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PRELIMINARY HYDROLOGY STUDY FOR:
GROVER BEACH LODGE
CITY OF GROVER BEACH, CALIFORNIA

Prepared For:

PACIFICA COMPANIES
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CTE Job No. 10-10460C

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INTRODUCTION

The purpose of this study is to determine storm water runoff and storm water runoff treatment required for the proposed development Grover Beach Lodge in Grover Beach California.

A hydrologic and hydraulic analysis for a 10, 25, and 100 year storm event will be conducted for existing and proposed conditions. The proposed stormwater management plan will incorporate Low Impact Development (LID) techniques along with post construction best management practices (BMPs) to mitigate any post development water quality impacts.

SITE LOCATION AND SITE DESCRIPTION

The subject property is located within Pismo State Beach and the City of Grover Beach west of Highway 1 between Grand Avenue and Le Sage Drive in San Luis Obispo County. North of the site is the golf course owned by the Department of Parks and Recreation and south of the project is State Parks recreational area. East of the project site running from north to south is Meadow Creek and west of the site is the beach dunes and the Pacific Ocean. East of Meadow Creek is a privately owned property. See Attachment 1 for a site vicinity map and site location map.

The project area is approximately 10.41 acres and is partially developed including Finns restaurant and public parking for the restaurant, beach, and golf course. The site located in a 100 year flood plain per the Flood Insurance Rate Map Number 06079C1582F (See Attachment 2). The flood elevation is 10.0 for the NGVD29 datum and 8.0 City of Grover Beach datum. The hydrology maps and elevations in this report are utilizing City of Grover Beach Elevations.

The development will consist of three (3) hotel buildings, landscaping, dune restoration areas, parking areas, and associated hardscape improvements.

DESIGN CRITERIA

The following is a summary of the design criteria used for this analysis:

- City of Grover Beach Standard Drawings D.1 Rainfall Intensity Chart
- City of Grover Beach Standard Drawings D.2 Table of Coefficient Runoff (C) Chart. Impervious area C=1.0 and Moderate Vegetation C=0.2
- City of Grover Beach Standard Drawings D.3 Nomograph for time of concentration
- From the USDA Natural Resources Conservation Service Web Soil Survey the site soil is Group "A" See Web Soil Survey Map (Attachment 2).

HYDROLOGY

EXISTING CONDITIONS

The existing runoff drains from the improved project limits to the west easterly into Meadow Creek. The existing site was divided into two (2) hydrologic basins and a weighted coefficient of runoff (C) was calculated. The weighted C value was obtained by averaging the impervious area versus the pervious areas. A C value of 1.0 was used for the impervious areas and a C value of 0.2 was used for the pervious areas. The existing total impervious percentage is 41.00 percent. The following is a summary of pre-development conditions:

TABLE 1: PRE-DEVELOPMENT SUMMARY

Basin	Area (acre)	Impervious Percentage	Q2 (cfs)	Q10 (cfs)	Q25 (cfs)	Q100 (cfs)
EX-1	7.073	25.25	3.98	6.54	7.39	9.38
EX-2	3.336	74.43	3.71	6.10	6.90	8.76
TOTAL	**10.409**	**41.00**	**7.70**	**12.64**	**14.29**	**18.14**

See Attachment 3 for a summary of the area, C calculations, and hydrologic calculations.
See Attachment 7 for the existing hydrology map.

PROPOSED CONDITIONS

The proposed drainage plan is to maintain the existing runoff and limit diversion and to provide a storm water management plan to treat the storm runoff. The proposed drainage plan is divided into eight (8) basins which all basins drain easterly to Meadow Creek. The weighted C value comprises of impervious areas (C=1.0), pervious areas (C=0.2), and pervious pavement (C=0.6). The proposed horse staging relocation area south of Grand Avenue will be developed with sand dunes and a dirt base. The hydrologic conditions will remain unchanged and considered not to increase the pre-development hydrologic conditions. The following is a summary of post-development conditions:

TABLE 2: POST-DEVELOPMENT SUMMARY W/ NO DETENTION

Basin	Area (acre)	Impervious Percentage	Q2 (cfs)	Q10 (cfs)	Q25 (cfs)	Q100 (cfs)
PR-1A	0.733	51.72	0.63	1.04	1.17	1.49
PR-1B	0.835	55.06	0.75	1.23	1.39	1.77
PR-2	0.769	40.51	0.56	0.93	1.05	1.33
PR-3	0.805	32.06	0.51	0.84	0.95	1.21
PR-4	1.371	22.32	0.73	1.19	1.35	1.71
PR-5	0.981	28.03	0.76	1.25	1.41	1.79
PR-6	0.995	65.98	1.11	1.83	2.07	2.62
PR-7	1.226	61.89	1.29	2.11	2.39	3.03
PR-8	2.694	75.45	3.03	4.98	5.63	7.14
TOTAL	**10.409**	**52.24**	**9.37**	**15.40**	**17.41**	**22.10**

See Attachment 4 for a summary of the area, C calculations, and hydrologic calculations.

See Attachment 8 for the existing hydrology map.

The proposed impervious percentage is 52.24 and has increased 13.24 percent. The difference in post construction runoff is indicated in Table 3 below. The following is a comparison summary of pre- and post-development (no detention) conditions:

TABLE 3: PRE- AND POST-DEVELOPMENT COMPARISON W/ NO DETENTION				
Basin	**Q2 (cfs)**	**Q10 (cfs)**	**Q25 (cfs)**	**Q100 (cfs)**
EXISTING	**7.70**	**12.64**	**14.29**	**18.14**
PROPOSED	**9.37**	**15.40**	**17.41**	**22.10**
DIFFERENCE	**1.67**	**2.76**	**3.12**	**3.96**

Based on the post development flows, the project will be utilizing the infiltration ponds as detention basins to decrease the post peak discharge and volume to the pre-development conditions.

Detention Calculations

The detention basin will be designed and evaluated utilizing an inflow hydrograph, stage-storage relationships, and the stage-discharge relationships for the outlet structures. HydroCAD Version 9.10 was utilized for the analysis. Curve Numbers were adjusted for each basin to reflect the runoff from the rational method. Each basin was analyzed individually. See Attachment 5 for routing and hydrograph calculations. Below is a table of the post runoff with detention:

TABLE 4: POST-DEVELOPMENT SUMMARY WITH DETENTION						
Basin	**Area (acre)**	**Impervious Percentage**	**Q2 (cfs)**	**Q10 (cfs)**	**Q25 (cfs)**	**Q100 (cfs)**
PR-1A	0.733	51.72	***0.23***	***0.45***	***0.48***	***0.56***
PR-1B	0.835	55.06	0.75	1.23	1.39	1.77
PR-2	0.769	40.51	***0.28***	***0.47***	***0.53***	***0.59***
PR-3	0.805	32.06	***0.25***	***0.46***	***0.49***	***0.56***
PR-4	1.371	22.32	***0.34***	***0.55***	***0.56***	***0.68***
PR-5	0.981	28.03	***0.41***	***0.46***	***0.49***	***0.56***
PR-6	0.995	65.98	1.11	1.83	2.07	2.62
PR-7	1.226	61.89	1.29	2.11	2.39	3.03
PR-8	2.694	75.45	3.03	4.98	5.63	7.14
TOTAL	**10.409**	**52.24**	**7.69**	**12.54**	**14.03**	**17.51**

TABLE 5: PRE- AND POST-DEVELOPMENT COMPARISON WITH DETENTION				
Basin	**Q2 (cfs)**	**Q10 (cfs)**	**Q25 (cfs)**	**Q100 (cfs)**
EXISTING	**7.70**	**12.64**	**14.29**	**18.14**
PROPOSED	**7.69**	**12.54**	**14.03**	**17.51**

DIFFERENCE	**-0.01**	**-0.10**	**-0.26**	**-0.63**

Ponding Requirements

Per the City of Grover Beach Standards and Specifications Section 505 G 12.1., proposed developments are subject to volume capacity requirements. Below is a summary of the capacity requirements for each proposed basin:

TABLE 6: PONDING REQUIREMENTS

Basin Number	Total Area	% Coverage	Pond Capacity Req.*
PR-1A	31,937.440	51.72%	5,369
PR-1B**	36,382.870	55.06%	6,511
PR-2	33,493.280	40.51%	4,410
PR-3	35,045.700	32.06%	3,651
PR-4	59,732.950	22.32%	4,334
PR-5	42,745.900	28.03%	3,894
PR-6**	43,345.700	65.98%	9,295
PR-7**	53,398.140	61.89%	10,740
PR-8**	117,337.200	75.45%	28,774
TOTAL	453,419.180	4.330	638,117

*The capacity requirement is assumed to be for the 100 year storm interval.
**Basins will be designed for water quality only.

It is interpreted that the city's ponding requirements is intended to compensate for the 100 year increase in runoff from pre- to post development conditions and to provide water quality treatment. The preliminary grading plan proposes storage ponds that satisfy the city requirement for basins PR-1A, 2, 3, 4, and 5 above the 100 year flood elevation. However, due to site constraints including the 100 year flood elevation of 8.0 (CGB), providing ponding basins (above or below ground) for the remaining hydrological basins would not be physically achievable.

In order to satisfy the city's storage requirements, it is proposed to utilize the proposed ponds in basins PR-1A, 2, 3, and 5 for detention. The ponds will be designed as detention basins which will decrease the post-development runoff to pre-existing runoff rates for the entire project. The detention basins will also act as volume-based treatment control BMPs for basins PR-1, 2, 3, and 5. The detention basins will drain easterly into Meadow Creek and will not co-mingle with any untreated runoff.

Basins PR 1B, 6, 7, and 8 will not include a dedicated storage but will be designed to treat the 24-hours, 85th percentile rainfall depth. Post BMPs will include pervious pavement, vegetated swales, and bio-infiltration basins.

Storm drains

A preliminary hydraulic analysis was conducted for all storm drain pipes for he 100 year storm event. Bentley's FlowMaster software was utilized to calculate catch basin capacities. See

Attachment 8 for pipe sizes. And Attachment 6 for hydraulic calculations.

STORM WATER MANAGEMENT

The project will comprise of Low Impact Development (LID) techniques, along with volume and flow based treatment control BMPs.

Low Impact Design (LID) uses site based planning and design strategies to manage the quantity and quality of stormwater runoff. The proposed LID design will reduce the amount of runoff by mimicking the natural hydraulic function of the existing development site. The design will promote infiltration and using landscape features, and detention basins to filter, slow, and infiltrate surface runoff at the source.

All basins will drain into landscape areas, detention basins, and bio-infiltration basins. Onsite impervious areas will be directed into pervious landscaping and promote infiltration to maximum extent possible. Runoff from parking lots will be directed to landscape areas and then into bio-infiltration basins.

The project will utilize the proposed detention basins and bio-infiltration basins for water quality purposes and will be design according to the Urban Runoff Quality Management, WEF Manual of Practice No. 23, ASCE Manual and Report on Engineering Practice No. 87, ASCE 1998. See Attachment 7 for the water quality calculations.

The detention basins will incorporate a storm drain control structure which will control the proposed runoff for the 100 year flood, 85th percentile (first flush), and the LEED storm water quality and quantity requirements.

Maintenance of BMPS and Storm Water Structures

The proposed bmps and storm drain structures that will require maintenance are as follows:

1. Detention basins and bio-infiltration basins
2. Vegetated Swales
3. Rip Rap energy dissipators
4. Storm drain systems including catch basins and cleanouts.

Maintenance will be required and monitoring will be implemented in order to maintain the performance of the drainage system. The detention structures will have to be maintained on a quarterly basis and after every storm event.

SUMMARY AND CONCLUSIONS

The proposed site drainage will mimic the existing conditions and will discharge into Meadow Creek. Due to the project being within the 100 year flood plain, the project will propose detention basins satisfying the City of Grover Beach's ponding requirements to the maximum extent feasible. Detention basins will be proposed on the western area of the project above the 100 year flood elevation. The eastern area of the project is within the 100 year flood elevation and providing detention basins would not be possible. In order to satisfy the City of Grover Beach's ponding requirement for the entire project, the detention basins on the western side of the project is designed to reduce the peak runoff and volume to pre-existing conditions. The eastern side of the project will propose a combination of pervious pavement, bio-infiltration, and vegetated swales to treat the 85th percentile (first flush) storm events.

Impervious areas will be directed into pervious landscaping and promote infiltration to maximum extent possible. The velocity of the proposed runoff will be calculated and the drainage system will be designed to minimize scouring. Onsite runoff will be separated, treated, and then discharged into the natural drainage course.

DECLARATION OF RESPONSIBLE CHARGE

I, hereby declare that I am the Engineer of Work for this project, that I have exercised responsible charge over the design of the project as defined in section 6703 of the business and professions code, and that the design is consistent with current standards.

I understand that the check of project drawings and specifications by the City of the City of Grover Beach is confined to a review only and does not relieve me, as Engineer of Work of my responsibility for project design.

ENGINEER OF WORK:

Construction Testing and Engineering, Inc.
1441 Montiel Road, Suite 115
Escondido, CA 92026

10-29-10

David V. Caron
R.C.E. 70066 Exp.9-30-12

Date

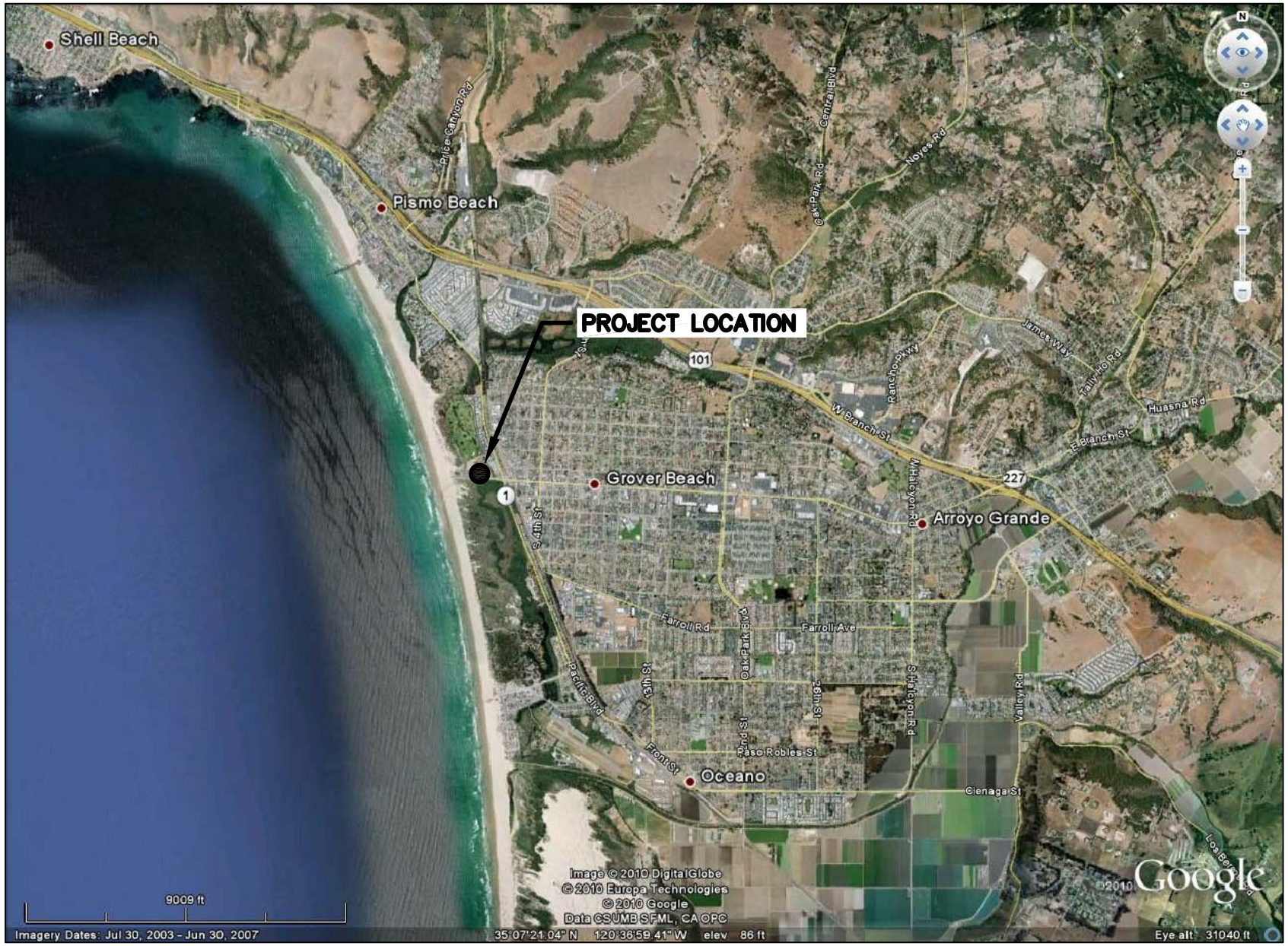
REGISTERED PROFESSIONAL ENGINEER
DAVID V. CARON
RCE C 70066
Exp. 09/30/12
CIVIL
STATE OF CALIFORNIA

REFERENCES

1. Standard and Specifications, City of Grover Beach Community Development Department, 2007.
2. Stormwater Management Program, City of Grover Beach, September 2008 Draft.
3. Urban Hydrology for Small Watersheds, Technical Release 55 (TR-55) USDA. Rational method for basins less than 1 square mile.
4. Hydraulic Engineering Circular No. 22, Second Edition, Publication FHWA-NHI-01-021, August 2001.
5. HydroCAD, Version 9.10. 2010 HydroCAD Software Solutions LLC.
6. United States Department of Agriculture, Natural Resource Conservation Service (NRCS).
7. USDA Natural Resources Conservation Service Web Soil Survey.
8. Bentley FLOWMASTER, Version 8.11.01.03, 2009.
9. Urban Stormwater Hydrology, A Guide to Engineering Calculations, A. Osman Akan, 1988.
10. Urban Runoff Quality Management, WEF Manual of Practice No. 23, ASCE Manual and Report on Engineering Practice No. 87, ASCE 1998.

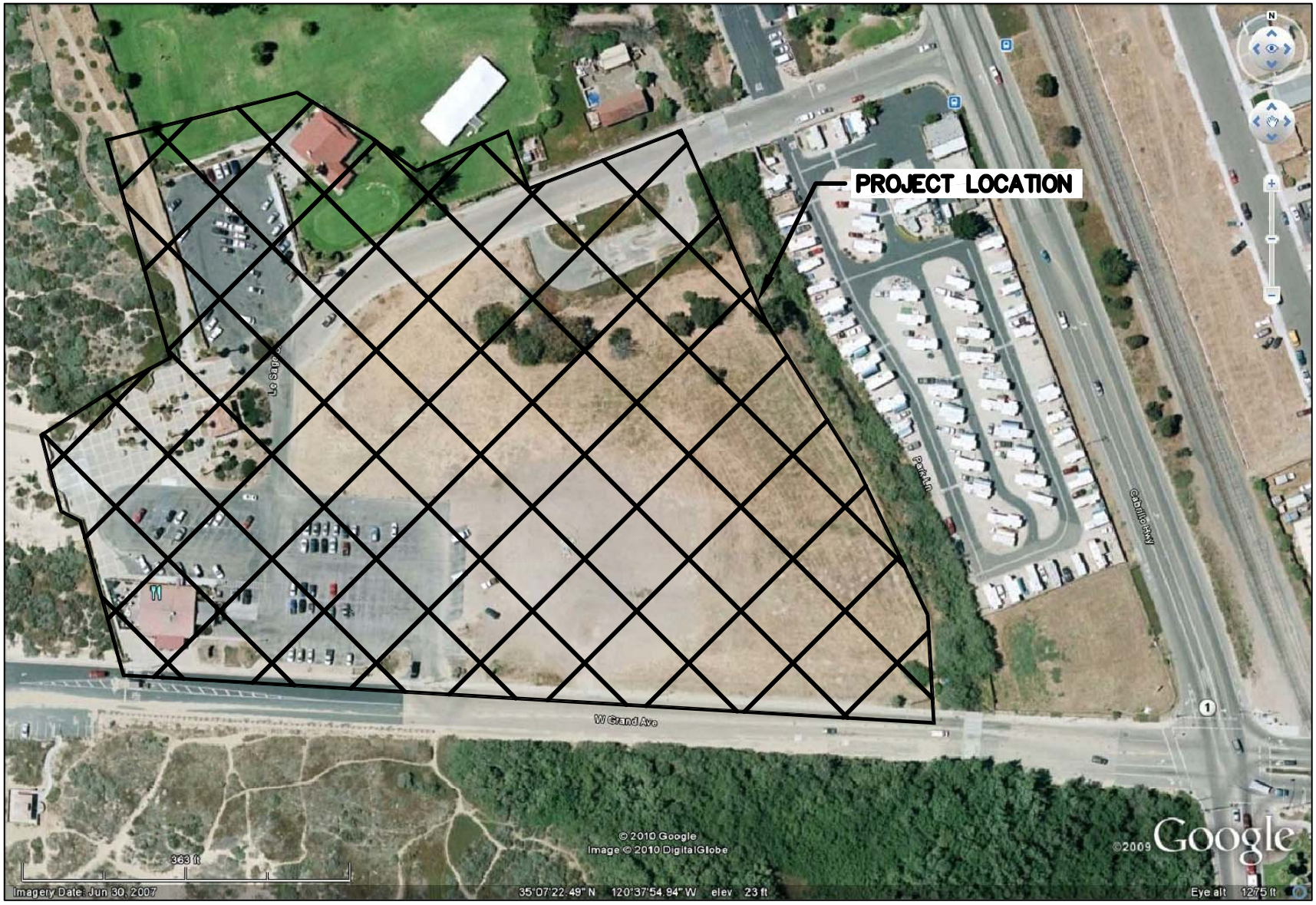
ATTACHMENT 1

VICINITY AND SITE LOCATION MAP



SITE VICILINTY MAP

DATE: 10-4-10	GROVER BEACH LODGE GROVER BEACH, CALIFORNIA	
SCALE: AS SHOWN		DRAWN BY: D.CARON



SITE MAP

DATE: 10-4-10

SCALE: AS SHOWN

GROVER BEACH LODGE

GROVER BEACH, CALIFORNIA

DRAWN BY: D.CARON

ATTACHMENT 2

100 YEAR FLOOD MAP
SOIL MAP
CITY STANDARD DRAWINGS

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' National Geodetic Vertical Datum of 1929 (NGVD 29). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations tables in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations tables should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 10. The **horizontal datum** was NAD 83, GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the National Geodetic Vertical Datum of 1929. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713-3242**, or visit its website at http://www.ngs.noaa.gov.

Base map information shown on this FIRM was derived from U.S. Geological Survey Digital Orthophoto Quadrangles produced at a scale of 1:12,000 from photography dated 1994 or later.

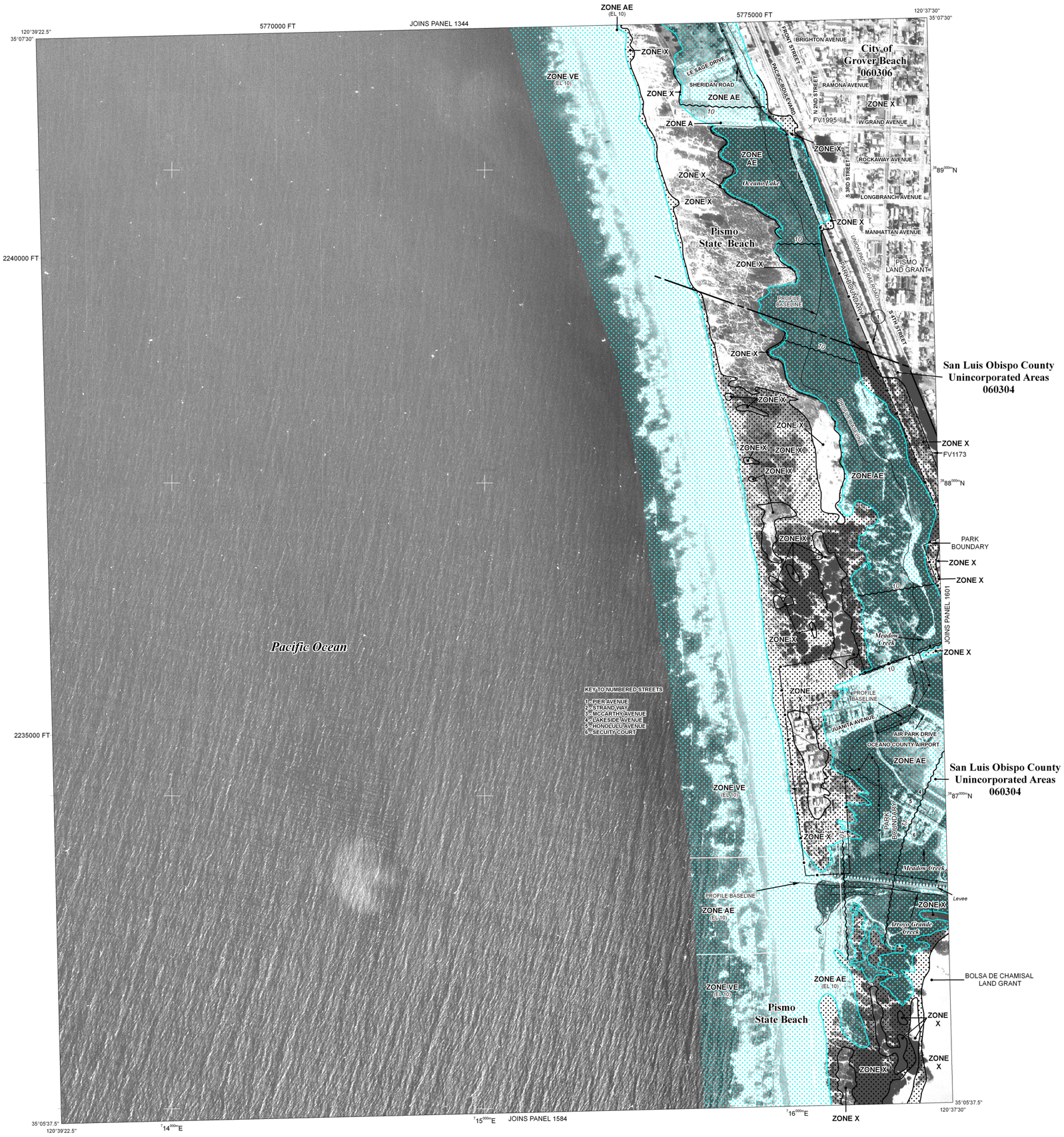
This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

Contact the **FEMA Map Service Center** at 1-800-358-9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study report, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and its website at http://msc.fema.gov.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov.



LEGEND

SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X — Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X — Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D — Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% annual chance floodplain boundary

0.2% annual chance floodplain boundary

Floodway boundary

Zone D boundary

CBRS and OPA boundary

Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

513	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the National Geodetic Vertical Datum of 1929

A — A	Cross section line
23 - - - - 23	Transect line
87°07'45", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere
$^{24}76^{000m}$N	1000-meter Universal Transverse Mercator grid values, zone 10
600000 FT	5000-foot grid ticks: California State Plane coordinate system, zone V (FIPSZONE 0405), Lambert Conformal Conic projection
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
● M1.5	River Mile

MAP REPOSITORY
Refer to listing of Map Repositories on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
August 28, 2008

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your Insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

N

MAP SCALE 1" = 500'

250 0 500 1000 FEET

150 0 150 300 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 1582F

FIRM

FLOOD INSURANCE RATE MAP

SAN LUIS OBISPO COUNTY, CALIFORNIA

AND INCORPORATED AREAS

PANEL 1582 OF 2050

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
GROVER BEACH, CITY OF	060306	1582	F
SAN LUIS OBISPO COUNTY	060304	1582	F

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
06079C1582F

EFFECTIVE DATE
AUGUST 28, 2008

Federal Emergency Management Agency

Map Scale: 1:1,670 if printed on A size (8.5" x 11") sheet.

N

Meters: 0 20 40 80 120

Feet: 0 50 100 200 300

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Units

Soil Ratings

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Political Features

Cities

Water Features

Oceans

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

MAP INFORMATION

Map Scale: 1:1,680 if printed on A size (8.5" × 11") sheet.

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

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 10N NAD83

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

Soil Survey Area: San Luis Obispo County, California, Coastal Part
Survey Area Data: Version 4, Jan 2, 2008

Date(s) aerial images were photographed: 6/26/2005

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

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — San Luis Obispo County, California, Coastal Part				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
124	Corralitos sand, 0 to 2 percent slopes	A	7.4	65.5%
125	Corralitos sand, 2 to 15 percent slopes	A	0.8	6.9%
134	Dune land	A	3.1	27.6%
Totals for Area of Interest			**11.2**	**100.0%**

Description

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

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

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

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

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

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

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

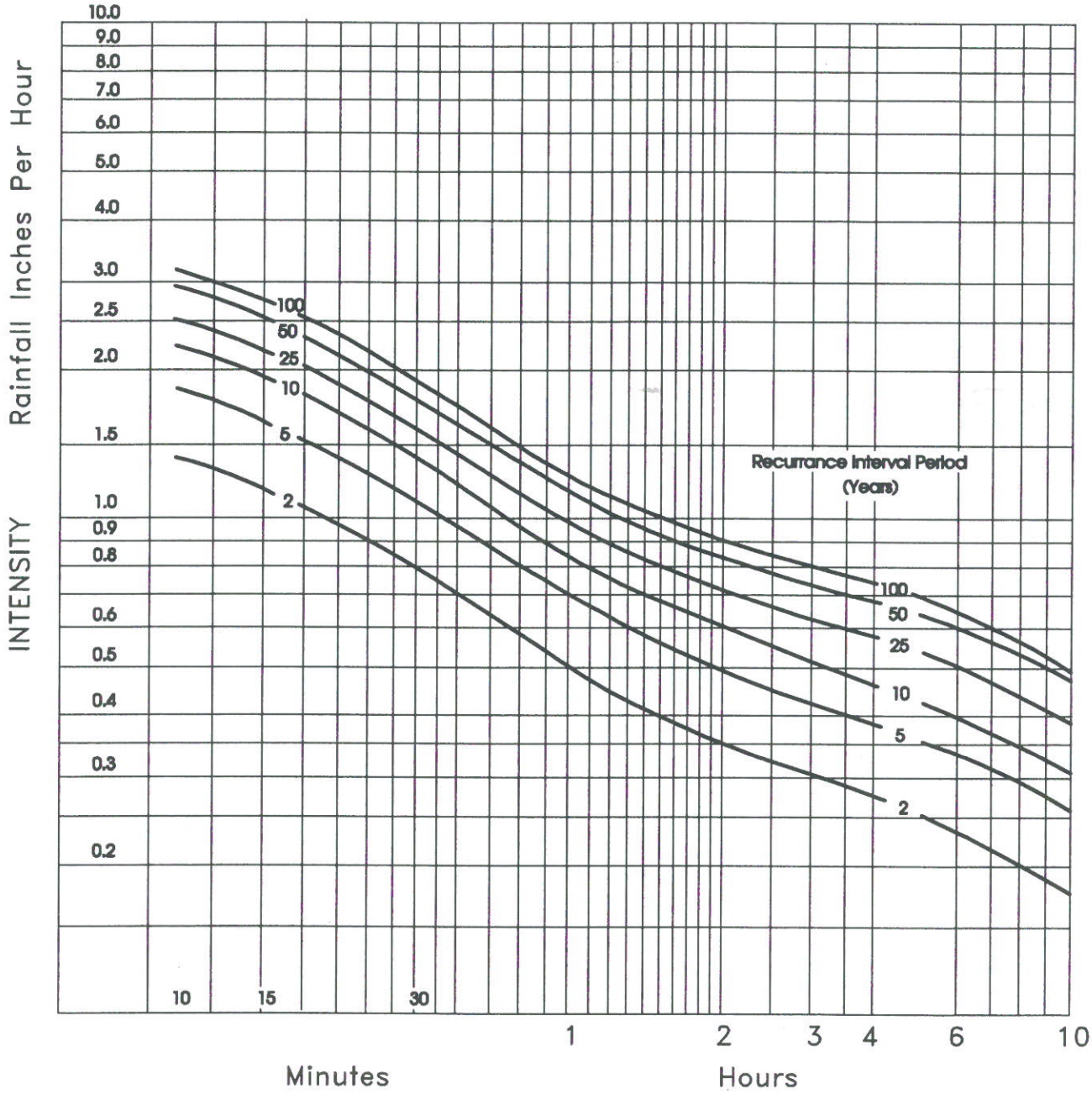
Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: *None Specified*

Tie-break Rule: Lower

City of Grover Beach: 16 inches Annual Average Rainfall



See Drawings D.2 and D.3

Approved:

7 Nov 07

Director of Public Works/ Designee

7 Nov 07

R. James Garing, RCE 26993
City Engineer

REGISTERED PROFESSIONAL ENGINEER
R. JAMES GARING
No. 26993
Exp. 3-31-09
CIVIL
STATE OF CALIFORNIA

City of Grover Beach

Rainfall Intensity Duration Curve

D.1

corrected 7 Nov 07

New Development in areas of sand shall use the total percentage of coverage of the site or lot as the runoff factor or coefficient of runoff. Coverage is to include roofs of all structures, all paved areas, pools and other water features, infiltration basins, and all other non-pervious coverage of the lot.

Use the following coefficients when studying large areas—not for new development.

Type of Development	Type of Soil**	Coefficient of runoff for Slope* <2%	2% to 10%	>10%
20,000 Sq. Ft.	c	.35	.40	.45
	s	.25	.35	.40
10,000 Sq. Ft.	c	.40	.45	.55
	s	.30	.40	.45
6,000 Sq. Ft.	c	.45	.55	.65
	s	.35	.40	.50
Apartments	c	.50	.60	.70
	s	.40	.50	.60
Industrial	c	.55	.65	.75
	s	.45	.55	.65
Commercial	c	.75	.80	.85
	s	.70	.75	.80
Dense Vegetation	c	.15	.25	.35
	s	.10	.15	.20
Moderate Vegetation	c	.20	.30	.40
	s	.15	.20	.25
Sparse Vegetation	c	.25	.35	.45
	s	.20	.25	.30
Impervious: paved, etc.	–	1.0	1.0	1.0

*Note: These values are intended to be a minimum. Higher values may be required by the City Engineer and/or Community Development Director.

**Note: Soil Type
C = Clay, Adobe, Rock Material
S = Sand, Gravel, Loam, or Pervious Material

See Drawings D.1 and D.3

Approved:

29 JUNE 07
Director of Public Works/
Designee

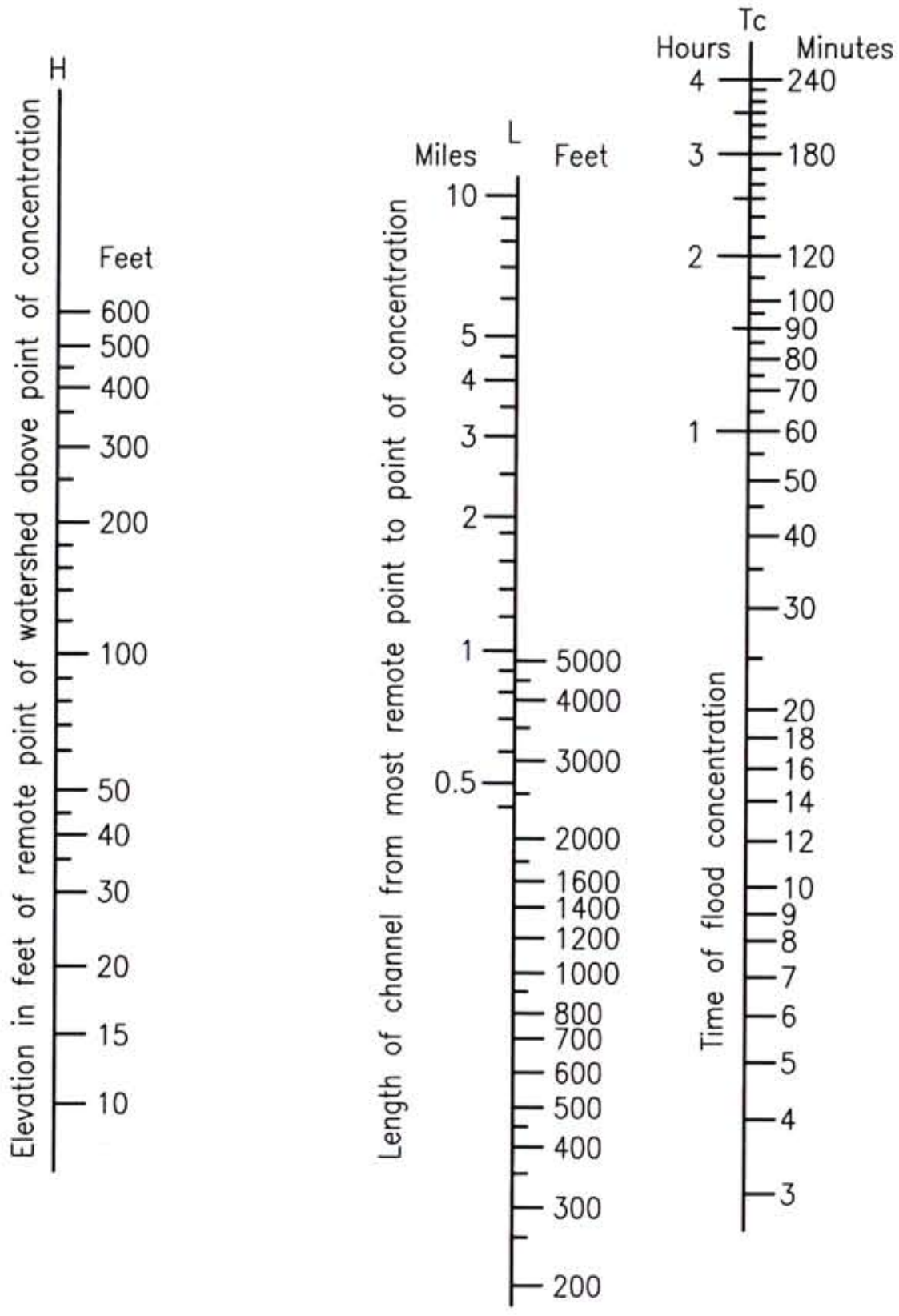
29 June 07
R. James Garing, RCE 26993
City Engineer

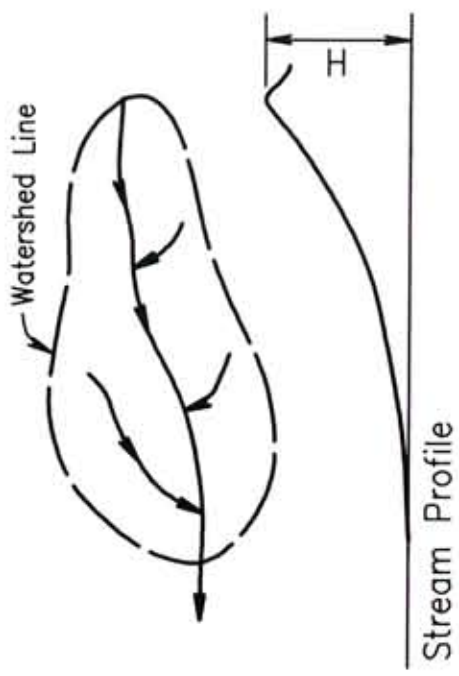
REGISTERED PROFESSIONAL ENGINEER
R. JAMES GARING
No. 26993
Exp. 3-31-09
CIVIL
STATE OF CALIFORNIA

City of Grover Beach

Table of Coefficient Runoff Chart

D.2





Equations for estimated "Time of Concentration"

$$Tc = \left(\frac{11.9L^3}{H}\right) 0.385$$

Tc = Time of Concentration in hours.

L = Length of Channel in miles.

H = Difference in elevation between most remote point & point of concentration.

This nomograph is to be limited to areas of 200 acres or less.

See Drawings D.1 and D.2

Approved:

29 JUNE 07

Director of Public Works/ Designee

29 June 07

R. James Garing, RCE 26993
City Engineer

REGISTERED PROFESSIONAL ENGINEER
R. JAMES GARING
No. 26993
Exp. 3-31-09
CIVIL
STATE OF CALIFORNIA

City of Grover Beach Nomograph

For Determining "Time of Concentration" of Small Drainage Basins

D.3

ATTACHMENT 3

EXISTING HYDROLOGIC CALCULATIONS

AREA CALCULATIONS

EXISTING HYDROLOGIC BASINS

Basin Number	Total Area SF	Total Area Acres	Impervious Area SF	Impervious Area Acres	Percent Impervious	C Value Weighted
EX-1	308,100.000	7.073	77,800.600	1.786	25.25%	0.40
EX-2	145,300.000	3.336	108,151.420	2.483	74.43%	0.80
TOTAL	453,400.000	10.409	185,952.020	4.269	41.01%	0.53

*C values per City of Grover Beach Standards Table of Coefficient Runoff Chart D.2.

AREA CALCULATIONS

PROPOSED HYDROLOGIC BASINS

Basin Number	Total Area SF	Total Area Acres	Impervious Area SF	Landscape Area SF	Pervious Pavement SF	Percent Impervious	C Value* Weighted
PR-1A	31,937.440	0.733	16,518.880	15,418.560	0.000	51.72%	0.61
PR-1B	36,382.870	0.835	20,033.090	16,349.780	0.000	55.06%	0.64
PR-2	33,493.280	0.769	13,569.680	19,923.600	0.000	40.51%	0.52
PR-3	35,045.700	0.805	11,234.730	23,810.970	0.000	32.06%	0.46
PR-4	59,732.950	1.371	13,334.850	46,398.100	0.000	22.32%	0.38
PR-5	42,745.900	0.981	11,981.200	16,968.700	13,796.000	28.03%	0.55
PR-6	43,345.700	0.995	28,599.090	7,046.610	7,700.000	65.98%	0.80
PR-7	53,398.140	1.226	33,046.900	13,075.120	7,276.120	61.89%	0.75
PR-8	117,337.200	2.694	88,534.185	28,803.015	0.000	75.45%	0.80
TOTAL	453,419.180	10.409	236,852.605	187,794.455	28,772.120	52.24%	0.690

*C values per City of Grover Beach Standards Table of Coefficient Runoff Chart D.2.

ATTACHMENT 4

PROPOSED HYDROLOGIC CALCULATIONS

AREA CALCULATIONS

PROPOSED HYDROLOGIC BASINS

Basin Number	Total Area SF	Total Area Acres	Impervious Area SF	Landscape Area SF	Pervious Pavement SF	Percent Impervious	C Value* Weighted
PR-1A	31,937.440	0.733	16,518.880	15,418.560	0.000	51.72%	0.61
PR-1B	36,382.870	0.835	20,033.090	16,349.780	0.000	55.06%	0.64
PR-2	33,493.280	0.769	13,569.680	19,923.600	0.000	40.51%	0.52
PR-3	35,045.700	0.805	11,234.730	23,810.970	0.000	32.06%	0.46
PR-4	59,732.950	1.371	13,334.850	46,398.100	0.000	22.32%	0.38
PR-5	42,745.900	0.981	11,981.200	16,968.700	13,796.000	28.03%	0.55
PR-6	43,345.700	0.995	28,599.090	7,046.610	7,700.000	65.98%	0.80
PR-7	53,398.140	1.226	33,046.900	13,075.120	7,276.120	61.89%	0.75
PR-8	117,337.200	2.694	88,534.185	28,803.015	0.000	75.45%	0.80
TOTAL	453,419.180	10.409	236,852.605	187,794.455	28,772.120	52.24%	0.690

*C values per City of Grover Beach Standards Table of Coefficient Runoff Chart D.2.

PROPOSED HYDROLOGY TABLE (no detention)

100 YEAR STORM

Basin Number	High Elev feet	Low Elev feet	H Elev. Diff. feet	Flow Length Feet	Flow Length Miles	Slope Percent	Tc* Minutes	Intensity (I)** Inches/hour	C Value Weighted	Total Area Acres	Flow (Q) cfs
PR-1A	12.30	10.00	2.30	222.00	0.04	1.04%	2.00	3.30	0.61	0.733	1.49
PR-1B	12.30	8.50	3.80	222.00	0.04	1.71%	2.00	3.30	0.64	0.835	1.77
PR-2	14.50	12.50	2.00	162.00	0.03	1.23%	2.00	3.30	0.52	0.769	1.33
PR-3	12.00	9.50	2.50	144.00	0.03	1.74%	2.00	3.30	0.46	0.805	1.21
PR-4	17.00	11.00	6.00	220.00	0.04	2.73%	2.00	3.30	0.38	1.371	1.71
PR-5	19.00	13.60	5.40	225.00	0.04	2.40%	2.80	3.30	0.55	0.981	1.79
PR-6	13.00	10.00	3.00	300.00	0.06	1.00%	3.00	3.30	0.80	0.995	2.62
PR-7	11.50	7.50	4.00	278.00	0.05	1.44%	2.80	3.30	0.75	1.226	3.03
PR-8	10.00	7.00	3.00	400.00	0.08	0.75%	4.00	3.30	0.80	2.694	7.14
TOTAL											**22.10**

25 YEAR STORM

Basin Number	High Elev feet	Low Elev feet	H Elev. Diff. feet	Flow Length Feet	Flow Length Miles	Slope Percent	Tc* Minutes	Intensity (I)** Inches/hour	C Value Weighted	Total Area Acres	Flow (Q) cfs
PR-1A	12.30	10.00	2.30	222.00	0.04	1.04%	2.00	2.60	0.61	0.733	1.17
PR-1B	12.30	8.50	3.80	222.00	0.04	1.71%	2.00	2.60	0.64	0.835	1.39
PR-2	14.50	12.50	2.00	162.00	0.03	1.23%	2.00	2.60	0.52	0.769	1.05
PR-3	12.00	9.50	2.50	144.00	0.03	1.74%	2.00	2.60	0.46	0.805	0.95
PR-4	17.00	11.00	6.00	220.00	0.04	2.73%	2.00	2.60	0.38	1.371	1.35
PR-5	19.00	13.60	5.40	225.00	0.04	2.40%	2.80	2.60	0.55	0.981	1.41
PR-6	13.00	10.00	3.00	300.00	0.06	1.00%	3.00	2.60	0.80	0.995	2.07
PR-7	11.50	7.50	4.00	278.00	0.05	1.44%	2.80	2.60	0.75	1.226	2.39
PR-8	10.00	7.00	3.00	400.00	0.08	0.75%	4.00	2.60	0.80	2.694	5.63
TOTAL											**17.41**

PROPOSED HYDROLOGY TABLE (no detention)

10 YEAR STORM

Basin Number	High Elev feet	Low Elev feet	H Elev. Diff. feet	Flow Length Feet	Flow Length Miles	Slope Percent	Tc* Minutes	Intensity (I)** Inches/hour	C Value Weighted	Total Area Acres	Flow (Q) cfs
PR-1A	12.30	10.00	2.30	222.00	0.04	1.04%	2.00	2.30	0.61	0.733	1.04
PR-1B	12.30	8.50	3.80	222.00	0.04	1.71%	2.00	2.30	0.64	0.835	1.23
PR-2	14.50	12.50	2.00	162.00	0.03	1.23%	2.00	2.30	0.52	0.769	0.93
PR-3	12.00	9.50	2.50	144.00	0.03	1.74%	2.00	2.30	0.46	0.805	0.84
PR-4	17.00	11.00	6.00	220.00	0.04	2.73%	2.00	2.30	0.38	1.371	1.19
PR-5	19.00	13.60	5.40	225.00	0.04	2.40%	2.80	2.30	0.55	0.981	1.25
PR-6	13.00	10.00	3.00	300.00	0.06	1.00%	3.00	2.30	0.80	0.995	1.83
PR-7	11.50	7.50	4.00	278.00	0.05	1.44%	2.80	2.30	0.75	1.226	2.11
PR-8	10.00	7.00	3.00	400.00	0.08	0.75%	4.00	2.30	0.80	2.694	4.98
TOTAL											**15.40**

2 YEAR STORM

Basin Number	High Elev feet	Low Elev feet	H Elev. Diff. feet	Flow Length Feet	Flow Length Miles	Slope Percent	Tc* Minutes	Intensity (I)** Inches/hour	C Value Weighted	Total Area Acres	Flow (Q) cfs
PR-1A	12.30	10.00	2.30	222.00	0.04	1.04%	2.00	1.40	0.61	0.733	0.63
PR-1B	12.30	8.50	3.80	222.00	0.04	1.71%	2.00	1.40	0.64	0.835	0.75
PR-2	14.50	12.50	2.00	162.00	0.03	1.23%	2.00	1.40	0.52	0.769	0.56
PR-3	12.00	9.50	2.50	144.00	0.03	1.74%	2.00	1.40	0.46	0.805	0.51
PR-4	17.00	11.00	6.00	220.00	0.04	2.73%	2.00	1.40	0.38	1.371	0.73
PR-5	19.00	13.60	5.40	225.00	0.04	2.40%	2.80	1.40	0.55	0.981	0.76
PR-6	13.00	10.00	3.00	300.00	0.06	1.00%	3.00	1.40	0.80	0.995	1.11
PR-7	11.50	7.50	4.00	278.00	0.05	1.44%	2.80	1.40	0.75	1.226	1.29
PR-8	10.00	7.00	3.00	400.00	0.08	0.75%	4.00	1.40	0.80	2.694	3.03
TOTAL											**9.37**

*Time of concentration is per City of Grover Beach Nomograph Drawing No. D.3
*Intensity is per City of Grover Beach Nomograph Drawing No. D.1

ATTACHMENT 5

DETENTION CALCULATIONS

Summary for Pond 2P: PR1A

Inflow Area = 0.733 ac, 0.00% Impervious, Inflow Depth > 1.16" for 2 YEAR event
Inflow = 0.63 cfs @ 9.95 hrs, Volume= 0.071 af
Outflow = 0.23 cfs @ 10.16 hrs, Volume= 0.070 af, Atten= 63%, Lag= 12.9 min
Primary = 0.23 cfs @ 10.16 hrs, Volume= 0.070 af

Routing by Stor-Ind method, Time Span= 5.00-29.99 hrs, dt= 0.03 hrs
Peak Elev= 9.30' @ 10.16 hrs Surf.Area= 0 sf Storage= 715 cf

Plug-Flow detention time= 96.8 min calculated for 0.070 af (98% of inflow)
Center-of-Mass det. time= 85.3 min (878.7 - 793.4)

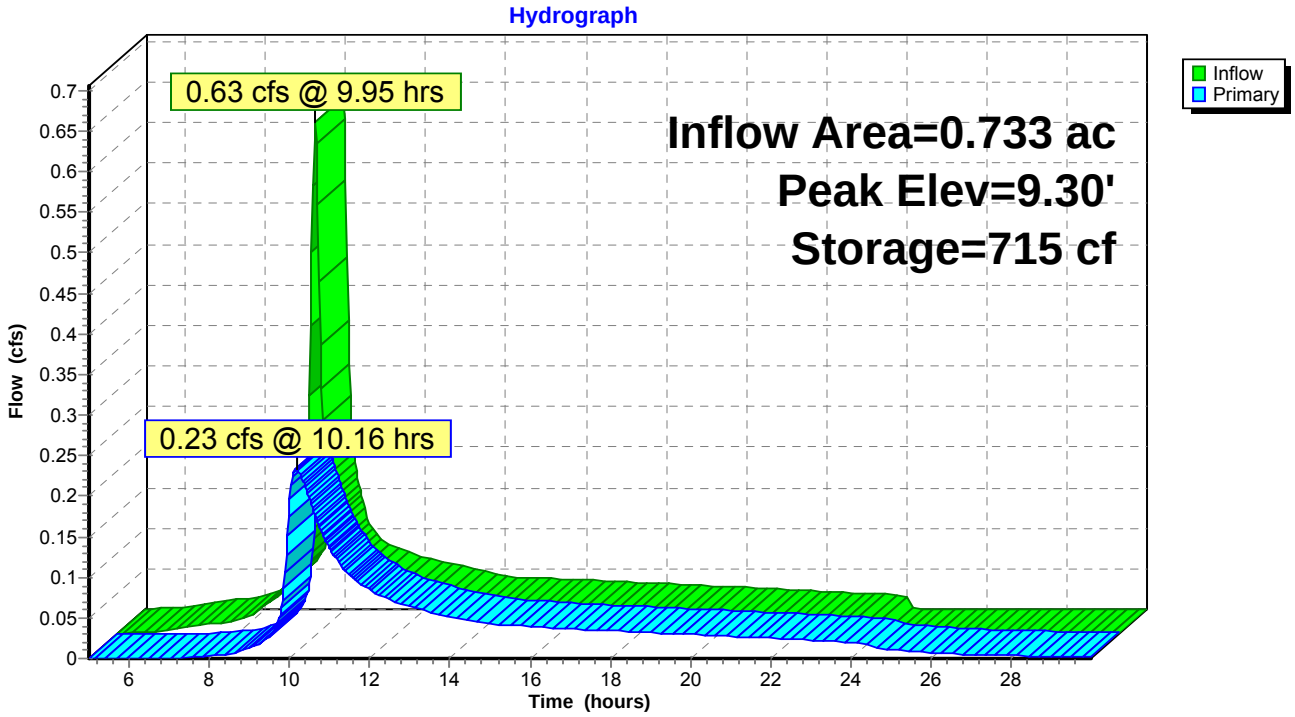
Volume	Invert	Avail.Storage	Storage Description
#1	9.00'	5,991 cf	**Custom Stage Data** Listed below

Elevation (feet)	Cum.Store (cubic-feet)
9.00	0
9.50	1,179
10.00	2,564
10.50	4,164
11.00	5,991

Device	Routing	Invert	Outlet Devices
#1	Primary	9.00'	**6.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.23 cfs @ 10.16 hrs HW=9.30' (Free Discharge)
└─**1=Orifice/Grate** (Orifice Controls 0.23 cfs @ 1.87 fps)

Pond 2P: PR1A


Hydrograph
0.63 cfs @ 9.95 hrs
0.23 cfs @ 10.16 hrs
Inflow Area=0.733 ac
Peak Elev=9.30'
Storage=715 cf
Inflow
Primary
Flow (cfs)
Time (hours)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
0.65
0.7
6
8
10
12
14
16
18
20
22
24
26
28

Summary for Pond 2P: PR1A

Inflow Area = 0.733 ac, 0.00% Impervious, Inflow Depth = 2.02" for 10 YEAR event
Inflow = 1.09 cfs @ 9.95 hrs, Volume= 0.123 af
Outflow = 0.45 cfs @ 10.14 hrs, Volume= 0.122 af, Atten= 59%, Lag= 11.3 min
Primary = 0.45 cfs @ 10.14 hrs, Volume= 0.122 af

Routing by Stor-Ind method, Time Span= 5.00-29.99 hrs, dt= 0.03 hrs
Peak Elev= 9.47' @ 10.14 hrs Surf.Area= 0 sf Storage= 1,106 cf

Plug-Flow detention time= 75.5 min calculated for 0.122 af (99% of inflow)
Center-of-Mass det. time= 68.3 min (863.0 - 794.7)

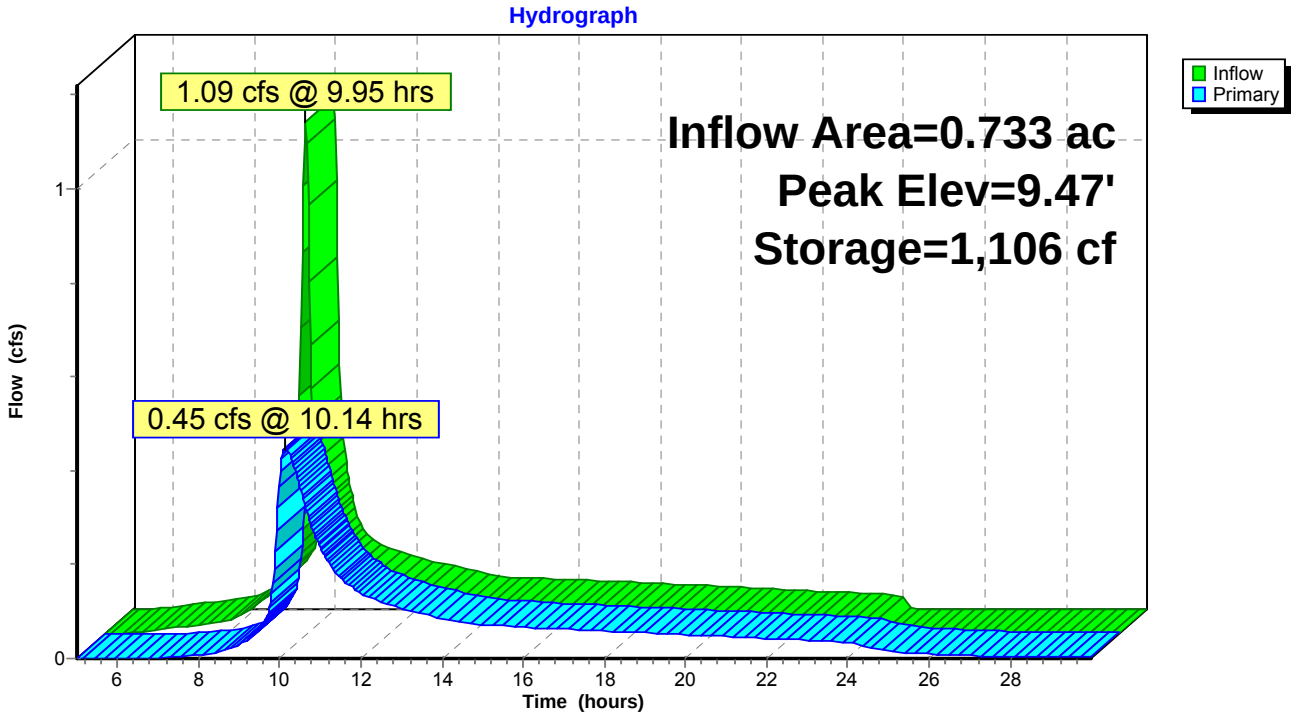
Volume	Invert	Avail.Storage	Storage Description
#1	9.00'	5,991 cf	**Custom Stage Data** Listed below

Elevation (feet)	Cum.Store (cubic-feet)
9.00	0
9.50	1,179
10.00	2,564
10.50	4,164
11.00	5,991

Device	Routing	Invert	Outlet Devices
#1	Primary	9.00'	**6.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.45 cfs @ 10.14 hrs HW=9.47' (Free Discharge)
└─**1=Orifice/Grate** (Orifice Controls 0.45 cfs @ 2.33 fps)

Pond 2P: PR1A


Hydrograph
1.09 cfs @ 9.95 hrs
0.45 cfs @ 10.14 hrs
Inflow Area=0.733 ac
Peak Elev=9.47'
Storage=1,106 cf
Inflow
Primary
Flow (cfs)
0
1
6
8
10
12
14
16
18
20
22
24
26
28
Time (hours)

Summary for Pond 2P: PR1A

Inflow Area = 0.733 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25 YEAR event
Inflow = 1.21 cfs @ 9.95 hrs, Volume= 0.140 af
Outflow = 0.48 cfs @ 10.15 hrs, Volume= 0.139 af, Atten= 61%, Lag= 12.1 min
Primary = 0.48 cfs @ 10.15 hrs, Volume= 0.139 af

Routing by Stor-Ind method, Time Span= 5.00-29.99 hrs, dt= 0.03 hrs
Peak Elev= 9.50' @ 10.15 hrs Surf.Area= 0 sf Storage= 1,188 cf

Plug-Flow detention time= 70.5 min calculated for 0.138 af (99% of inflow)
Center-of-Mass det. time= 64.4 min (874.4 - 810.0)

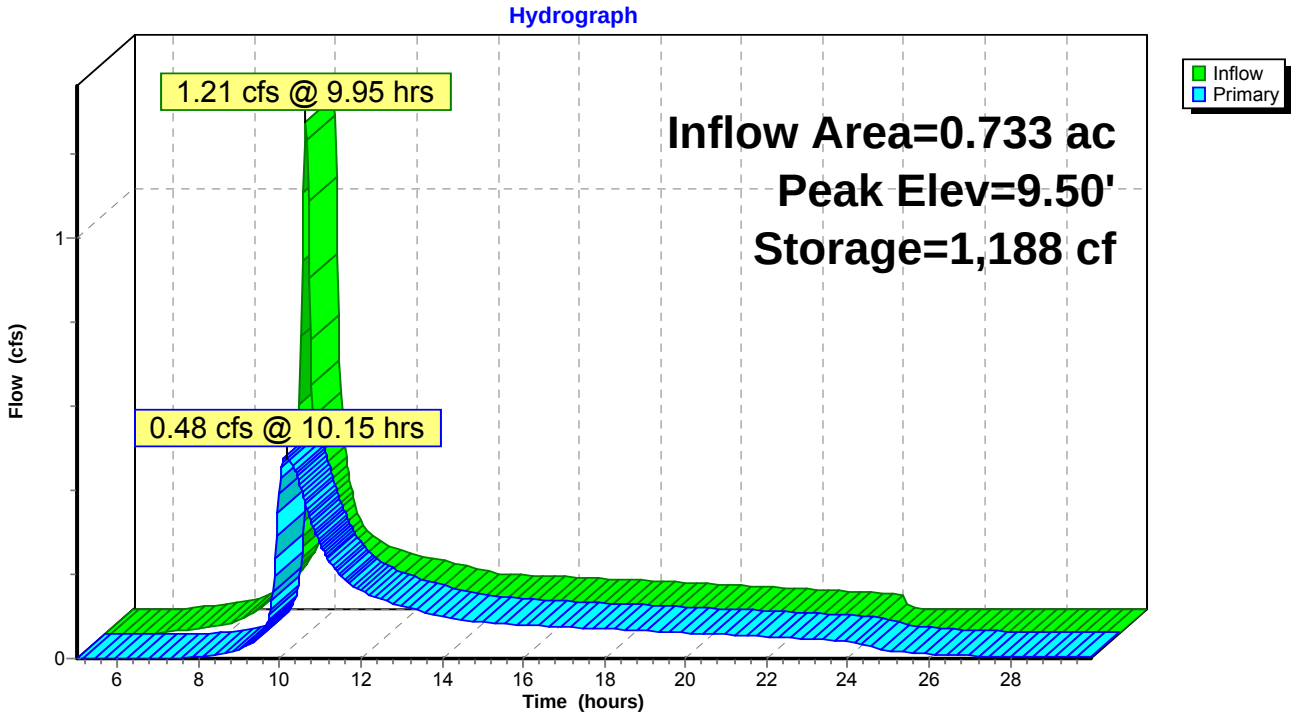
Volume	Invert	Avail.Storage	Storage Description
#1	9.00'	5,991 cf	**Custom Stage Data** Listed below

Elevation (feet)	Cum.Store (cubic-feet)
9.00	0
9.50	1,179
10.00	2,564
10.50	4,164
11.00	5,991

Device	Routing	Invert	Outlet Devices
#1	Primary	9.00'	**6.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.48 cfs @ 10.15 hrs HW=9.50' (Free Discharge)
└─**1=Orifice/Grate** (Orifice Controls 0.48 cfs @ 2.42 fps)

Pond 2P: PR1A


Hydrograph
1.21 cfs @ 9.95 hrs
0.48 cfs @ 10.15 hrs
Inflow Area=0.733 ac
Peak Elev=9.50'
Storage=1,188 cf
Inflow
Primary
Flow (cfs)
0
1
6
8
10
12
14
16
18
20
22
24
26
28
Time (hours)

Summary for Pond 2P: PR1A

Inflow Area = 0.733 ac, 0.00% Impervious, Inflow Depth = 2.90" for 100 YEAR event
Inflow = 1.52 cfs @ 9.95 hrs, Volume= 0.177 af
Outflow = 0.56 cfs @ 10.17 hrs, Volume= 0.176 af, Atten= 63%, Lag= 13.3 min
Primary = 0.56 cfs @ 10.17 hrs, Volume= 0.176 af

Routing by Stor-Ind method, Time Span= 5.00-29.99 hrs, dt= 0.03 hrs
Peak Elev= 9.60' @ 10.17 hrs Surf.Area= 0 sf Storage= 1,450 cf

Plug-Flow detention time= 64.1 min calculated for 0.175 af (99% of inflow)
Center-of-Mass det. time= 59.2 min (875.4 - 816.2)

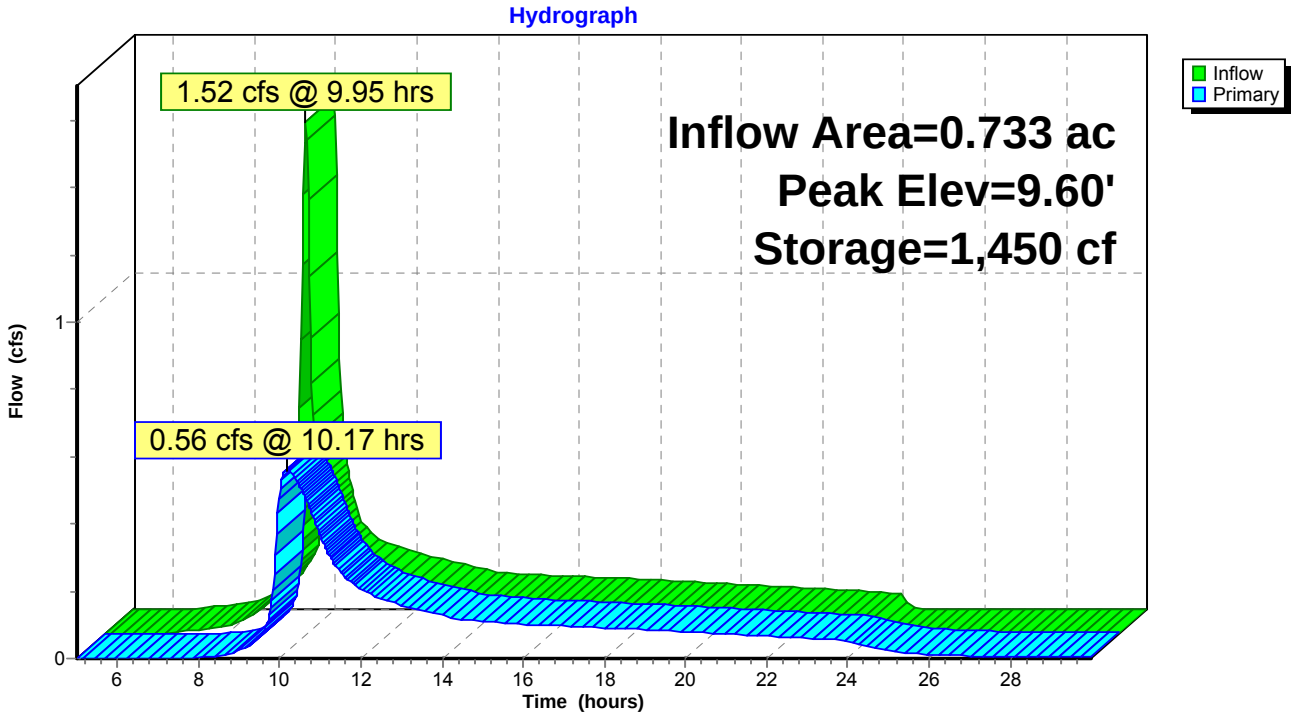
Volume	Invert	Avail.Storage	Storage Description
#1	9.00'	5,991 cf	**Custom Stage Data** Listed below

Elevation (feet)	Cum.Store (cubic-feet)
9.00	0
9.50	1,179
10.00	2,564
10.50	4,164
11.00	5,991

Device	Routing	Invert	Outlet Devices
#1	Primary	9.00'	**6.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.56 cfs @ 10.17 hrs HW=9.60' (Free Discharge)
└─**1=Orifice/Grate** (Orifice Controls 0.56 cfs @ 2.84 fps)

Pond 2P: PR1A


Hydrograph
1.52 cfs @ 9.95 hrs
0.56 cfs @ 10.17 hrs
Inflow Area=0.733 ac
Peak Elev=9.60'
Storage=1,450 cf
Inflow
Primary
Flow (cfs)
0
1
6
8
10
12
14
16
18
20
22
24
26
28
Time (hours)

Summary for Subcatchment 1S: PR2

Runoff = 0.57 cfs @ 9.95 hrs, Volume= 0.066 af, Depth= 1.03"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-29.99 hrs, dt= 0.03 hrs
Type I 24-hr 2 YEAR Rainfall=2.00"

	Area (sf)	CN	Description
*	33,493	89	
	33,493	89	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.0					**Direct Entry,**
2.0	0	Total, Increased to minimum Tc = 5.0 min			

Summary for Pond 2P: PR2

Inflow Area = 0.769 ac, 0.00% Impervious, Inflow Depth = 1.03" for 2 YEAR event
Inflow = 0.57 cfs @ 9.95 hrs, Volume= 0.066 af
Outflow = 0.28 cfs @ 10.10 hrs, Volume= 0.065 af, Atten= 51%, Lag= 9.0 min
Primary = 0.28 cfs @ 10.10 hrs, Volume= 0.065 af

Routing by Stor-Ind method, Time Span= 5.00-29.99 hrs, dt= 0.03 hrs
Peak Elev= 10.84' @ 10.10 hrs Surf.Area= 0 sf Storage= 507 cf

Plug-Flow detention time= 63.1 min calculated for 0.065 af (99% of inflow)
Center-of-Mass det. time= 57.7 min (866.6 - 808.9)

Volume	Invert	Avail.Storage	Storage Description
#1	10.50'	4,507 cf	**Custom Stage Data** Listed below

Elevation (feet)	Cum.Store (cubic-feet)
10.50	0
11.00	747
11.50	1,727
12.00	2,971
12.50	4,507

Device	Routing	Invert	Outlet Devices
#1	Primary	10.50'	**6.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.28 cfs @ 10.10 hrs HW=10.84' (Free Discharge)
└─**1=Orifice/Grate** (Orifice Controls 0.28 cfs @ 1.98 fps)

Summary for Pond 2P: PR2

Inflow Area = 0.769 ac, 0.00% Impervious, Inflow Depth = 1.71" for 10 YEAR event
Inflow = 0.94 cfs @ 9.95 hrs, Volume= 0.109 af
Outflow = 0.47 cfs @ 10.10 hrs, Volume= 0.109 af, Atten= 50%, Lag= 8.8 min
Primary = 0.47 cfs @ 10.10 hrs, Volume= 0.109 af

Routing by Stor-Ind method, Time Span= 5.00-29.99 hrs, dt= 0.03 hrs
Peak Elev= 11.00' @ 10.10 hrs Surf.Area= 0 sf Storage= 748 cf

Plug-Flow detention time= 49.6 min calculated for 0.109 af (99% of inflow)
Center-of-Mass det. time= 46.5 min (861.5 - 815.0)

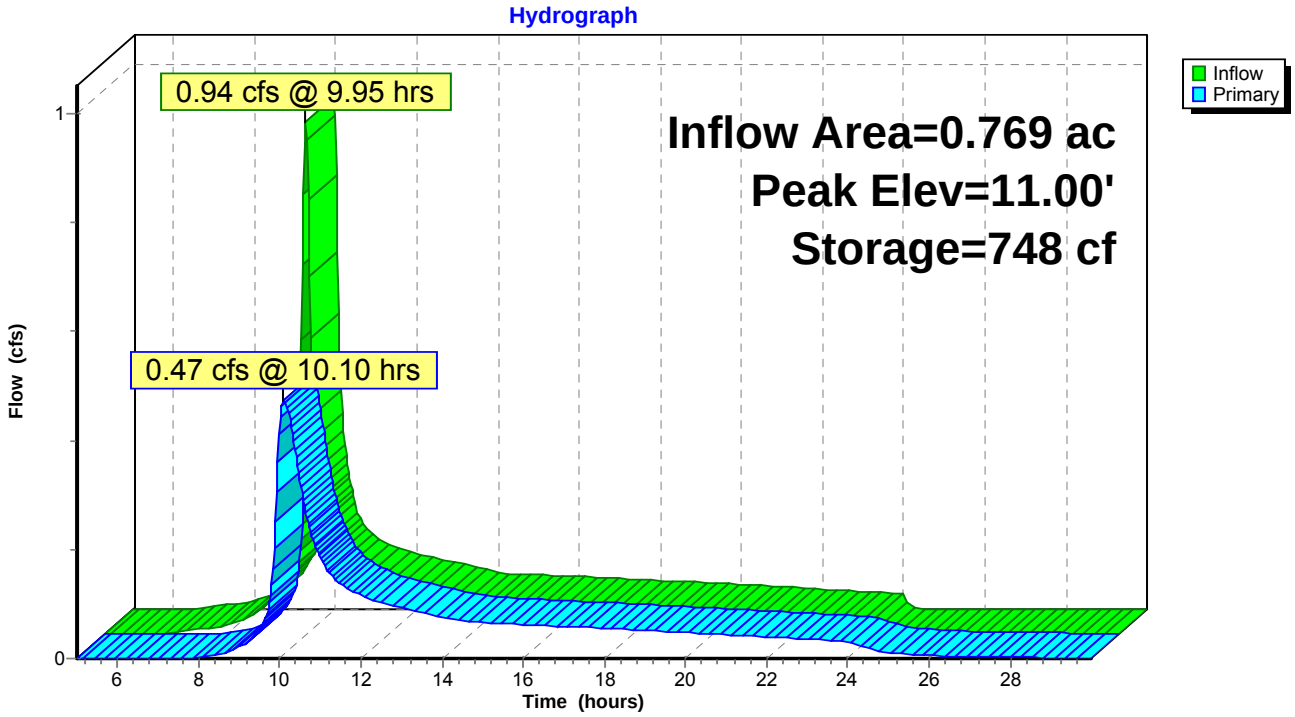
Volume	Invert	Avail.Storage	Storage Description
#1	10.50'	4,507 cf	**Custom Stage Data** Listed below

Elevation (feet)	Cum.Store (cubic-feet)
10.50	0
11.00	747
11.50	1,727
12.00	2,971
12.50	4,507

Device	Routing	Invert	Outlet Devices
#1	Primary	10.50'	**6.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.47 cfs @ 10.10 hrs HW=11.00' (Free Discharge)
└─**1=Orifice/Grate** (Orifice Controls 0.47 cfs @ 2.41 fps)

Pond 2P: PR2


Hydrograph
0.94 cfs @ 9.95 hrs
0.47 cfs @ 10.10 hrs
Inflow Area=0.769 ac
Peak Elev=11.00'
Storage=748 cf
Inflow
Primary
Flow (cfs)
1
0
6
8
10
12
14
16
18
20
22
24
26
28
Time (hours)

Summary for Pond 2P: PR2

Inflow Area = 0.769 ac, 0.00% Impervious, Inflow Depth = 2.05" for 25 YEAR event
Inflow = 1.11 cfs @ 9.95 hrs, Volume= 0.131 af
Outflow = 0.53 cfs @ 10.11 hrs, Volume= 0.131 af, Atten= 53%, Lag= 9.5 min
Primary = 0.53 cfs @ 10.11 hrs, Volume= 0.131 af

Routing by Stor-Ind method, Time Span= 5.00-29.99 hrs, dt= 0.03 hrs
Peak Elev= 11.06' @ 10.11 hrs Surf.Area= 0 sf Storage= 864 cf

Plug-Flow detention time= 46.1 min calculated for 0.131 af (100% of inflow)
Center-of-Mass det. time= 43.2 min (866.0 - 822.8)

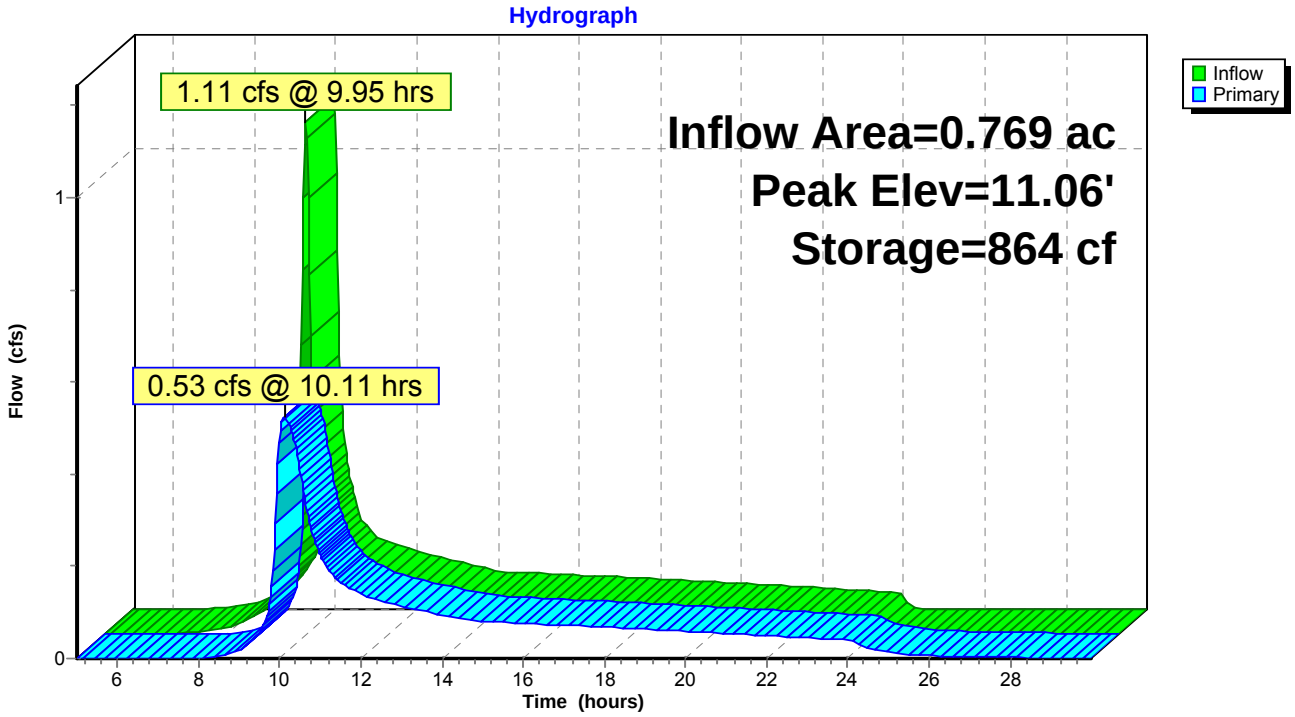
Volume	Invert	Avail.Storage	Storage Description
#1	10.50'	4,507 cf	**Custom Stage Data** Listed below

Elevation (feet)	Cum.Store (cubic-feet)
10.50	0
11.00	747
11.50	1,727
12.00	2,971
12.50	4,507

Device	Routing	Invert	Outlet Devices
#1	Primary	10.50'	**6.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.53 cfs @ 10.11 hrs HW=11.06' (Free Discharge)
└─**1=Orifice/Grate** (Orifice Controls 0.53 cfs @ 2.68 fps)

Pond 2P: PR2


Hydrograph
1.11 cfs @ 9.95 hrs
0.53 cfs @ 10.11 hrs
Inflow Area=0.769 ac
Peak Elev=11.06'
Storage=864 cf
Inflow
Primary
Flow (cfs)
0
1
6
8
10
12
14
16
18
20
22
24
26
28
Time (hours)

Summary for Pond 2P: PR2

Inflow Area = 0.769 ac, 0.00% Impervious, Inflow Depth = 2.53" for 100 YEAR event
Inflow = 1.34 cfs @ 9.95 hrs, Volume= 0.162 af
Outflow = 0.59 cfs @ 10.13 hrs, Volume= 0.161 af, Atten= 56%, Lag= 10.5 min
Primary = 0.59 cfs @ 10.13 hrs, Volume= 0.161 af

Routing by Stor-Ind method, Time Span= 5.00-29.99 hrs, dt= 0.03 hrs
Peak Elev= 11.14' @ 10.13 hrs Surf.Area= 0 sf Storage= 1,029 cf

Plug-Flow detention time= 42.0 min calculated for 0.161 af (99% of inflow)
Center-of-Mass det. time= 40.0 min (871.3 - 831.3)

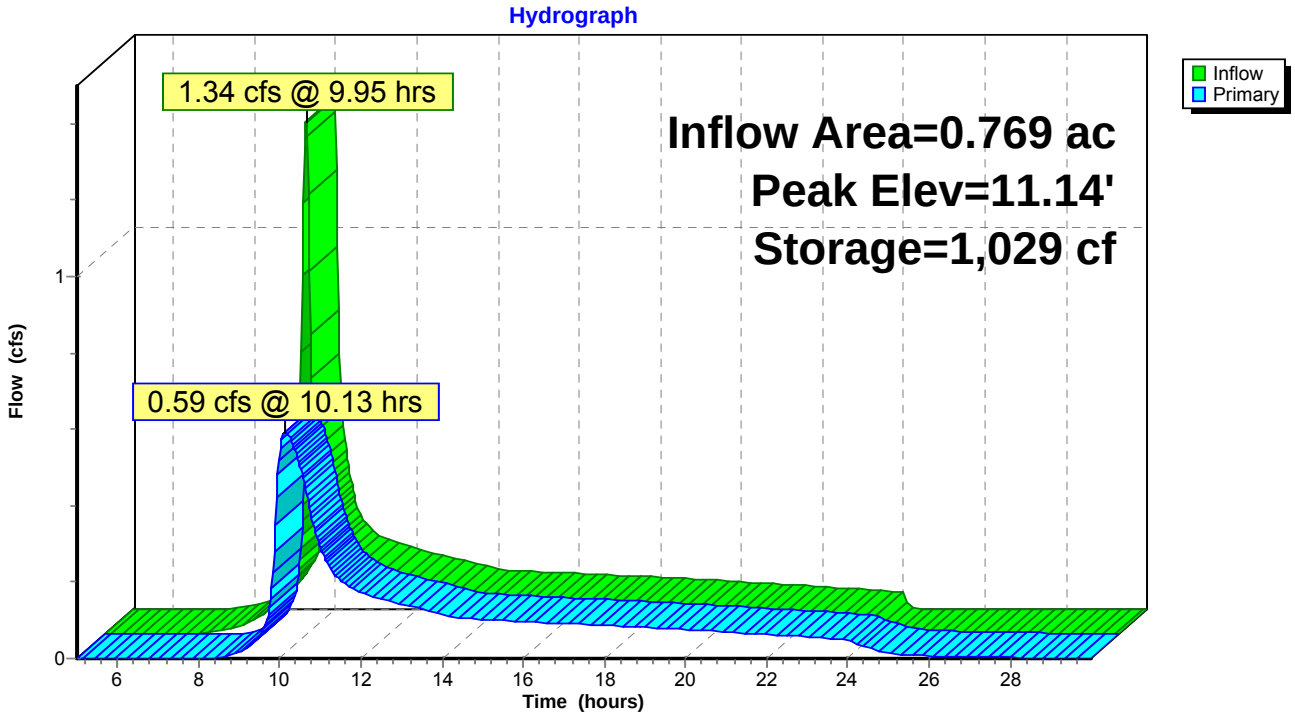
Volume	Invert	Avail.Storage	Storage Description
#1	10.50'	4,507 cf	**Custom Stage Data** Listed below

Elevation (feet)	Cum.Store (cubic-feet)
10.50	0
11.00	747
11.50	1,727
12.00	2,971
12.50	4,507

Device	Routing	Invert	Outlet Devices
#1	Primary	10.50'	**6.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.59 cfs @ 10.13 hrs HW=11.14' (Free Discharge)
└─**1=Orifice/Grate** (Orifice Controls 0.59 cfs @ 3.02 fps)

Pond 2P: PR2


Hydrograph
1.34 cfs @ 9.95 hrs
0.59 cfs @ 10.13 hrs
Inflow Area=0.769 ac
Peak Elev=11.14'
Storage=1,029 cf
Inflow
Primary
Flow (cfs)
0
1
6
8
10
12
14
16
18
20
22
24
26
28
Time (hours)

Summary for Pond 2P: PR3

Inflow Area = 0.805 ac, 0.00% Impervious, Inflow Depth = 0.91" for 2 YEAR event
Inflow = 0.51 cfs @ 9.95 hrs, Volume= 0.061 af
Outflow = 0.25 cfs @ 10.11 hrs, Volume= 0.060 af, Atten= 51%, Lag= 9.2 min
Primary = 0.25 cfs @ 10.11 hrs, Volume= 0.060 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.03 hrs
Peak Elev= 9.32' @ 10.11 hrs Surf.Area= 0 sf Storage= 440 cf

Plug-Flow detention time= 60.4 min calculated for 0.060 af (99% of inflow)
Center-of-Mass det. time= 55.7 min (879.2 - 823.5)

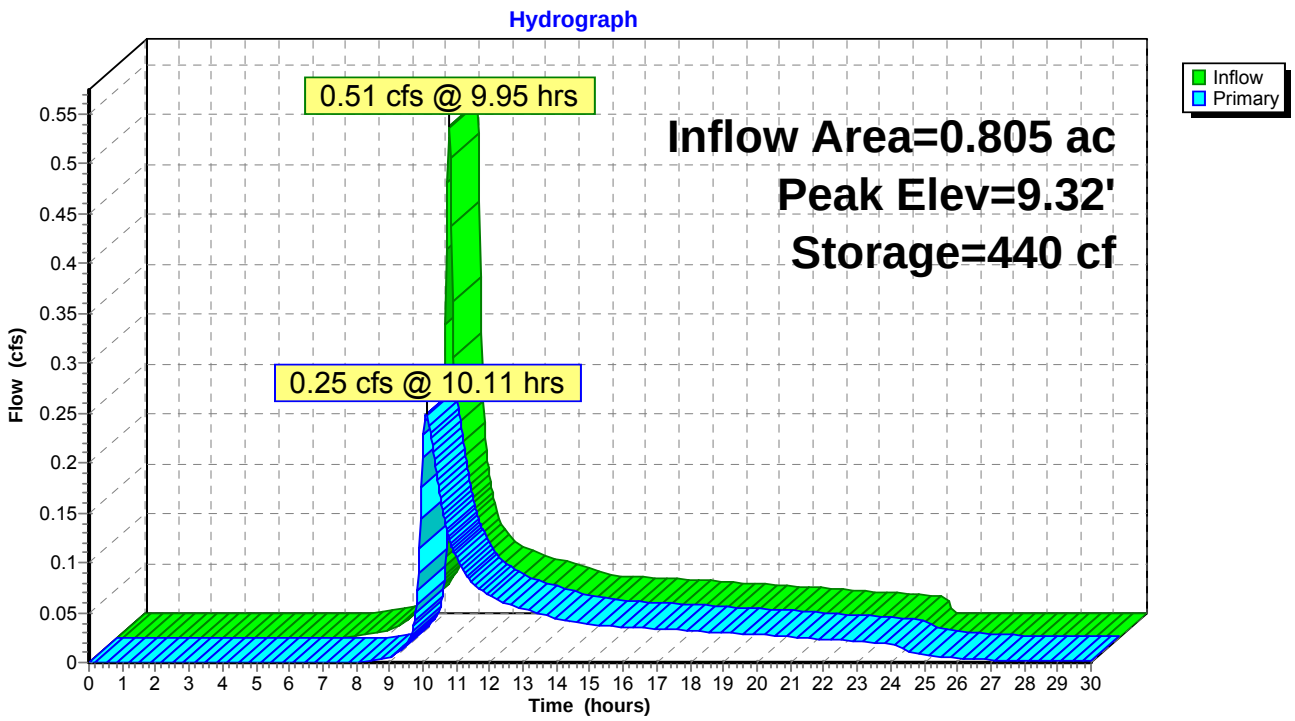
Volume	Invert	Avail.Storage	Storage Description
#1	9.00'	4,360 cf	**Custom Stage Data** Listed below

Elevation (feet)	Cum.Store (cubic-feet)
9.00	0
9.50	697
10.00	1,637
10.50	2,849
11.00	4,360

Device	Routing	Invert	Outlet Devices
#1	Primary	9.00'	**6.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.25 cfs @ 10.11 hrs HW=9.32' (Free Discharge)
└─**1=Orifice/Grate** (Orifice Controls 0.25 cfs @ 1.91 fps)

Pond 2P: PR3


Hydrograph
0.51 cfs @ 9.95 hrs
0.25 cfs @ 10.11 hrs
Inflow Area=0.805 ac
Peak Elev=9.32'
Storage=440 cf
Inflow
Primary
Flow (cfs)
Time (hours)

Summary for Pond 2P: PR3

Inflow Area = 0.805 ac, 0.00% Impervious, Inflow Depth = 1.57" for 10 YEAR event
Inflow = 0.88 cfs @ 9.95 hrs, Volume= 0.105 af
Outflow = 0.46 cfs @ 10.09 hrs, Volume= 0.104 af, Atten= 48%, Lag= 8.4 min
Primary = 0.46 cfs @ 10.09 hrs, Volume= 0.104 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.03 hrs
Peak Elev= 9.48' @ 10.09 hrs Surf.Area= 0 sf Storage= 673 cf

Plug-Flow detention time= 46.9 min calculated for 0.104 af (99% of inflow)
Center-of-Mass det. time= 44.1 min (869.0 - 824.8)

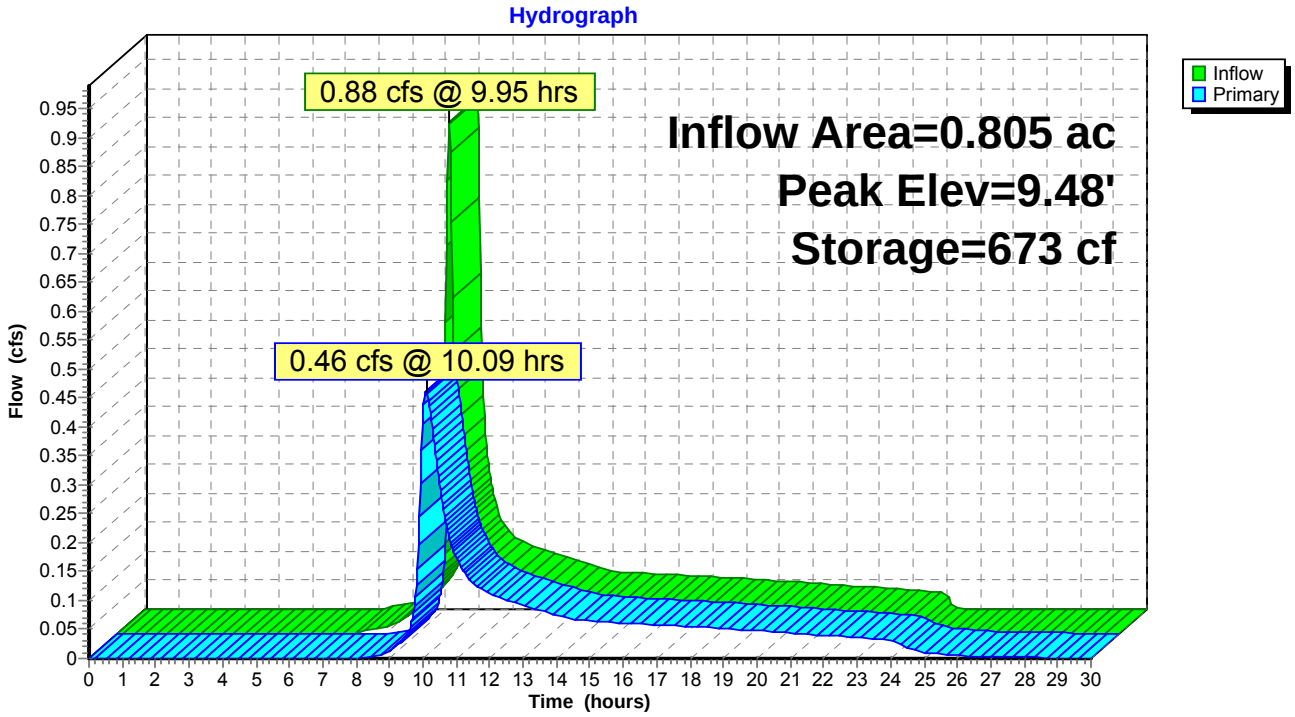
Volume	Invert	Avail.Storage	Storage Description
#1	9.00'	4,360 cf	**Custom Stage Data** Listed below

Elevation (feet)	Cum.Store (cubic-feet)
9.00	0
9.50	697
10.00	1,637
10.50	2,849
11.00	4,360

Device	Routing	Invert	Outlet Devices
#1	Primary	9.00'	**6.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.46 cfs @ 10.09 hrs HW=9.48' (Free Discharge)
└─**1=Orifice/Grate** (Orifice Controls 0.46 cfs @ 2.36 fps)

Pond 2P: PR3


Hydrograph
0.88 cfs @ 9.95 hrs
0.46 cfs @ 10.09 hrs
Inflow Area=0.805 ac
Peak Elev=9.48'
Storage=673 cf
Inflow
Primary
Flow (cfs)
Time (hours)

Summary for Subcatchment 1S: PR3

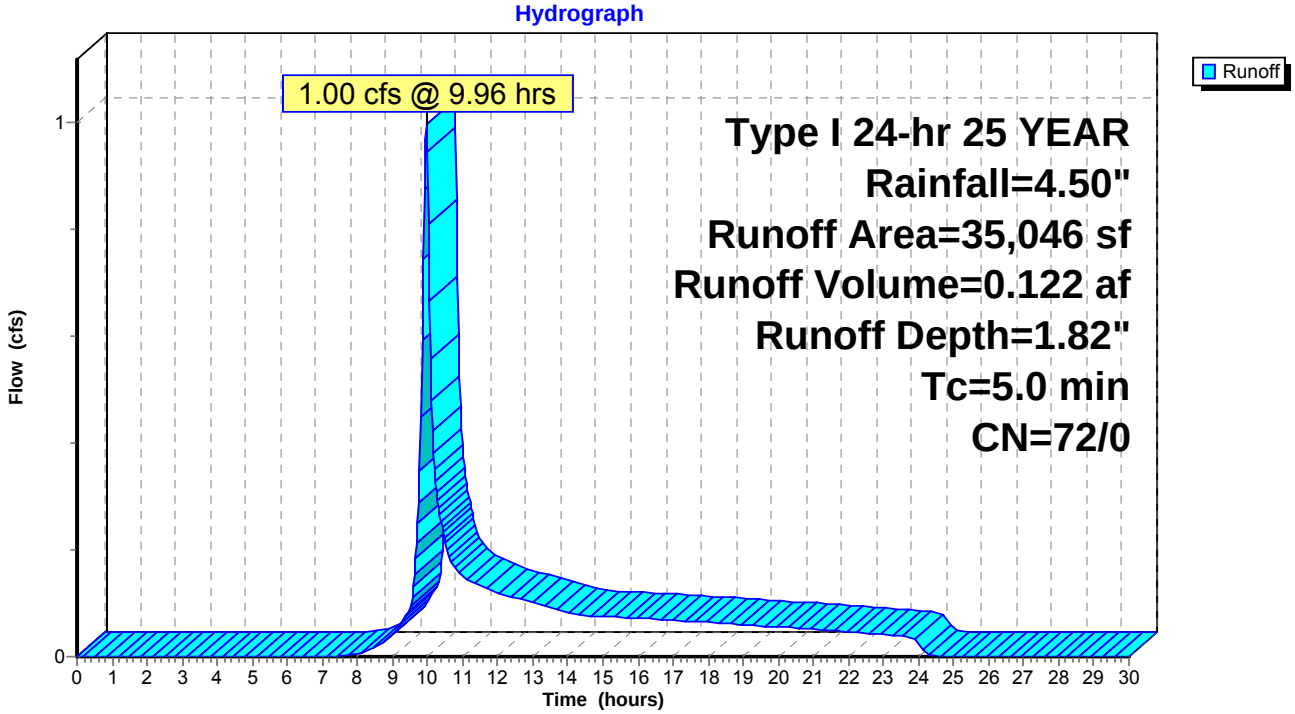
Runoff = 1.00 cfs @ 9.96 hrs, Volume= 0.122 af, Depth= 1.82"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-30.00 hrs, dt= 0.03 hrs
Type I 24-hr 25 YEAR Rainfall=4.50"

	Area (sf)	CN	Description
*	35,046	72	
	35,046	72	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.0					**Direct Entry,**
2.0	0	Total, Increased to minimum Tc = 5.0 min			

Subcatchment 1S: PR3



Summary for Pond 2P: PR3

Inflow Area = 0.805 ac, 0.00% Impervious, Inflow Depth = 2.26" for 100 YEAR event
Inflow = 1.21 cfs @ 9.96 hrs, Volume= 0.152 af
Outflow = 0.56 cfs @ 10.12 hrs, Volume= 0.151 af, Atten= 54%, Lag= 10.0 min
Primary = 0.56 cfs @ 10.12 hrs, Volume= 0.151 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.03 hrs
Peak Elev= 9.60' @ 10.12 hrs Surf.Area= 0 sf Storage= 883 cf

Plug-Flow detention time= 40.2 min calculated for 0.151 af (100% of inflow)
Center-of-Mass det. time= 38.0 min (881.1 - 843.1)

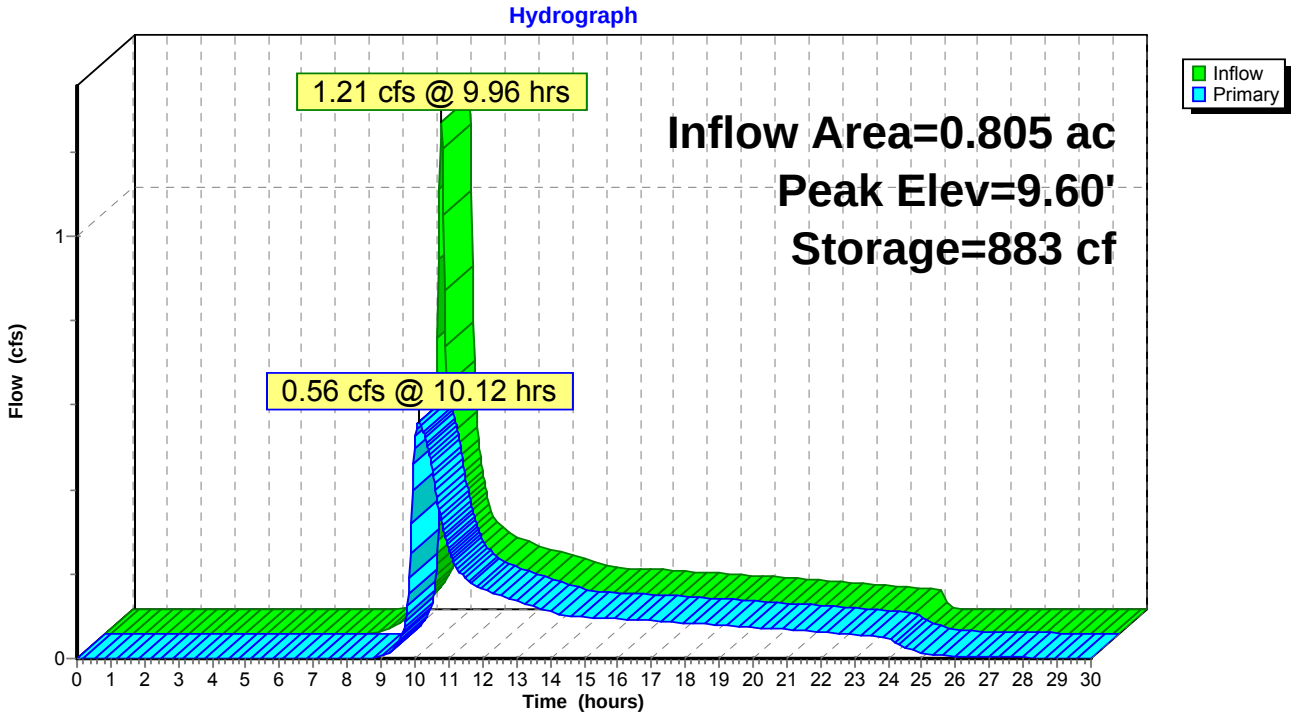
Volume	Invert	Avail.Storage	Storage Description
#1	9.00'	4,360 cf	**Custom Stage Data** Listed below

Elevation (feet)	Cum.Store (cubic-feet)
9.00	0
9.50	697
10.00	1,637
10.50	2,849
11.00	4,360

Device	Routing	Invert	Outlet Devices
#1	Primary	9.00'	**6.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.56 cfs @ 10.12 hrs HW=9.60' (Free Discharge)
└─**1=Orifice/Grate** (Orifice Controls 0.56 cfs @ 2.84 fps)

Pond 2P: PR3


Hydrograph
1.21 cfs @ 9.96 hrs
0.56 cfs @ 10.12 hrs
Inflow Area=0.805 ac
Peak Elev=9.60'
Storage=883 cf
Inflow
Primary
Flow (cfs)
Time (hours)
0
1
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

Summary for Pond 2P: PR4

Inflow Area = 1.371 ac, 0.00% Impervious, Inflow Depth = 0.80" for 2 YEAR event
Inflow = 0.74 cfs @ 9.96 hrs, Volume= 0.091 af
Outflow = 0.34 cfs @ 10.12 hrs, Volume= 0.090 af, Atten= 54%, Lag= 10.0 min
Primary = 0.34 cfs @ 10.12 hrs, Volume= 0.090 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.03 hrs
Peak Elev= 11.38' @ 10.12 hrs Surf.Area= 0 sf Storage= 617 cf

Plug-Flow detention time= 57.6 min calculated for 0.090 af (99% of inflow)
Center-of-Mass det. time= 53.3 min (890.9 - 837.6)

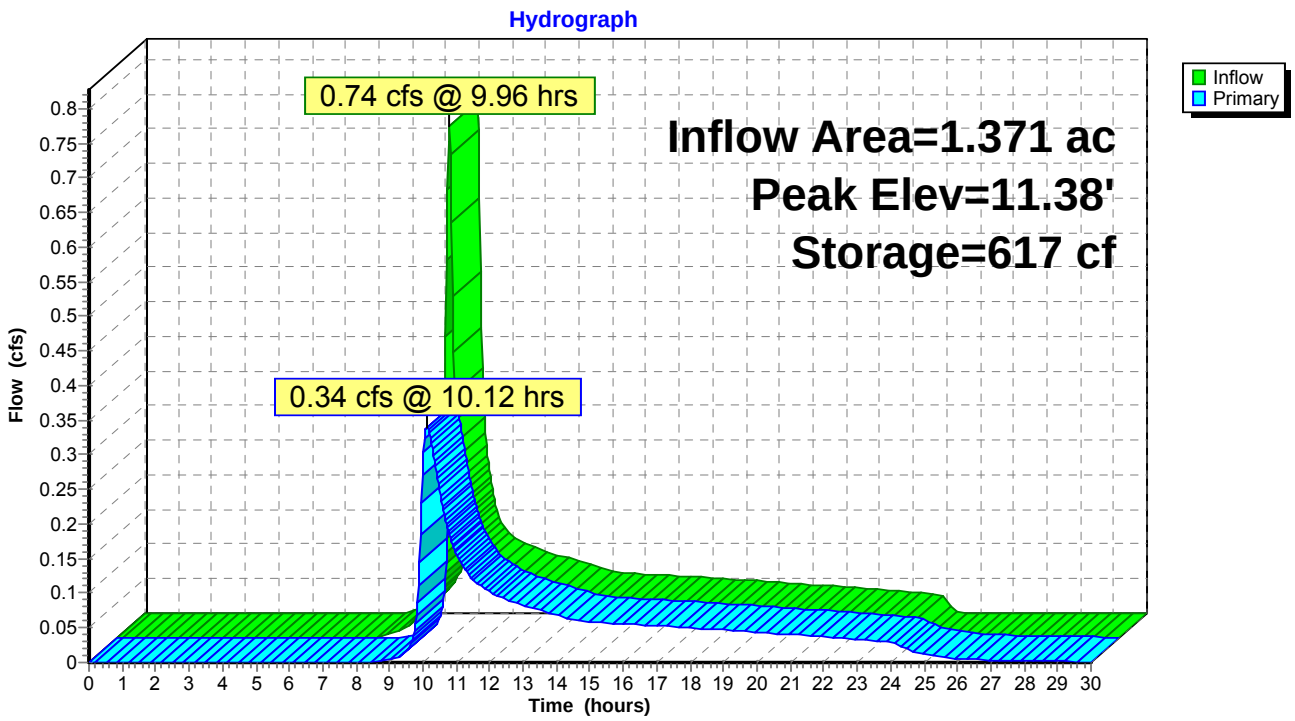
Volume	Invert	Avail.Storage	Storage Description
#1	11.00'	4,538 cf	**Custom Stage Data** Listed below

Elevation (feet)	Cum.Store (cubic-feet)
11.00	0
11.50	805
12.00	1,819
12.50	3,057
13.00	4,538

Device	Routing	Invert	Outlet Devices
#1	Primary	11.00'	**6.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.34 cfs @ 10.12 hrs HW=11.38' (Free Discharge)
└─**1=Orifice/Grate** (Orifice Controls 0.34 cfs @ 2.11 fps)

Pond 2P: PR4


Hydrograph
0.74 cfs @ 9.96 hrs
0.34 cfs @ 10.12 hrs
Inflow Area=1.371 ac
Peak Elev=11.38'
Storage=617 cf
Inflow
Primary
Flow (cfs)
Time (hours)

Summary for Pond 2P: PR4

Inflow Area = 1.371 ac, 0.00% Impervious, Inflow Depth = 1.37" for 10 YEAR event
Inflow = 1.26 cfs @ 9.96 hrs, Volume= 0.156 af
Outflow = 0.55 cfs @ 10.14 hrs, Volume= 0.155 af, Atten= 56%, Lag= 10.8 min
Primary = 0.55 cfs @ 10.14 hrs, Volume= 0.155 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.03 hrs
Peak Elev= 11.59' @ 10.14 hrs Surf.Area= 0 sf Storage= 984 cf

Plug-Flow detention time= 45.6 min calculated for 0.155 af (99% of inflow)
Center-of-Mass det. time= 43.1 min (882.7 - 839.6)

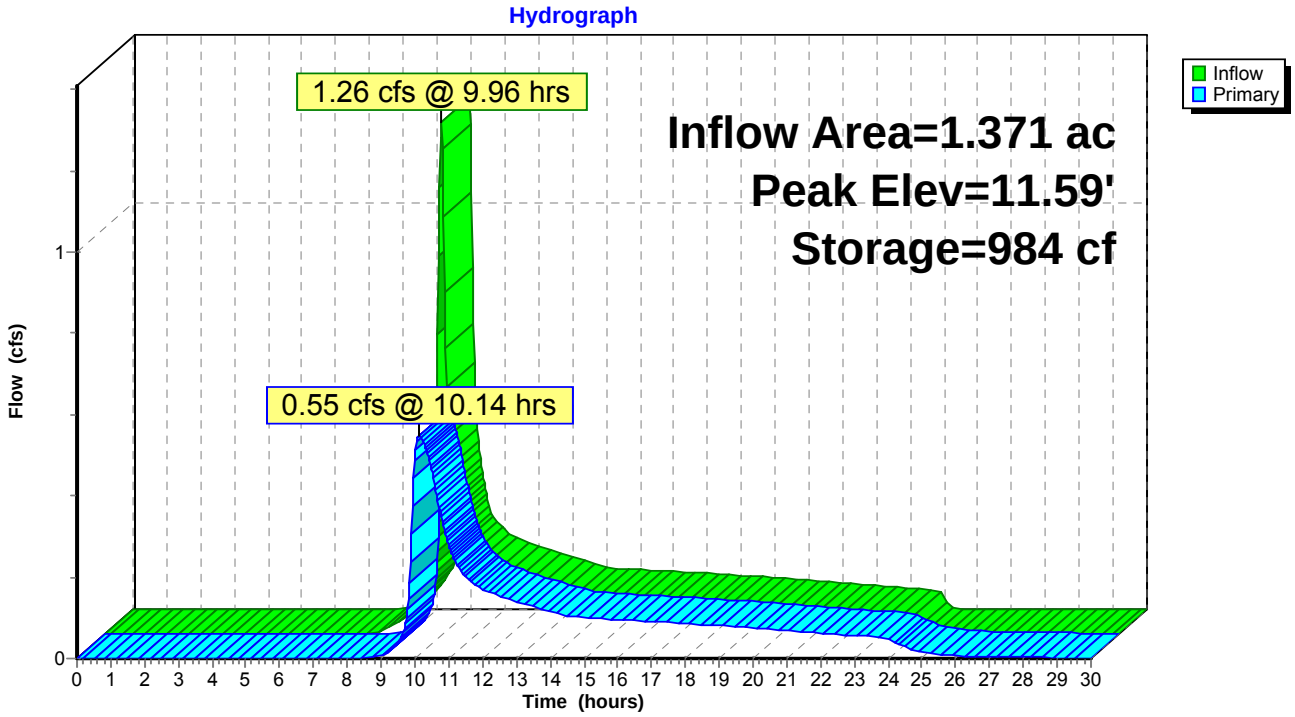
Volume	Invert	Avail.Storage	Storage Description
#1	11.00'	4,538 cf	**Custom Stage Data** Listed below

Elevation (feet)	Cum.Store (cubic-feet)
11.00	0
11.50	805
12.00	1,819
12.50	3,057
13.00	4,538

Device	Routing	Invert	Outlet Devices
#1	Primary	11.00'	**6.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.55 cfs @ 10.14 hrs HW=11.59' (Free Discharge)
└─**1=Orifice/Grate** (Orifice Controls 0.55 cfs @ 2.80 fps)

Pond 2P: PR4


Hydrograph
1.26 cfs @ 9.96 hrs
0.55 cfs @ 10.14 hrs
Inflow Area=1.371 ac
Peak Elev=11.59'
Storage=984 cf
Inflow
Primary
Flow (cfs)
Time (hours)
0
1
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

Summary for Pond 2P: PR4

Inflow Area = 1.371 ac, 0.00% Impervious, Inflow Depth = 1.53" for 25 YEAR event
Inflow = 1.35 cfs @ 9.96 hrs, Volume= 0.175 af
Outflow = 0.56 cfs @ 10.15 hrs, Volume= 0.174 af, Atten= 58%, Lag= 11.7 min
Primary = 0.56 cfs @ 10.15 hrs, Volume= 0.174 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.03 hrs
Peak Elev= 11.61' @ 10.15 hrs Surf.Area= 0 sf Storage= 1,020 cf

Plug-Flow detention time= 43.6 min calculated for 0.174 af (100% of inflow)
Center-of-Mass det. time= 41.1 min (894.7 - 853.6)

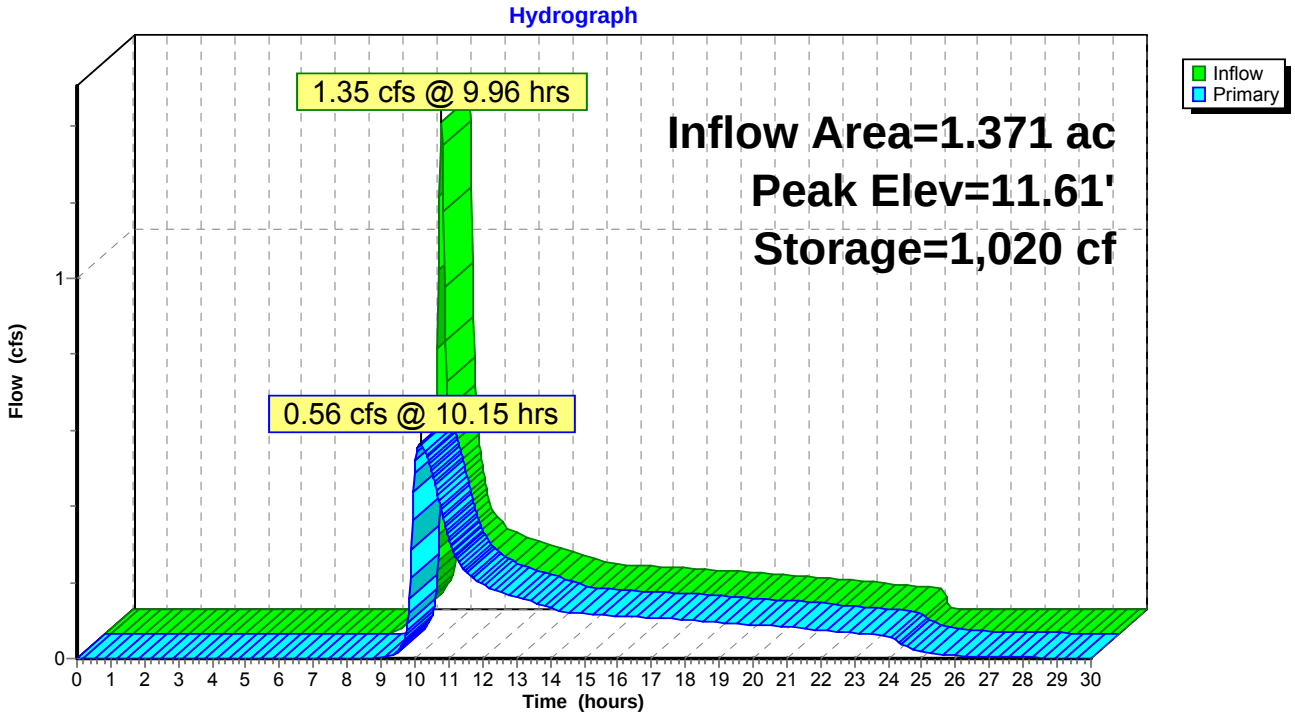
Volume	Invert	Avail.Storage	Storage Description
#1	11.00'	4,538 cf	**Custom Stage Data** Listed below

Elevation (feet)	Cum.Store (cubic-feet)
11.00	0
11.50	805
12.00	1,819
12.50	3,057
13.00	4,538

Device	Routing	Invert	Outlet Devices
#1	Primary	11.00'	**6.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.56 cfs @ 10.15 hrs HW=11.61' (Free Discharge)
└─**1=Orifice/Grate** (Orifice Controls 0.56 cfs @ 2.87 fps)

Pond 2P: PR4


Hydrograph
1.35 cfs @ 9.96 hrs
0.56 cfs @ 10.15 hrs
Inflow Area=1.371 ac
Peak Elev=11.61'
Storage=1,020 cf
Inflow
Primary
Flow (cfs)
Time (hours)
0
1
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

Summary for Pond 2P: PR4

Inflow Area = 1.371 ac, 0.00% Impervious, Inflow Depth = 2.01" for 100 YEAR event
Inflow = 1.75 cfs @ 9.96 hrs, Volume= 0.229 af
Outflow = 0.68 cfs @ 10.18 hrs, Volume= 0.228 af, Atten= 61%, Lag= 13.4 min
Primary = 0.68 cfs @ 10.18 hrs, Volume= 0.228 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.03 hrs
Peak Elev= 11.76' @ 10.18 hrs Surf.Area= 0 sf Storage= 1,334 cf

Plug-Flow detention time= 39.5 min calculated for 0.228 af (100% of inflow)
Center-of-Mass det. time= 37.9 min (893.3 - 855.5)

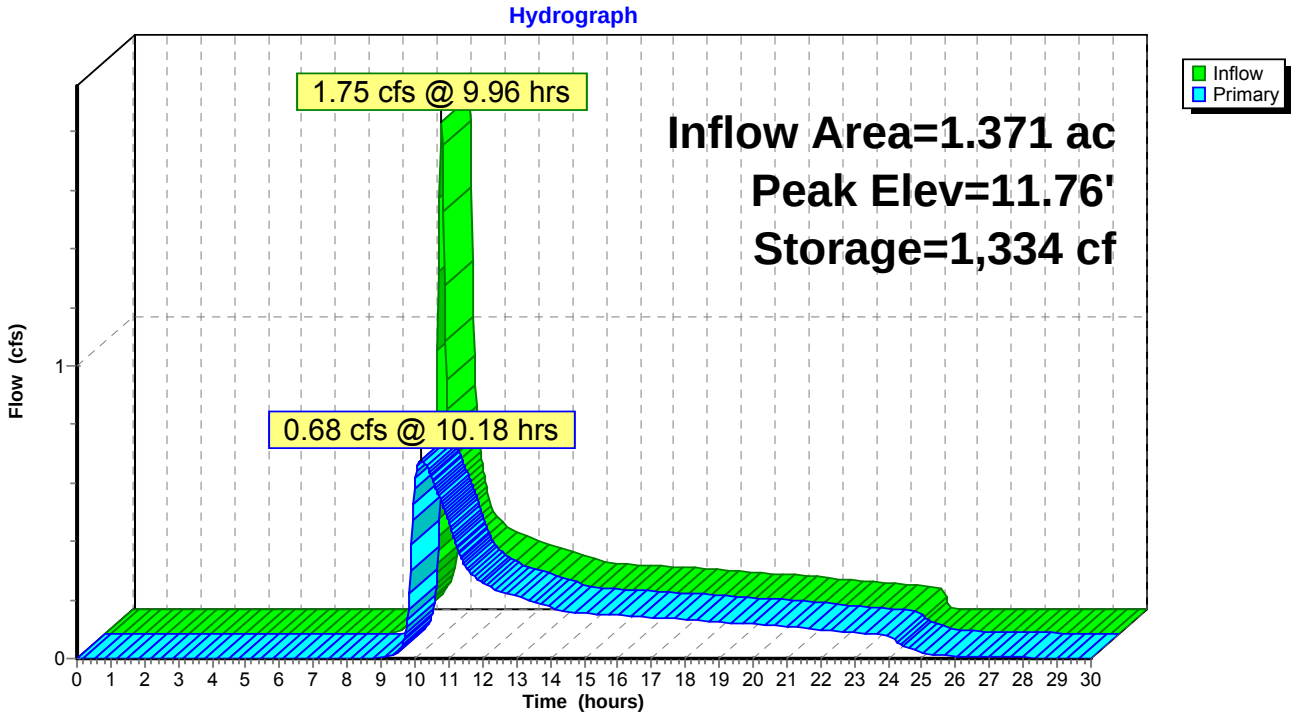
Volume	Invert	Avail.Storage	Storage Description
#1	11.00'	4,538 cf	**Custom Stage Data** Listed below

Elevation (feet)	Cum.Store (cubic-feet)
11.00	0
11.50	805
12.00	1,819
12.50	3,057
13.00	4,538

Device	Routing	Invert	Outlet Devices
#1	Primary	11.00'	**6.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.68 cfs @ 10.18 hrs HW=11.76' (Free Discharge)
└─**1=Orifice/Grate** (Orifice Controls 0.68 cfs @ 3.44 fps)

Pond 2P: PR4


Hydrograph
1.75 cfs @ 9.96 hrs
0.68 cfs @ 10.18 hrs
Inflow Area=1.371 ac
Peak Elev=11.76'
Storage=1,334 cf
Inflow
Primary
Flow (cfs)
Time (hours)

Summary for Pond 2P: PR5

Inflow Area = 0.981 ac, 0.00% Impervious, Inflow Depth = 1.09" for 2 YEAR event
Inflow = 0.79 cfs @ 9.95 hrs, Volume= 0.089 af
Outflow = 0.41 cfs @ 10.09 hrs, Volume= 0.089 af, Atten= 48%, Lag= 8.3 min
Primary = 0.41 cfs @ 10.09 hrs, Volume= 0.089 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.03 hrs
Peak Elev= 9.44' @ 10.09 hrs Surf.Area= 0 sf Storage= 654 cf

Plug-Flow detention time= 55.1 min calculated for 0.089 af (99% of inflow)
Center-of-Mass det. time= 50.9 min (852.3 - 801.3)

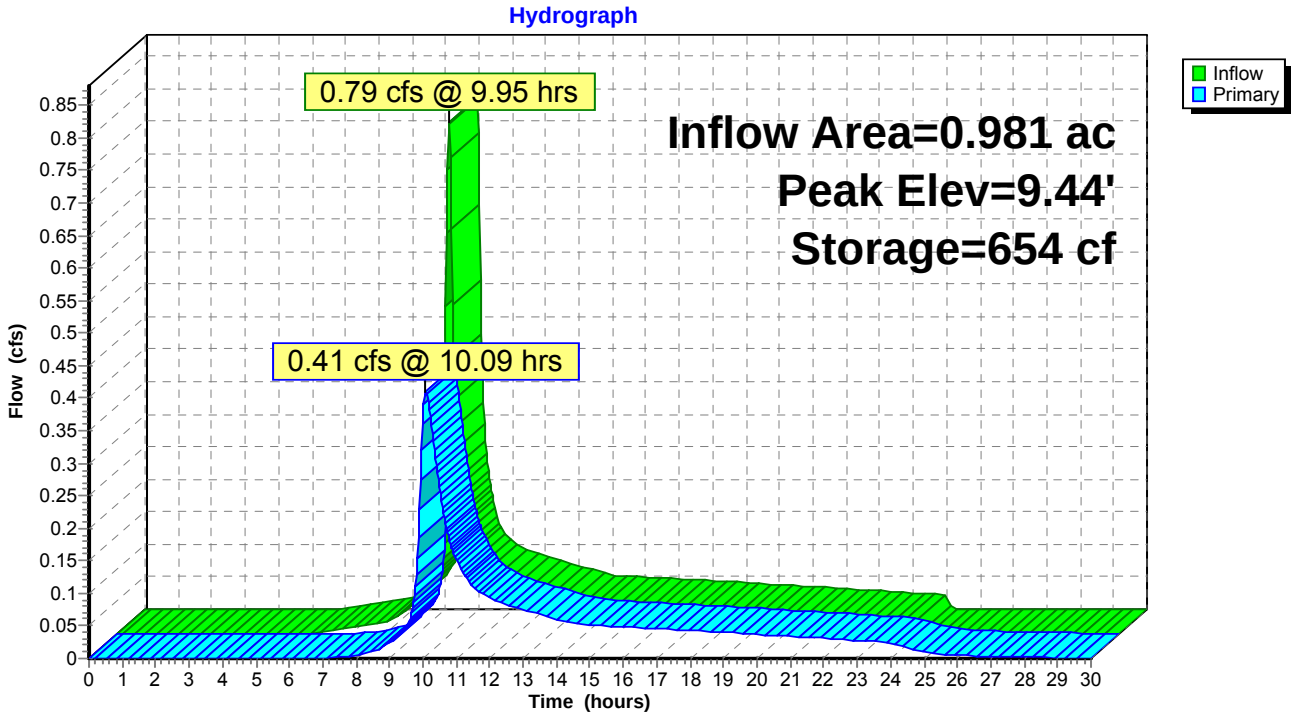
Volume	Invert	Avail.Storage	Storage Description
#1	9.00'	4,415 cf	**Custom Stage Data** Listed below

Elevation (feet)	Cum.Store (cubic-feet)
9.00	0
9.50	747
10.00	1,720
10.50	2,937
11.00	4,415

Device	Routing	Invert	Outlet Devices
#1	Primary	9.00'	**6.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.41 cfs @ 10.09 hrs HW=9.44' (Free Discharge)
└─**1=Orifice/Grate** (Orifice Controls 0.41 cfs @ 2.25 fps)

Pond 2P: PR5


Hydrograph
0.79 cfs @ 9.95 hrs
0.41 cfs @ 10.09 hrs
Inflow Area=0.981 ac
Peak Elev=9.44'
Storage=654 cf
Inflow
Primary
Flow (cfs)
Time (hours)

Summary for Pond 2P: PR5

Inflow Area = 0.981 ac, 0.00% Impervious, Inflow Depth = 1.78" for 10 YEAR event
Inflow = 1.26 cfs @ 9.95 hrs, Volume= 0.146 af
Outflow = 0.46 cfs @ 10.18 hrs, Volume= 0.145 af, Atten= 64%, Lag= 13.4 min
Primary = 0.46 cfs @ 10.18 hrs, Volume= 0.145 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.03 hrs
Peak Elev= 9.70' @ 10.18 hrs Surf.Area= 0 sf Storage= 1,128 cf

Plug-Flow detention time= 49.8 min calculated for 0.145 af (99% of inflow)
Center-of-Mass det. time= 47.1 min (857.1 - 810.0)

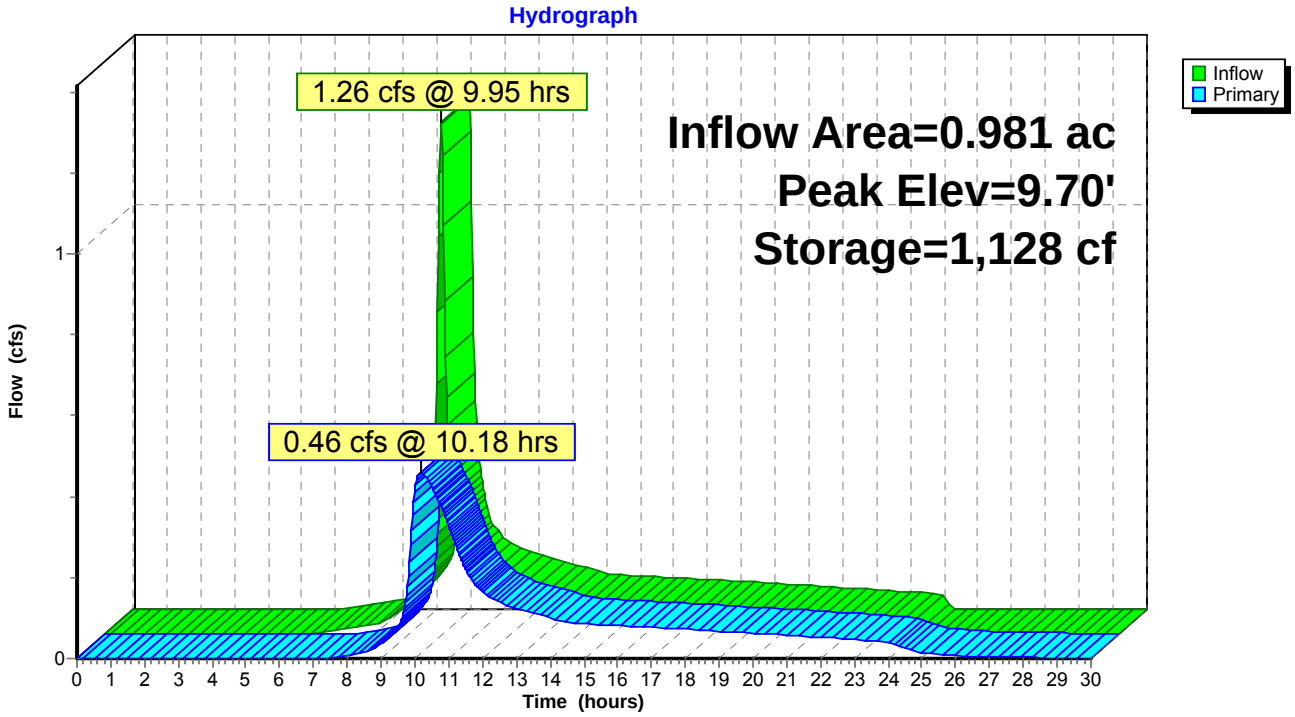
Volume	Invert	Avail.Storage	Storage Description
#1	9.00'	4,415 cf	**Custom Stage Data** Listed below

Elevation (feet)	Cum.Store (cubic-feet)
9.00	0
9.50	747
10.00	1,720
10.50	2,937
11.00	4,415

Device	Routing	Invert	Outlet Devices
#1	Primary	9.00'	**5.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.46 cfs @ 10.18 hrs HW=9.70' (Free Discharge)
└─**1=Orifice/Grate** (Orifice Controls 0.46 cfs @ 3.36 fps)

Pond 2P: PR5


Hydrograph
1.26 cfs @ 9.95 hrs
0.46 cfs @ 10.18 hrs
Inflow Area=0.981 ac
Peak Elev=9.70'
Storage=1,128 cf
Inflow
Primary
Flow (cfs)
Time (hours)

Summary for Pond 2P: PR5

Inflow Area = 0.981 ac, 0.00% Impervious, Inflow Depth = 2.05" for 25 YEAR event
Inflow = 1.42 cfs @ 9.95 hrs, Volume= 0.168 af
Outflow = 0.49 cfs @ 10.20 hrs, Volume= 0.167 af, Atten= 66%, Lag= 14.8 min
Primary = 0.49 cfs @ 10.20 hrs, Volume= 0.167 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.03 hrs
Peak Elev= 9.76' @ 10.20 hrs Surf.Area= 0 sf Storage= 1,254 cf

Plug-Flow detention time= 47.4 min calculated for 0.167 af (99% of inflow)
Center-of-Mass det. time= 45.2 min (868.0 - 822.8)

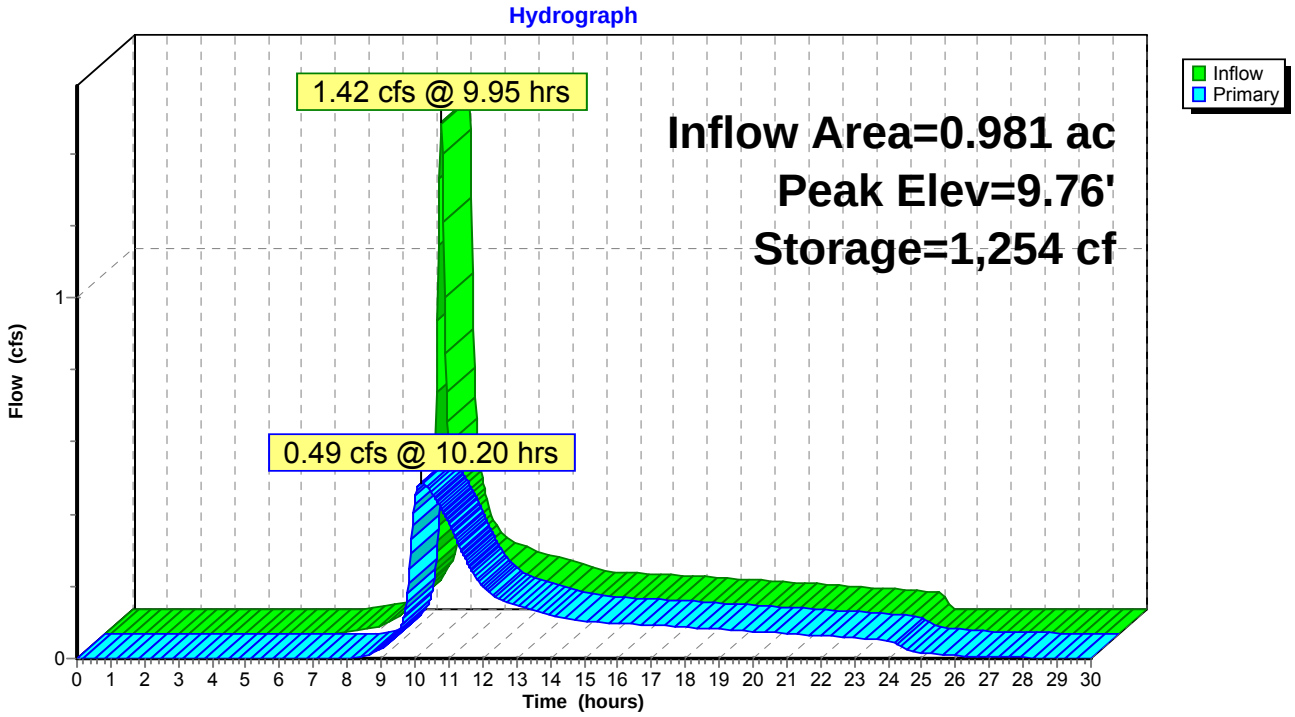
Volume	Invert	Avail.Storage	Storage Description
#1	9.00'	4,415 cf	**Custom Stage Data** Listed below

Elevation (feet)	Cum.Store (cubic-feet)
9.00	0
9.50	747
10.00	1,720
10.50	2,937
11.00	4,415

Device	Routing	Invert	Outlet Devices
#1	Primary	9.00'	**5.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.49 cfs @ 10.20 hrs HW=9.76' (Free Discharge)
└─**1=Orifice/Grate** (Orifice Controls 0.49 cfs @ 3.58 fps)

Pond 2P: PR5


Hydrograph
1.42 cfs @ 9.95 hrs
0.49 cfs @ 10.20 hrs
Inflow Area=0.981 ac
Peak Elev=9.76'
Storage=1,254 cf
Inflow
Primary
Flow (cfs)
Time (hours)

Summary for Pond 2P: PR5

Inflow Area = 0.981 ac, 0.00% Impervious, Inflow Depth = 2.62" for 100 YEAR event
Inflow = 1.79 cfs @ 9.95 hrs, Volume= 0.214 af
Outflow = 0.56 cfs @ 10.24 hrs, Volume= 0.214 af, Atten= 69%, Lag= 17.3 min
Primary = 0.56 cfs @ 10.24 hrs, Volume= 0.214 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.03 hrs
Peak Elev= 9.94' @ 10.24 hrs Surf.Area= 0 sf Storage= 1,609 cf

Plug-Flow detention time= 45.5 min calculated for 0.214 af (100% of inflow)
Center-of-Mass det. time= 43.5 min (870.9 - 827.5)

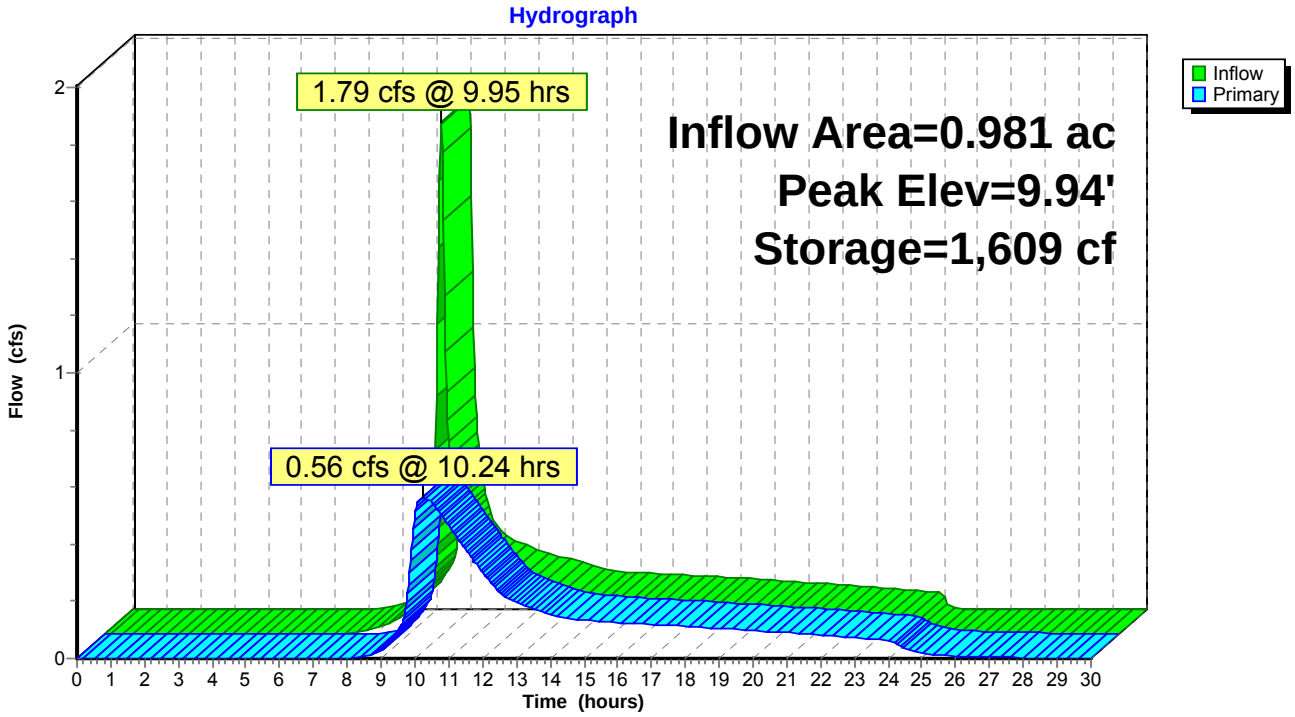
Volume	Invert	Avail.Storage	Storage Description
#1	9.00'	4,415 cf	**Custom Stage Data** Listed below

Elevation (feet)	Cum.Store (cubic-feet)
9.00	0
9.50	747
10.00	1,720
10.50	2,937
11.00	4,415

Device	Routing	Invert	Outlet Devices
#1	Primary	9.00'	**5.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.56 cfs @ 10.24 hrs HW=9.94' (Free Discharge)
└─**1=Orifice/Grate** (Orifice Controls 0.56 cfs @ 4.13 fps)

Pond 2P: PR5


Hydrograph
1.79 cfs @ 9.95 hrs
0.56 cfs @ 10.24 hrs
Inflow Area=0.981 ac
Peak Elev=9.94'
Storage=1,609 cf
Inflow
Primary
Flow (cfs)
Time (hours)

ATTACHMENT 6

HYDRAULIC CALCULATIONS

Worksheet for SD-1

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00500	ft/ft
Diameter	1.00	ft
Discharge	1.79	ft^3/s

Results

Normal Depth	0.62	ft
Flow Area	0.51	ft^2
Wetted Perimeter	1.82	ft
Hydraulic Radius	0.28	ft
Top Width	0.97	ft
Critical Depth	0.57	ft
Percent Full	62.3	%
Critical Slope	0.00657	ft/ft
Velocity	3.48	ft/s
Velocity Head	0.19	ft
Specific Energy	0.81	ft
Froude Number	0.84	
Maximum Discharge	2.71	ft^3/s
Discharge Full	2.52	ft^3/s
Slope Full	0.00252	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	62.29	%
Downstream Velocity	Infinity	ft/s

Worksheet for SD-1

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	0.62	ft
Critical Depth	0.57	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.00657	ft/ft

Worksheet for SD-2

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00500	ft/ft
Diameter	1.50	ft
Discharge	4.77	ft^3/s

Results

Normal Depth	0.87	ft
Flow Area	1.07	ft^2
Wetted Perimeter	2.61	ft
Hydraulic Radius	0.41	ft
Top Width	1.48	ft
Critical Depth	0.84	ft
Percent Full	58.3	%
Critical Slope	0.00568	ft/ft
Velocity	4.46	ft/s
Velocity Head	0.31	ft
Specific Energy	1.18	ft
Froude Number	0.93	
Maximum Discharge	7.99	ft^3/s
Discharge Full	7.43	ft^3/s
Slope Full	0.00206	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	58.28	%
Downstream Velocity	Infinity	ft/s

Worksheet for SD-2

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	0.87	ft
Critical Depth	0.84	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.00568	ft/ft

Worksheet for SD-3

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00500	ft/ft
Diameter	1.50	ft
Discharge	4.77	ft^3/s

Results

Normal Depth	0.87	ft
Flow Area	1.07	ft^2
Wetted Perimeter	2.61	ft
Hydraulic Radius	0.41	ft
Top Width	1.48	ft
Critical Depth	0.84	ft
Percent Full	58.3	%
Critical Slope	0.00568	ft/ft
Velocity	4.46	ft/s
Velocity Head	0.31	ft
Specific Energy	1.18	ft
Froude Number	0.93	
Maximum Discharge	7.99	ft^3/s
Discharge Full	7.43	ft^3/s
Slope Full	0.00206	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	58.28	%
Downstream Velocity	Infinity	ft/s

Worksheet for SD-3

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	0.87	ft
Critical Depth	0.84	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.00568	ft/ft

Worksheet for SD-4

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00500	ft/ft
Diameter	1.50	ft
Discharge	4.77	ft^3/s

Results

Normal Depth	0.87	ft
Flow Area	1.07	ft^2
Wetted Perimeter	2.61	ft
Hydraulic Radius	0.41	ft
Top Width	1.48	ft
Critical Depth	0.84	ft
Percent Full	58.3	%
Critical Slope	0.00568	ft/ft
Velocity	4.46	ft/s
Velocity Head	0.31	ft
Specific Energy	1.18	ft
Froude Number	0.93	
Maximum Discharge	7.99	ft^3/s
Discharge Full	7.43	ft^3/s
Slope Full	0.00206	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	58.28	%
Downstream Velocity	Infinity	ft/s

Worksheet for SD-4

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	0.87	ft
Critical Depth	0.84	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.00568	ft/ft

Worksheet for SD-5

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00500	ft/ft
Diameter	1.50	ft
Discharge	8.36	ft^3/s

Results

Normal Depth	0.87	ft
Flow Area	1.07	ft^2
Wetted Perimeter	2.61	ft
Hydraulic Radius	0.41	ft
Top Width	1.48	ft
Critical Depth	0.84	ft
Percent Full	58.3	%
Critical Slope	0.00568	ft/ft
Velocity	4.46	ft/s
Velocity Head	0.31	ft
Specific Energy	1.18	ft
Froude Number	0.93	
Maximum Discharge	7.99	ft^3/s
Discharge Full	7.43	ft^3/s
Slope Full	0.00206	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	58.28	%
Downstream Velocity	Infinity	ft/s

Worksheet for SD-5

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	0.87	ft
Critical Depth	0.84	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.00568	ft/ft

Worksheet for SD-6

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00500	ft/ft
Diameter	1.00	ft
Discharge	1.71	ft^3/s

Results

Normal Depth	0.60	ft
Flow Area	0.50	ft^2
Wetted Perimeter	1.78	ft
Hydraulic Radius	0.28	ft
Top Width	0.98	ft
Critical Depth	0.56	ft
Percent Full	60.4	%
Critical Slope	0.00648	ft/ft
Velocity	3.45	ft/s
Velocity Head	0.18	ft
Specific Energy	0.79	ft
Froude Number	0.85	
Maximum Discharge	2.71	ft^3/s
Discharge Full	2.52	ft^3/s
Slope Full	0.00230	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	60.41	%
Downstream Velocity	Infinity	ft/s

Worksheet for SD-6

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	0.60	ft
Critical Depth	0.56	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.00648	ft/ft

Worksheet for SD-7

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00500	ft/ft
Diameter	1.00	ft
Discharge	1.33	ft^3/s

Results

Normal Depth	0.52	ft
Flow Area	0.41	ft^2
Wetted Perimeter	1.60	ft
Hydraulic Radius	0.26	ft
Top Width	1.00	ft
Critical Depth	0.49	ft
Percent Full	51.6	%
Critical Slope	0.00608	ft/ft
Velocity	3.25	ft/s
Velocity Head	0.16	ft
Specific Energy	0.68	ft
Froude Number	0.90	
Maximum Discharge	2.71	ft^3/s
Discharge Full	2.52	ft^3/s
Slope Full	0.00139	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	51.64	%
Downstream Velocity	Infinity	ft/s

Worksheet for SD-7

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	0.52	ft
Critical Depth	0.49	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.00608	ft/ft

Worksheet for SD-8

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.01000	ft/ft
Diameter	1.00	ft
Discharge	3.57	ft^3/s

Results

Normal Depth	0.82	ft
Flow Area	0.69	ft^2
Wetted Perimeter	2.27	ft
Hydraulic Radius	0.30	ft
Top Width	0.77	ft
Critical Depth	0.81	ft
Percent Full	82.2	%
Critical Slope	0.01034	ft/ft
Velocity	5.17	ft/s
Velocity Head	0.42	ft
Specific Energy	1.24	ft
Froude Number	0.96	
Maximum Discharge	3.83	ft^3/s
Discharge Full	3.56	ft^3/s
Slope Full	0.01004	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	82.15	%
Downstream Velocity	Infinity	ft/s

Worksheet for SD-8

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	0.82	ft
Critical Depth	0.81	ft
Channel Slope	0.01000	ft/ft
Critical Slope	0.01034	ft/ft

Worksheet for SD-9

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.01000	ft/ft
Diameter	1.00	ft
Discharge	3.03	ft^3/s

Results

Normal Depth	0.71	ft
Flow Area	0.60	ft^2
Wetted Perimeter	2.00	ft
Hydraulic Radius	0.30	ft
Top Width	0.91	ft
Critical Depth	0.75	ft
Percent Full	70.9	%
Critical Slope	0.00880	ft/ft
Velocity	5.09	ft/s
Velocity Head	0.40	ft
Specific Energy	1.11	ft
Froude Number	1.11	
Maximum Discharge	3.83	ft^3/s
Discharge Full	3.56	ft^3/s
Slope Full	0.00723	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	70.87	%
Downstream Velocity	Infinity	ft/s

Worksheet for SD-9

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	0.71	ft
Critical Depth	0.75	ft
Channel Slope	0.01000	ft/ft
Critical Slope	0.00880	ft/ft

Worksheet for SD-10

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.01000	ft/ft
Diameter	1.00	ft
Discharge	2.62	ft^3/s

Results

Normal Depth	0.64	ft
Flow Area	0.53	ft^2
Wetted Perimeter	1.85	ft
Hydraulic Radius	0.29	ft
Top Width	0.96	ft
Critical Depth	0.69	ft
Percent Full	63.8	%
Critical Slope	0.00790	ft/ft
Velocity	4.96	ft/s
Velocity Head	0.38	ft
Specific Energy	1.02	ft
Froude Number	1.18	
Maximum Discharge	3.83	ft^3/s
Discharge Full	3.56	ft^3/s
Slope Full	0.00541	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	63.76	%
Downstream Velocity	Infinity	ft/s

Worksheet for SD-10

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	0.64	ft
Critical Depth	0.69	ft
Channel Slope	0.01000	ft/ft
Critical Slope	0.00790	ft/ft

ATTACHMENT 7

WATER QUALITY CALCULATIONS

ENGINEERING CALCULATIONS FOR BMP VOLUME BASED TREATMENT SIZING

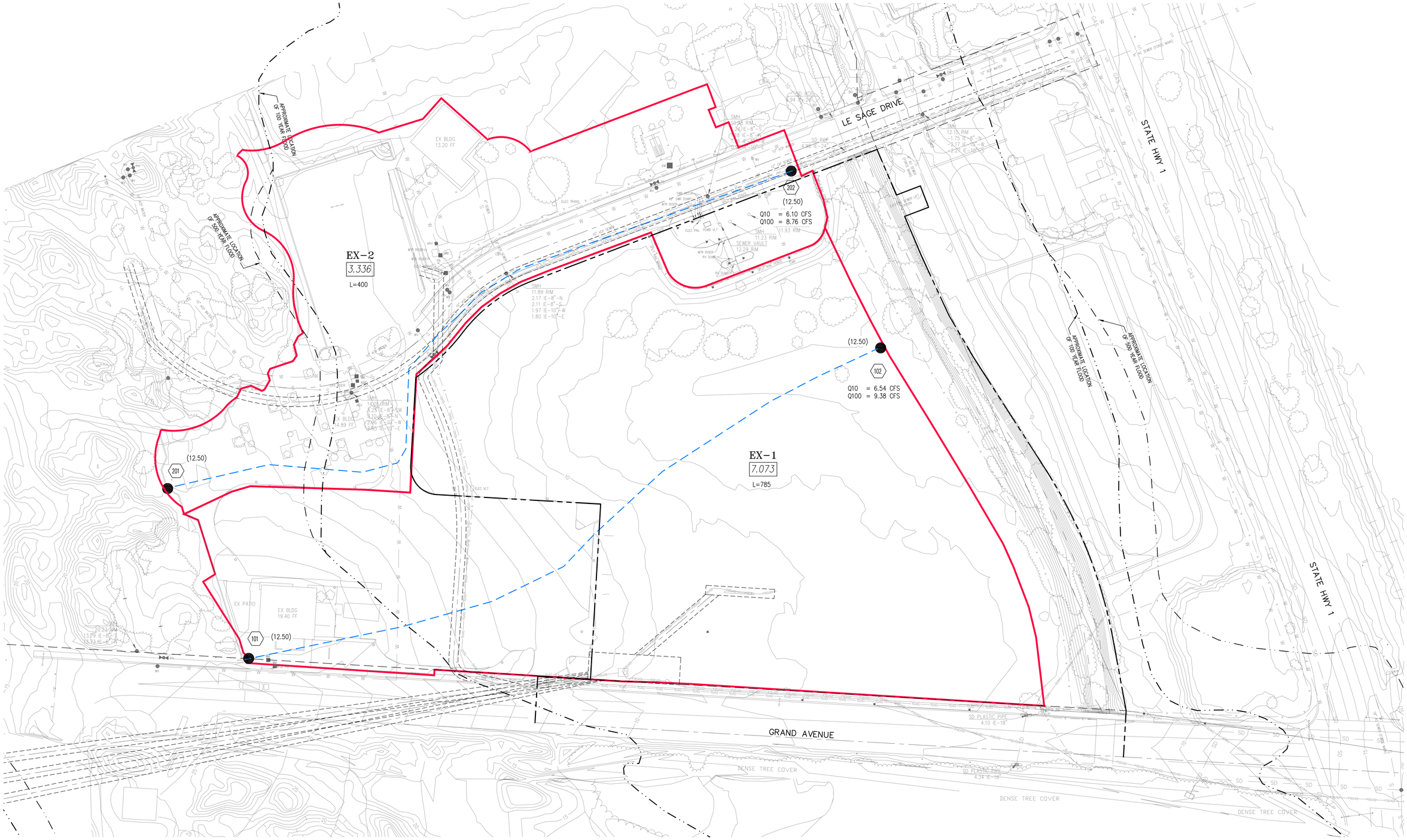
Basin Number	Total Area Acres	Percent Impervious	C wqrt	V wqrt CF	BMP Proposed
PR-1A	0.733	51.72%	0.35	1,098	Bio-retention basin/detention basin
PR-1B	0.835	55.06%	0.37	1,332	Bio-retention basin/detention basin
PR-2	0.769	40.51%	0.28	929	Bio-retention basin/detention basin
PR-3	0.805	32.06%	0.24	813	Bio-retention basin/detention basin
PR-4	1.371	22.32%	0.18	1,076	Bio-retention basin/detention basin
PR-5	0.981	28.03%	0.21	900	Bio-retention basin, porous pavement
PR-6	0.995	65.98%	0.46	1,947	Bio-retention basin, porous pavement
PR-7	1.226	61.89%	0.42	2,220	Bio-retention basin, porous pavement
PR-8	2.694	75.45%	0.55	6,317	Bio-retention basin, porous pavement

Note: all basins are designed to the above volumes

Source: Urban Runoff Quality Management, WEF Manual of Practice No. 23
ASCE Manual and Report on Engineering Practice No. 87, ASCE 1998.

ATTACHMENT 8

HYDROLOGY MAP – EXISTING CONDITIONS



GRAPHIC SCALE

40 0 20 40 80 160

1 inch = 40 ft.

LEGEND

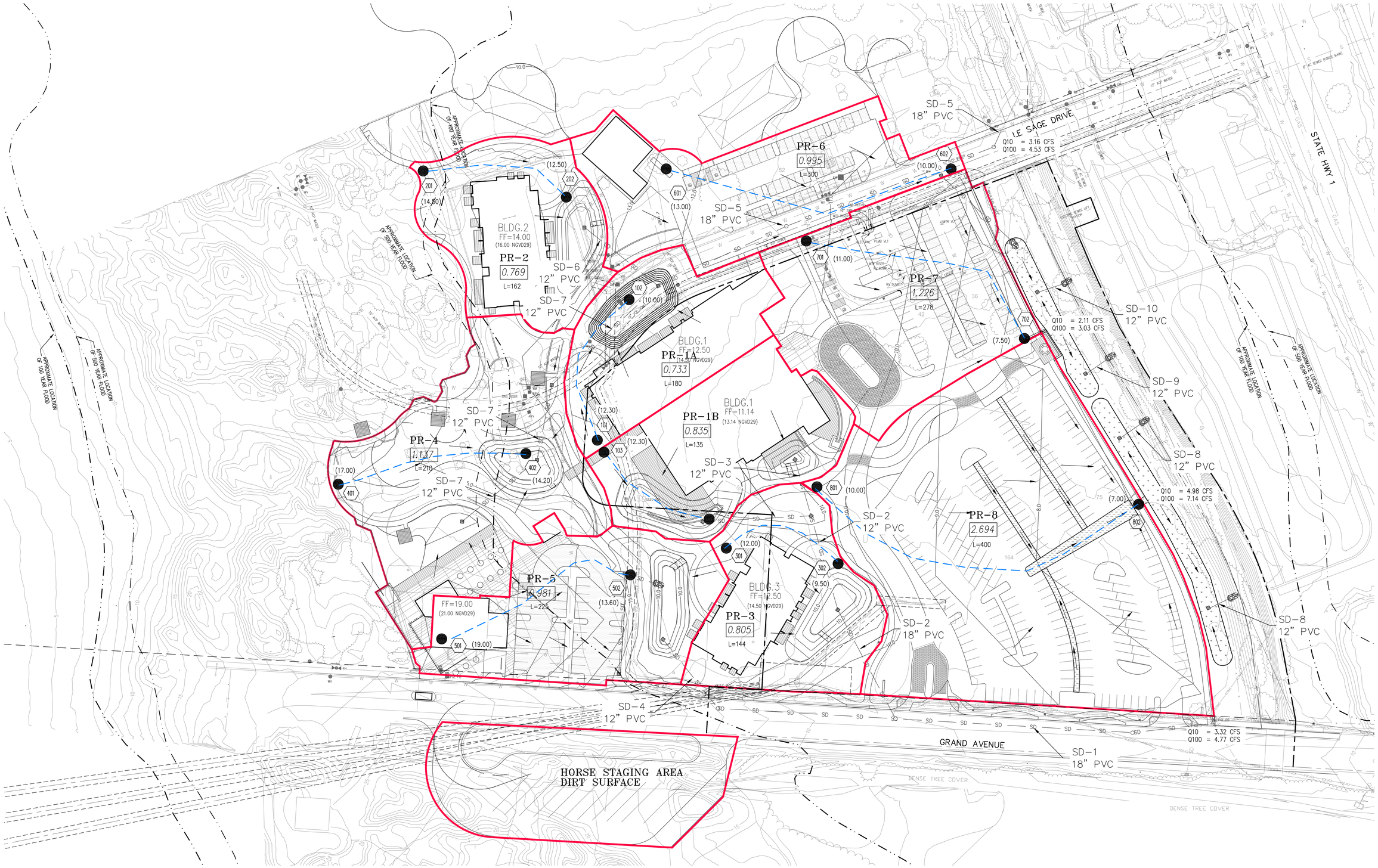
10	EXISTING CONTOUR (MAJOR)
	EXISTING CONTOUR (MINOR)
	HYDROLOGIC BASIN BOUNDARY
	HYDROLOGIC FLOW PATH
EX-1	BASIN NUMBER
0.63	AREA (ACRES)
101	NODE NUMBER
(12.00)	ELEVATION (FEET)

EXISTING HYDROLOGIC CONDITIONS

CONSTRUCTION TESTING & ENGINEERING, INC.
PLANNING · CIVIL ENGINEERING · LAND SURVEYING · GEOTECHNICAL
1441 MONTIEL ROAD, SUITE 115 ESCONDIDO CA. 92026, PH:(760) 746-4955

ATTACHMENT 9

HYDROLOGY MAP – PROPOSED CONDITIONS



GRAPHIC SCALE

40 0 20 40 80 160

1 inch = 40 ft.

LEGEND

10	EXISTING CONTOUR (MAJOR)
	EXISTING CONTOUR (MINOR)
	HYDROLOGIC BASIN BOUNDARY
	HYDROLOGIC FLOW PATH
PR-1	BASIN NUMBER
0.63	AREA (ACRES)
101	NODE NUMBER
(12.00)	ELEVATION (FEET)

PROPOSED HYDROLOGIC CONDITIONS

CONSTRUCTION TESTING & ENGINEERING, INC.
PLANNING · CIVIL ENGINEERING · LAND SURVEYING · GEOTECHNICAL
1441 MONTIEL ROAD, SUITE 115 ESCONDIDO CA. 92026, PH:(760) 746-4955