.4** (25.3-34.8)	**32.4** (27.3-39.2)	**35.2** (29.0-43.6)	**37.9** (30.4-48.3)	**41.3** (31.8-54.7)	**43.6** (32.5-59.8)
60-day	**16.0** (14.3-18.1)	**20.4** (18.4-23.2)	**25.8** (23.1-29.4)	**29.8** (26.5-34.3)	**34.8** (29.9-41.3)	**38.3** (32.3-46.3)	**41.6** (34.2-51.5)	**44.7** (35.8-56.9)	**48.5** (37.3-64.2)	**51.1** (38.1-70.1)

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

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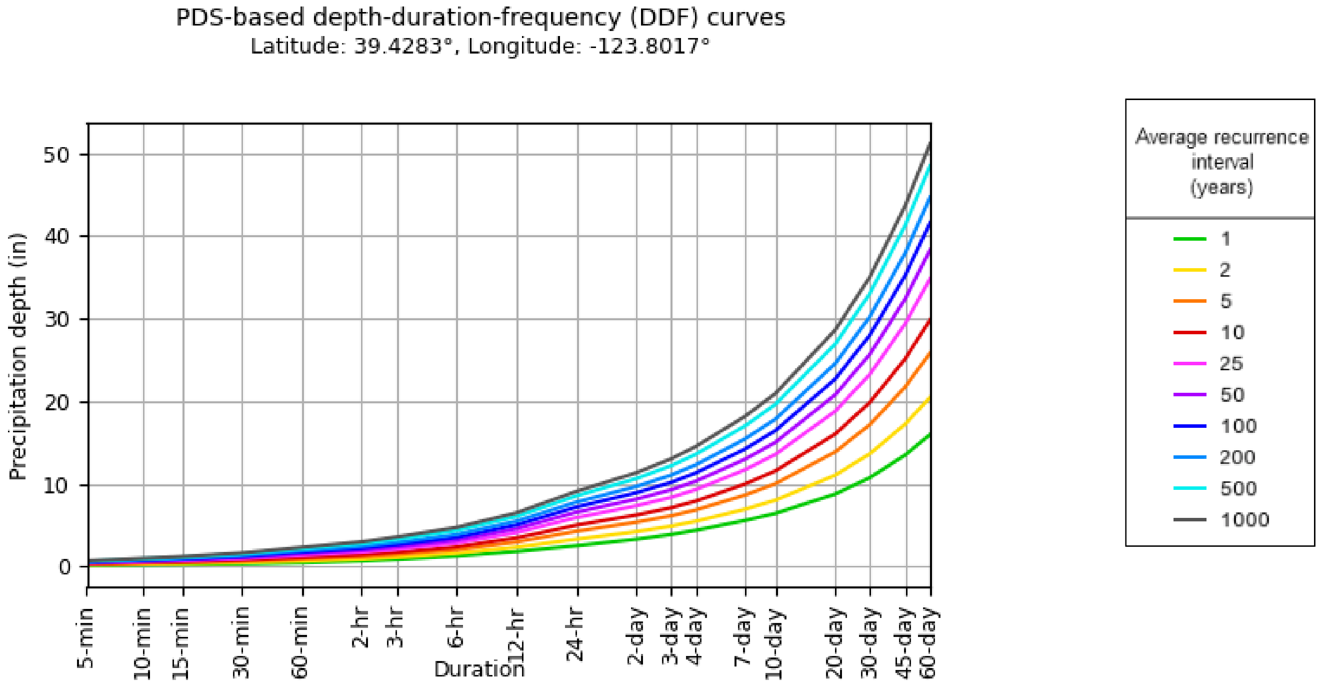
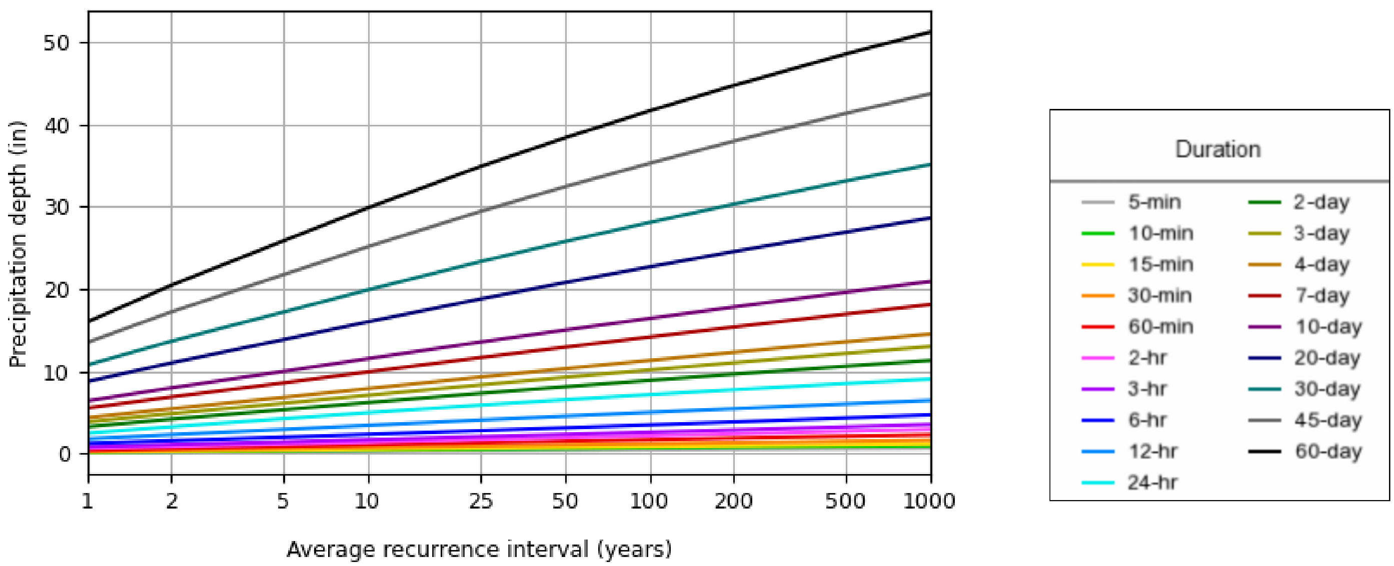
PF graphical





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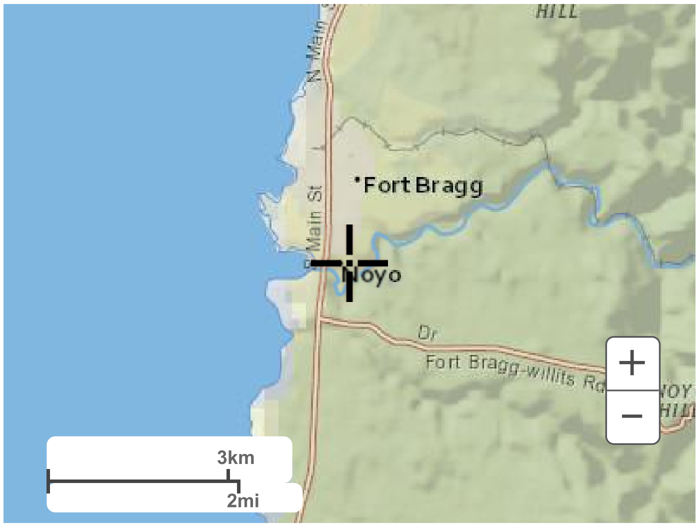
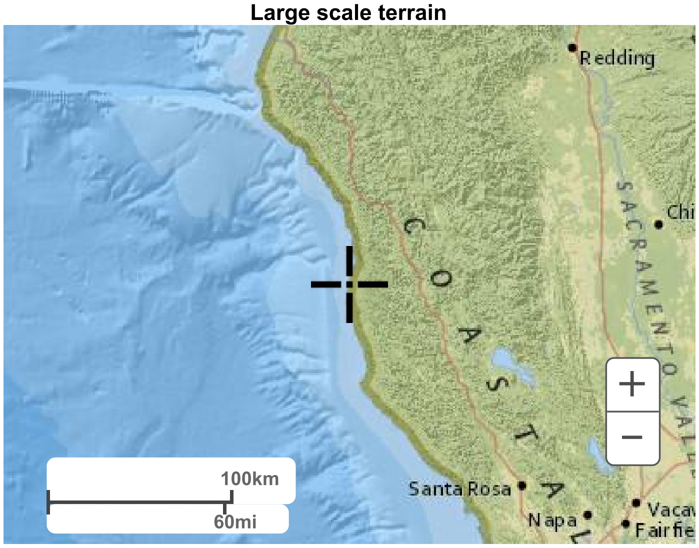
Maps & aerials

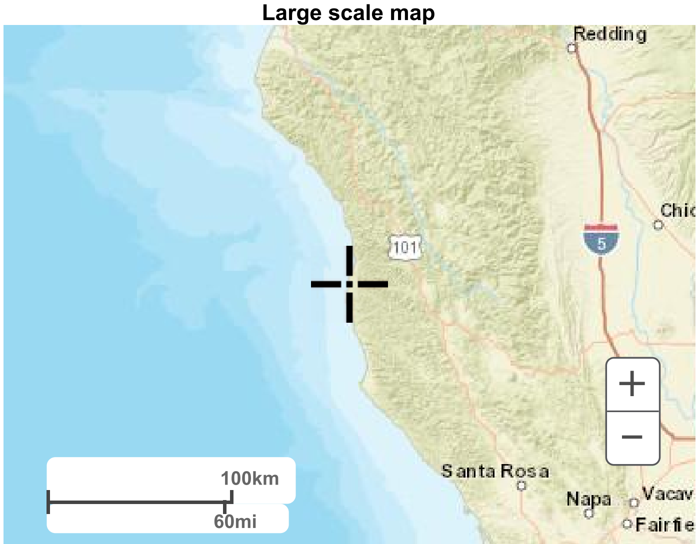
Small scale terrain



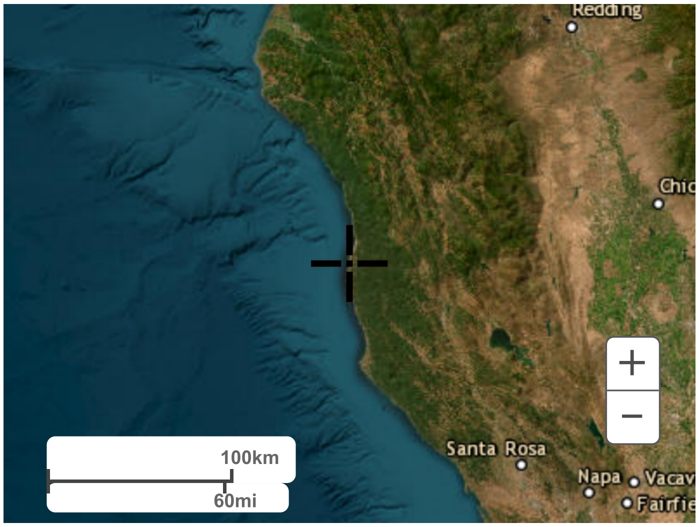
Large scale terrain



Large scale map



Large scale aerial



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National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
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Disclaimer

Table 2-2a Runoff curve numbers for urban areas [1]

Cover type and hydrologic condition	Average percent impervious area [2]	A	B	C	D
		Curve numbers for hydrologic soil group			
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

1 Average runoff condition, and $I_a = 0.2S$.
2 The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.
3 CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.
4 Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.
5 Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

Table 2-2b Runoff curve numbers for cultivated agricultural lands [1]

Cover description			Curve numbers for hydrologic soil group			
Cover type	Treatment [2]	Hydrologic condition [3]	A	B	C	D
Fallow	Bare soil	—	77	86	91	94
	Crop residue cover (CR)	Poor	76	85	90	93
		Good	74	83	88	90
Row crops	Straight row (SR)	Poor	72	81	88	91
		Good	67	78	85	89
	SR + CR	Poor	71	80	87	90
		Good	64	75	82	85
	Contoured (C)	Poor	70	79	84	88
		Good	65	75	82	86
	C + CR	Poor	69	78	83	87
		Good	64	74	81	85
	Contoured & terraced (C&T)	Poor	66	74	80	82
		Good	62	71	78	81
	C&T+ CR	Poor	65	73	79	81
		Good	61	70	77	80
Small grain	SR	Poor	65	76	84	88
		Good	63	75	83	87
	SR + CR	Poor	64	75	83	86
		Good	60	72	80	84
	C	Poor	63	74	82	85
		Good	61	73	81	84
	C + CR	Poor	62	73	81	84
		Good	60	72	80	83
	C&T	Poor	61	72	79	82
		Good	59	70	78	81
	C&T+ CR	Poor	60	71	78	81
		Good	58	69	77	80
Close-seeded or broadcast legumes or rotation meadow	SR	Poor	66	77	85	89
		Good	58	72	81	85
	C	Poor	64	75	83	85
		Good	55	69	78	83
	C&T	Poor	63	73	80	83
		Good	51	67	76	80

1 Average runoff condition, and I_a=0.2S
2 Crop residue cover applies only if residue is on at least 5% of the surface throughout the year.
3 Hydraulic condition is based on combination factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes, (d) percent of residue cover on the land surface (good ≥ 20%), and (e) degree of surface roughness.

Poor: Factors impair infiltration and tend to increase runoff.

Good: Factors encourage average and better than average infiltration and tend to decrease runoff.

Table 2-2c Runoff curve numbers for other agricultural lands [1]

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing. [2]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element. [3]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30 [4]	48	65	73
Woods—grass combination (orchard or tree farm). [5]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods. [6]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30 [4]	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

1 Average runoff condition, and $I_a = 0.2S$.
2 ***Poor:*** <50%) ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: > 75% ground cover and lightly or only occasionally grazed.
3 ***Poor***: <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.
4 Actual curve number is less than 30; use CN = 30 for runoff computations.
5 CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.
6 ***Poor:*** Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

Appendix B Synthetic Rainfall Distributions and Rainfall Data Sources

The highest peak discharges from small watersheds in the United States are usually caused by intense, brief rainfalls that may occur as distinct events or as part of a longer storm. These intense rainstorms do not usually extended over a large area and intensities vary greatly. One common practice in rainfall-runoff analysis is to develop a synthetic rainfall distribution to use in lieu of actual storm events. This distribution includes maximum rainfall intensities for the selected design frequency arranged in a sequence that is critical for producing peak runoff.

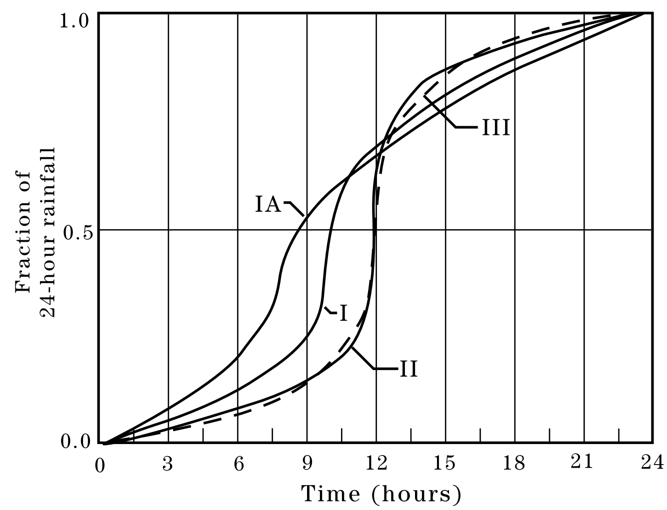
Synthetic rainfall distributions

The length of the most intense rainfall period contributing to the peak runoff rate is related to the time of concentration (T_c) for the watershed. In a hydrograph created with NRCS procedures, the duration of rainfall that directly contributes to the peak is about 170 percent of the T_c. For example, the most intense 8.5-minute rainfall period would contribute to the peak discharge for a watershed with a T_c of 5 minutes. The most intense 8.5-hour period would contribute to the peak for a watershed with a 5-hour T_c.

Different rainfall distributions can be developed for each of these watersheds to emphasize the critical rainfall duration for the peak discharges. However, to avoid the use of a different set of rainfall intensities for each drainage area size, a set of synthetic rainfall distributions having "nested" rainfall intensities was developed. The set "maximizes" the rainfall intensities by incorporating selected short duration intensities within those needed for longer durations at the same probability level.

For the size of the drainage areas for which NRCS usually provides assistance, a storm period of 24 hours was chosen the synthetic rainfall distributions. The 24-hour storm, while longer than that needed to determine peaks for these drainage areas, is appropriate for determining runoff volumes. Therefore, a single storm duration and associated synthetic rainfall distribution can be used to represent not only the peak discharges but also the runoff volumes for a range of drainage area sizes.

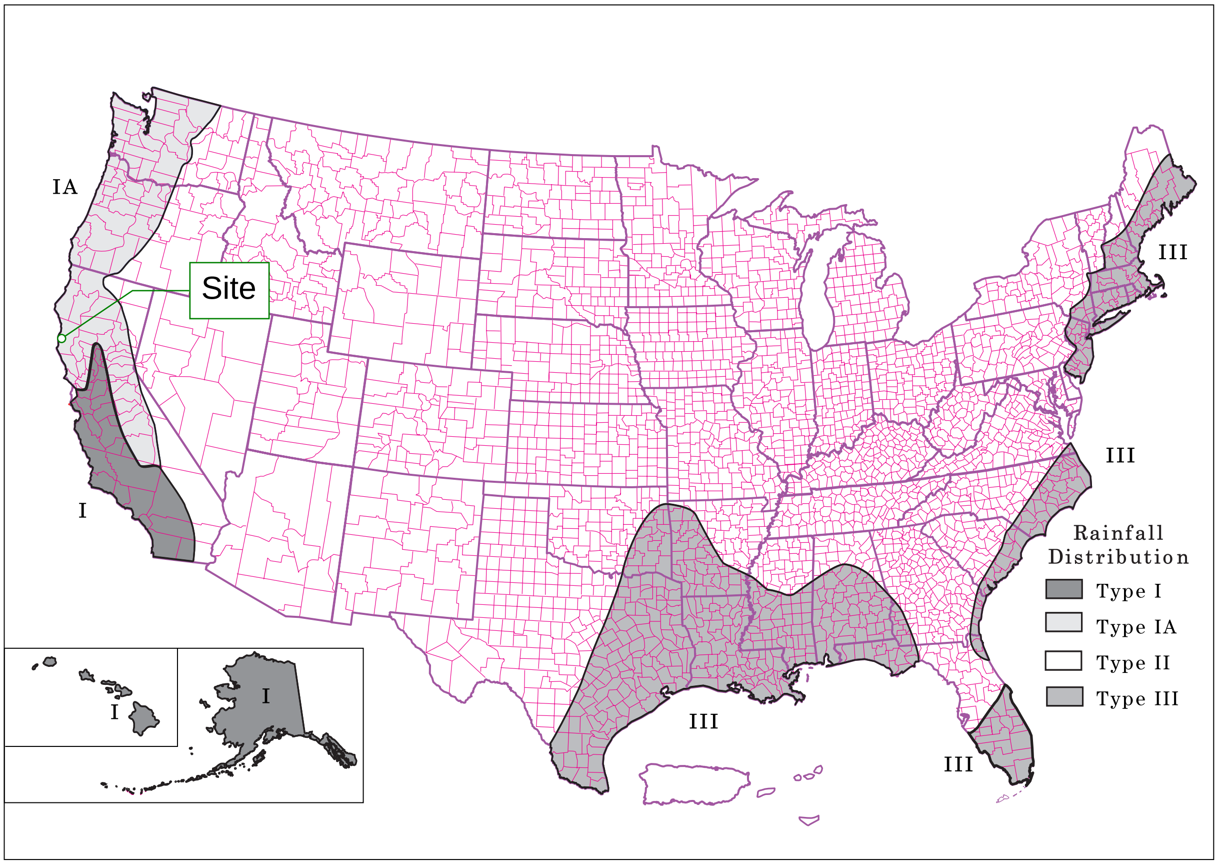
Figure B-1 SCS 24-hour rainfall distributions



The intensity of rainfall varies considerably during a storm as well as geographic regions. To represent various regions of the United States, NRCS developed four synthetic 24-hour rainfall distributions (I, IA, II, and III) from available National Weather Service (NWS) duration-frequency data (Hershfield 1061; Frederick et al., 1977) or local storm data. Type IA is the least intense and type II the most intense short duration rainfall. The four distributions are shown in figure B-1, and figure B-2 shows their approximate geographic boundaries.

Types I and IA represent the Pacific maritime climate with wet winters and dry summers. Type III represents Gulf of Mexico and Atlantic coastal areas where tropical storms bring large 24-hour rainfall amounts. Type II represents the rest of the country. For more precise distribution boundaries in a state having more than one type, contact the NRCS State Conservation Engineer.

Figure B-2 Approximate geographic boundaries for NRCS (SCS) rainfall distributions



Rainfall data sources

This section lists the most current 24-hour rainfall data published by the National Weather Service (NWS) for various parts of the country. Because NWS Technical Paper 40 (TP-40) is out of print, the 24-hour rainfall maps for areas east of the 105th meridian are included here as figures B-3 through B-8. For the area generally west of the 105th meridian, TP-40 has been superseded by NOAA Atlas 2, the Precipitation-Frequency Atlas of the Western United States, published by the National Ocean and Atmospheric Administration.

East of 105th meridian

Hershfield, D.M. 1961. Rainfall frequency atlas of the United States for durations from 30 minutes to 24 hours and return periods from 1 to 100 years. U.S. Dept. Commerce, Weather Bur. Tech. Pap. No. 40. Washington, DC. 155 p.

West of 105th meridian

Miller, J.F., R.H. Frederick, and R.J. Tracey. 1973. Precipitation-frequency atlas of the Western United States. Vol. I Montana; Vol. II, Wyoming; Vol III, Colorado; Vol. IV, New Mexico; Vol V, Idaho; Vol. VI, Utah; Vol. VII, Nevada; Vol. VIII, Arizona; Vol. IX, Washington; Vol. X, Oregon; Vol. XI, California. U.S. Dept. of Commerce, National Weather Service, NOAA Atlas 2. Silver Spring, MD.

Alaska

Miller, John F. 1963. Probable maximum precipitation and rainfall-frequency data for Alaska for areas to 400 square miles, durations to 24 hours and return periods from 1 to 100 years. U.S. Dept. of Commerce, Weather Bur. Tech. Pap. No. 47. Washington, DC. 69 p.

Hawaii

Weather Bureau. 1962. Rainfall-frequency atlas of the Hawaiian Islands for areas to 200 square miles, durations to 24 hours and return periods from 1 to 100 years. U.S. Dept. Commerce, Weather Bur. Tech. Pap. No. 43. Washington, DC. 60 p.

Puerto Rico and Virgin Islands

Weather Bureau. 1961. Generalized estimates of probable maximum precipitation and rainfall-frequency data for Puerto Rico and Virgin Islands for areas to 400 square miles, durations to 24 hours, and return periods from 1 to 100 years. U.S. Dept. Commerce, Weather Bur. Tech. Pap. No. 42. Washington, DC. 94 P.

ATTACHMENT 6

Geotechnical Report

Civil Design